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Towards A Sustainable Use of Water at Home: Understanding How Much, Where and Why?

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Abstract

This paper presents the findings which have arisen from a literature review carried out at the beginning of a three year CONACYT sponsored PhD project, investigating water-related activities in the home and the growing need to understand user behaviour when consuming water. It illustrates how habits and routines emerge and develop. It then considers how perceptions of consumption and hygiene influence domestic water use, reflecting on how social, psychological and technological aspects influence domestic water use. The paper concludes by identifying a number of research questions which will be investigated through the remainder of the project.

Keywords: Water consumption, Household, User behaviour

1. Introduction

Clean, unpolluted water is essential to all kinds of life, and even though it is considered a renewable resource, pollution and over-usage are threatening the world supplies of this precious liquid. In many regions of the world groundwater has been extracted at a rate that exceeds natural precipitation back into the water cycle; this combined with pollution jeopardizes the availability and easy reuse of it (see Figure 1).

Water extracted from the ground has three main uses: agriculture, industry and urban consumption. While domestic water use accounts for only a low percentage of the overall use of water, it is an issue that every person can relate to –and act upon. It is therefore essential to carry out research to understand the behaviour related to water usage. Given the decreasing amount of fresh water available, making the most out of the water resources available to us should be taken as a personal goal for everyone. Consuming water sustainably should be amongst everyone's priorities: consuming responsibly, even if it means shifting one's consumption habits, and consuming less.

2. Factors behind water consumption in the home

Findings indicate that in some countries, such as the UK and USA people have, in general, a sound awareness of the environmental issues going on in the world (Barr, 2004). When enquired in surveys, they tend to respond in favour of environmental actions. Even when people express commitment or excitement about conservation plans, the actual change of behaviour/response is not evident (De Oliver, 1999; Jensen, 2008). Expressing support to conservation policies is often regarded as socially correct, it adds on to the social capital (Medd & Shove, 2005b) and it adheres to the social norms (Corral-Verdugo & Frías-Armenta, 2006). For one reason or another, this 'aesthetic' rightness struggles to go beyond the attitude into a real sustainable behaviour.

Figure 2 gives a simplified estimated view of the distribution of water consumed at home

People's choices concerning water usage are attached to many drivers apart from environmental concerns: comfort, convenience, cleanness, economy and design. According to a study carried out in Denmark, among the drivers for one's actions environmental qualities generally rank lower than the above marked ones (Jensen, 2008; Wiese, 2001). Ethnicity and religion are also two influential factors towards actions and consumption patterns, this though, has been less researched (Smith & Ali, 2006). Behavioural intentions, also referred to as attitudes, are just one of the aspects of actual behaviour. Situational and psychological circumstances also play a role and they all interrelate and act to finally produce one's actions (see Figure 3).

People, even when they feel they are responsible for their own actions (either pro or anti environmental), may assume that their actions have little or no weight on the whole global environment picture (Barr, 2004; Eden, 2000) resulting in a dismissal of the intention of behaving sustainably. This relates to Askew and McGuirk's (Askew & McGuirk, 2004) conclusions that people think about conservation in an impersonal way, disconnected to their own water practices. The sometimes inconspicuous consequences of environmentally damaging behaviours are beaten by the immediate results in comfort and convenience of many antisocial and unsustainable behaviours (Lehman & Geller, 2004). Lilley, Lofthouse *et al.* (Lilley, Lofthouse, & Bhamra, 2005) refer to the fact that people think in large scale, rather than local scale, causing them not to relate to the larger consequences of their actions, and thus behave unsustainably.

A large amount of the water consumed in the home happens in the bathroom, with showering and bathing accounting for 20-30% (Hand, Southerton, & Shove, 2003). Kitchen activities, mainly dishwashing, appear to have high water consumption. The use of dishwashers is becoming more and more common in western societies. Technologies are evolving, different sizes are being created to accommodate smaller households and prices are dropping, making such an appliance affordable to many. Some studies indicate that current electrical dishwashers are more efficient than manual dishwashing in terms of time, cleanness and water consumption (Stamminger, Elschenbroich, Rummler, & Broil, 2007); yet, surveys have shown that in the UK only 28% of the population owns a dishwasher (DEFRA, 2007).

Water consumption is usually not obvious to the eye or mind. People tend to use water unconsciously, not referring to the use of water as an activity by itself, but as a tool to accomplish other activities (Gram-Hanssen, 2008; Medd & Shove, 2005a), whether related to hygiene (brushing teeth or washing clothes) or home care (gardening or mopping the floor), for pampering and relaxation (a nice bath after a long day of work) or even as a daily practice (the morning shower to 'feel fresh and awake'). Most of the time in today's rushing life, people are not fully aware of the amounts of water consumed (Randolph & Patrick, 2008), nor in which activities they consume the most. Since water-related actions present no particular personal-significance, with the acceleration in modern life, referred by some as 'Time squeeze' (Hand *et al.*, 2003), people often opt for the most convenient solution in terms of time and ease, rather than the best solution regarding performance or environmental consequences.

Population growth and change in lifestyle are two of the many factors that contribute in the rise of water use in households. People living in individual households (DEFRA, 2006), a growing trend today, increases the water consumption per capita by up to 40%. One two-person household consumes 300 litres of water per day, whereas a single occupancy household consumes 210 litres (DEFRA, 2006; DEFRA, 2007; Memon, Ton-That, & Butler, 2007). A study by Memon, Ton-That *et al.* (Memon *et al.*, 2007) based on UK population, showed that indeed single occupancy has 'the highest consumption from taps and those with high occupancies have the lowest'.

3. Everyday practices

The majority of domestic water related activities such as laundering, washing dishes or working in the garden are often performed in time-space coordination with other activities: watching the children, rushing off for a social engagement, or trying to finish before the 3pm football match. Most of the water related actions at home are continuously performed as part of habits or routines that are more complex than one simple action. They are divided into little practices (Schatzky, 1996) that people do in 'auto-pilot' most of the time. Human behaviour is often composed of several routines and habits which are individually developed throughout time in order to feel in control.

Routines develop over time from childhood, with the influence of parents and the environment (Gram-Hanssen, 2008), evolving along with the circumstances that come along (Medd & Shove, 2005b). People stick to those routines to create a feel-safe environment (Guiddens, 1990). Krantz (Krantz, 2006) refers to this 'safe environment' as matter in place, which when disturbed changes into matter out of place (i.e. dirty dishes in sink). This triggers an action to re-establish the original state (wash and put them away). Many routines we learn and carry out without consciously thinking about them: we have a preconceived convenient technical arrangement of resources to revert the 'out of place' in short notice. People's perception of a matter out of place, along with the personal arrangement of available resources are individual and unique; while one might not mind the pile of dishes in the sink until it interferes with other activities; others might like to have the sink empty and clean at all times. That is one of the reasons for which activities are carried out at different times, with different actions in the processes.

Behavioural psychologists consider that the process of changing habits and routines into more sustainable (or unsustainable) ones happens in different stages (Pelletier, Lavergne, & Sharp, 2008): being aware of the problem, identifying the different possible solutions; choosing one and initiating a behaviour, and making the behaviour a long term habit, or in the worst case scenario, reverting to the original behaviour. Different approaches must be taken for each stage in order to succeed, as people will process the information in a more paused way and in the right time to make the best out of it. It is important to assess attitudes and behaviours and their evolution throughout time, since people tend to react favourably to sustainable or green campaigns in the beginning, but the interest seems to decline over time, as 'behaviour returns to baseline if the source of motivation is withdrawn' (Lehman & Geller, 2004).

4. Evolution of water routines

Shifting routines to make true long term changes is a long lasting process. New-more-sustainable habits might be well embraced in the beginning, but with time they tend to decline allowing the old routine to retake its place (Pelletier et al., 2008). It is an attitude-behaviour evolution through which user perception, lifestyle, technologies and infrastructure and social acceptance transform, and once people become comfortable and act almost automatically, it is harder to go back to previous behaviours.

An example of this 'evolution' given by some authors (Hand et al., 2003) is bathing and showering. During the Roman times bathing was seen as something luxurious and social; then in the middle ages it was felt to be as something dangerous; and later, as part of cleaning and personal hygiene habits, it became a status symbol, differentiating upper and lower classes (Ger & Yenicioğlu, 2004). Nowadays daily showering has become part of most people's routine, probably due to changes in cleanness perception or to the 'time-squeeze' phenomenon. Thirty years ago a weekly bath was regarded as normal, sometimes even a bath a month. With time, hygiene perceptions changed, technology emerged and infrastructure became available to a majority of the population; these factors, along with the change in lifestyle towards a more rushed one, lead to the evermore common practice of daily showering (Hand et al., 2003).

Another transformation of common habits related to changes in time and hygiene standards happened in laundering activities. Clothes used to be regarded as protection of the body from dirt; whereas now, it is the body that seems to soil the clothes, as they are washed even if used only once and for a brief period of time and show no dirt, they are washed simply to get rid of the 'impurity' of the body (Shove, 2003). A curious fact related to convenience and 'time squeeze' appears when even if clothes are not really dirty, many people conveniently wash all clothes worn, from all members of the family, rather than separate dirty from clean (Randolph & Troy, 2008); and this of course increases the number of washes and resources wasted. This implies that the what (is washed), when and how, are not enough to understand the washing practice. The reasons behind it might have a strong influence in one's performance, therefore the importance of studying the activities in a wider context rather than in isolation.

Changing peoples' mindsets is not enough alone, adapting infrastructure and introducing technologies is also required. In an effort to reduce electricity consumption at home with little changes in behaviours, food and clothing superstores Asda and Marks and Spencer (UK) both launched campaigns for lowering garment washing temperatures from 40°C to 30°C in early 2007. "Think climate" was Marks and Spencer's attempt (Mark and Spencer's, 2007), displaying in most clothing labels a maximum washing temperature of 30°C (see Figure 4).

In late 2008, a new campaign in the UK 'cold is the new hot' (Ariel, 2008) was launched the Ariel laundry detergent brand (Proctor and Gamble), promoting the use of 15°C with a new washing media in the form of gel. This would make reasonable savings in energy, being better for the environment and for the pocket of consumers. Nevertheless most washing machines in current homes do not have the option of such a low temperature, and many of them, go only as low as 40°C. So even if people truly want to engage to the 15°C washing, there is a technological barrier that prevents them from doing so.

5. Encouraging water saving

From all of the activities at home that require water use, some of them can be considered as necessary and some as not-essential. Trying to change people's behaviour into a more sustainable one, either through replacing a technology to a more efficient one, through a conscious change of routines from the part of the user, or by changing behaviour through product design, has to take into account the situation-context of the activity in play. In terms of water, demand can be elastic or inelastic for different purposes (Martinez-Espineira & Nauges, 2004). There is a baseline of consumption or 'subsistence level' that satisfies essential uses such as personal hygiene, cooking and drinking. These appear to be inelastic to variation in pricing or campaigns. Such essential uses should be targeted with the aim of conservation, whereas water used in recreational or non-vital activities, where use is elastic and therefore sensitive to context, should be tackled towards reduction or even avoidance of use.

Geller *et al.*, (1983) carried out a study on three different approaches for diminishing domestic water consumption: educational (pamphlets and handbooks), behavioural (written feedback of daily/weekly consumption and recommendations) and engineering (installation of water saving devices). The investigation indicated that with the

installation of water conservation devices (aerators, cistern displacement units, shut off shower control) the expected savings of water and energy were not achieved. The findings suggest this was because it was done along with the distribution of information regarding the savings, and people could justify using the toilet more times, or taking more time in the shower. This phenomenon is referred to as 'rebound effect' (Herring & Roy, 2006) in which energy efficient appliances and new technologies do not always achieve a lower energy consumption. Psychologically, people justify the over-use of the resource (energy, water, etc.) and end up consuming the same or even higher amounts. As an example, fitting light saving bulbs outside the house could justify leaving them on all night to improve 'security' (Herring & Roy, 2006). The study on water consumption by Geller et al. (1983) confirms the rebound effect as only the users unaware of the water devices being installed in their homes achieved the savings predicted from the laboratory testing on the water devices.

6. Reducing water consumption at home

Introducing new and more efficient products is one of the choices to reduce water consumption in the household. Some of them replace other appliances keeping the old routines while using less energy and water, while others are meant to push the user to behave more sustainable by giving no option but to change behaviour. Finally, others simply give feedback on the resource consumption and leave the user the choice of changing or maintaining behaviour (see Figure 5).

Some products available in the current market include systems that connect the hand basin or shower/bathtub with the toilet cistern, which accounts for a major part in water consumption in the bathroom; and shower systems that have the option of cycling the water to have a longer shower without huge wastes (see Figure 6).

Simpler solutions include feedback gadgets (see Figure 5) and shower timers that help keeping track of the water used. Communicating intrinsic motives for environmental behaviours is one of the possible solutions or paths to take when trying to stimulate interest on sustainable/responsible actions/behaviour (O'Brien, 2008; Pelletier et al., 2008).

New products and technologies are only effective if the consumer embraces them and uses them in the way they were designed to be used. That is a great challenge for designers.

7. Conclusions and further research

Concerning reducing water consumption at home, it appears that it must be tackled by changing user behaviour. In order to do so, approaches must focus on the factors behind the various water-related activities that take place in the household. Policies, methods and campaigns must be designed in view of the local cultural and social background, alongside financial and technological accessibility (current or possible in the near future). In addition, the approaches must be multi-staged, in the sense that they must change behaviour in a gradual manner and must interconnect various means, from informing the user and providing feedback to making the use of new products be embraced by users and updating legislation accordingly – not necessarily in that order.

The next stage of this project is designing a tactic to assess water consumption in households consisting of carrying out observational research into different lifestyle backgrounds in Anglo and Hispanic communities (Mexico and the UK). It will develop knowledge and experience with regards to how different methodologies may or may not apply in distinct cultures, and in how they are best applied. It will also enable the development of a more detailed understanding of user behaviour in terms of 'water use' in two distinct cultural contexts. Even though routines and habits are unique for each individual, similar situations can be recognized and can be regarded as widespread amongst people. The study will aim to identify similar patterns and analyse the differences in terms of cultural background; perceived value of water; perception of hygiene and comfort; technologies available; and infrastructure. A cross-cultural comparative analysis will be carried out in order to produce a series of conclusions on factors that influence peoples' attitudes and trigger sustainable behaviours on water usage at home.

Everything in life, both actions and things, take time and occupy space. Projects in life are formed by several little activities that interrelate in the 'time-geography' (Krantz, 2006) and at certain time coexist in a particular context. Water and humans interact when one takes a shower, then their link diverts again as the water and the person move on from that activity. Constraints and resources available at the time of the activity are unique for each occasion, and it is those along with the individual's aims that indicate what practices are within reach and how they will be carried out (Krantz, 2006). Therefore activities and routines must be studied within a bigger context and not as isolated activities. In order to achieve a more sustainable level of water consumption there has to be a merge of the technologies available, product design and consumer demands, which all have a strong influence in behavioural evolution from traditional patterns towards sustainable practices (Nash, 2009).

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Figures

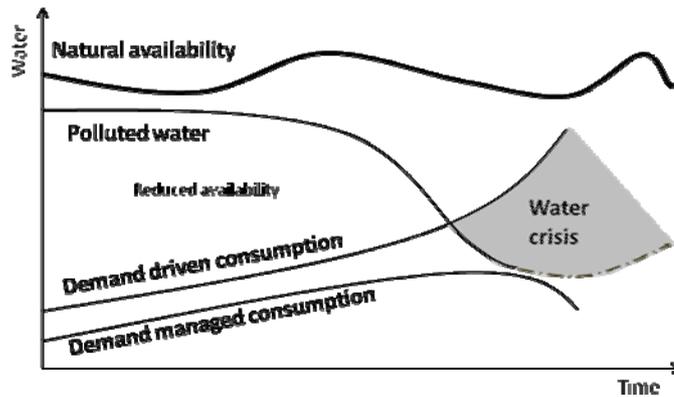


Figure 1. Water availability according to management. Adapted from (Butler, 2006)

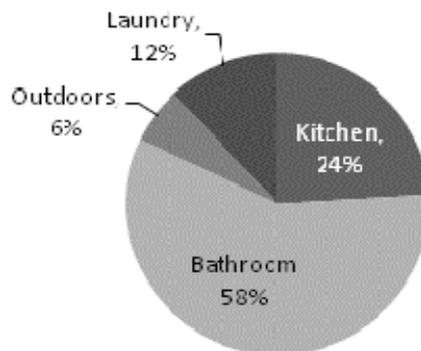


Figure 2. Domestic water use distribution by house-area. Adapted from (Butler, 2005)

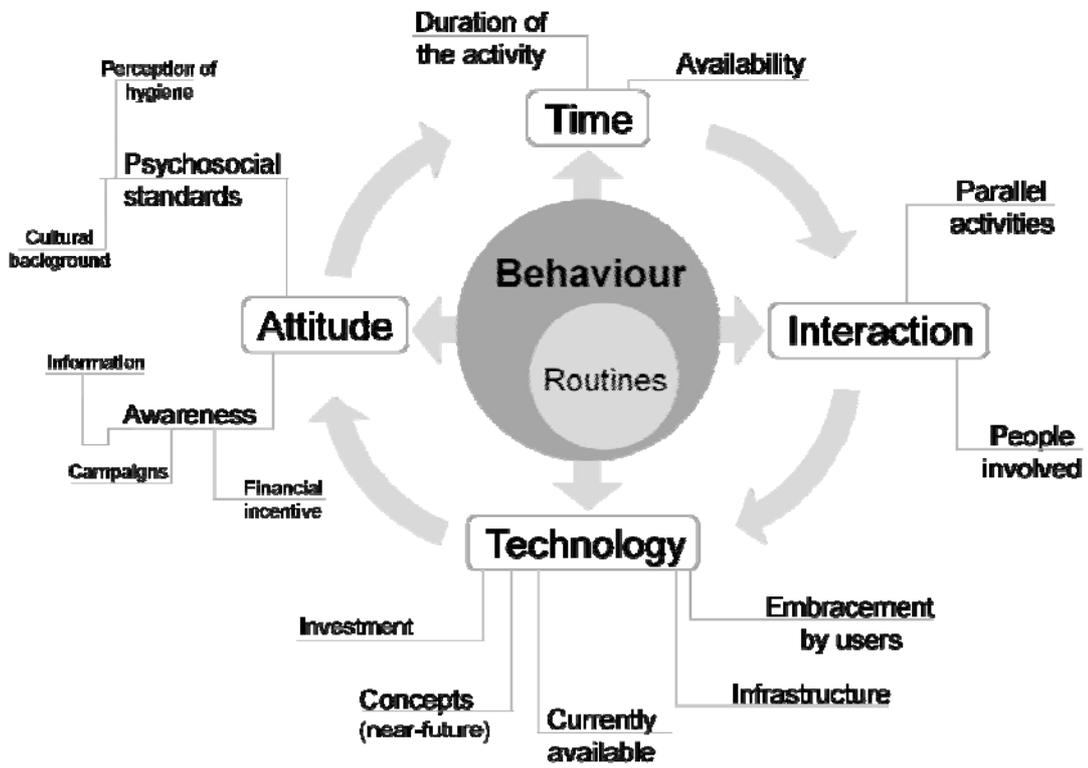


Figure 3. Factors influencing the creation of patterns and routines



Figure 4. Marks and Spencer's labelling– *Think Climate* - Wash at 30°C



Figure 5. Products in the market: *Sinkpositive*, *Autotaps*' retrofit infrared sensor and *faucet buddy*

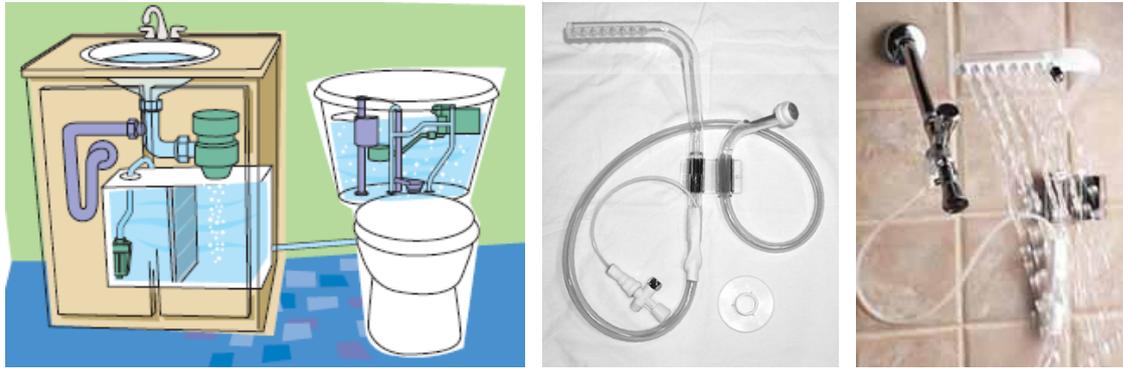


Figure 6. *Aqus* connects sink with toilet. *Wow shower* cycles the water.



A Case Study of Carbon Sequestration Potential of Land Use Policies Favoring Re-growth and Long-term Protection of Temperate Forests

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Abstract

There is a traditional view suggesting forests remove carbon dioxide from the atmosphere (Pregitzer & Euskirchen, 2004), but they cease to serve as a carbon sink as they fully mature (Odum, 1969). Recent modeling of old-growth forest carbon sequestration indicate they continue to serve as a “net sink” of carbon even after maturity (Carey, Sala, Keane, & Callaway, 2001; Zhou et al., 2006) - sequestering an average of $2.4 \pm 0.8 \text{ tC ha}^{-1} \text{ yr}^{-1}$ (tC = metric tons of carbon; ha = hectare; yr = year), and yielding a ratio of heterotrophic respiration (Rh) to net primary production (NPP) of approximately 0.65 ± 0.02 (Luyssaert et al., 2008). These figures show the strongest correlation amongst temperate forest regions.

Two calculations are made using this carbon sequestration average. One is made identifying the amount of carbon sequestered through a small-scale land protection organization, yielding a net carbon sequestration of approximately 224 metric tons of carbon per year. The other is based on the amount of land required to offset current anthropogenic emissions of carbon in the global carbon budget, showing approximately 235 million hectares of new forest growth would be required to offset current global anthropogenic emissions. One implication of these calculations is the traditional assumption of carbon neutrality increasing with age (Magnani et al., 2007) is incorrect, suggesting mature forest protection may be a favored policy choice for carbon sequestration strategies.

Keywords: Climate change, Carbon sequestration, Forests, Policy, Law

1. Introduction

For decades in the United States, land use policies have existed that favor planning to include the maintenance of open space. (Note 1) What may become an important question is how such land use policies support carbon sequestration as a means of absorbing net increases in atmospheric carbon concentrations. Recent research indicates old-growth forests may be serving as a continual net carbon sink over time (Luyssaert et al., 2008). This differs from previous work that assumed old-growth forests are “carbon neutral,” where the change in carbon mass over time (also referred to as *net ecological production*) is zero (Odum, 1969). This research is supported by other studies showing net ecological production (via the continual accrual of carbon in forest systems) is robust, resisting various stressors like water deprivation and anthropogenic nitrogen fluxes (Magnani et al., 2007). Assuming natural background forest conditions, land use policies favoring forest re-growth will result in a continual net carbon storage capacity, even as the forest reaches full maturity.

One policy-relevant question to consider is the magnitude of the observed carbon sequestration potential for carbon mitigation purposes. For instance, assuming an average rate of carbon sequestration of $2.4 \pm 0.8 \text{ tC ha}^{-1} \text{ yr}^{-1}$ (tC = metric tons of carbon; ha = hectare; yr = year), how much land is required to be set aside for *new* forest growth in order to offset current anthropogenic forcing or carbon into the atmosphere? Calculations suggest an area approximately equivalent to the entire current forest area of the United States, or approximately 226 million hectares of new forest land, is required (explained in more detail below).

For application purposes, the calculated average carbon sequestration rate ($2.4 \pm 0.8 \text{ tC ha}^{-1} \text{ yr}^{-1}$) has been applied to a case study of land use policies favoring open space designations. Making certain assumptions about land use choices, a “net carbon offset” of continual forest growth in an area of Southeastern Massachusetts (referred to as “DNRT” lands below) has been determined. Using the ratios and carbon sequestration patterns established by Luyssaert et al. (2008), the net effect of small-scale land conservation measures on carbon sequestration efforts were determined. The suggestion is that continuation and expansion of open space policies, multiplied over larger spatial scales, can prove effective as a growing sink of carbon to offset current anthropogenic forcing of atmospheric carbon concentrations.

Because of the substantial scales required to achieve full carbon offset, localized efforts multiplied over the entire globe may be an effective tool in implementing carbon mitigation through forest re-growth.

2. Materials and Methods

2.1 Materials

Original data was collected by Luysserat et al. (2008), which can be found at: <http://www.nature.com/nature/journal/v455/n7210/extref/nature07276-s1.pdf>. The heterotrophic respiration (Rh) to net primary production (NPP) ratio was validated at 0.65 +/- 0.02, which represents a net carbon sink. The resulting 0.35 (1.0 - 0.65) factor was used as a means of determining the net carbon sequestration of Southeastern Massachusetts temperate forest areas (assuming they would continue in an undisturbed and optimal density state). This resulted in an average net rate of carbon sequestration per unit area per unit time, or 2.4 +/- 0.8 tC ha⁻¹ yr⁻¹.

Open space land use information was obtained using the sources identified in Table 1. The land use summary statistics database (updated November 2007) is maintained by the Massachusetts Department of Conservation and Recreation: Forestry Management Program. The protected and recreational open space database (updated February 2009) is maintained by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA).

Relevant data was used to establish consistency in open space patterns and to ensure the validity of the original information obtained through DNRT research. This data was further used to identify DNRT lands that are capable of supporting full forest maturation, while also identifying areas incapable of forest maturation (wetland areas for example).

2.2 Methods

A database search was conducted to determine land areas within DNRT resources that can support forest ecosystem functions. A database search was conducted using Massachusetts land use information collected by the Department of Conservation and Recreation. The following land use designations were coded into regionalized zones for interpretation purposes. Each regionalized zoning code is translated into a landuse/zoning aggregate translation code, which is then given a unique classification ID scheme (see Figure 1). ID numbers of 1, 2, 3, 6, and 21 were used as identifiers of potential forested land for study purposes. Any additional lands held by DNRT, including those designated as "Residential" (10, 11, 12, 13) or Recreation (7, 8) were included where it was shown these lands were placed into sufficient private land use restrictions to provide sufficient time (at least 10 years based on data provided by Luyssaert et al. (2008)) for forest growth to incorporate continual net ecological production. Commercial land use designations (ID# 15) were not incorporated into the study because they did not represent a significant source of DNRT lands, either through direct ownership or shared land use restrictions.

After coding was completed, DNRT lands under management were identified and analyzed to determine what percentage of DNRT land maintained sufficient forestry characteristics to be included in the study. *Forestry characteristics* was defined as land that was either currently identified as forest land, as well as land that is capable of becoming forest land over time (pasture land is one example). Other lands, such as submerged wetlands and salt-water wetlands, were not included for analysis purposes. The portion of DNRT land deemed capable of supporting forest growth became the basis for further evaluation.

A land use protection ratio was calculated based on changing rates of land use patterns over time in the town where DNRT lands reside. The assumption is that absent specific land use protection policies, DNRT protected lands would exhibit background rates of land transition observed in the local community. For instance, if the surrounding community was shown to be developing land at a rate of thirty percent (30%) over the past decade, then it was assumed DNRT land, absent special protections, would also have this same rate of development. Data for rates of land use change in the town were obtained by using the Land Use Summary Statistics database maintained by the Massachusetts Department of Conservation and Recreation, as well as summary data provided by the Protected and Recreational Open Space database maintained by the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA).

The summary data identifies the current land use budget of the town for specific intervals: 1971, 1985, and 1999. (It just so happens DNRT began its land conservation operations in 1971, the same date as the earliest summary land use database currently available and accessible in public format.) Both the actual changes in land use (focusing primarily on the rate of increase in residential land measured against decreases in forested and agricultural land) and the rate of change was calculated for these intervals, with an overall rate of change calculated between 1971 and 1999. This rate of change was then used to measure the relative land mass protected by DNRT that was available for land modification to other uses (agricultural and residential), to determine a "net" forest conservation measure. This net forest conservation measure then served as the "baseline" from which further calculations of NEP were made.

The land area identified as maintaining a net forest conservation measure was then subjected to a calculation using the NEP factor of 0.35 based on previous estimates (Luyssaert et al., 2008). The resulting number indicated the ultimate NEP potential, measured in tons of carbon per hectare per year ($\text{tC ha}^{-1} \text{ yr}^{-1}$).

Land area needed to fully offset anthropogenic forcing of carbon was calculated using peer-reviewed estimates of current anthropogenic forcing rates (identified as 6.0 gigatons of carbon from direct anthropogenic forcing, and 0.9 gigatons based on a current net destruction of vegetation, for a total of 6.9 gigatons of carbon per year) (Schlesinger, 1997). This total forcing rate was then divided by the average carbon sequestration potential rate of new forest growth ($2.4 \text{ tC ha}^{-1} \text{ yr}^{-1}$) to achieve a total land area required to mitigate current anthropogenic forcing of carbon.

To determine the effect of land use policies on NEP, a search of public and private laws in Massachusetts was conducted to determine the longevity potential of maintaining land in open space. A focus was placed on understanding the temporal extent of laws affecting land use restrictions favoring the continued designation of open space. The results of this search aids in further understanding the longevity of continued net carbon sequestration through forest development and maturation. While this search was not conducted comprehensively to determine the outer boundaries of legal tools for land use designations supporting forest growth and maturation, a cursory review was sufficient to ensure the current policies supporting DNRT preservation of lands is allowable for the immediate future (timeframes on the decadal scale). A more in-depth legal review would enhance this analysis to support some of the conclusions made below.

3. Results

Since its inception, the DNRT has actively engaged in land use restrictions on some 4,500 acres, or 1,800 hectares. The proportion of DNRT land that can be unequivocally identified as land capable of being developed but placed into reserves is approximately 1,500 acres, or 600 hectares. Using this number as a conservative estimate of open space (since they are designated as reserves), a potential rate of development based on average rates can be attached within the greater Town of Dartmouth from 1971 – 1999. Using the average rate of development over those twenty-eight (28) years, an increase in land transition into a developed state, on average, of 7.7% was seen. (Note 2) Using this average, one can conservatively assume DNRT efforts have saved approximately 47 hectares (600 hectares \times .077). (Note 3) Using the data obtained, an average net carbon sequestration rate of $2.4 \pm 0.8 \text{ tC ha}^{-1} \text{ yr}^{-1}$ was determined based on NEP for the 47 hectares. Taking the low, average, and extreme, the following rates of net carbon sequestration based on DNRT land preservation policy are:

- Low: $(1.6 \text{ tC ha}^{-1} \text{ yr}^{-1}) * (47 \text{ ha}) = 75\text{tCyr}^{-1}$
- Average: $(2.4 \text{ tC ha}^{-1} \text{ yr}^{-1}) * (47 \text{ ha}) = 112\text{tCyr}^{-1}$
- High: $(3.2 \text{ tC ha}^{-1} \text{ yr}^{-1}) * (47 \text{ ha}) = 150\text{tCyr}^{-1}$

Using a more liberal interpretation, to include some of the lands under managed restriction (Note 4), one can conservatively assume one-third (1/3) of the remaining 1,200 hectares under management are allowing for forest growth. This would equate to an additional 600 hectares subject to the same calculations and assumptions above, yielding a conservative estimate of human forest disturbance (resulting in the conversion of forest land) of an additional 47 hectares. Thus, the initial NEP values for net carbon sequestration can be doubled at the various low, average, and high rates of carbon sequestration. This would yield result in 150tCyr^{-1} for the low, 224tCyr^{-1} for the average, and 300tCyr^{-1} for the high.

Taking the average carbon sequestration per year, an extrapolation can be made to determine the extent of land area required to fully mitigate global anthropogenic forcing of carbon. For comparison purposes, the average of 224 metric tons of carbon sequestration per year is equivalent to 2.24×10^{-7} gigatons per year (for 84 hectares of protection). Current net destruction of vegetation is calculated at approximately 0.9 gigatons of carbon per year (Schlesinger, 1997). Thus, it would take approximately 33,600,000 hectares of similar land protection to offset the current global net destruction of vegetation. The United States has approximately 226,000,000 hectares of forest land (FAO, 2001), so the amount of land needed to offset current global net destruction of vegetation would be approximately fifteen percent of the current total forest land of the United States. The amount of land to offset current anthropogenic burning of fossil fuels (approximately 6 gigatons of carbon per year) would be approximately six times the amount of land mass indicated to offset net destruction of vegetation, or 202,000,000 hectares. In this way, one can see the importance of U.S. forests, as total forest area in the U.S. (226,000,000 hectares) is roughly equivalent to the current global anthropogenic forcing of carbon emissions (from fossil fuel burning and net destruction of vegetation).

4. Discussion

The conservative estimates used in this study reveal a net carbon sequestration potential for land use planning policies that favor open space planning. The assumption is made that some proportion of uplands otherwise available for development will be differentially treated for that purpose. As such, active planning to preserve and “re-grow”

temperate forest areas can result in maximizing indirect use values such as carbon sequestration. The results of the conservative estimates suggest anywhere from 75 to 300 tons of carbon are sequestered each year as a result of DNRT preserving and re-growing temperate forest areas. For instance, a close examination of the information provided by Luyssaert et al. (2008) suggests temperate forests exhibit different NEP rates during different life stages, with the greatest rates of carbon sequestration occurring when the age of the forest is between the 5-10 year timeframe, maximizing at approximately $4.0 \text{ tC ha}^{-1} \text{ yr}^{-1}$. This suggests efforts to re-establish temperate forests from other lands (agriculture for example) can have a significant impact within the first decade of establishment. Such timeframes are important considerations when balancing the benefits against the costs of open space policies. Further, since most of the protected forest (and those re-created through DNRT efforts) would have occurred within the last thirty-eight (38) years, the average net carbon storage is closer to the $2.4 \text{ tC ha}^{-1} \text{ yr}^{-1}$ rate. Most importantly, a close review of the data suggests that while a reduction may occur in the yearly carbon sequestration after approximately year twenty (20), the rate will equalize and remain constant for about 100 subsequent years and longer. This is true even though the ultimate “carbon capacity” of the re-growth forest may be diminished from that of an original stand (Houghton et al., 1983; Harmon, Ferrell, & Franklin, 1990).

The assumptions of undisturbed forest stands is conservative to the extent legal instruments exist to maintain the site in an undisturbed state for relatively long periods of time (on the order of 50 years). Massachusetts does contain both public and private laws that allow for the continued protection of open space on the timescale of decades. However, federal and state constitutional powers of eminent domain can supersede both public and private agreements relating to land conservation. A more in-depth analysis on how legal frameworks may affect such land use policies is advisable to fully consider the potential impacts of this study.

The assumption of optimal density is also conservative considering the current state of knowledge regarding forest density, age heterogeneity, growth factors, and carbon sequestration potential. Mangini et al. (2007) has done recent work on the effects of anthropogenic and natural disturbances to forest carbon sink activity. In order to better understand the effects of various stressors on forest systems, which are linked to the age-composition of the forest, age effects were filtered out by determining the average of carbon fluxes over the entire forest rotation, resulting in a net ecosystem production average, or NEP_{AV} . The results showed both anthropogenic-induced and natural stressors reduce, in parallel, both respiration and primary production. As a result, NEP_{AV} is weakly correlated with such stressors. Instead, NEP_{AV} is more highly correlated with the availability of limiting nutrients, such as nitrogen (Aber et al., 1998; Galloway et al., 2004). Thus, higher nutrient availability (through greater anthropogenic deposition of nitrogen) allows for continued forest growth and NEP_{AV} . The implications suggest the assumption of optimal density structure is conservative because age effects (the direct variable in determining optimal density) are of less importance than other factors (like availability of nutrients) when determining NEP. It is important to note the age effects analysis of Mangini et al. (2007) has been generally accepted, whereas their suggestion of a lack of nitrogen saturation through anthropogenic forcing has drawn some critical debate (De Schrijver et al., 2008; De Vries et al., 2008). For this analysis, it is clear the assumption that the protected forests will continue to grow to maturation, on the average, is conservative and bolstered by general trends of net forest re-growth identified in the literature (Caspersen et al., 2000). This is especially true where further conservative calculations have been made regarding the proportion of landmass being preserved, and the proportion that is viably adding to carbon sequestration rates through forest re-growth patterns has increased.

5. Conclusion

The results of this study suggest relatively small-scale preservation efforts of land suitable for forest growth can substantially impact global carbon budget patterns. While the scale of carbon sequestration rates in this study is orders of magnitude smaller than required to highly influence current global anthropogenic carbon budgets, an extrapolation of this small effort suggests the replication of small-scale measures, such as the DNRT example case, can mitigate anthropogenic fluxes of carbon into the atmosphere. While the total land area required to fully mitigate current anthropogenic forcing under the average rate of carbon sequestration is substantial, it is by no means impossible, especially if efforts for re-growth are diffused over the entire globe. Further, conservation measures limiting net deforestation can reduce the total amount of land required to fully mitigate anthropogenic forcing. It may be small-scale efforts at forest re-growth (bolstered by land conservation policies) can substantially aid in solving current anthropogenic carbon forcing.

While policies of carbon sequestration technologies are currently being discussed and tested (for example Herzog, 2001; Riahi, Rubin, Taylor, Schrattenholzer, & Hounshell, 2004), it may be worthwhile to further evaluate land use policies favoring both maintenance and re-growth of temperate forest systems. Not only may forest re-growth policies serve (in the aggregate) as substantial and continual carbon sinks, but they also provide additional direct, indirect, and non-use values that are of interest to society (Plantinga & Wu, 2003). Further work in this area would include expanding the

current research to larger land holding operations, as well as a more in-depth analysis of legal principles and doctrines that ensure the longevity of land use policies favoring the continued protection of forest systems.

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Notes

Note 1. For the purposes of this paper, *open space* can mean both areas limited to development due to legal restrictions, as well as areas that remain open simply due to a lack of will to develop the particular area in question.

Note 2. Calculation – 1971 Developed Land: 3,954 acres of 39,768 acres total land mass. 1999 Developed Land: 7,047 acres. Change from 1971 – 1999 = 3,092 acres of 39,768 acres, or 7.7 percent of total land mass changed to developed land from 1971 to 1999.

Note 3. This calculation is based on the amount of DNRT reserve land that is technically capable of development (600 hectares), multiplied by the observed rate of development that has occurred within the vicinity in which these preserves are located (7.7 percent).

Note 4. *Managed restriction* is meant to indicate lands held in private ownership, but are managed cooperatively between DNRT and the private landowner (using some form of private land use restriction agreement). This allows us to account for some of the 1,200 hectares of land in some form of partnership restriction based on DNRT efforts, but not part of the original 600 hectares currently under direct ownership by DNRT and in a preserved status.

Table 1. Sources for open space land information used in study

Source	Information
Dartmouth Natural Resources Trust (DNRT)	Information with author.
Mass GIS geodata system	www.mass.gov/mgis
Mass GIS land use summary statistics	http://www.mass.gov/mgis/landuse_stats.htm
Mass GIS protected and recreational open space	http://www.mass.gov/mgis/osp.htm

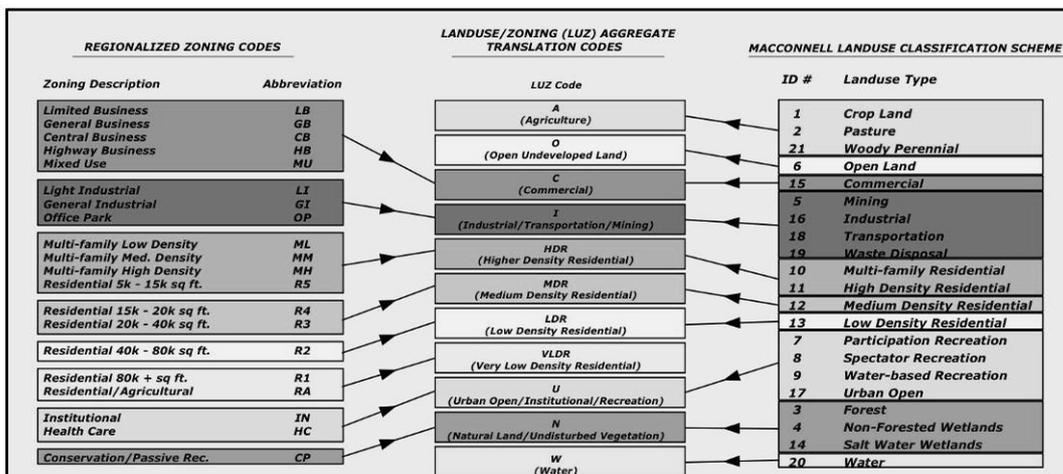


Figure 1. Land Use Aggregate Translation Code



Management Research about Solutions for the Eradication of Global Poverty: A Literature Review

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Abstract

This article is a review of traditional literature about how business tackles poverty eradication and a later specific discussion of major issues in the research on business approach to poverty eradication. The article goes beyond traditional approaches to emphasize that although changing the observation angles can help scholars explore various sides of poverty, targeting poverty by one or some of its symptoms can not help break down the mechanism of interacting constraints locking poor victims deep inside. Sustainability of the business model and awareness of the poor are also two significant factors that should be taken into consideration. Moreover, the article argues and implies that research about business for poverty eradication should start from breaking free of established assumptions about poverty such as ‘bottom’ or ‘low buying power’, ensuring construct validity by capturing poverty as constraints that interactively surround the poor and discussing how to break these interacting constraints. These are foundational steps in advancing the development of this field.

Keywords: Research on business for poverty eradication, No ‘bottom of the pyramid’, Construct validity, Victims of interacting constraints

1. Introduction

Gradual explosion and wide spreading of poverty issues together with pioneering steps in research and practice towards poverty eradication have created an unprecedented outburst of studies about business literature for poverty eradication. This paper is a review of literature about how business can help to exterminate poverty, especially in developing countries where poverty occurs on a large scale. The review is carried out with a concern about complete poverty alleviation as well as possible solutions for it. From this viewpoint, it aims to investigate what and how business, as a possible approach, can do to solve the poverty issue completely.

Though there has been a fall in the number of people living on less than \$1.25 a day from 1.8 billion in 1990 to 1.4 billion in 2005, about 55 million to 90 million people are estimated to be living in extreme poverty in 2009 than anticipated before the economic crisis (United Nations, 2009). Despite a considerable drop in the proportion of undernourished people from 20% in the early 1990s to about 16% the years of 2004-2006, the rate of undernourishment showed a reverse trend in following years due to escalating food prices (United Nations, 2009). Still about a quarter of children in developing regions are underweight, and undernutrition becomes the main cause for one third of child deaths in the world (United Nations, 2009). Therefore, the high economic growth of large-population countries, such as China and India, has brought about many job opportunities and brought down the overall poverty level, it is still not sufficient to reach other targets in the Millennium Development Goals (MDGs) (World Bank, 2004).

Along with the increasing concern of the global community about poverty eradication, business perspectives have been gradually positioned as a useful tool in healing the most chronic disease of the world. That interest has appeared to become much more worldwide through being catalyzed by pioneer approaches, both in practice and theory, which have awakened business attention to the old-but-always-hot problem, poverty. Professor Muhammad Yunus won the 2006 Peace Nobel Prize for the model of Grameen Bank - a successful innovative business solution with the primary goal of providing small loans to poor people, particularly women, without any collateral to run their small profit-making businesses and lift their families out of poverty. The model has successfully benefited 100 million families in rural Bangladesh. Along with the practice side, the scholarly approach of pioneer researchers, such as Prahalad, Hammond has blown a new wind to the old problem of poverty by capturing the vast majority of 4 billion people earning less than \$2000 each per year at the lowest tier of the economic pyramid -Bottom of the pyramid (BOP)- as new sources of growth for multinationals, and ignited scholarly inquiries, arguments and debates around BOP targets (Prahalad and Hammond, 2002).

Pioneer approaches have created a global wave of business attention to poverty eradication together with an explosive phenomenon of scholarly investigation of business strategies for poverty eradication. However, each approach is examined and emphasized of its strength within the standpoint or through the specialty of researchers. An openly and fairly evaluated synthesis of these approaches is needed so as to examine effects of existing perspectives towards poverty eradication as well as to figure out what is left and needed for future research to achieve the goal of completely alleviating poverty.

The paper is constructed as follows. The next section, the article introduces the methods used to locate studies of the review and criteria for including studies. In the third section, the article discusses the results of the review by giving a description of leading concepts, definitions, theories as well as solutions already attempted in previous work on the topic. In the final section, the article gives some proposals that can help deal with the identified problems, recommendations for alternative approaches, and points out future research needs to achieve complete poverty alleviation.

2. Methods

2.1 Details of the literature search

Information on extant works on the topic is located based on three main channels: formal channels (primarily electronic journals, reference lists), secondary channels (primarily citation indexes) and informal channels (primarily personal contact, the World Wide Web). The search focuses on such key words as poverty, developing countries, business and management to locate studies on the topic in each channel.

There are many studies located from the search. However, the foreword-mentioned purpose of the research helps to narrow the scope of the review. The review does not include research that focus on analyzing and evaluating the contribution of foreign direct investments into developing countries to providing jobs and raising income of poor workers through their business activities. Neither are studies on the contribution of business activities to the economic development, as a result bringing down the overall poverty rate through the 'trickle-down' effect. Though there are also a few emerging fields discussing about innovative methods of catalyzing social changes, existing studies often focus on examining these new phenomena themselves rather than specifically examining their approaches to directly dealing with poverty issues. The review does not have an indirect look, but a direct one at the relationship between business and poverty, the way business targets poverty and how poverty can be reduced from this targeting. There are also other reviews or summaries about business solutions for poverty eradication, which mostly base on descriptive studies or case studies. The research does not deny but supplement them by specializing in exploring the academic approach of business to poverty eradication in order to enhance the development of this field.

Though there are still too many potentially relevant items hit, technically scanning contents or looking at abstracts of these items help to reduce the list further. Besides, researches those just stay in case studies are not included in the review. On the other hand, despite the fact that there are also emerging business approaches to poverty eradication recently, researches that discuss around these phenomena without investigating the approach of the phenomena to poverty eradication are not included as well. The search is also narrowed by identifying studies in English.

2.2 Criteria for including studies

Though the list has been reduced considerably after those narrowing tactics, not all the left items are to be included in the review. It is important to identify and review core studies that are frequently cited by other authors, or considered to have certain influence on the development of future research on the topic. This task is performed by using three tactics.

First, Social Science Citation Index (SSCI) is used to identify which studies to include in the research. Key words are firstly used to search for relevant items, which are then sorted according to its relevance. Technically looking at abstracts and reference lists of these items helps to identify more relevant items. However, what are selected to review are studies that have been cited at least once and also carry the contents suitable to the literature search procedure of the research.

Second, due to the fact that citation indexes usually take time to catalog documents, there comes a possible mistake that recent studies can be missed, or some emerging perspectives, new approaches to the issue of research can be neglected. Therefore, besides SSCI, the review is based on the following criteria proposed by Hart (1993) in identifying core works. According to Hart (1993), a core work is:

'an item, published or unpublished, which had an important effect on subsequent work on the topic as a whole and on the development of sub-areas within the main topic'

'an application of a technique or methodology which others had replicated and which was consistent with the methodological assumptions of the topic had been traditionally defined'

'an item that had been used across several disciplines and movements so that the topic became a research topic in those disciplines and movements'

Third, some new business approaches to poverty eradication should not be neglected. Though these perspectives about poverty eradication still receive little attention or appear as new phenomena due to the fact that they are still at the first stage of theory construction, they are expected to have certain influence in future research on the topic. Therefore, selection of what to include and what not to include in the research from these approaches is based on the judgment about its relevance, influence and potential.

3. Results

The primary characteristics of selected studies are summarized in Table 1. The review shows a number of interesting findings.

3.1 Poverty in business perspectives

Poverty has a diverse appearance in existing business approaches, such as the vast majority of 4 billion people living on less than \$1 or \$2 a day (Prahalad and Hammond, 2002), poor producers (Karnani, 2007), gender (Thierry, 2007), self-employed poor people, microentrepreneurs, microfranchisees (Gibson, 2007), employees, business owners, etc. (Note 1). Despite this diversity of poverty, it is primarily captured and expressed under two ways in traditional literature.

First, poverty is viewed as a problem, a phenomenon with various expressions like what it has been captured in other fields (which can be said to be the traditional poverty). Gender, inequality and social exclusion are some examples of this viewing.

Second, the attention is not placed on poverty as a whole, but on its attributes and its causes. This view helps uncover interesting facets of poverty, explain its causes, and explore possible ways business can innovatively deal with poverty. For example, the construction of a new image of poverty in business perspectives as well as development of its literature is contributed much by the pioneering idea of Prahalad and Hammond (2002) when they focus on the large buying power of 4 billion people earning less than \$ 2000 each per year at the lowest tier of the economic pyramid. Poor people are described not through the state they have low-income but through the potential market of \$ 13 trillion at purchasing power parity (PPP) that the vast majority of 4 billion people with unmet needs are supposed to represent. Because MNCs usually have their view conditioned on their knowledge and familiarity with consumers of purchasing power of upper tiers, these markets have been neglected for a really long time and the basic needs of poor people have not been met (Prahalad and Hart, 2002). Another example is looking at self-employed poor people. In this case, it is the instability of the businesses run by the poor themselves and sufferings from poverty penalty that keep them deep in poverty and make it hard to escape (Gibson 2007). A much more general view of poverty is given when both the consuming side (poor clients, customers) and the earning-a-livelihood side (employees, producers, and business owners) are mentioned (UNDP, 2008).

3.2 Poverty eradication in business perspectives

Viewing poverty like the way it has been traditionally portrayed drives studies to evaluate and criticize existing business approaches to poverty. For example, talking about the approach of corporate social responsibility (CSR) activities, Newell and Frynas (2007) criticized that different models of current CSR activities have limited potentials to address different types of poverty due to its focus on output. Therefore, they suggested enabling the implementation of a CSR agenda targeting poverty by the role of governments is considered a possible solution.

The second view of poverty introduces a variety of possible solutions for poverty. Focusing on the buying power, buying behaviors of poor people, Prahalad and Hammond (2002) argued that the process of exploring of BOP markets will help multinationals serve the poor well as potential customers, improve their lives and bring about poverty eradication effects. Change in attitudes and practices of executives in multinationals together with new strategies, innovations are argued to help MNCs operate successfully in these markets and serve the poor well (called BOP 1.0). Specifically speaking, the poor can not normally afford to buy products of large unit packages because of their low and unpredictable income streams. Therefore, innovations are needed to create the capacity of poor customers to consume based on three principles of 'affordability', 'access' and 'availability' of products and services. For example, single-serve packaging, purchase schemes will enable the availability, access, affordability of the products, services; as a result, the needs of poor people can be met through these innovations (Prahalad 2004). Hart (2007) added that those business tools MNCs have been used should be put aside because they can constrain the imagination of incumbent firms at BOP markets. Hart (2007) suggested that the perspective of the poor themselves should be taken into consideration and exploited in BOP ventures (called BOP 2.0). Specifically, BOP ventures should engage in a deep dialogue, a two-way learning with local people to co-develop appropriate customer solutions for the poor.

In some cases, argument about business strategies for poverty eradication also varies when the same poverty object is observed and discussed from different angles. Talking about BOP markets, Karnani (2007) criticized that BOP market size is of only \$1.2 trillion at PPP because of the fact that there are only 2.7 billion people with per capita income below \$2 a day at PPP rates. Furthermore, he added that the BOP market with only 0.3 trillion is so small that there is no

fortune to be made by selling to the poor. Therefore, raising the real income and buying from the poor rather than selling to them is the best way to alleviate poverty. It is to create opportunities for steady employment at reasonable wages, increase their productivity with the help of the private sector and the government.

Focusing on poor people as self-employed poor people, microentrepreneurs, Gibson (2007) suggested that constructing and running microfranchising models that pair franchisors (MNCs or non-governmental organizations), microfranchisors (independent business people) with other poor people to expand the business and get other poor people involved in a self-employment venture can help empower poor people to raise their standard of living and gain a greater degree of financial stability.

Furthermore, poverty and poverty eradication are often captured and discussed under such viewpoints of multinational companies, governments, non-profit organizations, etc. Subsequently, poverty eradication can be seen as a direct goal or an indirect one, according to various viewpoints of existing studies. Therefore, current approaches to the topic show various views about what poverty is, how to reduce poverty and what the effects are.

3.3 Summary about traditional literature

The table demonstrates the variety, difference as well as relevance, similarity, relations between current viewpoints towards poverty and perspectives about their sequent approaches to poverty eradication. It shows how poverty has been captured, why there are various viewpoints about poverty, poverty eradication effects and what serves as the basis for these arguments.

These assumptions about poverty and poverty eradication provide a methodological framework. It is the framework about meeting basic needs of poor people, generating income for the poor and considering business as a development tool. The approach of meeting basic needs implies the necessity of innovations to bring the poor into the value chains of business models, to get them closer to products and services for their basic needs. It also implies about partnerships with other stakeholders if possible to generate value for all parties. The approach of generating income for the poor stresses on helping the poor to raise their income and earn a good living. Collaborating with poor suppliers, producers, self-employed poor people is an example for this. The last approach is evaluated to be a significant one. Business models to target poverty should be considered differently from traditional ones. At least, they should not be merely captured as a tool to generate profits for multinationals, but a tool to bring about development. It is the development of poor people inside poverty.

4. Discussion

The article holds a synthesizing view of existing business perspectives towards poverty eradication with the focus to be placed not on each of the perspective itself but onto what extent poverty can be reduced by these perspectives and whether the poor can escape from poverty or not.

4.1 Questions to be answered in existing studies

4.1.1 Studies on the consuming side of poor people

In discussing about the consuming side of the poor as poor customers, clients, traditional researches focus on answering such questions as ‘how can multinationals convert poor people into potential consumers?’, ‘What should they do to perform well in these markets?’ and ‘How to form partnerships with other parties, such as government, not-for-profit organizations in these markets?’. For example, as introduced above, because the poor have low and unpredictable income streams, such innovations as single-serve packing, purchase schemes are made to create the capacity of poor customers to consume. However, there are a few questions that have not been answered satisfactorily by traditional literature. Whether will actions of buying and consuming those products and services by those innovations naturally lift the poor out of poverty?. Though the approach stresses that the poor have low and unpredictable income streams, it does not touch the side of what and how poor people do to generate money to buy these products, services; from where and how comes the money for the poor to buy these products or services though these are at low costs.

Furthermore, there are also other determining factors that business approaches will fail to work well if they neglect these factors. First, it is the awareness about poverty eradication of poor people as well as sequent behaviors or actions driven by that awareness. For example, to tackle the lack of teachers and the poor quality of service in developing countries, low-cost laptops are supposed to be an innovative method of helping children to explore, experiment and express themselves. What ensures that these laptops will definitely be used to revolutionize the method of educating children all around the world, encouraging their self-study and getting them into school, or will these laptops be surprisingly used to access porn sites for adults?. On the other hand, computers can be useful assistants to equip poor farmers, who are struggling to change their lives, with information about weather forecast or knowledge for their agricultural productions. Three-wheel bikes enable poor people with disabilities in developing countries, who have a desire to be able to support themselves and lead lives of normal people, to go to work, overcome inconvenience in daily lives, and above all, lead a good life as others in the society.

Second, approaches of traditional literature remain in supplying products and services for poor customers and aiming to bring about traditional values, such as customer value, and customer satisfaction. In constructing theories about their business approaches, they have not discussed about the process from the point that poor customers buy those products, services to the point how those products, services help them get out of poverty. Though a piece of soap can be supplied with a single-serve packing to create the capacity to consume for poor customers, they do not know how to use soap, how to wash clothes cleanly. The example of low-cost laptops mentioned above is a similar one. Though in traditional business approaches, creating customer value or bringing about customer satisfaction is considered the goal for every business to reach, it is quite different in business approaches to poverty reduction (Figure 1). Using laptops to study or to access porn sites are those behaviors done to reach the satisfaction of users or behaviors done in ways that users can satisfy their needs. Actually, not all directions in which poor people use their laptops can result in helping them escape from poverty.

4.1.2 Studies on the generating-income side of poor people

Stressing about income generation of the poor, traditional literature argues that it is the essence of helping the poor raise their living standards and escape from poverty when the poor are observed here as self-employed people, employees, producers or businessmen. These are jobs that the poor can generate income from their efforts and hard work. However, due to some reasons, they are trapped inside the vicious circle of poverty and have no chance to escape from it. Traditional literature on this side puts an emphasis on raising the poor's incomes. For example, providing knowledge, know-how of business to the poor so that they can become microfranchisees to provide products and services to others and expand the business (Gibson, 2007); employing them as salesmen to deliver products, services to poor customers in remote villages or gather information about the market; forming an alliance with poor producers to ensure the stability of material sources for manufacturing companies and income sources for poor people (UNDP, 2008). These works undeniably create jobs and chances of raising income for the poor. Traditional literature often questions: why comes this kind of perspective? How to get poor people involved in the business model in a win-win engagement bringing about benefits for all sides? What are detailed benefits that participants in these models such as NGOs, MNCs and the poor can enjoy? How do these business models work? However, these are still unclear questions related to poverty eradication effects of these approaches. The point of evaluation does not lie on whether the poor can raise their income or not, but the possibility and sustainability that the model can enable the poor to get out of poverty successfully through raising their income. For example, the business model that helps poor people raise their income through microfranchising can be influenced badly by ineffective operations of microfranchisors. The alignment with peasants for the supply of good materials can collapse if products are not marketed well and companies cannot compete in a serious competition. Or, even if the business model is designed so perfectly that all participants can enjoy many benefits, low commitment to the model and low awareness about poverty eradication of poor people can lead the model to failure.

The two significant factors that this paper wants to stress are sustainability and awareness of the poor. Sustainability requires the business model to achieve the goal of lifting the poor of poverty, not in a short-time mechanism, but in a continuous and sustainable one. The second factor does not look at the awareness mentioned in the consuming side of poor people, but it mentions about the awareness, effort to work, struggle (not to use or consume the supplied products and services). Let's consider a special case of people with disabilities in developing countries. They face many difficulties such as limited job opportunities, limited access to public transport, facilities, inconvenience, which reinforce each other and interlock to trap them in the tyranny of poverty. Especially, for various mobility means, people with disabilities cannot depend on regular electric three-wheel bikes because they are too poor to afford bikes of thousands of dollars. However, they do not want to become burdens to the families and desire to have a common voice and integrate equally, fully into the society, and above all support their families. They do self-study, produce and perfect three-wheel motorbikes with reverse gears that can move forward and backward freely in order to move around without difficulties, to commute to work and to earn a living.

4.1.3 Studies on business as a development tool

Discussed above are the inappropriate aspects of completely applying the traditional business thinking to poverty when current researches usually emphasize the importance of traditional values, such as customer satisfaction, economic benefits of the models and so on. Additional judgments or tasks need to be done to make these approaches be adaptive to the goal of eliminating poverty. To put it in another way, it can be argued that business should escape from traditional values that have been set for ages as the foundation, measure, standard of effectiveness, success of any business, and at the same time business should come to a new and much more suitable value. It is development or poverty eradication. Although this point has been mentioned in existing researches, it merely refers to the involvement of CSR activities in poverty eradication in an indirect direction through reinforcing state-led development policies (Newell and Frynas, 2007). However, specific directions to poverty eradication are still vague and need more elaboration.

Though specific ways and action frameworks are still vague, the perspective of business as a development tool should

be taken into consideration as a fair measure of business approaches to poverty. This is a really significant point to be based on to distinguish between a business targeting poverty, which as a result improves lives of the poor, with a business trying to eliminate poverty completely. Despite the fact that the former approach can result in an income improvement, creation of co-invented customer solutions for the poor or growth opportunities for firms, it is still vague about whether poverty can be reduced totally, whether the poor can escape from the tyranny of poverty completely or not. If we take a look back at low-cost computers at the discussion of studies on the consuming side of poor people, we can have a clearer image of this business. What can be said about these approaches is that they are businesses targeting the poverty object. The latter business is carried out with the primary goal of poverty eradication. Therefore, what this kind of business struggles for is not creation of innovations, BOP ventures, but the elimination of poverty. They are businesses for development.

The direct approach of business tools to poverty issues as a development tool has not been touched and discussed much in existing studies. Some clues that can be given are a combination of traditional business approaches and necessary adjustments to the goal of poverty elimination, which is, in other words, traditional business plus α . Understanding of this ' $+\alpha$ ' can give some hints from the evaluation of existing approaches on the consuming and raising-income sides of the poor as discussed above. For example, since customer satisfaction is not a terminal for business approaches to poverty eradication, the adjustment is needed to drive customer satisfaction to the achievement of poverty eradication. Or, how to bring out the awareness of poor people about the meaning of poverty eradication as well as their efforts for it in business models? Since research about business approaches to poverty eradication still lies at an early stage, this ' $+\alpha$ ' can now be understood merely through the above-mentioned additional tasks for the business models to clear. However, research about this ' $+\alpha$ ' may make the basis for the formation of literature about business as a development tool later. This viewpoint will orient the search for needs and targets to bring about the formulation of appropriate business models for poverty eradication.

4.2 Necessity for a suitable viewpoint about poverty and poverty eradication

4.2.1 Some questions about the construct validity of existing observation angles

Poverty has been known and discussed in existing literature as a multi-dimensional concept. Due to the diversity of poverty, business approaches to poverty also vary according to the way it is captured by scholars. In traditional literature, paying attention to some attributes of poverty and its causes helps discover the aspects to be the basis for the formation and operation of business models to deal with poverty. The difference between these approaches lies on the shift of viewpoint or the observation angle. It results in various observations of the poor, such as poor consumers, employees, self-employed people, entrepreneurs, business owners, etc. However, the change of the observation angle with different discussions about poverty eradication like this leaves some questions.

- Connecting views rather than conflicting ones

Existing literature has witnessed several changes of observation angles, several pictures of poverty as well as debates between these angles. However, they are actually connecting views rather than absolutely conflicting ones. Needless to say, working to earn a living and consuming to meet their own needs are all necessary facets of life for not only the poor but also the non-poor. Therefore, observing poverty in only one or two facets cannot help to capture a full image of the so-called poverty, or a full image of the lives of poor people. It means that tackling only the consuming side or the generating income side of the poor unintentionally creates the limitations of poverty eradication effects for itself in its approach. For example, people with disabilities in developing countries often find it hard to integrate fully and equally into the society since they often face such problems as a lack of job opportunities, limited access to public transport, facilities, or inconvenience in life. Therefore, simply a placement of job opportunities for disabled people in developing countries can not help eliminate poverty completely, since they still can not commute to work, or take part into many social activities due to inaccessibility and inconvenience of public transport or facilities.

- Mass poverty and existing 'poverty' concepts

Actually, changing the observation angles can help scholars explore other sides of the so-called poverty, for example, from the consuming side to the generating-income side. It does not matter much in these changes. However, on the other hand, there still exists the fact that mass poverty is still present at most developing countries. Some business literature tends to refer 'poverty' to 4 billion people – about two-thirds of the world's population. For example, it is called BOP market in Professor Prahalad's research (Prahalad and Hammond, 2002). Research on BOP school tends to discuss their approaches around these 4 billion targets. Whether targeting 4 billion people as 'poverty' can really cover the whole mass poverty and help exterminate the global poverty is a really simple question for further consideration about how to capture accurately the so-called 'poverty'.

Since mass poverty still exists as a challenging problem, recently, governments, NPOs, civil societies are sustainably involved in tackling this problem with big budgets. To put it in another way, in which order that capturing the poor as poor consumers, employees, self-employed people can possibly link itself to bringing the whole poverty to extinction is

still unanswered. Dividing poverty into several segmentations and discussing poverty eradication within those segmentations, though it can bring about some poverty eradication effects, is not enough to solve the whole problem.

4.2.2 Construct validity in research about business for poverty eradication

Academic inquiry of business for poverty eradication can not keep changing the observation angle of looking at some aspects of poverty and neglecting others, but needs to capture the full picture of poverty. The paper points out that a business aiming to reduce poverty completely should put aside these traditional ways of viewing poverty and restart its approach to poverty from the very first step of how to capture poverty accurately and fully. Though some pioneer studies recently put an emphasis on dealing with constraints that firms can face when tapping into markets for poor people, constraints that make the poor not be able to escape from poverty are still not paid attention to or discussed much (Note 2). Furthermore, the fact that these constraints also reinforce each other and interlock to keep the poor inside the so-called poor has also been neglected. As shown in the example of people with disabilities above, a lack of job opportunities, limited access to public transport, facilities, inconvenience in life are some aspects that keep the poor sunk into poverty.

Therefore, poverty can be seen as ‘the mechanism of constraints that reinforce each other and interlock to keep the poor inside so that they can not break and escape from it’. In this interpretation, there is no one at ‘the bottom’ of the so-called ‘economic pyramid’ or no base to talk about poor people as those who are living at that bottom, because low buying power is only one facet of the mechanism that holds poor people deep inside and it is not all about poverty. The poor are only victims of poverty. Traditional studies often place their observation of poverty on the causes that are capturing the poor in poverty, but seemingly forget that inside poverty there are poor people originally living, suffering from poverty and even struggling against it. They are also living, working, trying and struggling like the non-poor. What makes the difference is that these living, working, trying and struggling can not lift the poor out of poverty because of the poverty mechanism.

A poverty eradication business calls for breaking free of established assumptions about something as ‘bottom’, ‘low buying power’, and takes into consideration about how to break down the poverty mechanism for the poor victims. This way of capturing poverty will explore unexplored facets inside poverty. In this way, business models can serve as poverty eradication tools not only for non-poor stakeholders but for poor people in their escape from poverty. On the other hand, it can also be the case that poor people become innovators, social entrepreneurs and solve problems of their own and others. Research on business approaches to poverty can also escape from the traditional platform and explore other unknown aspects of poverty, such as entrepreneurship, innovation, social entrepreneurship by poor people. These are business models in which the poor become self-independent and struggle to solve problems of their own and others based on their awareness of poverty and their efforts to escape from it.

4.2.3 Poverty eradication mechanism

Viewing the poor as victims of the mechanism of interacting constraints helps a poverty eradication business know what to tackle or attack. Certainly, the primary goal of the business is not to break down only one or two constraints, but the mechanism. Though this is really a hard task, imagination about breaking down the poverty mechanism can be based on the poverty eradication mechanism that works in the direction of exterminating poverty completely. In this perspective, traditional values of business such as customer value, customer satisfaction, and innovations can not serve as the base for evaluating the effects of any approach. It is quite difficult to state specifically what poverty is due to its diversity and answer the question what the poverty eradication mechanism is. Poverty eradication mechanism can be understood through using an analogy. This is a common way of comparing one thing with another, describing something similar to another and referring something with which people are similar in order to make the objective to be explained become easier to understand in social sciences. Since children and the poor have similar features, both of whom are still fragile and can not become independent enough at present, how parents should help children become independent is similar to how business should target and help the poor escape from poverty. In this way, the mechanism business targets and exterminates poverty is oriented similarly to the way of child rearing (Table 2).

4.3 Further research directions

Further research about business for poverty eradication is needed to systematically generate much more effective results on a larger scale. The above-mentioned discussions can give out some directions for future research (Figure 2).

First, since the basis and accumulation of business literature over a hundred years can serve as the valuable foundation for future research about its application in dealing with poverty issues, much more research attention should be paid to this aspect.

Second, sustainability is an unavoidable matter of any business organization, even if its primary goal is for poverty eradication. How to create economic value as a means of sustaining the model? Future research should focus on partnerships between business models for poverty eradication and other approaches of international organizations, MNCs, not-for-profit organizations. How to build win-win relationships to order to generate value for all players and to

eradicate poverty? These are also important issues.

Third, more research is needed to understand thoroughly the role of the awareness and effort of the poor in business models, and to explore other possible unknown aspects of the poor such as innovators, social entrepreneurs, which may characterize the emerging approaches of poor people inside poverty for a complete escape from poverty.

Fourth, a conceptual framework about business positioning as a development tool is needed to orient the formation of its specific goals, targets and business models as well as discipline.

Fifth, research in this field should take into consideration the research needs about those factors as well as the coordination and harmony between these elements to bring about an effective poverty eradication business that can break down the poverty mechanism and lift the poor victims out of its tyranny.

Finally, in order to deal with the whole mass poverty, how to scale these poverty eradication businesses is also an issue. To state it in another way, the construction of a poverty eradication business is definitely important, but it is not enough if further research neglects specific strategies that can help these models be copied or replicated easily and widely inside the mass poverty.

5. Conclusion

Along with the increasing concern of the world community about poverty issues, there is also a similar trend in the academic world and the practice world regarding an outburst of business approaches to poverty. This is a praiseworthy signal about the higher possibility of complete poverty elimination with a dramatically significant contribution of business approaches. However, poverty and poverty eradication have accidentally become a word to be said or mentioned so much that, to be straightforward, they have been overused. Selling to the poor or employing the poor is not so easy as what business has done to serve clients or employ workers in developed countries. Business for poverty eradication can not replicate or imitate completely what traditional business has done over one hundred years but it needs its own version. It is necessary for business for poverty eradication to put aside established assumptions about poverty and the poor, recapture them as poor victims being held deep in the poverty mechanism with various constraints, and discuss how to break those interacting constraints. Sustainability, business as a development tool, the potential of poor people, and further application of traditional business are significant elements as well as focuses for further research needs in order to build up a scientific basis for the research and practice of poverty eradication businesses. A world without poverty is not far away.

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Notes

Note 1. UNDP (2008) described poverty under specific expression as poor clients, customers, producers, employees, and business owners. 'Poor clients, customers' shares the similar meaning with the way Prahalad and Hammond (2002) describes about poverty.

Note 2. For example, UNDP (2008) identified limited market information, ineffective regulatory environments, inadequate physical infrastructure, missing knowledge and skills, restricted access to financial products and services as some broad constraints that prevent businesses from taking advantage of opportunities in poverty.

Table 1. Summary of selected studies about business perspectives for poverty eradication(chronological order)

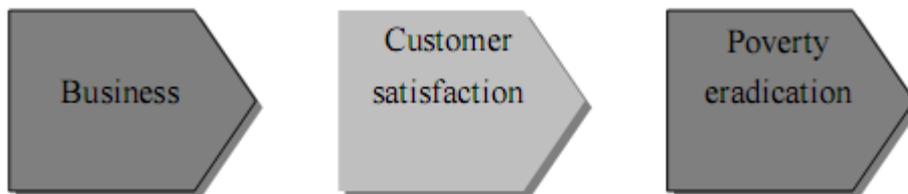
Study	Poverty	Poverty eradication	Argument
Prahalad & Hammond, 2002	4 billion people living on less than \$1 or \$2 a day (Bottom of the pyramid, BOP)	The exploration of BOP markets by multinationals will help improve the lives of poor people	4 billion people with unmet needs represent for the potential market of \$ 13 trillion at PPP. Change in attitudes and practices of executives in multinationals will help them operate successfully in these markets and serve the poor well.
Prahalad, 2004	BOP	The needs of poor people can be met through such innovations as single-serve packaging, purchase schemes, which will enable the availability, access, and affordability of the products, services.	The poor cannot afford to buy products of large unit packages. They have low and unpredictable income streams. Innovations are needed to create the capacity of poor customers to consume based on three principles of 'affordability', 'access' and 'availability' of products and services.
Karnani, 2007	Poor producers	Creating opportunities for steady employment at reasonable wages, increasing their productivity with the help of the private sector and the government.	Profits are not repatriated at PPP rates, but the financial market exchange, then the BOP market is small (less than \$ 0.3 trillion) and there is no fortune to be made by selling to the poor. Small packages just increase convenience and help manage cash flow. Providing credit just changes the ways poor people pay for it, not change the affordability of a product. The best way to alleviate poverty is raising the real income and buying from the poor rather than selling to them
Gibson, 2007	Self-employed, microentrepreneurs, microfranchisees	Microfranchising helps empower poor people to raise their standard of living and gain a greater degree of financial stability	Self-employed poor people, microentrepreneurs usually run unstable businesses, suffer from poverty penalty (high price for basic goods), and have no chance to escape from poverty. The model that pairs talented microentrepreneurs with other poor people to expand the business and get other poor people involved in a self-employment venture.

Table 1 (continued)

Newell & Frynas, 2007	Multiple forms, inequality and social exclusion	The role of governments to enable the implementation of a CSR agenda targeting poverty and achievement of MDGs. Reinforcing state-led development policy is the greatest contribution for CSR activities to make	With focus on output, many CSR activities have limited potential to address the forms of exclusion, and the range of development issues CSR initiatives address is limited. CSR activities for poverty eradication should be in a development tool, not a business tool.
Hart 2007	Base of Pyramid (BoP)	Engaging in two-way learning with local people to co-develop appropriate custom solutions for the poor and becoming native to the places in which companies operate.	The poor are still left out entirely or remain poorly served by existing products. Therefore, serving 4 billion people at BoP gives MNCs a unique opportunity of both satisfying social and environmental stakeholders and generating growth.
UNDP, 2008	Poor clients, customers, producers, employees, business owners	Including the poor at various points at in the value chain as clients, customers, employees, and producers in inclusive business models to help them enjoy benefits from these businesses.	There are vast opportunities at poverty: new markets, new sources of profit and growths. So are obstacles: limited market information, ineffective regulatory environments, inadequate physical infrastructure, missing knowledge and skills, restricted access to financial products and services. Adapting products and processes, investing to remove market constraints, leveraging the strengths of the poor, combining resources and capabilities with others, engaging in policy dialogue with governments are strategies to help businesses operate successfully in these poor markets.

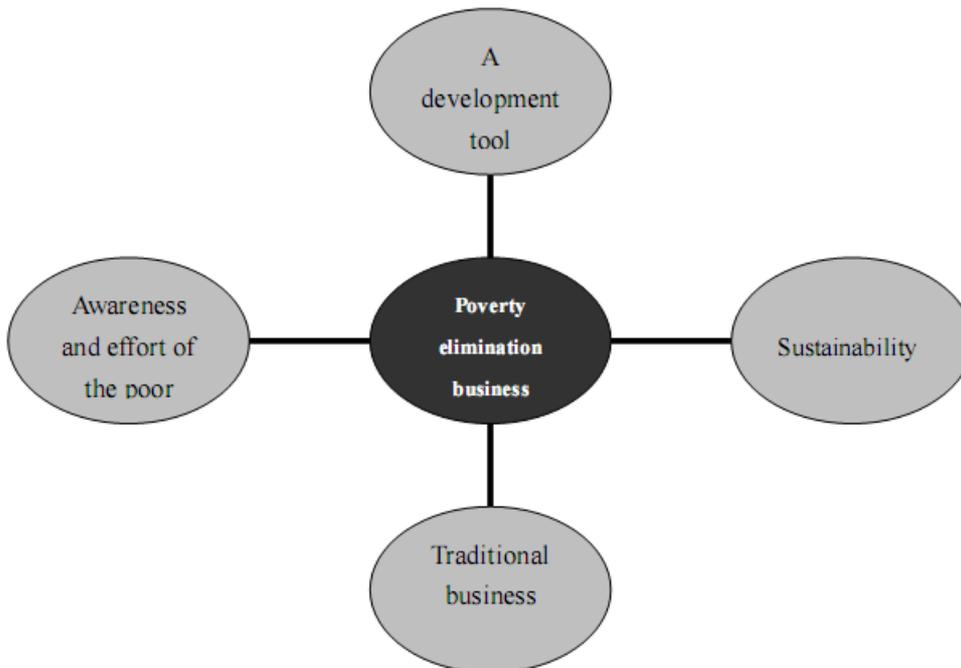
Table 2. Exploration of poverty eradication mechanism in terms of the properties of child rearing

Poverty eradication agrees with child rearing in four conspicuous peculiarities	
1 Supplying, giving something for their needs or leaving something for them is merely a short-term approach if the receivers do not know to reserve, make good use of and develop it effectively.	Focus on the further aspect of giving or supplying something: whether and how they receive and use it in the expected directions.
2 Creating conditions for them to study, equip them with knowledge and get a stable work so that they can make a living and raise themselves.	The main figure is the party themselves. A stable livelihood is what they should strive for.
3 Educating, bringing out their awareness and effort in these directions.	The awareness and effort for it are the premise as well as the prerequisite.
4 To a certain extent, they can independently make both ends meet, furnish their own needs and ensure the stability of their livings in a sustainable development.	The destination is that they can become independent and lead a good life in a sustainable development pattern.



Source: Illustrated by author

Figure 1. Customer satisfaction is not a terminal for business approaches to poverty eradication



Source: Illustrated by author

Figure 2. Focuses for future research on business for poverty eradication



Identifying the Economic Effects of Salt Water Intrusion after Hurricane Katrina

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Abstract

Hurricane Katrina made landfall August 29, 2005 becoming the costliest and one of the deadliest hurricanes in U.S. history. Katrina caused widespread loss of life, with over 700 bodies recovered in New Orleans by October 23, 2005. Before Hurricane Katrina, the region supported approximately one million non-farm jobs, with 600,000 of them in New Orleans. The ecological consequences were considerable including storm surge floods into coastal areas. These ecological impacts are still being felt throughout the region through human-driven coastal erosion and saltwater intrusion—issues that have long been damaging the region's natural storm buffers—were made worse by the hurricane. Specifically this research will: (1) provide current updates of the economic and ecological impacts from Katrina (2) review the current literature relating to salt water intrusion and (3) identify the economic impact of salt water erosion from hurricane Katrina including a specific case.

Keywords: Economics, Environment, Ecology, Salt water intrusion, Economic impact, Ecological impact, Coastal erosion, Economic impact studies

1. Economic Impact of Hurricane Katrina

After Hurricane Katrina hammered the U.S. Gulf Coast and spurred massive flooding in New Orleans, the economic and ecological impacts are still being felt throughout the region. The economic damage from Hurricane Katrina is still being tallied. While most hurricanes have economic effects, Katrina had many unique factors: its impact on the individuals living in the affected areas, the U.S. energy production; the gambling industry, the impact on agriculture and forestry, and the vast array of ecological effects. Action Economics decided to take a first pass at estimating the economic damage and how it has affected U.S. economic output. Their estimates assumed that Katrina would subtract 0.7 percentage points from growth in gross domestic product in the third quarter, lowering the expected U.S. growth rate to 3.7%. Additionally, they predicted a 0.4 percentage point hit to the fourth quarter, with growth in that quarter now set at 3.9%.

(1) Katrina's Impact on the Individuals Living in the Affected Areas

Hundreds of thousands of residents of southern Louisiana and Mississippi, including nearly everyone who lived in New Orleans, were left unemployed. No paychecks were being cashed, and no money was being spent; therefore no taxes were being collected by local governments. The lack of revenue has limited the resources of the affected communities and states and will do so for years to come. Productive workers lost their jobs. It will take years for most of them to recover the level of earnings (productivity) that they enjoyed; therefore the overall economy experienced a severe loss in productivity.

Before the storm, the region was already one of the poorest in America with one of the highest unemployment rates. Furthermore, Jim Sensenbrenner, Republican chairman of the House Judiciary Committee, refused to allow victims of the hurricane to take advantage of any exception to the recent Bankruptcy Reform, a recent bill passed with widespread support of the banking industry which was aimed to curb abuse of bankruptcy protection by repeat filers and those who are able to repay debts reasonably.

Area residents were also somewhat concerned when, on September 8, 2005, President Bush temporarily suspended the Davis-Bacon Act in the affected areas, which allowed for contractors working on Federal construction projects to be paid less than the prevailing local wage. The concerns over these actions were primarily that allowing the government to pay less than the prevailing wage would contribute to increased poverty in the region, which already ranked among

the lowest in the nation in terms of household income. The act was later reinstated on October 26, 2005, amid political pressure from both Democrats and Republicans in the United States Congress.

The storm left hundreds of thousands homeless in the region, at least 100 dead in hardest-hit Mississippi alone, and homes damaged by floods and winds well inland from Tennessee to Georgia. Estimates of insured losses go as high as \$25 billion, although many experts believe the total will come in lower. More than 1,300 people in Louisiana died during Hurricane Katrina and the ensuing floods last year. And while the deaths cut across all races, it was age that appeared to determine the likelihood of survival. Nearly 40 percent of the people identified so far were over the age of 71.

(2) Katrina's Impact on U.S. Energy Production

Hurricane Katrina impacted the oil and the gas infrastructure, not just short term but long term as well. More specifically, the impact of the storm was that the Gulf was shut down; all of the affected areas of the storm were shut down; and a half billion dollars a day of oil and gas were unavailable.

The storm interrupted oil production, importation, and refining in the Gulf area, thus having a major effect on fuel prices. Before the storm, one-tenth of all the crude oil consumed in the United States and almost half of the gasoline produced in the country came from refineries in the states along the Gulf's shores. An additional 24% of the natural gas supply was extracted or imported in the region. Furthermore, the nation's Strategic Petroleum Reserve was also stored in this region.

Perhaps equally important were the power outages in the wake of Katrina which caused distribution problems for oil and natural gas. Pipelines which move petroleum products from places like Houston to areas of the east coast had their flow interrupted because of the power outages that shut down the pumps which kept materials flowing. After the storm, at least twenty offshore oil platforms were missing, sunk, or had gone adrift.

The Louisiana Offshore Oil Port, which imported 11% of all U.S. oil consumption, closed on August 27, and Shell reported a reduction in production of 420,000 barrels per day. The port was undamaged by the storm and resumed operation within hours of getting power back.

Due to fears that the production of oil in the United States would be cut by up to one-third of normal capacity, the price of oil fluctuated greatly. In some areas, gasoline was being sold for as much as \$6 per gallon. International oil prices also rose. In the United Kingdom, pump prices for unleaded petrol (gas) hit £1 per liter (\$7 per U.S. gallon) for the first time in a significant number of places (averaging about 95p), a rise of about 3% from pre-Katrina prices. Wholesale prices were up 5% by September 6. Long lines developed at some gas stations throughout the U.S. as customers rushed to buy gasoline, anticipating price increases in the wake of the storm.

As a result of Katrina, by August 31, eight Gulf of Mexico refineries remained shut down, and one was operating at reduced capacity. Aside from the problems involved in restarting the refineries (which is a lengthy process) there were additional major issues with worker housing, since a large proportion of homes were destroyed by the hurricane.

The Environmental Protection Agency moved to reduce prices by temporarily lifting fuel standards in America until September 15. Some crude oil was also released from the Strategic Petroleum Reserve, as well, to combat prices as major economic consequences were predicted if prices remained high for a long period of time. Also consumer spending dropped and this alone caused many foreign economies, especially in Asia, to suffer. Ultimately, President Bush also temporarily waived the Jones Act, allowing foreign oil companies to ship oil between ports of the United States.

By September 7, Gulf oil production had returned to 42% of normal. Of 10 refineries that were shut down by Katrina, four were expected to be back at full capacity within a week; however another four could be out of commission for months.

(3) Katrina's Impact on the Gambling Industry

Katrina forced many casinos along the Mississippi Gulf Coast to close and evacuate. Before the storm, at least 14,000 people were employed at Gulf Coast casinos. Listed below are the specific details of major casinos which were impacted.

- 1) The Hard Rock Hotel & Casino was scheduled to open the first week of September, but has remained closed indefinitely due to structural damage.
- 2) The Beau Rivage was severely damaged by water that reached the third floor, but seems to have suffered the least damage of the beachfront casinos.
- 3) Grand Casino Biloxi had its mammoth gaming barge blown across U.S. 90. Treasure Bay's pirate ship was washed ashore.

- 4) The President Casino Biloxi was washed across U.S. 90 and landed on top of a Holiday Inn, nearly a mile (2 km) from the casino's berth.
- 5) In Gulfport, the western Grand Casino Gulfport barge, containing Kid's Quest, washed across U.S. 90 and was left blocking the highway.
- 6) The Copa Casino barge was pushed onto land next to the Grand Casino Gulfport's parking garage.
- 7) Casino Magic and Isle of Capri in Biloxi both suffered heavy damage to their gaming barges, likely beyond repair.
- 8) Harrah's New Orleans closed shortly before the storm and sustained storm damage. The building was also used by first responders as a base of operations in the days following the storm.

An update since the hurricane revealed that Harrah's casino reopened on February 17, 2006, just in time for Mardi Gras, and the Beau Rivage Resort and Casino in Biloxi, Mississippi, reopened on August 29, 2006, on the one year anniversary of Hurricane Katrina's landfall. The Grand Casino Biloxi is undergoing extensive renovation, and is expected to reopen during the summer of 2006. The Grand Casino Gulfport was destroyed as portions of the structure collapsed across Highway 90 and was demolished.

(4) Katrina's Impact on Agriculture and Forestry

According to the United States Department of Agriculture (USDA), the national impact of Hurricane Katrina on Gulf Coast crops was described as minimal, with most of the damage borne by minor producers of major crops (corn, soybeans, and cotton). The main impact of the storm on agriculture is likely to involve ocean shipping and exports. In 2004, 22% of U.S. wheat exports, 71% of corn exports, and 65% of soybean exports passed through Gulf ports. However, major grain shipping usually does not occur until later in the fall, when ports would again be operational.

In addition to the 48 Mississippi counties covered by the Presidential primary natural disaster designation, the USDA declared an additional 31 counties as primary agricultural disaster areas. This made farmers and other agricultural producers eligible for low interest emergency loans to cover losses. The remaining four Mississippi counties were classified as, "contiguous" and were also eligible for assistance.

Gulfport, Mississippi serves as a major ocean shipping port for the southern United States, which was found to be inoperable for as much as one year. Chiquita, Dole, Crowley, Gearbulk, P&O, and others had significant operations in Gulfport. On a short-term basis, these companies have relocated necessary operations to unaffected ports.

Forestry constitutes a major industry in southern Mississippi, accounting for 10% of all jobs in the state. According to the Mississippi Forestry Commission, Hurricane Katrina caused significant damage to 1.3 million acres (5,300 km²) of forestland in the state. The greatest damage occurred from the coastal counties northward to Laurel, with heavy damage to pine forests in Hancock, Harrison, and Pearl River counties.

An estimated 14.6 million cords (52,900,000 m³) of paperwood and 3.2 billion board feet (7,600,000 m³) of sawtimber were destroyed. The estimated economic impact of this loss was \$1.3 billion. Additionally, there was an estimated \$1.1 billion in damage to urban trees in 181 Mississippi communities.

(5) Katrina's impact on the ecology

A major economic impact which is sometimes overlooked is the economic impact of the ecological damage. This research attempts to translate these damages into comparable dollars. The ecological consequences from Katrina were considerable: storm surges flooded coastal areas. Powerful winds felled forests in south Louisiana and Mississippi which were havens for wildlife and migratory birds. Saltwater and polluted floodwaters from New Orleans surged into Lake Pontchartrain. Wetland restoration plans must close or restrict the Mississippi River Gulf Outlet, a canal that contributed to the flooding of New Orleans and disconnects the river from its delta plain. Wetlands help stem storm surges and diffuse powerful winds.

The continuing effects of saltwater intrusion driven by Katrina can be still seen in the wilting trees and plants far from the coast. The inland saltwater intrusion caused the state's rice crop to decrease by 20 percent this year. The canals that connect the city to the coast allow storm surges to travel inland, bringing salt water that damages the land. An example of such a canal is the Mississippi River Gulf Outlet, which was built in the mid-1960s to be a 76-mile (122-kilometer) shortcut between the Gulf of Mexico and New Orleans. Before the record hurricane season of 2005, salt water brought inland by the canal was fingered as the culprit in the death of thousands of acres of cypress swamp, a natural buffer against storms. When Katrina hit, levee failures on the canal allowed water to pour into St. Bernard Parish and New Orleans East.

Some fields could take up to two years to recover. The rice acreage was down in southwest Louisiana by about 80,000 to 90,000 acres [32,400 to 36,400 hectares] because of the storm surge. Many plants were not planted because of soil contamination or contaminated waterways that would be used to flood the rice fields. Lake Pontchartrain is one of the few examples of quick ecological recovery following the record storm season.

In the weeks after Katrina, polluted floodwaters dubbed the toxic stew were pumped directly from the streets of New Orleans into the lake. It was estimated by Carlton Dufrechou, an environmental engineer and executive director of the Lake Pontchartrain Basin Foundation, that about 10 billion gallons (38 billion liters) of contaminated water were dumped into Pontchartrain. One saving grace was that it was less than 10 percent of the lake's volume, therefore the bacteria counts dropped almost immediately after the pumping stopped in October.

The barrier islands that extend from Texas to Florida have historically served as the Gulf Coast's major natural protection from hurricanes. These long thin islands just off shore buffer the mainland from strong winds and ocean waves. The constant battering from intense tempests over the years has taken its toll on these islands. Hurricane winds cut Petit Bois Island from Dauphine Island 150 years ago, and in 1969 Hurricane Camille sliced Ship Island in half. Additionally, canals and levees along the Mississippi River prevent fresh sediment deposits from building the islands back up.

Louisiana's Chandeleur Islands—which have shrunk considerably in the past decade—were almost wiped off the map because of Katrina. According to Rick Clark, chief of science and resources management for the Gulf Islands National Seashore, “Katrina's towering storm surge completely washed over most of the barrier islands along the Mississippi coast, scattering hefty amounts of debris. A substantial amount of our recovery effort was just getting that inorganic debris off [Ship Island]. Some of it is still scattered; heavy equipment and all-terrain vehicles that might have ended up in a pond or an area that is just too sensitive for us to go in right now.” For the future, scientists say, there are many viable solutions for restoring and protecting the coast against further storm damage.

Thick layers of sediments deposited over the coast can help create wetland sustainability, but it will become more difficult to maintain in coming years because of more frequent and more intense hurricanes. Raising public and political awareness of the threats to Louisiana's ecology is the most critical path of action.

2. Review of Salt Water Intrusion

When fresh water is withdrawn at a faster rate than it can be replenished, a draw down of the water table occurs with a resulting decrease in the overall hydrostatic pressure. When this happens near an ocean coastal area, salt water from the ocean intrudes into the fresh water aquifer. The result is that fresh water supplies become contaminated with salt water as is happening to communities along the Atlantic and Gulf coasts.

More specifically, saltwater intrusion is the movement of salt water into a non-salt water environment, such as a freshwater marsh. This intrusion may occur as the result of a natural process like a storm surge from a hurricane or from human activities such as construction of navigation channels or oil field canals. These channels and canals provide conduits for salt water from the Gulf of Mexico to reach deep into interior marshes.

Saltwater intrusion can be detrimental to these marshes because water with high salt concentrations can adversely affect vegetation in the marsh. For instance, when highly saline water enters a low-saline or non-saline area, most or all of the native plant life will be destroyed. Because plant root systems are essential in holding the marsh soil together, loss of plant life eventually leads to rapid erosion.

Saltwater intrusion is a natural process that occurs in virtually all coastal aquifers. It consists in salt water (from the sea) flowing inland in freshwater aquifers. This behavior is caused by the fact that sea water has a higher density (which is because it carries more solutes) than freshwater. This higher density has the effect that the pressure beneath a column of saltwater is larger than that beneath a column of the same height of freshwater. If these columns were connected at the bottom, then the pressure difference would trigger a flow from the saltwater column to the freshwater column.

The flow of saltwater inland is limited to coastal areas. Inland the freshwater column gets higher and the pressure at the bottom also gets higher. This compensates for the higher density of the saltwater column. Where this happens, saltwater intrusion stops.

The higher water levels inland have another effect: they trigger flow of freshwater seaward. This completes the picture: at the sea-land boundary, at the high part of the aquifer freshwater flows out and in the lower part, saltwater flows in. The saltwater intrusion assumes the virtual shape of a cone.

Saltwater intrusion is a natural process, but it becomes an environmental problem when excessive pumping of fresh water from an aquifer reduces the water pressure and intensifies the effect, drawing salt water into new areas.

When freshwater levels drop, saltwater intrusion can proceed inland, reaching the pumped well. Then saltwater, is unfit for drinking or irrigation. It will then be produced by the pump. To prevent this, more and more countries adopt extensive monitoring schemes and numerical models to assess how much water can be pumped without causing such effects.

The first physical formulations of saltwater intrusion were made by W. Baydon-Ghyben (1888, 1889) and A. Herzberg (1901), thus called the Ghyben-Herzberg formulation. They derived analytical solutions to approximate the intrusion behavior, which are based on a number of assumptions that do not hold in all field cases. The Ghyben-Herzberg ratio

states, for every foot of fresh water in an unconfined aquifer above sea level, there will be forty feet of fresh water in the aquifer below sea level.

Over the years, many laboratory and field experiments have been conducted to estimate decreases in crop yield as a function of increasing levels of salinity in the soil root zone. Knowledge of the ability of crops to tolerate salinity and still produce a measurable agricultural product is critical to optimal management of salt-affected lands. In 2004, Harold Steppuhn, Van Genuchten and Grieve made a detailed assessment of available literature and devised a general relationship that accurately estimates crop yield in response to soil root-zone salinity. Their data indicated that product yields of agricultural crops grown subject to increasing levels of root-zone salinity decrease according to a sigmoidal-shaped response curve. Comparisons among six possible empirical response models applied to the results from a spring wheat test crop reveal that the modified compound-discount function is the most precise. This function features two parameters: the salinity level causing a 50 percent product loss, and the absolute value of the general decline in relative crop yield with salinity at and about the 50 percent yield level. Combined, these parameters form a salinity tolerance index (the ST-Index) useful in developing crop lists of tolerances to root-zone salinity.

Even so, the modeling of saltwater intrusion is considered difficult. Some typical difficulties that arise are:

- The possible presence of fissures and cracks and fractures in the aquifer, whose precise positions are unknown but which have great influence on the development of the saltwater intrusion
- The possible presence of small scale heterogeneities in the hydraulic properties of the aquifer, which are too small to be taken into account by the model but which may also have great influence on the development of the saltwater intrusion
- The change of hydraulic properties by the saltwater intrusion. A mixture of saltwater and freshwater is often undersaturated with respect to calcium, triggering dissolution of calcium in the mixing zone and changing hydraulic properties.
- The process known as cation exchange, which slows the advance of a saltwater intrusion and also slows the retreat of a saltwater intrusion.
- The fact that saltwater intrusions are often not in equilibrium makes it harder to model. Aquifer dynamics tend to be slow, and it takes the intrusion cone a long time to adapt to changes in pumping schemes, rainfall, etc. So the situation in the field can be significantly different from what would be expected based on the sea level, pumping scheme etc.
- For long-term models, the future climate change forms a large unknown. Model results often depend strongly on sea level and recharge rate. Both are expected to change in the future.

Saltwater intrusion is also an issue where a lock separates salt water from fresh water (for example the Hiram M. Chittenden Locks). In this case a collection basin was built from which the salt water can be pumped back to the sea. Some of the intruding salt water is also pumped to the fish ladder to make it more attractive to migrating fish.

Fresh water is a scarce resource. According to the World Meteorological Organization, only 2.5 percent of the total water volume on the Earth is fresh water and the remainder is saline. The largest available source of fresh water still lies underground and the availability of surface water has become sparse in many areas in the world. Groundwater is used extensively to supplement available surface water to meet ever increasing water demand in the world. When considering the water resources in areas bordering seas, coastal aquifers are important sources of fresh water.

Use of coastal aquifers as operational reservoirs in water resource systems requires the development of tools that facilitate the prediction of the aquifer behavior under different conditions. Quantitative understanding of the patterns of movement and mixing between freshwater and saltwater, as well as the factors that influence these processes, are necessary to manage the coastal groundwater resources. It is imperative to understand these processes when planning salinity management strategies. Hence, the studies on saltwater intrusion have become necessary in designing and planning of groundwater systems in coastal areas.

In nature, the freshwater-saltwater interface seldom remains stationary. Large scale recharge into the aquifer as well as withdrawals from it will result in the movement of the freshwater-saltwater interface from one position to another. The movement will advance or retreat, depending on whether the freshwater flow through the aquifer is decreased or increased. Therefore, change in groundwater recharge directly affects the saltwater intrusion. Subsequently, saltwater intrusion of coastal aquifers will accelerate due to the reduction of groundwater recharge. This could mean a reduction of fresh groundwater resources in coastal aquifers. Even though groundwater recharge is the major source of freshwater across most aquifers, particularly in arid and semi-arid regions, there has been very little research on the potential effects of groundwater recharge on saltwater intrusion and factors affecting the saltwater intrusion.

3. Economic Impact of Salt Water Intrusion for Hurricane Katrina

Economic impact studies measure direct and indirect effects on an area economy. Direct impact refers to the area's spending on goods and services, its various sources of income, and employment levels. Indirect impact is the effect of the area's spending and employment on other sectors of the economy through the multiplied impact of spending and job creation. The indirect impact is an attempt to measure the impact on various businesses and industries that depend on the re-spending of income and other expenditures generated by an area. The analysis in this research begins the creation for estimates to be used in explaining the direct effects of salt water intrusion as a result of hurricane Katrina.

Hurricanes Katrina caused tidal surges that left concerns about salt deposition in soil. The unprecedented flooding inundated almost 40,000 acres of sugarcane in the coastal parishes of Louisiana.

While a considerable acreage of sugarcane was damaged or killed by the direct effects of the flood waters, the extent of the effects on sugarcane from the salt content of sea water is not completely known.

Representatives of several state and federal agencies met in October to discuss the hurricanes and their aftermath. A decision was made to develop a soil sampling protocol to be used to survey the soils in the flood zone for salinity.

Initial sampling was limited in scope and specifically sought information on the enormity of the salt contamination problem. Seven sites across Iberia, St. Mary and Vermilion parishes were chosen for the initial round of sampling. The sites were selected on the basis of soil texture, depth and duration of the flood waters and distance from the coast.

Soil cores were taken at depths of 0-3 inches, 3-6 inches, and 6-12 inches to determine the distribution of salt within the soil profile.

The amounts of salt measured in the first samples varied widely, as anticipated. The highest concentration was found at the 0-3 inch depth, ranging from 268 to 4,329 ppm. Though salt levels decreased with depth of sampling, the saltiest site contained almost 2,000 ppm in the 6-12 inch core.

The level of salinity across sites was not predictable and did not appear to be associated with texture or any other variable.

Published reports suggest sugarcane is moderately sensitive to salt, with a saturated-extract electrical conductivity (EC) threshold for yield reduction at 1.7 dS m⁻¹ (multiplying dS m⁻¹ times 640 equals ppm). Research in Texas measured reductions in Brix, pol and purity and increases in fiber with each dS m⁻¹ increase in EC.

Because salt levels for most sites in the survey exceeded that of the salinity damage threshold of approximately 1,100 ppm, an additional 20 sites were sampled across a four-parish area in early November. A couple of the new sites contained levels of over 6,000 ppm in the surface 3 inches of soil.

Twelve of the original sites were re-sampled in early February to determine whether sufficient leaching had occurred to reduce the salinity. Surprisingly, despite over 14 inches of rain at several sites, salinity levels increased at five of the 12 sites.

At the time of the February re-sampling, a majority of the sampling sites contained salt at levels which exceeded that of the damage threshold of 1,100 ppm.

Flooding of agricultural land by hurricane storm surges can have both short-term and long-term effects on both crops and soil structure. While most of the "salt" in seawater is sodium chloride (table salt), it also contains appreciable amounts of magnesium sulfate (Epson's salts) and other elements.

After heavy rains, sodium and chloride will be preferentially lost in runoff and leachate. Therefore, within the next two years, much of the agricultural land flooded by last season's storm surges should naturally recover and return to previous levels of productivity.

Recovery will occur more quickly in fields that received lower amounts of salt. A few areas that accumulated very high levels of salt are possibly at risk of becoming sodic, and may not recover without help.

The storm surge analysis offered by the LSU AgCenter's Soil Testing Lab reports both salinity (ppm) and SAR (sodium absorption ratio). Salinity (ppm) is the better indicator of the salt impact on crops; however, if the SAR is greater than 15, the site should be carefully monitored. Not only will it take considerable time for salinity levels to drop, but the field is at risk of collapsing during the process. Water will not infiltrate a collapsed soil, the pH will rise above 8, and toxic amounts of sodium will remain.

Reclaiming such soils is costly and requires addition of large amounts of gypsum plus mechanical drainage. None of the sites in their initial monitoring studies is currently in need of gypsum, but some would benefit from the addition of lime. If a field has an SAR >15 and low pH, application of agricultural lime will ensure that sodium is leached and sodic conditions are avoided. Even where the SAR is <15, if soil pH is below 6.0, the addition of lime can help offset the effects of excessive salt and accelerate the leaching process.

Monitoring of soil salt levels will continue until sugarcane harvest, at which time a yield impact assessment will be made in an attempt to confirm the applicability of the salinity damage threshold for sugarcane in Louisiana.

Preliminary estimates of the economic impact from hurricane Katrina to Louisiana agriculture were calculated as well over \$1 billion dollars (refer to table 1 in the appendix). The major contributing factors which led to these impacts were reduced revenue, lower market prices and increased production cost. The three largest commodities which were impacted were forestry (\$612.9 M), agronomic crops (sugarcane, cotton and rice) (\$156.1 M) and fisheries (\$142.2 M). Damage estimates for forestry were developed based on forestry industry personnel's assessment of the percentage of timber affected in impacted regions and the expected Christmas tree loss. Damage estimates for sugarcane were based on personnel's assessment of production losses, increased planting and harvesting costs and revenue loss and increased costs associated with flooded cane acres. Experience with past storms has indicated that sugarcane production could be affected by 10 to 15 percent in subsequent future years because of carry-over effects including saltwater intrusion. These estimates include an estimate for the direct economic effects of salt water intrusion.

4. A Specific Case of Salt Water Intrusion in New Orleans's City Park

The impact of salt water intrusion on New Orleans's City Park was enormous. Katrina's floodwaters damaged 122 park buildings and submerged 90 percent of City Park in saltwater, killing the grass on the golf courses and the plants in the botanical garden. More than four feet of water in the parks administration building ruined computers, archives and records. A portion of the maintenance building collapsed and nearly every piece of equipment was destroyed. Total park damages are estimated at well over \$43 million.

Since the storm, the 1,300-acre park has reopened many of its facilities, including the golf driving range, the Botanical Garden, pavilions and tennis courts. Saltwater and muck covered the fountain and its surrounding grounds during flooding after Katrina, and a 2,700-foot ornamental iron perimeter fence sustained major damage. The Starwood-led effort included landscaping, general cleanup and fence-painting, along with a push to clear nearby limbs and debris from the banks of a nearby bayou. While the 11-acre Popp Fountain site is a minuscule slice of the 1,300-acre park between Lakeview and Bayou St. John, it holds unusual interest because of its history -- and, especially now, it's potential for generating money. In the months before Katrina, the fountain area brought in \$1,750 in rent for each private party, not including income from catering and liquor sales, and the cash-starved park is determined to open it up to private rental again in coming months.

Hurricane Katrina took down about 1,000 of the park's 14,000 trees and snapped thousands more limbs. Muck smeared roads and paths. Salty floodwater had poisoned acres of grass and thousands of plants. More than 90% of its 1,300 acres were submerged after the surge from Lake Pontchartrain spilled in from the 17th Street Canal, a mile west. Katrina derailed the park's kiddie railroad, destroyed vehicles and damaged every building. Four swans ended up in a park across town. All of the paddleboats floated away.

City Park is as integral a part of the New Orleans community as are the police, the firefighters, and the doctors. With virtually no park income, approximately 98% of the \$10.8 million annual budget came from user fees and donations. Katrina destroyed the revenue base and caused a lay off of more than 90% of the 260-member staff. Repairs will cost well over \$43 million, much of which the Federal Emergency Management Agency may cover. Additionally the operating funds for the park will be scarce for months. City Park gets no city money and only \$200,000 a year from the state. Nominal income now includes only fees from an occasional footrace and from the tennis courts. Before Katrina, a steady parade of people found recreation and relaxation in barbecues, golf, high school football, family reunions, softball, soccer, boat rides and so many weddings that the park was the largest non-hotel caterer in town. In summary, Hurricane Katrina changed the following aspects of City Park:

- 1) Trees. The signature live oaks lost many limbs, but most survived. Many magnolias and pines and 150 cypress trees did not. The brackish deluge may have killed 1,000 more trees that won't show until spring.
- 2) Plants. The saltwater flood killed all but a fraction of the garden stock which includes 2,100 plants. The rose garden alone lost 1,658 bushes.
- 3) Golf. The three Bayou Oaks courses, a key revenue source and the South's largest municipal golf center, were wiped out, a \$15 million loss. They are unlikely to reopen until many more people return.
- 4) Amusements. Besides the wrecked mini-train, the park rides are closed, as is Storyland, a garden with fairy-tale figures. Katrina buckled the century-old carousel's floor but spared its antique carved horses. Staffers salvaged fallen cypress logs for a saw mill to cut new floorboards.
- 5) Other facilities. Tad Gormley Stadium, site of the 1992 U.S. Olympic track and field trials and a 1964 Beatles concert, took a \$2 million hit. The New Orleans Museum of Art suffered \$6 million in damage and had to lay off most of its staff, but all of its artworks survived.

For now, the biggest potential income source for New Orleans's City Park is rent. Park managers hope to win FEMA approval to install up to 1,800 trailers for residents whose homes were lost. Scores of cleanup workers already pay to park RVs or to pitch tents there in the park.

5. Summary

Approximately 70% of the world's population lives in coastal areas. Groundwater systems in coastal areas will continue to come into contact with saline water; therefore, one of the major problems is saltwater intrusion. Saltwater intrusion will continue to replace the fresh water in coastal aquifers by saltwater due to the motion of a saltwater body into the freshwater aquifer. Saltwater intrusion will reduce the available fresh groundwater resources in coastal aquifers. At present, many coastal aquifers in the world, especially shallow ones, experience an intensive saltwater intrusion caused by both natural and human-induced processes.

Changes in climatic variables, such as precipitation and temperature, and the land-use change have significantly altered groundwater recharge rates for major aquifer systems. Under such circumstances it is important to study the problem of saltwater intrusion and to accurately estimate the saltwater intrusion due to changes in recharge or discharge of groundwater and related activities such as climate changes and change in land-use pattern.

Climate change will have profound effects on the hydrologic cycle through altered precipitation, evapotranspiration, and soil moisture patterns. Atmospheric carbon dioxide levels have continually increased since the Industrial Revolution. The continuation of this phenomenon may significantly alter global and local climate characteristics, including temperature and precipitation. Extra precipitation will continue to be unequally distributed around the globe. Some parts of the world may experience significant reductions in precipitation, or major alterations in the timing of wet and dry seasons. These changes will lead to altered groundwater recharge in watershed areas, which will change the groundwater flow to coastal regions and determine the rate of saltwater intrusion in coastal aquifers. Therefore, information on the local or regional impacts of climate change on hydrological processes and coastal water resources is becoming more important. Inclusion of these activities as a part of the management planning stage is paramount for coastal areas.

Changing land use and land management practices can also alter the hydrological system. Land-use change has a direct effect on hydrologic processes through its link with the evapotranspiration regime on one hand and the sometimes extreme change in surface runoff on the other hand. Hence, land use also plays a major role in assessing groundwater resources. Precipitation is the primary source of groundwater and varies both temporally and spatially. For most hydrological applications, it is appropriate to assume that precipitation is independent of vegetation type, and evapotranspiration and surface runoff are closely linked with land-cover characteristics. A large number of land-use impact studies on water resources have been carried out for watersheds with a focus on water scarcity, flood, erosion, and water management.

The accumulation of economic and ecological damages from hurricane Katrina is still increasing. Many effects still need to be evaluated, and only time will determine the devastation, including salt water intrusion. Future studies, which will account for the immediate and the long-term effects and as well the indirect economic effects of salt water intrusion, will become increasing more important as the dollar value for Katrina continues to mount. Modeling these economic impacts will increase our knowledge and assist planners in preparing for future variable weather patterns.

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Appendix

Table 1. Louisiana Agriculture Preliminary Economic Damages: the direct effects of Salt Water Intrusion (\$Million)

Commodity	Est. Economic Damages
Timber	\$611
Christmas Trees	2
Sugar Cane	145
Cotton	10.4
Rice	0.483
Vegetables	2.57
Usuries	19
Citrus	11
Alligators	3.8
Turtles	5.4
Fisheries	142.2
Total	\$953



Organic Farming as A Development Strategy:

Who are Interested and Who are not?

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Abstract

Much evidence shows that implementation of organic farming (OF) increases productivity in the Global South, and that it will be possible to feed a growing world population with food produced in OF systems. OF is explored, analysed and discussed in relation to the principles of Ecology, Health, Care and Fairness as enunciated by IFOAM, as a developmental strategy.

Major financial powers are involved in the agro-related industries. A number of civil society-based organisations point to the major negative side effects of the trade with and use of agro-chemical products environmentally and in the further deepening of the gaps between rich and poor. The MDGs target the environmental sustainability explicitly, and OF is regarded as being a relevant strategy to meet many goals. A global development strategy is needed that explicitly includes future generations, ecosystems, biodiversity and plant and animal species threatened by eradication.

Keywords: Organic farming principles, Health, Care, Fairness, Ecology, Development strategy, Millennium Development Goals (MDGs), Food security

1. Introduction: Organic and agro-ecological agriculture can feed the world – if we want to

Organic and agro-ecological farming methods are based on the key principles of Health, Ecology, Fairness and Care enunciated by IFOAM (IFOAM, 2005; see Table 1). These principles are implemented in various sets of standards, legislation and guidelines in different countries, and are valued by the consumers and citizens of those countries for different reasons, such as that they guarantee healthy food production, assure environmental protection and emphasise local resources and food systems.

In the Global South, the meaning of ‘organic farming’ very often becomes confused with ‘farming with no chemical inputs,’ ‘traditional farming’ or ‘certified organic farming for export’. In this article, organic farming refers to farming according to the four basic principles mentioned above, a concept which does not necessarily imply certification. Organic farming following the principles in practice enhances soil fertility and biodiversity (Note 1), while minimising land degradation, erosion, poisoning and other negative side effects of chemical or industrialised agricultural activities. In the following, the use of the term ‘agro-ecological’ will be used in relation to the specific methods which contribute to this kind of farming. Agro-ecological farming methods include, for instance, inter-cropping, mulching, use of compost, crop rotation and non-chemical pest and disease prevention.

During recent years, a number of inter-related crises have caused concern, such as the so-called ‘global food crisis’ (although a ‘food crisis’ is not a new phenomenon [Sen 1999; Halberg, *et al.*, 2009]) the financial crisis, and the climatic crisis. The attention has mostly been on trying to protect those most vulnerable to food insecurity, primarily by creating long term strategies to ensure food for increasing number of chronically hungry people (now estimated to be close to 1 billion), and to prevent crises for future generations. In this context of crisis, the main concern raised has been how we can produce food enough on a global level for a growing population, and with the use of chemical inputs and genetically modified and high yielding varieties of crops being promoted as the solution; whereas organic farming has been regarded as ‘low-yield’ and unproductive, and even as a luxury production for the few people who can afford to pay extra for products which are grown in ways and under circumstances which do not fully use the capacity of the land. Halberg, *et al.*, (2009) explain that this view is raised when limiting the understanding of ‘organic’ to, *e.g.*, an export production of certified organic products, such as, for example, fruit, coffee or cotton, from the global South to the wealthy North and West. Farnworth and Hutchings (2009) point to certified organic farming as predominately

driven and supported by political, cultural, economic and social structures that are located within western ideologies and practices, while Halberg *et al.*, (2009) note that organic certified production of a cash crop does not necessarily lead to introduction of the organic principles on the farm level as a whole. When organic farming is understood to conform to the principles mentioned above, the misperception of 'organic' as 'extensive and non-productive' can arise. There are several pieces of evidence, however, that prove that this is a false perception, in particular when talking about tropical agricultural systems. Halberg, *et al.*, (2006) conclude on basis of evidence from projects and modelling that organic agriculture does not increase food security problems, but on the contrary, presents solutions to them both in terms of increased productivity and of improved access to food. Where the yield often drops when converting chemical farming systems to organic production (as is e.g. shown in Europe), several studies show that yields often more than double when converting from traditional farming systems or through consciously building up soil fertility using purely non-chemical methods (Badgley, *et al.*, 2007; Halberg, *et al.*, 2006; Funes-Monzote, 2008; IAASTD, 2008; Pretty & Hine, 2001; Pretty *et al.*, 2006). Furthermore, use of farming methods can maintain or even increase the fertility of the soil, while producing healthy, diverse food locally for people (Altieri, 2002; Pretty, 2006): Much evidence exists showing that farming systems can be organised in ways which maintain a high yield for the present population without degrading the land (eco-functional intensification, as described by e.g. Halberg *et al.*, 2009), and in systems which become increasingly resilient in response to change. One concrete example is given in Box 1 to illustrate the contribution of a conscious agro-ecological approach to farming in a vulnerable and partly degraded local area in Ethiopia.

The organic principles of Fairness and Care contribute to the idea of a farming and food system that is sustainable, meaning one which can be defined as 'meeting the needs of the present generation without compromising the possibilities of the future generations to meet their needs' (Note 2). Organic farming is *per se* sustainable, but the term 'sustainable farming' will not be used in the following, because it is overly broad and, in some contexts, does not exclude non-organic elements, e.g., the use of chemical inputs. In relation to the discussion of the Fairness principle, I will discuss the current generation's equal rights to food, goods and the sharing of responsibilities, decisions and work. I will also discuss future generations' same rights, which we may choose to disrupt or try to ensure through our current farming and food system practices. Moreover, aspects of the maintenance of ecosystems can both relate to the principle of Ecology and also to the principle of Fairness, viewing species of animals, plants and eco-systems as having their own right to exist.

In a fairly recent report by the UNCTAD-UNEP Capacity-Building Task Force on Trade, Environment and Development (CBTF), it was stated that '*the evidence presented in this study supports the argument that organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long term. This is in line with the findings of the Food and Agricultural Organization of the United Nations (FAO) International Conference on Organic Agriculture and Food Security, held in May 2007. Therefore we encourage policymakers and development cooperation partners in Africa and around the world to take a new look at this promising production system with fresh eyes. It offers not only improved food security, but also an array of other economic, environmental, health and social benefits*' [signed by Supachai Panitchpakdi, Secretary-General of UNCTAD and Achim Steiner, Executive Director of UNEP]' (UNCTAD-UNEP, 2009). Thus, with particular reference to Africa and more specifically East Africa, the group behind this report emphasised the potentials not only for food security in relation to organic farming, but also a number of other aspects, which partially will be explored in the following.

Agro-ecological methods build primarily on local resources and rely on interactions with natural systems, and there are no patents or major trade systems involved. Since these methods do not use industrially produced inputs, they are not connected to economic interests. No patent rights exist on 'working with nature' methods of farming. Very often, they are quite labour-intensive farming systems, managing many types of crops and products. Furthermore, the methods require knowledge, awareness and an ability to reflect and be innovative. These farming methods are therefore owned by the people who practice them. In this understanding, organic farming also contributes to the enhancement of food sovereignty (Note 3). This concept will only be mentioned in the discussion of the Fairness principles, but will not be treated in depth in this article.

The aim of this article is to explore, discuss and analyse organic agriculture in relation to the four principles of Ecology, Health, Care and Fairness, as a development strategy in relation to food security for current and future generations with specific focus on sub-Saharan Africa. This includes a review of existing goals and strategies for development as expressed in the Paris Declaration and the Millennium Development Goals (MDG), and with reference to actors, who express interest for or against organic farming as a future global development strategy.

2. Food security in terms of stability, availability and access

Food security 'exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life' (FAO, 2003, with reference to the

World Food Summit, 1996). Table 2 gives an overview of different dimensions of food security, and the current global food system seems to fail to address all dimensions of food security. This is not only due to the lack of food and productivity. Nærstad and co-authors (2007) point to the fact that Africa can feed itself, and that unfair distribution is a main reason for food insecurity. A highly distorted pattern of distribution can be described by contrasting priorities both in the industrialised part of the world and in the so-called developing world. The production of pork in Denmark (approx. 25 mill. pigs produced per year, a figure which is 5 times that of the country's population) means that approx. 70% of field crops in Denmark are used solely for animal feed, in addition to import of feedstuffs. Much of the produced meat is exported, and the average Danish consumer eats huge amounts of meat. In contrast to this, India is an example of a country with a huge number of chronically hungry people. More than 200 million people are food insecure, and the net export of agricultural products over the last decades have been between US\$1,000-US\$6,000 million annually (Chakravarty & Dand, 2005), or e.g. in 2006/2007, there was a net export of rice at 4 million tonnes (MAP, 2008). These and many other examples and cases lead to serious questioning about our priorities and real interest in solving the major problems with food insecurity for the world's poor, and the food sovereignty principles seem to answer the call for food systems which are in accordance with the organic principles (note 3).

Despite the drop in international food prices, local food prices remain high in many countries, and especially the prices of basic staple food in the Global South. The solution to the so-called 'Food Crisis' is clearly not to export cheap food to African or other developing countries. The dumping of cheap food and low world market food prices have proved to disrupt the local food systems and survival possibilities of poor African and Asian farmers, who cannot sell their crops because of swamping of the market by heavily subsidised, cheap and industrially produced food from, e.g., EU or USA (Sen, 1999, p. 207). In addition, low world market prices and dumping of cheap wheat and other agricultural products mean that poor farmers in developing countries cannot compete and receive sufficient prices for their products, leading to increased poverty.

3. The principle of Ecology: Enhancing resilient agricultural systems through the use of agro-ecological farming methods

An apparently increasing international consensus seems to have been created, focusing on resilience in agricultural systems as a response to food crises and climatic changes (FAO, 2008; United Nations, 2008). United Nations (2008) recommends that *'the likely increase in extreme events, such as droughts, floods and pest outbreaks (which are not considered in these projections) suggests that it would be a risky strategy to focus the response to climate change exclusively on adaptation'*. Resilience can be understood as diminishing vulnerability through a focus on increasing the adaptive capacity of the people as well as the ecosystems in which they depend (Adger, 2003). This needs to build on farmer knowledge and capacity building, soil and water resource management and enhanced biodiversity. As illustrated in Table 1 above, the organic principles and the use of agro-ecological agricultural methods will contribute significantly to the creation of resilient farming systems.

As illustrated above (Box 1 and Introduction), the use of agro-ecological methods leads to increased soil fertility and many other features of resilient farming systems. The development of resilient farming builds on local knowledge and necessarily will interact with local eco-systems and conditions. The world – and especially the Global South – is covered by many vulnerable ecosystems, e.g., drylands, which cover approximately 40% of the surface of the land on Earth (and 65% of this is rangeland, of which approx. 40% can be cultivated despite low soil moisture). The Earth's drylands are inhabited by approx. a third of the global population, and 90% of these people live in developing countries (United Nations, 2008). The lowest GDP and the highest child mortality rates are seen in drylands, which are ecologically vulnerable and are particularly dependent on fragile ecosystems. Fresh-water systems are also under great pressure and are threatened, while eco-systems in a broader sense have undergone dramatic changes over the last decades, with many of these changes possibly connected to farming and unsustainable agricultural methods. As pointed to by Sarukhán & Whyte (2005; page 95): *'Because many ecosystems services are not traded in markets, markets fail to provide appropriate signals that might otherwise contribute to the efficient allocation and sustainable use of the service. Even if people are aware of the services provided by an ecosystem, they are neither compensated for providing these services nor penalized for reducing them. In addition, the people harmed by the degradation of ecosystem services are often not the ones who benefit from the actions leading to their degradation, and so those costs are not factored into management decisions'*.

Sarukhán & Whyte (2005) additionally give a state of the art of biodiversity in ecosystems on a global level, on the basis of which they conclude that humans significantly, and to some extent irreversibly, change life on Earth, with most of the changes relating to biodiversity, that is to say, that genetic diversity has declined significantly globally, mostly among cultivated species. The number of species on the planet is declining, and at the moment 10% to 30% of species are estimated to be threatened with extinction, especially in freshwater ecosystems. Thrupp (2000) also notes the link between the vulnerability of crops and the severe reduction of varieties, as, for example, in Sri Lanka, where the number

of rice varieties has decreased from 2,000 in 1950s to fewer than 100 in 2000. Much of the literature emphasises the need for local seed banks and a focus on local breeds (both plants and animals).

One can point to many elements of solutions to address the sustainable management of ecosystems, elements including the overcoming barriers such as inappropriate institutional and governance arrangements, including the presence of corruption and weak systems of regulation and accountability. In conclusion, many of these potential partial solutions point to a need and relevance of combining efforts toward the development of organic and sustainable agricultural systems with efforts to ensure environmental care and relevant, appropriate and effective eco-system management. Agricultural actors can therefore relevantly work together with actors from the environmental protection sectors.

4. The principle of Health in farming systems not involving chemicals

The principle of Health covers many facets of organic agriculture in tropical countries and elsewhere,--e.g., animal health promotion and management and the relationship of human health to a bio-diverse production allowing a well-balanced and nutritious diet. Nevertheless, the health aspect of merely avoiding use of chemicals for current and future generations will be the focus in the following.

Current farming practices involving use of mineral fertilizers and chemical synthetic pesticides have huge negative side effects, both in terms of poisonous effects on living organisms (Pretty, 2005) and of long term effects on ecosystems (Pretty, 2005). Through the stimulation of systems relying on mono-cropping, which cause land degradation through decreasing humus layer, severe long terms negative health effects are created. Bad side effects for the current generations of high-chemical-input farming were clearly demonstrated through the so-called Green Revolution in India, where the country reached a point of productivity where they could export food, but where severe negative side-effects on the ecosystems were created, and where many smallholder farmers were bypassed, while the number of hungry people remained over 200 million. The bad side effects are, if possible, even more critical to a number of 'silent actors': the eco-systems, biodiversity, and the yet-unborn future generations, who must suffer from irreversible poisonings of the environment. Africa is the continent least affected so far by chemical inputs (FAO, 2006), which really should increase awareness and motivate existing smallholder systems to become conscious of sustainable organic farming with use of those agricultural methods which do not create hazards for the environment or jeopardize the health of soil, plants, animals, humans and ecosystems.

5. The organic principle of Care with social capital in local communities as example

The principle of Care is also reflected in ecosystem management and is related to animal welfare and other issues linked to organic farming practices. With inspiration from the statement in the UNCTAD-UNEP (2008) CBTF-report on social capital as one of the major benefits of organic farming, this social capital will be the focus in this article's discussion about the principle of Care. Social capital is built up through--and at the same time stimulates--the interaction of marketing groups, civil society actors, associations, and NGO networks. Scialabba and Hattam (2002) also emphasise the potential of organic farming to strengthen human as well as social capital.

Social capital can be defined in various ways. Bordieu (1986, p. 51) defines social capital as *'the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition -- or in other words, to membership in a group -- which provides each of its members with the backing of the collectivity-owned capital, a 'credential' which entitles them to credit, in the various senses of the word'*. Bordieu's perspective is very much connected with his work about the connection of power relations to social conflicts and deprivation. This perspective seems relevant when addressing food distribution and access, on the levels of family, community and society. Bordieu sees social capital as a resource linked to social struggle. Munene and co-authors (2004) work with social capital from the point of view that the individual sacrifices something to the group or a network in order to gain on a long term basis to his/her own benefit. Munene *et al.* (2004) based their analysis on studies in Uganda with smallholder farmers in local communities, which showed how the building of social capital strengthened the local community and thereby benefitted all members in terms of food security. They emphasised the need for continuous stimulation from outside in order to develop both human and social capital in the local community, when they have exchanged and built on what is already in the group. When examining the relationship between social capital (as defined by Munene and co-authors) and organic farming, a mutual dependency seems to exist, because, on one hand, the group and the common effort can contribute to mutual experience exchanges, common learning and collaboration and perhaps can reach the level where advocacy is possible. On the other hand, it is in some cases necessary to collaborate and find common solutions when working with organic methods, as, for example, in the case of non-poisonous handling of certain endemic/epidemic diseases of organic livestock in the tropics, which successfully can be managed with a collected community effort (Vaarst *et al.*, 2005). Land-shaping, fighting certain plant pests and prevention of earth erosion also calls for a community effort rather than an individual effort. Agro-ecological methods and resilient farming rely on innovation and are knowledge intensive, and, consequently, the building of social capital as organic farming develops in a local community is absolutely necessary. In order to have effect, the network needs to overcome class, caste, gender and other traditional societal gaps.

6. The principle of Fairness guiding development and consolidation of organic farming and food systems

Where organic principles of Ecology and Health suggest a strong link to environmental policies, the principle of Fairness in particular links strongly with organisation of farming and food policies, social policies and trade systems throughout the whole food chain. Two – partly interrelated - aspects of fairness related to organic farming, namely the gender issues, and general trading policies which, among other things, deal with income generating organic production, will be treated in the following.

6.1 Gender aspects of organic farming practices

A recent report by Farnworth and Hutchings (2009) has analysed several aspects of gender issues and women's empowerment related to organic agriculture based on literature and case studies. Since agro-ecological farming practices are work-intensive, and since many women are heavily engaged in smallholder farming, it is important to target gender equality, especially in relation to traditional perceptions that certain responsibilities and types of work, decisions, privileges and assets are linked to each sex. They point to an important link between rural masculinity and especially conventional farming in the North, as shown in farm fairs and learning spaces, where the exclusion of women indicates male domination. Women are often linked to family food production and largely un-mechanised work, and they point especially to the knowledge of indigenous women, which is valuable in relation to sustainable agriculture development, and the fact that women often bring new and exciting understandings of sustainability, as well as they show different ways of interactions with societies and ecologies. Women generally operate small scale farms, where men take care of cash crop (including the money earned unless agreed otherwise). These aspects clearly need to be addressed when, for example, stimulating the development of networks, training, Farmer Field Schools (FFS), and common marketing initiatives. Farnworth and Hutchings (2009) further address women's agency (Note 4), which is not automatically gained through mere representation in groups, boards, positions, or having resources. Being supported, rather than dominated, by men will improve women's agency, and training, education and spaces for development will be necessary to create gender equity. How it should be organised – whether in purely female or in mixed groups – is context-specific, and both advantages and disadvantages are described for all models. Finally, Farnworth and Hutchings point to the fact that male actors dominate the whole chain of trade, which is a big challenge for the organic movement. Cash crop-focused farming is often more large scale, mono-cultural, mechanised and industrialised and therefore is often perceived to be closer to the male identity, but the advisors, traders and other external partners are also men, who mostly consider working exclusively with male farmers: '*A consistent and clear message was that the structure that organic farming operates within continues to privilege and give priority to relationships with men over relationships with women (page 4)*'. This issue of gender equality urgently needs to be efficiently targeted, because it is clearly linked to the basic principles of organic farming.

6.2 Trading and marketing organic agriculture products

Food security in the rural areas in Africa also includes income-generating activities. Rural households are still predominantly dependent on informal sources for their financial needs (United Nations, 2008), and, in general, access to credit has proved to have a positive impact on poverty reduction on long term basis. Various 'innovative finance possibilities' exist in rural areas, such as mobile banking, links between financial institutions and organisations, and weather-index-based insurance for agriculture (United Nations, 2008, p.16). Non-farm income generally represents a significant and increasing share of rural income in developing countries, in average up to 40% in Africa (Haggblade *et al.*, 2007).

Gura (2008a) points to the threat of corporate livestock farming as a means of displacing smallholders. This is because such farming leads to socio-economic, genetic and environmental damage, thereby posing a long term threat to food security. Contract farming is the most common approach to livestock industrialisation, and it can sound like a win-win situation, because this model keeps many people in their jobs and looks well-organised and efficient, but the principles emphasised in the food sovereignty concept are violated and the control over the food systems may be owned by people from outside the area. Gura (2008b) stresses that contract farming systems often are non-transparent, *e.g.*, because market risks are not shared equally between the contracted and the contracting farmers, so smallholders often loose in case of poor market situations (Gura, 2008b). Furthermore, they often include mass culling of local breeds and genetic uniformity and lead to environmental damage and export contracts, which does not improve the food security situation in a given local area (Gura, 2008 a&b).

When dealing with international trade in organic products, there is considerable work remaining to be done related to the Fairness principle, in particular the issue of certification of organic products for import--*e.g.*, the EU, where certification is 'owned' by European companies who inspect in accordance with EU regulations, and Ugocert, the East African certification system, is not fully acknowledged, although living up to the international standards. From 2003 to 2008, a task force organised by UNCTAD, FAO and IFOAM has tried to reach harmonization and equality among the various systems of certification of organic products worldwide (UNCTAD-FAO-IFOAM, 2008).

7. The interest of 'silent actors' in organic farming

The actors who probably will be intensely interested in the development of organic food and farming systems are future generations, who clearly do not have a voice yet. To meet future generations' need for healthy food, we need to maintain healthy soil and a food chain which enables fair distribution of food. The environmental sustainability of organic farming as compared to both conventional and many traditional farming systems--e.g., traditional systems relying on slash-and-burn-systems--is beyond question. A huge number of environmental benefits of organic agro-ecological farming practices exist, such as improving soil fertility, bio-diversity, prevention of earth erosion, farming in accordance with local conditions, water management and emphasis on local breeds (both seeds and animals). The organic agro-ecological farming practices enhance sustainability to the benefit of the future generations. The other 'silent actors' mentioned above, namely eco-systems, biodiversity and a number of species of plants and animals, can also be claimed to have an intrinsic value and therefore a moral right to survive and exist and not be destroyed and eradicated (Vilkkä, 1997), although taking an eco-centric position and expressing the value of ecosystems may – and in some cases does – include humans as part of the ecosystems (Curry, 2006). Alrøe *et al.* (2006) discuss ecological justice and ethics and point to the possible link between ecological and environmental ethics, which considers the extension of moral consideration beyond humans. A conscious inclusion of future generations and ecosystems into our development policies and strategies can be considered to be the present generations' agency and voice in order to prevent crisis on long term basis. The relevant question is whether our development policies consider future generations' and other silent actors' ability to survive.

8. A new green revolution in Africa involves actors who express interests against organic farming as a development strategy

'Alliance for a Green Revolution in Africa' (AGRA) is an initiative started in 2007 with the goals of reducing food insecurity by 50% in at least 20 countries, increasing income for 20 million people and putting at least 30 countries on track for an African green revolution. Bill and Melinda Gates Foundation and Rockefeller Foundation are among the donors for this initiative, which build on among others '*a steady flow of improved farming practices and new crop varieties developed to thrive in local climates and meet local needs*' (quote from their webpage (2009) <http://www.agra-alliance.org/>). In this initiative, the term 'sustainability' is also mentioned several times, although it seems to mean something different than in other sources, e.g., as defined in the Brundtland report, since the use of so-called improved seeds, chemical fertilizers and chemical pesticides seems to be involved. An example cited from Tanzania tells that AGRA's partnership has changed the lives of smallholder farmers by selling 'improved seeds, fertilizer, pesticides and other farm inputs to hundreds of small-scale farmers' from two successful shops (AGRA, 2009 p.9). One motivation and justification is the reference to the traditional slash-and-burn farming method, and it is clearly said, for example, that improving soil alone through use of organic matter is not enough, and in their strategy papers, organic or agro-ecological farming is not mentioned once.

Mittal (introduction of Mittal & Moore, 2009) analyses the rationale behind the AGRA initiative, and in this connection points to the heavy financial and other involvement from agro-industries, in particular the seed and breeding industries. Beyond a number of connections between agro-industries and the AGRA-initiative, Mittal (2009) points to the fact that investment in agriculture in general has declined over the past 3 decades, both from African governments and from donors. Even more seriously, she notes a growing uncompetitive and financially unstable initiative to introduce a flood of heavily subsidised cheap farm inputs, in addition to the way that markets have been opened to commodities being dumped from industrialised countries to African markets below their cost of production. This takes away the countries' ability to govern the inflow of these products, and the fact that any countries rely on export of few products (e.g., coffee and cocoa) increases their dependency on imports from industrialised countries, while simultaneously displacing their own small farmers. Mittal & Moore (2009) contain 15 contributions from different African countries raising a voice against the new green revolution for several reasons, including the loss of knowledge about indigenous farming methods, loss of biodiversity, food sovereignty, and one cited by Kabusimbi in the contribution simply entitled 'Hands off our food!': '*90% of the population in the majority of Sub-saharan African countries are peasant farmers with holdings averaging 2 hectares who use self regenerating planting materials, as opposed to state managed food production. Our method, giving the grassroots peasant farmers control of production of food for their own consumption, is the first defence against hunger*' (Mittal & Moore, p. 37). The dependence on wealthy countries' products in combination with the loss of biodiversity in terms of hundreds of varieties of each crop are major threats, especially in the time of climatic changes. Organic farming is based on local farming and food systems relying on local seeds and breeds, and local, often nature based, resources in harmony with the surrounding ecosystem. The many existing varieties have proved to fit the climatic conditions under which they have developed for centuries, and furthermore they are also much more likely to cope with climatic changes rather than hybrids developed under laboratory and growth conditions very far from Africa. The so-called New Green Revolution depends on predictable framework of inputs, weather and markets (Anonymous, 2008), and Holt-Gimenez *et al.* (2006) point to the critical issue of not addressing structural inequities in the market and political systems, relying on high input technologies and private sector initiatives.

Organic agriculture stays outside the global agro-chemical and seed industry (and other industries), emphasises local stability in food production, resilient farming systems and minimum reliance on food import (including dumped products), and thereby stays relatively independent of the world market prices. This means that the whole organic sector is less interesting for and attractive to actors who are key players within these areas of traded inputs for farming. For instance, most agro-chemical products and GM crops are produced almost exclusively in the Northern and Western hemispheres (industrialised countries) and are interrelated since more than 75% of the existing developed GM crops are characterised by nothing other than herbicide resistance [GMO Compass 2009].

9. Current development strategies

How are future generations and environment/ecosystems addressed in present development strategies, and how can OF contribute to reaching the goals? I have chosen to focus on two documents which create a basis for formulation and evaluation of current development strategies and projects among others in Denmark, namely the Millennium Development Goals (MDG) and the Paris Declaration, see Table 3.

Most of the MDGs can claim to target future generations through an assumption that when these goals are reached for the present generation, the situation will remain for the future generations. Goal 7, including the four sub-goals, explicitly targets what this article calls the silent actors, namely future generations and ecosystems, biodiversity and species and varieties threatened with eradication.

The strategies expressed in the Paris Declaration both are based on and target collaboration between countries and the forms in which development is brought about. All aid initiatives must build on the recipient countries' own strategies, policies and ownership of the processes. There is no explicit mention of future generations or the environment in terms of threatened species or vulnerable ecosystems. This leads to a conclusion that implementation of development strategies where the interests of the silent actors are included presupposes existing strategies and policies that include these interests in national and regional strategies. It furthermore raises the important question: Who is responsible for raising a voice for sustainability--in the meaning of the word expressed in the Brundtland report--and embracing the voiceless and those with no present power or financial interests?

Properly implemented organic farming based on the four principles seems to create a basis for a fair farming and food system, one which both meets the needs of the present and builds a framework which enables future generations to meet their needs in terms of food security, social capital and fair trading systems.

10. Conclusion: Organic agro-ecological farming: Are we interested?

Global organic food systems in accordance with the organic principles of Health, Ecology, Fairness and Care have the potential to contribute significantly to future food security and sovereignty relying on integrated, robust, resilient, productive and ecologically intensified systems, which are owned by the people practicing these methods in their daily life. The avoidance of chemical pesticides creates a healthy environment for all living organisms. The principles also include future generations and the silent actors--eco-systems, bio-diversity and wild as well as cultivated plant and animal species threatened with eradication. Capacity and knowledge building, education and strengthened social capital are necessary when using OF as development strategies, which stimulate empowerment and gender equity, as well as equality. The principle of Fairness points to an organisation of organic farming and food systems that emphasises gender equality throughout the sector, as well as within the trade system of national, regional and international markets.

Major financial powers are involved in the agro-related industries. The so-called Alliance for a new Green Revolution in Africa e.g. promotes subsidised agro-chemicals and GMO products in research and development initiatives for development of African farming. A number of civil society based organisations and movements illustrate the major negative possible side effects within this alliance, both in environmental terms and in the further deepening of the gaps between rich and poor.

The MDG explicitly target environmental sustainability and regards OF as a relevant strategy for meeting many of the goals. The Paris Declaration forms a basis for development strategies among others in Denmark, and deals primarily with forms of collaboration and partnerships. The Paris Declaration does therefore not give a basis for a development strategy on a global level explicitly addressing the interests of future generations, ecosystems, biodiversity or plant and animal species threatened by eradication.

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Notes

Note 1. In this article, biodiversity has two meanings, one being the number of varieties of a given species, e.g., that there are 2000 varieties of rice, and the other being the number of different varieties, types and species in a given area, e.g., a forest with a huge number of different plants, or a farm with a lot of different crops and/or animals.

Note 2. The term ‘sustainability’ is broad, used and understood in many ways, and has several dimensions as e.g. discussed by Halberg et al. (2006b), where the authors discuss sustainability based on economic, ecological and justice perspectives, or Spangenberg (2004) who includes economic, environmental, social and institutional aspects into the sustainability concept. Here, I use the rather simple definition of the Brundtland report: *Our Common Future: Report of the World Commission on Environment and Development*, 1987, web-version: <http://www.worldinbalance.net/agreements/1987-brundtland.php>

Note 3. Food sovereignty does not have an international definition but was defined by IAASTD (2008) as the right of peoples and sovereign states to democratically determine their own agricultural and food policies. The international movement Via Campesina defines Food Sovereignty by 7 principles: 1) Food: A basic human right, 2) Agrarian reform (especially targeting womens’ right to own land), 3) Protecting natural resources, 4) Reorganising Food Trade, 5) Ending the Globalization of hunger, 6) Social peace, 7) Democratic control.

Note 4. Sen (1999, p. 19) defines agency ‘as someone who acts and brings about change, and whose achievements can be judged in terms of her own values and objectives, whether or not we assess them in terms of some external criteria as well’.

Table 1. Keywords for the four IFOAM principles for organic farming, emphasising that many keywords cover more than one principle.

Organic principle as enunciated by IFOAM	Keywords for understanding the importance of the organic principles for development of food system with emphasis on food security and food sovereignty for current and future generations
Health Organic Agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible	<ul style="list-style-type: none"> - The health of ecosystems inseparable from the health of individuals - Wholeness and integrity of living systems - Immunity, resilience and ability to regenerate are key features
Ecology Organic Agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them	<ul style="list-style-type: none"> - Living ecological systems - OF, pastoral and wild harvest systems fit to cycles of ecology - Recycling - Maintenance of diversity
Fairness Organic Agriculture should build on relationships that ensure fairness with regard to the common environment and life opportunities	<ul style="list-style-type: none"> - Equity and mutual respect - Justice and stewardship of the shared world (humans and other living beings) - The whole food chain - Food sovereignty - Natural behaviour and well being of animals - Natural resource management - Social and ecological justice
Care Organic Agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment	<ul style="list-style-type: none"> - No risk of jeopardizing health and well-being - Care of animals by building up humane farming systems - Precaution - Responsible management and development - Rejection of unpredictable technologies - Transparency

The four organic principles as enunciated by IFOAM and their possible relations to aspects of food security for current and future generations

Box 1. An example of agro-ecological methods improving the ecological sustainability of land.

The main aim of the Tigray project was to find out whether a community-based approach to rehabilitating the land and improving crop production, based on ecological principles, can improve the livelihoods of poor smallholder farmers. The project was initiated in 1996 and run by the Regional State bureaus, the Institute for Sustainable Development (ISD) and local communities, experts and administrators.

Tigray is regarded as one of the most degraded areas in Ethiopia, with a population density of 80 to 131 persons per square kilometre (depending on zone), and less than 1 hectare per household and afflicted with serious soil erosion and low yield. Chemical fertilizers were introduced in 1960s, and subsidies were withdrawn from 1998, which, in combination with decreasing farm gate prices, left many farmers in extreme poverty and food insecurity.

The project was based solely on methods including composting, restricted grazing for animals, trench bunds for water and soil, ponds, gullies and using by-laws to control fair use of local biological resources. Farmers were also selecting own seed varieties rather than buying HYV seed. The author of the report concluded to have huge positive impact both on food security both for the families and for rehabilitation of the land.

The project was extended in 1998, when the regional government adopted the key elements of the project as part of the food security development plan for the region, and in the following years, several steps were taken including exchange visits, training and education of trainers within the farmer communities.

Many households were headed by women because of many years of civil war. Issues like womens' dependency on male relatives to do the ploughing because this was not a woman's job were targeted. Therefore, much effort was put into improving their farms. Targeting such issues proved to be extremely challenging. Throughout the project, the role and work of women was worked with, and women were encouraged to form cooperatives.

The effect of the implementation of agro-ecological methods was very encouraging. Productivity was increased of both crops and livestock. It was concluded (p.43) that *'Use of ecologically sound organic principles can have very quick positive impacts on the productivity and well-being of smallholder farmers, so that they do not necessarily have to face a conversion period of reduced yields while changing from chemical to organic production'*.

The example of the project titled 'Sustainable Development and Ecological Land Management with Farming Communities in Tigray' (Araya & Edwards, 2006), where application of agro-ecological methods was demonstrated to lead to improved soil fertility and better chances for future food security

Table 2. Four dimensions of food security linked to the four IFOAM principles for organic farming

Four dimensions of food security	Possible contributions from organic farming in terms of practical use of agro-ecological methods and referring to the four IFOAM principles of Health, Ecology, Care and Fairness
Food availability <i>- referring to having sufficient quantities of food of appropriate quality supplied through domestic production or inputs, food aid and net imports.</i>	<ul style="list-style-type: none"> - 'Ecology': productive systems - 'Care': precautionary principles and responsible management - Focus on food crops in on-farm diverse systems - Intensified land use / intercropping - Increasing yields
Food access <i>- access, by individuals, to adequate resources and entitlements for acquiring appropriate foods for a nutritious diet.</i>	<ul style="list-style-type: none"> - 'Fairness': justice, equity and food sovereignty - More home production, diverse cropping systems - Local resource use and circulation - No premium price
Food Stability <i>- access at all times and with no risk for losing access to food as a consequence of shocks or cyclical events.</i>	<ul style="list-style-type: none"> - 'Ecology' through building up sustainable systems - Improved soil fertility, water conservation, reduced risk for earth erosion - Increased focus on 'Fairness' through building up sustainable food systems, including fair trading and distribution systems
Food Utilisation <i>- refers to ways in which food contributes to adequate diet, clean water, sanitation and health care, and in turn, to a state of nutritional well-being, where all physiological needs are met.</i>	<ul style="list-style-type: none"> - 'Health' : - Diverse food crops - Emphasis on healthy food incl. vitamins, minerals and crop diversity

Four dimensions of food security as used by FAO and given by Scialabba & Hattam (2002) and Scialabba, 2007, and suggestions to how they potentially relate to organic farming, with an emphasis on the implementation of agro-ecological practices. Scialabba (2007) emphasises the potential contribution of organic farming in terms of improved and increased household intake, transitional food emergency situations, healthy diets, local food provision, as well as provision of global environmental services.

Table 3. The potential contributions and challenges of organic farming in relation to the MDGs 2015 and the Paris Declaration

Millenium Development Goals 2015 (MDG 2015)	Potential contributions and challenges related to Organic Farming (OF)
<ol style="list-style-type: none"> 1. Eradicate extreme poverty and hunger 2. Achieve universal primary education 3. Promote gender equality and empower women 4. Reduce child mortality 5. Improve maternal health 6. Combat HIV/AIDS, malaria and other diseases 7. Ensure environmental sustainability <ol style="list-style-type: none"> A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources, B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss, C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation, D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers. 8. Develop a global partnership for development 	<p>OF increases productivity based on available resources, no inputs</p> <p>OF is knowledge intensive; knowledge is owned by users, not connected to products. Majority of smallholders are female farmers – emphasis on gender equity</p> <p>Diverse and well-balanced food rations, conscious gender equality and social capital building</p> <p>OF builds on biodiversity maintenance, improvement of soil fertility through improved humus layer, recycling, planning and use of intercropping and crop rotation systems, interaction with natural environments and ecosystems.</p> <p>Fair conditions for development, trade and knowledge exchange</p>
Paris Declaration – principles	
<p>Deals with the ways of creating mutual relationships and collaboration between donors and partner countries emphasising:</p> <ol style="list-style-type: none"> 1. Ownership 2. Alignment 3. Harmonisation 4. Managing for results 5. Mutual accountability 	<p>Voices for environmental sustainability and the interests of future generations and other silent actors must be raised by national governments if taken into account in development strategies.</p>
<p>Goals and strategies as expressed in MDG and the Paris Declaration, in combination with keywords (right column) regarding potential contributions of Organic Farming (OF), as well as challenges which should be targeted.</p>	



Economic Value of Ecotourism to Local Communities in the Nigerian Rainforest Zone

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Abstract

This study estimates community willingness to contribute for an ecotourism improvement project and its determinants in the Okwangwo Division of the Cross River National Park, Nigeria. Personal interviews were conducted with 150 households in three communities located in the proximity of the park. The study showed that the respondents were willing to contribute an average of about one percent of their mean annual income per year. Determinants of the respondents' willingness to contribute amount was estimated with the aid of the ordinary least squares and tobit models. The results showed that willingness to contribute were influenced by factors such as income, distance of respondents' residence to the park, post-high school education, occupation and membership of an environmental conservation group. The results generated from this study will contribute to the knowledge of sustainable management of ecotourism projects.

Keywords: Ecotourism, Willingness-to-contribute, Cross River National Park, Contingent valuation

1. Introduction

The increase in human population and preferences for leisure activities often leads to an increase in demand for recreational use of public lands in many parts of the world (Foot, 1990 and 2004; Bowler *et al.*, 1999; Nickerson, 2000). Ecotourism, travel to natural areas that conserves the environment and improves the well-being of local people (TIES, 1990), is a fast growing industry. Research shows that there are more than five million eco-tourists and most of them are from North America, Europe and Australia (Kamauro, 1996). Ecotourism accounts for a large share of some countries' gross domestic product, and so contributes to livelihoods of many people, as in Kenya, Madagascar, Nepal, Thailand and Malaysia (Isaacs, 2000). Benefits of protected areas often accrue to the national and global economy, but the costs are usually borne by local communities. Therefore integrating nature conservation and ecotourism has become a popular way to motivate local communities to support nature conservation projects (Abbot *et al.*, 2001). When ecotourism is supported in protected areas, it is often argued that economic benefits will accrue to local communities (Marsh, 2000). Some of the economic benefits which local communities can derive from ecotourism are employment opportunities, development associated with infrastructure (e.g. better road network and water) and ecotourism businesses (Hall, 2006a; Marsh, 2000; Weiler and Scidl, 2004).

Benefits from recreational use of public lands, e.g. ecotourism, are typically estimated by means of non-market valuation methods (Mitchell and Carson, 1989; Loomis, 1993). The contingent valuation method is widely applied in estimating the economic value of non-marketed goods (Champ *et al.*, 2003; Carson, 2004; Garrod and Willis, 1999; Majid *et al.*, 1983). It uses survey questions to elicit people's preferences for non-marketed goods by asking them how much they would be willing to pay for specified improvements or to avoid decrements in them (Mitchell and Carson, 1989). Most contingent valuation studies (Nuva and Shamsudin, 2009; Maharana *et al.*, 2000; Lindsey *et al.*, 2005; Yacob *et al.*, 2009) on ecotourism have focused on values which eco-tourists attach to ecotourism. Values of ecotourism development to local communities are rarely studied and it is often claimed that ecotourism promotes conservation of natural and cultural heritage of an area and may improve the standard of living of local residents (Boo, 1990; Linberg and Hawkins, 1993, Eraqi, 2008). Advocates of national parks often claim that income from ecotourism will supplement the livelihoods of individuals who reside in the vicinity of a park. The support of local communities is often required for sustainable development of ecotourism. Therefore, it is important to have knowledge about the value which local communities attach to ecotourism development projects. This will help policy makers with regards to decisions concerning how to package an ecotourism project to benefit more individuals in local communities. The aim of this study is therefore to estimate, using the contingent valuation method, how much local communities would be willing to contribute to support an ecotourism project and also the determinants of these values. The location of the study is the communities in the vicinity of the Okwangwo Division of the Cross River National Park.

The next section gives an overview of the Okwangwo Division as well as surrounding villages, and the data collection methodology, followed by theoretical framework and statistical analysis. Section four includes results and discussion, and the final section is devoted to concluding remarks.

2. Materials and methodology

2.1 Study site

The Okwangwo Division (OD) of the Cross River National Park is located in the Cross River State in south-eastern Nigeria and covers an area of 1 000 Km². The elevation of the OD ranges from 1 000 to 1 700 meters above sea level. The vegetation of the park comprises lowland rainforest at lower elevations and montane grasslands along the ridges in the higher elevations. The OD plays an important role in protection of fisheries, watersheds and climatic stability, ecotourism and preservation of genetic resources (Coldecott *et al.*, 1990). Wildlife found in the park includes antelopes, chimpanzees, high forest monkeys, buffaloes, high forest elephants, manatees, wild pigs, baboon, leopards and gorillas. The area is a centre of endemism for frogs, birds and four primates, including the endangered Cross River Gorilla – *Gorilla gorilla diehli* (Oates *et al.*, 1990; White, 1990). Over 280 bird species have been recorded including *Picathartes oreas* and *Calyptocichla serina* (BirdLife International, 2009). The park harbours 950 species of butterflies (Cross River State Government, 2008). Apart from seeing diverse plant species and mammals the Okwangwo Division also offers eco-tourists opportunities for hiking, bird watching, sport fishing, and boat cruising. The park is surrounded by 66 villages with a total population of 36 000 people (Ite, 2004). The economy of these communities is characterized by subsistence agriculture. The crops cultivated include banana, plantain, cocoa, oil palm, cassava, and yam, while livestock reared include poultry, cattle, sheep and goats. Some individuals in the communities engage in hunting and gathering of non-timber forest products such as game animals, bush mangos, wild vegetables, mushrooms and medicinal plants. Some people already engage in ecotourism businesses such as guided tours, transportation of tourists and catering. If quality of services in the ecotourism sector of the economy is improved, more individuals in the local communities may participate in and benefit from ecotourism.

2.2 Data collection

The data collection involved standardized face-to-face interviews that were designed, and tested in a community outside the study area. Pre-test interviews were conducted in November 2007 covering 20 randomly selected individuals. Findings from the pre-test interviews motivated several changes in the questionnaire e.g. the wording of the hypothetical market scenario and the payment vehicle. The major survey was conducted during the months of April and May 2008. Two interviewers were recruited and trained for two days. Three villages from the 66 villages located within the proximity of the OD were randomly selected for the survey. The villages were Bukalom, Butatong and Wula in the Boki Local Government Area of Cross River State. Every other house along the street was visited in each of the villages. If a house was not occupied, then it was omitted and the next house was visited. The interviewees alternated between the eldest male and the eldest female in each selected household. If the gender of the eldest in a household did not coincide with the interviewee selection method, then a member of the opposite gender was interviewed and the respondent's gender was alternated again from there on. Interviews were conducted in the Boki language. A total of 150 respondents were interviewed in the study area (50 respondents in each village).

The study was described to the respondents and then they were asked series of demographic questions such as their occupation, annual income and whether they have passed through primary, high and post-high school education.

Furthermore, they were asked about the distance of their residence to the OD and also whether they belonged to an environmental conservation group.

2.3 Contingent valuation format

The hypothetical market scenario was developed to describe improvement in the quality of services in ecotourism in order to attract more eco-tourists to the OD. This would give more individuals in the local community the opportunity to derive income from ecotourism. It will also help to improve infrastructure such as better road network. The people in this study area often contribute to the provision of infrastructure such as community school classrooms. This kind of contribution is known as development levy. Therefore the payment vehicle – annual contribution to a community development fund – was not new to the respondents. Individuals in the study area often bargain the price of anything they wish to buy. This is the tradition of the people thus the bidding game elicitation technique may not be new to the respondents.

The hypothetical market scenario and payment vehicle was described to the respondents. They were asked if they were willing to contribute anything at all for improving the quality of services in ecotourism. If the answer was ‘no’, which was the case for only a small fraction (6%) of the respondents, the respondent was asked to give the reason. If the answer was ‘yes’, the second step was to determine the maximum amount the respondent was willing to contribute. The interviewer started the bidding game by an initial bid of 100 Nigeria Naira (NGN). If the respondent said ‘yes’ to that amount, which a large majority of the respondents did, the interviewer raised the amount sequentially by 5 times (NGN 500), 10 times (NGN 1,000), 15 times (NGN 1 500), 20 times (NGN 2 000), 30 times (NGN 3 000), 40 times (NGN 4 000), 50 times (NGN 5 000) and 60 times (NGN 6 000), until the respondent’s answer was ‘no’. No respondent answered ‘yes’ to the highest bid of NGN 6 000. The amount which the respondent said ‘no’ to was then reduced by 12.5%, 25% and 50% respectively, until the respondent’s answer was ‘yes’. If the respondent said ‘no’ already to the initial bid of NGN 100, the interviewer reduced the amount by 12.5%, 25% and 50%, respectively, until the respondent’s answer was ‘yes’. No respondent who said ‘no’ to the amount equivalent to 50% of the initial bid i.e. NGN 50.

3. Theoretical framework and statistical analysis

The Okwangwo Division serves as site for nature conservation. The park also attracts eco-tourists and some local residents in the periphery of the park benefit from income from ecotourism. However, it is considered that if quality of services in ecotourism is improved it will attract more eco-tourists to the park and more of the residents may derive income from ecotourism. Suppose that improvement in quality of services in ecotourism is proposed. Before the improvement in quality is implemented, we would like to know the residents’ preferences for the improvement. The utility function can be written as:

$$U = U(J, Q) \quad (1)$$

where, J denotes a vector of goods consumed and Q denotes quality of services in ecotourism. The status quo of the quality of services is Q_0 , and it is proposed to improve the quality to the level Q_1 . The individual’s willingness to contribute (WTC_i) for improvement in quality from Q_0 to Q_1 is given by:

$$WTC_i = e(p, U_i, Q_1; S_i) - e(p, U_i, Q_0; S_i) + \varepsilon_i - \varepsilon_{0i} \quad (2)$$

where, p is a price vector for goods consumed J , $e(\cdot)$ is an expenditure function and S_i is vector of personal characteristics of the individual i . The individual expenditure function is assumed to be known to the individual, but is known with a margin of error ε_i to investigators. WTC_i can be expressed as:

$$WTC_i = X_i \beta + \varepsilon_i \quad (3)$$

$$\varepsilon_i \sim N(0, \sigma^2)$$

where, X_i is vector of explanatory variables thought to influence the valuation process, β is the set of unknown parameters which reflect the effect of changes in a given explanatory variable on WTC_i , and ε_i is a random error term which reflect factors affecting utility that the researcher is unable to observe. The parameter ε_i is assumed to be normally distributed with zero mean and constant variance.

Valuation functions using WTC estimates, which result from open-ended contingent valuation studies, can be examined with ordinary least squares (OLS) and tobit models, respectively. However, there is often debate among contingent valuation researchers as to whether it is more appropriate to use censored regression (tobit) models or linear models using OLS. Proponents of the tobit models argue that it addresses the censoring, i.e. large number of zeros typically found in contingent valuation surveys, but linear models ignore this censoring. The OLS model fail to account for qualitative differences between zero and positive WTC values (Greene, 2003). This may result in a biased estimate of the parameters of interest. This has led to widespread use of tobit models especially among economists (Floro and Miles, 2003; Kimmel and Connelly, 2007). The linear models we estimate using OLS are of the form:

$$y_i = X_i \beta + \varepsilon_i \quad (4)$$

Where, y_i is the observed individual i WTC value which is greater than 0, X_i is the vector of the individual i personal characteristics, β is vector of parameter to be estimated and ε_i is the error term which is normally distributed with mean zero and variance σ^2 .

For the censored tobit, model the dependent variable is observed only if it is above or below some cut off level. The tobit model (Tobin, 1958) combines the elements from ordinary least squares with a normal probit equation, i.e. the size of the bid and the probability of bidding a positive amount. In this study the WTC values were censored at zero, i.e. all reported WTC values are larger or equal to zero since it is not possible to bid negative amounts. The formulation of the tobit model is:

$$y_i^* = X_i \beta + \varepsilon_i \quad (5)$$

where, $\varepsilon_i \sim N(0, \sigma^2)$. y_i^* is a latent variable that is observed for WTC values greater than 0 and censored otherwise. The observed y_i is defined by:

$$y_i = y_i^*, \text{ if } y_i^* > 0 \quad (6)$$

$$y_i = 0, \text{ if } y_i^* \leq 0$$

The log likelihood function for the tobit model is:

$$\log L = \sum_{y_i > 0} -\frac{1}{2} \left[\log(2\pi) + \log \sigma^2 + \frac{(y_i - \beta X_i)^2}{\sigma^2} \right] + \sum_{y_i = 0} \log \left[1 - F \left(\frac{\beta X_i}{\sigma} \right) \right] \quad (7)$$

These models were estimated using the LIMDEP NLOGIT version 4.0.1 statistical package (Table 3). In this study we have examined the impacts of the respondents' characteristics on WTC using the OLS and the tobit model, respectively. The OLS was used to analyse the influence of the respondents' characteristics on WTC > 0, and WTC \geq 0 for the tobit model, respectively.

The principles for consistency in the bidding game means that a point estimate of the individual respondent's maximum WTC was not determined. Instead, the respondent's true maximum WTC lies in the interval between the highest amount that the respondent said 'yes' to, and the lowest amount with a 'no' answer from the respondent. Mean WTC (MWTC) was thus estimated as:

$$MWTC = \frac{1}{n} \sum_{i=1}^n \frac{B_{ij} + B_{ik}}{2} \quad (8)$$

where, n is the sample size, B_{ij} is the highest amount with a 'yes' answer from the respondent and B_{ik} is the lowest amount with a 'no' answer from the respondent. A description of variables that were used in the analysis is presented in Table 1.

Table 1

We expect the following impacts of the explanatory variables on the WTC:

3.1 Annual disposable income

Individuals who have more money are often willing to pay more for public goods (Boman *et al.*, 2008; Hökby and Söderqvist, 2003). They are often less risk averse and may be more willing to invest in new projects. Hence, we expect a positive influence of income on WTC.

3.2 The distance of the respondent's residence to the Okwangwo Division

Ecotourism activities often take place in the national park therefore individuals (respondents) who live closer to the park will expect to derive more net benefit from an ecotourism project (Pate and Loomis, 1997). Therefore we expect a negative effect of distance of the respondent's residence to the park on WTC.

3.3 Respondents who have passed through primary, high, and post-high school education

Education often gives individuals the opportunity to access information about benefits of new projects (Brander *et al.*, 2006; Baral *et al.*, 2008). We expect a positive influence of the coefficients associated with the respondents who have passed through primary, high, and post-high school on WTC, respectively.

3.4 Occupation

Individuals who engage in formal (non-traditional) employment such as teaching and nursing often have more education thus may have greater tendency to infer the importance of developmental projects. Hence, we expect the coefficient associated with the respondents' occupation to have a negative influence on WTC.

3.5 Gender

In Nigeria, men are often 'bread-winners' of the household. Ecotourism projects would give them the opportunity to diversify their livelihood and earn more income. It is expected therefore that gender will have a positive influence on WTC.

3.6 Membership of an environmental conservation group

Environmental conservation groups comprise individuals who have positive views about protection of nature. Ecotourism project is an incentive for local communities to support environmental conservation. Therefore we expect the coefficient associated with membership of environmental conservation group to have positive influence on WTC.

The results of the impacts of the above variables on respondents' WTC are presented in Table 3.

4. Results and discussion

4.1 Description of the sample and WTC estimate

Ninety four percent of the respondents were willing to contribute to the improvement in quality of services in ecotourism and of these 47% were female and 53% male. Of the respondents who were not willing to contribute anything at all for ecotourism 78% (7) were male and 22% (2) female. The mean annual disposable income for the female and male respondents was NGN 123 672 (\$US 824.48) and NGN 185 508 (\$US 1 236.72), respectively. Seven percent of the respondents belonged to an environmental group. Descriptive statistics for the respondents' characteristics are presented in Table 2.

Table 2

Fifty-five percent of the respondents were male as shown in Table 2. Eighty-four percent of the respondents passed through the primary school education, about 71% passed through the high school education and 35% passed through the post-high school education.

The MWTC of the respondents was NGN 1 047. The mean willingness to contribute for the female and male respondents was NGN 885 and NGN 1 215, respectively. A possible reason may be that the male respondents earned more income than the female. The mean annual income of the male respondents (NGN 185 508) was 33% more than that of the female (NGN 123 672).

The adult population (≥ 20 years) in the Cross River State is estimated to be 35% as reported by the Cross River State Government (2008). Since the human population in the periphery of the OD is 36 000, the adult population there should be 12 600. Aggregating the MWTC over the relevant population of 12 600, the total perceived welfare benefit for the improvement in quality of services in ecotourism to residents at the periphery of the OD is estimated to be NGN 13 192 200 (US\$ 87 948) each year.

4.2 Impacts of the respondents' characteristics on willingness to contribute

We now examine whether support for the improvement in quality of services in ecotourism cuts across all, or just some groups of the respondents, and so whether some common factors might have influenced the elicited WTC amount. This analysis is shown in Table 3, which is based on OLS and tobit models estimates. The dependent variable was respondents' WTC amount for the improvement in quality of services in ecotourism.

Table 3

The tobit, and OLS estimates showed similar effects. For these models, coefficients associated with the respondents' income, post-high school education, distance of residence to the OD, occupation and membership of environmental conservation group were statistically significant. A possible reason may be that the data used in this study contains only a few observations (6%) that were censored at zero. There are some sizable differences between OLS coefficients and that of tobit. In general tobit coefficients are larger than that of the OLS.

The coefficient associated with the respondents' annual disposable income has a positive and statistically significant impact on WTC for the improvement in quality of services in ecotourism. This suggests that an increase in the respondents' annual disposable income increases the WTC. A possible reason may be that respondents who earn more income may expect to derive more benefit from the improvement of quality in services perhaps because they often have more access to resources for investment. For example, respondents who earn more income may have higher propensity to save money thus giving them more opportunity to invest in more alternatives to increase livelihood.

As expected, the coefficient associated with the distance between the respondent's residence and the OD had a negative and statistically significant effect on WTC, i.e., the farther the respondent's residence is from the park the lower would the WTC be. A possible reason may be that the respondents who live farther from the Okwangwo Division may not expect to derive much benefit, in the form of an increase in income from the improvement in the services in ecotourism, because most of the ecotourism activities take place in areas closer to the OD. The distance between the respondent's

residence and the park is also likely to influence the amount of information that the respondent may have about the improvement in quality of services, i.e. the longer the distance the less the information about the park would be. Respondents who have more information about the quality of services in ecotourism may be willing to contribute more.

The coefficient associated with the respondents who have post-high school education has a positive and statistically significant effect on WTC, i.e., the respondents who have post-high school education were more likely to contribute to the ecotourism project. Respondents who have post-high school education are more likely to be employed in the formal sector of the economy and may earn more income and thus may have more money to support the improvement in quality of services project. Another reason may be that post-high school education helps to comprehend the news about e.g. future benefits of an improvement in quality of services in ecotourism.

Unexpectedly, the coefficient associated with the respondents' occupation has a positive and statistically significant effect on WTC, i.e., respondents who engaged in traditional employment such as farming and gathering of non-timber forest products were more willing to contribute for the improvement in quality of services in ecotourism. A reason may be that respondents who are occupied with traditional income generating activities may expect to benefit more from the improvement in quality of services because it may provide them the opportunity to diversify in their livelihood activities. This may reduce the risk associated with farming activities and thus improve their opportunity to have a sustainable livelihood. Furthermore, income from farming activities is often seasonal therefore improvement in quality of services in ecotourism may give the respondents whose livelihood are associated with farming an opportunity to earn more income to supplement their present income.

As expected, the coefficient associated with the membership of an environmental conservation group has a positive and statistically significant effect on WTC. This indicates that respondents who were member of an environmental conservation group were more willing to contribute for the improvement in quality of services in ecotourism. A possible reason may be that members of environmental conservation groups are often individuals who support environmental friendly activities. Ecotourism is often seen as an activity which has the potential to promote sustainable development of nature conservation, i.e. contribute to the livelihood of local communities and also maintain nature conservation. This is often the goal of environmental conservation group thus respondents who belonged to this group may be willing to contribute more for ecotourism project to indicate their interest for the environmental group.

The coefficient associated with the respondents' gender has the expected sign however it was not statistically significant. The coefficients associated with the respondents who have primary school, and high school education, respectively were not statistically significant.

4.3 Respondents who were not willing to contribute

As with any type of economic development, ecotourism development could create changes that threaten the quality of life. Social and cultural changes that ecotourism may introduce to host societies include changes in value systems, traditional life styles, family relationships, individual behaviour or community structure (Ratz, 2002). Six percent of the respondents did not support the improvement in the quality of services in ecotourism, and all of these were farmers and most (78%) were male. The most important reason was that they thought that the project will decimate their land and thus dissipate their source of livelihood. Another important reason was that they raised doubt about the capacity of the park authority to successfully implement the quality improvement project, and they also raised concerns regarding the sustainability of the project. They thought that successful implementation of the quality improvement project will attract more people to the area and could increase the demand for land for commercial activities such as market places and guest houses, which could reduce the land available for farming and collection of non-timber forest products.

The portion of respondents who did not support the project appears to be small, but the concerns raised indicate the presence of lapses in communication between the Okwangwo Division authority and the local residents, especially farmers. It suggests that sensitive issues, such as the impacts of ecotourism on the traditions of the people, need to be addressed.

5. Concluding remarks

Local communities often support projects which they believe will contribute to their livelihood. If they do not expect to derive benefit from a project they may not cooperate with the managers of the project. This study has been conducted in a developing country to examine the value which local communities attach to an ecotourism project and factors which may influence this value. The study showed that most of the respondents were willing to support the project. The study revealed that respondents who earn more income, reside closer to the OD, are occupied in traditional income generating activities, have post-high school education and belonged to an environmental conservation group may benefit more from the ecotourism project. There was no difference in the qualitative results for our models regardless of whether we used OLS or tobit model. The study indicated that annual contribution to a community development fund can be used as payment vehicle for contingent valuation studies in developing countries. The study suggests that when planning an ecotourism project there may be a need to involve the local communities. This may give them more access to

information about the project and may influence more of the local people to support the ecotourism project. Further research is needed in areas such as estimation of costs of a proposed improvement in quality of services in ecotourism and factors which could engender more local support for protected areas.

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Table 1. Definition of variables

Variable	Description
WTC	Willingness to contribute for the improvement in the quality of services in ecotourism (NGN per individual per year).
INCO	Annual disposable income (NGN per individual per year)
DIST	Distance (Kilometre) between the respondent's residence and the OD
P_SC	Respondent has passed through primary school (Yes = 1, No = 0)
H_SC	Respondent has passed through high school (Yes = 1, No = 0)
PH_SC	Respondent has passed through post-high school (Yes = 1, No = 0)
OCCU	Occupation of the respondent (1 = traditional, 0 = non-traditional)
GENDER	Gender of the respondent (Male = 1, Female = 0)
MEG	Member of environmental conservation group (Yes = 1, No = 0)

Table 2. Descriptive statistics for respondents

Variable	Mean	Std. Dev.
INCO	158,554.000	88,191.800
DIST	4.763	3.099
PR_SC	0.840	0.368
H_SC	0.707	0.457
PH_SC	0.353	0.479
OCCU	0.483	0.501
GENDER	0.553	0.499
MEG	0.0733	0.262

1 \$US = NGN 150

Table 3. OLS and tobit models results for determinants of respondents' WTC

Variable	OLS	Tobit
	Coefficient	Coefficient
Constant	283.002 (254.003)	210.825 (275.623)
INCO	0.002* (0.001)	0.002* (0.001)
DIST	- 59.844** (25.676)	- 72.963** (29.400)
PR_SC	231.209 (269.867)	318.672 (287.042)
H_SC	112.248 (245.128)	157.026 (257.714)
PH_SC	453.973** (181.440)	423.235** (189.456)
OCCU	355.316** (159.853)	358.429** (168.201)
GENDER	21.291 (164.150)	- 31.447 (172.657)
MEG	545.548** (263.374)	545.466** (275.260)
R ²	0.263	0.243 ⁺
Adjusted R ²	0.208	
Log likelihood	- 942.255	- 872.290
Chi-sq	35.660****	
LM statistic for tobit		35.742***

Figures in parenthesis are standard errors.
⁺ represents pseudo R².
*, **, ***, **** represents 0.10, 0.05, 0.01, and 0.001 levels of statistical significance, respectively.



Sustainable Approaches to A Reform of Coal Mining Industry in Serbia

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Abstract

Societies in transition focus on a set of specific aspects of sustainability critical to their efficient and effective transformation. The complexity of transitional process is defined by radical changes occurring in the domain of privatization, intensive technological change, business strategy and competitiveness, developing markets and infrastructure with the overall concern for the well being of all interested and involved groups and environmental issues. Currently, in many mining companies in Serbia, privatization process is still active and in this paper we review some of examples of sustainable strategies that have been developed for the reform process of coal mining industry in Serbia. We examine how earlier mentioned factors are integrated into these strategies and at the end give recommendations for their more effective application on the basis of sustainable technology management and development principles.

Keywords: Sustainability, Mining industry, Sustainable technology management and development principles

1. Introduction

Sustainability can be described as a state in which humankind is living within the carrying capacity of the earth. This means that the earth has the capacity to accommodate the needs of existing populations in a sustainable way and is therefore also able to provide for future generations. Humankind is nowadays facing the fact that, with its intensive industrial activities, pollution, and resource exploitation has exceeded the earth's carrying capacity. We must make strong and concerted shift of development in direction where earth can sustain humankind needs. This concerted and integrated action and change of direction can be referred to as sustainable development. Changes and integrated action can be first applied on micro level - sectors like mining industries, where cumulative effects of such small changes can give very good results, in terms of sustainable development.

Currently, in many mining companies in Serbia, privatization process is still active and in this paper we review some of examples of sustainable strategies that have been developed for the reform process of coal mining industry in Serbia. Paper also discusses how sustainability principles can be applied to the mining industry and resulting remarks can further serve as a guidance for development of sustainable approaches in other regions with similar situations.

2. Sustainable development objectives

A review of literature on sustainability suggests that sustainability can be described in terms of social, economic and environmental states that are required in order for overall sustainability to be achieved. The World Summit on Sustainable Development Plan of Implementation provides range of sustainable development objectives that should be aimed in order to achieve sustainability.

Environmental Sustainable Development Objectives:

- Size, productivity and biodiversity: Ensure that development conserves or increased the size, biodiversity and productivity of the biophysical environment.
- Resource management: Ensure that development supports the management of the biophysical environment.
- Resource extraction and processing: Ensure that development minimizes the use of support of environmentally damaging resource extraction and processing practices.
- Waste and pollution: Ensure that development manages the production of waste to ensure that this does not cause environmental damage.
- Water: Ensure that development manages extraction, consumption and disposal of water in order not to adversely affect the biophysical environment.
- Energy: Ensure that development manages the extraction and consumption of resources in order not to adversely affect natural systems (Gibbert, 2005).

Economic Sustainable Development Objectives:

- Employment and self-employment: Ensure that development supports increased access to employment and supports self-employment and the development of small enterprises.
- Efficiency and effectiveness: Ensure that development (including technology specified) is designed and managed to be highly efficient and effective, achieving high productivity level with few resources and limited waste and pollution.
- Indigenous knowledge and technology: Ensure that development takes into account and draws on, where appropriate, indigenous knowledge and technology.
- Sustainable accounting: Ensure that development is based on a scientific approach that takes in to account, and is formed by, social, environmental and economic impacts.
- An enabling environment: Develop an enabling environment for sustainable development including the development of transparent, equitable, supportive policies, processes and forward planning.
- Small-scale, local and diverse economies: Ensure that development supports development of small-scale, local and diverse economies, (Gibbert, 2005).

Social Sustainable Development Objectives:

- Access: Ensures that development supports increased access to land, adequate shelter, finance, information, public service, technology and communications where this is needed.
- Education: Ensure that development improves levels of education and awareness, including awareness of sustainable development.
- Inclusive: Ensure that development processes, and benefits, are inclusive.
- Health, Safety and Security: Ensure that development considers human rights and supports improved health, safety and security.
- Participation: Ensure that development supports interaction, partnerships and involves and is influenced by the people that it affects.

This description provides simple definitions for sustainability and sustainable development. A useful aspect of the definition is that it provides both an ultimate state that must be strived for a swell set of actions or objectives, which if addressed and implemented, will lead towards this state (Gibbert, 2005).

3. Challenges of mining industry in the process towards sustainability

Creating the sustainable and feasible development strategy takes into account the diversified needs and goals and strongly relies on the effort to evaluate the internal strengths and resources from the perspective of their competitive capacity. Traditionally, valuable, rare, non-substitutable and non-imitable resources represent key factors that create and maintain an advantageous position with respect to competitors (Barney, 2004).

Today, a lot of industries, in order to support sustainable development need some extensive reforms, especially with aim to stay/become competitive. Mining industry for itself is facing a lot of challenges on the road towards sustainability, which can be divided, as follows:

Environmental challenges:

- Erosion, landslides, soil instability,
- Remediation of old sites,
- Storage of different waste types,
- Mine waste waters,
- Chemical safety at operations,
- Use of ozone depleting substances,
- Energy (in)efficiency,
- Protection of bio – and geodiversity (Portfolio committee meeting presentation, School of Mining Engineering, University of the Witwatersrand, 2000).

Social and economic challenges:

- Small scale mining
- Poverty and jobs
- Training and education

- Technological achievements and innovations
- Gender issues in mining
- Community participation in decision making
- Mineral ownership and evaluation
- Post mine closure
- Employment
- Resettlement
- Corporate responsibility. (Portfolio committee meeting presentation, School of Mining Engineering, University of the Witwatersrand, 2000).

All these challenges need to be mitigated and facilitated effectively, where one way is through development, translation and application of the principles of Sustainable Development (SD) into principles of Sustainable Technology Management & Development (STMD). But first, we can take a look on similar work with regard to the use of sustainable development principles in the context of mining and we can see that there are still some initiatives in progress. Of particular note are the Global Reporting Initiative standards. Recently there have been developed Sustainability Reporting Guidelines & Mining and Metals Sector Supplement (2009). The guidelines propose the identification of different:

1) Economic Performance Indicators

2) Environmental Performance Indicators

3) Social Performance Indicators:

- Labor Practices and Decent Work;
- Human Rights;
- Society;
- Product Responsibility;

which can serve as an orienteer for decision makers in organization and lead to an improved refocusing of organization towards sustainability and higher environmental performance. A special attention is given to report process since some researches show that while there is evidence of increasing sophistication in the development of social and environmental disclosure in the biggest world mining companies, there is considerable variation in the maturity of reporting content and styles of these companies (Jenkins and Yakovleva, 2006).

Another tool that should be also emphasized is the application of ISO 14031 standards. It brings into focus central aspects related to the construction and use of environmental performance indicators (EPIs) and their application in industrial companies. EPIs may be used on a macro level by external stakeholders for regulatory, control, influence and risk minimization purposes. They may also be used on a micro level inside the company for goal setting, control and surveillance of product performance and performance of manufacturing and administrative processes, as well as for benchmarking purposes by comparing own performance vs. competitors' performance or vs. branch average process and product performance (Thoresen, 1999).

Transitional process brings to industries a lot of challenges, in every sector, and as already emphasized they have environmental, social and economic aspects. In order to mitigate efficiently recognized challenges we need to formulate objectives of reform process, since they specify the directions for improvement. It is essential, in the process of determining which operative measures we must apply to accomplish reform goals.

Environment: Challenges → Reform Objectives → Performance Indicators

Society: Challenges → Reform Objectives → Performance Indicators

Economy: Challenges → Reform Objectives → Performance Indicators

These approaches can be integrated and serve for development of methodology, where is implied identification of suitable indicators (on the merit of defined objectives) that quantitatively and qualitatively can help in estimation of our progress towards sustainability.

Also, considerations of ICM (International Council on Mining and Metals) sustainable development framework should be taken into account since it provides directions where implementation of SMTD principles can be developed. It suggests:

- Work on development of effective regulations and procedures that can facilitate the mining, minerals in collaborations with governments, industry, public and other stakeholders;

- Design and implementation standards that will assure continual improvement, preventions mitigate and minimize various environmental impacts;
- In area or risk management design and implementation of adequate risk management systems with information dissemination (inform potentially affected parties of significant risk from mining, minerals and other similar operation);
- Respect conservation of biodiversity and cultural heritage;
- Remediate degraded land affected or occupied by operations;
- Popularize, promote and support the development of integrated land use planning and mining exploration;
- Provide adequate waste management system (storage and disposal of residual and hazardous waste);
- Separate waste and where possible apply recycling;
- Conduct and support innovation that focuses on the use of products and technologies that are safe and efficient in the use of energy, natural sources and other materials;
- Design adequate work safety procedures with strictly defined responsibilities and trainings;
- Integrate social and economic needs into all above mentioned principles which shall contribute to community development, protection and above all tolerance and cooperation in areas where mining operations are conducted, (International Council on Mining and Metals, 2003).

3.1 Sustainable technology management and development principles

Sustainable competitiveness means the achievement of a set of different goals – economic and non-economic, meaning that it is a concept based on quantitative and qualitative performance indicators, namely, the integration of traditional performance goals measured by traditional economic indicators (e.g. profitability, GDP) and a set of new non-economic performance criteria that emphasize the satisfaction of needs of the customers, employees and all other stakeholders. The performance balanced scorecard approach is based on the efforts to build sustainable competitiveness taking into account multiple factors (Meyer, 2002).

The next table (1) shows the results of the effort to relate the proclaimed principles of sustainable development of society and sustainable technology management (Rainey, 2006). All this defined principles can be effectively applied in various industries such as mining industry.

In Serbia for instance, many coal mining sites are facing a lot of environmental and economic problems which clearly indicate the need for their reforms and there lies the opportunity for application of SMTD principles.

Identified environmental problems are as follows:

- 1) Mine waters generated from the underground operations (maximum values in spring and fall can reach over 5.0 m³/min on some sites) in some cases can contain a large freight of suspended fines (coal, clay), as well as occasional traces of oil, fuel and grease. The water is usually discharged into nearest rivers and streams without treatment.
- 2) Old mechanization for coal exploitation and production.
- 3) Self ignition and combustion of residual coal content in the waste rock, which emits noxious fumes (in high concentrations the SO_x content can be irritating and toxic) and has lead to complaints from local residents.
- 4) Surface deformations and sinkholes.
- 5) There are severe slope stability problems above the upper boundary of the explorations pits, which affect small settlements around the mining area. These sites are proclaimed to be of high risk since they can induce forming of landslides.
- 6) Improperly stored hazardous waste;
- 7) The huge size of waste dumps and the low percentage of rehabilitated areas (for example in the Kolubara basin, waste from four coal mines occupies an area of 3,481 ha, of which only 36% has been recultivated; in Kostolac, waste from three mines is deposited over a total surface of 1,479 ha of which only 34% has been rehabilitated and the situation is similar with other coal mining sites in Serbia);
- 8) Other problems are also related to coal bed methane, (Ministry for protection of natural resources and environment, 2003).

3.2 Application of STMD in mining industry

What is important here is that identified environmental problems cannot be analyzed selectively, without taking a deep reflection on social and economical status of communities where mining sites are located. Social and economic problems are seen in facts that coal mines historically have great role and huge importance, in the first place in economical development of local communities where they are positioned, mostly in central and eastern Serbia.

Development of this industrial centers was followed by the increase in population and closely related to the fact that mining industry has dominating part in the forming of GDP during last five decades. Especially difficult circumstances are that municipalities where the mines are located belong to the least developed in Serbia. Even 4 municipalities have GDP below the 50% and have unemployment rate with almost 24%. As a result of over a decade of low prices and minimal investment, the Serbian coal industry is now in a difficult situation. Prices are less than half the level needed for short-term cost recovery, which is estimated at US\$ 6.4/ton. Production costs, including maintenance, depreciation and expropriation, total approximately US\$ 11/ton. In such atmosphere, every change is seen as a threat and fear that the conditions might get worse, which induces also certain social tensions, (Ministry for protection of natural resources and environment, 2003).

For example, established in 1853, Senje is Serbia's oldest coal mine, complete with shafts, workshops and administrative buildings. The mine is part of an ensemble which also includes houses, a school, a house of culture, a railway station, a church, museum and a hospital, many of which are still in use.

This is a typical industrial community of the 19th-20th centuries, now in economic and physical decline, in need of new sources of income and employment. The mine is still in operation, but it is estimated that coal reserves will run out in seven to ten years with a consequent risk of depopulation (Senje coal mine, integrated rehabilitation project plan/Survey on the architectural and archaeological heritage, 2003).

On the other hand, as it is recommended by STMD principles, we should look more closely to other values that this locality certainly hold and emphasized them as advantages. This would mean respect and development of relationships, interactions and interdependence between natural and cultural heritage and industrial operations, communication and acceptance of responsibility between public and relevant community institutions which would lead to nurturing of long term values.

The village is sited on the River Ravanica, in a hilly and surprisingly unspoiled landscape in central Serbia, south of Belgrade, in the vicinity of two famous medieval monasteries: Ravanica and Manasija. There is considerable potential here for tourism which could be encouraged as part of the regional development program through for example the establishing of an eco-museum, the restoration of the industrial buildings (particularly the shafts and the narrow-gauge railroad) and the overall transformation of a dying settlement into a cohesive tourist centre. (Senje coal mine, integrated rehabilitation project plan/Survey on the architectural and archaeological heritage, 2003). The historical significance of the mine is considerable since it is the oldest preserved industrial area in Serbia and in the period from the building of the railway in 1892 until 1941 it was one of the most prosperous industrial regions in the country. The mine shafts themselves - Alexander's Shaft of 1853, the first in Serbia, and the Main Shaft, still in use and retaining 19th century steam machinery and head-gear - are of outstanding national importance. Although the condition of many of the buildings at the mine and in the town is bad, and will continue to deteriorate, the majority at least survive. This survival, together with the well-preserved urban structure, the splendid cultural landscape and the solid documentation held in the local museum, joined with the industrial tradition of the population, offers an excellent basis for authentic restoration and the comprehensive rehabilitation of the whole ensemble, from the industrial buildings to the social and commercial. The necessary addition of new buildings for the accommodation of tourists must be done in a manner which respects the existing building pattern and character of the village. (Senje coal mine, integrated rehabilitation project plan/Survey on the architectural and archaeological heritage, 2003).

Senje Rudnik offers an excellent opportunity to achieve a sustainable development which respects the historic fabric of the mine and the village, and encourages new uses which enable the continuation in situ of the long-established community, but where industrial, environmental and social issues should be integratively defined. (Senje coal mine, integrated rehabilitation project plan/Survey on the architectural and archaeological heritage, 2003).

In that sense, it is important to note that in May 2008, "The strategy for Serbia sustainable development" has been adopted, where according to the existing state of mining in Republic Serbia, is recommended for sustainable development to be achieved through several distinctive sectoral goals:

- harmonizing regulative in mining area with EU legislative,
- successful finalization of transition phase in mining sector with additional participation of private sector and improvement in area of business economy,
- rational management of nonrenewable resources and restriction on illegal exploitations,
- application of technological solutions for minimizing the environmental impact of mineral resource exploitation,
- sustainable supply of market with mineral resources,
- industry development and employment rate increment with involvement of all stakeholders in decision making process, during the whole mining life cycle and later.

It is also anticipated through “Strategy of development of Serbia mineral complex” which creation is still in progress, to further define instruments, measures and activities that could lead to achievement of long term goals in sustainable development of mining sector. As it can be seen, by following the Serbia Government vision about sustainable development of mining industry, by application and implementation effective programs and instruments, Senje coal mine can become one of representative localities in terms of reforms towards sustainability. In next chapter of this paper we will elaborate some of directions that can be followed with according established goals on the Senje example.

3.2.1 Application of STDM principles in mining industry– example of Senje coal mine in Serbia

Nowadays, some of mining sites in Serbia are due to be privatized, and they can be a very good starting point for implementation of mentioned principles and tools described earlier. By their application, not only the environmental problems can be effectively mitigated, but also more efficient operation, productiveness and competitiveness of mining industry can be achieved.

According to the results of analysis conducted through projects “Strategy for Serbia sustainable development”, it is estimated that until 2014 approximately 26 millions of euros of investments in mining industry are needed, but what one must keep in mind is that these mining sites also characterize social and economic challenges that are domineering. It is obvious that integrative approach is needed to effectively resolve these challenges.

Integrated rehabilitation project plan/Survey on the architectural and archaeological heritage for Senje mine anticipates:

- Immediate repairs and protection of the most important individual buildings.
- New, wider protection of the site (concept, plans, preparing study supporting legal acts).
- The town infrastructure repairing works, narrow gauge railroad;
- Preparing for a mining museum in situ, tourist accommodation facilities, etc.
- Establishing an eco-museum, concept, project design, management study, equipment, education programs and public awareness programs for inhabitants.

These are all good suggestions how some aspects of sustainable development can be mitigated, but still there are a lot of questions rising, especially economic issues due to transition and privatization process. Adequate form of privatization can introduce more effective managerial approach which can lead to paying more attention to eliminating waste, more efficient usage of resources and energy which would on the other hand enhance the increment of productivity. This opens the possibility for adequate restructuring of mine operations which brings direct economic benefits. Simultaneously new doors are open for investments in innovative and clean technology and implementation of continual environmental management system.

Some of activities that can be further implemented according to the STDM principles are:

1) The privatization process should be taken as a chance for existed potentials to be used, not only in direction of increase of economical efficiency, but also in the direction of integral environmental protection, (since that privatization has usually been seen as possibility for improvement in efficiency, competitiveness, management, product development and capital market, where the main focus is to decrease the pressure on the state budget that some companies are making). This process can usually bring and introduce new, innovative and clean technologies. A noticeable improvement in job quality, desirable from the point of view of social sustainability, is one of the major advantages of clean technologies (Getzner and Ritt, 2004).

2) Since privatization plans for coal industry in Serbia includes reduction in number of employees, different models and social programs should be developed and comprehensively presented to workers. This means defining the local criteria for sustainable outcomes, and activating organizational practices according to these criteria (Achterkamp and Vos, 2006). One, very important model of social program that can be developed is the one with aim that certain number of workers through intensive training programs can be trained for work on remediation and recultivation of mines and their waste dumps (with their own mechanization and engagement, mines could deliver greater part of projected activities, both on remediation process and building). As a part of this process, it is prerequisite to organize debates, counseling centers along the focus groups in all categories: managers, miners, citizens, stakeholders with aim for all structures in time to be introduced with possible options and solutions; this would “softer” the resistance towards privatization process that predominantly exists among citizens and workers. Implementation of such social programs could lead to lowering the costs of remediation and help on the minimizing of consequences of the increased unemployment rate due to privatization.

3) Life cycle assessment along with environmental risk assessment should be implemented to coal process production, since it can help on deriving the EPI indicators which could serve as the basis for defining action plans with tasks where certain improvements can be made, according to social, economic, and environmental local criteria. It will help to identify the most efficient and cost effective options for increasing the environmental performance of production

process. Also, assessment of a company's operations and production processes should be conducted with aim to opportunities for efficiency improvements to be identified.

4) Social and economic benefits should be comprehensively presented to all stakeholders since, resolving environmental problems usually can bring improvements in infrastructure and on the other hand contributes to better life quality and better working and living standards.

5) Remediation, recultivation programs and landslide geotechnical measures and procedures can contribute to bringing houses and green surfaces to their original functions, which is the common interest of all residents in local communities that are affected by mining operations.

6) Establishing of the systematic monitoring of quality of all relevant environmental mediums (components) would be of great importance, because in real time observations of environmental quality parameters citizens and employees could be informed about the results of mine production, (especially important for their health quality and communal hygiene, because it would resolve many doubts concerning ecological issues that arise every day).

7) Continual communication among all interested parties in mine sites should be forced and improved; a reporting of mine activities should be more transparent and consult public opinion while making crucial decisions which can affect community as a whole.

4. Conclusion

The emphasis on sustainable technology management is related to the role of technology and its position at the core of all the business operations, and with focus on primary operations delivering value in the form of products and services to the customers, but also in satisfying the goals of the society, economy, local community, while simultaneously developing profitable business results (Levi-Jaksic, 2006). In this paper, only few facts and possible applications of sustainable development in mining coal industry have been discussed. More detailed and documented survey should be conducted in this area, but even with these narrow implications that have been presented here, it is clear that wide opportunities are lying in Serbian mining sector for its effective transformation towards sustainability.

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Table Captions

Table 1. Transforming the principles of Sustainable Development (SD) into principles of Sustainable Technology Management & Development (STMD)

SD	STMD
Coexistence (the right to)	Strategic enterprise thinking, “cradle to cradle” approach, balanced objectives; strategies leading to followers approaching leaders; reducing technological gap; life-cycle thinking; value chain approach; competency approach.
Recognize interdependence	Technological cooperation – vertical and horizontal relations; in – sourcing R&D; R&D Consortia; technological fusion; competitive co-evolution.
Respect relationships	Value networks – business environment and natural world; Strategic technological alliances and networking – synergetic effect.
Accept responsibility	Social responsibility – Integrity, Honesty, Enterprise Management; Leading technological change with environmentally sound options, ecologically conscious innovation ECI, finding the right measure of technological change in relation to political, economic, social, technological and ecological factors – PESTE.
Create long-term value	Value creation, Create operations based on technologies that offer products and services satisfying the needs of all the stakeholders.
Eliminate wastes	Continuous innovativeness and creativity, Life – cycle assessment – LCA; sustainable technological products and processes.
Rely on balanced solutions	Openness, transparency, balanced score-card thinking; Strategic fit as balancing of strategic and operations technological goals.
Design limitations	Risk mitigation; LCA; Risk assessment; Managing technological risk and threats at the same time accepting the chances and challenges; technological forecasting.
Continuous improvement	Technological forecasting as the base for short – term/long – term plans and technological strategies.



Sustainable Agriculture in Benin: Strategies for Applying the Chinese Circular Agriculture Model

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Abstract

Recently, many emerging economies try to follow the example of the West's industrialization by developing material-intensive production systems. As a solution to the environmental problems caused by this kind of economic growth, China is implementing the concept of Circular Economy by drawing on the experiences from Germany, Denmark and Japan. This concept in agriculture is called 'circular agriculture'. Benin through its Strategic Plan for Agricultural Sector Revival (PSRSA), wishes to attain poverty alleviation within short time (2008-2015). This study aimed to establish basic aspects required for Benin to adopt the circular agriculture which is in practice in China. Primary data from Government reports and interviews were used. The study shows how important agriculture is for food security in Benin. It also shows progress made by China in the path of Circular Economy in general and especially in circular agriculture. Through circular agriculture, Benin could achieve the goal of sustainable agriculture.

Keywords: Circular economy, Circular agriculture, Sustainable agriculture, China, Benin

1. Introduction

Human beings are dependent on agriculture for food, which is essential for their survival (Atkinson, et al., 2007). According to the World Bank, nearly 75 percent of people facing dire poverty (earning less than 1USD per day) in the developing world live in rural environments and rely on agriculture as their major source of food and income (NRC, 2008). In addition, the World agricultural production is still challenged by the world demand for food and industrial crops. This may explain why significant attention has been given to the question of whether agriculture, particularly modern agriculture, can maintain its current levels of production and those predicted for the near future. However, through its emphasis on high production, the industrial model has degraded soil and water, reduced the biodiversity that

is a key element to food security, increased our dependence on imported oil, and driven more and more acres into the hands of fewer and fewer farmers, crippling rural communities (Earles, 2005). Moreover new technologies such as genetically engineered plants are not expected to be a major factor in food production increase in developing countries during the next two decades (Hazelle, 1995). Concerns also are growing about the long-term sustainability of agriculture. FAO estimates that some 850 million people worldwide are currently undernourished (FAO, 2008). According to the same institution the number of undernourished in developing countries will exceed 400 million in 2030. Therefore developing countries and the international development community are presently increasing and redirecting their resources in order to achieve various development objectives such as reductions in poverty, hunger and malnutrition (Fan, et al., 2008). In addition, consensus about the future demand growth will have to be met essentially by increasing the productivity of land already in cultivation, especially through yield increases (Cuffaro, 2003). As a result of the challenge to feed its growing population, developing countries have opted for agriculture development. Highly productive fertilizer and new technologies such as genetically engineered plants have been introduced over the past three decades (Gruhn et al., 2000). Unfortunately, over application of inorganic and organic fertilizer has led to environmental contamination of water resources and soils in developing countries (Gruhn et al., 1998). Furthermore, harsh climatic conditions, population pressure, land constraints, and the decline of traditional soil management practices have often reduced soil fertility (Stoorvozel and Smaling, 1990; Tandor, 1998). Sustainable agriculture¹ is viewed as an alternative against threats from present kind of agriculture. Sustainable agriculture integrates the goals of environmental health, economic profitability, and social and economic equity (ESCAP, 2009).

Environmental problems and the daunting challenge of feeding the world's largest population with limited resources have led China to define ways and means of better aligning resource use with societal interests and environmental sustainability (OECD, 2001). One of these strategies to sustain China's agriculture is the 'circular agriculture'. Circular agriculture involves applying the principles of the Circular Economy² to agricultural production. It is an entirely new concept and set of strategies, an improved approach to agricultural economy that addresses the coordinated development of populations, resources and the environment (Tang, et al., 2006). The implementation of this new concept has resulted in greater economic, environmental and social benefits in China (Tang, et al., 2006; Xu, 2006; Zhong, 2006).

Benin, like other developing countries is trying to develop and implement strategies for poverty reduction. Among those strategies, food security via sustainable agriculture is considered vital to any poverty alleviation strategies. Then, after an initial 'Strategy for Poverty Reduction (2003-2005)', a second strategy called 'Growth Strategy for Poverty Reduction (SCRIP)' for the period 2007-2009 was formulated. Benin has also launched the 'Strategic Plan of Agricultural Sector Revival' called PSRSA' in 2008 (MAEP, 2008). The challenge of this plan is to make Benin an agricultural power and food safe by 2015.

The application of this agricultural modernization plan (PSRSA) foresees changes in the cropping system in Benin such as widespread use of machines and fertilizers, large-scale exploitation of farmland and so forth. Furthermore, cooperation between China and Benin is growing more and more especially in the agricultural field (presence of Chinese agricultural technicians in Benin) and in the field of scientific research (grant of scholarships to Benin's students by China). Hence, there is a need for Benin to learn from China about circular agriculture on its way to modernize its agriculture sector. This has advantages for a developing country to feed its growing population without causing damage on environment and threatening life of the world population.

This study aimed to establish basic aspects required for Benin to adopt the circular agriculture currently in practice in China. To date, China's experience in circular agriculture is reviewed and Benin's agricultural situation has been analyzed taking into account both the situation of the past as that envisaged in the future through the PSRSA.

2. Environmental settings

This study is based on two case studies, China and Benin. China was used as study area to explore and grasp the potentials, challenges and lessons about 'circular agriculture'. Benin is the targeted area for implementation of the concept. Therefore the details given about environmental settings are only of Benin.

2.1 Location of Benin

The Republic of Benin is located in West Africa, between 6°30 and 12° North Parallels and 1° and 3°40 East Meridians. It is bordered by the Republic of Niger to the North, Burkina Faso to the North-East, the Atlantic Ocean to the South, Togo to the West and the Federal Republic of Nigeria to the East. It covers an area of 112 622 Km².

2.2 Climate

The climate is hot and wet, with an annual rainfall mean ranging from about 700 mm (North) to 1500 mm (South-East) and the average air temperature of about 27°C. Most certainly, geographical elements such as the stretching of the territory in latitude, the existence of the Atacora Mountain and the orientation of the coastline bring about a slight difference in the climate pattern.

2.3 Geology, soils and hydrology

Benin belongs to a leveled Western African unit constituted of primary rocks supporting relatively recent sedimentary stratifications. There are three units or zones: mountainous zone, coastal zone and plateau zone.

There are five main types of soils in Benin: tropical ferruginous soils (cover 80% of the area of Benin), ferralitic soils (8% of the area of the country), hydromorphic soils (5 to 8%), vertisols (5% of the territory), and minerals soils. The ferralitic soils are today very threatened because they are occupied by nearly half of the population of Benin. In 2005, the land use in Benin shows that the arable land is 23.53%, the permanent crops 2.37% and other 74.1%.

The hydrographical network comprises 3048 Km of water courses and more than 333 Km² of water areas (lakes and lagoons) located in the South part of the country.

2.4 Demographic characteristics

Benin's population was estimated at 8 294 941 inhabitants in July, 2008 with an annual growth rate which remains stagnated at 2.8 %. The population is unequally distributed on the national territory and is concentrated for more than 35% on the southern part, which only represent 10% of the country area. It is however young (around 50% are below the age of 15 years) and characterized by a high female proportion (around 52%). The population constitutes the main force for agriculture: employs over 45% of the active population.

2.5 Economic and political context

Economy growth which was negative before 1991 has increased during the past decade and reached 6.1% in 2001 before dropping down to 4.5% in 2009 because of international market situation and recent economic crisis.

The new institutional order introduced through the historical Conference of the Active Forces of Nation held in February 1990, the materialization of which is in progress, has made of Benin an easier destination and hoisted it at the vanguard of "New Democracies". Benin has got the experience of peaceful, fair and transparent elections.

3. Materials and method

3.1 Literature review

3.1.1 Circular economy

The Circular Economy concept was introduced in China to address environmental degradation and resources scarcity associated with rapid economic development (Geng, et al., 2008). Based on the experiences of certain countries such as Germany, Japan, Denmark, China declared Circular Economy as a national strategy (Yin, 2006). China has conducted trial work for Circular Economy at three levels: Cleaner Production at enterprise level; build ecological industry parks (EIPs) in the industrial areas; and develop provincial and municipal experiment with circular economy. To date, a number of economic and informational instruments have been used to implement Circular Economy principles. These include: pollution levies, environmental taxes and eco-labeling, environmental management tools (such as co-generation and wastewater recycling and reuse), Life Cycle Assessments (LCAs) and "3Rs" (Reduction, Reuse and Recycling) of waste (Ren, et al., 2005; Lu, et al., 2005; Hinton, 2008). Additionally, environmental management systems such as ISO 14001 have been used.

1998: Circular Economy was proposed for the first time by Scholars.

1999: Eco-industrial parks were launched.

2002: Cleaner Production Promotion Law and Environmental Impact Assessment were passed.

2004: The National Development Reform Commission (NDRC) was appointed for the duty of promoting Circular Economy principles.

2005: Law on pollution prevention and control of solid waste was passed.

2006: The National Economic and Social Development Plan (11th Five-Year Plan) was put forth and Green public procurement was put into official guidelines.

2007: Draft of the Circular Economy Law was discussed by standing Committee of the 10th National People's Congress.

3.1.2 Circular agriculture

The application of the principles of Circular Economy to agriculture is called 'circular agriculture'. Circular agriculture is an entirely new concept and set of strategies, an improved approach to agricultural economy that addresses the coordinated development of populations, resources and the environment. At its core are the principles of sustainable development, Circular Economy and extended production chains (Geng, et al., 2008). Many factors are involved, which can be enumerated as follows: technological innovations and organizational reforms; optimization of the internal and production structures of agri-ecological systems and extension of production chains (Tang, et al., 2006). Others are

multilevel in nature, which include circular utilization of energy; maximal utilization of biomass energy resources; utilization of every material link in the production process; promotion of clean production and conservation-minded consumption; stringent control of harmful inputs and waste production; maximum reduction of pollution and ecosystem destruction. At the same time, efforts are made to increase the value of each stage of production and to improve the quality of the human environment so that production and producers alike take their place in a benign agri-ecological circle conducive to the harmonious development of the agricultural industry and rural communities alike. As a low-input, high-recycling, high-efficiency, high-technology and industrialized set of practices, 'circular agriculture' is distinct from conventional or traditional agriculture and represents a revolution in the sector (Tang, et al., 2006).

3.1.3 Some achievements

Compared with developed countries (Germany, Japan, and Denmark), the achievements made in China about Circular Economy in general and circular agriculture in particular, are meager. Among the successes of implementation include conserving water, materials, energy and land (Geng, et al., 2008; Li, et al., 2009). China has now had almost a decade of experience in developing and implementing a Circular Economy concept. Chosen as a demonstration city, Dalian has implemented the Circular Economy strategy as a means of conserving water, materials, energy and land (Geng, et al., 2008).

The implementation of circular agriculture in Linquan, County of Anhui Province which features linkage of forest products, grasses, livestock, fungi, biogas and fertilizers, results in greater economic and social benefits. It has proven particularly valuable in the handling of cattle manure, for which three downstream channels have been found, in the production of mushrooms, methane and foodstuffs respectively (Tang, et al., 2006).

The same model developed in the Eastern Xihu district of Wuhan, for example, achieves standardized, large-scale production of raw materials by integrating industry, locality and farmers in a system that brings in orders of RMB 60 million annually to local cattle farmers. At the same time, manures and liquid animal wastes are processed in a composting facility that uses modern fermentation and odor-reduction technology to produce high-quality organic fertilizers that bring in a further RMB 10 million of income (Tang, et al., 2006).

Also the Ecological Industrial Park model developed in the Sujiatun district of Shenyang, results in great success. The external framework consists of the various systems governing grape cultivation, wine production, anti-oxidant bio-engineering, bio-fertilizers production and environmental protection, such that the respective functions of the grape, manufacturing and agro-tourism industries are combined in a single entity that manifests itself in a closed-loop eco-economic network.

The Circular Economy in Suzhou (Jiangsu Province) High-Tech Development Zone's economic growth mode has changed from investment expansion in the past to efficiency advancement (China Daily, 2005). The industrial water recycle rate has also been raised from 65 per cent to 75 per cent and the utilization rate for industrial waste also increased from 73 per cent to 80 per cent. Moreover, a collection and classification garbage system in the zone has been established according to the same journal. Also, the air quality has met the nation's second-level standard for the past two consecutive years while the zone's sewage disposal rate remained at 100 per cent and the zone's green cover-age also rose from 32 per cent to 40 per cent on a yearly basis.

However, there are much to be done by China to achieve the same success as developed countries like Germany and Japan. Besides, the 11th Five-Year Plan for National Economic and Social Development of China believes that: "energy consumption per unit GDP will be cut down by 20% and total discharge of major pollutants (COD and SO₂) will be reduced by 10% in 2010 compared with that of 2005" by implementing Circular Economy strategy (Xu, 2006).

3.2 Data sources

This study is based on primary data which have been substantiated by secondary sources. An multidisciplinary approach was used, so a wide array of fields was incorporated. Also, it was acknowledged that using multiple sources of evidence can be important in revealing different perceptions of the same phenomena (Yin, 2003; Hinton, 2008). The data used in this study have been collected between February and May 2009 in Benin. Primary data have been collected from Government reports and interviews. The information collected came from two sources: The Ministry of Agriculture (towards the Strategic Plan of Agricultural Sector Revival-PSRSA) and interviews involving some agricultural experts. Data collected focused on productions from previous years, forecasts of future (PSRSA) and problems related to past agricultural system in Benin. Virtually no data obtained on the impacts of agriculture on the environment. This gap of data was filled by interviewing some experts, which gave us a clear view on the matter. These experts are from the Ministry of Agriculture, IITA (International Institute of Tropical Agriculture) and Faculty of Agricultural Sciences. Semi-structured interviews have been carried out with the aim to get a better understanding, experiences and interests of the interviewees. Interviews were carried out by phone calls and electronic mails. Due to fact that the subject material is not very sensitive and the answers are not likely to change according to mood or emotional circumstances (Kvale, 1996), there is no problem by substituting a live, phone conversation with written communication (emails). The literature

review was focused on Chinese 'circular agriculture' situation so as to get a deeper understanding of the concepts and theories related to Circular Economy. This literature review also involves the use of secondary data on both China and Benin. These secondary data are related to China's progress about Circular Economy, agriculture contribution to pollution in Benin, land use and so forth. Although, this approach is not popular but was the best way due to the limited resources (time and money), and distance between researchers (China) and respondents (in Benin).

Analytical technique

The data have been analyzed by using descriptive statistics such as means, minimums, maximums, standards deviation, as well as the Bivariate Correlation. This correlation aims to determine the relationships between the variables (acreage and yield, fertilizer input and soil degradation), to know how the variables are distributed. SPSS 13.0 software has been used for that purpose. Charts and histograms have been drawn using Microsoft Office Excel.

4. Results and discussion

4.1 Importance of agriculture in Benin

The contribution of agriculture to the economy of Benin is not negligible. Agriculture contribution to Gross Domestic Product has evolved from 33.1% in 1995 to 32.6% in 2005 with an average rate of 35.3% over the period (Figure 1). Agriculture is the second largest sector contributor to the economy of Benin behind the service sector. Table 1 shows the descriptive statistics on the agriculture contribution to the Gross Domestic Product (GDP) by sector. In the eleven years (1995 to 2005) taken into account in this study, the minimum in terms of contribution to GDP is 31.90 while the maximum is 38.40 with a mean of 35.31 and a Standard Deviation of 2.54.

The analysis on the evolution of the cropping areas of some major crops (Figure 2) allows us to make the observations below:

- 1) An upward trend in the cropping areas of all major crops.
- 2) Some crops have evolved faster than others (case of maize and cashew nut) throughout the period (1995 to 2005).
- 3) Other crops have grown in size at varying rates over a period of the decade (case of rice).
- 4) The cultivation of cotton on the other hand has declined significantly in terms of area between 1997 and 2000.

The sharp increase in the maize cropping area is the result of the widespread cultivation to meet growing demand from national and regional markets for human consumption and industry (poultry feeding). As for the cashew nut, it is justified by a strong international demand. Regarding the cultivation of rice, it is being promoted to reduce national dependence vis-à-vis Asian imports. It is within this framework that was launched the promotion of NERICA rice, rice that can grow on all soil types. With regard to cotton, the cropping areas have evolved at a contrasted rhythm correlatively to the conjuncture of the market and Government incentives. The area experienced a significant growth in 1997 and 2002 due to the substantial increase in the prices paid to producers by the Government. But the gloomy international market was not always possible to maintain high prices or reduce input costs, which fully justifies the years of decline.

The situation described above is showed in Tables 2, 3 and 4 that present the correlations between the cropping areas and yields obtained over the period 1995-2005. Tables 2 and 3, show a significant positive correlation at the level of 0.05 for maize and cashew nut whereas it is a negative correlation for cotton.

4.2 Agriculture and environment

In many developing countries poverty and environment degradation are often related (WCED, 1987). It is known that the use of land for agricultural production is one of the strongest factors affecting environmental quality (Brady and Weil, 2002; Liu, et al., 2005; Zhang, et al., 2007; Oyekale, 2008).

Figure 3 shows an increasing utilization of fertilizer from 1994 to 2002 and a relative stabilization between 2004 and 2006. Although the rate of chemical fertilizer use in Benin remains low compared to other countries in the region, this could potentially present a long-term danger to the environment.

Besides the correlation fertilizer-soil degradation (Table 5) is significant at the 0.01 level. All experts interviewed on this subject agree that the greater the use of chemical fertilizers greater the risk of soil degradation. Furthermore, other studies have shown in Benin a close link between soil degradation and cultural practices (Olanrewaju, et al. 2007; Igué, 2008). The use of 'Endosulfan' pesticide in Benin was linked to significant health concern. 'Endosulfan' was widely used in cotton farming in Benin. Following dozens of farmers and their family falling sick or being exposed to it, some studies had concluded the health consequences to be closely related to 'Endosulfan' (Glin, et al., 2006).

Figure 4 shows the role of agriculture in environmental pollution in Benin. From a communication presented by the Environment Department in 2001, agriculture alone accounts for about 70% greenhouse gas emissions (MEHU, 2001). Thus, special attention should be paid to projects in Benin.

4.3 Strategic Plan for Agricultural Sector Revival (PSRSA)

Agriculture is an essential component of the economies of West Africa. In Benin, agriculture employs about 45% of active population and contributes to over 35% of Gross Domestic Product (Figure 1).

However, agriculture suffers from many problems including low productivity and correspondingly high prevalence of poverty. The land available for agriculture is also underused. The Strategic Plan for Agricultural Sector Revival (PSRSA) aims at improving the performance of agriculture in Benin to make it able to ensure permanent food security and contribute to economic and social development of the country. Thus the Strategic Plan for Agricultural Sector Revival is a part of the Millennium Development Goals.

The analysis of figure 5 allows us to see the facts of the goals of this plan. Significant growth is envisaged for the main crops. In terms of productivity corn could increase from 841 000 tons in 2005 to 14 000 000 tons in 2011. Similarly rice productivity expected to increase from 60 000 tons to 180 000 tons whilst cotton would increase from 190 000 to 600 000 tons. Some crops may even surpass the double of their productivity of 2005 (such as pineapple). The growth in production shown implies an increased cultivatable land and fertilizer input (see Tables 2 and 3). Furthermore the variable fertilizer-soil degradation was positively correlated at the 0.01 level (Table 5). Still the planned investments under the plan for modernization of agriculture indicate an increase in all crops with widespread use of machines and fertilizers. However there is indication that the highly production based on fertilizer and seed technologies introduced over the past three decades may be reaching a point of diminishing returns (Bouis, 1993; Cassman, et al., 1995). It appears from the following analysis the risk of soil degradation and even pollution of the environment will exist when this plan will be implemented. Nonetheless both the over and under application of fertilizer and the poor management of resources damages the environment (Gruhn, et al., 2000). It is therefore important for the agricultural engineers, environmental experts, soilists and all in charge of the implementation of PSRSA to seek for strategies to minimize the risk of environmental degradation.

4.4 Strategies for circular agriculture implementation in Benin

Several requirements are necessary in implementing circular agriculture in Benin (figure 6).

However more researches need to be done about Circular Economy in general and especially about circular agriculture. These researches will help to appropriate the concept, to understand all the details about it, other countries experiences, and the methodological approach for a total success of its implementation in Benin. It is important that the implementation of circular agriculture strategy need to be done by taking into account Benin's socio-economic and environmental situation. Benin will therefore need to keep on sending students and researchers to China and even other countries like Germany, Japan etc. to learn more (in theories and practice) about circular agriculture.

Secondary, an appropriate legal environment needs to be created so as to implement:

- Natural resources related legislation and policies (water resources, land resources, mineral resources, and energy).
- Laws, regulations and policies on environmental protection and comprehensive utilization of resources (much have been already done in this area: Law 87-16 about Water Code of the Republic of Benin; Law 98-030 about the Framework Law on the Environment in the Republic of Benin and so forth) and Cleaner Production.
- Legislation and policies on production and consumption areas.
- Legislative recommendation for 'circular agriculture' implementation.

Finally follow the principles of 'Cleaner Production' enterprises to come to ecological parks where the circular agriculture initiative will be done. Also financial effort must be made by Benin to the acquisition of 'clean technologies' (environmental-friendly technologies). This strategy must be first experienced at city level for five years at least before being adopted at national level. This could help to know how its works in aim to make some recommendations for its extension.

5. Conclusion

This study has showed how important is agriculture for food security and poverty alleviation in Benin. It has also proven the desire of Benin Government to make of Benin an agricultural power in West Africa through the program called 'PSRSA'. Although environmental degradation related to agriculture is not very noticeable in Benin, the risk of environmental degradation exists with the new plan of agricultural modernization. For this reason, strategies must be adopted to avoid the nightmare experienced by several countries that were formerly engaged in an intensive agricultural production. China who is experiencing successfully in circular agriculture strategy could serve as a model in Benin for sustainable agriculture promotion. The implementation of circular agriculture in Benin requires laws and policies establishment, agricultural infrastructures and technologies development up to the challenge and many researches. For this end, farmers, institutions, and Government all have an important role to play in sustaining agricultural productivity.

This could help the country to feed its growing population without causing damage on environment and threatening life of the world population. However more researches still needed to deepen the conditions for implementing this strategy in Benin given the limitations of our research.

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Notes

Note 1: Sustainable agriculture is one that produces abundant food without depleting the earth's resources or polluting its environment. It is the agriculture that follows the principles of nature to develop systems for raising crops and livestock that are, like nature, self-sustaining.

Note 2: The Circular Economy further aims at improving the ecological efficiencies of production and reproduction activities, and maximizing economy output with minimized resource and energy consumption, so that the economic, environmental and social benefits could be harmonized and sustainable production and consumption patterns accomplished.

Table 1. Showing descriptive statistics of agriculture contribution to Benin GDP (Source: Benin Department of Agriculture).

	N	Minimum	Maximum	Mean	Std. Deviation
Agriculture	11	31.90	38.40	35.3182	2.54040
Industry	11	13.40	14.60	13.8091	.37803
Service	11	47.70	54.70	50.8727	2.60465
Valid N (listwise)	11				

N= Number of years

Table 2. Showing correlation between cropping area and yield: case of maize (Source: Benin Department of Agriculture).

		Acreage	Yield
Acreage	Pearson Correlation	1	.873*
	Sig. (2-tailed)		.010
	N	7	7
Yield	Pearson Correlation	.873*	1
	Sig. (2-tailed)	.010	
	N	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

N= Number of years

Table 3. Showing correlation between cropping area and yield: case of cashew nut (Source: Benin Department of Agriculture).

		Acreage	Yield
Acreage	Pearson Correlation	1	.874*
	Sig. (2-tailed)		.010
	N	7	7
Yield	Pearson Correlation	.874*	1
	Sig. (2-tailed)	.010	
	N	7	7

*. Correlation is significant at the 0.05 level (2-tailed).

N= Number of years

Table 4. Showing correlation between cropping area and yield: case of cotton (Source: Benin Department of Agriculture).

Correlations

		Acreage	Yield
Acreage	Pearson Correlation	1	.227
	Sig. (2-tailed)		.625
	N	7	7
Yield	Pearson Correlation	.227	1
	Sig. (2-tailed)	.625	
	N	7	7

N= Number of years

NB: About the structure of these outputs (tables 2, 3, 4 and 5), notice that the upper portion of each cell identifies the correlations between variables accurate to three decimals; the middle portion indicates the significance of each corresponding correlation; and the lower portion records the number of subjects or elements involved in each correlation.

Table 5. Showing correlation between fertilizer input and soil degradation (Source: Survey data 2009).

Correlations

		FertilizerInput	Soil Degradation
FertilizerInput	Pearson Correlation	1	.998**
	Sig. (2-tailed)		.000
	N	6	6
SoilDegradation	Pearson Correlation	.998**	1
	Sig. (2-tailed)	.000	
	N	6	6

** . Correlation is significant at the 0.01 level (2-tailed).

N= Number of experts interviewed

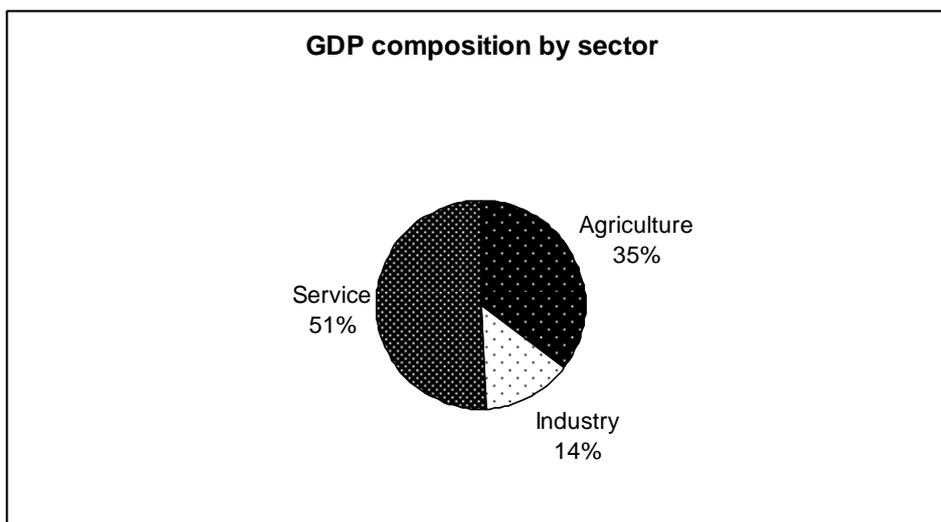


Figure 1. Showing agriculture contribution to GDP in Benin (Source: Benin Department of Agriculture)

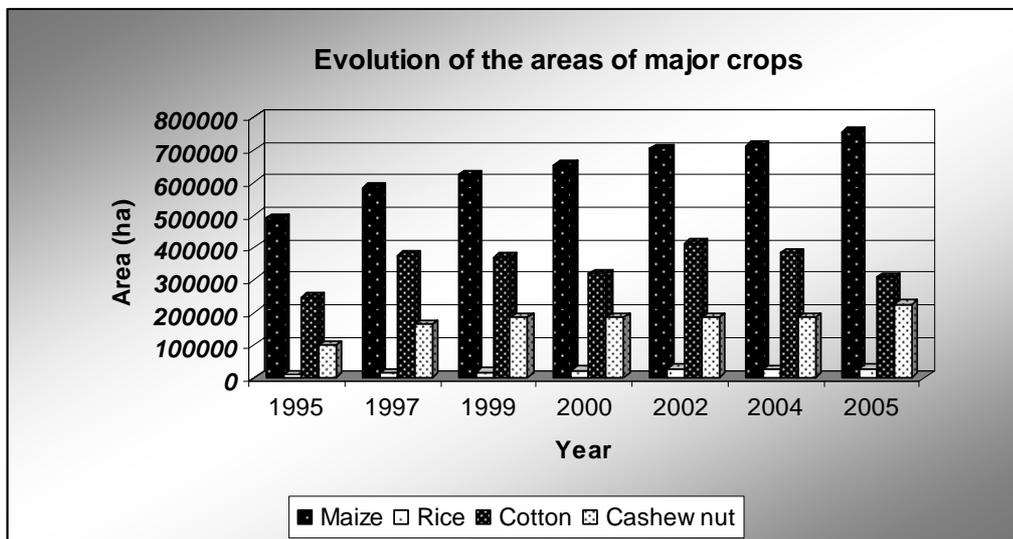


Figure 2. Showing the cropping areas evolution in Benin (Source: Benin Department of Agriculture).

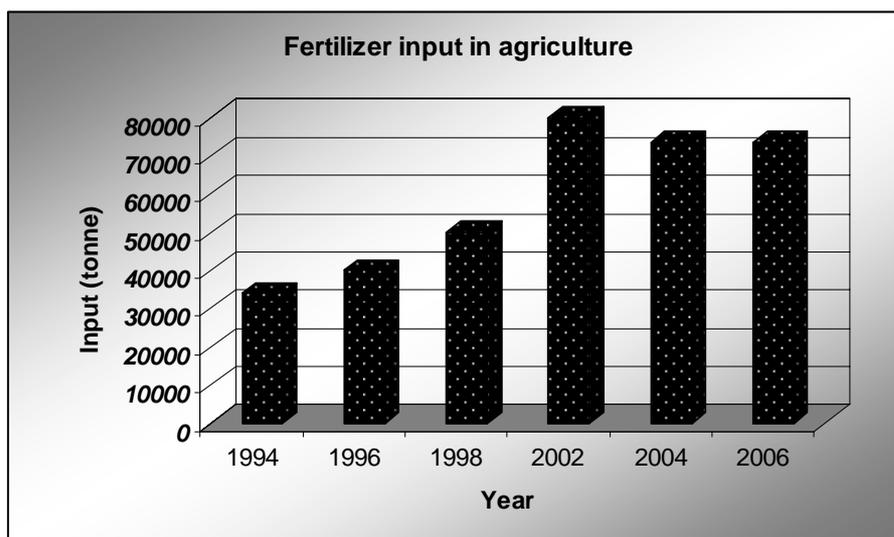


Figure 3. Showing fertilizer input in agriculture from 1994 to 2006 in Benin (Source: Benin Department of Agriculture).

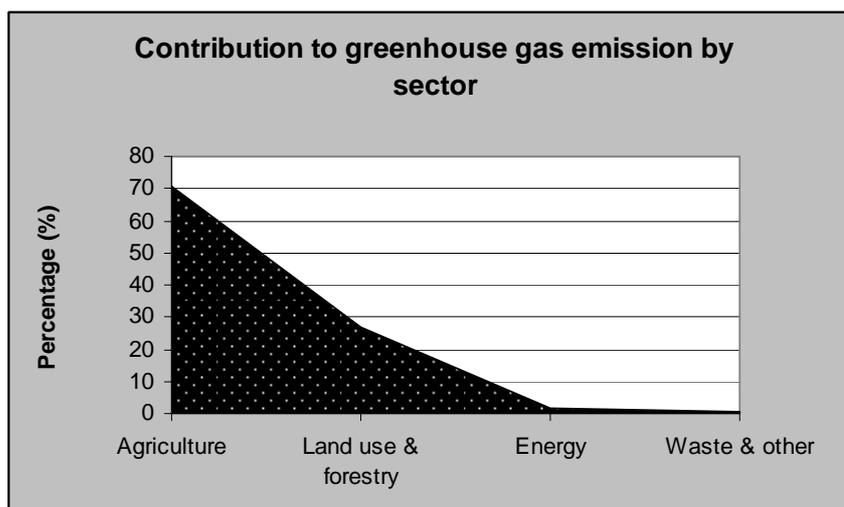


Figure 4. Showing agriculture contribution to environmental pollution in Benin (source: MEHU, 2001).

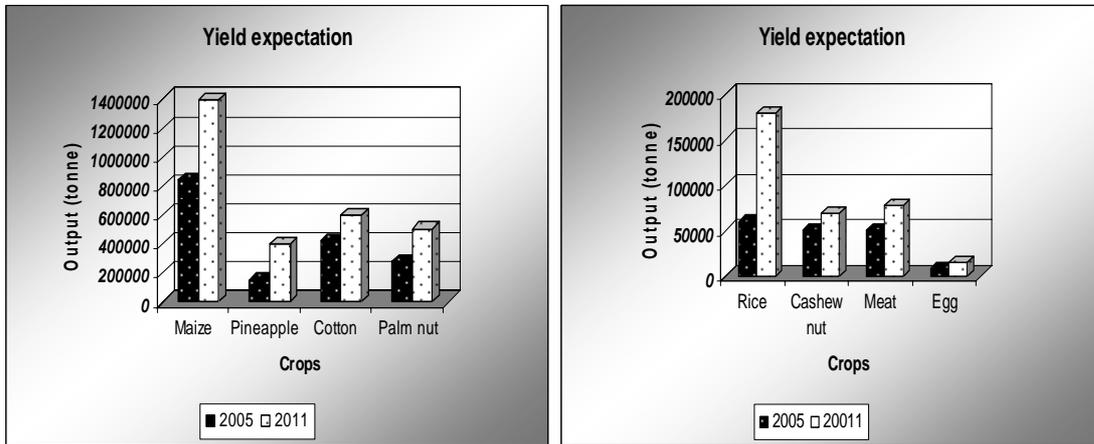


Figure 5. Showing PSRSA crops yields for 2005 and expectations for 2011 (Source: Benin Department of Agriculture).

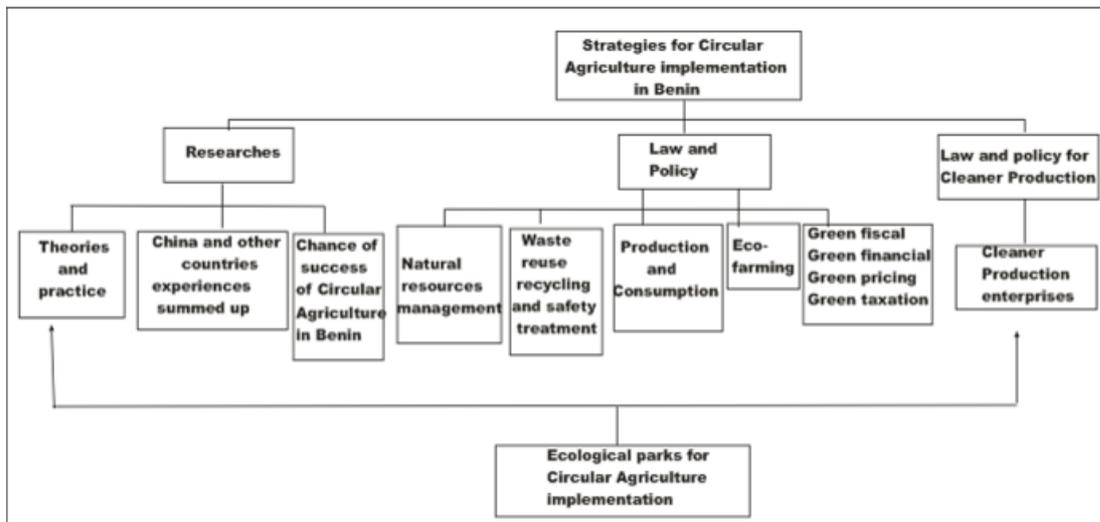


Figure 6. Showing conceptual framework for circular agriculture implementation in Benin



Assessing the Level of Community Capacity Building in Tourism Development in Local Communities

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Abstract

This paper attempts to summarize the findings of a study, which explored the levels of community capacity building (CCB) that contributed to tourism development in local communities. The study was carried out in Shiraz, Iran. The study focused on the level of community capacity building in local communities that involved in tourism activities. The research methodology of the study was based on qualitative and quantitative methods. Findings of the study show that the level of CCB in tourism development in the study area is generally low. Secondly, the CCB in the Old District of Shiraz was higher compared to the New District. The result also shows that the level of CCB is different according to types of tourism activities. The objective of the study also was to determine the relationship between the level of CCB and community leaders' perception of tourism impacts and their characteristics. The results from the multiple regression indicated that CCB can be predicted by community leaders' income, tourism income, extra activities, length of residence, educational level, and number of family members engaged in tourism activities.

Keywords: Community capacity building, Tourism development, Local communities

1. Introduction

Although CCB has been given only limited attention in the tourism literature, it has, however, been extensively discussed in other areas of development, especially health (George et al., 2007; Labonte & Laverack, 2001a; 2001b; Labonte et al., 2002; Maclellan-Wright et al., 2007; Raeburn et al., 2007; Seremba & Moore, 2005; Wickramage, 2006), education (Harris, 2001; Smyth, 2009) and agriculture (Dollahite et al., 2005). Lack of community capacity, coupled with limited understanding of tourism and its impacts, has been recognized as barriers to effective tourism development in third world countries (Moscardo, 2008). Capacity development in communities can be seen as the capacity of

community residents to participate in tourism activities. One important aim of CCB is to verify whether individuals, organizations and communities have been building their capacity for development of tourism in their communities.

Tourism development in local communities cannot be successful without the participation of community leaders and community residents. In the case of tourism development in local communities cannot be successful without participation of community leaders and community residents. In the case of study area, Shiraz has a lot of prospects in building various forms of tourism activities. However, in the absence of community participation, tourism industry in Shiraz is not likely to improve (Aref & Ma'rof, 2008). CCB is the key to tourism development. Understanding how CCB could develop tourism in local communities is fundamental to continued successful tourism development projects. Hence, assessing the level of CCB is an important step in developing community strategies for achieving community development (Marre & Weber, 2007).

2. Literature Review

Many local communities recognize the importance of tourism in stimulating change in social, cultural, environmental and economic dimensions, where tourism activities have had a close connection with the local communities (Richards & Hall, Beeton, 2006; 2000). Tourism is a community development tool used by many local communities to promote community economic development. In relation to this, local community leaders play a vital role in addressing tourism issues. Meanwhile, tourism development and CCB programs have increasingly placed emphasis on community development. In pursuing this direction, the concept of community capacity has become of particular importance in identifying priorities and opportunities for community development (Hackett, 2004; Victurine, 2000). Moreover, CCB is a necessary condition for improving the process of tourism development and enhancing its benefits for local communities. There is an argument that CCB is necessary for community development and participatory processes at the community level (Reid & Gibb, 2004). The term community capacity is widely used among those who are concerned about community development or involved in social work and social service delivery (Marre & Weber, 2007). Community capacity in tourism development can be seen as the capacity of the people in communities to participate in tourism activities (Cupples, 2005), where tourism developers often have the tendency to invest in community training and CCB as a way of contributing to long-term community development. In relation to this, community development practitioners should regard the concept of CCB not as something new, but as a refinement of ideas found within literature (Gibbon et al., 2002). CCB, like community development, describe a process that increases the assets and attributes that a community is able to draw upon in order to improve their lives (Labonte & Laverack, 2001a).

Balint (2006, p. 140) states that CCB as a level of competence ability and skill and knowledge, is necessary in order to achieve the community goals. It, therefore, concerns the development of skills and abilities that will enable local people to make decisions and actions for tourism development. The decisions and actions of the community are based on their desire to develop their community tourism. Thus, community capacity in tourism development is closely linked to community development. This study provides a portrait of applying an approach of the level of CCB in 175 local communities which involved in tourism development. While there is a substantial body of literature on the definition and conceptualization of CCB (Chaskin, 2001; Clinch, 2004; Goodman et al., 1998; Laverack, 2001), however, CCB has proven difficult to measure (Ebbeseb et al., 2004), and also there is very little literature which discusses practical application of approaches that have been successfully used to measure CCB in tourism development. CCB can be seen as the capacity of community residents to participate in tourism development activities, both as individuals and through groups and organizations. It is not primarily about their ability to act in their personal, family or employers' interest, which are catered for in other spheres. However, many of the same skills are involved, and people who are active in the community invariably benefit in other ways as well (Cupples, 2005). Meanwhile, CCB is widely acknowledged as an important strategy for community development. It is recognized as an essential strategy to strengthen the wellbeing of individuals and local communities and underpins much of the work of government and non-government agencies (Fiona 2007). CCB also is the ability to empower community residents to self-manage their community tourism through participation in the building and enactment of shared community vision.

3. Methodology

The study was carried out in local communities of Shiraz. Shiraz is a central area for Persian civilization and culture. It is situated in the south western region of Iran. Shiraz also is one of the most popular cultural tourism destinations in Iran with a long interesting history of the Roman Empire (Cultural Heritage News Agency, 2006). Throughout history, foreign visitors to Shiraz have praised the city's gardens, its site, its wines, and the charm of its people. Iranians themselves, however, have long treasured Shiraz as a city of Islam. Its traditional Iranian name is Dar al -Elm (Abode of Knowledge) (Aref & Ma'rof, 2009b; Limbert, 2004).

The research methodology of this study was based on qualitative and quantitative methods to evaluate building community capacity for tourism development. The geographical area of analysis is divided into two districts; the Old District and the New Districts. The Old District includes 84 communities, which are located on the central part of Shiraz,

whereas the New District includes 91 communities which are modern (Aref et al., 2009; Aref et al., 2009). The research study uses questionnaire survey and focus group discussion (FGD).

The data for this study were collected from community leaders and local residents which engaged in tourism activities. Community leaders was identified as a key factor in developing tourism in local communities (Aref & Ma'rof, 2009a; Moscardo, 2008). According to Eyer et al. (1999), Thompson et al. (2000), and Von et al. (1992) community leaders are able to speak for the community because of their knowledge and their roles in the community. For this study, community leader is defined as those who can influence policy, or opinion, or action on community because of their roles and positions in the community (Aref et al., 2009). For the purpose of this survey, questionnaire was designed for data collection. Moutinho (2000) believed that questionnaire is the most commonly used in tourism marketing research. The items in the questionnaire for this survey were measured using Likert scale. The Likert scale is also commonly used in marketing research (Grover & Vriens, 2006).

In this study, CCB is a composite variable, consisting of eight domains, namely, participation (7 items), community leadership (6 items), community structure (5 items), skill and knowledge (5 items), community power (5 items), sense of community (7 items), resource mobilization (5 items) and external support (5 items). The study used Likert-scale to measure every item. For measurement of the level of CCB in tourism development, as well as to determine the relationship between level of CCB and the leader characteristics and their perception towards tourism impacts, this study performed descriptive statistics, utilizing t-test, one-way Anova, correlation and multiple regression analysis. The sample population for questionnaire survey were community leaders. The respondents for FGD were residents who engaged in tourism activities.

4. Findings of the Study

4.1 Level of CCB in Tourism Development and its difference based on districts and types of tourism activities

The result from questionnaire indicated that generally the level of CCB in tourism development is low, except for the sense of community. However, based on the findings of the measurement of the three levels of CCB, it shows that according to the scores of individual level of CCB, sense of community is higher than skill and knowledge. In the organizational level of CCB; it shows that the score of leadership is higher than external support and resources mobilization. At the community level of CCB, the level of participation scores higher than community structures and community power. Overall, the results which illustrate the skill and knowledge, community structure, external support and resource mobilization are given a low rating of 2.0, and have been identified as being weak. This is might be due to the failure of community leaders to provide resource and skills to other members of the community. Therefore, it can be deduced that the leaders had failed to develop community structures adequately. The findings also show that 'sense of community' received a high rating of three (3). This is an indication that the overall level of CCB is weak, and that there is a need for the community to prioritize which domains they wish to strengthen. Hence, the findings imply that the community leaders were unable to develop CCB for tourism development. However, due to lack of technical assistance and other support from the government, community leaders could not be blamed as the main reason for the low level of CCB for tourism development. When comparing the three levels of CCB descriptively, the results show a high level of CCB in individual level for tourism development. By using the mean readings, it is found that generally, the individual level in tourism development is higher than organizational and community levels.

To support of the findings, the FGDs were also performed. Base on FGD, local people illustrated that community capacity in tourism development was weak. This finding emerged pursuant in 10 FGD sessions conducted in response to this objective. The findings support the researchers' argument that CCB needs to be developed further to enable local people to participate in tourism development processes. However, as it was mentioned earlier, one of the reasons of underdevelopment of tourism industry in Iran is the low level of collaboration between government sector and the local communities. In other words, the government has taken little initiative to improve tourism as a source of income for local communities. The role of government is important for tourism development in third world countries. In support with this argument, Cole (2007) believes that government can play an important role in mediating for tourism development in local communities. Some writers also believed technical assistance from government as the key element in building community capacity (Rural Voices for Conservation Coalition, 2007). This might also the reason why there was a little effort taken by the community leaders to building capacity in tourism development, even though there are many tourist attractions found in Shiraz. In relation to the above discussion, community leaders could not be blamed as the main reason for the lack of community capacity for tourism development.

According to the results of this study, individual level of capacity building has more effect in the process of CCB in tourism development. The findings illustrate a range of strengths and weaknesses of the level of building capacity in local communities for tourism development. Skill and knowledge, community structure, external support and resource mobilization were given a low rating of 2.0, and were identified as being weak because of the failure of community leaders to provide resources and skills to other members of the community. Therefore, the community leaders failed to develop the community structure for tourism development. In local communities of Shiraz, this situation had led to a

reduction in the number of community meetings and low level of participation in tourism decision making among community residents. However, most research suggests that tourism is a community decision making, and tourism development is an effort that has community support (Luloff et al., 1994). But in some local communities of Shiraz, the respondents indicated that the decision making to develop tourism was not a community decision. This follows the paradigm that without community participation, it "is difficult to develop a tourism industry in the community" (Andereck & Vogt, 2000 p. 27). The interpretation of the findings gives 'sense of community' a high rating of 3. Therefore, the hospitality of the local community is vital to the tourism development. Hence, tourism in the local communities should be developed according to sense of community (Andriotis, 2005). However, Chapman & Kirk (2001) state that skill and knowledge is vital to CCB, but the finding of this study shows that skill and knowledge is not that important. However, the result of analysis of the 392 case studies of tourism development indicated that the most barriers to effective tourism development were a lack of skill and knowledge. The lack of tourism knowledge is a critical barrier that not only directly limits the ability of local people to participate in tourism development but also contribute to the next barriers: a lack of local tourism leadership and domination of external agents (Moscardo, 2008).

To prove whether the differences are significant, t-test statistical analysis was used. According to the results, the Old Districts of Shiraz reported significantly higher level of CCB compared to the New District of Shiraz, with significant comparative levels of .000, $t = 9.465$, $p < .05$. Findings show that development of sense of community in the New District is lower than the Old District of Shiraz. This is because of community diversity in culture and ethics. This result also indicates that most people in this city are hospitable towards tourists. However, participation in the New District is lower than the Old District. This is due to fact that people in this district are closely related to each other. The findings of this study also illustrate the level of sense of community as a high when compared to other levels. This finding is consistent with Andriotis' finding (2005,) which illustrated that hospitality of the local communities is vital to development of tourism industry. Meanwhile, Murphy (1985) agrees that tourism development depend not only on the natural and community resources but also on the sense of community. Thus the sense of community is essential for tourism development. Therefore, the communities that are antagonistic to tourists, no amount of attractions will compensate for the hospitality. The findings can be support by the Gemeinschaft theory. According to Tonneis's theory; the local communities in the Old District of Shiraz are a sample of Gemeinschaft and local communities in the New District are a sample of Gesellschaft. Based on Tonneis theory, in a Gemeinschaft society, the members live together and develop common experiences, interests, memories and histories (Appelrouth & Edles, 2007).

To test the difference between the levels of CCB based on types of tourism activities One-way Anova was performed. The results show that the levels of CCB in medical services (Mean = 93.25) and culture tourism activities (Mean = 91.67) are higher than other types of tourism activities. These results show the variance between groups and the variance within groups. For CCB significant level =.000 shows a significant difference of CCB between different types of tourism activities, $F(4,170) = 9.014$, $P < .000$. The findings of comparison of CCB according to types of tourism activities illustrated that level of building capacity in cultural activities is the highest than others tourism activities. The findings are consistent with previous studies about cultural tourism (Aref & Ma'rof, 2009c). According to Moscardo (2008, p. 86) types of tourism activities identified which supposedly has the potential to involve and capacity development for tourism development. Therefore, these finding are consistent with the findings of Moscardo (2008) about the importance of cultural tourism activities. It is considered that the government have special vision and attention on cultural tourism activities. Also, Godfrey & Clarke (2000) stated that types of tourism activates do not have same effect and impacts on local communities. Therefore, level of development in each type of tourism activity is different. The finding of this study is also supported by Cole (2007) in which he believes that cultural tourism is one of the important types of tourism activities that brings community development. According to the Travel Industry Association of America (2005), the cultural tourism is more educational when compared with others types of tourism. Thus, cultural tourism, in addition to having more impacts on the level of community development, it has many potential for development. Among all findings, the work of Ivanovic (2009) is highly supporting the findings of this study. Ivanovic (2009) states that the cultural tourism has more resources than other types of tourism activities. This is because cultural tourism is dependent more on community cultural resources than on expensive infrastructures and accommodations. This characteristic gives cultural tourism activities the power to become the main tool of socio-cultural development through poverty alleviation and job creation among historically disadvantaged communities (Ivanovic, 2009, p. xx).

4.2 Community leaders' perception toward tourism impacts and its relation with level of CCB

Descriptive statistics reveal that respondents from both districts of Shiraz rated high positive perception and lower negative perception towards tourism impacts in local communities. Based on the mean measures of impact items, the impact items related to economic impacts has the lowest scores. When comparing between the three aspects of tourism impacts descriptively, the findings reveal that the community leaders have positive perceptions towards these threes aspect of impacts. Meanwhile, differences among respondents were also observed. The size of the standard deviations of 20 statements also indicated a moderate spread around the theoretical mean of three (3). The study has also found that

the community leaders perceived socio-cultural aspects of tourism impacts as more favourably than environmental and economic impacts (Aref et al., 2009).

This study also recognized community residents' perception towards tourism impacts through focus group discussions (FGD). It indicates a certain level of harmony between residents' perception and community leaders' perception toward tourism impacts. Relationship between leaders' perception toward tourism impacts with the level of CCB was also measured. For an alpha level of .05, the correlation between socio-cultural impacts and level of CCB was found to be statistically significant, ($r = -.092$, $N = 175$, $p < .224$), and the correlation between economic impacts and level of CCB was found to be statistically significant too, ($r = -.252$, $N = 175$, $p = .001$). This indicates that environmental impacts, and level of CCB are correlated negatively significant ($r = -.257$, $N = 175$, $p < .001$). The result also illustrated that leader' perception towards total tourism impacts has no significance ($r = -.075$, $N = 175$, $p < .325$). When comparing the socio-cultural, environmental and economic impacts of tourism and total tourism impacts descriptively, only economic impacts show positive relationship with the level of CCB for tourism development (Aref, Ma'rof, & Sarjit, 2009). However, the perception of environmental impacts has a negative significant relationship with levels of CCB. As have been mentioned earlier, Moscardo (2008) believed that the lack of understanding of tourism impacts can be a factor for underdevelopment of tourism in third world countries. Therefore, the findings of community perception towards tourism impacts on local communities helps to understanding relationship between community perceptions of tourism impacts with community support for building capacity for tourism development.

Based on all results that have been indicated above, it could be concluded that community leaders' perception towards tourism impacts cannot be a factor for underdevelopment tourism industry in local communities of Shiraz. These findings are inconsistent with the findings of Hafeznia et al., (2007), in which they believed in local communities of Iran; many people have negative perceptions especially about external tourism. In addition, the findings provide an introduction for discussion about relationship between level of CCB in tourism development and community leaders' perception towards tourism impacts. Gursoy & Rutherford (2004) suggested that tourism developers need to consider the perception of residents before they start investing resources in tourism development. Fisher (2005) also states on importance of leaders perception as an effective element in the processes of community economic development. The findings from this study supported the previous studies in terms of positive tourism impacts and their support for tourism development.

The finding which related to the perception towards economic impacts is consistent with the past studies that have been conducted by Ap (1992) and Yoon et al (2001). Most of these studies evaluated community residents' perception and assessments of cost and economic benefits of tourism and their support for further tourism development in their communities. In relation to this, social exchange theory supports that community residents balance the costs and benefits of tourism development, and their support for tourism depends on the outcome of this cost-benefits equation (Andriotis, 2005). Thus, it is believed that the economic impacts of tourism are the most widely researched impacts of tourism on a destination (Mason, 2003). Studies done by Andereck & Vogt (2000) also support the findings of this study. According to their studies, there is a relationship between community residents' support for tourism development and their perception toward tourism impacts. However, it can be concluded that community leaders support for building community capacity in tourism development is positively related to their benefits from tourism development. Empirical findings from these studies have suggested that people will act to maximize benefits and minimize costs in different situations. They also weigh total benefits against total costs that effect their decision to participate in tourism decision making and tourism development planning (Kayat, 2002; Lawler, 2001; Yoon et al., 2001). Andriotis & Vaughan (2003) also found that when the exchange of the economic, social, and environmental resources is at least balanced for the local communities, only then tourism will be perceived positively by residents. However, they caution that the benefits of tourism may be experienced by only a handful of individuals in the community and only those who benefit will be more likely to support tourism development. Accordingly, in order to have tourism be supported by all community members, the benefits of tourism must be evenly distributed (Andriotis & Vaughan, 2003). Hence, social exchange theory helps us to build a clear relationship between perceived impacts and support for tourism development (Perdue et al., 1990).

4.3 Leaders' characteristics and level of CCB in tourism development

The result from the present study shows that there was a significant positive correlation between age and CCB ($r = .416$, $N = 175$, $p = .000$). Moreover, there is a significant positive correlation between duration of residence and CCB ($r = .402$, $N = 175$, $p = .001$). The result also shows there is a significant positive correlation between duration of position held and CCB ($r = .462$, $N = 175$, $p = .000$) and significant positive correlation between income and CCB ($r = .601$, $N = 175$, $p = .000$). A Spearman correlation also found that there is a significant positive correlation between education and CCB ($r_s = .401$, $N = 175$, $p < .000$), income and CCB ($r_s = .644$, $N = 175$, $p < .000$), extra activities and CCB ($r_s = .214$, $N = 175$, $p < .004$), tourism jobs and CCB ($r_s = .546$, $N = 149$, $p < .000$) and number of family engaged in tourism activities with CCB ($r_s = .356$, $N = 175$, $p < .000$). The present findings are consistent with the findings of study by Fisher (2005) which stated that the characteristics of the leaders have successful effect in the context of community

economic development. Meanwhile, Schultz (2004) also stated the importance of leaders characteristics in relations to community development effort. One of the key leaders' characteristic in this study is educational level. In relation this, Vaughan (2003) stated that people with high education have the tendency to support tourism development.

The finding also shows that educational level has a significant relationship with level of CCB. This consistent with the finding of the study Andriotis & Vaughan (2003), who found that the higher the level of education, the more likely residents were to express their apprehension to tourism development in their communities. Meanwhile, age is also considered as a leaders' characteristic which has a significant relationship with the level of CCB. Consistent with this finding is the findings by Chen (2000) and Lawton (2005), who found that older residents also more likely to support tourism. Other key leaders' characteristic is income. A leaders' annual income is also found to have a significant relationship with the level of CCB. Chen (2001) also states that people with high income have more tendency to get involve in tourism development. He stated that economic benefits of tourism have an effect on the support given by local people for the development of tourism. Income from tourism and the number of family members who engage in tourism activities also have a positive significant relationship with the level of CCB for tourism development. Moreover, social exchange theory also supports the findings of the study. Length of resident was significantly relation to level of CCB. These findings are also supported by the studies carried out by Green et al. (1986) and Lawton (2005). Green et al. (1986) state that permanent residents may be more supportive of tourism development than seasonal residents (Green et al., 1986). Lawton (2005) also finds that the duration of residence in the destination plays an important role when examining community residents' support for tourism development. The duration of the leaders' position is also considered to have a significant relationship with the level of CCB. Those community leaders who have lived in the community with the longer duration as leaders have a tendency to exert more effort for development of CCB for tourism development. However, the variable related to having activities related to tourism, has a negative significant relationship with the level of CCB for tourism development. The finding shows that community leaders who may not work directly in the tourism industry may have different effort in CCB for tourism development. Martin et al (1998) conclude that those who do not receive real economic benefit from tourism do not have the tendency to seriously involve in the development of tourism industry.

4.4 Contributing factors in predicting the level of CCB in tourism development

A multiple regression analysis was conducted to identify the factors that contributed to the level of CCB in tourism development. Twelve predictors were included. However, based on the interviews with the leaders, only six predictors (income, tourism income, extra activities from tourism, duration of residence, educational level, and family engaged in tourism activities) were considered in the regression modelling. In the first model, only income was adopted as a predictor. The R^2 value of 0.737 implies that the six variables explain around 74% of variance/variation in the CCB in tourism development in local communities of Shiraz. According to the model summary, about 74% of the variation in the criterion variable Y (level of CCB) can be explained by the regression model with the six predictors. The regression model with six predictors is significantly related to the criterion variable Y, $F(6,141) = 65.912$, $p < .05$. The finding shows that the largest beta coefficient is 0.350, which is for the tourism income. The beta value for "income" is the second highest (.299). Thus, the model summary information reveals that the R^2 for this data set was .737. This indicates that 74% of CCB for tourism development by community leaders could be predicted by the independent variables of leaders' income, tourism income, extra activities, length of residence, educational level, and family engaged in tourism industry.

Since the findings of the present study shows that the important predictors for CCB in tourism development are income and income from tourism activities, therefore, it can be inferred that community leaders' support for CCB in tourism development is positively related to their economic benefits from tourism industry. Moreover, the findings of this study could be explained by theory of social exchange. Based on the social exchange theory community residents' support for tourism development depends on the outcome of this cost-benefits equation (Andriotis, 2005). Findings from these studies have suggested that local people will act to maximize benefits and minimize costs in different situations. They also weigh total benefits against total costs that effect their decision to participate in tourism decision making and tourism development planning (Kayat, 2002; Lawler, 2001; Yoon et al., 2001). The findings of this study also emphasize on role community leaders in CCB for tourism development. The findings are supported by Austen (2003), who stated that without the community leaders effort in building the community capacity in local communities, the tourism development would not materialized. Littrell & Hobbs (1989) also confirmed the importance of community leaders role in their discussion of the self help approach to building capacity in communities. According to Israel & Beaulieu (1990), without powerful leaders, it was virtually impossible for local communities to tackle problems. Taylor (2003) also believed that without the significant role of community leaders, building capacity cannot be developed. Therefore, tourism development planners should take into considerations the community leaders' characteristics as important elements in the development of tourism in local communities.

5. Conclusion

The main purpose of this paper is to illustrate and discuss variables related to the CCB for the tourism development. Although, there are several studies which discuss the construct of CCB, particularly in health promotions and agriculture, however, there seems a very few studies that discuss the CCB in the context of community tourism development. In relation to this, the present researchers have attempted to embark a study in order to understand CCB in tourism development. The data presented in this paper demonstrate that there is a need for the development of CCB in local communities of Shiraz. In terms of assessing levels of CCB; three main findings have been discovered. Firstly, CCB in tourism development in the study area is generally low. Secondly, the CCB in the Old District is higher than the New District of Shiraz. Thirdly, the level of sense of community is the dominant factor compared to other dimensions. Moreover, the results also show that the levels of CCB are different according to the perception of types of impacts of tourism. These findings have also been supported by FGD. The study also proves that a high percentage of the answers stressed the positive aspects of socio-cultural, environmental and economic impacts of tourism in local communities. The results of the study also show that there is a relationship between the level of CCB and community leaders' perception of tourism impacts as well as leaders' characteristics. The findings show that perception of economic impacts has a positive significant relationship with the level of CCB. Furthermore, some leaders' characteristics also had significant relationships with levels of CCB in tourism development. Meanwhile, the results from the multiple regression analysis indicated that CCB can be predicted by community leaders' income, tourism income, extra activities form tourism, duration of residence, educational level, and number of members family engaged in tourism activities. According to the result, the largest beta coefficient is for the perception of income. In sum, regression analysis indicated that approximately 74 percent ($R^2 = .737$) of the variance in CCB was predicted by those variables. It is hoped that the findings of this study could be used to assist community leaders in the design and implementation of tourism development strategies in local communities that are undertaking tourism planning. Moreover, it is expected that the findings of this study could be utilized by the leaders and tourism developers for their future follow-up studies and reassessment of CCB for tourism development.

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Bioconversion of Municipal Solid Waste (MSW) and Water Hyacinth (WH) into Organic Manure by Fungal Consortium

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Abstract

The present study was carried out to assess the degrading efficiency of the fungal consortium (Cellulolytic fungi - *Paecilomyces variotti* and *Chaetomium globosum*, lignolytic fungi - *Pleurotus florida* and *Trametes versicolor* and actinomycetes - *Streptomyces lavendulae* and *Thermobifida fusca*) in converting the Municipal solid waste (MSW) and Water hyacinth (WH) mixture into an eco-friendly value added organic manure. The results revealed that the biomanure obtained by inoculation of fungal consortium into the municipal solid waste (MSW) and water hyacinth (WH) mixture was found to be efficient in enhancing the rate of decomposition within as they showed a drastic reduction in the biochemical parameters like organic carbon (21.09 per cent), cellulose (20.56 per cent), phenolic content (0.46 mg g⁻¹) and reducing sugars (0.67 mg g⁻¹). C: N ratio was narrowed down from 92:1 to 15:1, while nitrogen content increased from 0.37 percent to 1.39 per cent compared to uninoculated MSW-WH compost. β -glucosidase and urease enzyme activities were much pronounced upto 75 days from 0.05 to 2.82 U l⁻¹enzyme protein (β -glucosidase) and from 0.93 to 2.39 μ mol of ammonia formed mg⁻¹enzyme protein (urease) in fungal consortium inoculated MSW-WH over the uninoculated MSW-WH compost.

Keywords: Municipal Solid Waste (MSW), Water Hyacinth (WH), Fungal consortium, Biomanure

1. Introduction

Coimbatore is an inland district in the Tamil Nadu state in India. The amount of municipal solid waste generated in Coimbatore city has been increased dramatically during the past several years. On an average, the city generates 800 metric tonnes per day of solid waste (Jayapriya and Saseetharan, 2007). Disposal of solid waste is by open dumping. A part of the waste is composted through a pit system. Coimbatore Municipal Corporation is now facing problems associated with solid waste management system.

The modern concept of environmental management is based on the recycling of waste. In this context, composting appears to be a safe form of treatment of some waste and the reclamation of the nutrients contained in them (Iranzo *et al.*, 2004). During the last few years, composting has gained wide acceptance as a key component of integrated solid waste management. It has been promoted as an eco-friendly and sustainable solution to urban waste management. It encourages the production of beneficial microorganism (mainly the fungus) which in turn breaks down organic matter to create humus. Humus, a rich nutrient filled material, increase the nutrient content on soils and helps soil to retain moisture. Compost has also been shown to suppress plant diseases and pests and enhance higher yields of agricultural crops.

Water hyacinth, *Eichhornia crassipes* (Mart) Solms also known as 'blue devil', grows rapidly as a dense green mat over stagnant water bodies such as lakes, streams, ponds, waterways, ditches and backwaters. It is ranked as one of the world's worst invasive water weeds causing wide spread problems to millions of users of water bodies and water resources. It alters the ecosystem of the water body, causing oxygen fluctuation and raising the water temperature. There are many man-made lakes and ponds in Coimbatore district, which were once used to store water for domestic, irrigation and most importantly to promote ground water recharge. Most of these tanks and ponds receive invariably untreated sewage, untreated and partially treated effluent from local electroplating industries. Utilizing this potential

water bodies, water hyacinth has grown enormously, which largely prefers nutrient-rich places for its sustenance. Fresh plant contains moisture - 92.8 per cent; ash content 417 - g kg⁻¹; pH- 8.1; total organic carbon - 338 g kg⁻¹; total nitrogen - 9.5 g kg⁻¹; C:N ratio - 36:1; total potassium 9.7 g kg⁻¹; phosphorus - 5.4 g kg⁻¹; total-ferrous -1640 mg kg⁻¹; total-copper 312 mg kg⁻¹; total cadmium- 1.36 mg kg⁻¹; total chromium- 41.18 mg kg⁻¹; total lead- 67 mg kg⁻¹ and total-Zn - 640 mg kg⁻¹. The weed rots in 15 days and it is an ideal component in fertilizers which makes the soil more fertile thereby enhancing better yield of crops. (Gupta *et al.*, 2007).

Large amounts of compost prepared from municipal refuse are available. But most of these have low nitrogen and phosphorous content and are poor sources of nutrients for plant growth (Kapoor *et al.*, 1983). One of the possible ways of increasing the nutrient content of the final compost product is microbial enrichment technique. This can be achieved either by introducing beneficial microorganisms by way of inoculation or by increasing the microbial activity by the incorporation of amendments (Rao and Tak, 2001). Inoculation of specific microflora during different stages of composting would hasten the decomposition potential that could imperatively yield good quality composts in shorter time spans (Taiwo and Oso, 2004).

Municipal solid waste is made up of different organic and inorganic fractions like food, vegetables, paper, wood, plastics, glass, metal and other inert material. Easily degradable fractions can be segregated from non-biodegradable fractions, suitably amended with water hyacinth and converted into nutrient enriched organic manure by microbial inoculants. The amendments not only influence soil fertility, but may also enhance the composition and activity of soil microorganisms. The overall goal of waste management is to collect, treat and dispose the waste using the most economical means available.

Hence, the present investigation was carried out to convert the municipal solid waste (MSW) and water hyacinth (WH) mixture into value added nutrient enriched organic manure by inoculating with the fungal consortium (Cellulolytic fungi - *Paecilomyces variotti* and *Chaetomium globosum*, lignolytic fungi - *Pleurotus florida* and *Trametes versicolor* and actinomycetes - *Streptomyces lavendulae* and *Thermobifida fusca*).

2. Methodology

Municipal solid waste was collected from Vellalore municipal corporation yard, Coimbatore. Water Hyacinth (WH) was collected from a pond in Kurichi, Coimbatore District. Cellulolytic fungi (*Paecilomyces variotti* and *Chaetomium globosum*), lignolytic fungi (*Trametes versicolor*) and actinomycetes (*Streptomyces lavendulae* and *Thermobifida fusca*) were bought from the Institute of Microbial Technology, Chandigarh, India. Lignolytic fungi (*Pleurotus florida*) was bought from Centre for Advanced studies in Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore.

Paecilomyces variotti (MTCC - 480), *Chaetomium globosum* (MTCC - 155) and *Pleurotus florida* were cultured in - Potato Dextrose Agar Medium (PDA) (250 g of autoclaved potato, 20 g of dextrose and 15 g of agar in 1 litre of distilled water). *Trametes versicolor* (MTCC - 138) was cultured in yeast extract medium (5 g of yeast extract 10.0 g of glucose and 15 g of agar in 1 litre of distilled water). *Streptomyces lavendulae* (MTCC - *706) was cultured in malt and yeast extract medium (3.0 g of malt extract, 3.0 g of yeast extract, 5.0 g of peptone, 10.0 g of glucose and 20.0 g of agar in 1 litre distilled water). *Thermobifida fusca* (MTCC - * 1754) was cultured in yeast extract and tryptone medium (3.0 g of tryptone, 3.0 g of yeast extract, 3.0 g of glucose, 1.0 g of dipotassium hydrogen phosphate and 20.0 g of agar in 1 litre distilled water). 1000 g of sterilized and dry MSW and WH was taken in the ratio 2:1 in a perforated thick gauge polythene bags. The polythene bags were marked and a mixture of fungal mass and actinomycetes were added to it, under aseptic conditions (approximately 100g of microbial mass).

The rate of degradation of MSW - WH substrate mixture was determined at an interval of 15 days for 90 days by analyzing physical and biochemical parameters. The physical parameters analyzed were appearance, color, odor, pH and electrical conductivity. Appearance, color and odor were determined visually. The pH and Electrical conductivity were determined in 1:10 (w/v) waste/distilled water soluble extract using a pH meter and electrical conductivity meter in the Department of Botany, Avinashilingam University for Women, Coimbatore. Biochemical parameters determined were Cellulose (Updegroff, 1969), Organic Carbon (Walkely and Black, 1934), Total nitrogen (Microkjeldhal method - Humphries, 1956), Phenol (Folin Ciocalteu method - Bray and Thorpe, 1954), Reducing sugars (Dinitrosalicylic acid method - Miller, 1972), β -glucosidase - filter paper activity (Sadasivam and Manikam, 1996) and Urease (Nesslerization method - Sumner, 1955).

3. Results and discussion

3.1 Physical parameters (Table -1)

The mature compost in uninoculated MSW-WH mixture was dark brown in color, granular with wood earthy smell while in inoculated MSW-WH mixture; it was black in color, granular and fibrous with pleasant earthy smell compared to the raw MSW-WH mixture which was light brown in color, coarse in appearance with a foul smell. The appearance of black color is indicative of its maturity. Pandharipande *et al.* (2004) reported that the mature compost must be dark

brown or black, granular, spongy in feel and smell normally. A significant decrease in pH and EC were observed in uninoculated MSW-WH compost which was 7.90 and 0.32 dSm⁻¹ and 6.83 and 0.28 dSm⁻¹ in fungal consortium inoculated MSW-WH compost over the raw MSW-WH (8.28 and 0.49 dSm⁻¹) respectively. The occurrence of pH 6.83 and EC 0.28 dSm⁻¹ in fungal consortium inoculated MSW-WH compost after 90 days of decomposition can be due to the bioconversion of organic materials into various intermediate types of organic acids and higher mineralization of the nitrogen and phosphorus into nitrites/nitrates and orthophosphates respectively. Jeevan Rao (2008) reported a pH of 7.9 and EC of 0.46 dSm⁻¹ in urban solid waste compost and showed a decrease with the advancement in period of composting from 30 to 120 days.

3.2 Biochemical parameters (Table -2, 3, 4 and 5)

The cellulose content in raw MSW-WH mixture was 56.68 per cent. It was decreased to 31.55 per cent in uninoculated MSW-WH compost and 20.56 per cent in fungal consortium inoculated sample. A significant decrease in cellulose content in fungal consortium inoculated MSW-WH after 90 days of decomposition might be attributed to the significant production of cellulase enzyme by microbes. The cell free enzymes are capable of completely hydrolyzing crystalline cellulose *in vitro*. Tamilarasi (2006) observed a decrease in cellulose content of kitchen waste from 34.71 per cent to 10.93 per cent ($P < 0.01$) after 60 days of decomposition with activated Effective microorganism treatment. Padmaja and Sangeeth (2008) also reported a decrease in the cellulose content of Municipal Solid Waste (MSW) from 34.71 per cent to 10.93 per cent with Effective Microorganism treatment.

The Organic carbon (OC) and Organic matter (OM) of raw MSW-WH mixture were 34.07 per cent and 58.73 per cent and after 90 days decomposition, it was decreased drastically to 24.45 per cent and 39.91 per cent in uninoculated MSW-WH and to 21.09 per cent and 36.36 per cent in fungal consortium inoculated sample. The reduction in Organic carbon and Organic matter in fungal consortium inoculated MSW-WH decomposed sample might be due to higher mineralization of organic matter by micro flora. Jilani (2007) reported a decrease in organic carbon and organic matter from 33.0 per cent to 23.0 per cent (OC) and from 57.0 per cent to 39.65 per cent (OM) respectively in windrow method of composting municipal solid waste of Karachi city. A significant increase of 1.39 per cent in total nitrogen content was noticed in fungal consortium inoculated MSW-WH compost than the uninoculated MSW-WH compost (1.03 per cent) after 90 days decomposition. The apparent increase in total nitrogen content in the biocompost is not only due to enhancement of nutrient but also due to reduction in weight because of decomposition. Padmaja and Sangeeth (2008) obtained an increased total nitrogen content of 1.23 per cent from 0.57 per cent in Effective Microorganism inoculated solid waste compost (after 60 days). C: N ratio has been used as an indication of the potential of compost maturity. C: N ratio of the raw MSW-WH mixture was 92:1 and it was narrowed down drastically to 24:1 in uninoculated compost and to 15:1 in fungal consortium inoculated compost after 90 days of decomposition. Indeed, the decrease of the C/N ratio is explained by the transformation of carbon into carbon dioxide followed by a lower decrease in the concentration of organic acids (Chefetz *et al.* 1998). Jeevan Rao (2008) observed a significant reduction in C: N ratio from 43:1 to 17: 1 in *Pleurotus sajor caju* inoculated urban solid waste.

The total phenolic content in raw MSW-WH waste was 2.73 mg g⁻¹. A marked reduction in total phenolic content of 0.71 mg g⁻¹ in uninoculated compost and 0.46 mg g⁻¹ in fungal consortium inoculated MSW-WH compost was recorded after 90 days of decomposition. A Significant reduction in total phenolic content in fungal consortium inoculated MSW-WH sample might be due to metabolic activity of cellulolytic, lignolytic and actinomycetous organisms and is indicative of the antitoxicity effect of the compost for application to agricultural crops. Padmaja and Sangeeth (2008) during their study on the recycling of solid waste into organic manure by EM (Effective Microorganism), observed a reduction in the total phenolic content in EM-SW compost from 1.50 mg g⁻¹ to 0.67 mg g⁻¹ after 60 days of decomposition.

The reducing sugar content in raw MSW-WH mixture was 2.37 mg g⁻¹ and it was decreased significantly to 0.80 mg g⁻¹ in uninoculated MSW-WH compost and 0.67 mg g⁻¹ in fungal consortium inoculated compost after 90 days of decomposition. Reduction in reducing sugars content in fungal consortium inoculated MSW-WH sample might be due to the action of microorganisms that partake in the degradation process which utilize sugar as their carbon source. Padmaja and Sangeeth (2008) also obtained a remarkable reduction in reducing sugar during the decomposition of solid waste by Effective Microorganisms.

β -glucosidase activity was very much pronounced (2.82 IU mg⁻¹) in fungal consortium inoculated MSW-WH compost than the uninoculated MSW-WH compost (0.92 IU mg⁻¹) upto 75 days and declined to 1.69 and 0.72 IU mg⁻¹ over 90 days of degradation. The least β -glucosidase activity was registered in raw MSW-WH mixture (0.05 IU mg⁻¹). Imanuel *et al.* (2006) also obtained a high level of β -glucosidase enzyme production of 0.34 IU ml⁻¹ and 29 IU ml⁻¹ by *Aspergillus fumigatus* and *A.niger* fermented coir waste and saw dust.

A significant increase in urease activity of 1.32 μ mol of Ammonia formed min⁻¹ mg⁻¹ enzyme protein was recorded in uninoculated MSW-WH compost and of 2.39 μ mol of Ammonia formed min⁻¹ mg⁻¹ enzyme protein in fungal consortium inoculated MSW-WH samples upto 75 days and gradually declined to 1.26 and 1.89 μ mol of Ammonia

formed $\text{min}^{-1} \text{mg}^{-1}$ enzyme protein. Fungal consortium inoculated MSW-WH mixture showed much pronounced urease enzyme activity and it might be attributed to the production of ammonia and also due to the progressive utilization of organic acids by microbial population present in the decomposed product. Chang *et al.* (2007) during their study on different application rates of compost, observed that the populations of bacteria, fungi and actinomycetes as well as soil enzyme activities like urease and phosphatases increased significantly in the compost treated soils compared to chemical fertilizer treated soil.

4. Conclusion

Thus, it can be deduced from the present findings that the waste, municipal solid waste and water hyacinth can be effectively harnessed by microorganisms as cost effective, value added nutrient enriched organic manure. By this waste management technology, waste disposal and fertilizer usage costs can be reduced.

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Table 1. Changes in physical parameters of raw and composted MSW -WH

Parameters	Initial (Raw)	Composted	
		Control (uninoculated)	Fungal consortium (inoculated)
Color	Light brown	Dark brown	Black
Appearance	Coarse	Granular	Granular and fibrous
Odor	Foul smell	Wood earthy smell	Earthy smell
pH	8.28	7.90	6.83
EC (dSm ⁻¹)	0.49	0.32	0.28

Table 2. Changes in biochemical parameters of raw and composted MSW - WH

Days of observation	Cellulose (in per cent)		Organic carbon (in per cent)		Organic matter (in per cent)	
	Control (uninoculated)	Fungal consortium (inoculated)	Control (uninoculated)	Fungal consortium (inoculated)	Control (uninoculated)	Fungal consortium (inoculated)
Initial (raw)	56.68		34.07		58.73	
15	48.94	48.37	32.88	29.48	56.69	51.43
30	43.82	40.56	29.28	26.96	50.48	46.48
45	41.39	34.45	28.15	25.08	48.53	43.24
60	38.15	30.50	26.28	23.74	45.31	40.93
75	34.22	28.00	25.43	22.46	41.42	38.72
90	31.55	20.56	24.45	21.09	39.91	36.36
SED	0.62		0.52		0.90	
CD (P<0.01)	1.71		1.46		2.52	

Table 3. Changes in biochemical parameters of raw and composted MSW - WH

Days of observation	Total nitrogen content (in per cent)		C:N ratio	
	Control (uninoculated)	Fungal consortium (inoculated)	Control (uninoculated)	Fungal consortium (inoculated)
Initial (raw)	0.37		92:1	
15	0.53	0.64	62:1	56:1
30	0.64	0.86	46:1	31:1
45	0.72	0.99	39:1	25:1
60	0.81	1.04	32:1	23:1
75	0.93	1.21	27:1	19:1
90	1.03	1.39	24:1	15:1
SED	0.04			
CD (P<0.01)	0.12			

Table 4. Changes in biochemical parameters of Raw and composted MSW- WH

Days of observation	Total phenolic content (mg g ⁻¹)		Reducing sugars (mg g ⁻¹)	
	Control (uninoculated)	Fungal consortium (inoculated)	Control (uninoculated)	Fungal consortium (inoculated)
Initial (raw)	2.73		2.37	
15	2.48	2.02	1.42	1.92
30	2.17	1.83	1.30	1.81
45	1.69	1.19	1.22	1.49
60	1.47	1.00	0.92	1.33
75	0.92	0.73	0.83	1.03
90	0.71	0.46	0.80	0.67
SED	0.07		0.04	
CD (P <0.01)	0.20		0.11	

Table 5. Changes in enzyme activity of raw and composted MSW-WH

Days of observation	β -glucosidase*		Urease**	
	Control (uninoculated)	Fungal consortium (inoculated)	Control (uninoculated)	Fungal consortium (inoculated)
Initial (raw)	0.05		0.93	
15	0.12	0.30	0.32	0.52
30	0.20	0.54	0.48	0.71
45	0.38	0.72	0.55	0.89
60	0.52	0.99	1.12	1.31
75	0.92	2.82	1.32	2.39
90	0.72	1.69	1.26	1.89
SED	0.04		0.05	
CD(P<0.01)	0.11		0.14	

* Enzyme activity expressed in $U^{-1} \text{ mg}^{-1}$ enzyme protein

** Enzyme activity expressed in (μ mol of ammonia formed mg^{-1} enzyme protein)



Occupants' Satisfaction and Rent Paid for Residential Properties Close to Waste Dump Sites in Nigeria

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Abstract

The paper examined occupants' satisfaction and rent paid for residential properties within three neighbourhoods (Olusosun, Abule – Egba, and Solous) close to waste dump sites and Ketu neighbourhood (not close to dump site) in Lagos Metropolis. Relative Satisfaction Index, Analysis of Variance and Correlation Coefficient are used to analyse the data based on the System Unit, Dwelling and Environmental Subsystems. The results show that the occupants of properties close to dump sites have a minimum level of satisfaction of 37.22, 40.48 and 27.09 percent in the system unit and subsystems; while Ketu is 60.00, 60.71 and 56.25 percent. Also, a weak linear relationship between rental value and the satisfaction of occupants in the neighbourhoods (Olusosun, 0.056 ($p > 0.05$); Solous, 0.026 ($p > 0.05$); Abule-Egba, 0.062 ($p > 0.05$); and Ketu, 0.108 ($p > 0.05$) exist.

The paper recommends that property investors should avoid building around dump sites to enhance property values

Keywords: Occupants Satisfaction, Rent, Residential Properties, Waste Dump Sites

1. Introduction

The value of properties can be attributable to the nature of property as a package of goods and services (Bello and Bello, 2008). Therefore, property extends beyond shelter to include environmental characteristics or attributes. Bello and Bello (2008) noted that their influences on value are difficult to assess. This is more so in Nigeria considering the wide range of negative and positive externalities that the environment impacts on the property market.

The negative externalities are characterized by proliferation of squatter settlements, air and water pollution, squalid condition of environmental sanitation, and breakdown of waste disposal arrangement to mention a few. On the other side are positive externalities such as good roads, schools, shopping facilities, and accessibility to good health care facilities etc. These immediate influences of environmental characteristics are therefore, manifested in the form of pull and push effect of the neighbourhood on the prospective buyer or occupant. A push effect like the presence of waste dump site may affect property value and the satisfaction the occupants derive from the environment and the property they occupy (Jackson, 2001c). Hence, occupant's satisfaction of their dwellings and environment is influenced not only by the engineering elements, but also by the social, behavioural, cultural, and environmental variables (Michelson, 1970; Philips, 1967; Onibokun, 1974).

Economic theory tells us that "all things being equal", buyers would avoid purchasing a property that is contaminated or close to a dangerous facility because of potential health risk, difficulty in selling the property, uncertainty, nuisance associated with environmental damages and stigma (Patchin, 1994). Occupants of property may seek to approach or obtain properties towards which they hold positive attitudes and avoid those for which they hold negative ones in order to be satisfied. Satisfaction according to McCormick and Ilgen (1985) is the "hedonic response of liking or disliking the attitude object" which may be property. As a result, occupants' satisfaction is frequently associated with their

behaviours. The question is, are the occupants satisfied with an environment close to waste dump site and hence the rent paid for properties in such environment? Several studies have addressed the effect of waste dump sites on property values in many countries among which include studies on landfills by Thayer et al, 1992 (in Baltimore, Maryland), Reichert et al, 1992 (in Cleveland, Ohio), Arimah and Adinnu, 1995 (Lagos); Adewusi and Onifade, 2006 (Surulere, Lagos); Bello, 2007 (Lagos); Udo and Egbenta, 2007 (in Enugu) and proposed radio active waste sites by Michaels and Smith 1990 (Boston area). Results from these studies generally support the notion that waste dump sites have negative effects on property values. Specifically property values decreases with closeness to the dump sites. These studies however did not address whether the occupant’s are satisfied with the environment and the low rent paid. It is in the light of this that this study is undertaken to make contribution. Therefore, the effect of waste dump sites on property values on the level of satisfaction of the occupants of these properties is examined. The intention is to identify any correlation between the rent paid and the occupants’ level of satisfaction.

2. Data and Research Methods

2.1 The Data

The data for this study was collected from a sample of occupiers of residential properties located within 1000 meters to waste dump sites (Olusosun, Abule –Egba, and Solous dump sites). Since no information was given as to the number of properties within the region of 1000 meters in the Census Bureau office, house counts of properties were undertaken. Therefore, a survey of 105 residential properties in Olusosun, 109 in Solous and 112 in Abule - Egba that fall within the 1000 meters was taken. These constitute the sample frame for the properties studied. For a comparative analysis, 113 properties were also taken from Ketu, the neighbourhood not close to waste dump site. Ketu was chosen because of its similar characteristics in terms of property types and socio economic characteristics of the residents. In all, a sample of 439 residential houses was made in the neighbourhoods. Questionnaires were administered to occupants of these properties to elicit information on how satisfied they are with the physical and environmental characteristics of their properties and the rent paid for the properties. Of these, 373 (Olusosun, 95, Abule – Egba 93, Solous 92 and 93 in Ketu) completed questionnaires were returned and analyzed representing 85% response rate.

2.2 Research methods for the analysis

The tools for data analysis involve Relative Satisfaction Index, Analysis of Variance and Correlation Coefficient. Onibokun (1974) defined the Relative satisfaction index as a type of tenants – dwelling – environment and management interaction system. According to Onibokun (1974), the system produces a type of dwelling, which is regarded by the tenant component of the system as relatively acceptable or adequate. Therefore, the Relative Satisfaction of an occupant with a system is the sum of the occupants actual scores (on a four point scale drawn from the respondents assessment of each attribute or variables) expressed as a percentage of the sum of the occupants potential scores (or the maximum scores possible) on all the variables selected for weighing under the subsystem.

Mathematically Onibokun gave the index of relative satisfaction as:

$$RSI_s = \left\{ \frac{\sum_{i=1}^{N_1} d_1 + \sum_{i=1}^{N_2} e_1 + \sum_{i=1}^{N_3} m_1}{\sum_{i=1}^{N_1} D_1 + \sum_{i=1}^{N_2} E_1 + \sum_{i=1}^{N_3} M_1} \right\} X100 \dots\dots\dots (1)$$

Where RSI s = the index of relative satisfaction of an occupant with the total system.

N₁, N₂, N₃ = are the variables selected for scaling under the dwelling (D), environment (E) and management (M) subsystems

d₁, e₁, m₁ = the actual scores by an occupant on the ith variable in the dwelling, environment and management subsystems

D_i, E_i, M_i = the maximum scores that variable “i” in the dwelling, environment or management subsystem could have on the scale of habitability.

However, this study adopts the form of equation (1) but ignoring the management subsystem, since management subsystem is not within the scope of this work. The equation for this study therefore, is

$$RSI_{DE} = \frac{\sum_{i=1}^{N_1} d_1 + \sum_{i=1}^{N_2} e_1}{\sum_{i=1}^{N_1} D_1 + \sum_{i=1}^{N_2} E_1} X100 \dots\dots\dots (2)$$

Where RSI_{DE} = the Index of Relative Satisfaction of an occupant with the total system.

$N_1, N_2,$ = are the variables selected for scaling under the dwelling (D) and environment (E) subsystems respectively.

$d_i, e_i,$ = the actual scores by an occupant on the i th variable in the dwelling and environment subsystems

$D_i, E_i,$ = the maximum scores that variable “ i ” in the dwelling and environment subsystem could have on the scale of habitability.

The maximum satisfactions index that could be obtained is 100 percent while the minimum is 25 percent. According to Onibokun (1974) maximum satisfaction rarely exists therefore; this is not likely to exist in the study areas. In spite of this, the closer to 100 percent the Relative Satisfaction Indices, the higher the degree of satisfaction of the occupant. Onibokun (1974) adopted three levels of satisfaction as the framework of interpreting the observed levels of satisfaction in his study. The levels included:

- (i) Less than 70 percent RSI = region of low level satisfaction
- (ii) 70 – 79 percent RSI = region of medium level satisfaction
- (iii) 80 percent and over = region of high level of satisfaction

These levels of satisfaction are the ones adopted for this study with slight modification. This is because 70 percent taken by Onibokun (1974) as a medium level satisfaction could be regarded as too high for a study like this since in a normal life situation 70 percent is often judged to be of a good performance. Therefore, for this study below 50 percent was taken as a region of no satisfaction while 70 percent and above was taken as region of high level satisfaction as against that of Onibokun (1974). In this wise, four levels (region) of satisfaction were used as a framework for interpreting the observed levels of satisfaction in the study areas.

- (i) Less than 50 percent RSI = region of no satisfaction
- (ii) 50 – 59 percent RSI = region of fair satisfaction
- (iii) 60 - 69 percent RSI = region of satisfaction
- (iv) 70 percent RSI and above = region of high level of satisfaction.

RSI were computed for each of the four neighbourhoods while Analysis of Variance was used to test if there are any significance differences in the satisfaction levels in these neighbourhoods (Olusosun, Solous, Abule-Egba and Ketu).

Correlation coefficient was used to analyse the relationship between satisfaction levels of the occupants and the rent paid for the property occupied.

3. Results

3.1 Relative Satisfaction Index

In Table 1, the Average mean Relative Satisfaction Index (the three neighbourhoods combined) in the System unit, Dwelling and Environmental Subsystem in the neighbourhoods (Olusosun, Solous and Abule – Egba) close to waste dump sites were given as 56.82 percent, 69.02 percent and 46.16 percent respectively. The result indicated that the occupants in these neighbourhoods are not satisfied with the System Unit (Dwelling and Environmental Subsystems combined) and Environmental Subsystem but are satisfied with the dwelling subsystem. This is contrary to the situation in Ketu neighbourhood that is not close to waste dump site where the mean Relative Satisfaction Index in the System unit, Dwelling and Environmental subsystems are 70.77 percent, 74.92 percent and 67.14 percent respectively. Also, it is evidence from Table 1, that the occupants in the neighbourhoods close to dump sites have a lower level of Satisfaction of 37.22 percent in the System unit, 40.48 percent in the Dwelling subsystem and 27.09 percent in the Environmental subsystem. In Ketu neighbourhood (not close to waste dump site) the minimum level of satisfaction by the occupants in the System Unit, Dwelling and Environmental Subsystems are 60, 60.71 and 56.25 percent respectively. The implication here is that why some occupants in the three neighbourhoods (Olusosun, Abule – Egba and Solous) may not be satisfied with their neighbourhood, the result is different in Ketu neighbourhood where none of the occupants fell below 50 percent level of satisfaction.

3.2 Analysis of Variance (ANOVA)

The second stage was to test whether the observed difference across the neighbourhoods (Olusosun, Abule – Egba, Solous and Ketu) was statistically significant using Analysis of Variance (ANOVA). Tables 2, 3 and 4 show the Analysis of Variance for the System unit, Dwelling and Environmental Subsystems in the three neighbourhoods (Olusosun, Abule – Egba and Solous) close to dump site and Ketu neighbourhood that is not close to a dump site. The significant values of the F – test in the ANOVA Table for the Systems unit, Dwelling and Environmental subsystems are 0.000, 0.001 and 0.000 respectively. This implies that at 5% level, there is a significant difference between the mean levels of satisfaction across the four neighbourhoods (Olusosun, Abule – Egba, Solous and Ketu) for the Systems unit, Dwelling and Environmental subsystems. While Olusosun, Abule – Egba, and Solous has the same physical and environmental characteristics, Ketu is entirely different. This result might probably be due to the reasons that owners of

properties close to the dump sites in Olusosun, Abule – Egba, and Solous are not favourably disposed towards investing substantially on the properties hence, these properties are not well maintained. Consequently, the occupants have lower Relative Satisfaction Index (RSI). On the contrary, majority of the properties in Ketu are well maintained hence, higher Relative Satisfaction Index (RSI) exist.

3.3 Correlation Coefficient.

The relationship that exists between the satisfaction of the occupants in the neighbourhoods and the rent paid for the property occupied was examined using the Correlation Coefficient.

In Olusosun neighbourhood, the correlation coefficient between rental value and satisfaction level is 0.056 ($p > 0.05$); Solous is 0.026 ($p > 0.05$), Abule – Egba is 0.062 ($p > 0.05$) while Ketu is 0.108 ($p > 0.05$) as shown in Table 5. These results however, show the correlation coefficient to be close to zero indicating that there is a weak linear relationship between rental value and the satisfaction of occupants in the neighbourhood. The results, although not significant are however, not contrary to expectation in an environment where demand is higher than supply. For instance, the quantity of housing units in Nigeria cities has been reported to be grossly inadequate compared to her population size (F.O.S. (1992); NHP, (1992); Onyike, (2007). In such a situation irrespective of what the occupiers are paying, there are tendency for them not to get adequate satisfaction since it is a sellers market.

4. Conclusion

The Relative Satisfaction Index of the occupants living close to the dump sites (Olusosun, Abule – Egba and Solus) shows lower level of satisfaction. A comparison of the three neighbourhoods with Ketu, a neighbourhood far away from any dumpsite in its vicinity shows that the three neighbourhoods close to waste dump sites are significantly different from it. This shows that the closer the property to the dumpsite, the lower the satisfaction derived. The satisfaction derived from properties is expected to influence the value of the property; although, the general property rental levels is lower in the properties close to waste dump sites, however, this study revealed that there is a weak but not significant linear relationship between rental values and satisfaction levels.

The study recommended that the Town Planning Authority should enforce strictly building regulation of setting back. This will forestall situations where people build close to and even over landfills without taking necessary precautions. Also, government and non – governmental organisations should embark on programmes to enlighten the public on the danger of living close to waste dumpsites. Property investors should avoid investment in properties close to waste dump sites.

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Table 1. The Average Relative Satisfaction Scores of the System Unit, Dwelling and Environmental Subsystems in the three neighbourhoods close to dump sites compared with Ketu not close to waste.

Statistics	System Unit		Dwelling Subsystem		Environmental subsystem	
	Area close to dump sites	Area not close to dump site	Area close to dump sites	Area not close to dump sites	Area close to dump sites	Area not close to dump site
Mean	56.82	70.77	69.02	74.92	46.16	67.14
Median	56.11	70.00	67.86	71.43	44.79	65.68
Mode	51.67	71.67	67.86	71.43	32.30	71.88
Standard Deviation	± 9.15	± 5.164	± 12.50	± 9.27	± 12.40	± 6.192
Minimum	37.22	60.00	40.48	60.71	27.09	56.25
Maximum	80.67	85.00	92.86	92.86	75	78.13
Variance	83.78	26.664	157.42	85.946	154.81	38.345
Kurtosis	- 0.005	- 0.092	- 0.18	- 0.722	- 0.67	- 1.053
Skewness	0.307	0.292	- 0.08	0.527	0.37	0.040

Note: Below 50 percent is not satisfied, 50 percent – 59 percent fairly satisfied, 60 percent – 69 percent satisfied, 70 percent and above highly satisfied.

Table 2. Analysis of Variance for the System unit in the four neighbourhoods

	Sum of Squares	Df	Mean Squares	F	Sig
Between groups	14303.868	3	4767.956	68.329	0.000
Within groups	25748.695	369	69.780		
Total	40052.563	372			

Significant level of the F – test is 0.000 at 5 percent significant level.

Table 3. Analysis of Variance for the dwelling subsystem in the four neighbourhood

	Sum of Squares	Df	Mean Squares	F	Sig
Between groups	2437.375	3	812.458	5.851	0.001
Within groups	51241.358	369	138.865		
Total	53678.732	372			

Significant level of the F – test is 0.001 at 5 percent significant level.

Table 4. Analysis of Variance for the environmental subsystem in the four neighbourhoods

	Sum of Squares	Df	Mean Squares	F	Sig
Between groups	33275.205	3	11091.735	88.675	0.000
Within groups	46155.503	369	125.083		
Total	79430.708	372			

Significant level of the F – test is 0.000 at 5 percent significant level.

Table 5. Correlation Matrix between Rental Value and Satisfaction levels of occupants in the neighbourhoods

	EnvOlu	EnvSolous	EnvAbule	EnvKetu
RentOlu	0.056* (0.592)**			
RentAbule			0.062* (0.563)**	
RentSolous		0.026* (0.808)**		
RentKetu				0.108* (0.313)**

* Pearson Correlation Coefficient is significant at the 0.05 level (2 – tailed)

** P – Value.



Study on Sustainable Development of Ecotourism in the Northern Piedmont in the Qinling Mountains

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Abstract

Tourism resources in the Northern Piedmont in the Qinling Mountains (NPQM) are quite abundant and play an important role in the development of the tourist industry in Shaanxi Province. Based on reviewing the status quo of ecotourism in the NPQM and existing issues, this paper puts forward countermeasures and recommendations for sustainable development of ecotourism in the NPQM. Firstly, a systemic tourism resources investigation should be conducted; secondly, a comprehensive assessment should be made on tourism resources; thirdly, suitable and reasonable principles of protective development should be established, considering to facilitate organic unification of ecological environmental protection and exploitation of tourism. All steps are helpful to realize scientific and sustainable development of ecological economy and tourism zone in the NPQM.

Keywords: North Piedmont of Qinling Mountains, Ecotourism, Sustainable development, Countermeasures

Qinling Mountains is not only a climatic boundary between North and South in China, but also one of areas with abundant biological diversity, acknowledged as "Kingdom of Animals and Plants" and "Chinese Medicinal Herb Storehouse". In recent years, the surrounding tourism roads and highways have been constructed in the NPQM and Shaanxi Province and Xi'an city governments have published series favorable polices and promoted the infrastructure investment, tourism industry has rapidly developed at the Northern Piedmont in the Qinling Mountains (NPQM). However, extravagant exploitation and negligence of protective construction have led to ecological crisis, such as, random development of tourism resources, vegetation deterioration, valley and water interception, environmental pollution, aggravation of water loss and soil erosion, and shortage of water resources, etc. On the basis of analyzing the status quo of ecotourism in the NPQM and existing problems, this paper puts forward countermeasures and recommendations for sustainable development of ecotourism in the NPQM.

1. General condition of NPQM and ecotourism resources

NPQM is located between Qinling watershed and South Rim of Kuan-Chung Plain, with important ecological functions, and is the ecological protective screen and water source reserve in the Central Shaanxi area. Its west is to Gansu, its east is to Henan, its north extends to villages and towns along mountainous highway, and its south is to the major ridge of Qinling Mountains. It presents a zonate form from west to east. It is approximately 450 km long, with an area of about 9290 km², among which the area of scenic spot and forest park is 1116 km², accounting for 12% of the total area. Administratively, it is attached to the three cities of Xi'an, Baoji and Weinan with well developed transportation. Qinling Mountains possess different climate features because of complicated topography, have various rare animals and plants, which are favorable to develop ecotourism. Its main tourism resources are as follows:

1.1 Natural ecotourism resources

There are abundant natural tourism resources in the NPQM, with grotesque peaks and steep mountains, suspending spring and waterfall on the upper reaches of rivers and rivulets, hot springs distributed along the piedmont, relatively obvious vertical zoning of mountainous region, complicated geological structure, abundant geothermal resources,

diversified forest covers and animal types within the area, typical remains of fossil glacier, unique magic of physiographic sight, hydrologic sight and climatic and biological sight of landslide physiography and karst landform. Its major scenic spots include the 6 national natural reserves. There are 11 state-level forest parks, such as Zhongnanshan and Taibai Mountain, three state-level scenic spots of Hua Shan, Lishan and Tiantai Mountain, and four provincial level scenic spots, and wetland ecotourism resources. In addition, the National Botanical Garden of Qinling Mountains is under construction. Biological resources in Qinling Mountains are extremely rich, such as, 3446 species of seed plants, 144 species of beasts, 399 species of birds, more than 5000 species of insects. There are 28 kinds of plants with key state protection, such as, *Kingdonia uniflora*, yew, and 56 species of wild animals with key state protection, such as, giant panda, golden monkey, *Nipponia nippon* and takin. Hence, Qinling Mountains will not only become the base of bio-diversity conservation, research and popularization of science, but will also become a brand-new ecotourism garden plot in Shaanxi Province, and even all over the country.

1.2 Humanistic ecotourism resources

The 800-li Qinchuan (plain) at the NPQM is the birthplace of Chinese nation, and is the capital city for 13 emperors of the five dynasties of Zhou, Qin, Han, Sui & Tang, its humanistic ecotourism resources spread over the NPQM. The Holy Land of the Taoism of Lantian Man ruins (a history of 1.1 million years), and Terra-cotta Warriors (the Eight Wonders of the World), and the holy place of Buddhism of Caotang Temple are located in the plain.

1.3 Rural ecotourism resources

There are numerous rivers at the NPQM, especially along the circle line of mountainous tourism, with green mountains, fresh air, clear water and hot springs, and it is a good choice for vacation tourism. With further development of tourism industry in the NPQM, vacation mountain villa, summer villa, place of entertainment and happy farmhouse are rapidly development.

2. Status quo and problems of development of ecotourism

In recent years, with implementation of the policy of Western Development, rapid development of economy and general improvement of people's living standards, tourism industry in Shaanxi Province has experienced a fast development. At the time of reconstructing former scenic spots, new tourist attractions have continued to bring out in the NPQM. Declaration for the World Geological Park of Zhongnanshan in Qinling Mountains gained success in August 2009, and the Central National Park that is under declaration promotes rapid development of regional ecotourism industry to a great extent. Statistically, the tourist population in only 45 major scenic spots in Xi'an and Baoji in 2007 attained 10.876 million and they earned 513.097 million Yuan. The 39 scenic spots in Xi'an had a tourist population of 10.385 million in 2007, accounting for 96% of the total tourist population, and their annual gate receipts reached 497.807 million Yuan, accounting for 97% of the total gate receipts. The 4 scenic spots in Lintong in Xi'an had an annual tourist population of 6.2 million and their annual gate receipts reached 382.028 million Yuan, respectively accounting for 60% of the total annual tourist population in Xi'an and for 77% of the total gate receipts in Xi'an. The 5 scenic spots in Baoji had an annual tourist population of 0.49 million and their annual gate receipts attained 15.3 million Yuan. In 2009, the Municipal Party Committee and Government of Xi'an is considering to establish the tourism base in the NPQM, and an area of 6000 Mou of tourism ecological region will be constructed in the NPQM. In August 2009, Shaanxi Travel Bureau formally issued <<Tourism Development Project in Qinling Mountains>>, and attempted to establish Qinling into a demonstration base of international ecotourism. However, there still exist the following problems at the time of tourism development.

2.1 Ecotourism resources of geological landform is damaged

Damage of geological landform resources is mainly embodied in that of mountains shapes, ecology, landscape and environment, which is mostly caused by such economic activities as exploitation of real estate, mineral exploration, construction and highways, cables and hotels, etc. In the NPQM, some projects of exploitation of real estate, exploitation of mineral resources and scenic spots go to construction without any approval or assessment of environmental impact. Besides, the phenomena of construction getting out of line are serious. Thus, such geologic hazards as serious water loss and soil erosion and mountain landslide happen. In June 2002, Dabagou Forest Park and Fengyu Manor suffered from flood disaster as a result of occupying riverways, and caused heavy losses. In 2007, construction projects of NPQM merely within Chang'an District were as many as 50, but there were only 8 projects with authentic procedures. With villa projects in the NPQM being called to a stop and villa exploitation in the guise of tourism project again "seeking for new life", the degree of damage to geological landform resources were not under effective control.

2.2 Ecotourism resources of water body and biology are polluted.

There are 28 branches of Weihe river in the Kuan-chung Plain from Baoji and to Tongguan along the NPQM, there are 16 branches are polluted in some extent. In recent years, many vacation mountain villas, hotels, guesthouse and agritainment have been constructed in the surrounding of mountain passes of such rivers as Fengyukou in Qinling

Mountains. However, because environmental protection facilities are lacking in urban and rural areas, household garbage and waste residue in these units have had no fixed storage occasion, and are concentratively landfilled by local towns and villages at present. However, formal measures to prevent and control pollution are lacking in landfill occasions, and there exists indiscriminate discharge without any treatment, and even some units discharge a great deal of household garbage and sewage into valleys and riverways without any treatment. A large majority of industrial enterprises are short of sewage treatment facilities or are unable to run normally, and their industrial waste water is discharged without reaching standards, which causes environmental pollution and endangers security of water source. Therefore, the Xi'an Municipal Government planned to invest an amount of 0.5 billion Yuan in 2009 to concentratively treat with the problems of garbage and pollution in exploitation of ecotourism in the NPQM. At the same time, devastation of forests for arable land, ore exploitation, excessive cutting of forest and excavation of medicinal materials, etc, result in serious damage to forest cover, and frequently poaching for rare animals. Animals protected in some of happy farmhouses along Qinling Mountains become a specialty. Ecological environment of Tourism is seriously damaged.

2.3 Relatively laggard project, disordered management, serious duplication of similar projects, and low level of tourism resources exploitation

Quite a large number of scenic spots are short of a unified management and coordination institution and a long-term plan, with blind and disordered construction, and a large majority of forest parks and holiday resorts simply go on their own way, following the same pattern, without any individual characteristics. The phenomena of construction by several units and management by several departments exist, without a unified standard and requirement, outstanding phenomenon of disordered management and insufficient coordination of management system, which has a direct influence on investment and construction, and constrains exploitation of tourism resources and development of tourism industry. By the year 2008, there had already 1130 projects of sightseeing tour and agritainment in the NPQM merely within the urban district of Xi'an, including Shangwang Village and Tangyu Town, etc. There are also a large number of tourism development projects and all sorts of happy farmhouses that are not approved and registered in the government. Exploitation of tourism resources in a large majority of scenic spots are in an initial state, with low levels and monotonous activities of tourism, and their tourism functions are similar, merely focusing on the aspect of sightseeing, with bad comprehensive tourism benefits.

2.4 Shortage of talents and inefficient management

Ecotourism industry is an industry with high scientific content, which calls for professional talents with high quality. However, the relatively laggard local education, under-emphasis on talents of tourism, and unsound training mechanism, together with intensification of talents mobility, shortage of talents in ecotourism becomes more serious. Such shortage of talents is not only embodied in shortage of talents in high-level project and management, but also in low level of their managerial and administrative expertise and their shortage of experiences, so they cannot adapt to the needs of tourism development. Shortage of managerial and operational talents and corresponding scientific knowledge and skills causes low management efficiency of ecotourism within the district. Besides, randomness of decision making and the fact that everyone goes his own way result in chaos of the ecotourism market, inferiority of service quality and difficult development of real ecotourism.

3. Countermeasures and suggestions of sustainable development of ecotourism in the NPQM

Ecotourism is a form of tourism that involves traveling to tranquil and unpolluted natural areas. According to the definition and principles of ecotourism established by The International Ecotourism Society (TIES) in 1990, ecotourism is "Responsible travel to natural areas that conserves the environment and improves the well-being of local people". Connotation of ecotourism attaches more importance to protection on natural tourism resources, and refers to tourism with sustainable development. Ecotourism should not only harmonize with the nature at the cost of sacrificing the environment. On the contrary, ecotourism should qualify contemporary human beings with equal opportunities to share the natural landscape and human landscape of tourism with the later generation. A tourist should share vivid and concrete ecological education in the whole process of ecotourism. In order to bring advantages of tourism resources in the NPQM into play, and to realize rational utilization and rational distribution of tourism resources, the author puts forward the path for tourism resources exploitation in the NPQM in the future. First of all, an investigation is necessary to find out the foundation, and a comprehensive assessment should be conducted on tourism resources to establish the principle of protective exploitation; a medium and long term project should be strengthened to highlight characteristics of ecotourism in Qinling Mountains; the strategy of sustainable development should be carried forward to promote the organic integration of ecological environmental protection and tourism exploitation; characteristics and individuality of each district should be emphasized, and investment should be strengthened to develop rural ecotourism and ecological agriculture; quality of practitioners and level of managerial personnel should be improved so as to realize the scientific and sustainable development of ecological and economic tourism zones in the NPQM.

3.1 In order to provide potent scientific support for exploitation of ecotourism, a comprehensive survey and assessment should be conducted on ecotourism resources in the NPQM.

Scientific experts and experts from universities and colleges are organized to conduct a detailed survey and assessment on ecotourism resources in the NPQM, determining ecological environment capacity of each ecotourism scenic spot, controlling carrying capacity of ecological environment and confirming critical capacity of tourists in sightseeing districts at different periods. At the same time, we should analyze existing issues in development of ecotourism from the perspective of sustainable development of tourism industry, and provide scientific evidence for the government to formulate medium and long term tourism projects.

3.2 To establish the principle of protective development, strengthen medium term project and to highlight characteristics of ecotourism in Qinling Mountains

Development of ecotourism in the NPQM should be undertaken appropriately on the precondition of protecting ecological environment. Development and construction of ecotourism should not be undertaken at the cost of sacrificing ecological environment. Thus, when preparing to construct tourism facilities and travelling routes, we should pay special attention to those fragile and sensitive ecological districts, and when conflicts happen between economic interest and ecological environment, we should lay more importance to protecting the ecological environment. The project should follow the standard of advanced level in the world, designed in a long-range vision and persisting in the strategy of sustainable development. Hence, Shaanxi Province is going to formulate a series of standards about tourism development in Qinling Mountains, and especially stationing of newly developed tourist attractions and happy farmhouses should be conducted according to formally issued standards. High standards should be carried out, such as, environmental protection standard, environmental capacity standard, happy farmhouse construction standard, standard of tourist receipts capacity and sanitary standard, etc. A medium and long –term project should be drawn up, in which standards will be implemented one by one in batches, and those areas with mature conditions will be taken into consideration with priority and those projects that cannot meet standards or are not in accordance with the project should be refused. In August 2006, Shaanxi Province passed << Environmental Protection Project in the NPQM in Shaanxi >>. This project makes an analysis and assessment on the status quo and existing issues of ecological environment in the NPQM, and has directive significance to coordinating relationship between ecological environmental protection and development of tourism in the NPQM.

3.3 Strengthening the prevention of water loss and soil erosion and ecological environmental protection

In the NPQM, forest cover suffers unprecedented damage, together with clouded rivers, high drop of rivers, frequent rainstorms, and frequent geologic hazards of land slide and debris flow, so water loss and soil erosion is extremely serious. Therefore, we should strengthen comprehensive prevention by combination with establishment of forest for water and soil conservation, returning land for farming to forestry, natural forest protection and river training works, so as to guarantee security of people's lives and properties. We should extensively publicize and deeply carry out << Act of Ecological Environmental Protection in Qinling Mountains >>, and come to realize that ecological environmental protection is not only obligation of leaders at all levels and relevant departments of the government, but is also responsibility and obligation of the great masses and tourists. We should intensify management of protection on waterhead areas centered with reservoirs, especially reservoirs of Heihe and Stonebrook, etc. We should prohibit or restrict some exploitation activities so as to improve water quality and guarantee drinking water security of people and animals. We should insist on the strategies we have always been following to protect biological diversification.

3.4 To strengthen development for poverty relief and capital investment, to development vigorously rural ecotourism and ecological agriculture, and to realize regional sustainable development

We should enlarge capital investment in tourism, green industries and development for poverty relief, and strengthen investment force by means of governmental investment, attraction of investment, utilization of foreign investment and social financing, etc. We should support all projects of exploitation and construction, and vigorously development rural ecotourism economy and such new types of ecological agriculture as vegetables, flowers, fruits and forest, and sightseeing tour, etc, to promote overall coordination of regional tourism and social economy, to realize sustainable development and to establish a harmonious society.

3.5 To improve quality of practitioners in tourism and relevant industries and the level of managerial personnel, and to build up an ecological atmosphere in the scenic spots

Protection of ecological environment is one of the central connotation of ecotourism, which requires ecotourism managerial personnel to change the traditional development scheme of tourism, and to place ecological environmental protection in the first place. It is not allowed to take ecotourism as a "label" to attract tourists and to concentrate merely on economic interest, regardless of damage to tourism resources and environmental protection. Thus, we should strengthen training, cultivate professional ecotourism talents and establish a scientific management concept. For the time being, most practitioners in relevant industries in the NPQM come from local rural areas, who have no

professional learning and training experiences, with low professional quality, management level and inferior service quality. At the time of improving tourism infrastructure, we should continue to improve quality of practitioners, and their service quality. We should adopt various means to conduct ecological education on tourists and to improve their self-consciousness to protect ecological environment. At the time of making a sightseeing tour, tourists should protect every tree and bush within the conservation district. We should attempt to make our tourists come to comprehend the environmental protection idea of “taking only photos, leaving only footprints”.

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Common Medicinal Plants Species Found at Burned and Unburned Areas of Klias Peat Swamp Forest, Beaufort, Sabah Malaysia

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Abstract

The aims of this study is to survey the abundance and diversity of medicinal plants found in burned and unburned areas of klias peat swamp forest, Beaufort. There are 16 plots established with the size of 25m x 25m for each plot with total area of 1 ha. All the plots were established using random sampling method and Simpson's Index and Important Value

(IV) were used to determine the diversity and abundance of the species. The result of the study shows that 11 species have been found in burned area while 10 species at unburned area. The most common medicinal plant species are identified as *Stenochlaena palustris*, *Melastoma malabathricum*, *Lygodium flexuosum*, and *Clidemia hirta*. The most abundant medicinal plant species found in burned area was *Stenochlaena palustris* with 185 percent (%). While in unburned area, the most abundant medicinal plants were *Hedychium longicornutum* and *Lygodium flexuosum* with 55 percent each. Simpson's Index is higher with 0.55 in burned area compared in unburned area with only 0.14. Where when the value of Index increases, the diversity will decrease and this proved that diversity of medicinal plants in unburned area was slightly higher than the burned area. This situation might be caused by the previous land clearing due to burning and small scales landuses activities at the edges of Klias peat swamp forest. More research is needed in order to gain more precise data

Keywords: Medicinal plants, Peat swamp forest, Abundance and diversity, Sabah

1. Introduction

Plants contribute many uses for human since long time ago. Many species of plants are used as part of the treatment of diseases and for the well-being of man. Medicinal plant is a plant that used in the treatment of diseases and to maintain health (Lewis & Elvin-Lewis, 2003). According to the latest reports, there are about 1200 species of plants in Malaysia that potentially had a pharmaceutical or medicinal value (Khatijah, 2006).

In Malaysia, around 2,000 plants species have therapeutic characteristics and can be use in traditional treatment (Rukayah, 2006). Usually plants such as shrubs, bushes and wild flower have the pharmaceutical value (Wiat, 2000). Wild plants are plants that grow wildly in their habitat without human involvement. But recently, some medicinal plants faced extinction because of the disturbance in their habitat such as forest fire, logging or encroachment by human (Sabah Forestry Department, 2005). According to Mojiol (2006), humans are the agents of extinction to the natural environment. They caused the extinction by altering habitats (mainly forests, but also fresh waters and wetlands), overexploiting and introducing an exotic species.

Medicinal plants were divided into herbs and woody plants. Medicinal plant contains of many pharmacologically active compounds (Khatijah, 2006). Some medicinal plants' part like leaves, barks, roots and fruits can be used in treatment of diseases (Fasihuddin & Ghazally, 2001). Nowadays, because of lack of knowledge in importance of plants, forest has been disturbed where unmanaged logging happened everywhere. Klias peat swamp forest also faced the same situation. Since there is no data of medicinal plants yet being identify at KFR. This study had been carried out to give guidelines for researchers or students on species of medicinal plant can be found in burned and unburned area in Klias Peat Swamp Forest Reserve (KFR).

The major objectives of this study are to compare the species abundance and diversity of medicinal plants in burned and unburned area and to list and identify potential medicinal plants found in burned and unburned area at Klias Forest Reserve.

1.1 Study Site: Klias Forest Reserve, Beaufort, Sabah

The study has been done in Klias Peat Swamp Forest Reserve or also known as Klias Forest Reserve (KFR). Klias Forest Reserve was a Class 1 protection forest with an area of 3,630 ha and located within the Klias Peninsula. It was gazetted as a Class 1 protection forest in 1984 under jurisdiction of the Sabah Forestry Department. Its latitude was 5° 22' 60N with longitude 115° 45' 0E. The average annual rainfall was about 3,300 mm but varied between 2,300 to 4,700 mm according to 20 years of observations.

The pH in Klias peat swamp forest was around 3.66 to 3.56. This pH showed an acidic soil where the peat swamp was due to waterlogged soils condition which prevents dead leaves and wood from fully decomposing, which over time creates thick layer of acidic peat. Temperature in Klias Forest Reserve was around 26°c to 30°c and had experienced with peat fires during El Niño in 1998 and logged over before this. So far, KFR was divided into burned and unburned area (Sabah Forestry Department, 2005).

KFR was a part of the wetland ecosystems which included floras and faunas. The freshwater swamp forest, nipah swamps, peat swamps forest and kerangas, secondary dry land forest and mangroves were the habitats that can be found in this area. Various communities reside in the areas bordering the Klias Forest Reserve. Among them were the villagers of Kg. Bukau and Kg. Pulaimanang with an estimated combined population of 1, 000 people. Both of these villagers were predominantly Muslim. According to Ng (2000), about 60 percent of communities in Beaufort are Bisaya, 14 percent of Kadazan-Dusun, 9 percent Murut, 3 percent Chinese and others with 2 percent.

2. Materials & Methods

2.1 Experimental Design and Field Procedure

Data collection process for abundance of medicinal plants in Klias Peat Swamp Forest has successfully completed by applying inventory method. Inventory method with a random sampling was done because it is the most suitable

inventory method to be use in this research. Random sampling method can be represented the whole forest area and also the easiest way to apply. About 1 ha plot was involved in this research (consisted of 8 subplots in burned and 8 subplots in unburned areas respectively). Each subplot was plotted with plot size 25m x 25m for each area. One sub-plot equals to 0.0625 ha. The abundance of the species is referring to the measurement of the amount of a species in a sample plot. The abundance provides information about the density, the frequency and the coverage of the species that can be determined in plots. The calculation of important values incorporates with the relative density, relative coverage and relative frequency of the species. Besides calculating the abundance (density, coverage and frequency) of fern species, the index of diversity of fern species in Klias Forest Reserve both in burned and unburned area were also calculated. By using the Simpson index, the comparison of the diversity of fern species in burned and unburned area of Klias Forest Reserve is also counted.

3. Results and Discussion

3.1 Abundance of Medicinal Plant in Burned Area

Referring to the Table 1, *Stenochlaena palustris* was the highest important value (IV) than other species in burned area with 185 percent. According to Rukayah, 2006, *Stenochlaena palustris*'s habitat usually in peat swamp, opened area, and soil which was rich of sulfate acid. Species with the lowest IV percentage was *Nepenthes* sp. From Nepentaceae or also known with as Periuk Kera with 2 percent. *Nepenthes* sp. or Periuk kera was the lowest abundant species in burned area. *Nepenthes* sp. usually lived in moist and shaded area. Burned area was not a suitable habitat for *Nepenthes* sp. to grow because of the acidic soil and an opened area.

3.2 Abundance of Medicinal Plant in Unburned Area

In unburned area, the most abundant medicinal plants were *Hedychium longicornutum* and *Lygodium flexuosum* with 55 percent each (Table 2). According to Rukayah (2006), *Hedychium longicornutum*'s and *Lygodium flexuosum*'s habitat was in the forest and bushes. Therefore, unburned area or natural habitat was the most suitable place for *Hedychium longicornutum* and *Lygodium flexuosum* to grow. *Labisa pumila* was the lowest abundant species in unburned area. According to De Padua *et. al* (1999), *Labisa pumila*'s habitat was in shaded area. This species cannot grow in an opened area but can grow successfully in loam soil that rich with organic structure and humus. Unburned area was the most suitable place for *Labisa pumila* to grow. But, somehow the abundance of *Labisa pumila* was low in unburned area because the local communities who reside near the KFR happened to collect this plant for consumption and medicinal purpose.

According to the Ketua Kampung of Kg. Bukau stated that this plant was use by the local to release pain after giving child birth and give energy especially for woman who was pregnant. According to Japar (Pers. com: 2007), local people intend to enter Klias Forest Reserve for fishing and collect forest produce for their own use especially for food, shelter and medicine. This fact supported by Timothy (2003) in his report about Current Land-use and Relevant Planning Instruments Surrounding the Klias Peninsula. Where according to Timothy (2003), unsustainable land-uses surrounding peat swamp forest of Klias Peninsula can be a destructive to the environment if not controlled, such as fishing, hunting and extraction of forest produce that have been known.

3.3 Comparison of Diversity between Burned and Unburned Area

The Simpson's Index showed a value of 0.55 in burned areas while 0.14 in unburned areas. According to Magurran (2005), the value of diversity (D) in Simpson's Index was between 0 and 1. As the diversity indexes (D) increases, the diversity will decrease. Referring to the graph below, burned area had slightly highest Simpson's Index where the index was nearly to one. Further while, unburned area showed a lower index than Simpson's Index in burned area. This means, the diversity of medicinal plant in unburned area was higher than in burned area.

Referring to Figure 4, Simpson's Index in unburned area was lower than in burned area. This was also means that medicinal plants in burned area were denser with individually species compared to unburned area. The abundant of medicinal plants was higher with *Stenochlaena palustris* colonizing the burned area. As mentioned before, burned area had experienced peat fire during El Niño in 1998. According to Whitmore (1991), rate of regeneration in burned area was higher because this area was an opened area. Therefore, there will be more plants such as shrubs and herbs that have medicinal value grow in burned area. In addition, the abundance of medicinal plant in unburned area was lower because of the local people activities who collect the medicinal plant within the unburned area in KFR. As mentioned before, local people intend to enter Klias Forest Reserve to fishing and collect forest produce for their own use especially for food, shelter and medicine (Japar, Pers. com, 2007). Somehow, this activity also contributes in decreasing of the number of medicinal plants collected in unburned area.

4. Conclusion

The abundance and diversity of medicinal plants in both burned and unburned area in Klias Forest Reserve has successfully collected after the entire inventory had been done. The total of medicinal plant species in both burned and

unburned area were 21 species. Important value was used to count the abundance of medicinal plants that successfully collected in both areas. Density, frequency, and coverage also gained from the inventory.

The objectives of this study were successfully achieved. All information to determine the abundance in both areas was gained. The abundance of medicinal plants in both areas was differing from the number of species found. There were eleven (11) species of medicinal plants found in unburned area while ten (10) species of medicinal plants found in burned area. In unburned area, the most abundant medicinal plants were *Hedychium longicornutum* and *Lygodium flexuosum* while *Labisa pumila* was the lowest abundant species in this area.

In burned area, the most abundant medicinal plant was *Stenochlaena palustris* while *Nepenthes* sp. or Periuk kera was the lowest abundant species in this area. Medicinal plants in unburned area were more diverse than medicinal plant that founded in burned area where random sampling method was used to gain all data needed.

Medicinal plants that were successfully collected in this study including *Stenochlaena palustris*, *Chromolaena odorata*, *Melastoma malabathricum*, *Lygodium flexuosum*, *Cyperus rotundus*, *Clidemia hirta*, *Passiflora foetida*, *Hedychium longicornutum*, *Peperomia pellucida*, *Nepenthes* sp, *Imperata cylindrical*, *Licuala spinosa*, *Etingera littoralis*, *Labisa pumila* and *Mikania cordota*. The total area that included using random sampling method was still not enough to cover the whole area of Klias Forest Reserve. Therefore, advance study recommended to covers the area that not been included in this study.

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Table 1. Important Value (IV) of Medicinal Plant Species in Burned Area

No.	Family	Species	Local name	RD(%)	RF(%)	RC(%)	IV(%)
1	Polypodiaceae	<i>Stenochlaena palustris</i>	Lembiding	42	34	109	185
2	Melastomaceae	<i>Melastoma malabathricum</i>	Senduduk	12	14	6	32
3	Schizaeaceae	<i>Lygodium flexuosum</i>	Ribu-ribu besar	2	12	3	17
4	Cyperaceae	<i>Cyperus rotundus</i>	Rumput halia hitam	1	12	0	13
5	Melastomaceae	<i>Clidemia hirta</i>	Senduduk paksa	1	12	0	13
6	Passifloraceae	<i>Passiflora foetida</i>	Letup-letup	1	11	0	12
7	Zingerberaceae	<i>Hedychium longicornutum</i>	Kunyit hantu	0	9	0	9
8	Asteraceae	<i>Chromolaena odorata</i>	Pokok kapal terbang	1	7	1	9
9	Piperaceae	<i>Peperomia pellucida</i>	Ketumpangan air	1	7	0	8
10	Nepentaceae	<i>Nepenthes</i> sp.	Periuk kera	0	2	0	2
TOTAL				61	120	119	300

RD = Relative dominant. RC = Relative Coverage. RF = Relative Rrequency.

Table 2. Important Value (IV) of Medicinal Plant Species in Unburned Area

No.	Family	Species	Local name	RD(%)	RF(%)	RC(%)	IV(%)
1	Zingerberaceae	<i>Hedychium longicornutum</i>	Kunyit hantu	15	21	19	55
2	Schizaeaceae	<i>Lygodium flexuosum</i>	Ribu-ribu besar	3	21	31	55
3	Gramineae	<i>Imperata cylindrica</i>	Lalang	5	11	34	40
4	Palmae	<i>Licuala spinosa</i>	Palma	4	11	23	38
5	Zingerberacea	<i>Etilingera littoralis</i>	Tepus	3	11	9	23
6	Annonaceae	<i>Ellipeia cuneifolia</i>	Kayu Bibiris	5	4	13	22
7	Melastomaceae	<i>Clidemia hirta</i>	Senduduk paksa	2	11	4	17
8	Rubiaceae	<i>Lasianthus inaequalis</i>	Pikolas	1	11	3	15
9	Polypodiaceae	<i>Stenochlaena palustris</i>	Lembiding	1	11	3	15
10	Compositae	<i>Mikania cordota</i>	Selaput tunggul	0	4	10	14
11	Myrsinaceae	<i>Labisa pumila</i>	Kacip fatimah	0	3	3	6
TOTAL				39	119	152	300

RD = Relative dominant. RC = Relative Coverage. RF = Relative Rrequency.

Table 3. Classification, Identification and Uses of Medicinal Plant

No.	Family	Scientific name	Local name	Uses
1	Asteraceae	<i>Chromolaena odorata</i>	Pokok kapal terbang	Thrombogenic, stop bleeding
2	Compositae	<i>Mikania cordota</i>	Selaput tunggul	Stomach pain and dysentery
3	Cyperaceae	<i>Cyperus rotundus</i>	Rumput halia hitam	Indigestion, Skin diseases, Irregular menstruation
4	Gramineae	<i>Imperata cylindrica</i>	Lalang	Hemoptysis, hematuria, and nose bleeding
5	Melastomaceae	<i>Melastoma malabathricum</i>	Senduduk	Diarrhoea and dysentery
6	Melastomaceae	<i>Clidemia hirta</i>	Senduduk paksa	Relieves heart burn
7	Myrsinaceae	<i>Labisa pumila</i>	Kacip Fatimah	Release pain after giving birth especially for woman
8	Nepentaceae	<i>Nepenthes sp.</i>	Periuk kera	Diarrhea and fever
9	Palmae	<i>Licuala spinosa</i>	Palma	Dehydration
10	Passifloraceae	<i>Passiflora foetida</i>	Letup-letup	Thrombogenic, stop bleeding
11	Piperaceae Cure	<i>Peperomia pellucida</i>	Ketumpangan air	eye ache, fever, stomach ache
12	Polypodiaceae	<i>Stenochlaena palustris</i>	Lembiding	Fever, skin disease
13	Schizaeaceae	<i>Lygodium flexuosum</i>	Ribu-ribu besar	Hemoptysis, cough, fever
14	Zingerberaceae	<i>Hedychium longicornutum</i>	Kunyit hantu	Fever
15	Zingerberaceae	<i>Etingera littoralis</i>	Tepus	Fever and stomach ache
16	Annonaceae	<i>Ellipeia cuneifolia</i>	Kayu bibiris	Fever
17	Rubiaceae	<i>Lasianthus inaequalis</i>	Pikolas	Fever

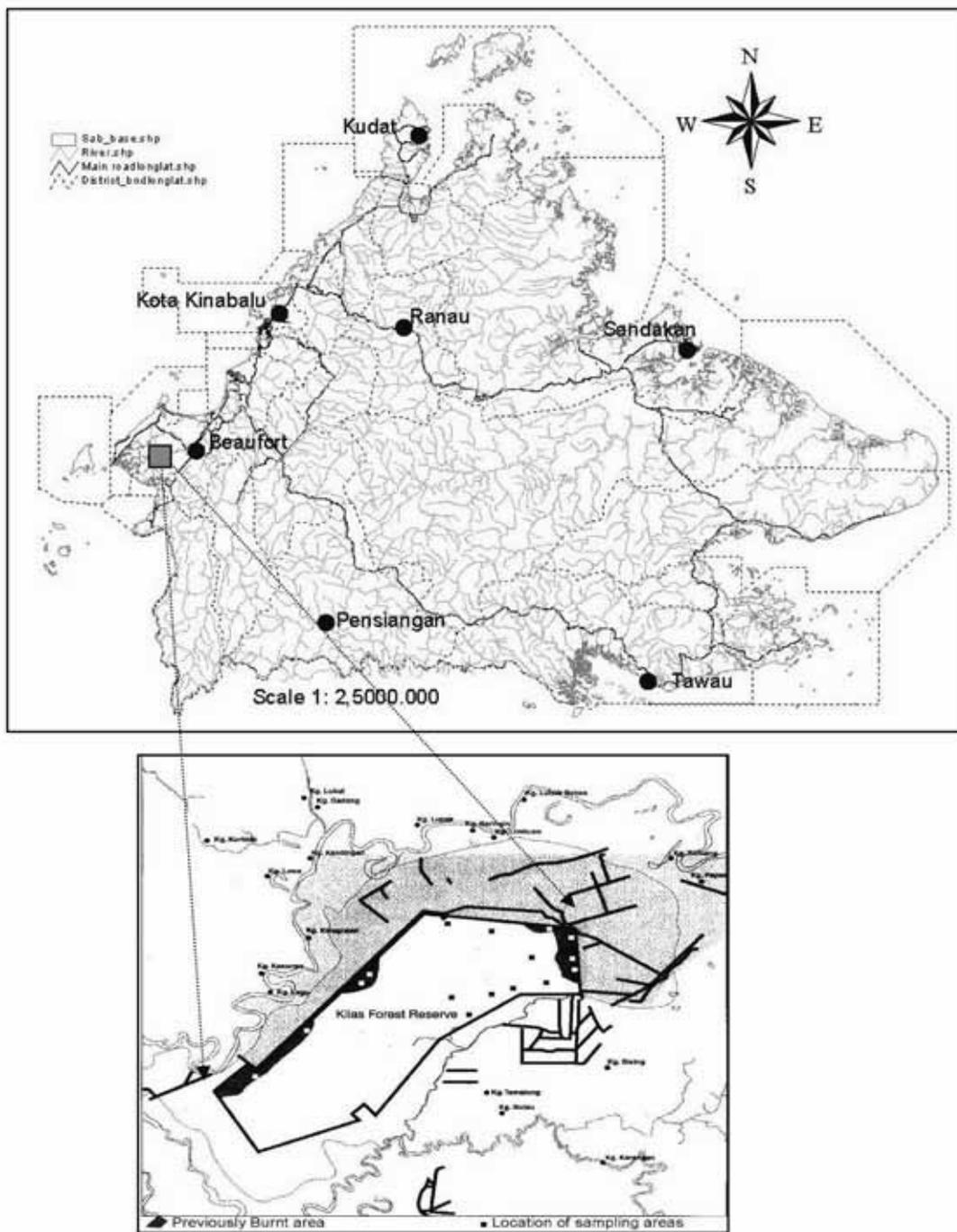


Figure 1. Location of Klias Peat Swamp Forest, Beaufort, Sabah Malaysia.

This figure shows the location of sixteen (16) randomly selected sampling plots at Klias Peat Swamp Forest



Exploitation of Renewable Energy Sources and Its Legal Regulation

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Abstract

There is great potential for exploitation of renewable energy sources in China, but the strength of policy support and stimulation measures is far from enough. Many practices in foreign countries to lead and standardize development of renewable energy sources can be used as sources of reference in China. *The People's Republic of China Renewable Energy Law* and relevant supporting regulations have stimulated and promoted exploitation of renewable energy sources in China.

Keywords: Renewable energy sources, Legal regulation

Renewable energy sources refer to energy sources that can be regenerated and sustainably utilized in the nature, including non-fossil energy, such as, wind energy, solar energy, water power, biomass energy, geothermal energy and ocean energy, etc. Energy is the necessary and fundamental material guarantee for production and living of human beings. For the time being, finiteness of fossil energy in the world and environmental issues caused in its exploitation seriously restrict development of circular economy. Exploitation of renewable energy sources has received high concentration from the whole world. Quite a lot of countries regard exploitation of renewable energy sources as a significant component of developing circular economic strategy, and lead and standardize development of renewable energy sources by means of the law, which can be used as reference in China.

1. Status quo of exploitation of renewable energy sources in China

So far, China has become the second largest country in production of energy and consumption of energy. Renewable energy sources in China are extremely abundant. It is calculated by the National Development and Reform Committee (NDRC), in the following twenty to thirty years, the following renewable energy sources will produce 800 million tons of standard coal each year: small hydro power, wind energy, solar energy and biomass energy, etc, which is able to fulfill conditions of utilization, and have great potential for exploitation. Considering development of renewable energy sources in China, China is leading the world in total utilization capacity of small hydro power, biogas and solar water heater.

1.1 Wind energy

With a vast territory and long coastline, China is abundant in wind energy sources. It is preliminarily estimated, available wind energy sources on the land are approximately 250 million kilowatt, and maritime wind energy sources are approximately 750 kilowatt, altogether 1 billion kilowatt or so. Wind power construction in China dated from 1980s, and with development for more than 20 years, synchronization wind farms with a large scale have been constructed in the country.

1.2 Solar energy

Most regions of China are located in the south of the north latitude 45°, and are abundant in solar energy sources. Solar energy utilization in China is mainly concentrated in solar energy power generating and solar water heater. By the end of 2005, the total installed capacity of solar photovoltaic had reached approximately 70 thousand kilowatt around the

whole country, which was mainly utilized to resolve residential power utilization in remote areas and to satisfy demands of particular commercial power utilization (decentralized power, such as communications, navigation and traffic, etc). The industry of solar water heater in China is relatively mature, and its yield capacity and amount of usage rank the first in the world.

1.3 Biomass energy

Biomass energy sources in China are also extremely abundant. Cultivation area of crops in China occupies 1.5 billion Mou, and annual production of biomass is about 700 tons. In addition to being used as papermaking raw material and animal husbandry and feed, all remaining part is used as fuels. The existing forestry area in China is about 175 million hectare, and each year, approximately 0.8 to 1 billion tons of biomass sources can be acquired by means of normal bush stump and rejuvenation, forest thinning, trimming of fruit trees and green fences, and collecting forest harvested, rough-hew and processed remainders. At the same time, there are more than 46 million hectare of forestation-suitable land that can be used to grow energy plants by considering ecological construction. Municipal refuse is also a sort of important biomass sources. Current quantity of refuse in urban areas reaches about 130 million tons, and with development of urbanization, the quantity of refuse will be on a continual increase. At present, biomass energy is still an important living energy source in many rural areas in China, but mostly are in the form of traditional utilization with low efficiency. The most successful utilization of biomass energy through modernized technology is biogas technology, especially rural household biogas technology. China also has had an installed capacity of over 2 million kilowatt in generators. Forms of biomass generating mainly include agricultural wastes of bagasse, rice hulls, forestry wastes, biogas and garbage power, etc. From the perspective of sources, garbage may be the unique ever-increasing renewable energy source on the earth. Therefore, recycling utilization of garbage seems extremely significant. Generating through waste incineration is an important approach to recycling utilization of garbage. Currently, annual production capacity of urban refuse in China is about 120 million tons, and it will continue to increase with development of urbanization. Annual production capacity of rural straws exceeds 600 million tons, and there is huge potential to make full use of biogas and exploit new types of fuel or generating. In addition, the project of using aged grain to produce alcohol fuels is being pushed forward, with an anticipated annual production capacity of 1 million tons and the technique of utilizing energy sources and crops to produce alcohol fuels and biodiesel is also being tested and demonstrated.

1.4 Hydroelectric power

China has abundant hydraulic power sources, which are the most important energy sources. Exploitable capacity of economy in China is 400 kilowatt and its annual power generation is approximately 1.74 trillion kilowatt-hour. By the end of the year 2005, the total installed capacity of hydropower station had reached 117 million kilowatt all over the country, accounting for one fourth of the total installed capacity of generators, and the annual power generation capacity had been 390 billion kilowatt-hour, accounting for 16% of the total power generation capacity.

Although exploitation of renewable energy sources has attained great achievements in China, the strength of policy support and stimulation measures is far from enough. At the current technical level and under the current policy environment, except that hydraulic power and solar water heater are qualified to participate in market competition, a large majority of renewable energy sources have too high exploitation cost, together with characteristics of disperse sources, small scales and discontinuity of production, so they are short of competitive strength in the current market condition and are in urgent need of relevant regulations and policies.

2. Policy and legal regulations on exploitation of renewable energy sources in foreign countries

In the past few years, renewable energy sources have got rapid development all over the world. Renewable energy sources have become important alternative energy sources to realize energy diversification and circular economy. Development of renewable energy sources has been widely concentrated by many countries and has become a hot issue in the field of international energy.

In 1997, European Union issued a white paper for development of renewable energy sources, and formulated the magnificent target, that is, renewable energy would account for 12% of total EU energy consumption by 2010 and would account for 50% of energy source composition in all members in EU by 2050. In 2001, EU Council of Ministers proposed the common instruction about generating of renewable energy sources, and required EU members to realize the control target of renewable energy sources accounting for 12% of all energy consumption and 22.1% in the total power consumption by 2010. US Department of Energy put forward the development plan of gradually increasing green power, and formulated technical development roadmap of wind power generation, solar power generation and biomass generation in the hope of increasing proportion of green energy resources by all these means. Since 1993, Japan has begun to carry out "New Sunshine Program" to accelerate exploitation of photovoltaic cell, fuel cell, hydrogen energy and geothermal energy, etc. In 1997, Japan announced a roof plan of 70 thousand solar photovoltaic with a view to installing solar cell of 7.6 million KW. As early as in 1970s, Brazilian government began to implement development plan of biofluid, and developed alcohol fuels with raw materials of cane and cassava, etc.

Renewable Energy Law belongs to part of legal system of circular economy. It can even be said, the core issue of legal system of circular economy is legal regulations on regeneration of energy. Some foreign countries have realized strategic significance of renewable energy to the future very early, and have conducted relevant legislative activities. In 1990, Germany formulated <<Stromeinspeisungsgesetz>>, which stipulated that medium-and-large-sized power consumers should pay electricity generated by means of wind power, solar energy, hydraulic and biomass energy at a price of 90% of residential power price. For wind power generation, German government pays subsidy in accordance with quantity of power output or facility cost. As for enterprises with investment in renewable energy sources, the country provides them with a preferential loan equivalent to 75% of facility investment cost at a favorable interest rate 1-2% lower than the market interest rate. In 1997, Japan formulated <<New Energy Law>>, and such countries as Denmark, Holland and Britain, etc, also rapidly promoted the industry of renewable energy sources by adopting a series of policies and legal systems.

It should be particularly mentioned that, << Erneuerbare Energien Gesetz >> by Germany is one of the most advanced legislations about clean energy in the world, and most of its principles and specific items are of great innovation. They have given full play in practice and have promoted development of renewable energy sources in Germany to great extent. On February 25, 2000, German Parliament passed << Erneuerbare Energien Gesetz >> (abbreviated as EEG). This law is established on the basis of successful experiences of << Law of Mains Supply through Renewable Energy Generation>>, and is regarded as the most advanced legislation about clean renewable energy sources in the world. The << Law of Mains Supply through Renewable Energy Generation >>, which took effect from January 1, 1991, focused on development of wind power. However, this law hasn't promoted other energy sources to enter the market on a large scale, especially photovoltaic cell and biomass energy. Therefore, << Erneuerbare Energien Gesetz >> made new provisions, with the purpose of promoting generating of all sorts of renewable energy sources. Generally speaking, << Erneuerbare Energien Gesetz >> facilitated development of renewable energy generation by setting the obligation of purchasing electricity on power grid operators. To stipulate fixed on-grid price of renewable energy power is a prominent feature of << Erneuerbare Energien Gesetz >>. Fixed electricity price system (also called mandatory feed in law) (Note 1), refers to a system in which a country determines on-grid price of its renewable energy power according to actual generating cost of generation technology in various renewable energy sources or according to average price of electricity, and requires power on-grid enterprises to purchase renewable energy power produced by renewable energy developers. Germany is a typical country which implements fixed electricity price system of renewable energy sources, and this system has gained tremendous achievements in exploitation of renewable energy sources. In August 2004, the newly revised << Erneuerbare Energien Gesetz >> came into force, which proposed the new target: generated renewable energy accounting for 20% of gross generation will be adequately and legally guaranteed by 2020 and development of renewable energy sources will have solid foundation and broader space.

3. Legal regulations on exploitation of renewable energy sources in China

Exploitation of renewable energy sources earlier in China was aimed at resolving rural energy shortage. As early as 1970s, Chinese government issued some policies to support construction of renewable energy sources in rural areas, such as development of hydropower, popularization and application of biogas in rural households, and popularization of firewood-saving, etc. Unveiling of these policies and measures enabled China to take a leading position among developing countries in exploitation of renewable energy sources and also to maintain an advanced level in the world.

In terms of laws, regulations and administrative regulations, China has made stipulations to encourage exploitation of clean energy, including renewable energy sources, in <<Electricity Act>>, <<Energy Conservation Law>> and <<Air Pollution Control Law>> etc, which were passed earlier. In some administrative regulations issued by departments concerned of the State Council, such as "national policies of energy technology", "industries, products and technical catalogs developed with focus currently", "notification on some issues to further support development of renewable energy sources", and "administrative provisions on wind power generation through synchronization", etc, the country also has made decisions to encourage exploitation of renewable energy sources and to carry out mandatory electricity on-grid and economic incentive, etc, to stimulate development of renewable energy sources. On February 28, 2005, the 14th Meeting of the 10th NPC Standing Committee passed <<Renewable Energy Law of P.R. China>>, which raised exploitation of renewable energy sources to a strategic height of "increasing energy supply, improving energy structure, ensuring energy security, protecting the environment and realizing sustainable development of an economic society.

<< Renewable Energy Law of P.R. China >> is the first law in China in the field of renewable energy sources, and it has established some important legal systems as follows: the target system of gross amount of renewable energy sources, approval of renewable energy generation through synchronization and full acquisition system; on-grid price and cost allocation system of renewable energy sources; financial incentives. Generally speaking, <<Renewable Energy Law>> is a framework method of policies, and its effective implementation depends on the State Council and departments concerned to unveil in due time assorted administrative rules, regulations, technical standards and corresponding development plans. After <<Renewable Energy Law>> was passed, the National People's Congress and departments

concerned of the State Council issued some specific policies and measures, mainly including generation and on-grid of renewable energy sources, fixed electricity price, cost allocation, standard rules, special fund, taxation and credit policies, etc, such as, <<Experimental Method for Management on Price of Electricity Generation from Renewable Energy and Cost Allocation>>, <<Management Regulations for Electricity Generation from Renewable Energy>> and <<Interim Measures on Special Fund Management for Development of Renewable Energy>>, etc.

It is stipulated in << Experimental Method for Management on Price of Electricity Generation from Renewable Energy and Cost Allocation >>, price of electricity generation from renewable energy sources is set and directed by the government, that is, to determine tender price via bid inviting. << Experimental Method >> makes the following stipulations on price of generation from renewable energy sources: price of hydroelectric power is temporarily based on the existing provision; on-grid price of wind power generation project is directed by the government, and price of electricity is established based on the price formed in bidding by Price Competent Department of the State Council; on-grid price of solar power generation, ocean power generation and geothermal energy generation projects is set by the government, and the standard of price is determined by Price Competent Department of the State Council based on the principle of rational cost plus rational profit; on-grid price of biomass generation project is set by the government and the standard of price is composed of on-grid price of desulfurization coal-fired unit benchmarking pool in all provinces (autonomous regions and municipalities) in 2005 plus subsidized price of 0.25 Yuan per kilowatt-hour. << Management Regulations for Electricity Generation from Renewable Energy >> defines management at different levels by Central Government and local governments for power generation projects of renewable energy sources, and stipulates the plan of generation from renewable energy sources should be brought into electricity program at the same level. In addition, << Management Regulations>> requires, generating enterprises should take the initiative to invest and establish programs of electricity generation from renewable energy sources, and undertake obligation of generation quota in renewable energy sources specified by the country; large-scale generating enterprises should give priority to investment in programs of power generation from renewable energy sources. << Interim Measures on Special Fund Management for Development of Renewable Energy >> stipulates, special funds for development should be arranged by means of central budget, and should be mainly used to support exploitation of renewable energy sources, such as, substitutes of petroleum with great potential and good prospects, heat supply, heating and refrigeration of buildings, and electricity generation, etc.

Price of renewable energy sources has been an outstanding issue in development of renewable energy sources. Auxiliary regulations of <<Renewable Energy Law>> define price of renewable energy sources. Investment in renewable energy sources may bring considerable profits, so more and more enterprises will be involved in this field.

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Notes

Note 1. Fixed electricity price system and portfolio standard are two major systems in development of renewable energy sources. Quota of renewable energy sources refers the system in which a country or region executes mandatory provision on portion of renewable energy in the total power supply by legal means, and in which electricity price is determined by the market so as to promote development of renewable energy sources. Britain and America (represented with Texas) are typical countries which carry out the Portfolio Standard, whereas Germany is a typical country which carries out fixed electricity price system.



Role of Local Government in Indigenous Market Management in the Rural Areas of Bangladesh: Do These Markets Play Development Roles?

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Abstract

Hat-Bazars are the indigenous markets that work under the supervision of Local Government and owned by the Local Government in Bangladesh. These markets play vital role for the development in the rural areas of Bangladesh. But, there are challenges for proper management of the markets. Hat-Bazar under local government has the following characteristics:

- 1) It has legal entity under Local Government bodies and formed through an act of legislature named The State Acquisition and Tenancy Act, 1950.
- 2) It helps the local Government bodies to earn revenue and maintenance expenses.
- 3) Local businessmen and farmers can market their products and crops in these Hat-Bazars.
- 4) Central Government also earns revenue getting the land tax, VAT, income tax from the Hat-Bazars.

This article is written based on a study. Objectives of the study were to learn the lease procedure of Hat-Bazar (Local Govt. Markets), to identify the strengths, weaknesses, opportunities, and threats of Hat-Bazar and to analyze the Hat-Bazar management under Upazila Parishad and Pourashava and to find out the ways for augmenting their income and its efficient and effective utilization. . In respect of any particular reference the study was confined to the local government bodies of rural areas only. This study focused on the scheduled government markets (Hat-Bazar) of rural areas (Municipality and Upazila) only, but there were unauthorized markets in Govt. owned land also. Those markets were not taken into considerations. Depth interview method with structured questionnaire was adopted. A total number of 240 persons were interviewed. The interviewees comprised of cross-section of people including public representatives, Govt. officials, businesspersons, lessee and NGO workers. Observations and focus group discussion methods were taken into account also. Secondary sources of data were also included.

Existing policy for the management of indigenous markets (Hat-Bazar) was reviewed for the study.

Analyzing the responses of the respondents, collected data and observations following recommendations could be summarized:

- 1) Political interference should be stopped to make the local Govt. bodies effective and active.
- 2) Proper maintenance, sanitation and infrastructure should be ensured to make the govt. Hat-Bazar effective.
- 3) Political interference and administrative control should be avoided to make the Hat-Bazar committee effective. Businesspersons should get priority in Hat-Bazar management.
- 4) Hat-Bazar management policy should be made more understandable.
- 5) Lease should be ensured and direct collection should be avoided in order to increase revenue.
- 6) Leasing procedure should be made easy and should be done in short period.
- 7) Share of Upazila and Union Parishad and Municipality from Hat-Bazar should be increased.
- 8) Hat-Bazar management activities should be done in Upazila level.
- 9) Union Parishad may be given full authority to manage all Hat-Bazars up to a certain pecuniary limit.
- 10) Women marketers should get proper security and sitting arrangements.
- 11) Law and order situation should be maintained in Hat-Bazar.

12) The Hat-Bazar management committee should arrange special transportations for the businessperson so that they can carry their products in appropriate price.

Government Hat-Bazars are the main indigenous markets of Bangladesh. From the very ancient period these markets are the only places where farmers and producers can sell their products. These markets control the local business as well as the national business. So, environment, infrastructure, and, law and order of these markets should be maintained properly. The Hat-Bazar management committees can ensure these with the help of local administration and the local Govt. authority. If proper management is ensured these indigenous markets could be able to aid the development of Bangladesh.

Keywords: Bangladesh, Rural areas, Hat-Bazar, Indigenous markets, Development role, Challenges

1. Background

Indigenous markets popularly known as Hat-Bazars work under the supervision of Local Government and owned by the Local Government in Bangladesh. Duane Lockard defines local government as “a public organization authorized to decide and administer a limited range of public policies within a relatively small territory which is a sub-division of a regional or national government”. This definition doesn’t take into account the financial and legal status of local government and it doesn’t specify its representative character. The UN definition is rather comprehensive. It defines local government as “Local government refers to a political sub-division of a nation or state which is constituted by law and has substantial control of local affairs, including the power to impose taxes or exact labor for prescribed purpose. The governing body of such an entity is elected or otherwise locally selected”. The Encyclopedia of Social Sciences defines local government as “The government, which has a territorial non-sovereign community having/ possessing the legal right and the necessary organization to regulate its own affairs”. The Report of the Indian Statutory Commission of 1930 defines local government as “A representative organization, responsible to a body of electors, enjoying wide powers of administration and taxation, and functioning both as a school for training and a vital link in the chain of organizations that make up the government of the country”. Whatever the definition may be the local government, the Hat-Bazar under local government has the following characteristics:

- 1) It has legal entity under Local Government bodies and formed through an act of legislature named The State Acquisition and Tenancy Act, 1950.
- 2) It helps the local Government bodies to earn revenue and maintenance expenses.
- 3) Local businessmen and farmers can market their products and crops in these Hat-Bazars.
- 4) Central Government also earns revenue getting the land tax, VAT, income tax from the Hat-Bazar.

2. Objectives of the study

The objectives of the study are:

- 1) To evaluate the functions of local Govt. (Upazila Parishad, Union Parishad and Pouroshava) in Hat-Bazar management in the rural areas of Bangladesh and their present development roles based upon the respondents’ opinion towards effective, efficient and people oriented Hat-Bazar management.
- 2) To learn the lease procedure of Hat-Bazar (Indigenous Markets).
- 3) To identify the strengths, weaknesses, opportunities, and threats to Hat-Bazar management.
- 4) To analyze the Hat-Bazar management under Upazila Parishad and Pourashava and to find out the ways for augmenting their income and its efficient and effective utilization.
- 5) To know the role of Govt. Hat-Bazar in income generation for women, businesspersons and farmers.

3. Research Methodology

This research is mainly a qualitative study, based on both primary and secondary sources of data. Both primary and secondary sources of data have been collected.

To collect primary data in-depth interview with semi-structured questionnaire has been followed. The interviewees comprised of cross-section of people including people’s representatives to the local government bodies, government official and staffs, businesspersons, lessee and NGO workers. Total number of interviewees was 240.

To get the idea of Hat-Bazar management procedure and rules as well as to know the opinions, focus group discussion with the public representatives, Govt. employee, and businesspersons has been carried out. Observations also have been carried out.

This study is focused on the scheduled government indigenous markets (Hat-Bazar) of Narayangonj Sadar Upazila and Narayangonj Pourashava (Municipality), Chhatak Upazila and DoaraBazar Upazila of Sunamganj district areas of

Bangladesh only, but there were unauthorized markets in Govt. owned land also. Those markets have not been taken into considerations.

The secondary source includes registers, books, journals, government gazettes, government circulars, government publications etc.

4. Concept of Hat-Bazar

Hats are the Govt. controlled markets with no permanent or semi-permanent shops but holding Hats daily or once or twice a week where only squatters assemble on fixed days.

Bazars are Govt. controlled markets with permanent or/and semi-permanent shops holding daily or once or twice a week where vendor squatters.

4.1 Classification of Govt. Hat-Bazar (Indigenous Markets)

There are generally two classes of Government hats and markets.

1) Markets with permanent or/and semi-permanent shops holding daily or once or twice a week where vendor squatters, i.e., casual vendors who have no permanent or semi-permanent shops display their goods on roadsides or in Hat-stalls or in the open space (Tohabazar) of the market place.

2) Markets with no permanent or semi-permanent shops but holding Hats daily or once or twice a week where only squatters assemble on fixed days.

4.2 Establishment of new Hat-Bazar

According to the Government Estate Manual, 1958 to establish Hats and Bazars (Markets) the below mentioned rules may be followed:

1) Hats and Bazars (Markets) may be established in the Government Estate where there is demand for these to suit the convenience of the public. Where there are suitable Hats in existence for a long time in the neighbourhood, there is no need to establish a new one in its vicinity.

2) In making a new settlement of waste char or accreted lands it is desirable to make provision for Hats. No new Hat except in isolated and remote areas should be established which does not promise to financially profitable.

4.3 Procedure to establish new Hat

When submitting proposals for the establishment of a new Hat, the collector (Deputy Commissioner) should estimate:

- i. Cost of preparing the site.
- ii. Cost of construction of shops and sheds.
- iii. Receipts expected from the Hats, salami and rent separately.
- iv. Cost of arrangement, recurring expenditure on account of maintenance, repairs, and establishment.
- v. Cost of construction should be met out of the grant for improvement of Government Hats.

4.4 Leasing Procedures of Government Hat-Bazar:

4.4.1 Lessor

Upazila Nirbahi Officer of the concern Upazila will reserve the jurisdiction to lease out the Hat-Bazar under the geographical area of the Upazila.

Concern Municipality/City corporation authority will lease out the Hat-Bazars under its geographical area.

4.4.2 Lease process:

Lease activities shall be commenced in the month of Bangla (Bengali) month Magh of the year prior to the lease year preparing a complete calendar of lease activities. Deputy Commissioner and the local govt. department must provide the calendar.

Hat-Bazar shall be leased out for one year according to the Bangla year. Lease process shall be completed by the Bangla month of Chaitra.

Expenditures for lease process shall be met from the lease money of Hat-Bazar.

4.4.3 Tender Process:

(a) Sealed bid will be invited for each lease case of Govt. Hat-Bazar. All the bids will be accompanied by 20% of total quoted price by bank draft. 15% of total quoted price will be adjusted with the lease money and rest 5% will be reserve as earnest money. The earnest money will be declared forfeited if the lessee fails to maintain the Hat-Bazar properly or

do any harm to existing infrastructures. Otherwise at the end of the year the earnest money will be refunded in favour of the lessee.

(b) The money earned by selling the tender schedule will be considered as the revenue income of municipality and for Upazila it will be deposited in development fund.

(c) Following steps will be taken to make tender schedule and form available:

Tender forms shall be collected from the following offices.

i.e. Forms of Hat-Bazar controlled by Upazila Nirbahi Officer shall be available in his/her office, Assistant Commissioner (Land) office, Police station, Sonali Bank, DC office.

Tender schedule of Hat-Bazar under municipality authority shall also be collected from concern municipality office.

(d) At least 15 days before the submission date of the bids the tender schedule shall be properly advertised in the Hat-Bazar, in important Govt. and private offices using mikes, posters and using the notice boards. If the expected lease value is between 2 lac taka to 25 lac taka then tender schedule shall be published in local newspaper and if the value is more than 25 lac taka it must be published in national newspaper.

(e) Bids shall be submitted in office of the UNO or DC office or AC (Land) Office.

(f) Highest quotation price of the bids will be accepted and if the amount is less than that of average of the preceding 3 years then re-tender will be declared.

The re-tender process will be continued until attaining the expected price. If the Bengali New Year begins then the steps for direct collection (Khas collection) will be taken.

(g) Activities for direct collection (Khas collection):

Hat-Bazar under Upazila Parishad: An eight member committee for Hat-Bazar controlled by Upazila Nirbahi Officer will be headed by him/her and AC (Land), concern UP chairman and UP members of concern ward; DC's representative shall be the members.

Hat-Bazar under Pourashava: Hat-Bazars under municipality will be headed by the Chief Executive Officer/Municipality (Pourashava) chairman of municipality and there shall be 5 members.

The committee can appoint manpower for khas (direct) collection.

The committee can meet its expenditure during activities from the collections and it cannot be more than 5% of the collected money.

If any Hat-Bazar leased out during the direct collection period the payable will be, the amount got deducting the direct collected money from the total lease money.

If the lessor fails to transfer the possession to the lessee due to legal restriction or the lessee is compelled to remain off raising the toll, the lessor has to pay out the proportional ratio of lease in favour of the lessee.

(h) Lease decision should be made prompt adopting the following processes:

Upazila Nirbahi officer, with his/her opinion will present a comparative statement of the submitted bids before the Upazila development and coordination committee within 3 working days. The committee will convey the decision within 7 working days.

The comparative statement of submitted bids will be published for all.

i) For municipality the sealed bids shall be submitted to either DC office or to municipality office. DC will send the comparative statement of submitted bids to the Municipality Chairman. CEO of municipality will consolidate all the bids submitted to both DC office and municipality office and will present before the municipality tender committee within 3 working days. After sorting out the bids in committee the bids shall be presented accompanied by the opinion of the committee before the chairman for approval within 2 working days. The chairman will give his/her consent within 2 working days.

j) Same procedures will be followed for City Corporation also.

k) If it is indispensable to change the date of bid submission then Mayor/Chairman, or Deputy Commissioner or UNO or his/her representative will declare the next date and time in written. Successful bidders will be informed within 3 days from the date of approval and the bidder will deposit the rest amount of the lease money within 7 days being informed. Otherwise his/her bid will be declared void and the earnest money will be forfeited. Forfeited money will be deposited as the revenue income. After depositing all the lease money in Govt. fund the lessee makes covenants with the lessor.

l) UNO will send a statement of lease money to the Deputy Commissioner within 15 days of leasing out the Hat-Bazar and he/she will send a comparative statement of lease money of last 3 years to the local Govt. division.

m) The lease money earned from the Hat-Bazar will be deposited in a bank account names 'Income from Hat-Bazar lease'. The revenue earned will be distributed among different sectors.

n) Deputy Director of local govt. will be a member of municipality tender committee.

4.5 Appeal/Disposal of Appeal

(a) If there is any grievance about the Hat-Bazar lease, the written grievance shall be submitted to the next higher authority within 7 working days after the approval of the bid. The DC will hear the grievance about the UNO's and 'B', 'C' grade municipality authority's decision and he/she will pass a decision. For any grievance about DC's decision the Divisional commissioner will hear and give a decision. The local govt. division will hear the grievance against the divisional commissioner.

(b) UNO/Municipality Chairman or DC/CEO or their representative will sign the covenant of lease.

(c) The lessee will sign the covenant and that will be according to the form prescribed in The Land Management Manual, 1991.

(d) The lessee will keep the Hat-Bazar clean on regular basis.

(e) DC for Upazila, Divisional Commissioner for municipality will prepare and approve a toll chart for different commodities. The lessee must place the toll chart in a visible place; otherwise the lessor may cancel the covenant.

(f) The lessee cannot lease out the Hat-Bazar to another person or cannot give sub-lease. In any case if this event takes place the lease treaty will be voided.

4.6 Distribution of lease money earned from the Hat-Bazar

(a) Lease money of Hat-Bazar leased out by UNO will be distributed as follows:

i. 5% of Lease money after deducting the expenditure will be deposited in Govt. fund as '7-land revenue' within 7 working days.

ii. 20% of that money will be deposited for the salary of UP secretary and staffs in '4-deposit from Hat-Bazar lease' under '7-land revenue' within 7 working days.

iii. 15% of that money will be spent for the maintenance and development for respective Hat-Bazar under the approval of Upazila development coordination committee. For the routine and periodical maintenance of Hat-Bazar this expenses might be risen up to 25%.

iv. 10% of the money will be spent for all the Hat-Bazars under the Upazila.

v. 5% of the money will be given to that Union Parishad in additional where the Hat or Bazar is situated.

vi. Rest 41% money will be deposited in Upazila development fund. This money will be distributed proportionately among the Unions as 40% according to the population size, 40% according to the geographical area and 20% according to the underdevelopment.

vii. The Muktijoddha Sangsad will get 4%.

(b) Lease money of Hat-Bazars leased out by City corporation/Municipality will be distributed as follows:

i. 5% of Lease money after deducting the expenditure will be deposited in Govt. fund as '7-land revenue' within 7 working days.

ii. 45% of that money will be spent for development and maintenance of the Hat-Bazar under that Municipality/City Corporation.

iii. Rest 50% will be considered as the revenue income of Municipality/city Corporation.

4.7 Deputy Commissioner's responsibility on Hat-Bazar

In addition to the responsibilities mentioned in policy the DC will establish new Hat-Bazar, evict illegal markets, and demark the periphery of the markets according to the Land Management Manual, 1991.

The Hat-Bazars that are not identified according to this policy, if need to hold on the eve of Eid or any other festival then the concern UNO/Municipality Chairman with the prior permission of the DC will lease out following the rules. 20% of the Lease money will have to be deposited within 7 working days. Rest 80% of lease money will be deposited in Municipality fund or Upazila development fund.

5. Hat-Bazar Management Committee

Management committee will be formed for each of the Hat-Bazar for regular operations, maintenance, collections and for the development of the concern Hat-Bazar. In Upazila level Upazila Hat-Bazar Management committee will be

formed for directing, supervising and advising the Hat-Bazar Management committees. The DC will form the Upazila Hat-Bazar Management committee and the UNO will form the concern Hat-Bazar Management committee.

5.1 Hat-Bazar based Management Committee:

5.1.1 Composition:

The composition of each of the Hat-Bazar Management Committee will be as follows:

- i. The president will be the Union Parishad(UP) Chairman of the concern UP.
 - ii. One member will be elected among the shopkeepers of all the permanent shops of the concern Hat-Bazar.
 - iii. Union member of the concern ward will be a member.
 - iv. Woman (Reserved) Union Parishad member of the concern ward will be a member.
 - v. Union land Assistant Officer of the concern UP will be a member.
 - vi. One member will be elected/nominated among the women shopkeepers (if any) of the concern Hat-Bazar.
 - vii. Community organizer of Upazila Engineering office will be a member.
 - viii. One member will be elected/nominated among the shopkeepers of the entire temporary (operating for at least 6 months) shops of the concern Hat-Bazar.
 - ix. One member will be elected/ nominated among the rickshaw and van puller of the concern Hat-Bazar.
 - x. The bus/truck owners association will nominate one member.
 - xi. The shopkeepers of all the permanent shops will elect a member among themselves as the member secretary of the concern Hat-Bazar.
- No lessee can be the member of the committee.

5.1.2 Responsibilities:

- i. To chalk out the yearly development and maintenance plan of the concern Hat-Bazar based on the reserved money of the lease money and to submit the plan to the authority.
- ii. To supervise the toll collection and the collectors.
- iii. To resist the excess toll collection.
- iv. To resist the illegal toll collection, extortions, etc.
- v. To keep the Hat-Bazars clean and ensure sanitation.
- vi. To arrange at a meeting each month and submit the recommendations to the Upazila Hat-Bazar committee.
- vii. To facilitate the women seller and buyer for transactions.

5.2 Upazila Hat-Bazar Management Committee

5.2.1 Composition:

Upazila Hat-Bazar Committee will be formed as follows:

- i. UNO will be the president.
- ii. Upazila Engineer will be a member.
- iii. All the Union Parishad chairmen of the Upazila will be the members.
- iv. One distinguished person will be a member (nominated by the DC).
- v. One Govt. officer of the Upazila will be a member (nominated by the DC).
- vi. Two of the presidents of all of the Hat-Bazar committees will be the members (nominated by the UNO).
- vii. AC (Land) will be the member secretary.

5.2.2 Responsibilities:

- i. The committee will sit for meeting at least once in a month.
- ii. To supervise proper management, operation and maintenance of the all Hat-Bazars of Upazila.
- iii. To approve the development and maintenance plan submitted by the Hat-Bazar management committees.
- iv. To ensure the regular meeting of Hat-Bazar management committees.
- v. To supervise the activities of the Hat-Bazar management committees.

- vi. To inform the DC about the activities of the Hat-Bazar management committees and Upazila Hat-Bazar management committee.
- vii. To ensure the toll collection according to the toll chart.
- viii. To maintain law and order in Hat-Bazars.
- ix. To resist illegal occupations.

5.3 Municipality (Pourashava) Hat-Bazar Management Committee

5.3.1 Composition:

- i. Municipality Chairman/Administrator will be the chairperson.
- ii. Deputy director of local Govt. of DC office will be a member (for 'A' category municipality only).
- iii. Upazila Engineer will be member (for municipality under Upazila).
- iv. Two Govt. officers of the Upazila will be the members (nominated by the DC).
- v. All the ward commissioners of the concern municipality will be the members.
- vi. Two distinguished persons of the municipality will be the members (nominated by the DC).
- vii. One teacher of the schools/colleges of the municipality area will be a member.
- viii. Two shopkeepers/businesspersons of the each Hat-Bazar under the municipality will be the members.
- ix. Executive Engineer/ Assistant Engineer of the municipality will be a member.
- x. The Chief Executive Officer (CEO)/the secretary of the concern municipality will be the member secretary.

5.3.2 Responsibilities:

- i. To chalk out the development plan and implement those with the approval of the DC.
- ii. To supervise the toll collection and the collectors.
- iii. To resist the excessive toll collection.
- iv. To resist the illegal toll collection, extortions, etc.
- v. To ensure law and order of the Hat-Bazar.
- vi. To keep the Hat-Bazar clean and ensure sanitation.
- vii. To resist illegal occupation.
- viii. To make necessary toilet/latrines in each Hat-Bazar.
- ix. The committee will sit for meeting at least once in a month.

6. SWOT Analysis

SWOT is an acronym, which stands for Strength, Weaknesses, Opportunities, and Threats of an approach, a system, or an organization in achieving its goals and objectives. After analyzing the policy, activities of different Hat-Bazar management committees and the opinions of various cross sections of people, the SWOT analysis of Hat-Bazar could be done as follows:

6.1 Strengths:

- Participation of farmers and businessperson.
- Revenue generation.
- Proper utilization of govt. land.

6.2 Weaknesses:

- Political interferences.
- Administrative control.
- Inefficiency, Corruption and illiteracy of the elected representatives.
- Weak organizational structure.
- Absence of coordination.

6.3 Opportunities:

- Strengthening local government.
- Ensure women participation.

- Infrastructure development.
- Proper Land management.

6.4 Threats:

- Private markets.
- Illegal occupations.
- Middleman/brokers.
- Law and order situation.

7. Findings of the study: Development roles of indigenous markets

The indigenous markets can not play development roles properly as there are number of challenges for the effective management of these markets. Those challenges are various and those are the outcomes of the study. According to the primary and secondary data collected and observations, findings of the study are as follows:

7.1 Local Government system in grassroots level is not working properly

Local Govt. system in grassroots level is not working properly due to political interferences. Generally the big political parties support the public representatives of local Govt. bodies. Inefficiency is also a reason along with other reasons. There is lack of coordination in many of the Union Parishad and Pourashava as well as Upazila Parishad. In order to ensure good governance in grassroots level the local Govt. should work independently.

<Figure 1>

7.2 Hat-Bazars under Local Govt. bodies are not functioning properly

The Govt. Hat-Bazars controlled by the local Govt. authority are not functioning properly due to mainly the political interference. In many of the Union Parishad and Pourashava the Hat-Bazar management committees have not been formed till today. Generally political leaders rule the management of the Govt. markets that ultimately politicized the management. Absence of Hat-Bazar maintenance and absence of coordination also hamper the proper function of the Hat-Bazar.

7.3 Area of the Hat-Bazar is small

The area of the Hat-Bazar is too small to meet the peoples' need. Somewhere the size of the Hat-Bazar is accurate, but expansion is required.

<Figure 2>

7.4 Present Hat-Bazar management policy is not sufficient

Hat-Bazar management policy is not sufficient although Govt. employees think it is sufficient. It is not sufficient due to complex leasing policy, excessive administrative control and improper coordination.

<Figure 4>

7.5 Hat-Bazar leasing procedure is not satisfactory

Hat-Bazar leasing procedure is not satisfactory as it is tedious and administrative control is there.

7.6 Businesspersons in Govt. Hat-Bazar face different problems

In govt. Hat-Bazar the businesspersons faces different problems and the major problem is the involvement of the middlemen. The middlemen collect money from the businesspersons and control the markets. There are also other problem like transportation, security and sanitation problems. In observations it is found that the business space in Hat-Bazar is narrow and the environment is unhealthy. Sanitation system is absent there.

7.7 Hat-Bazar management committees don't work properly

Hat-Bazar management committees do not work properly due to mainly political interference, because the local leaders of the political parties control most of the management committees. There are also other reasons like absence of toll chart, ineffectiveness, poor maintenance, and poor coordination.

7.8 Hat-Bazar fulfill peoples' need, but not very much

The Govt. Hat-Bazar doesn't fulfill peoples' need very much, but fulfill much or not too much. People expect to market their product without any hassle, which the Hat-Bazar cannot ensue. Both sellers and buyers want terrorism free clean environment in Hat-Bazar that is generally absent in govt. Hat-Bazar. Poor infrastructures are also a great disadvantage of Hat-Bazar. Less women participation is also a problem.

7.9 Less women participation in Hat-Bazar

In govt. Hat-Bazar the female marketers cannot participate too much. The security measure can ensure their participation. Female marketers need toilets and sheds in the markets.

<Figure 3>

7.10 Union Parishads should get proper share from the Hat-Bazar revenue.

According to the present rule the Union Parishads get 5% of the revenue of each Hat-Bazar. But almost they don't get the proper share. Moreover most of respondents think it should be more than 5%.

7.11 Upazila Parishad sometimes doesn't get the proper revenue from Hat-Bazar

Upazila Parishad sometime doesn't get the proper share from Hat-Bazar due to syndicated competitions in tender. Poor infrastructures of the Hat-Bazar are other reasons, as Upazila Parishad has to maintain that. Corruption and inefficiency are also the reasons.

7.12 Highest portion of the revenue should be spent for maintenance.

Govt. Hat-Bazars are created to facilitate the people, so the Hat-Bazars should be maintained properly and highest part of the earned revenues should be spent for that.

7.13 Lease is the best way to collect revenues

To collect revenue from Hat-Bazars lease is the best process that ensures the revenue earnings. There are other processes also, but lease out processes ensure maximum revenue earnings. In the case of direct collection it is found that the revenue earning decreases.

<Table 1>

<Table 2>

<Table 3>

<Table 4>

7.14 Revenue can be augmented by improving the infrastructures

By improving the infrastructures of the govt. Hat-Bazars the revenue earnings can be increased. If infrastructures are improved then more buyers and sellers will participate and the lessee may earn more. Full authority to manage all Hat-Bazars up to a certain pecuniary limit can also ensure that, because the local govt. bodies can help the lessee for improvement of the infrastructure and management.

7.15 Hat-Bazar management activities should be done at Upazila level

Earlier Hat-Bazar management activities took place in district level and the DC used to do that. Later full authority to manage all Hat-Bazars up to a certain pecuniary limit was given to the Union Parishad for strengthen the local Govt. bodies. After that, this authority was withdrawn due to corruption and inefficiency. Presently Upazila Parishad and Pourashava are doing the activities that are running successfully.

7.16 The farmers and businesspersons do not get the proper price in Hat-Bazars

In most of the cases the farmers and businesspersons do not get the proper price of their products or they somewhat get proper price. The main impediment behind not getting the proper price is the role of middlemen.

7.17 Private markets and illegal occupation are the main threat to govt. markets

In most of the cases the illegal occupants capture the land Govt. Hat-Bazar as well as the roadside, riverside and establish illegal markets. These markets discourage the sellers and buyers to participate in govt. Hat-Bazars. Modern private markets also attract the marketers which may cause less participation in govt. markets.

8. Conclusions

Government Hat-Bazars are the main indigenous markets of Bangladesh. From the very ancient period these markets are the only places where farmers and producers can sell their products. These markets control the local business as well as national business. So, environment, infrastructure and, law and order situation of these markets should be maintained properly. The Hat-Bazar management committees can ensure these issues with the help of local administration and the local Govt. institutions.

Effective Hat-Bazar management can ensure local development from these markets. Some recommendations can be delivered for effective Hat-Bazar management. Analyzing the responses of the respondents and the observations following recommendations can be summarized:

- 1) Political interference should be stopped to make the local Govt. bodies effective and active.

- 2) Proper maintenance, sanitation and infrastructure should be ensured to make the govt. Hat-Bazar effective.
- 3) Political interference and administrative control should be avoided to make the Hat-Bazar committees effective.
- 4) Businesspersons should get priority in Hat-Bazar management.
- 5) Hat-Bazar management policy should be made more understandable.
- 6) Lease should be ensured and direct collection should be avoided in order to increase revenue
- 7) Leasing procedure should be made easy and should be done in short period.
- 8) Share of Upazila Parishad, Pourashava and Union Parishad from Hat-Bazar revenue earnings should be increased.
- 9) Hat-Bazar management activities should be done in Upazila level.
- 10) Union Parishad may be given full authority to manage all Hat-Bazars up to a certain pecuniary limit.
- 11) Woman marketers should get proper security and sitting arrangements
- 12) Law and order situation should be maintained in Hat-Bazars.
- 13) The Hat-Bazar management committees should arrange special transportations for the businesspersons, so that they can carry their products in an appropriate price.
- 14) The law enforcing force should control the activities of the middlemen.
- 15) Illegal occupants should be evicted from the govt. land.

Hat-Bazars under Local Govt. bodies are not functioning properly, as the local govt. bodies do not have the authority. To fulfill peoples' need the policy should be made sufficient. Illegal occupants should be evicted. Accountability of the management personnel should be ensured. If the market management committees work properly then people will be benefited and local Govt. bodies will earn revenue in a huge scale, which ultimately ensures local development.

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Notes

Note 1: Source of Data –UNO, Doarabazar

Note 2: Source of Data - Md. Matiul Islam Chowdhury, UNO, Chhatak

Note 3: Source of Data - AC (Land), Narayangonj Sadar

Note *: Bangla (Bengali) year. Starts on 14th April each year.

Acronyms

ADC: Additional Deputy Commissioner

BIDS: Bangladesh Institute of Development Studies

BBS: Bangladesh Bureau of Statistics

DC: Deputy Commissioner

FGD: Focus Group Discussion

GOB: Government of Bangladesh

MP: Member of Parliament

NGO: Non-Government Organization

OSD: Officer on Special Duty

TK.: Taka (Bangladesh currency)

UNO: Upazila Nirbahi Officer

UP: Union Parishad

UZP : Upazila Parishad

ZP: Zila Parishad

Glossary of Bengali Terms

Baishakh: 1st Month of Bangla (Bengali) calendar.

Bazar: Indigenous Market for commodities.

Chaitra: Last (12th) Month of Bangla (Bengali) calendar.

Char : New land created by accumulating silts in rivers/seas.

Crore: 10 millions.

Gram: Village

Gram Sarkar: Village Government.

Hat: Village Periodic Market.

Khas land : Government Owned Land.

Lac: 1 lac equals to 0.1 million.

Magh: 10th Month of Bangla (Bengali) calendar.

Muktijoddha Sangsad: An Association of the freedom (Liberation War) fighters of Bangladesh.

Parishad: Council.

Pourashava: Municipality.

Salami: Down payment of lease money.

Union: A rural area consisting of some villages.

Upazila: Sub-District.

Upazila Nirbahi Officer: A civil servant deputed by the government to the UZP as Chief Executive Officer.

Zila: District.

Table 1. Revenue earned from Scheduled Hat-Bazar Under DoaraBazar Upazila of Sunamganj District (Note 1, Note *)

Serial Number	Name of the Hat-Bazar	Lease Value					Remark
		1412* (Taka)	1413* (Taka)	1414* (Taka)	1415* (Taka)	1416* (Taka)	
1	Baliura Bazar	5,36,782	10,26,000	10,26,600	10,27,000	15,31,000	Direct Collection in 1412
2	Dohalia Bazar	4,02,500	4,05,500	4,21,000	4,22,051	6,50,501	--
3	Bangla Bazar	1,42,000	1,46,000	2,06,006	2,10,000	1,90,000	--
4	Bogla Bazar	1,47,894	99,350	2,40,200	2,41,000/-	2,00,000	Direct Collection in 1412-1413
5	Mohabbatpur Bazar	23,050	23,100	24,200	24,500	25,500	--
6	Doara Bazar	73,100	74,200	55,000	50,000	69,600	--
7	Tablai Bazar	1,679	3,100	3,550	3,600	4,000	Direct Collection in 1412
8	Norsinghpur Bazar	20,440	10,500	31,000	28,100	57,500	Direct Collection in 1412-1415
9	Chairgaon Bazar	10,525	8,800	12,000	8,000	-	Direct Collection in 1412-1415
10	Nasimpur Bazar	22,500	23,200	23,200	22,610	24,000	--
11	Ambari Bazar	3,90,100	4,33,000	4,91,000	6,32,000	7,76,600	--
12	Katakhali Bazar	7,500	8,525	10,100	10,200	12,040	--
13	Shyamol Bazar	7,100	3,795	8,250	12,500	9,500	Direct Collection in 1413-1414
14	Bangobondhu Bazar	2,300	2,400	3,100	3,500	3,000	--
15	Biani Bazar	5,500	3,450	5,650	6,000	5,500	Direct collection in 1413
16	Bhabanipur Bazar	5,500	5,550	5,550	7,850	7,320	--
17	Sripur Bazar	17,600	17,800	31,200	31,500	32,000	Direct Collection in 1412-1414
18	Mongolpur Bazar	6,300	6,600	7,100	7,200	7,300	--
19	Tengra Bazar	13,650	14,500	14,500	15,520	21,075	--
20	Eruakhai Bazar	8,300	8,600	9,100	9,200	9,200	--
21	Liakatganj Bazar	1,45,000	2,11,000	2,55,000	2,85,750	3,08,750	--
22	Achhirmagar Bazar	3,225	3,250	3,600	3,700	3,800	--
23	Naillar Bazar	180	-	-	-	-	Direct Collection

Table 2. Revenue earned from Scheduled Hat-Bazar under Chhatak Upazila of Sunamganj District (Note 2, Note *)

Serial Number	Name of the Hat-Bazar	Lease Value			Land Area of the Market
		1413* (Taka)	1414* (Taka)	1415* (Taka)	
1	Jawa Bazar	62,41,000	68,54,000	68,71,000	10.32 Acre
2	Borokapan Bazar	--	--	---	--
3	Gobindagonj New Bazar	23,29,999	23,50,000	24,05,000	6.2553 Acre
4	Dharon Bazar	--	--	90,100	1.41 Acre
5	Pirpur Bazar	--	12,350	12,450	2.1225 Acre
6	Kalaruka Bazar	2,460	2,500	2,800	3.21 Acre
7	Rampur Bazar	--	--	---	--
8	Hasnabad Bazar	4,400	4,500	4,500	--
9	Bawsha Bazar	--	2,550	2,650	--
10	Chhanbari Bazar	--	--	---	--
11	Islampur Bazar	--	--	1,020	--
12	Chanpur Bazar	--	--	---	--
13	Chowmuhuni Bazar	--	3,650	---	--
14	Laxmibaur Bazar	3,300	3,400	3,500	--
15	Amertoil Bazar	--	--	---	--
16	Aligonj Bazar	14,000	14,500	14,600	--
17	Haidarpur Bazar	--	2,600	2,650	--
18	Lakeshwar Bazar	--	25,550	---	--
19	Bangla Bazar	--	--	810	--
20	Buraiya Bazar	--	1,350	1,450	--
21	Dolar Bazar	--	--	1,80,000	4.67 Acre
22	Moinpur Bazar	7,500	9,000	9,100	--
23	Zahidpur Bazar	950	1,000	1,050	0.89 Acre
24	Ziapur Bazar	1,600	2,500	2,600	1.77 Acre
25	Shirajgonj Bazar	--	20,500	20,600	--
26	Kamargaon Bazar	18,500	18,550	18,600	--
27	Tetia Bazar	15,000	26,000	26,200	--

Table 3. Revenue earned from Scheduled Hat-Bazar Under Narayangonj Pourashava(Municipality)(Note 3, Note *)

Serial No.	Name of the Hat-Bazar	Locality	Income in 1407* (taka)	Income in 1408* (taka)	Income in 1409* (taka)	Income in 1410* (taka)	Income in 1411* (taka)	Income in 1412* (taka)
1	Digubabu Bazar	Municipality	5,45,000	6,05,000	15,00,000	10,25,000	14,21,500 Direct Collection	12,00,000 Direct Collection
2	Kalir Bazar	Municipality	1,08,001	1,10,100	1,78,500	2,01,000	2,36,100	2,37,600
3	Bhagobangonj Bazar	Municipality	2,05,000	2,22,000	2,51,100	2,60,000	2,63,000	2,65,000
4	Godnail Bazar	Municipality	54,000	55,000	56,000	56,800	57,100	61,500

Table 4. Revenue earned from Scheduled Hat-Bazar Under Narayangonj Sadar Upazila (Note 3,Note *)

Serial No.	Name of the Hat-Bazar	Locality	Income in 1407* (Taka)	Income in 1408* (Taka)	Income in 1409* (Taka)	Income in 1410* (Taka)	Income in 1411* (Taka)	Income in 1412* (Taka)
1	Fatulla Hat-Bazar	Fatulla UP	15,44,00	19,31,000	19,98,585	35,00,000	35,05,000	51,00,000
2	Shiddhirgonj Hat-Bazar	Shiddhirgonj Municipality	85,200	66,790 Direct Collection	48,093 Direct Collection	47,695 Direct Collection	35,255 Direct Collection	24,375 Direct Collection
3	DecreerChar Hat-Bazar	Alirtek UP	4,400	4,800	5,000	5,200	5,300	6,200
4	Baktabali Hat-Bazar	Baktabali UP	-	-	-	1,05,555	3,375 Direct Collection	3,215 Direct Collection

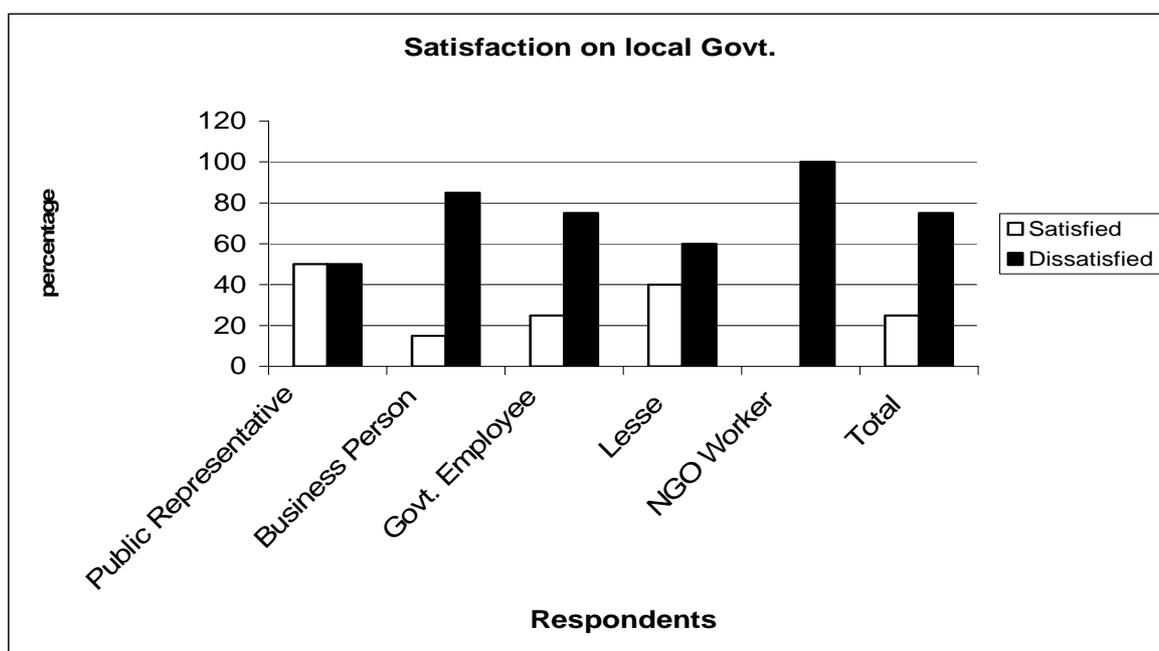


Figure 1. Responses on the satisfaction on the activities of the local Govt.

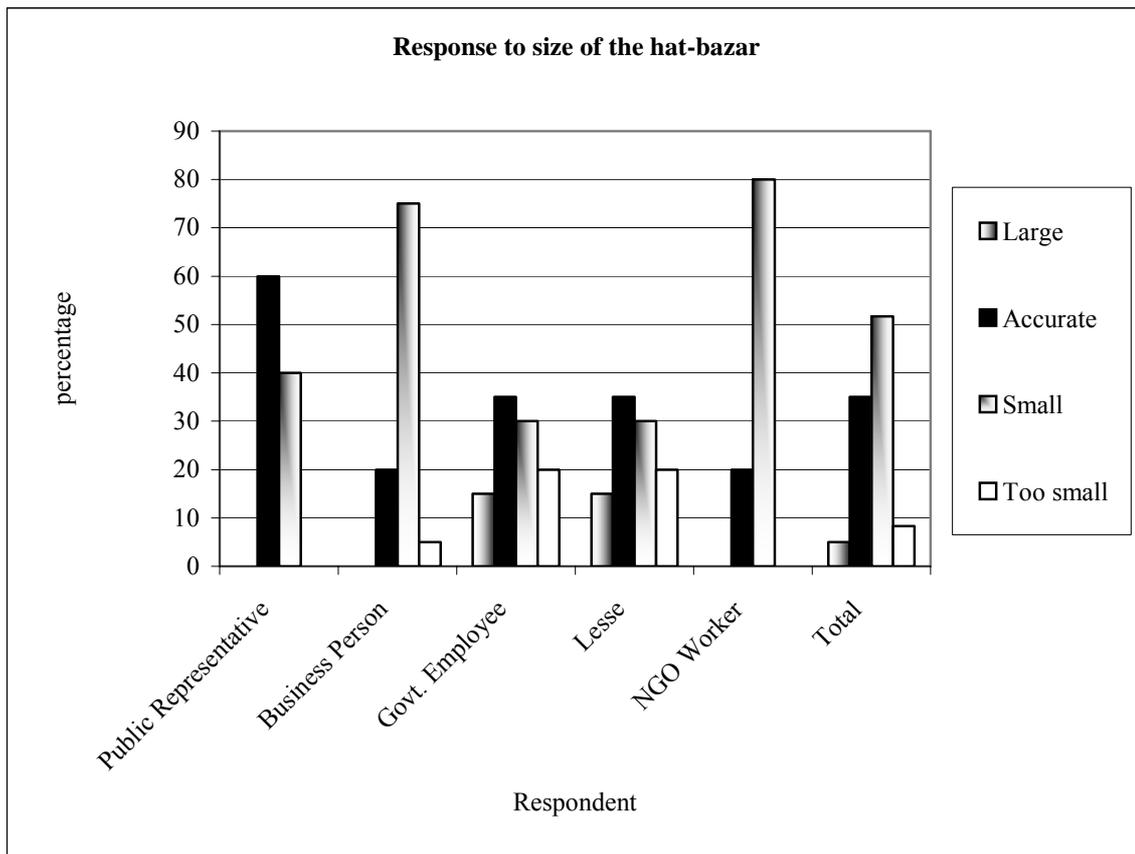


Figure 2. Responses to the size of the Hat-Bazar.

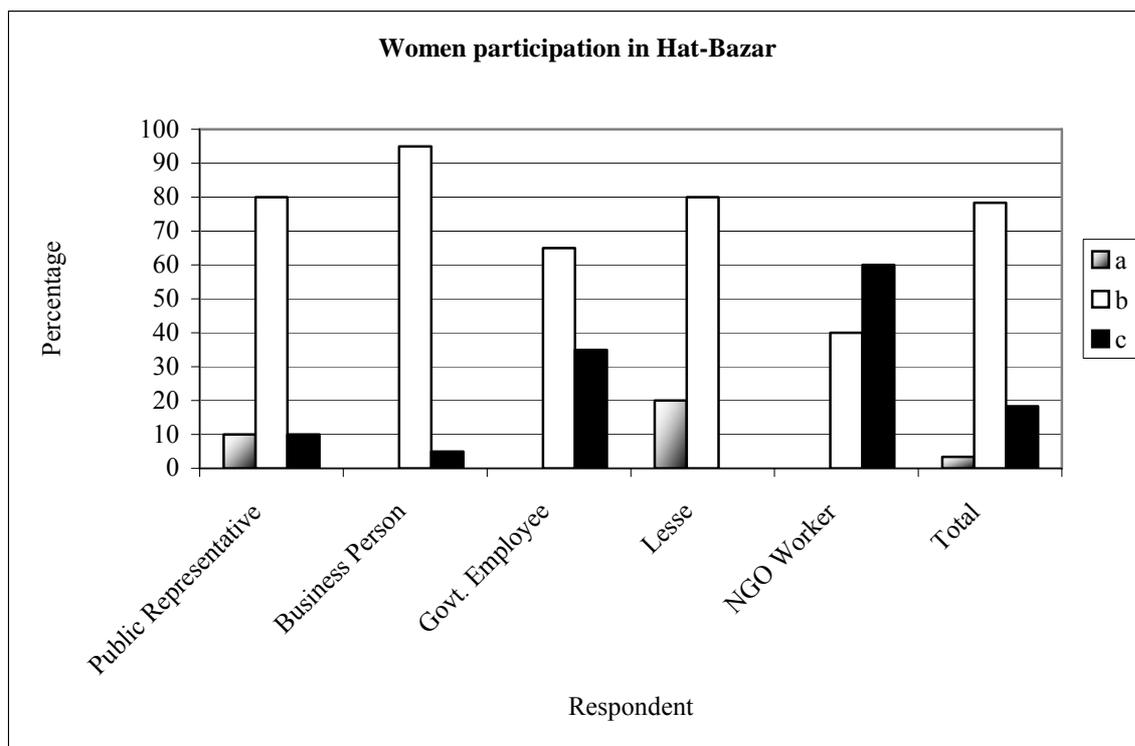


Figure 3. Responses on women participation in the Hat-Bazar.

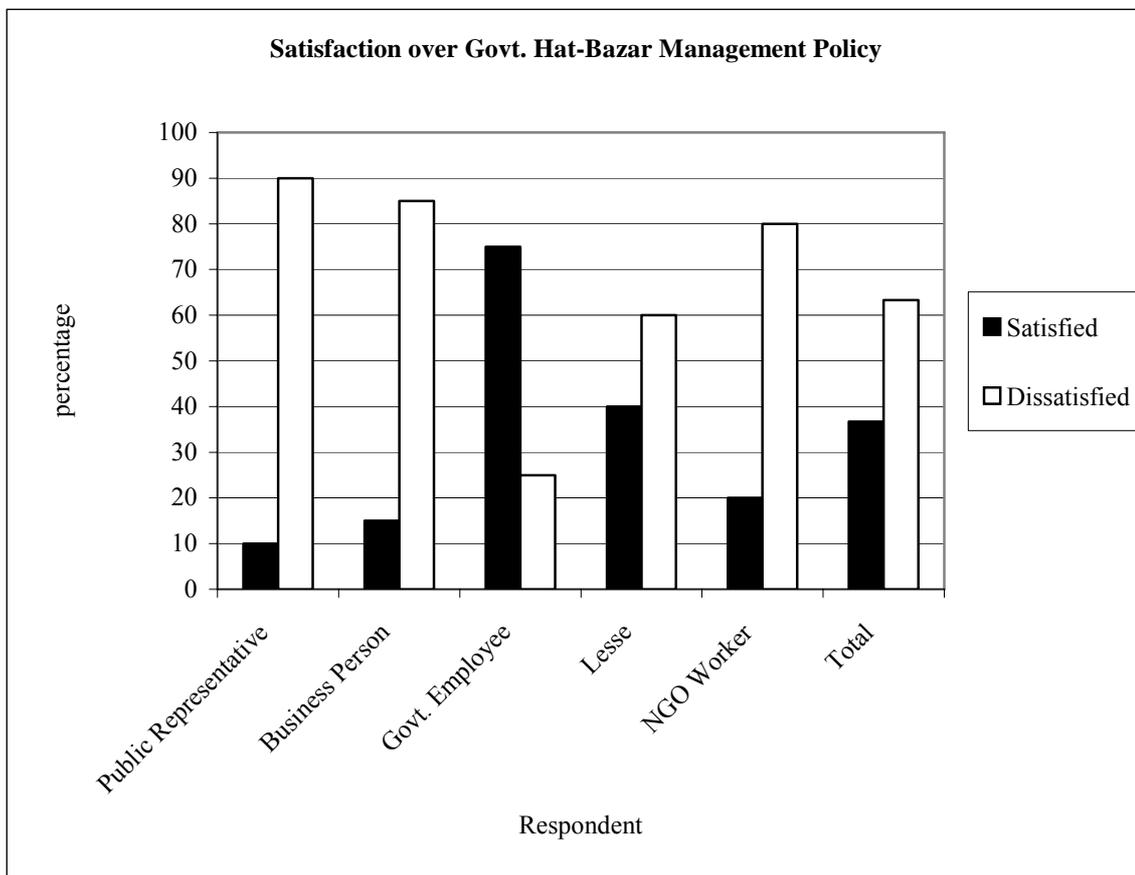


Figure 4. Responses on the satisfaction over the Hat-Bazar Management Policy.



Figure 5. A view of a traditional Bazar (indigenous market) of Bangladesh.



Socio-Economic Impact Assessment for Exploration of Coastal Zone in Yantai Region

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Abstract

Based on analyzing different definitions for Coastal Zone, a new definition paying more attention to the determination of the regional border of Coastal Zone is obtained and adapted to the concept of scientific development. According to the above, with a new regional border of coastal zone in Yantai region gotten, the potential environmental impacts on the development strategy of this zone are discussed and a socio-economic impact assessment for the development is also advanced, finally, some suggestions are proposed.

Keywords: Coastal areas, Development strategy, Socio-economic impact assessment, Yantai region

1. Introduction

Coastal zone is a kind of transitional zone between the terrestrial and marine ecosystems, influenced by both natural forces, such as the ocean, land and atmosphere, and other non-natural forces coming from human society, making matter and energy exchange actively (Zhang Yongzhan and Wang Ying, 2000). In addition, the coastal zone is a typical fragile ecosystems and in poor stability, for being disturbed frequently by marine and terrestrial ecosystem (Lin Tao *et al.*, 2007). Definition of the coastal zone can be divided into two kinds of narrow and broad sense. Based on an international biosphere plan on coastal zone, the narrow concept of coastal zone divided the coast into three parts: coastal zone from coast, intertidal zone and underwater bank slope, (IGBP/LOICZ, 1995). Broad sense of coastal zone, refers to watershed areas where rivers flow directly into ocean and the whole outer continental shelf, but actually refers to a belt region extend certain distance on both sea and land side (Shen Chengping and Han Xue, 2007). There are differences between narrow and broad sense, mainly due to the narrow definition of coastal zone only consider the direct effect of sea or land, such as a role of ocean tides; broad definition of coastal zone seems to take the indirect effects of sea or land into account, and a role of sea and land along the coast on both sides to the coastal zone boundary line are reducing, the farther from the shore, the more fuzzy (Chen Shupeng, 1996). As in the East Asian region, for example, according to the impact of oceans on land in different ways, the landward side of coastal zone from near and far from the coast can be divided into inter-tidal zone, sea-land breeze area, typhoon zone, monsoon areas, inland areas, and several other areas. Boundary of each district furthest away from the sea roughly follows as: inter-tidal zone 2km; sea-land breeze area 60km (Xue Deqiang *et al.*, 1995); Typhoon District 1000km (a well-developed typhoon, circular vortex radius is generally 500km ~ 1000km); monsoon region 3000km. Inland area of more than 3000km from the shore. Interactions of land and sea are obvious in inter-tidal zone; force in sea-land breeze area is mainly the land-sea breeze; while typhoon in the typhoon area; the main force in the monsoon region coming from differences in the formation of hot air masses from sea and cold air masses from land.

Traditionally, Human development and utilization of marine resources mainly based on taking marine resources as objects to obtain a product, and following the use of marine space resources. Strategy of coastal development that is also a typical strategy of developing the coastal zone (Fang Qinhua, 2006, p. 51) will, directly or indirectly, impact on

the environment of coastal zone through the guide or restrict economic activity (Munsinghe M, 1998). Among them, the socio-economic impact assessment is an important organic part of a strategic environmental assessment of coastal development (Field JG *et al.*, 2002), and also an important part to evaluate the sustainability of coastal zone strategy. Current coastal development strategy highlights two aspects in China: the socio-economic impact macroeconomic and microeconomic assessment. The former is an analysis of coordination between proposed strategy and related strategies that have been implemented, and the latter analysis in equity among different groups to the impact of proposed strategy results (Fang Qinhu, 2006, p. 94). According to the new definition of coastal zone boundaries, this paper assesses the coastal socio-economic effects of Yantai, development, then presents the corresponding countermeasures and suggestions.

2. Yantai coastal zone development strategy and environmental impact

2.1 General setting

Yantai Locating in the southern part of Jiaodong peninsular close to the Yellow Sea and Bohai Sea, facing Japan, South Korea and North Korea across the sea, governs 5 districts, 1 county and 7 county-level cities only one of which is not bordered on the sea within all areas under jurisdiction. The coastline of yantai stretches for 702.5km, two parts of the north or south, the width of north and south sides is both about 120km, due to land-sea breeze extends inland about 60km, North-South cross-strait sea-land breeze converged in the central region (Xue Deqiang *et al.*, 1995), so two parts in Yantai: the inter-tidal zone at a distance of 2km from the coast and the rest of the region in the land-sea breeze area. Most county-level cities (counties, districts) have inter-tidal zone, namely: Zhu Zhifu, Laishan, Fushan, Muping District, Economic and Technological Development Zone and Hi-tech zone, an area of 2643.6 km², with a total population of 1.7million people, accounting for 26.5% of the city; Longkou City, Zhaoyuan City, Laizhou City, Penglai City and Changdao County also on the verge of the northern coast, five cities (counties), with a total area of the city accounted for 38.8%and the total population of 2.5million people, accounting for 38.7% of the city; Laiyang and Haiyang, 2 county-level cities on the verge of southern coast. These two citis and Qixia city, the only city not having the inter-tidal zone, located in south-central region of Yantai, with a total area of 5634.3 km², a total population of 2.2million people, accounting for 34.1% of the city.

2.2 Yantai Coastal Zone Development Strategy

In these geographical conditions, Economic Development Strategy of Yantai and the Coastal Zone development strategy are inseparable. The major coastal development strategies in the next five years are mainly the following point: firstly, focusing on building the port group, in this port group, Yantai Port as a center port, Longkou port as a main port, supplemented by other small and medium sized ports. Secondly, strengthening the coastal land area development. Finally, strengthening economic interaction of land and sea, promoting marine economic development. By 2010, total port cargo throughputs of Yantai strive to reach 200 million tons, the container up to 200 million standard containers. And marine industry output value reach up to 800 billion yuan, accounting for 20% of the city's GDP (Municipal Planning Bureau of Yantai, 2005).

2.3 The Environmental Impact of Coastal Development of Yantai

With the rapid economic development, utilization and protection in the coastal zone resources of Yantai are also facing increasing pressure. These pressures that are mainly coming from the economic activities in coastal zones are mainly manifested in the following aspects:

2.3.1 Population growth and changes in the structure of life

The urban population annual growth rate is around 6%, by 2010, the urban population in the center city close to 2 million people, the total population in county-level cities up to 2 million people (Municipal Planning Bureau of Yantai, 2005). With the population growth and consumption patterns changing in the Coastal Zone, More pressure to the limited energy and resources in Yantai will emerge. Through an annual survey estimates of land-based emissions from domestic sewage waste water, it reached to nearly 150 million tons or more once year, and the emissions increase every year and will damage to coastal eco-environment seriously (State Oceanic Administration Institute for Marine Development Strategy Planning Group,2007). Parts of the coastal region which absorbed nutrients or were taken as a place for hatching are completely abandoned now for being full of garbage wastes (Li Shitai, 2000).

2.3.2 The rapid development of industrial

Surveys in 2000 showed that, there are 18 rivers flowing into the sea and 27 sewage draining exits discharged more than 40 million tons of industrial and domestic sewage every day (Li Shitai,2000). Impact to the coastal zone environment is mainly embodied in industrial wastewater emissions increasing constantly, and will increase in Eleventh Five-Year period, for many high-polluting enterprises, such as petrochemical, metallurgy, bio-pharmaceutical and other potential industries being raised. Loads to the ecological environment in the inter-tidal zone of Yantai also are increasing for some reasons, such as a regional central city being under construction and a coastal industrial belt till Laizhou Bay to

Yangma island planning to construct (Mao Berkow, 2005).

2.3.3 Coastal Engineering continuous construction

Coastal construction projects, including port construction that occupy coastal resources, also produce large amounts of oil, wastewater and waste causing severe environmental stress and Reclamation land from the sea. It is noteworthy that, with the West Yantai Port building and petrochemical industries developing, the number of oil throughput and the harbor greater risk of oil spills will both increase. The statistics results in 2000 show that, the pollution from ships in Zhifu Harbor, is mainly manifested in the oil port and operational areas. More than 15,000 pieces of ships of Yantai discharged oil into the sea about 680 million tons each year (Li Shitai, 2000). With blind development of saltern, shrimp pond, over the past 20 years in Yantai, Large amounts of seawater invade into the interior (Li Shitai, 2000).

2.3.4 Sea-beach wetland aquaculture

In addition to the transformation of coastal outline and the intensity and mode changes of action caused by coastal dynamics directly (Du Guoyun *et al.*,2007), rapid development of marine aquaculture also increase the pollution of the coastal zone. Aquaculture pollution is still important sources of marine pollution (State Oceanic Administration Institute for Marine Development Strategy Planning Group 2007).Among these, shrimp farming are the most profitable and also pollutant one. For example, organic materials to discharge into the sea from the process of shrimp farming were about more than 85,000 t in Yantai, heavily polluted coastal environment (Li Shitai, 2000).

2.3.5 Coastal Tourism

The total tourism revenue of Yantai would reach 24 billion in 2010, with an average annual increase of 17% (Municipal Planning Bureau of Yantai, 2005). The impact of coastal tourism business on the coastal zone environment is mainly reflected in sewage emissions being swelled with tourists increasing constantly. An example that some tidal flat area in a beach named Golden Sands beach in the Economic and Technological Development Zone governed by Yantai government is occupied to build tourism facilities, resulting in destruction of beaches balanced cross-section, and exacerbating beach erosion, shows that tourism development would also damage the beach tourism resources.

2.3.6 Other Terrestrial Coastal Zone Resource Development

Other coastal zone resources development specifically manifest in misusing non-renewable resources, such as the acceleration of coastal coal mines (Longkou coal) and gold (Sanshandao gold, the gold warehouse) and other non-metallic and metallic mineral resources development in east coast of Laizhou Bay coastal zone since 1960s, causing surface subsidence (Du Guoyun *et al.*,2007); and in the exploitation intensity of renewable resources too excessive to seriously damage their regeneration process, so in a serious imbalance in resource structure. For example, although the coastal dune-fixing wind Japanese black pine forest has not yet folded, there are many manners of deforestation could be found. Some scholars have pointed out that along the coast sand-fixing storm Japanese black pine forest in Tiou long zui region Yantai domain has been severely damaged, almost as a barren land there (Li Shitai,2000).

3. Socio-economic impact assessment

3.1 Macro Impact Assessment

In connection with a region, land value affected by the environmental pollution, that is to say if the land was contaminated, its market price would be bound to decline, can be converted into a total investment of local economic development, and the total economic benefits received are the regional gross national product affected by degree of regional development, pattern of city layout, structure and layout of regional industries and resource utilization efficiency. The higher coastal development of Yantai, the more land prices needed, and the maximum investment amount of land will be the most close to. Suppose the land price of inter-tidal zone and sea-land breeze zone farther than inter-tidal zone from coastline where land price is lower than inter-tidal zone are separately set to 1,000 and 300 yuan/m² as values of urban construction land in 2005. Then the total purchase price of coastal zone of Yantai is 13.75 trillion yuan with dimensions of roughly 702.5km by 2km in inter-tidal zone and 702.5km by 58km in sea-land breeze zone in 2005. As a total investment of local economic development of Yantai, assuming the rate of return on investment is 10%, the estimated total revenue of Yantai(abbreviated as TLRY) would be 1.375 trillion yuan. While the real GDP of Yantai is 201.25 billion yuan in 2005, about 15% of TLRY and the estimated GDP in 2010 would reach to 370 billion yuan, or about 27% of TLRY and close to TLRY in 2020, that means, the urbanization of yantai would be more complete and coastal zone resources fully used at that time. While one of prerequisites for GDP reaching to 1 trillion yuan in 2020 is the environmental quality and ecological conditions of Yantai still remained the state in 2005. Due to environmental pollution continuously, in all probability, before the GDP of Yantai had exceeded 1 trillion yuan, earlier than the year estimated, the GDP would equal to TLRY when changing the rational planning of urban layout, improving resource utilize efficiency and scientific adjustment of the regional industrial structure and layout would be needed if the GDP still increased.

In addition leading to the decline in the value of land, environmental pollution can also wear the national income through environmental improvement. For instance, every million tons of sewage treatment almost need one-time investment in 0.5 million yuan (based on 20 years of depreciation), and operating costs for 2 million yuan annually, then totally the economic losses about 2.5 million yuan in one year. A variety of unexpected events, for example, fishery pollution accidents resulting from illegal dumping of wastes due to harbor dredge and also caused by land-based sewage (Oceanic and Fishery Bureau of Yantai, 2003) are also the depletion of the total investment. With increasing rapidly of marine refuse in recent years, the amount of garbage dumping is also increasing, for instance, 2.86 million m³ in 2005 (Oceanic and Fishery Administrator of Shandong Province, 2005), 42.437m³ in 2006 (Oceanic and Fishery Administrator of Shandong Province, 2006). To dispose the above-mentioned marine litter, it will take a one-time investment in 3.7 million yuan according to 10-year depreciation, for the purchase of a large-capacity marine refuse collection fleet and a pier to construct for vessels collecting marine garbage to park. In addition, in order to maintain the marine refuse collection daily, the maintenance costs would be about 0.7million every year, and another 0.24 million yuanaslo need for of 20 refuse collection staffs' salaries ($20 \times 1000 \text{ yuan} / (\text{months} \cdot \text{persons}) \times 12 \text{ months}$). It is means that the economic losses of marine litter every year is about 4.64 million yuan, the cost of total as follows: $3.7 + 0.7 + 0.24 = 4.64$ million yuan / a. The direct impacts of the economic losses on coastal development are in Table 1 where some of these not reflected, such as, the direct and indirect losses of waterway dredging and remediation for clogging waterways by siltation sediment.

There are some conflicts also to reduce TLRY amongst coastal zone development related strategies of Yantai, such as conflicts between coastal tourism and port-related maritime industry; conflicts for beach resources between marine aquaculture and port construction manifesting in ports occupied by some marine fishery not conducive to construct and fairway waters occupied endangering the security of maritime transport, mainly manifested in contradictions between the marine sewage discharge of the non-marine industries polluting marine environment and the development of marine industries needing high-quality marine environment; conflicts in the exploitation and utilization of coastal zone resource between marine industries and non-marine industries; also inconsistencies between economic and social development planning of Yantai and coastal tourism planning. One instance manifests conflicts that the Coastal Tourism Development Project of Yantai includes 18 major goals distributed along the coastal zone, most of these in the inter-tidal zone (State Oceanic Administration Institute for Marine Development Strategy Planning Group 2007), meanwhile, where a coastal industrial belt with 200km from Yangma island to the Laizhou Bay have been implemented in.

3.2 Micro-impact assessment

The socio-economic impact assessment in micro level which is an important content of the strategic sustainability evaluation is mainly analysis of effects of the proposed strategy in fairness among different groups. The impact of coastal zone development strategy of Yantai to intra-generational equity relevant to intra-generational equity and intergenerational equity in a view of sustainable development (Hong Huasheng *et al.*, 1998) is the market allocation mechanism far from completion, causing that resources and ecological environment of Yantai originally jointly owned by all members of citizens, while were occupied by companies with a certain rate of return or departments of power with a low-return rate, and meanwhile economic losses due to pollution undertaken by personal themselves, such as, in most instances, hospital treatment costs caused by a problem of environmental pollution undertaken by the sick individual without the complete health care system. Coastal zone pollution could impact on the health of residents living in the coastal zone and infect them primarily after residents swam in contaminated water or ate the deteriorated seafood that were polluted. Coastal zone polluted water also as a means of disease transmission, spread of diseases, such as hepatitis, malaria, etc (Hong Huasheng *et al.*, 1998). The following formula could calculate economic losses of human impaired health caused by marine pollution: $T_{\text{value}} = P \cdot L \cdot H$; $T_{\text{treat}} = (T_c \cdot P_c \cdot L_c) + (T_n \cdot P_n \cdot L_n)$ (Hong Huasheng *et al.*, 1998). Where T_{value} refers to the lost gross national product during workers are sick; $T_{\text{treatment}}$ refers to the increase in expenditure in treatment of workers' diseases; P refers to the average net output of one person in one day; H refers to the days of illness time of one person; T_c , T_n respectively refers to the average outpatient and inpatient treatment expenditure daily; L_c , L_n respectively refer to the number of outpatient and hospital patients; P_c , P_n respectively refer to the average sick days of a patient, one treatment cycle of hepatitis A patients caused by marine pollution about 15-30d (taking 22.5d when calculate their economic losses). Then in Yantai, according to the formula: $T_{\text{value}} = \text{gross national product per capita}(20,221\text{yuan in } 2003 \text{ and } 58.48 \text{ thousand U.S. dollars in } 2010) \div 365 \times 22.5\text{d}$ (Statistics Bureau of Yantai, 2004; Municipal Planning Bureau of Yantai, 2005), then T_{value} in 2003 = $20221 \div 365 \times 22.5 = 1246.5$ yuan; Similarly, T_{value} will be 3604.9 yuan in 2010. T_{treat} should be equal to the average daily expenditure multiplied by 22.5, then $T_{\text{treat}} = 800 \times 22.5 = 18000$ yuan in 2003. Taking the level of health care reform and the improvement of health care into account, proportion to the growth of the average daily expenditure in outpatient and hospital treatment higher than per capita gross national product, T_{treat} may be calculated by per capita growth in gross national product temporarily, then, T_{treat} will be 52,056.8 yuan in 2010, so $T_{\text{total}} = T_{\text{output}} + T_{\text{treat}} = 19,246.5$ yuan in 2003, while $T_{\text{total}} = 55,661.7$ yuan in 2010. Namely, the economic loss of hepatitis A amounted to 19,246.5 yuan in

2003, while 55,661.7 yuan which close to per capita gross national product at that time in 2010. If a liver disease is prevalent in the popular crowd, it would cause more economic loss.

The impact of intergenerational equity in the coastal zone of Development Strategy of Yantai is mainly reflected in the standard of living of future generations likely lower than contemporary people beyond 2020 if coastal resources exploitation end by 2020 while the population has not been a corresponding restriction in Yantai.

4. Countermeasures and Suggestions

In addition to improving the overall urban planning, strengthening urban environmental infrastructure construction, rational development and utilization of resources to achieve the maximization of resources and optimization, changing in energy structure, curbing environmental pollution, there are still the following two aspects need to focus on:

4.1 Transformation of economic growth mode, adjust the industrial structure and optimize the industrial space layout

There are two reasons to adjust economic growth mode as soon as possible in the view of the coordinated regional development to increase TLRY in the future. Firstly, a similar structure between the neighboring cities, including Dalian, Qingdao, Yantai, with same industrial development direction, such as three pillar industries in the future or potential industry equipment manufacturing, composed of electronic information and software industry and bio-pharmaceuticals in the next decade will result in a highly competitive market price lower than the value, causing the yield decline in resource development. Value of the coastal zone with the original ecological environment at that time in Bohai Rim region will be manifest, resulting in increased earnings of eco-tourism. Secondly, with the evolution of global industrial structure and the wage level along China's coast rising, then the original layout of the manufacturing sector in China's coastal areas transferred to inland, it is inevitable that some industries, such as coastal tourism, port logistics and services become pillar industries. Therefore shifting the direction of industrial development to coastal tourism, port logistics industry to an earlier date, will avoid relocation after construction of the manufacturing sector, and increase TLRY.

4.2 Strengthen management on the coastal zone

In the coastal zone management, polluting enterprises stationed in the area should be levied a higher amount of pollution control costs depended on the degree of pollution, and government should likewise facilitate these polluting enterprises relocate to the land-sea breeze area. Environmental compensation fee charged to residents, according to water price management of different areas, for example, for urban sewage treatment, water fees charged to residents in tidal zone more than 5-fold in sea-land breeze area. Note that air pollution of land-sea breeze area, due to the impact of land-sea breeze, elevated source likely to cause pollution in their own region, which is unique to the pollution of land-sea breeze circulation phenomena (Qian Donglin and Li Zhaoyong,1991).For there being a large area forest vegetation in the sea-land breeze Distribution of Yantai, the construction of polluting enterprises should pay attention away from the protection ecological sub-region of forest vegetation (Zheng Binghui *et al.*,2007).

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Table 1. direct impact on economic losses of coastal development of Yantai

	Coastal Zone environmental issues and environmental protection projects	The amount of economic loss
1	treatment cost of sewage and waste gas	the loss of every million tons of sewage treatment 2.5 million yuan / a; due to the loss of air pollution share to various businesses, it is incalculable.
2	Marine waste disposal costs	4.64 million yuan per year
3	Port economic losses resulting from oil pollution	For the number of oil spills difficult to calculate, the loss can not be estimated
4	Other terrestrial resources development in Coastal Zone	Difficult to estimate
5	Construction of coastal nature reserves	costs of Built-up and operating need 0.2million yuan per year
6	regression caused disorder of aquaculture fisheries	Some of the most serious incidents, the economic loss can not be measured, such as billions of dollars of economic losses happened during 1997-1999 in the Long Island County.



Strategic Guidance Model for Product Development in Relation with Recycling Aspects for Automotive Products

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Abstract

This paper discusses a strategic guidance model for the product development process of automotive components in order to fulfil the requirements of the recycling aspects in End-of-Life Vehicle (ELV) Directive. This proposed model will enable automotive designers to assess products for their technical and economic viability at end-of-life. The paper presents an example of the whole vehicle as a case study in order to demonstrate and validate the proposed framework. It argues that indicators from the analysis can be used to inform the strategic development plans of the vehicles, infrastructures and spare part businesses. Based on this concept, a design guidance model is presented in order to help the designer make a right decision in the product development process so that value can be maximised at a product's end-of-life.

Keywords: Strategic Guidance Model, Value Analysis, Financial Analysis, Payback Period, Automotive Recycling, End-of-Life Vehicle Directive, Automotive Design

1. Introduction

In recent years, environmental issues have become a priority for manufacturing companies. In particular, the automotive industry has taken a proactive stance due to legislative pressures. Legislation such as the End-of-Life Vehicle (ELV) Directive (The European Parliament and of the Council of European Union, 2000, 2002, 2005a, 2005b, 2005c, and 2008)

has highlighted the need for automotive Original Equipment Manufacturers (OEMs) to design vehicles that can conform or, indeed, exceed ELV targets. At present, approximately 75% to 80% of end-of-life vehicles in terms of weight, mostly metallic fractions, both ferrous and non ferrous are being recycled. However, the remaining 20% to 25% in weight, consisting mainly of heterogeneous mix of materials such as resins, rubber, glass, textile, etc., is still being discarded (Toyota Motor Company, 2005).

EU ELV Directive forces the vehicle manufacturers to (The European Parliament and of the Council of European Union, 2000, 2002, 2005a, 2005b, 2005c, 2008):

- 1) Reduce the use of hazardous substances.
- 2) Design new vehicles that are easier to dismantle, reuse, recycle and recover components/materials/energy from vehicles that have been junked or totalled.
- 3) Increase the use of recycled materials in new vehicles.

The EU draft on ELVs also outlined that car manufacturers must reuse or recover 85% of ELV by 2006. Stating that at least 80% of a vehicle's weight must be reused or recycled; although up to 5% can be dealt with through other recovery operations such as incineration. This target increases to 95% by 2015 and at least 85% of that weight must be reused or recycled (The European Parliament and of the Council of European Union, 2000, 2002, 2005a, 2005b, 2005c, 2008). A summary of the general recycling targets, based on the ELV Directive, and recycling targets for the type-approval of new vehicles are shown in Table 1 and 2 respectively.

Currently most developed countries set legislation that will significantly change the way automotive OEMs and vehicle recycling companies (i.e. dismantlers and shredders) design and dispose of vehicles. This situation allows the recycling industry to play a more significant part in a vehicle's life cycle. The vehicle recycling business will be replaced by corporate recycling factories. It will move from spare parts to a raw materials business (PricewaterhouseCoopers, 2002).

In response to this, German and Holland authorities introduced the concept of 'Producer Responsibility', which obliged the car manufacturers to take back ELVs. This is to control the disposal of ELVs. The vehicle manufacturers decide to reduce the environmental burden of their products by improving the recyclability of cars. However, when the EU Directive stated that they must take back and treat ELVs at no cost to the last owner it generated intense opposition from the manufacturers, as they would have to assume a great financial cost (Kenari, Pineau and Shallari, 2003).

The introduction of the directive will affect all players involved in the management of ELVs in terms operational strategy, infrastructure and financial investment. The whole structure of automotive recycling is expected to change. The traditional dismantling techniques will become more advanced, as legislation demands the removal of all hazardous liquids and components. Also some form of plastics, rubber and glass recovery is necessary, either during the dismantling phase or during the separation process.

The directive has resulted in a plethora of research in the areas of design for recycling and into new techniques and technologies for vehicle disassembly (Desai and Mital, 2005). However, research has not focused on the strategic decisions automotive designers must make when they are designing vehicles for recyclability which, at the same time, can also minimise cost or maximise revenue when a vehicle comes to its end-of-life. Based on this scenario, the body of this paper is to discuss a model of Strategic Guidance for vehicle design in relation with recycling and cost/value aspects. This model will enable automotive designers to assess the design of products for their technical and economic viability at end-of-life.

In this scenario, a rigorous Strategic Guidance model is needed for automotive design recyclability assessment to fulfil the requirement of the ELV Directive and at the same time to improve the design of the vehicle components in order to increase the value at end-of-life. The paper begins with a short description of literature in this area and follows this with a detailed explanation of the proposed model. After that, the paper presents a case study in order to demonstrate and validate the proposed model. Lastly, the results are discussed and conclusions drawn with recommendations for further research.

2. Literature Review

2.1 Recycling Processes of ELVs

The understanding of the recycling processes of ELVs is very important in the design of a new vehicle; its sub-system and components. It can assist automotive designers to design new vehicles that are more economical and valuable at the end-of-life. These two aspects can be maximised if the vehicle can be disassembled and recycled easily. So in order to achieve this target, several stages in the recycling process must be clear defined.

An important stage of the recycling process is disassembly. Desai and Mital (2003) defined disassembly, in the engineering context, as organized process of taking apart a systematically assembled product (assembly of components).

Disassembly process may be clearly distinguished into two categories, based on the method of disassembly, non-destructive disassembly (dismantling) and destructive (shredding). Non-destructive disassembly can be divided into total disassembly and selective disassembly (Desai and Mital, 2003).

From end-of-life vehicles, dismantling companies first remove the oil, engine, transmission, tire, battery, catalytic converter, and other parts, which are commonly recycled or reused. Shredding companies then sort out the ferrous and non-ferrous metals and resin from the remaining vehicle bodies. While the ferrous and non-ferrous metals are recycled, the shredder residue is being disposed of as waste in landfills (Toyota Motor Company, 2005). Figure 1 shows this process.

In order to most effectively utilize the earth's resources and reduce the volume of disposable waste, automobile recycling activities must include efforts to further reduce the volume of this waste and promote its reuse and recycling to ultimately achieve zero waste.

According to Joshi, Venkatachalam and Jawahir (2006), shifting from the 3R concept (reduce, reuse, recycle) to the 6R concept (reduce, remanufacture, reuse, recover, recycle, redesign) may result saving gains for both manufacturers and consumers. Figure 2 describes this concept. In order to enhance this 6R effort and to make it more cost effective, based on the review of the literatures, it is essential to integrate the 6R criteria into all phases of the vehicle development process.

2.2 Current Environmental Tools used for Strategic Guidance in Design

There are several tools and techniques that can help guide designers in the design process and also influences the resultant design in a proactive environmental way. The main tools are life Cycle Costing, Value Analysis and Eco Design:

a. Life Cycle Costing (LCC)

LCC is a method of analysis used when quantifying the cost related to the product during its life cycle. Woodward (1997) defined LCC as the sum of all funds expended in support of the items from its conception and fabrication, through its operation, to the end of its useful life. It is clear that, the cost of End-of-Life (EOL) is one of main the elements in LCC. That means the cost of EOL has to be considered at an early stage of the product development process. This is to optimise the total cost for each process and also to optimise the value for money for any investment.

It is important because management can realise the source and magnitude of lifetime cost so that effective action can be taken. This approach encourages a long-term outlook for the investment decision-making process. Based on this, the concept of LCC can assist a designer to predict the EOL cost at the early conceptual design stage.

According to Westkemper, Niemann and Dauensteiner (2001), the LCC is the new cost accounting method to assess the share of costs and revenues. It can be used in order to assess the increasing expenditures during the use, service and disposal phases. A minimum of the total cost and a maximum of benefit are achieved when considering the costs of production, installation use and disposal.

The main elements of LCC are the production, usage (market) and disposal (deproduction). It is clear that, the costs and revenues for recycling processes must be carefully considered during the early stages of product development. This is in order to produce the right model for disposal at the end of the LCC. Figure 3 shows the relationship of these elements.

b. Value Analysis

Value analysis is a functional approach that identifies the necessary and unnecessary costs such as reducing the number of components in order to reduce the assembly time. For example, by just considering a simple vehicle component such as bumper there are various possible combinations of processing or reprocessing this component. Value analysis can investigate the functionality of each part, material, structure etc. in order to reduce the costs and increase revenue in terms of quality, safety, recyclability etc.

Value analysis is not an easy task, especially in the area of recycling purposes as there are a lot of factors that influence the performance of the recycling process. It is usually considered during the early stages of product development and the target for when the product reaches an EOL situation is typically 13 years later (Motorparc, 1997). Any design decision now can forecast the impact to the performance of recyclability of the product in 13 years time. Therefore, without any proper analysis and consideration, the precise model for recyclability performance can be difficult to develop especially if the analysis involves investments considerations (i.e. costs and revenue aspects).

Currently, the most common tools in making decisions for any investment are Future Worth, Annual Worth, Rate of Return, Benefit-Cost Ratio, Net Present Value, Return of Investment and Payback Period. All of these methods are well documented by Meredith and Suresh (1986). Based on their survey, the majority of the firms (about 91%) use Payback Period (PP) and Return of Investment (ROI) as an economic justification approach.

c. Eco Design

Eco Design is a design process in which environmental attributes are treated as design objectives rather than as constraints. It incorporates environmental objectives with minimum loss to product performance, useful life or functionality (U.S. Congress, 1992). It is one of the key elements in design tools especially in the areas of Design-for-X (DFX) such as Design-for-Environment (DFE), Design-for-Recycling (DFR) and Design-for-Disassembly (DFD).

Basically, it is the front-end planning discipline that simultaneously takes into account impacts of design, manufacturing, use and disposal of product on the environment. It covers the wide areas of current design requirements such as health and safety, service life, toxicity, recycled content of manufacturing materials, reuse of products, recyclability of products, energy use, manufacturing wastes and disposal alternatives (ASME, 1994).

Related to these, several approaches have been described in the literature. Rose and Ishii (1999), propose an Internet based tool to guide designers to determine EOL strategies, called End-of-Life Design Advisor (ELDA). Knight and Sodhi (2000) present an analysis of materials separation, which determines the least cost or maximum profit level of materials separation.

Several other Eco Design approaches have been proposed. Viswanathan and Allada (2001), propose a Configuration Value (CV) model to evaluate and analyse the effect of configuration on disassembly. Meanwhile, Ernzer and Wimmer (2002), highlight the quantitative and qualitative methods to reduce the environmental burden of products.

Recently, Xu, Lam and Tang (2004), developed a green design automation system. This is a computational design tool that plays an active part in environmental conscious design and development. Sakita, Mori and Igoshi (2004), propose the functions of computer aided design and simulation systems for the conceptual design of environmentally conscious products.

The literature mentioned above represents the current developments in the area of design tools for the environment taking account of cost/revenue issues. This previous work has been considered when the research team developed the strategic guidance model for product development relating to recycling aspects.

2.3 Current Development Tools used for Strategic Guidance Specifically for ELVs

Basically, there are two factors to influence that development of a Strategic Guidance model; cost and revenue relating to the recycling process. Several approaches to developing Strategic Guidance models for ELVs have been described in the literature. In recent years, research activity related to the recycling activities, has increased dramatically. This is because recycling activities are the key components of the ELV Directive (The European Parliament and of the Council of European Union, 2000).

Generally, there are many economic models that have been developed such as reported by Tipnis (1991). With the introduction of the concept of LCC, in relation with EOL issues, some of the conventional economic models need to be modified in order to fulfil the requirements of an EOL situation; to take account of environmental aspects, disassembly concepts and recycling activities.

In the early 90's, several economic model for recycling activities have been developed. Dieffenbach and Mascarini (1993), examined the cost and value associated with the vehicle recycling infrastructure using a technique called Technical Cost Modelling. It is a computer spreadsheet technique used by IBIS Associates for the simulation of process costs. Using this technique, several alternatives are developed for the recovery of plastics from scrapped vehicles based on varying a vehicle's material mix. This is to determine how best to recover the plastic materials. This model can help a designer to design the component to be more recyclable.

Meanwhile, Low, Williams and Dixon (1998), present the improved models of the economic analysis for manufacturing products with EOL consideration. They consider several options at the end of the first life of a product: resale, remanufacture, upgrade, recycling and scrap. The option model that has been developed is compared with current commercial data and it is then used to generate the empirical constants for elements of each model. The effects of the design changes on the financial impacts of EOL operations have been modelled based on several design alternatives of a telephone. The results, based on the analysis, shows that a strategy that increases recycling operations is likely to reduce the overall net revenue and the effect of the increasing take back costs also contributes to a negative revenue gradient. Johnsons and Wang (1998), introduced a procedure, which integrates economical factors into the scheduling of disassembly operations for Materials Recovery Opportunity (MRO). An MRO is defined as an opportunity to reclaim post-consumer products for recycling, remanufacturing and reuse. The outcome of this study is a determination of the most economical level of product disassembly and the corresponding sequence of disassembly operations. This is in order to improve the current disassembly process by reducing disassembly time and maximising profitability.

Several other Strategic Guidance approaches have been proposed. Veerakamolmal and Gupta (1999) present a technique to analyse the efficiency of designing electronic products for the environment. The efficiency of each design is indicated using Design for Disassembly Index (DfDI) to measure the economic efficiency of the recycling process. This technique involves the analysis of the trade-off between the costs and benefits of end-of-life disassembly to find

the combination of components that provides the optimum cost-benefit ratio for end-of-life retrieval. The cost considerations include the costs of disassembly (labour) and disposal, while the benefit is derived from the sale of recovered components and materials. The index offers a designer an important measure to help improve the future design of products.

Recently, a Strategic Guidance model was developed by Harrison and Blount (2000) and also Vogtlander, Bijma and Brezet (2002). Harrison and Blount developed a new tool for evaluating automotive recyclability in the design process, within a whole life cost methodology. This model has adapted the life cycle analysis techniques to give special consideration for recyclability and costing of alternatives automotive design strategies. Furthermore, this model can assist the automotive designers to design a more recyclable vehicle and incorporates the economic viability of the recycling process at the design stage.

Vogtlander, Bijma and Brezet presents a new model to describe the sustainability of products. This model is called the Eco-cist/Value Ratio (EVR). It comprises of two concepts: the 'virtual eco-cost' as a LCA-based single indicator for environmental impact and the Eco-cist/Value Ratio (EVR) as an indicator for eco-efficiency.

The result of the literature review shows that there is a need for a model for Strategic Guidance for the automotive designers and the recycling industry, in order to successfully implement the ELV Directive. This aspect must be considered and evaluated more rigorously early on in the product design process. This scenario can help the automotive designers to design a more recyclable vehicle and enable economic viability of the recycling process.

3. The Methodology for Strategic Guidance to Optimise recycling in Product Development

The principle of the overall methodology for a Strategic Guidance model can be divided into four stages. These are the business strategy stage, evaluation stage, financial justification stage and the decision stage as shown in Figure 4 below.

i. Business strategy stage

The first step is to set the target of return or indicator for each vehicle or components that has been developed. The target of return or indicator means the value of that particular vehicle or components when its reaches EOL. Coinciding this, the competitors' performance must be analysed in order to produce a concrete strategy. After that, the availability of the facilities must be checked, in terms of technology, infrastructure, operator skills, company facilities and also external partnerships (e.g. recycling company, local authority etc.).

ii. Evaluation stage

This stage evaluates the performance of each facility in terms of process efficiency.

iii. Financial justification stage

This is the most important stage in the development of a Strategic Guidance model. Every single cost involved, such as direct cost and indirect cost must be clearly analysed. This is in order to get the right decision for any investment.

iv. Decision stage

Finally, the investment decision can be decided using the Payback Period method.

The Payback Period method is a logical way of making decisions based upon the probable outcome of various scenarios of action. Uncertainty and choice are attributes of every decision made, with the best option aimed at reducing risks and evaluating the cost and revenue implications of a new investment.

4. Development of Strategic Guidance Model for Value Analysis and Investment Appraisal

The Strategic Guidance model gives the user a clear idea of what is being considered, together with the specification of all assumptions made, combined with the rational behind all assumptions. The estimates of all expected costs such as direct and indirect associated with the recycling process is clearly identified as shown in Figure 5.

The model encompasses two main analyses: value analysis and financial analysis. The main objective of the proposed model is to be a vehicle design advisor. Although it can also be used to assist more strategic management decisions concerning recycling; as it provides a tool for measurement of business performance, in the recycling area, if a business is planning for investment in that area in the future.

The first path of the framework is Value Analysis for EOL as a design assessment tool. Details of this analysis are reported by Mat Saman et al. (2004) and are shown in Figure 6.

The outcome of this analysis is to determine the performance of the current design. This performance is given an indicator. In addition, the total operating cost and total revenue can also be determined.

There are six steps in the proposed framework of the value analysis, which encompasses three main principal operations as summarised in Table 3. Basically, three principal parameters will be considered in the proposed framework, i.e. reuse (including remanufacturing and reconditioning aspects), recycling for high-grade materials and also low-grade materials,

recovery and waste analysis. The detailed analysis for each parameter is based on the unit weight of the automotive components. When the initial analysis has been done, the measurement parameters can be determined based on costs and revenues. In this case, there are three measurement parameters; acquisition (purchase, handling and fee processes), dismantling (reuse, remanufacturing, reconditioning and de-pollution processes) and also shredding (recycling, recovery and waste processes).

Finally, the measurement parameters will be translated into a total indicator to show the ELV performance of the design process for each component or the whole vehicle. The indicator shows the performance of the current design when that vehicle, or its components, reaches end-of-life (EOL). The reference point here is zero. That means, at EOL there is no value for that particular design. The best value here is a positive value. The concept used is that the biggest value of the indicator is the best design. So, this value can be used in order to improve the future design.

Meanwhile, the total operating cost and total revenue will be produced when considering the capacity of the facilities for processing ELV per year. Based on these two values, the net profit can be determined. The second path is a development of financial analysis for strategic guidance and the development of an advisory mode to achieve a defined return. The purpose of this analysis is to determine the total investment cost to build-up a recycling facility. Based on the total investment cost and net profit, the investment appraisal can be evaluated using a payback period method. In the calculation of the investment appraisal, it assumed that there will be a 100% utilisation of each facility for the products being analysed.

5. Case Study

As the case study an ELV is chosen. In general, the steps in Figure 5 are followed. It can be divided into two analyses, value analysis and financial Analysis. Value analysis calculation is based on the steps in the Figure 6. A financial analysis is done by using a payback period method.

1) Value analysis

Step 1: General Characteristics of the ELV

The first step is to determine the general characteristics of the ELV. This information is very important for the general overview of the case study. The general characteristic of the ELV which are analyzed is as follow.

Vehicle = Jaguar

Total weight = 1576 kg/ ELV

Part = Whole vehicle

Income of vehicle = £35/ ELV

Analyses = Current design

Step 2: Determination of the Reused Content

The objective of this step is to determine the preliminary estimates for the reused analysis. This step is divided into 5 sub steps.

A. General Information of the ELV

Quantity of the ELV's (unit) = 1

Quantity of the ELV's (kg) = 1576

Average % of part studied = $(1576/1576) \times 100\% = 100\%$

B. Content Based Material Categories of Original ELV

Quantity of ferrous materials (kg)	=	1017.50
Quantity of nonferrous materials (kg)	=	187.10
Quantity of plastic materials (kg)	=	180.00
Quantity of high value materials (kg)	=	37.20
Quantity of others materials (kg)	=	84.00
Quantity of electrical materials (kg)	=	21.40
Quantity of hazardous materials (kg)	=	48.80
Total	=	1576

C. Fraction of Components or Parts Recovered

Expected % of reused components or parts = 25

Expected % of recycled components or parts = 75

D. Nominal Mass of Components or Parts

Reused components or parts (kg) = Expected % of reused components or parts x Total weight of part (kg) = 25% x 1576 = 394

Recycled components or parts (kg) = Expected % of recycled components or parts x weight of part (kg) = 75% x 1576 = 1182

E. Content Based Categories of Reused Components or Parts

Quantity of components or parts (original) (kg) = 294

Quantity of components or parts (remanufacture or reconditioning) (kg) = 100

Step 3: Determination of the Recycled Contents

After the reused components or parts have been determined, the balance goes to the recycling analysis. The details of this step are as follows:

F. Content Based Material Categories of Recycled Components or Parts

Quantity of ferrous materials (kg)	=	890.5
Quantity of nonferrous materials (kg)	=	107.10
Quantity of plastic materials (kg)	=	60
Quantity of high value materials (kg)	=	0
Quantity of low value materials (kg)	=	75.60
Quantity of hazardous materials (kg)	=	48.80
Total (kg)	=	1182

G. Fraction of Materials Recovered

Expected % of ferrous materials = 95

Expected % of nonferrous materials = 95

Expected % of plastic materials = 0

Expected % of high value materials = 0

Expected % of low value materials = 0

Expected % of hazardous materials = 100

Resulting % of wasted materials = 100

H. Nominal Mass of Materials

Ferrous materials (kg) = Expected % of ferrous materials x Quantity of ferrous materials (kg) = 95% x 890.5 = 845.975

Nonferrous materials (kg) = Expected % of nonferrous materials x Quantity of nonferrous materials (kg) = 95% x 107.10 = 101.745

Plastic materials (kg) = Expected % of plastic materials x Quantity of plastic materials (kg) = 0% x 60 = 0

High value materials (kg) = Expected % of high value materials x Quantity of high value materials (kg) = 0% x 0 = 0

Low value materials (kg) = Expected % of low value materials x Quantity of low value materials (kg) = 0% x 75.60 = 0

Hazardous materials (kg) = Expected % of hazardous materials x Quantity of hazardous materials (kg) = 100% x 48.80 = 48.80

Waste materials (kg) = 1182 - (845.975 + 101.745 + 48.80) = 185.47

Step 4: Determination of the Recovery and Waste Contents

There are two possibilities here for the ELV; either going to the landfill as waste or to be used for a useful purpose such as energy recovery, road surfacing etc. The weight of the ELV to be land filled or used for another purpose is determined here.

I. Fraction of Waste Materials Recovered

Expected % of landfill = 100

Expected % of useful purpose = 0

J. Nominal Mass of Waste Materials

Landfill = Expected % of landfill x Waste materials (kg) = 100% x 185.47 = 185.47

Useful purpose = Expected % of useful purpose x Waste materials (kg) = 0% x 185.47 = 0

Step 5: Value Analysis

This step has been developed based on the three main analyses. There are acquisition analysis, dismantling analysis and also shredding analysis. Each part of the analysis has data for the costs and also revenues for every process, every component or every material involved. Based on that, the return for each analysis can be calculated.

*K. Acquisition**Acquisition Data:*

a. Cost of buying EOL vehicle (£/vehicle) = 30

b. Payment from vehicle manufacturer or local authority (£/vehicle) = 35

Acquisition Cost:

Proportion for new vehicle (£) = 27

Total acquisition cost (£) = 27

3. Acquisition Revenue

Proportion for new vehicle (£) = 3.5

Total acquisition revenue (£) = 3.5

Total profit of acquisition (£) = Total acquisition revenue (£) - Total acquisition cost (£) = 3.5 - 27 = -23.5

*L. Dismantling**Data of the Dismantling Process*

Cost of dismantling processes (£/kg) = 0.05

Cost of disposing of hazardous materials (£/kg) = 0.10

Market price of spare part components (original) (£/kg) = 0.20

Market price of spare part components (remanufacture or reconditioning) (£/kg) = 0.10

Costs of Dismantling Process

Dismantling processes (£) = Cost of dismantling processes (£/kg) x Reused components or parts (kg) = 0.05 x 394 = 19.7

Disposing of hazardous materials (£) = Cost of disposing of hazardous materials (£/kg) x Nominal mass of hazardous materials (kg) = 0.1 x 48.8 = 4.88

Total Dismantling Cost (£) = Cost of Dismantling processes (£) + Cost of disposing of hazardous materials (£) = 19.70 + 4.88 = 24.58

Revenue of Dismantling

Spare parts components (original) (£) = Market price of spare part components (original) (£/kg) x Quantity of components or parts (original) (kg) = 0.20 x 294 = 58.8

Spare parts components (remanufacture or reconditioning) (£) = Cost of disposing of hazardous materials (£/kg) x Quantity of components or parts (remanufacture or reconditioning) (kg) = 0.10 x 100 = 10

Total Revenue of Dismantling (£) = Revenue of spare parts components (original) (£) + Revenue of spare parts components (remanufacture or reconditioning) (£) = 58.8 + 10 = 68.8

Total Profit of Dismantling = Total Revenue of Dismantling - Total Dismantling Cost = 68.8 - 24.58 = 44.22

*M. Shredding**Data of Shredding*

Cost of shredding processes (£/kg) = 0.05

Cost of disposing of waste (landfill cost) (£/kg) = 0.01

Market price of ferrous materials (£/kg) = 0.12

Market price of nonferrous materials (£/kg) = 0.22

Market price of plastic materials (£/kg) = 0.10

Market price of the other materials (£/kg) = 0.01

Market price of waste materials for useful purpose (£/kg) = 0.04

Costs of shredding

Shredding processes (£) = Cost of shredding processes (£/kg) x Total of Content Based Material Categories of Recycled Components or Parts = $0.05 \times (890.5 + 107.10 + 60 + 0 + 75.60 + 48.8) = 59.10$

Disposing of waste (landfill cost) (£) = Cost of disposing of waste (landfill cost) (£/kg) x Nominal mass of waste materials (kg) = $0.01 \times 185.47 = 1.8547$

Total Cost of shredding (£) = Cost of shredding processes (£) + Cost waste disposal (landfill cost) (£) = $59.10 + 1.8547 = 60.95$

Revenues of shredding

Ferrous materials (£) = Market price of ferrous materials (£/kg) x Nominal Mass of Ferrous materials (kg) = $0.12 \times 845.98 = 101.52$

Nonferrous materials (£) = Market price of nonferrous materials (£/kg) x Nominal mass of nonferrous materials (kg) = $0.22 \times 101.75 = 22.39$

Plastic materials (£) = Market price of plastic materials (£/kg) x Nominal mass of plastics materials (kg) = $0.10 \times 0 = 0$

Other materials (£) = Market price of other value materials (£/kg) x Nominal mass of other materials (kg) = $0.01 \times 0 = 0$

Total Revenue (£) of shredding = Revenue of ferrous materials (£) + Revenue of nonferrous materials (£) + Revenue of plastic materials (£) + Revenue of other materials (£) = $101.52 + 22.39 = 123.91$

Total Profit of Shredding (£) = Total revenue of shredding – Total cost of shredding = $123.91 - 60.95 = 62.96$

Step 6 Indicator

After completing an analysis in step 5, the grand total of the return for acquisition, dismantling and also shredding can be calculated. This value is called as the indicator

N. Grand Total of K + L + M = Total profit of acquisition (£) + Total profit of dismantling + Total profit of shredding (£) = $-23.5 + 44.22 + 62.96 = 83.67$ (Indicator)

2) Financial Analysis

In the financial analysis, it is assumed that the capacity of the recycling company is 1000 ELV/ year. So that the profit generated by the company is about $83.67 \times 1000 = 836700$ / year. The details of the investment invested by the company are as follows:

Investment	Quantity	Cost (£)/ unit	Investment Cost (£)
Land and Building			2,200,000
Weighbridge	1	60,000	60,000
Environment lock	1	100,000	100,000
Forklift	5	20,000	100,000
Dismantling equipment	1	600,000	600,000
Truck	3	90,000	270,000
Crusher	1	30,000	30,000
Container/skip	10	2,000	20,000
Engine hoist	5	500	2,500
Trolley jack	5	300	1,500
Skip loading	1	15,000	15,000
Total			3,399,000

Payback period (year) = $(3399000 / 836700) / \text{year} = 4.06$ years

7. Results and Discussion

Based on the result of the case study, it shows that, normally, the company is paid £35/vehicle, although (according to a UK recycler) currently only 10% of the time this situation happens. Besides that, if the owner sends the ELV to the recycling company, the company will pay £30/vehicle. Based on that data, the total cost and total revenue per vehicle

are £27.00 and £3.50 respectively. Then, the return for the acquisition process is -£23.50. That means the acquisition process is currently not profitable to the company.

The return for the dismantling process is £44.22/vehicle. For the shredding process, the return is £62.96/vehicle. Both of these processes give some profit to the company. The grand total is £83.67/vehicle. It shows that the current design of the vehicle is valuable when it reaches EOL. This value can be used as an indicator for the future design of the vehicle.

The result from the value analysis will be transferred into the financial analysis for the investment appraisal. In the financial analysis, it is assumed that, the capacity of the recycling company is 10000 ELV/year. The company generates a net of £836700/year. Meanwhile, the total investment for the whole site is £3399000. So based on this data, the payback period is calculated around 4.06 years.

8. Conclusions

The Strategic Guidance model presents a design assessment for the recyclability of a vehicle at the initial design stage. It assists automotive designers to identify the performance of the current design in terms of costs and revenue at EOL. The result from the analysis can also be used as guidance tool in order to improve the performance of the vehicle design in terms of recyclability aspects and at the same time to fulfil the ELV Directive. Besides that, the strategic guidance model is an advisory tool to a recycling company in order to determine a defined return.

The case study presented shows that the current design of that product has some value for recyclability. The detailed analysis highlights the performance of the investment in the recycling areas. The developed model is a tool to increase interaction between automotive designers and the recycling companies and also as a foundation for investment strategy for both types of business.

However, a further study will be carried-out in the development of a methodology for design improvement. This is to provide a guidance and justification on how the vehicle components should be developed.

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Table 1. Summary of the ELV Directive (The European Parliament and of the Council of European Union, 2000, 2002, 2005a, 2005b, 2005c, 2008)

Year	Event
2000	EU Directive on ELV was signed by the European Parliament and Council of Ministers
2002	Free of charge take back of new cars
2003	Use of certain heavy metals forbidden: Cd, Cr(VI), Hg, Pb
2005	Type approval: OEMs have to prove that car meets 2015 recycling/recovery quotas
2006	Dismantlers have to meet following quotas: $\geq 80\%$ recycling, $\leq 5\%$ energy recovery, $\leq 15\%$ landfill
2007	Free of charge take back of all ELVs
2015	Dismantlers have to meet following quotas: $\geq 85\%$ recycling, $\leq 10\%$ energy recovery, $\leq 5\%$ landfill

Table 2. Recycling targets for the type-approval of new vehicles (The European Parliament and of the Council of European Union, 2000, 2002, 2005a, 2005b, 2005c, 2008)

Year	Targets for the type-approval of new vehicles	
1.1.2005	Reused and Recycling	85% by weight per vehicle
	Reused and Recovery	95% by weight per vehicle

Table 3. Summary of the main elements in the proposed framework

Operation	Description
I	ELV Background
	Step 1: General Characteristics of the ELV
II	Preliminary Estimates
	Step 2: Determination of the Reused Contents
	Step 3: Determination of the Recycled Contents
	Step 4: Determination of the Recovery and Waste Contents
III	ELV Indicator
	Step 5: Value Analysis
	Step 6: Determination of an Indicator

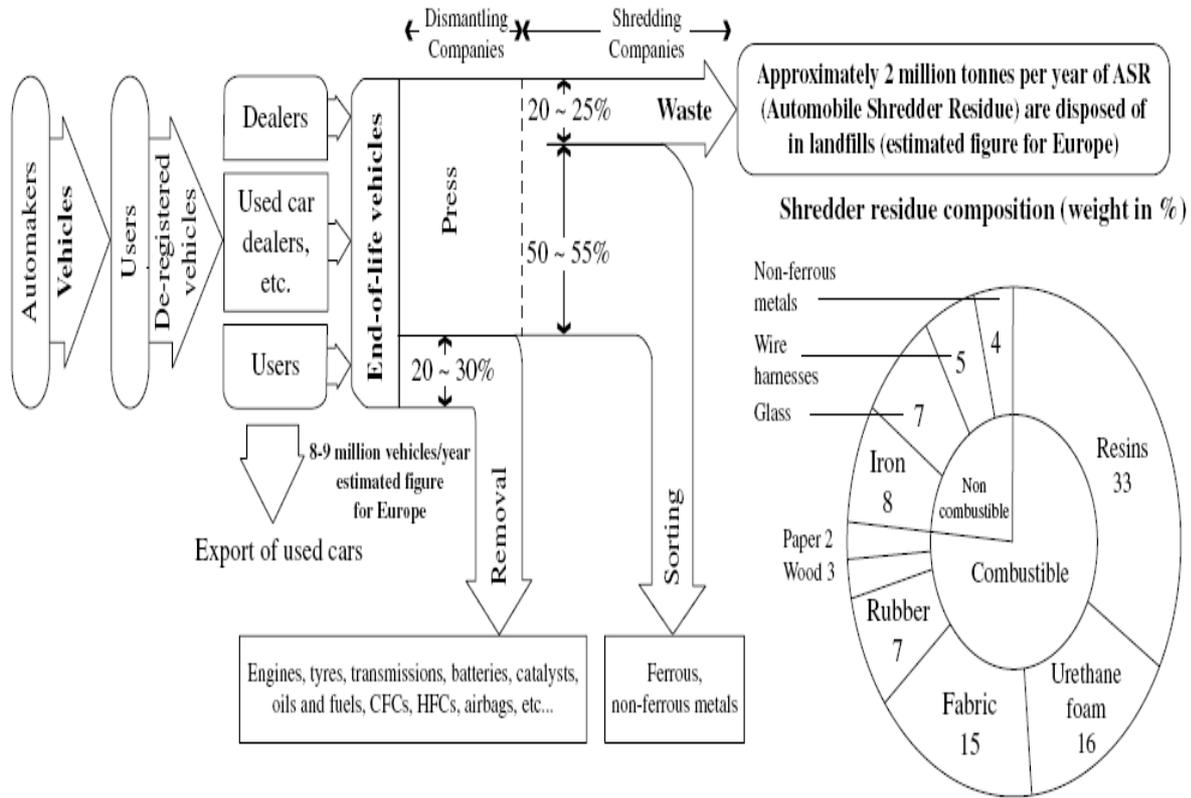


Figure 1. End-of-life vehicle recycling process

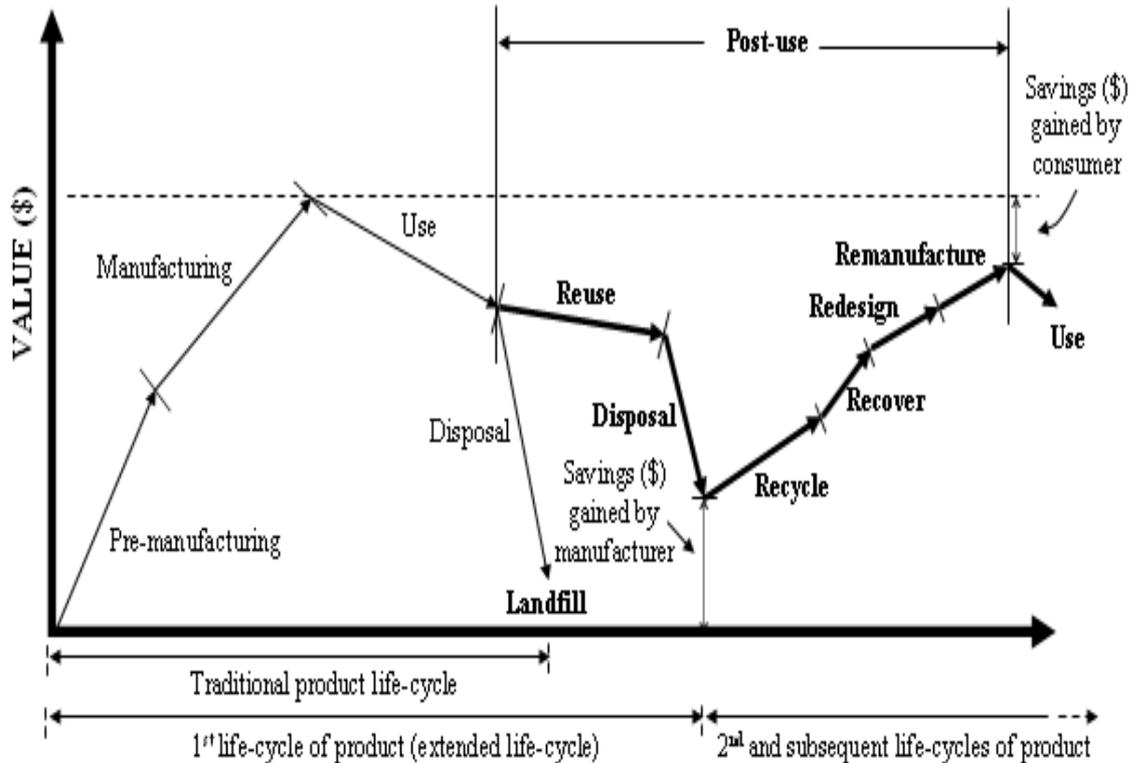
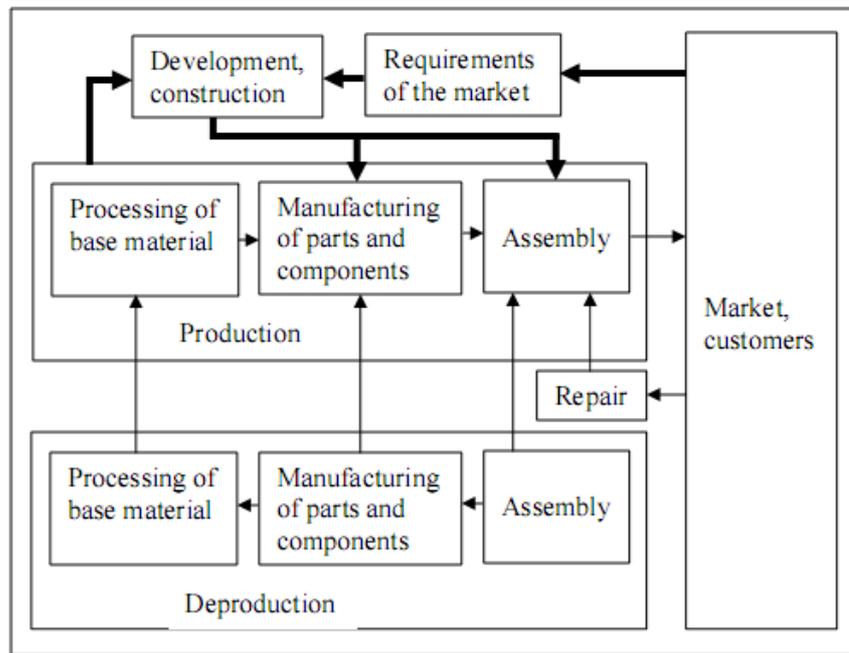


Figure 2. Product value gained from 6R (Joshi, Venkatachalam and Jawahir, 2006)



Note: **→** Information flow **→** Material flow
 Figure 3. The flows of the costs and revenues in LCC (Westkemper and Osten-Sacken, 1998)

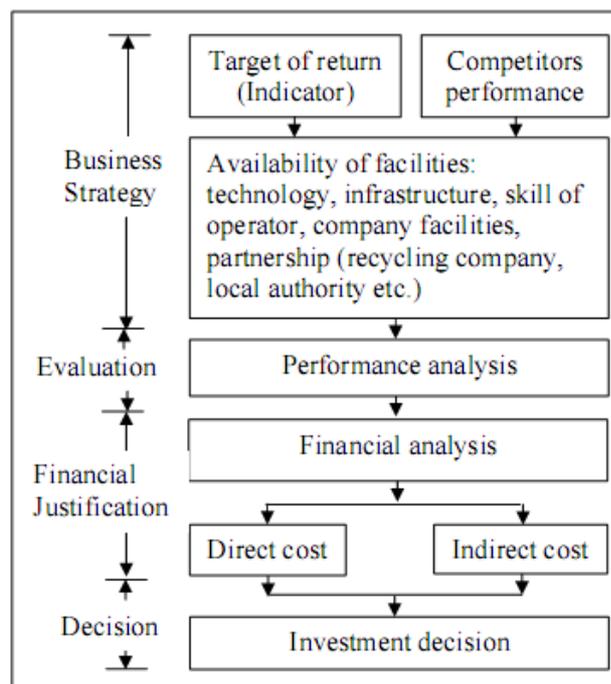


Figure 4. Principles of the study methodology for Strategic Guidance Model

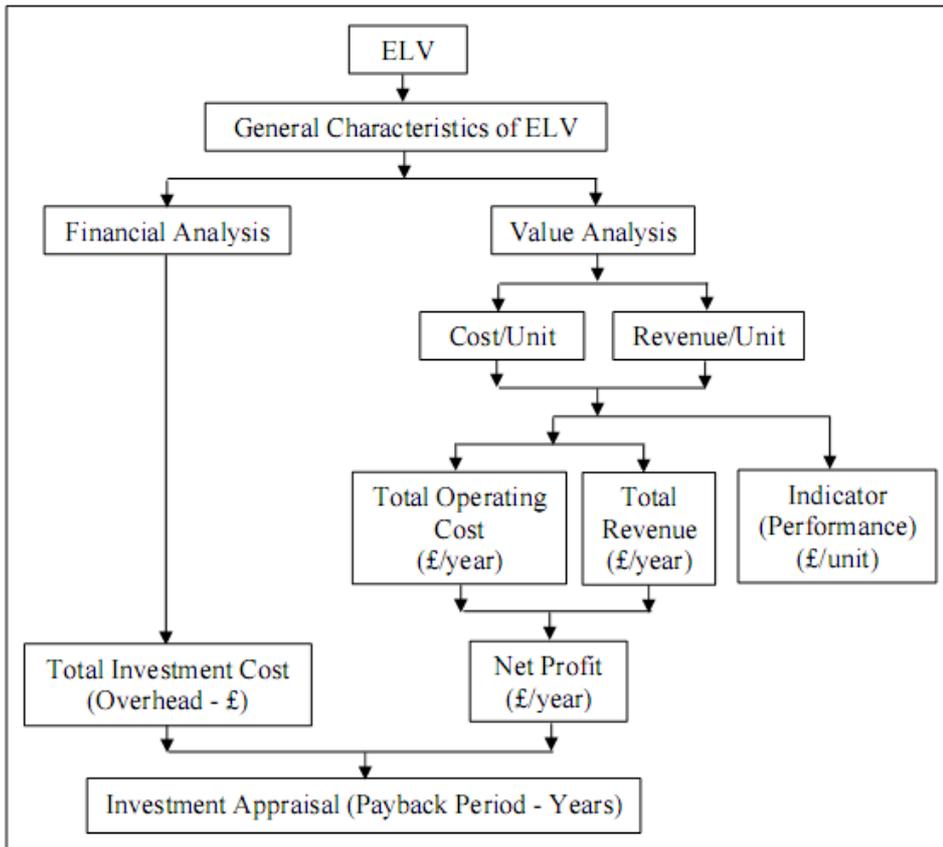


Figure 5. Strategic Guidance model

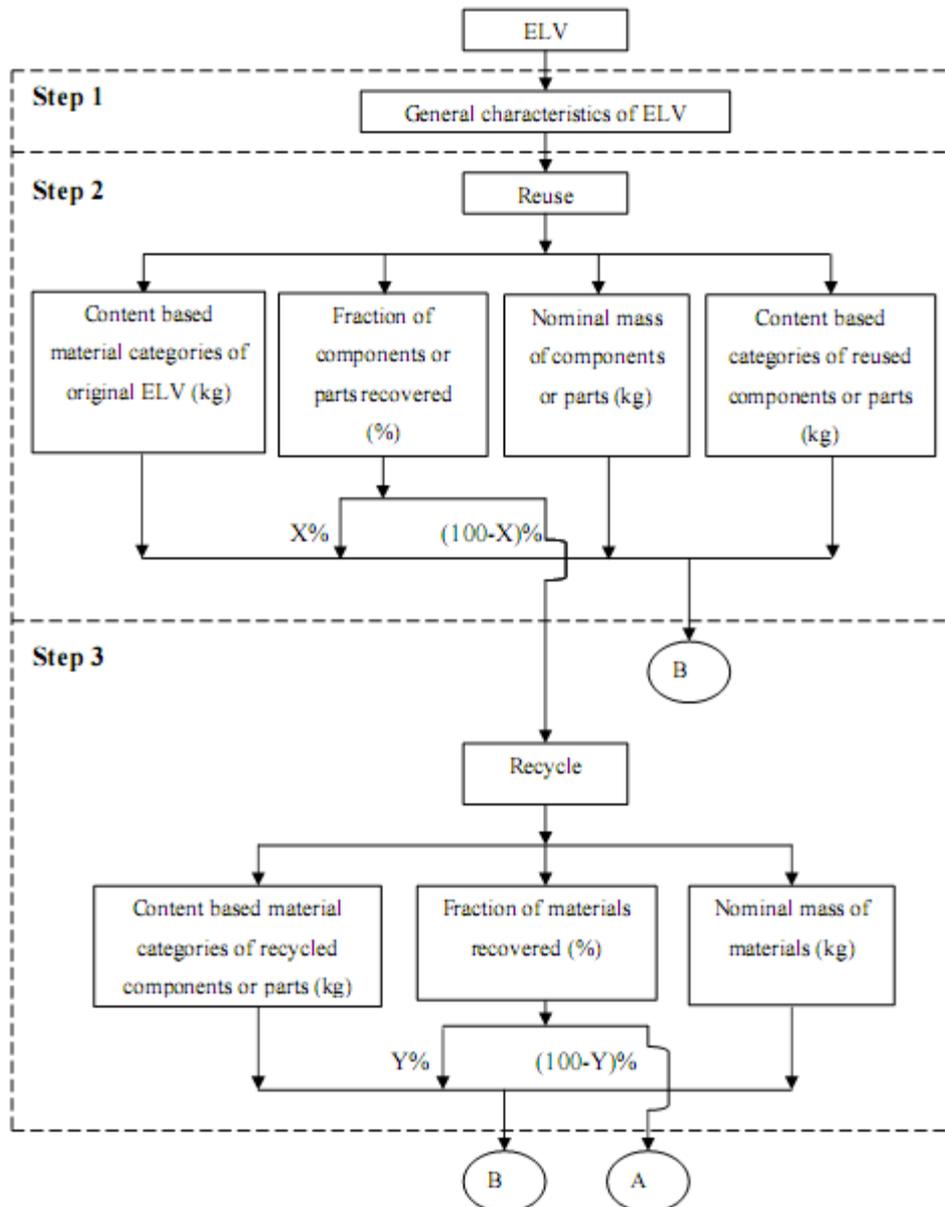


Figure 6. Framework for value analysis (continued overleaf)

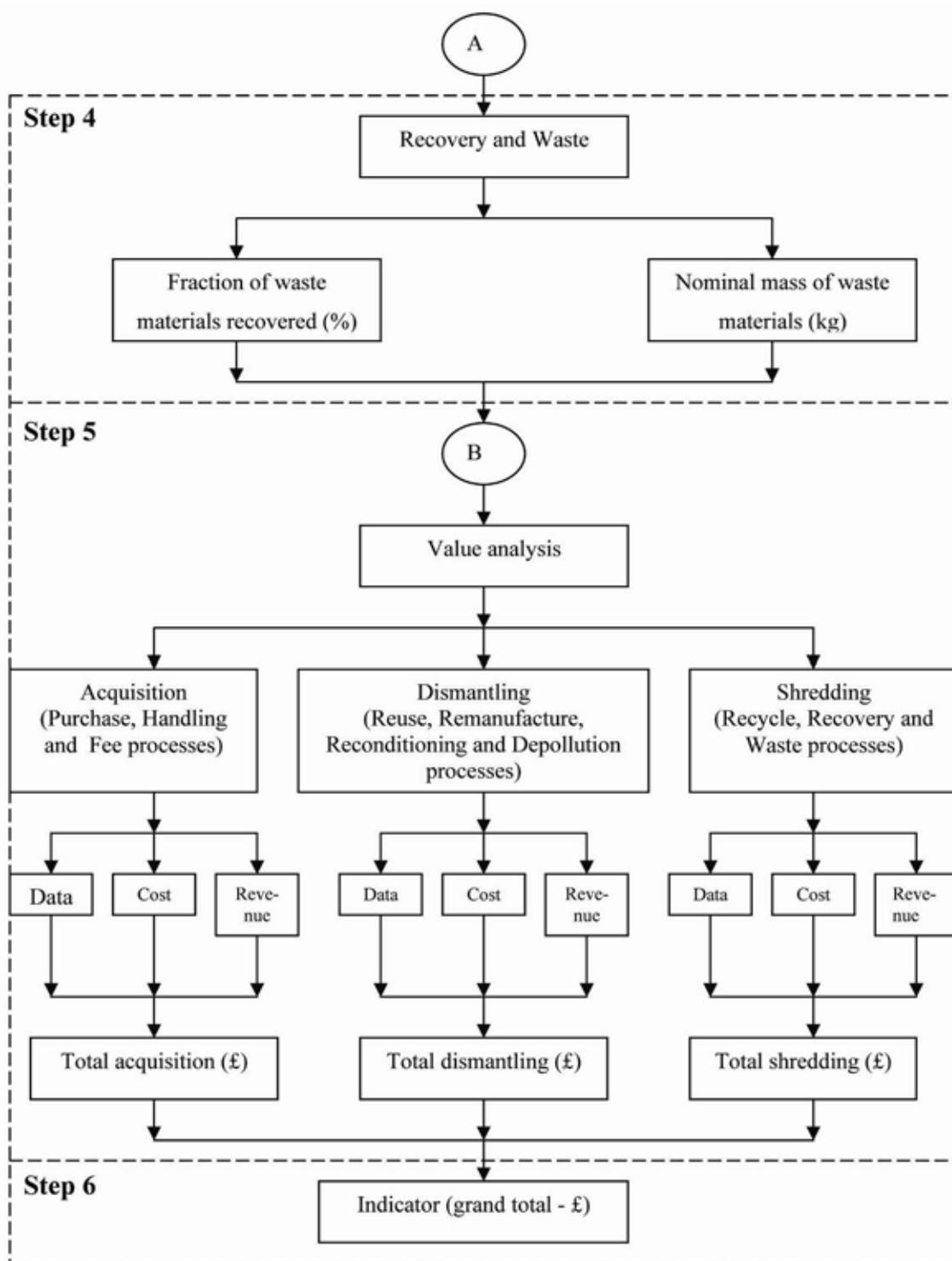


Figure 6. Framework for value analysis



Determining Suitable Probability Distribution Models for Annual Precipitation Data (A Case Study of Mazandaran and Golestan Provinces)

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Abstract

Statistical distributions can be used for data development in shortage data situations, as in many parts of Iran station. The aims of this study are to select the best frequency distribution to estimate average annual precipitation and assess the effects of data length on the selection of suitable distribution. Therefore 65 stations data of Mazandaran and Golestan provinces were analyzed. Relative residual mean square (RMS) was used to determine the best fitted distribution to any annual series and precipitation was estimated for different return periods. Relative frequency of first classes of fitted distributions showed that normal and Pearson distributions fitness decreased and Gumbel distribution had more fitness with data series by increasing statistical period length. The best-fitted distribution is Pearson with 15-year data; log Pearson for 20, 25 and 30-year periods. Based on Moment method and total given scores, two-parameter normal distribution has the best fitness in all statistical periods.

Keywords: Annual precipitation, Mazandaran, Golestan, Frequency distribution, Relative Residual Mean Square

1. Introduction

Precipitation is a key component of the hydrological cycle and one of the most important parameters for various natural and socio-economic systems: Water resources management, agriculture and forestry, tourism, flood protection, to name just a few (Schmidli, 2005). The study of consequences of global climate change on these systems requires scenarios of future precipitation change as input to hydrologic cycle. Hydrological and meteorological data show no random behavior. Then they can be analyzing by some statistical methods based on frequency analyses of precipitation and flood data. Therefore, statistical distributions can be employed for the studies such as the design of water structure, the management of water resource and watershed, and the determination of effective factors about hydrologic cycle. However, it is necessary to determine the best-fitted distribution to studied data. The primary aim of frequency analysis is to relate the magnitude of extreme events to their frequency of occurrence using the probability of distributions (Chow et al., 1988). The aim of this study is to determine suitable probability of distribution models for annual precipitation data in study area. Seven well-known probable distributing models including two-parameter standard normal, two-parameter log normal, three-parameter log normal, two-parameter gamma, Pearson type III, log Pearson type III and Gumbel with moment and maximum likelihood parameters which are tested to determine the best fitted distributions as well as precipitation in different return periods.

In Iran and other countries, many hydrologist and other experts have analyzed precipitation data. Mashayekhi (1972) considered Iran precipitation as normal distribution. Khalili (1973, 1976) studied 90-year Tehran precipitation data and 10-year central Alburz precipitation data and indicated credibility of gamma distribution. After investigating probability density function of monthly and yearly precipitation data of oldest station of Iran, Haghghatjou (2002) found that log Pearson type III is the best-fitted distribution to monthly data and there are no suitable distributions for yearly precipitation. After investigating of probable suitable distributions for meaning, maximizing and minimizing discharges in Mazandaran hydrological stations, Gholami (2000) concluded that more stations Gumbel distributions (L-moment method) and three-parameter log normal (moment method) had the most fitness for maximizing and minimizing annual discharges, as well as Gumbel (L-moment) for meaning and minimizing annual discharges. Bedeustani (1999), performed a study in the east Azarbayjan, indicated that although there was no suitable distribution for discharging estimation in short term, three-parameter log normal distribution and then log Pearson type III distribution showed more fitness with data series by increasing statistical period length. In addition, for maximizing precipitation in short and long terms, three-parameter log normal and three-parameter log normal along with log Pearson type III distributions were suitable, respectively. Markovich (1965) used minimum Square method for flowing assessment and concluded that gamma distribution had the best fitness among other distributions. Keshtkar (2001, 2006) compared moment and L-moment Methods to determine the probability of distributing parameters and suitable distributin for annual discharge series. 20 and 17 hydrometric station was chosen for meaning, maximizing and minimizing annual discharges and maximizing peak discharges respectively. In the central plateau watershed, the best fitted distribution for different annual discharges was studied. Results showed the best fitted distributions: for minimum discharges: Pearson distribution type III (L moment method); for Medium annual discharges: Pearson type III and Log Pearson type III distributions (L moment method); for Maximum annual discharges: Pearson type III (L moment method), Log Pearson type III and two-parameter Log normal (moment method) distributions; for Maximum annual momentous discharges: Log Pearson type III (moment), Pearson type III, three-parameter Log normal and two-parameter Log normal (L moment method) distributions. Dinpashoh (2004) studied the regionalization of Iran's precipitation climate by using Data from 77 synoptic stations in Iran. After selecting twelve variables from the 57 candidate variables, using Procrustes Analysis, the selected variables used to regionalize Iran's precipitation climate by factor analysis and clustering techniques. The H and Z-statistics, which were based on the L-moment technique, were used to test the homogeneity of each region and selected the distribution which best-fitted annual precipitation records- in that region. The countrywide area was divided into six regions with homogeneous and one with heterogeneous precipitation climates. They demonstrated Southern coastal of Caspian Sea as B homogeneous region i.e. the best-fitted distribution for annual precipitation records in that region of Generalized Logistic.

Tase (1982) assessed 50-year precipitation data of 82 meteorological stations in Japan and considered normal distribution for these data. Reich (1983) indicated monthly precipitation as a function of Gumbel distribution based on 15-year data. Based on results of a research conducting in the Seyhan river basin in Turkey (Topaloglu, 2002), Gumbel, log-Logistic, Pearson type III, log-Pearson type III and log-normal-3 distributions were applied to the series of annual instantaneous flood peaks and annual peak daily precipitation for 13 flow gauging and 55 precipitation gauging stations. According to the evaluations of chi-squared tests, Gumbel (the moments methods) for both hydrological and precipitation stations were founded to be the best models. Based on the K-S test, log-normal-3 (the moments methods) and log Pearson type III (the moments methods) models were determined to be the best for hydrological and precipitation stations, respectively. Dahamsheh et al (2007) described the structural characteristics and temporal and spatial variation of annual precipitation data in Jordan, together with possible projections for the future and using the probability distribution. Based upon their results, annual precipitation in Jordan was consistent in time with evidence of randomness. Finally they identified three distinct regions as 3-parameter lognormal distribution in the east, gamma distribution in the south and log-Pearson Type III distribution in the remainder of the country. Based on the chi-square goodness of fit test, Campbell (1981) found that the log Pearson type III distribution was the best distribution for culvert design in small-forested watersheds. Whereas Gumbel distribution with L-Moment method has been found to be a suitable distribution for peak flows by Gingras and Adamowski(1992), Pilon, and Adamowski (1992), Wallis(1988).

2. Method and Materials

The basin of Caspian Sea Rivers is located in the north slope of central Mountains and stretched along shore from Sefidrood delta to Bandar gaz. It is limited to Sefidrood watershed from the west, Central Basin from the south, Semnan and Khorasan basin from southern east and the Caspian Sea from the North. General patterns of atmospheric circulations over the Caspian Sea are controlled by the Eurasian High and Low Pressure Cells (Iceland Low, Indian Low, Azores High, Siberian High and Central Asian High; Lahijani, 2007). The Iranian coast has a sub-tropical climate and a rainfall pattern shows a strong gradient from west (around 1900mm in Anzali) to east (around 196mm in Hassan Gholi). Distribution of rainy weather is uniform throughout the year on the coast. The of average relative humidity is mostly above 75%. Mean summer temperature is around 26 1C, with fewer than 30 snowy and freezing days during the year (Lahijani, 2007).

In this study, precipitation-gauging data from stations of Golestan and Mazandaran provinces has used to investigate fitness of statistical distributions (figure 1).

Totally, a 30-year (1972-2001) common period data of 65 stations have been selected based on statistical period length and closeness to present time. After analyzing the outliers by U.S. Water Resources Council method (1981), the missing data has been completed by normal ratio method (Mahdavi, 2002) with attention to available number of years. Furthermore the homogeneity of data was tested by Double Mass Curve and Runs tests (Mahdavi, 2002).

Using HYFA (Hydrological Frequency Analysis) program, the best-fitted statistical distribution is determined for each station in periods of 15, 20, 25 and 30-year. In HYFA application, goodness of fit of relative residual mean square and chi-square test has been used and the parameters of the distributions were estimated by the methods of moments and maximum likelihood methods.

In this study, normal, two-parameter log-normal, three-parameter log-normal, Gumbel, two parameter gamma, Pearson type III and log Pearson type III distributions have been used (more information about distribution calculations are available in Applied Hydrology book, Mahdavi,2002 and Betül S thesis). After selecting the best-fitted distribution, it is possible to estimate mean annual precipitation for return periods of 2, 5, 10, 20, 25, 50, 100, 500 and 1000 year. By analyzing relative residual mean square and chi-square test tables (in HYFA output) in different time series (15, 20, 25 and 30-year), the best-fitted distributions ranked. Then scores 7-1 has been given to any distribution respectively, based on priority of them. Finally, the best-fitted probability of distribution selected by relative frequency of first classes (by analyzing the best-fitted distribution in any station) and total given scores for each statistical distribution.

3. Results

In HYFA software, using deviation table and volumes of relative residual mean square, the best statistic distribution, that has the least deviation, has been selected and introduced as the best-fitted distribution to data. Then in this distribution, by attending to determine average and occurrence probability (or return period) relating curve can be drawn. By this curve, volumes of considered variety with certain return period can be determined. HYFA output presents some of the statistical characteristics such as mean, standard deviation, variance, skewness, etc. Some statistical characteristics of 30-year data were tabulated in Table 1 and location of the studied stations depicted in fig. 1.

Obtained scores of distributions indicated that in all stations, there is no apparent predominance for any distribution (confirms with results of Haghghatjou study). In all stations, relative frequency of first Score of the best fitness in four assessed period changes as figures 2 & 3.

Based on the sum of given Scores to each distribution, in Moment method, two-parameter Log-normal distribution for four statistical periods was the most suitable distribution. As well as in Maximum likelihood method, by increasing the period length, Pearson, gamma, three-parameter log-normal and log Pearson type III have the best fitness with scores of 216, 210, 225 and 219 respectively (table 2 & 3).

Relative frequency of first classes and separated investigation of two methods used to estimating distributions parameters introduce Gumbel and normal (moment method), gamma and Pearson distributions (Maximum likelihood method) for 15-year period, log Pearson, Pearson, gamma and Gumbel distributions (Maximum likelihood method) for 20-year period, log Pearson, Pearson and gamma distributions (Maximum likelihood method) for 25-year period and log Pearson and gamma distributions (Maximum likelihood method) for 30-year period as the best fitted models.

According to the relative frequency of the best fitted distribution and comparative investigation of two methods used to estimating the parameters of distributions, the best fitted distributions are Pearson and normal ones (moment method) for periods of 15-year, log Pearson, gamma and normal distributions (moment method) for 20-year, log Pearson, Pearson and normal distributions (moment method) for 25-year and log Pearson, gamma and normal distributions (moment method) for 30-year.

4. Discussion and Conclusion

Based on obtained Scores of distributions in all stations, there is no apparent predominance for any distribution (confirms with results of Haghghatjou study). Therefore, it is more important to select the frequency distribution to estimate the value of annual precipitation data based on the best-fitted distribution for any region.

The changes in statistical period length in studied stations changes the best fitted distribution for 88 percent of stations and only 8 stations have no changes in the best fitted distribution (Table 4) that indicated relatively high variability of annual precipitation and insufficient data. It indicated the importance of appropriate distributing of station and the need to use the more data for researches.

Based on total given scores, two-parameter normal distribution has the best fitness in all statistical periods. Totally, it is noticed that by increasing statistical period length, normal and Pearson distributions are decreased and Gumbel distribution has more fitness with data series, based on relative frequency of the best-fitted distributions. Superiority of Pearson distribution in 15-year periods changed as log Pearson for 20, 25 and 30-year periods that maybe a result of

data short period or occurrence of extreme events (i.e. drought and wet year). Period length also effects skewness, standard deviation and distribution parameters. Therefore completing the gages and regular data collection has a significant role in hydrological data analysis. Having a long-term data also can be effective in appropriating interpretation of extreme hydrological events (i.e. drought and wet years) occurrence.

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Table 1. The statistical characteristic of given station data and location of the station.

Station	Annual precipitation Average (mm)	St. deviation	Skewness	Coefficient of variation
Inchehbroon	206.60	51.37	0.01	0.25
Ghaleh Jigh	351.75	87.45	0.50	0.25
Ghazanghayeh	264.09	87.10	-0.21	0.33
Maraveh Tappeh	347.29	80.41	1.03	0.23
Torshakly	214.27	68.45	0.51	0.32
Hootan	273.92	71.41	0.36	0.26
Tangrah	679.86	120.81	0.77	0.18
Tamr	503.54	124.26	0.78	0.25
Galikesh	759.27	193.21	1.38	0.25
Gonbad Kavooos ,	413.46	94.88	0.75	0.23
Lazooreh	864.96	184.59	1.21	0.21
Bahlakeh Dashli	427.32	97.08	0.78	0.23
Pas poshteh	960.18	214.79	0.74	0.22
Nodeh	825.63	172.06	-0.12	0.21
Araz Kooseh	449.67	81.73	0.80	0.18
Ghazaghly	359.89	78.46	0.06	0.22
Sad Gorgan	344.43	87.40	0.69	0.25
Tirtash	565.24	118.65	0.63	0.21
Salian Tappeh	332.22	70.67	0.60	0.21
Shilat Tazeh Abad	596.75	348.50	1.69	0.58
Taghi Abad	592.53	106.72	0.81	0.18
Nahar Khoran	750.51	192.57	0.61	0.26
Jafa Kandeh	490.43	136.23	1.48	0.28
Til Abad	253.30	70.79	0.24	0.28
Siah Ab	490.60	98.82	0.52	0.20
baghoo	548.95	115.32	0.33	0.21
Fazel Abad	678.58	95.95	-0.16	0.14
GHafar hajee	443.22	91.79	0.33	0.21
Barkola	475.30	96.02	-0.26	0.20
Abloo	711.07	203.24	1.55	0.29
Afrachal	834.09	384.61	1.17	0.46
Darabkola	751.01	171.47	0.41	0.23

Continued: Table 1.

Station	Annual Precipitation Average (mm)	St. deviation	Skewness	Coefficient of variation
Solaiman Tangeh	584.34	161.99	1.72	0.28
Rig Cheshmeh	750.03	146.97	0.67	0.20
Kord Khail	672.07	155.00	0.60	0.23
Shirgah	964.99	218.47	-0.33	0.23
Kiakola	670.99	184.67	0.07	0.28
Arab Khail	770.1	126.38	-0.09	0.16
Ghoran Talar	1074.26	244.84	0.60	0.23
Babol	656.8	148.34	0.53	0.23
Mian Dasht	798.06	165.56	0.46	0.21
Larim	732.47	149.83	0.55	0.20
Naharestagh	400.29	106.41	0.01	0.27
Panjab	202	65.9	0.65	0.33
Razan , Noor	320.98	110.56	0.5	0.34
Karehsang	946.23	236.14	0.92	0.25
Sorkh Rood	1137.26	307.48	0.63	0.27
Mahmudabad	1003.48	157.97	-0.37	0.16
Chamestan	781.28	164.62	0.43	0.21
Alam Kola	1023.76	185.79	0.79	0.18
Khair Rood Kenar	1395.31	368.22	0.91	0.26
Sardab Rood	1157.92	245.74	-0.33	0.21
Kelar Abad	1512.09	263.71	0.35	0.17
Abbas Abad	1552.77	185.6	0.32	0.12
Haratbar	1369.54	323.26	0.5	0.24
Pole Shir Rood ,	1245.06	318.25	0.82	0.26
Gelibin	1048.66	316.41	-0.53	0.30
Kangsar	1075.95	323.45	0.3	0.30
Rostam Rood	1088.12	226.25	-0.02	0.21
Alamdah	881.84	268.77	0.6	0.30
Tooskatook	1114.29	214.43	0.05	0.19
Sefid Chah	406.16	77.09	0.75	0.19
Nozar Abad	669.65	151.08	0.26	0.23
Talarom	539.53	88.93	0.29	0.16
Paen Zarandin	763.96	199.97	0.04	0.26

Table 2. Total given Scores for each statistical distribution fitted to annual precipitation data in different time series 15, 20, 25 and 30-year based on Moment method.

Gumbel	Log Pearson Type III	Pearson Type III	Two Parameter gamma	Three-Parameter Log-normal	Two-Parameter Log-normal	normal	Distribution Type / Statistical Period(year)
228	374	354	189	324	175	176	15
206	377	355	196	316	176	194	20
187	382	355	197	331	152	216	25
198	377	338	182	350	162	213	30

Table 3. Total given scores for each statistical distribution fitted to annual precipitation data in different time series 15, 20, 25 and 30-year based on Maximum likelihood method.

Gumbel	Log Pearson Type III	Pearson Type III	Two Parameter gamma	Three-Parameter Log-normal	Two-Parameter Log-normal	normal	Distribution Type / Statistical Period(year)
353	228	216	229	254	283	257	15
330	236	282	210	241	259	262	20
327	257	256	229	225	243	283	25
336	219	271	229	228	244	293	30

Table 4. The best fitted statistical distributions to stations without change in different time series.

station	The best fitted distribution
Hootan	normal distribution (each one of two methods)
Nodeh	Pearson distribution (moment method)
Araz Koosheh	Three Parameter Log normal distribution (maximum likelihood method)
Fazel Abad	Log Pearson type 3 distribution (moment method)
Barkola	Pearson distribution (moment method)
Shirgah	Log Pearson type 3 distribution (moment method)
Naharestagh	Log Pearson type 3 distribution (moment method)
Sardab Rood	Pearson distribution (moment method)

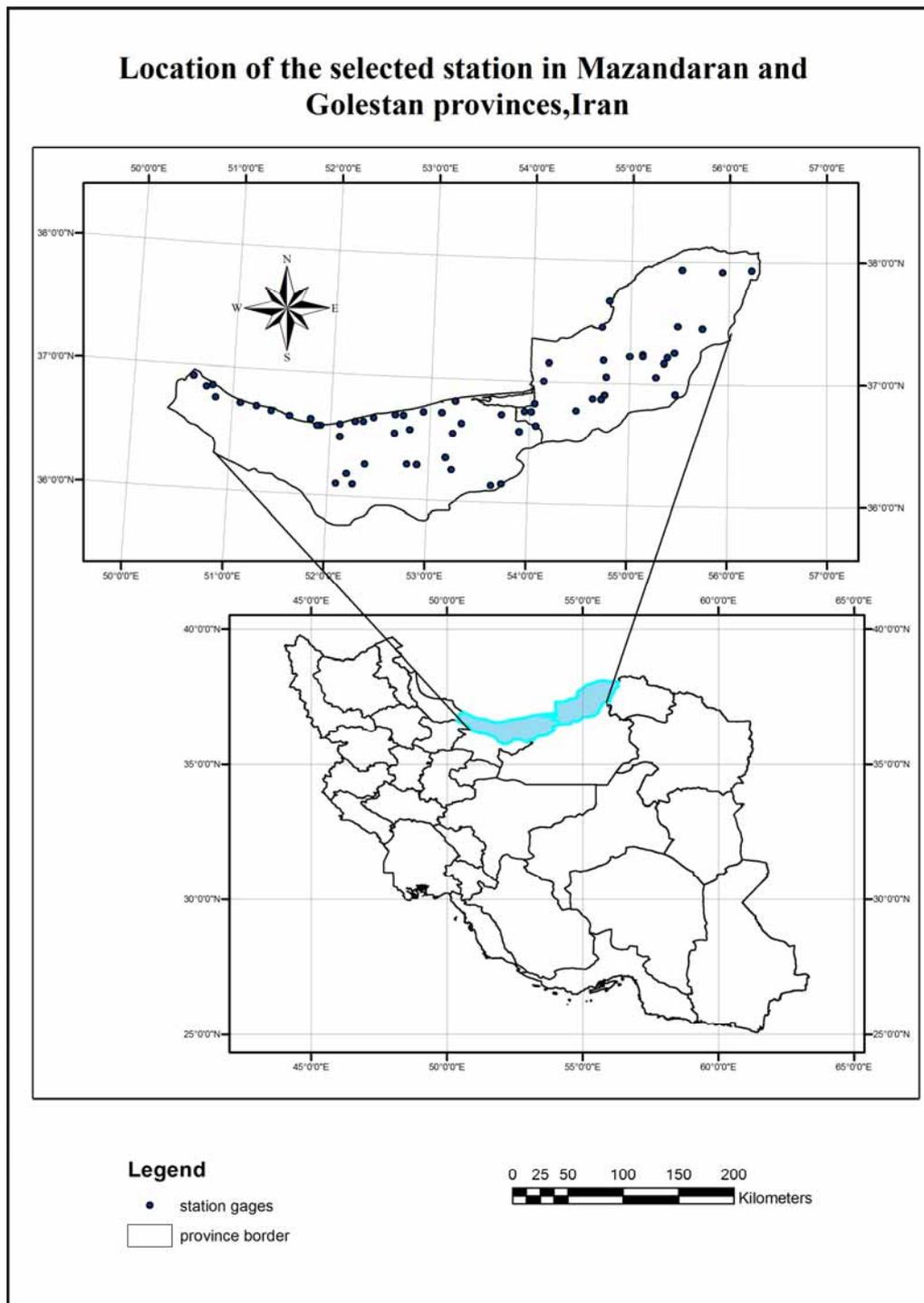
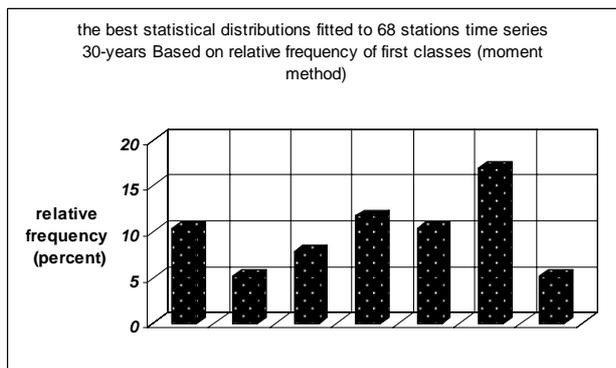
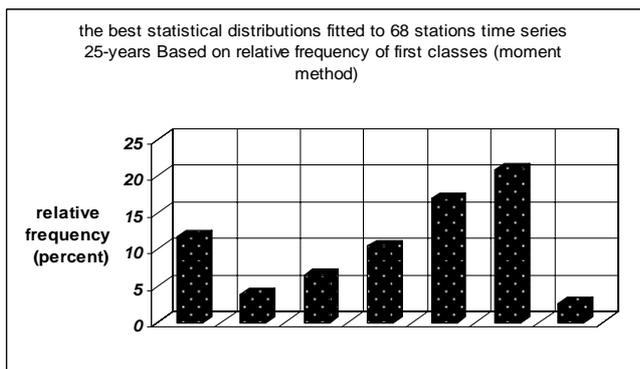
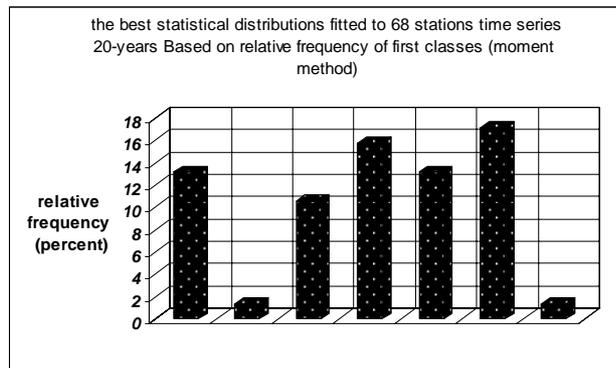
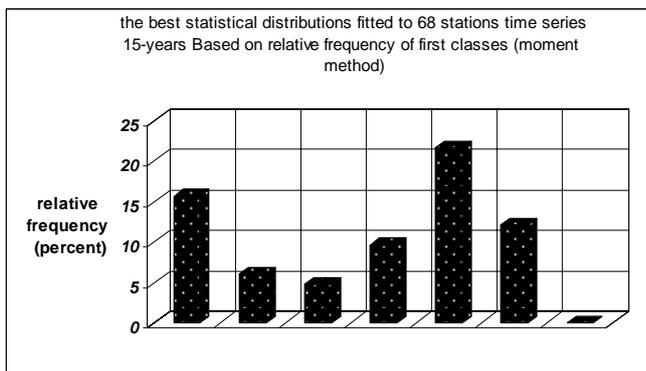
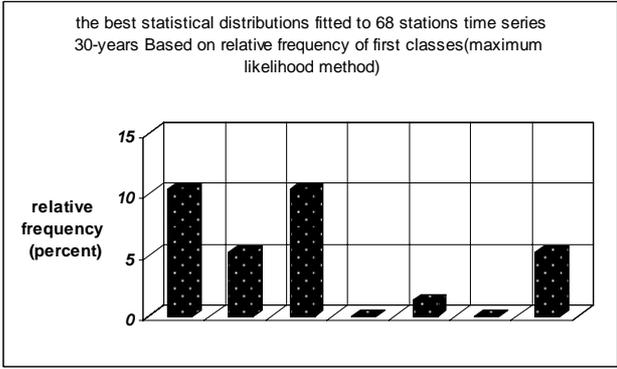
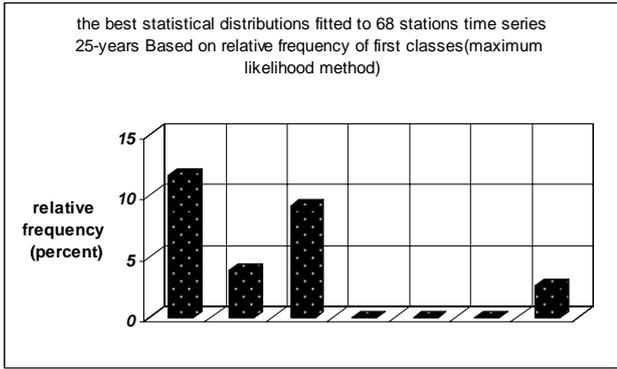
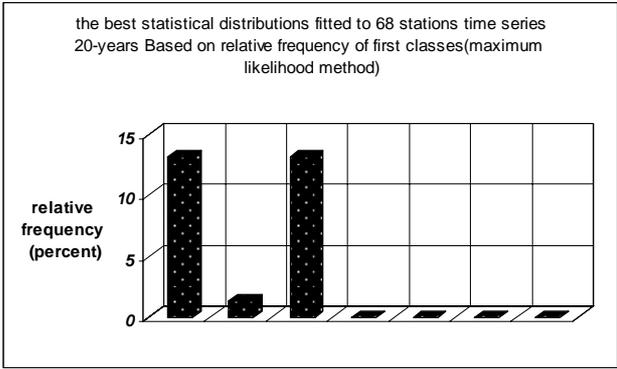
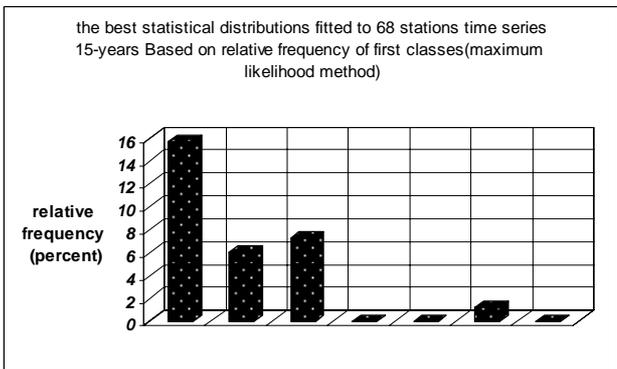


Figure 1. Location of the selected station in Mazandaran and Golestan provinces



Note: Distribution from left to right: normal, Two-Parameter Log-normal, Three-Parameter Log-normal, Two parameter gamma, Pearson Type III and Log Pearson Type III , Gumbel distributions

Figure 2. The best statistical distributions fitted to 65 stations in different time series 15, 20, 25 and 30-year based on relative frequency of first classes (moment method).



Note: Distribution from left to right: normal, Two-Parameter Log-normal, Three-Parameter Log-normal, Two parameter gamma, Pearson Type III and Log Pearson Type III, Gumbel distributions

Figure 3. The best statistical distributions fitted to 65 stations in different time series 15, 20, 25 and 30-year based on relative frequency of first classes (maximum likelihood method).



Analyze the Economic Value of Accounting Integrity in Market Mechanism

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Abstract

This paper analyzes the economic value of accounting integrity, agreeing that accounting integrity can decrease trading costs, improve enterprises' operational efficiency, enlarge market shares and competitiveness, evaluate and motive economic subjects, drive the formation and development of social capitals, and actualize the economy of scale.

Keywords: Market mechanism, Accounting integrity, Economic value

Accounting, in nature, is a contract relationship. The supply of real accounting information reflects the fulfillment of accounting contract. On one hand, accounting integrity requires enterprises to follow relevant principles and system in establishing, assessing, recording, and reporting relevant accounting issues. Enterprises can choose accounting methods objectively and fairly according to the contents of business. Other social investors can believe that the accounting information supplied by enterprises according to financial rules and accounting system is exact, real, complete, and timely. On the other hand, accounting integrity requires that enterprises must offer real and fair accounting information in final reports, which should be in accordance with enterprises' objective economic conditions. That is the universal understanding and ultimate requirements for accounting integrity in market.

Value, as a basic concept of philosophy, means the significance of people's objective activity and its product to their existence and development. If certain activities and the products are meaningful to people's existence and development, and show certain utility, people confirm their value. Here, the utility means the material effect obtained by people from physical products on one hand. On the other hand, it means the "symbol" value obtained by people from spiritual products. Facts prove that the moral practice of integrity can not only help people get certain "symbol" value and "internal interests", but also make people actualize certain physical effect and "external interests". Modern market economy can realize the resource allocation by market transactions that depend on strict contracts. It is credit economy taking contracts as the base. In market economy, integrity is the best strategy and guaranty for market subjects realizing self economic interests. The economic value of accounting integrity mainly focuses on these aspects as follow.

1. Accounting integrity can decrease trading costs for economic subjects.

Enterprises depend on the whole process of fulfilling contracts concerning the trade of factor use right. To sign, fulfill, and supervise contracts will inevitably face costs and losses. Factor owners expect accounting integrity in enterprise contract. They do not regulate on or dispute over the sign and the fulfillment of accounting contracts, which can save costs of signing contract. In the fulfillment of accounting contract, to perform accounting items according to accounting system can save costs of fulfilling contract and supervising the fulfillment. The sincere fulfillment of accounting contract can give an exact evaluation on enterprises' fulfillment of contract, which can ensure the optimized allocation of factor resources, decreasing losses. Therefore, accounting integrity can save trading costs for enterprises. In a word, although trading costs can be saved by laws and perfect economic system, the constitution and execution of laws cost more. The less the trust is, the more formal rules and regulations are necessary. As a result, trading cost will rise. Accounting integrity can help to build a wide trust between trading partners, maintaining transaction orders, and decreasing trading costs.

2. Accounting integrity can improve enterprises' efficiency

The trading efficiency is determined by the rate of trading costs to trading quantities. The lower the trading costs are and the higher the trading quantities are, the higher the efficiency is. Therefore, trading costs are the key factor determining the trading efficiency. To decrease the contract trading cost is equal to the improvement of efficiency. Accounting integrity can form a stable expectation among trading partners, which improves the motives of factor owners participating in enterprises. In other words, in an economic environment that has accounting integrity, the

quantities and the speed of contract trading are improved significantly. Accounting integrity can protect enterprises' interests against others' hurts, what can improve the economic efficiency greatly. For enterprises, as contract subjects, they hold a common recognition to accounting integrity as they sign contracts. It improves the efficiency of signing contracts. For enterprises, to deal with accounting affairs based on accounting integrity can improve the efficiency of financial management and decision. For the whole society, accounting integrity can make enterprises to provide real and fair financial reports that can reflect enterprises' practical business performances and investment values. By this way, it can speed up social resources' effective allocation, decrease capital costs, and improve the whole society's economic benefit. In other words, in an environment where everybody has integrity and credit, the trade will be more active and trading net will be more developed. And transaction quantities will be high. Trading cost will be decreased significantly. Trading efficiency will be improved greatly.

3. Accounting integrity can improve enterprises' market shares and competitiveness

For one single economic subject, long-term and continuous accounting integrity practice will help to form a credit, exerting a powerful and virtual attraction, which can help the economic subject to take sorts of markets and improve the economic effects. Reasons are: on one hand, credit is the best financing tool. Banks prefer to offer loans for enterprises with better accounting information and good credit. Enterprises can use loans to achieve self growth, improve the business conditions, and create more values and benefits. On the other hand, credit is the best brand to attract investors. As investors are selecting investment objects, they prefer to the enterprises with exact information and social responsibilities more and more. Credit is the best display of social responsibility. An enterprise with better credit can get more "credit investments". Credit has already become an important factor for economic subjects winning benefits.

Competition is the internal mechanism of market. In front of fierce competition, honesty is the best strategy. Accounting integrity can improve enterprises' market competitiveness effectively. Under the circumstance of market economy, accounting integrity, as a virtual asset, is an important innovation of economic subjects' nice social images, and also the factor of forming the core competence. The competition between economic subjects in market, in nature, is to compete for integrity. The economic subject that respects and follows the accounting integrity can decrease trading costs and improve market competence, obtaining long-term and high economic benefits. Honesty and integrity is an important competence.

4. Accounting integrity can evaluate and incentive economic subjects

The trust agency relationship in enterprises determines that business operators have entrusted duties. The entrusted duties must be expressed and valued by certain means. Then, others can judge whether enterprises fulfill contracts or not. According to the accounting theory, because accounting information reports enterprises' economic conditions to operators, it can reduce operators' entrusted duties. But here it neglects that accounting is also a contract relationship. Accounting information can not prove the fulfillment of accounting contracts, because the accounting information based on different quality standards stands for different fulfillment of accounting contracts. The fulfillment of accounting contracts can be revealed and valued by accounting integrity. Accounting integrity serves as a standard for evaluating market subjects. By observing market subjects' accounting activities, people can know the degree of integrity of the subjects. In a perfect market economic system, market subjects can get benefits from its accounting integrity. In other words, market subjects who have accounting integrity can get more interests from the market, but market subjects who lack of accounting integrity can not. By this way, accounting integrity has the function of evaluating and inspiring market subjects.

5. Accounting integrity can drive the formation and development of social capitals

As all parties cooperate with a spirit of trust and commission, they will get more return and improve the productivity. Social capitals are composed of a series of attitudes and values, including citizens' mutual trust and cooperation. Its core relies in the mutual sincerity and trust between social members. Under the market mechanism, accounting integrity can help to build a mutual beneficial and trust social relationship between enterprises, which is a kind of social capitals. For economic growth, it has special value as the efficiency. It is not only equal to economic capitals, but also has special values that can not be generated by economic capitals.

6. Accounting integrity can drive economic subjects actualizing scale economic effects

Along with the development of market economy, economic division tends to be more complicated. The degree of socialization and globalization is deepening. Cooperation and partners combine competition and coordination together, realizing the economy of scale. It is the tendency. Competition makes enterprises step into coordination. And coordination aims at powerful competition. Coordination exists in one organization or between organizations. No matter what kind of coordination it is, all can improve efficiency and decrease costs, generating scale economic effects for enterprises. Accounting integrity can benefit the formation of coordination between enterprises. Trust is the basis for coordination. Only by means of mutual trust, can it form a positive coordination in an organization. Right coordination can form powerful coherence, which can make enterprises enter an ideal state. Only by mutual trust, enterprises can

communicate widely; support each other, and share information, realizing the optimization of resources, decreasing transaction costs, and actualizing the scale effect.

To sum up, the operation of market economy depends on the developed credit system. Accounting integrity exerts an extremely important effect on the operation of market economy.

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Aquifer Reclamation Design: Combined Simulation-Optimization Approach

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Abstract

A simulation-management methodology is demonstrated for the rehabilitation of aquifers that have been subjected to seawater intrusion. Finite difference groundwater flow and solute transport simulation are combined with nonlinear optimization. The model is capable of determining well locations plus pumping and injection rates of groundwater quality control. Restrictions were placed on hydraulic heads and concentrations. These restrictions were distributed over space and time. Two design strategies such as optimal pumping and recharge rates are demonstrated for a polluted aquifer. The method is not limited to these cases. It is generally applicable to the optimization of many types of distributed parameter systems.

Keywords: Confined aquifer, Seawater intrusion, Pollution control, Remediation, Nonlinear optimization, Optimal control methods, Injection wells

1. Introduction

Although groundwater quality management models have been developed for important steady state and transient cases, research is needed for solution of nonlinear groundwater quality control problems such as capturing a contaminant plume that originates from waste disposal sites, saltwater intrusion control problem. Nonlinearity arises from management decisions that create unknown groundwater velocity fields as well as from problems involving chemical interaction. Nonlinearity constraints appear as a result of products of unknown velocity components which occur in advective and dispersive transport terms. Simulation of this nonlinear system has been successful. Research is needed to develop distributed parameter management models of saltwater intrusion that involve simulation of this nonlinear system. One such new approach is groundwater management methodology which optimizes aquifer remediation with the aid of nonlinear programming. In this paper a modeling approach is presented to determine the optimal design of reclamation schemes for saltwater intruded groundwater systems. The planning model combines a nonlinear, distributed parameter, groundwater flow and contaminant transport simulation model with a nonlinear optimization method. The resulting management model enables one to consider a linear or nonlinear water management objective subject to linear or nonlinear restrictions that include a complex, nonlinear aquifer simulation model. This paper deals with two scenarios which are demonstrated to control the seawater intrusion.

2. Combined Simulation-Optimization Models

Groundwater hydrologists developed simulation models to aid in predicting the migration pattern and fate of contaminants in aquifers. The application of finite difference and finite element methods to groundwater equations has permitted complex, real world systems to be modeled. Numerical simulation models have enabled hydrogeologists to understand the functioning of regional aquifers and to test hypothesis regarding the behaviour of particular facets of groundwater systems. The simulation method has provided a framework for conceptualizing and evaluating aquifer system. Models have become tools to evaluate the long term impacts of sustained water withdrawals, groundwater-surfacewater interaction and the migration of chemical contaminants. Clearly, simulation is a method to explore hydrogeologic problems and a tool to predict impacts upon groundwater systems will continue to be essential to hydrologists and to water managers. However, simulation models are often utilized to explore groundwater management alternatives. In such cases a model is executed repeatedly under various design scenarios which attempt to achieve a particular objective, such as isolating plume of contaminated groundwater, preventing saltwater intrusion, dewatering an excavation area or obtaining a sustainable water supply. Use of such an approach often sidesteps rigorous formulation of groundwater management goals and fails to consider important physical operational restrictions. Determining the proper objective function in a groundwater management model is often difficult but an essential aspect, which should not be avoided. It is unlikely that optimal management alternatives are discovered using simulation techniques alone. The requirement is not a simulation model alone, but a combined simulation and management model. A combined

simulation and management model considers the particular behaviour of a given groundwater system and determines the best operating policy under the objectives and restrictions.

3. Previous Works

Remson and Gorelick (1980) considered the optimal locations of minimum pumping rates for the hydraulic containment of contaminated groundwater. His approach was limited utility for problems involving aquifer rehabilitation. The reason is that the model only considers management of the groundwater flow field and does not explicitly consider contaminant concentrations. The management of pollutant sources under steady state conditions has been addressed by Willis (1976) and Gorelick and Remson (1982). In each of these studies the equations governing groundwater solute transport defined the constraints of a linear program in a management model aimed at maximizing safe waste disposal potential. The dynamic management of pollutant sources was studied by Gorelick et al. (1979), Willis (1979) and Gorelick (1982). Various approaches were adopted in these studies, but in general each relied upon using a simulation model to define constraints in a linear management model. The most severe limitation of the above groundwater quality management models is that the groundwater flow field must be determined before pollutant sources can be managed in order to maintain system linearity. The result is that restrictions could not be imposed simultaneously upon groundwater hydraulics and groundwater contaminant transport. For instance one cannot use the above models to determine a pumping and recharge scheme that would ensure that contaminant concentrations were maintained within purview of specified water quality standards.

Nonlinear programming techniques were used to incorporate fully into groundwater management process (Gorelick et al., 1984, Ahfeld, 1987). The nonlinear techniques were necessary because solute transport modeling is dependent on the velocity of groundwater, which in turn is affected by optimal pumping rates during optimization. Concerns about computational burden in field scale applications, global optimality and difficulty of handling multiple objectives of different cleanup technologies have led researchers to continue improved methods of optimizing groundwater remediation. The original applications (Gorelick et al., (1984) ; Ahfeld, 1987) and most of the studies since then have used MINOS (Murtagh and Saunders, 1980) or NPSOL (Gill et al., 1986). Both are well known optimization algorithms that use the gradient method combined with a projected Lagrangian to manage nonlinear constraints. Ahfeld (1987) found that Central Processing Unit time increases nonlinearly with the number of decision variables and logarithmically as the desired cleanliness increases. MINOS and NPSOL have difficulties to guarantee a global optimum where the problem is nonconvex, which is the case for most field applications.

In light of these concerns, two approaches that have found recent success in other areas of combinatorial optimization, Simulated annealing and Artificial Neural Network, are of interest to examine for use in groundwater research. Simulated annealing was developed by analogy to the statistical mechanics of annealing solids; Artificial Neural Network was developed by analogy to the collective processing behaviour of neurons in the human brain. Both the techniques believed to be robust with techniques to avoid being trapped in the local minimum of a function. Dougherty and Marrayott (1991), Marrayott et al., (1993) and Marrayott (1996) applied the simulated annealing methodology to groundwater management problems and expressed that the relative Central Processing Unit requirements for the simulated annealing approach increased at a slower rate than the gradient-based method of MINOS. They discussed that simulated annealing provides an optimal framework that is flexible enough to incorporate a number of different remedial technologies into the design process. Roger and Dowla (1994) used artificial neural network to design optimal remediation systems. Ritzel et al. (1994) solved a multi-objective groundwater contamination problem using genetic algorithms. In their study only steady state flow was simulated. McKinney et al., (1994) applied genetic algorithms to groundwater resource management and design of pump and treat systems in a hypothetical aquifer with a single management period. Johnson and Rogers (1995) combined neural networks and genetic algorithms to select the optimal pumping well locations of groundwater remediation problems. Barlow et al., (1996) used nonlinear programming solver to maximize pumping and found that it is highly efficient when compared with simulation alone.

Andricevic (1990) developed a penalty type cost function of two conflicting objectives, aimed to minimize deviation from the desired withdrawal rate and the specified target levels. Cheng et al., (1992) used hyperbolic penalty function to remediate the contaminated aquifer system. McKinney and Lin (1995) used a polynomial penalty function to minimize the cost of pump and treat aquifer remediation system. Keshari and Datta (1996) used exterior penalty function method along with pattern search Hooke and Jeeves method to solve the unconstrained optimization problem.

In this research a groundwater remediation management model is developed using penalty function method which is used to convert the constrained optimization method to an unconstrained optimization problem. The pattern search algorithm proposed by Hooke and Jeeves is used to solve the resulting unconstrained optimization problem. For the development of this model, three dimensional groundwater flow model MODFLOW (McDonald and Harbaugh, 1988), and solute transport model MT3D (Zheng, 1990) are used as simulation models so that the coupled simulation-optimization model can be applied to real world problems. The methodology is general and the results and suggestions are in particular to

Minjur-Mouthambedu Aquifer System, Chennai, India are much useful in decision making to control seawater intrusion and to utilize the resources effectively by the system managers.

Minjur-Mouthambedu Aquifer System consists of alluvial deposit underlined by tertiary rocks, which in turn overlies the massive Gondwana series [United Nations Development Programme Report, (1975)]. The aquifer is bounded on the eastern side by the Bay of Bengal, the northern and southern sides by the impervious formation and in the western side by alluvial deposits as shown in Fig.1. The permeability of the Chennai aquifer varies from 5×10^{-4} to 1.21×10^{-3} m/s from east to west. Central portion of the aquifer is highly porous having higher ranges of permeability. The aquifer system is conceptualized as a two layer system with an upper and lower formation, separated by an aquitard. The upper formation is an unconfined aquifer and the lower formation is a confined aquifer capped with clay beds and connected to the upper aquifer by vertical leakages. The recharge of the unconfined aquifer is from rainfall and irrigation return flow. The recharge for the confined aquifer is longitudinal and infiltration from exposed parts of lower aquifer. The withdrawal of water for irrigation, industrial and domestic uses are mostly from the confined aquifer.

The main reason for the intrusion was due to over extraction of groundwater to meet the various demands. Heavy pumping in the Minjur –Mouthambedu Aquifer System has created pronounced reversal of hydraulic gradient from sea to land, resulting rapid increase of chloride concentration in the groundwater. Due to continuous concentrated pumping, the interface further moved inland and its movement was back and forth depending on the discharge and recharge. The solute transport modeling involved two parts. The predicted head distribution computed from the flow model is utilized in the solute transport model to estimate the chloride concentration distribution. The model is calibrated for the period 1976 to 1982 and it is tested for the period 1983 to 1996. The head and concentration contours at the end of December 1996 was taken as initial condition for the beginning of the year 1997 and the system was projected for the future period 1997 to 2020.

4. Optimization Methodology

A key component of simulation-optimization modeling is the formulation of the optimization problem that requires definition of management objective, decision variables and management constraints. In this work, the goal is to reduce the salt concentration at the critical zone. This can be achieved through two formulations. One is to find the optimal reduction in the pumping and the other is by optimal recharge for which the concentration is reduced at the end of planning horizon.

4.1 Decision variables

Definition of the optimization problem includes decision variables whose values will be determined as part of the optimization solution. In a remediation system, there are two sets of variables. They are decision variables and state variables. Decision variables include the pumping and injection rates for the wells. Other possible decision variables include well locations. The purpose of the design process is to identify the best combination of these decision variables. The state variables are the hydraulic head and the chloride concentration. Any remediation design model shall include two major components. The simulation model updates the state variables and the optimization model selects the optimal values for the decision variables.

4.2 Managerial constraints

The formulation of optimization problem includes the definition of management constraints. Usually the constraints are placed on the piezometric heads, total recharge (or pumping) and chloride concentration in the case of quantity and quality management problems.

i. The temporal and spatial distribution of piezometric heads is stated such that it should not drop below the specified minimum values and the same should not rise above the specified maximum values;

$$(h_{lb})_{i,j}^k \leq h_{i,j}^k \leq (h_{ub})_{i,j}^k \quad (1)$$

ii. Total recharge (or pumping) must be within the specified range;

$$(R)_{i,j}^k \leq (R_{ub})_{i,j}^k \quad (2)$$

iii. The temporal and spatial distribution of pollutant concentrations should not exceed the specified threshold values so that the water quality standards in the aquifer will not fall below the specified value (usually zero) and the concentrations for the intended use;

$$(c_{lb})_{i,j}^k \leq (c)_{i,j}^k \leq (c_{ub})_{i,j}^k \quad (3)$$

Here h_{lb} , R_{lb} , and c_{lb} are the lower bounds on hydraulic head, artificial recharge and concentration, whereas h_{ub} , R_{ub} , and c_{ub} are the upper bounds on hydraulic head, pumping and concentration, respectively and k denotes the time step.

4.3 Objective Function

In most of the pollutant management problems, the goal is to find either the minimum recharge quantity or minimum reduction in pumping that satisfies a set of constraints to maintain the head, recharge and concentration in a specified range. To modify the formulation of the unconstrained nonlinear problem, the constraints are brought into the objective function through penalties. The objective function can be written as

$$\text{minimize } \sum ph * dh + \sum pc * dc + \sum pr * dr \quad \forall i, j, k \tag{4}$$

where,

- dh is the deviation of the head from the specified range at locations (i,j);
- dc is the deviation of the concentration from the specified range at locations (i,j);
- dr is the deviation of the recharge from the specified range at locations (i,j);
- (i,j) is a set of specified locations;
- k is the number of time steps considered within a planning horizon;
- ph is the penalty for head deviation;
- pc is the penalty for concentration deviation;
- pr is the penalty for recharge deviation;

4.4 Method of solution

To find the optimal solution, the constrained problem is transformed into an unconstrained problem using penalty application. The unconstrained nonlinear problem is then solved using the Hooke and Jeeves direct search algorithm (Rao, 1991). Hooke and Jeeves method is a sequential technique where each step consists of two kinds of moves, one called the exploratory move and the other called the pattern move. The first kind of move is included to explore the local behaviour of the objective function and the second kind of move is included to take advantage of the pattern direction. This method requires only objective function evaluation and does not require the partial derivatives of the function in finding the optimum point. It starts from an initial trial solution and the step length along the decision parameter axes is kept constant for each cycle of moves and a probe is made first in the positive direction and then in the negative direction of each axis. Iterative improvement can stuck in a local minimum. Consequently, the solution depends upon the starting configuration. Hence, several different starting points are used to make sure that a better solution is found. A simulation model is used as a sub-model with the Hooke and Jeeves nonlinear programming main model, which passes different configuration of the decision vector to the simulation model and receives an objective function value back. Based on the new value of the objective function, the Hooke and Jeeves model decides to move to the new configuration of the management decision vector. This is repeated until no further improvement in the objective function is possible.

5. Application

As the aquifer is intruded by seawater, it is essential to control the seawater intrusion either by reducing the pumping or by recharging artificially. The objective of the two strategies is to minimize total pumping and total injection. The transient reclamation design model is demonstrated using complex, heterogeneous aquifer system shown in Fig. 1.

5.1 Scenario 1: Optimal reduction in pumping

The aim of this formulation is to find the optimal reduction in the irrigation demand by maintaining the constraints on the head and concentration. This scenario is attempted to know the percentage of pumping in the year 1996 that can reclaim the aquifer optimally. Initially the constraints are kept on both heads and concentrations. After a number of trials, it was found that the reduction in the pumping is directly proportional to the cleanup criteria. The optimal pumping is the zero pumping for which maximum cleanup takes place. The head distribution is not uniform so constraints on head are introduced.

The objective function which constitutes the unconstrained minimization problem for the proposed management model can be expressed as

$$\text{minimize } \sum ph * dh \quad \forall i, j, k \tag{5}$$

5.1.1 Results of scenario 1

The optimal reduction in pumping is 28 percent of 1996 irrigation pumping for which the penalty value is 623. All the other neighbouring points show higher penalty values as shown in the Fig. 2. The optimal pumping was found out through bisection method. The constraints are piezometric heads, which should lie between 0.5 and 1.0 m. This range is selected on

the idea that maintaining piezometric pressure above mean sea level reduces or arrests seawater intrusion. The deviations from these constraints are penalized. Therefore, the objective is to minimize the penalties. Penalties are calculated for various percentage reductions in pumping. Penalties for zero and 100 percent reduction in pumping are 2781 and 6894 respectively. The bisection trials were carried out in between zero percent and hundred percent reductions in pumping. Penalties for various reductions in pumping were arrived at. Fig. 2 shows the change in penalty with reduction in irrigation demand.

The optimal reduction in pumping gives the minimum deviation from the constraints on head, that is, 28 percent reduction in pumping achieves the objective. After finding the optimal percentage reduction in pumping, the same was used in the simulation model to arrive at various results, such as head and concentration contours, water and salt balance and temporal variations of head and concentration as shown below.

The minimum piezometric head is improved by +8 m in the first nine years and the same was continued. Similarly, the reduction in concentration was steep in first nine years from 8329 mg/l in 1996 and then it reduces slowly and it reaches to 3783 mg/l at 6.5 km in 2020. Fig. 3a and 3b and Table 1 show the improvement in head and concentration;

The 1000 mg/l isochlor nearly at 10 km in 1996 retreats back to 8.5 km in 2020 from the coast. Hence, the 1000 mg/l isochlor front moves back by 1500 m as shown in Fig. 4;

If the pumping is cut down by 28 percent per year, there is an outflow of 120 mcm of either fresh groundwater or diluted seawater which washes out 0.95 million kilogram of salt in 24 years through sea boundary. When the zero percent reduction in pumping is compared with 28 percent reduction in pumping, the condition was reverse. It provides 131 mcm of saltwater that brings 4.5 million kilogram of salt in 24 years into the aquifer.

5.2 Scenario 2: Optimal recharge and location

The objective is to minimize the sum of temporal and spatial artificial recharge fluxes for a period of ten years. The purpose of this model is to minimize the total amount of recharge to the aquifer in order to reclaim the seawater intruded aquifer.

- i. The objective is to find the optimal (minimum) recharge rate to reclaim the polluted aquifer;
- ii. Though a 24 year time horizon is considered, only for last ten years, the values of head, concentration and recharge are used in the optimality check. Due to the imposed artificial recharge, the aquifer system may be in a disturbed condition in the initial years and hence the first fourteen years data on head, concentration and recharge are not considered in the optimality check;
- iii. One year is taken as a cycle. The recharge pattern between cycles is kept constant. Each annual cycle is divided into four stress periods based on rainfall pattern. The four distinct seasons are (i) January to May, (ii) June to September, (iii) October and November and (iv) December;

Division of a year into four stress periods leads to four decision variables and the other decision variable is the total recharge. The first four decision variables denote the sharing of the total recharge while the fifth decision variable is the total recharge itself. Thus this becomes a six dimensional problem in which the sixth axis is the penalty axis. The recharge in each stress period is distributed among 20 cells of the discretized aquifer. The simulation model uses all the aquifer parameters and boundary conditions that are finalized after calibration and testing of the aquifer. In this scenario, the optimal recharge is found without adjusting the 1996 pumping pattern.

The objective function that constitutes the unconstrained minimization problem for the proposed management model can be expressed as

$$\text{minimize } \sum p_h * dh + \sum p_c * dc + \sum p_r * dr \quad \forall i,j,k \quad (6)$$

5.2.1 Penalty values

The piezometric head h_{ij} is constrained in the range of 0.5 to 1 m, in order to maintain the piezometric head above the mean sea level. The penalty for the deviation from this range is taken as follows.

Head h (m)	Penalty (ph)
$h < 0.5$	$(0.5-h) * 10$
$0.5 \leq h \leq 1.0$	0
$h > 1.0$	$(h-1.0) * 10$

The recharge quantity is constrained to be less than 20 mcm/year. This has been decided based on the availability water at the recharge zone. The penalty for the deviation from the specified range of recharge is taken as follows.

Recharge R (mcm/Year)	Penalty (pr)
$R \leq 20$	0
$R > 20$	10000

The temporal and spatial distribution of pollutant concentration in the aquifer should not fall below the specified value (usually zero) and these concentrations should not exceed the specified threshold values to meet the water quality standards for the intended use. The penalty for concentration is fixed as follows.

Concentration C (mg/l)	Penalty (pc)
$C < 1000$	0
$C > 1000$	$(C - 1000) * 1$

The nonlinear optimization problem was solved with Hooke and Jeeves method combined with groundwater flow model and the solute transport model. To represent the behaviour of the groundwater flow and chloride concentration in the management model, flow and solute transport models were linked explicitly to the optimization program as a subroutine shown in Fig. 5. Flow and transport models are called repeatedly by Hooke and Jeeves model. Hooke and Jeeves model determines the recharge rates. These recharge rates are passed to flow and solute transport model and progresses towards an optimal point by comparing heads and concentrations with the previous point. This procedure will be continued until optimum point is determined that minimizes the objective.

5.2.2 Location analysis

After finding the optimal total recharge quantity and its distribution, optimal location analysis was carried out. In this aquifer system, two troughs in piezometric surface, one at 6.5 km and the other at 13.5 km from the coast are existing. It is obvious that through control of these troughs, it is possible to control seawater intrusion. The optimal location for recharge was searched between 3.0 and 13.0 km from the coast by using bisectional search method.

5.2.3 Results of scenario 2

The total recharge was initially distributed equally to all the stress periods. About 20 starting points are considered and for each starting point, a best point (local optimal point) is obtained. All the 20 starting points led to the same optimal point. The results are shown in the following Table 2. Optimal recharge quantity of 8.1 mcm/year and optimal location at 6.5 km from the seacoast were arrived through this analysis.

The optimal recharge quantity and its distribution at optimal location was fed into the simulation model to arrive at the various detailed results from which head and concentration contours, isochlor front movement and variations of heads and concentration were drawn. The summarized results of the scenario 2 are shown in the Table 3.

The minimum piezometric head improves steadily from -8.0 m to -4.65 m during the period 1996 to 2020 due to artificial recharge. The reduction in concentration is very steep in the first ten years from 8329 to 2264 mg/l and then it reduces steadily to 502 mg/l as shown in Table 3;

The 1000 mg/l isochlor front occupies 9.84 km in 2005 with a slight retrieval of the front as it moves back to 6.94 km in 2020. There is a large retrieval of the front in these five years and then it moved back slowly. On the whole the isochlor moved back by 3390 m in 24 years as shown in Fig. 6;

For the 8.1 mcm/year of artificial recharge it was able to wash out half million kilogram of salt through the outflow of diluted seawater quantity of 62 mcm;

Fig. 3a indicates that the piezometric head fluctuates steadily. The rate of improvement in the piezometric head for the scenario 1 is better than the scenario 2, because the pumping is cut down throughout the aquifer system;

Fig. 3b indicates the variations in the chloride concentration at various locations. In all locations the reduction concentration is more in scenario 1 compared to the scenario 2 except at location 11526. As the recharge is at 6.5 km near the well 11526, the clean up is more in scenario 2 compared to scenario 1;

6. Discussion

From the scenario 1 and 2, it is evident that the aquifer is not reclaimed completely. It is not possible to reclaim the aquifer within a short time horizon. It will take much longer time. Always the piezometric head reaches steady state quickly whereas the salt concentration will be always in transient condition because of dispersion and diffusion. When the scenarios 1 and 2 are compared, the reduction in pumping takes away more salt from the system than the artificial recharge. The 28 percent reduction in pumping reduces irrigation pumping by 10.4 mcm/year. This reduction in pumping takes away more salt than the 8.1 mcm/year recharge washout. Artificial recharge is expensive and hence reduction in pumping is suggested. This is possible by either changing the agricultural pattern or buying the groundwater rights from the farmers. Then the question of farmers employment arise. It is possible, that they can be employed under special category. Buying the groundwater rights may lead to unemployment problems, which must be solved with alternate arrangements to them.

7. Conclusion

A general methodology for the management of nonlinear distributed parameter systems has been demonstrated. The procedure enables the solution of a previously intractable class of nonlinear groundwater management problems. The

particular problem addressed here regards to reclamation schemes for contaminated groundwater systems. This approach is to unite a contaminant transport simulation model with a nonlinear optimization method. The design model is capable of identifying well locations and determining pumping and recharge rates for optimal aquifer restoration design. Useful extensions will include more complex nonlinear simulations, such as those involving multi-component chemical interactions and heat transport..

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Notations

- h_{lb} = lower bounds on hydraulic head;
 R_{lb} = lower bounds on artificial recharge;
 c_{lb} = lower bounds on concentration;
 h_{ub} = upper bounds on hydraulic head;
 R_{ub} = upper bounds on pumping;
 c_{ub} = upper bounds on concentration;
 k = time step;
 h = head
 C = concentration
 R = recharge
 dh = deviation of the head from the specified range at locations (i,j) ,
 dc = deviation of the concentration from the specified range at locations (i,j) ,
 dr = deviation of the recharge from the specified range at locations (i,j)
 (i,j) = a set of specified locations
 k = the number of time steps considered within a planning horizon.
 ph = the penalty for head deviation
 pc = the penalty for concentration deviation
 pr = the penalty for recharge deviation
 mcm = million cubic meter
 mg/l = milligrams per litre

Figure Captions

- Fig. 1 Study area and its location
 Fig. 2 Change in penalty with reduction in irrigation demand
 Fig. 3a Fluctuations of piezometric head for the scenarios 1 and 2 at the well 11526
 Fig. 3b Variations of projected chloride ion concentration for scenarios 1 and 2 at the well 11526
 Fig. 4 Projected isochlors at an interval of 1000 mg/l for scenario 1
 Fig. 5 Flow chart for the combined simulation-optimization model
 Fig. 6 Projected isochlors at an interval of 1000 mg/l for scenario 2

Table 1. Summary of results for scenario 1

Year	Minimum head (m)	Concentration at 6.5 km (mg/l)	Position of 1000 mg/l isochlor (km)	Distance moved by 1000 mg/l isochlor (m)
1996	-8	8329	9.95	-
2005	-0.38	6458	8.81	- 1140
2010	0	5423	8.63	- 180
2015	0	4608	8.44	- 190
2020	0	3783	8.44	-

Table 2. Input parameters and penalty

Starting Point No.	Total Recharge mcm/year	Recharge distribution (percentage)				Penalty
		Period 1	Period 2	Period 3	Period 4	
1	8.1	25.0	15.0	50.0	10.0	2976
2	8.1	70.0	20.0	5.0	5.0	561
3	6.4	63.6	27.1	4.2	5.1	742
4	4.8	70.6	27.1	1.1	1.2	1447
5	3.0	67.6	28.8	1.8	1.8	1933
6	1.6	40.9	52.5	3.3	3.3	2257
Optimal Point	8.1	58.5	26.8	7.4	7.3	120

Table 3. Summary of results for scenario 2

Year	Minimum head (m)	Concentration at 6.5 km (mg/l)	Position of 1000 mg/l isochlor (km)	Distance moved by 1000 mg/l isochlor (m)
1996	- 8.0	8329	9.95	No Change
2005	- 7.27	2264	9.84	- 110
2010	- 4.63	1358	6.94	- 2900
2015	- 5.27	716	6.75	- 190
2020	- 4.65	502	6.56	- 190

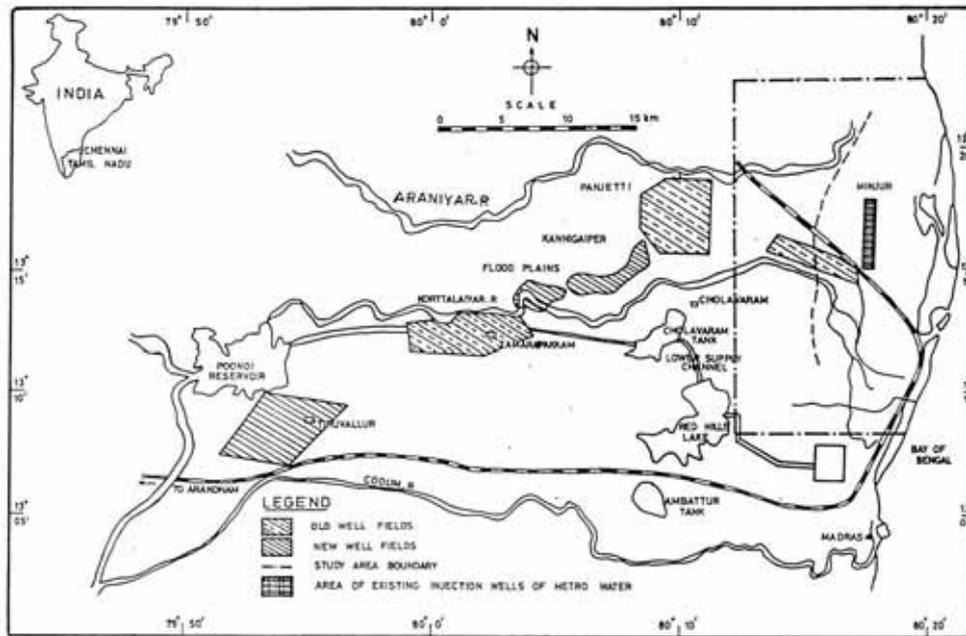


Fig. 1 Study area and its location

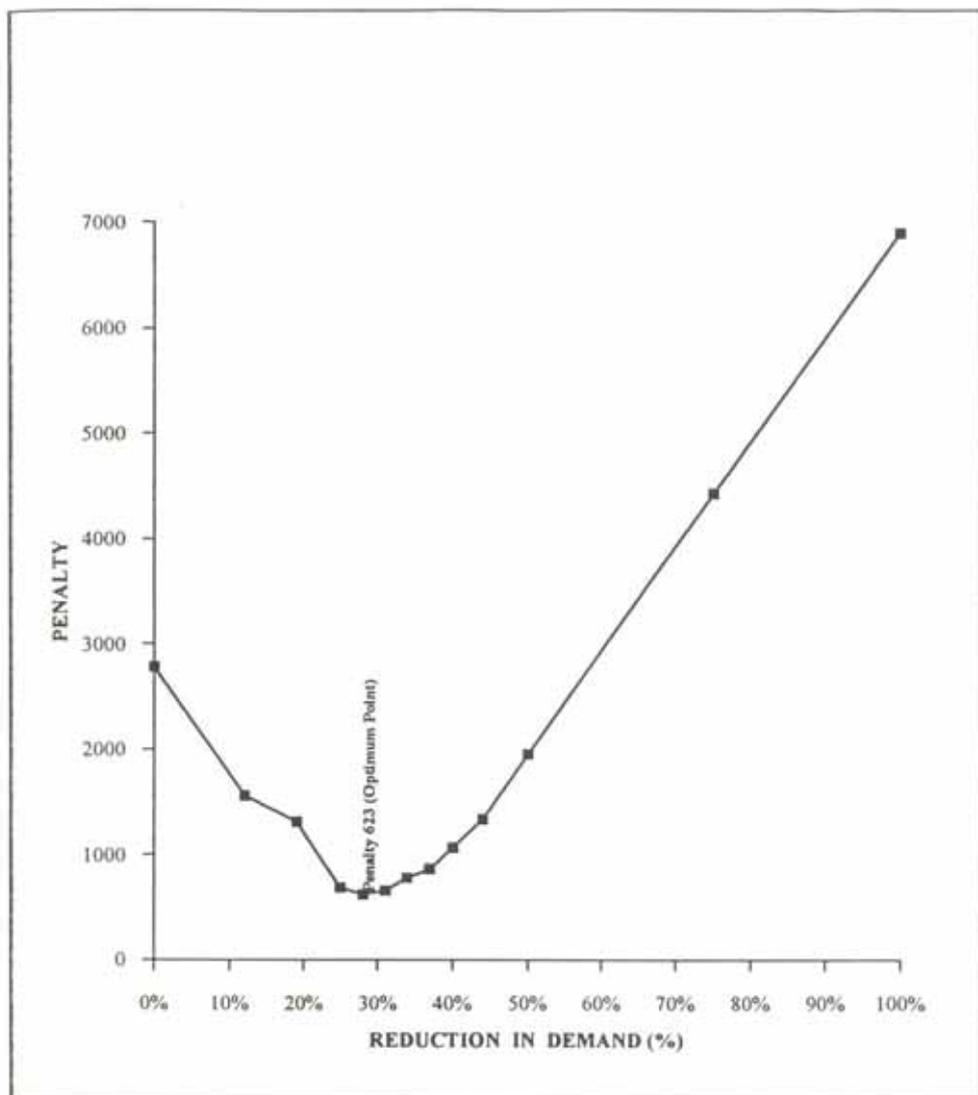


Fig. 2 Change in penalty with reduction in irrigation demand

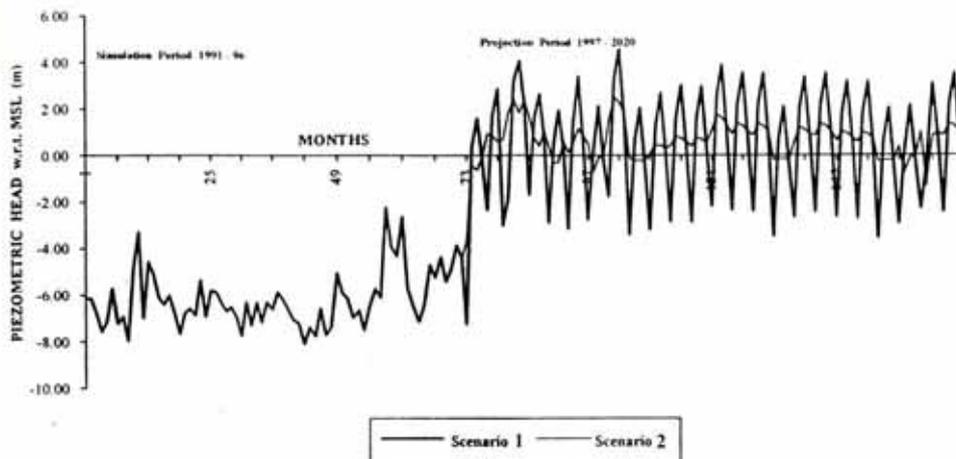


Fig. 3a Fluctuations of the piezometric head for scenarios 1 and 2 at the well 11526

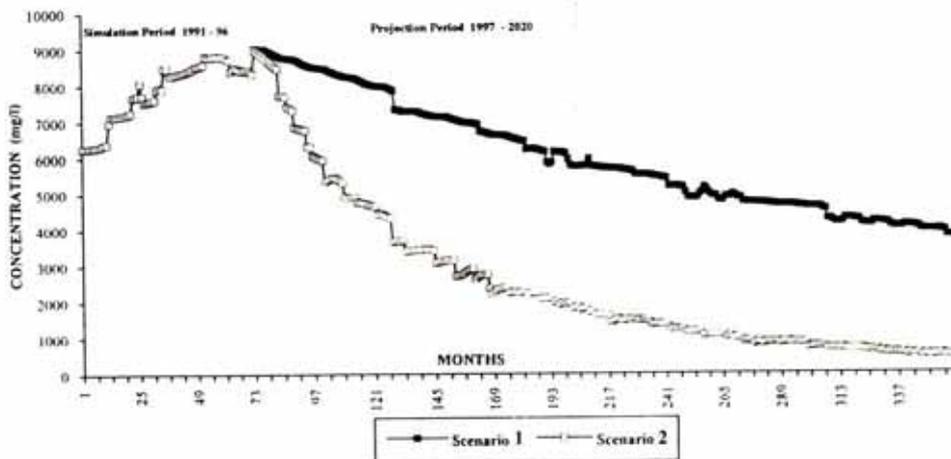


Fig. 3b Variations of projected chloride ion concentration for scenarios 1 and 2 at the well 11526

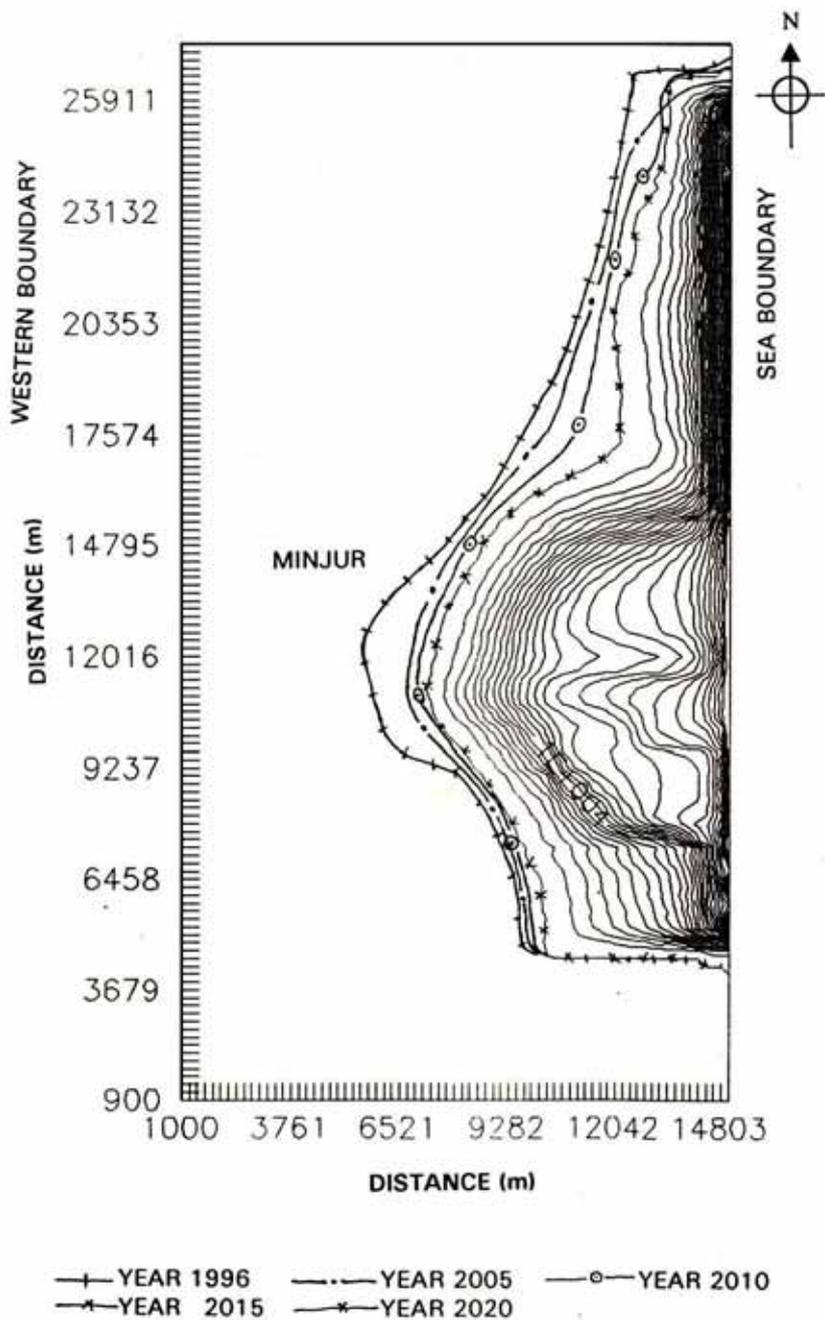


Fig. 4 Projected isochlors at an intervals of 1000 mg/l for scenario 1

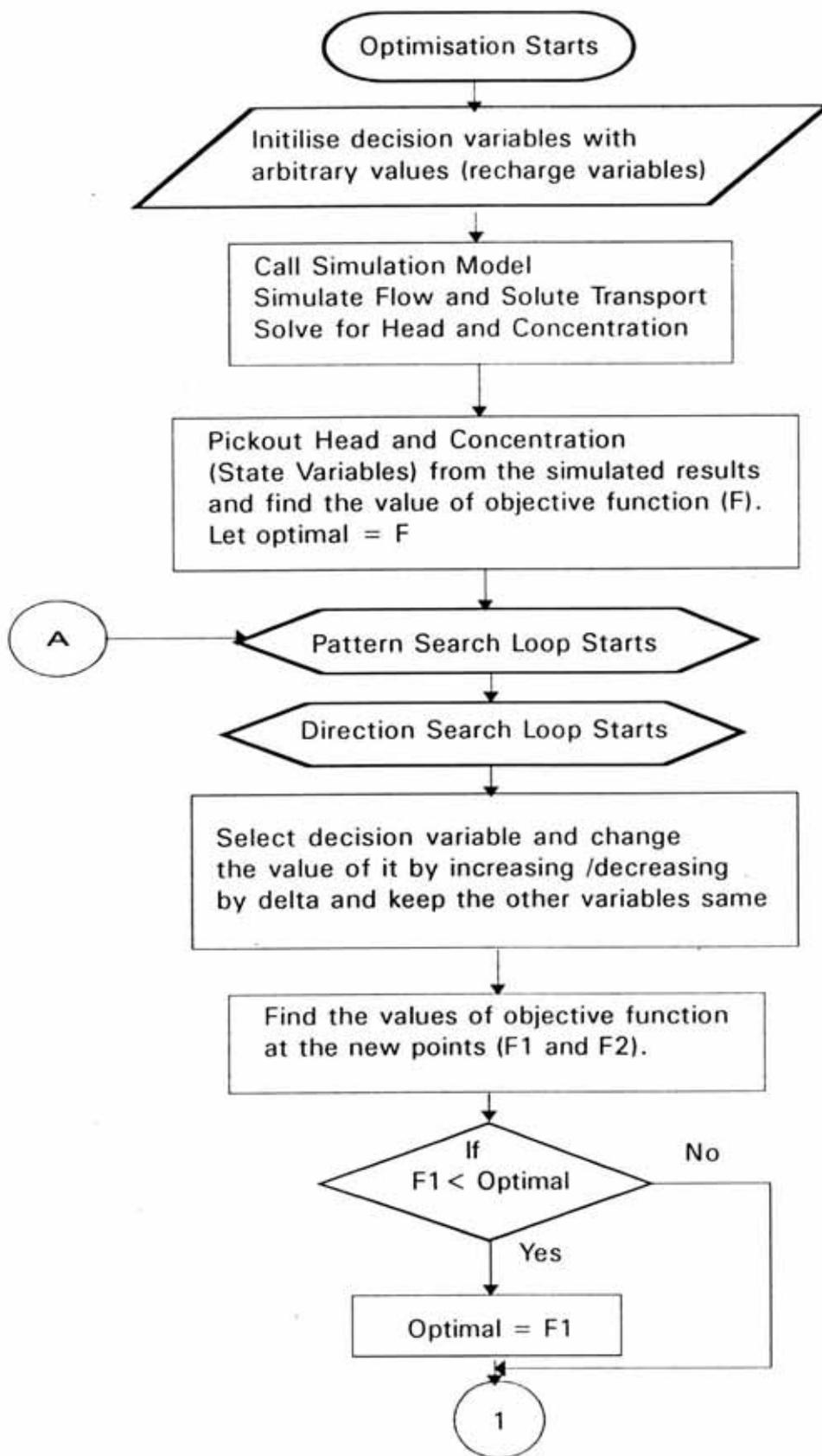


Fig. 5 Flow chart for the combined simulation-optimisation model (continued)

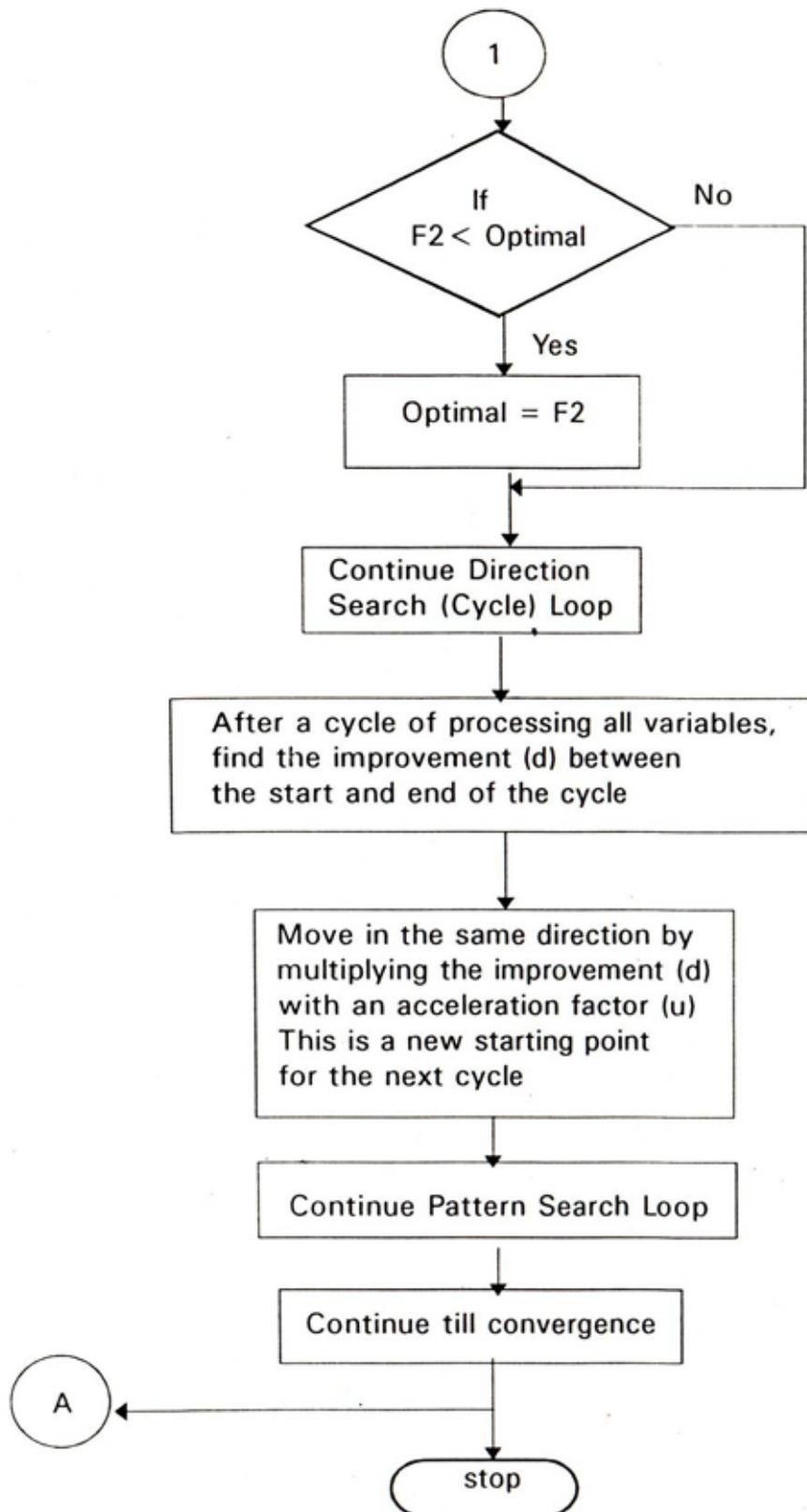


Fig. 5 Flow chart for the combined simulation - optimisation model

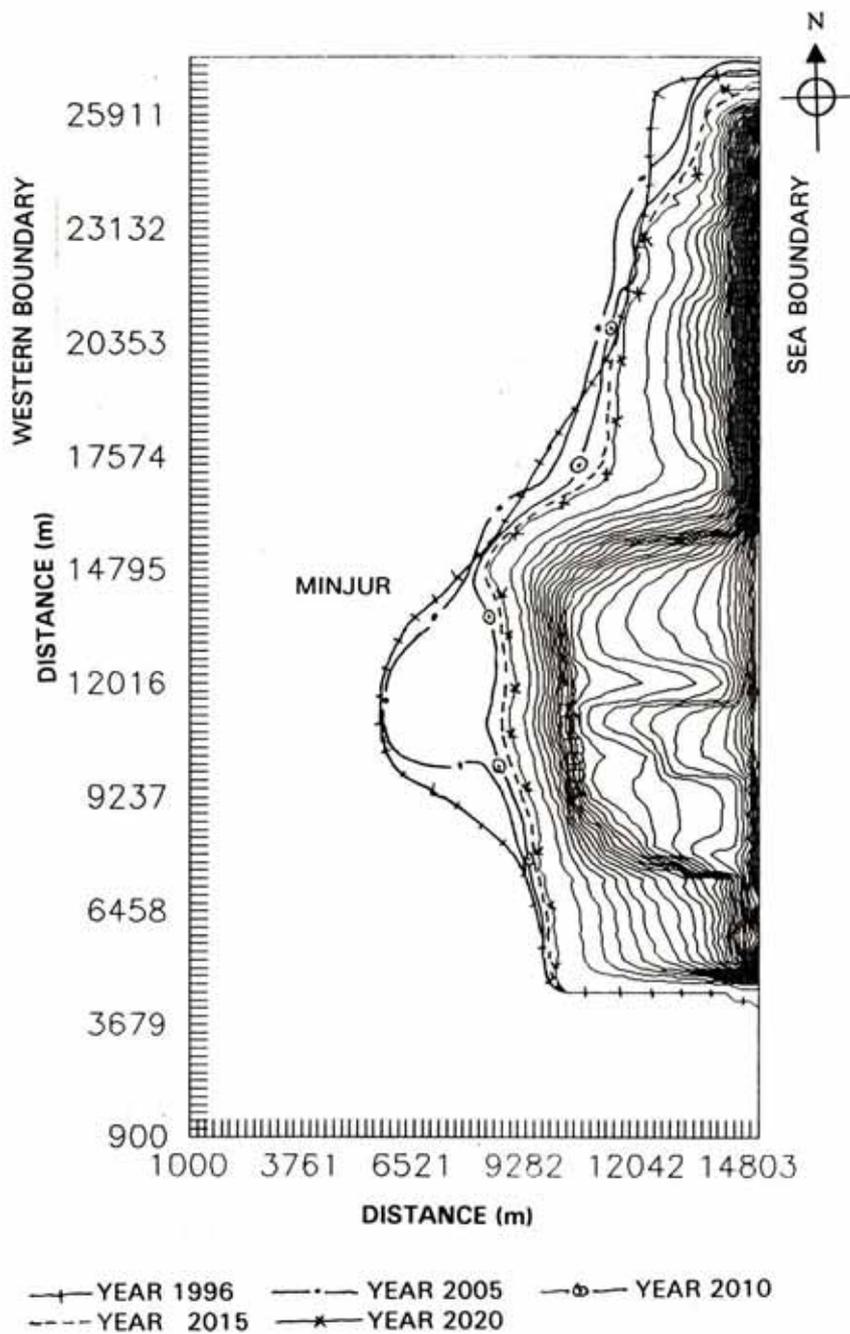


Fig. 6 Projected isochlors at an intervals of 1000 mg/l for scenario 2



On the Ecological Reconstruction of the Coal Mining Area Based on the Sustainable Development

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Abstract

The coal is the most important disposable energy in our country. Coal resources play a strategic role in our country's economic and social development, but there are a series of ecological environment problems about the mining and the utilization of coal resources. These problems in the coal mining area have already become an obstacle to the sustainable development and also a major hidden danger to the regional ecological security.

On the analysis of ubiquitous problems of the ecological environment in the coal mining area and supported by the theory of the sustainable ecological development, the thesis penetrates the characteristics and laws of the mine ecosystem succession and reconstructs the mine ecological industrial chain. To change the traditional thoughts of "development- pollution- governance", new ideas and ways of the sustainable development of the coal mining area have been put forward in order to achieve the harmonious development of economy, society and environment.

Keywords: Coal mining area, Ecological environment, Sustainable development, Ecosystem reconstruction

1. Introduction

In the long run, the coal is widely utilized in various national economic sectors as the important disposable energy in our country. Among all kinds of mineral areas, the coal mining area enjoys a top position in terms of its number, scale and distribution. Currently, there are over a hundred mineral cities in our country, about one fifth of the total number of cities. So the process of the sustainable development of the whole country relies largely on the sustainable growth of the coal mining area. But with the economic boom, a series of problems, such as exhausting coal resources, the contaminated ecological environment, frequent coal accidents, and so on, have become a serious obstacle to the sustainable development in coal mining area and a major hidden danger to the regional ecological security. The thesis inquires into the reconstructed strategies of coal mining area ecosystem on the basis of related ecological theories.

2. Basic analysis of IECMA

The coal mining area ecosystem is formed by the interactions of the human system, the natural environment system and the man-made economic system. It is an integrated ecosystem of coal mining area (IECMA) and is restricted by the laws of the natural eco-balance and the economy.

2.1 Structure analysis of the IECMA

IECMA is a changeable ecosystem. It can be divided into three interactive subsystems, i.e. the social, the economic and the natural subsystems, and each subsystem can be further divided into different systems, with each including various factors of its own. (See Fig.1)

2.2 Characteristic analysis of the IECMA

The structure of IECMA has been changed by the human, the circulations of material and energy been changed partly too. It is influenced by the human deeply, which is different from the natural ecosystem. IECMA has the following characteristics.

IECMA is a man-made ecological system deeply influenced by human activities. Due to the existence and production of human beings, the structure, the material circulation, and the energy transformation of the system have been changed completely or partially. Different from the natural ecosystem, IECMA has the following characteristics.

2.2.1 The dominant position of human in IECMA

For the sake of production and living, a large quantity of buildings and infrastructures for transportation and telecommunication are built. The main part of the coal mining area ecosystem has been changed into a man-made

environment. Human occupies a dominant position in this ecosystem. The previous natural ecosystem has been destroyed seriously by human with the exploitation of coal resources. The IECMA becomes more complex and diversified due to the violent interference and high intensity of human activities.

2.2.2 Fragility and incompleteness

IECMA is an open, complex and gigantic system. It is different from the natural ecosystem due to its lack of the producer and the decomposer. On the one hand, the material and the energy have to be imported from outside; on the other hand, plenty of garbage must be disposed through proper methods that cause no harm to the environment. So IECMA is a very fragile, incomplete and unstable system.

2.2.3 Complexity

IECMA is a transitional belt for the interaction among atmosphere, the rocks, the organism and the soil. It is restricted by the regional geology and terrain conditions. At the same time it has close relations with the residents in the coal mining area. The system keeps on fluctuating due to the continuous mining. Once the balance of the IECMA is destroyed, it is hardly recovered within a short period of time.

2.3 *Stress analysis of the IECMA*

Coal mining leads to the pollution and the destruction of the ecological environment, which have caused serious threat for the economic and social development of the coal mining area. Through the analysis of the exterior stress, the effective regulation and solution can be taken.

2.3.1 Pollution and destruction of water resources

During the mining process, the water is drained off by the worker to ensure their securities. Meanwhile, the crackle that is formed by mining also leads to pollute water resources. The declining of grand water level causes the reduction of crops and collapse of the ground. The polluted water threatens the health of local residents.

2.3.2 Occupation and pollution of land resources

Plenty of garbage like the gangue discarded during the mining process often occupies large areas; furthermore, the harmful heavy metal in the garbage pollutes the land, the river and the atmosphere through the run off and the air dust, taking a worse effect on the environment.

2.3.3 Destruction of ground vegetation

Coal mining and the collapsed ground due to the mining destroys the landform and the green vegetation, accelerates the process of the water and soil erosion, reduces the land value and deteriorates the ecosystem.

2.3.4 Pollution of atmosphere

The coal buried underground contains a small amount of hydrocarbon gas, which is a kind of greenhouse gas given off through the mining tunnels. Besides, some other poisonous gases such as H₂S & CO etc are discharged via the tunnels. They pollute the atmosphere seriously.

3. **Reconstruction of IECMA**

Reconstruction of IECMA is to optimize and reorganize the structure, the component and the function under the support of manual work. Corresponding technical and economic measures are applied to solve the problems in the regressive succession of the ecosystem so as to reconstruct a sustainable ecosystem.

3.1 *Theoretical basis of reconstruction*

3.1.1 Theory of ecological balance

In nature, the ecosystem can regulate by itself. It can achieve a good condition where the components and the proportions hardly change, and the input and output of material and energy approximately equal. The condition is called ecological balance. But IECMA is an open and man-made ecosystem. In order to keep the ecosystem stable and ordered, the flows of material, energy and information must be regulated artificially so as to harmonize the system and establish a new balance.

3.1.2 Law of ecosystem succession

When the ecosystem experiences a series of fluctuations, a general trend comes into being that the organism variety becomes more than ever, the structure develops from simple to complex, the system from unstable to stable, and at the same time, the conditions of resources and environment are utilized abundantly. This evolution is called the progressive succession. On the contrary, the destroyed ecosystem goes backwards by the exterior stress. When the organism variety becomes less, the structure becomes single, the balance is lost and the environment is worsened. The condition is called regressive succession. This kind of phenomenon is common in the coal mining area.

3.2 Technical ways of reconstruction

3.2.1 Restoration of ecological environment

Restoration of ecological environment is to reclaim the destroyed terrain and landform. It is feasible that the gangue and coal ash are used to reclaim the destructed land. The practice confirms that the reclaimed land improves a lot, the water and soil erosion declined and the soil fertility and the ecosystem enhanced. Good ecological and economic benefits are reaped.

3.2.2 Optimization of system structure

The principle of “adjusting measures to local conditions” should be implemented according with different characteristics of our country’s geological environment. The reclaimed land in the middle and the west regions are suitable for establishing comprehensive agricultural developing region, so as to regulate the proportions of the agriculture, the forestry and the animal husbandry. However, the east regions are suitable for developing ecological agriculture and building new types of mining cities simultaneously. Through optimizing and arranging the structure model of ecosystem artificially, the self-regulation ability of the system can be enhanced and the proper operation of the system be realized.

3.2.3 Construction of ecological industry chain

The origin of the environment pollution and ecosystem destruction in the coal mining area lies in the unreasonable mining ways and low utilization rate of resources, especially the linear flow rather than the circular flow of material and energy. Too much disposed materials discharged in the form of wastes and detained in the environment block the recirculation route. The ecological industry chain must be established for the sake of enhancing the comprehensive utilization rate of coal and the reduction of discarded material, so as to achieve circulatory economy.

(1) Sanitizing production

Sanitizing production is to reduce the amounts of the discharged materials. At present, some sanitized production technologies are applied in the coal mining, such as innovation of tunnel layout for reducing the amount of rocks; filling the mining tunnel with the gangue; gas drawing and emitting technology; recycling the mining water, etc. Meanwhile, the technology of sanitized coal is implemented in full scale, the advanced technology of coal procession, utilization, transformation and burning are carried out, so as to reduce pollution to the full extent and to transform the coal into a kind of sanitary fuel.

(2) Diversifying products

Although great progress has been made on the utilization rate of coal in recent years, the average recyclable rate is only 40 percents, which is far below the average level of 80 percents in developed countries. The related data are shown in Table 1. To achieve the sustainable development, the coal products must be operated in a diversified way, from the single raw coal to varied kinds of coal products. As a result, the comprehensive utilization rate and the market competitive power can be enhanced.

(3) Extending industry chain

The coal resource is increasingly rare. In order to achieve the sustainable development, new technology and craft should be recommended to extend the industry chain, the coal-electricity, coal-building materials and coal-making gas-carbinol industry chains be built, and the extra value of the coal product increased greatly. At the same time, the industrial tourism should be developed vigorously to expand the industry chain.

3.3 Management mechanism of reconstruction

Environmental management in coal mining area is to manage the behaviors of enterprises. The purpose is to implement the green mining techniques, keep the balance of IECMA and avoid the exhaustion of coal resources and the degradation of environment. The coal mining environmental management mechanism should adopt the biological and engineering techniques and the economic, administrative and legal methods comprehensively. It is the basic way to achieve the reconstruction of IECMA.

4. Conclusion

Today, the situation of the resource and environment is very critical. We humankind have realized that we should get along with the nature harmoniously. The coal mining area is special for its environmental problems. The reconstruction measures must be carried out according to the characteristics.

On the whole, the reconstruction of IECMA aims to harmonize the relations among economic development and the environmental protection, the coal industry, the agriculture and the other industry. It is a long-term system engineering. The structure and the function of IECMA should be regulated by human on the basis of the theories of ecology and system engineering. Only putting the above listed biological and engineering measures into effect in coal mining area

can we ensure the proper operation of IECMA and accomplish the sustainable developments of the economy, the social and the environment in the end.

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Table 1. Index of the coal comprehensive utilization rate from 2003 to 2007 in China

Year	Washing rate of raw coal	Utilization rate of mine water	Utilization rate of solid garbage	Utilization rate of the drawn gas	Average recyclable rate
2003	20%	30%	30%	20%	10-15%
2005	32%	44%	43%	40%	20-30%
2007	50%	70%	70%	60%	40%

Note: Data from the document of <Opinion on the work of saving energy and reducing emission of the coal industry> issued by the National Development and Reform Commission and the State Environmental Protection Administration in 2007.

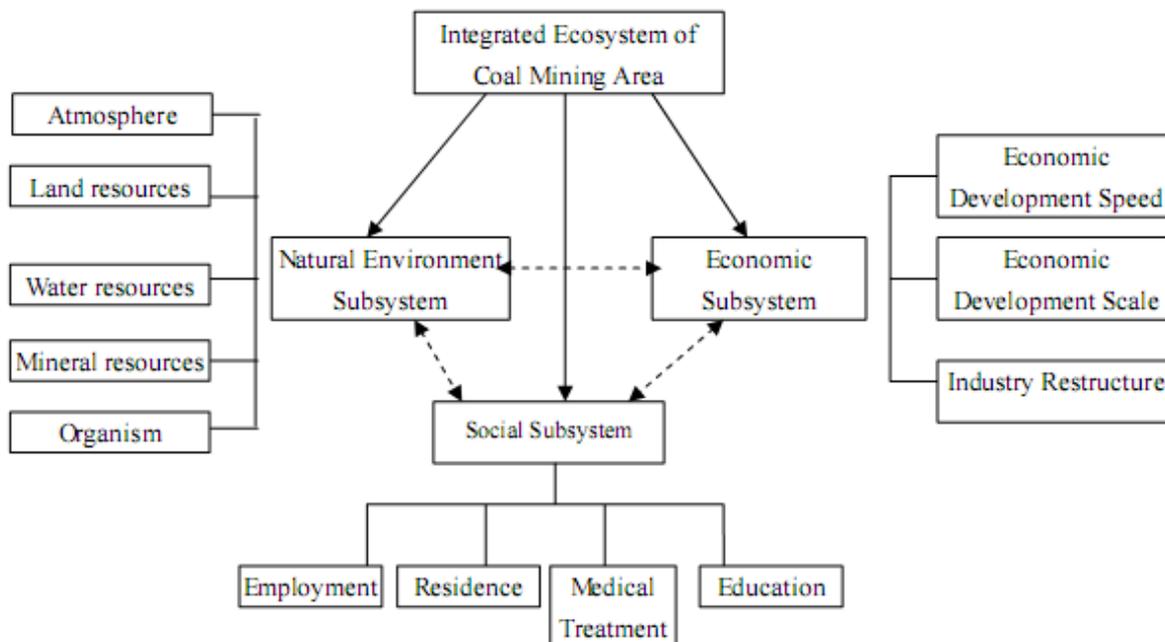


Figure 1. The Structure of Integrated Ecosystem of Coal Mining Area



Study on Removal of Organics of Different Molecular Weight by Coagulation-Membrane Filtration Process

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Abstract

This paper compares the difference in membrane flux between direct membrane filtration and coagulation-membrane filtration, and investigates the removal of organics of different molecular weight by coagulation-membrane filtration process, in turn studies the fouling removal mechanism of coagulation process. The results indicate that for COD removal from raw water, coagulation is effective mainly on the organics of molecular weight higher than 10 kDa, and membrane filtration is effective mainly on the organics of molecular weight between 30 kDa and 100 kDa and higher than 100 kDa; as for UV_{254} removal, coagulation is effective mainly on the organics of high molecular weight, and membrane filtration is effective mainly on the organics of molecular weight between 1 kDa and 100 kDa. Therefore, it proves that the high molecular organics are mainly responsible for the membrane fouling.

Keywords: Coagulation, Membrane filtration, Membrane fouling, Molecular weight distribution of organics

Preface

In-depth membrane cleaning process mainly includes pretreatment process and membrane filtration process. Pretreatment process is used to remove the foulants that have adverse effects on the subsequent membrane assembly, as well as the large-size or high-molecular foulants that can not be removed by membrane filtration process. Membrane filtration process is only used to remove the foulants that have suitable particle size for the membrane interception. Application of pretreatment process, as possible as it can, prolongs the service life and increases the processing efficiency of membrane (Shao, 2002, p. 30-32; Shao, 2001, p.26-27). As a type of pretreatment process for membrane filtration, coagulation has been widely applied in the processing of drinking water. Coagulation can remove not only suspensions and colloids, but also part of the organics from water. As a result, it can effectively lower the membrane fouling.

The molecular weight (MW) of organics in raw water has a certain effect on the membrane fouling. Therefore, coagulation pretreatment can slow down the decline of membrane flux. Kerry J Howe et al (2002, p. 3571-3576) separated the organics in natural water with ultrafiltration membranes of different MWCO (molecular weight cut-off) into different groups of 3,000 kDa, 10,000 kDa, 30,000 kDa and 100,000 kDa, conducted a filtration experiment for each fraction, and found out that the decline of membrane flux increases with the rise of MW of organics. Wei et al (2000, p. 5043-5050) reported that the high molecular humus resulted in severe membrane fouling. However, Carroll et al (2000, p. 2861-2868) reported that the most severe membrane fouling resulted from the low molecular hydrophilic organics. By investigating the change of membrane flux, as well as the change of organics of different MW after coagulation, this paper studies the fouling removal mechanism of coagulation process.

1. Experiment

1.1 Quality of raw water

The studied water sample is from Lake Pan at Tianjin Polytechnic University. Its water quality during experiment is shown in table 1.

1.2 Determination of MW

MW distribution is determined by ultrafiltration process (Table 2). The Millipore Ultrafiltration Membranes are provided by SINAP (Shanghai).

1.3 Determination method and equipment

The turbidity is determined with Hach turbidimeter; UV_{254} is determined with UV-2450 ultraviolet spectrophotometer; COD_{Mn} is determined by the acidic potassium permanganate method; and TMP (transmembrane pressure) is determined with U-gauge.

PVDF hollow fiber membrane is provided by MOTIMO Membrane Technology Institute of Tianjin Polytechnic University. It has an inner diameter of 0.6 mm, an outer diameter of 1.1 mm, and an average pore size of 0.2 μm .

2. Result and discussion

2.1 Effects of coagulation on the decline of membrane fouling

Respectively drive the raw water and the supernatant obtained by coagulation with 45 mg/L FeCl_3 across the microfiltration membrane. The effects of coagulation had been continuously investigated for 11 hours. Measure TMP with U-gauge every 10 minutes under the conditions that the filtration cycle is 1 hour, backflushing time is 5 minutes, and backflushing pressure is 1.2 times of initial pressure. Calculate the decay rate of membrane flux. Figure 1 exhibits the changes of membrane flux of the raw water and the supernatant obtained after coagulation.

Figure 1 indicates that the membrane flux of the raw water declines very rapidly, and is only 74% of the initial membrane flux after the first filtration cycle. Although recovered to 87% after backflushing, it still declines to 44% at the end of the whole operation period. Whereas, the membrane flux of the supernatant obtained after coagulation is stable and over 90% during the whole operation period. It proves that coagulation can remarkably increase the membrane flux.

2.2 The removal of organics of different MW from raw water directly by membrane filtration

The removal of organics from raw water with microfiltration membrane is shown in figure 2 and figure 3. Figure 2 reveals that COD of the lake mainly results from the organics of MW less than 1 kDa or 10~30 kDa; whereas UV_{254} mainly results from the organics of MW less than 1 kDa or 3~10 kDa. Therefore, the soluble organics in the lake mainly are the low molecular organics. This result is in accordance with the previous reports. Without considering industrial wastewater and domestic wastewater, organics in lake mainly result from the soil organics and the metabolites of algae and hydrophyte. Soil organics, generally, aromatic compounds, come from the soil-contacted groundwater or rainwater, and mainly consist of humic acid. Most of them have low MW of hundreds or thousands Dalton (Stuart W Krasner et al, 1996, p. 66-79).

From figure 2, we can see that membrane filtration has a little effect on the COD removal from raw water, especially on the organics of MW higher than 100 kDa and 30~100 kDa. Figure 2 also exhibits that COD in the effluent water during the latter 2 hours is much lower than that during the former 2 hours, and membrane filtration has an obvious effect on the organics of MW higher than 100 kDa and 30~100 kDa during the latter 2 hours. This is probably because the membrane pores are blocked with some high molecular organics and become smaller at the beginning of the filtration, and able to filtrate more organics, in turn improve the quality of effluent water. It indicates that membrane filtration has an excellent effect on the removal of high molecular COD.

Figure 3 also exhibits that membrane filtration has a little effect on the removal of UV_{254} , especially on the organics of MW 3~10 kDa and 1~3 kDa. It indicates that for UV_{254} removal, membrane filtration is effective mainly on the low molecular organics. This probably results from the membrane absorption. Similar to figure 2, the quality of the latter effluent water is much better than that of the initial effluent water.

2.3 The removal of organics of different MW from raw water by coagulation-membrane filtration

2.3.1 The removal of organics of different MW from raw water by coagulation

Add 45 mg/L FeCl_3 into the raw water. The MWD of organics in the supernatant obtained by coagulation is shown in figure 4 and figure 5.

From figure 4 and figure 5, we can see that coagulation has a good effect on the removal of COD and UV_{254} . The removal rates of them are over 50%. As for COD removal, coagulation has an obvious effect on the organics of MW higher than 100 kDa, 10~30 kDa and less than 1 kDa, but almost no effect on the organics in other MW range. However, for UV_{254} removal, coagulation has an obvious effect on all organics, especially on the organics of MW higher than 100 kDa, 30~100 kDa and 10~30 kDa, almost all of them can be removed.

The difference in the removal effect between COD and UV_{254} is mainly because they result from different organics. UV_{254} mainly comes from the polar group-contained organics (carbonhydroxyl organics or hydroxyl organics, for example) which is electronegative in the natural water. COD mainly results from the various soluble organics. Robert L Sinsabaugh reported that coagulation had an obvious effect on the removal of hydrophilic organics and hydrophobic organics, but a poor effect on the removal of neutral organics (Dong et al, 2002, p. 29-31). Therefore, coagulation process is generally used to remove the organics of MW higher than 10 kDa and less than 1 kDa.

2.3.2 Comparison among the removal rates of organics of different MW

From table 3, we can see that the COD removal rate by coagulation is up to 56%, and coagulation is effective mainly on the removal of organics of MW higher than 100 kDa, 10~30 kDa and less than 1 kDa. It proves that the COD removal effect by coagulation is better than that by direct membrane filtration. Table 3 also reveals that the COD removal rate

from the supernatant by membrane filtration, similar to that from the raw water by direct membrane filtration, is about 10% at the beginning, then rises up to 20% after a certain time of operation. In addition, the membrane filtration is proved to be effective mainly on the removal of organics of MW higher than 100 kDa, even results in a negative removal rate of organics of MW between 10 kDa and 30 kDa. This result is in accordance with the obvious reports (He, Beiping, 1996). It is probably because the organics in this MW region are susceptible to being absorbed into membrane hole, which leads to a negative removal rate of organics within a certain time.

From table 4, we can see that the UV₂₅₄ removal rate by coagulation is up to 52%, and coagulation is effective mainly on the removal of organics of MW higher than 10 kDa. Table 4 also reveals that direct membrane filtration is effective mainly on the removal of organics of MW 1~3 kDa from the raw water; whereas membrane filtration after coagulation is effective mainly on the removal of organics of MW 1~100 kDa from the supernatant, and the UV₂₅₄ removal rate can reach 100% by the end of the operation in most cases. It is probably because the organics of MW higher than 100 kDa, 30~100 kDa and 10~30 kDa has been removed by coagulation, and the rest is intercepted by the membrane whose holes have been partially blocked and become smaller.

Based on an overall consideration of table 3 and table 4, it is concluded that coagulation is effective on lowering the membrane fouling because coagulation works well on the removal of organics of MW higher than 10 kDa and less than 1 kDa, and it is mainly the high molecular organics that result in fouling on the membrane.

3. Conclusion

- (1) The result of screening experiment indicates that Lake Pan mainly consists of the organics of MW less than 1 kDa.
- (2) Coagulation can effectively prevent membrane from fouling, and the removal rate of organics by coagulation is over 50%. As for COD removal, coagulation is effective mainly on the organics of MW higher than 100 kDa, 10~30 kDa and less than 1 kDa; whereas for UV₂₅₄ removal, coagulation is effective mainly on the high molecular organics.
- (3) Membrane filtration has a poor effect on the removal of soluble organics. As for COD removal, it has an effect mainly on the organics of MW higher than 100 kDa and 30~100 kDa; whereas for UV 254 removal, it has an effect mainly on the organics of MW 1~3 kDa and 3~10 kDa.
- (4) The results of study indicate that the organics removal rate by membrane filtration is about 10% at the beginning, then rises up to 20% after a certain time of operation.
- (5) Coagulation-membrane filtration can not only prevent membrane from fouling, but also remove the soluble organics from water. The total removal rate by coagulation-membrane filtration is up to about 75%.

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Table 1. The quality of water from Lake Pan

Items	pH	Turbidity (NTU)	COD _{Mn} (mg/L)	UV ₂₅₄ (cm ⁻¹)
Range	7.92~8.19	2.67~3.26	5.10~7.97	0.114~0.176
Average	8.055	2.965	6.535	0.145

Table 2. Material and MWCO of membrane

Membrane specifications	Membrane materials	MWCO of organics
Microfiltration membrane (0.45 μm)	Cellulose acetate (CA)	Particle size is larger than 0.45 μm
Ultrafiltration membrane (100,000)	Polysulfone (PM)	>100 kDa
Ultrafiltration membrane (30,000)	Polysulfone (PM)	>30 kDa
Ultrafiltration membrane (10,000)	Polysulfone (PM)	>10 kDa
Ultrafiltration membrane (3,000)	Polysulfone (PM)	>3 kDa
Ultrafiltration membrane (1,000)	Polysulfone (PM)	>1 kDa

* 1 Dalton = 1.66×10^{-27} kg

Table 3. COD removal rate in different MW range by coagulation, direct membrane filtration and coagulation-membrane filtration

	>100 kDa	30~100 kDa	10~30 kDa	3~10 kDa	1~3 kDa	<1 kDa	Total removal rate
By direct membrane filtration (the former 2 hours)	33.2%	41.3%	17.4%	2.2%	—	2.2%	8.4%
By direct membrane filtration (the latter 2 hours)	79.5%	86.0%	18.7%	5.5%	—	16.5%	24.8%
By coagulation	80.3%	11.8%	85.6%	20.2%	40.0%	57.6%	56.4%
By coagulation-membrane filtration (the former 2 hours)	0.0%	14.9%	11.3%	30.8%	11.1%	5.1%	9.0%
By coagulation-membrane filtration (the latter 2 hours)	92.4%	53.0%	30.9%	26.3%	—	8.3%	19.1%

Table 4. UV₂₅₄ removal rate in different MW range by coagulation, direct membrane filtration and coagulation-membrane filtration

	>100 kDa	30~100 kDa	10~30 kDa	3~10 kDa	1~3 kDa	<1 kDa	Total removal rate
By direct membrane filtration (the former 2 hours)	10.0%	0	28.6%	32.1%	53.8%	1.3%	14.1%
By direct membrane filtration (the latter 2 hours)	20.0%	25.0%	0	39.3%	53.8%	6.3%	18.3%
By coagulation	70.0%	75.0%	71.4%	67.9%	38.5%	43.8%	52.1%
By coagulation-membrane filtration (the former 2 hours)	0	0	100%	55.6%	25.0%	0	13.2%
By coagulation-membrane filtration (the latter 2 hours)	33.3%	100%	0	100%	75.0%	4.4%	29.4%

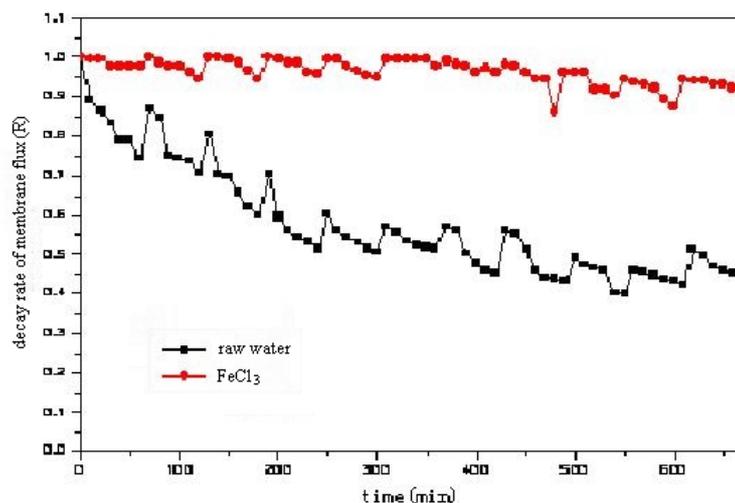


Figure 1. The effect of coagulation on membrane flux

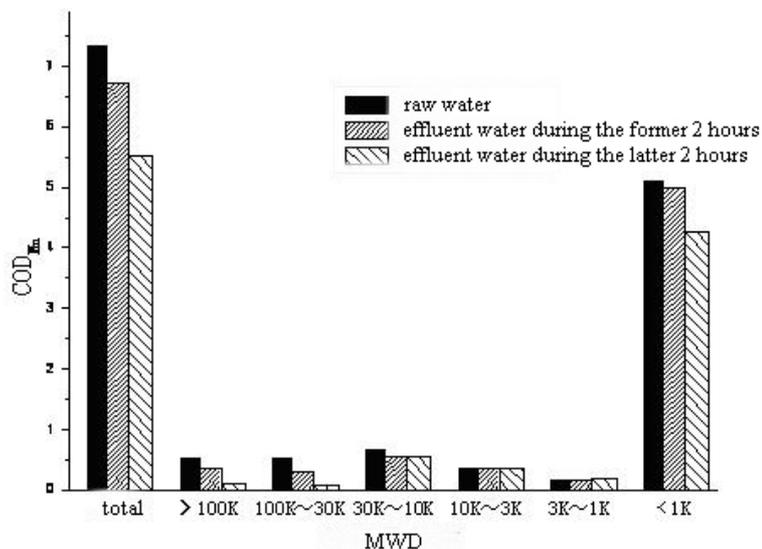


Figure 2. COD removal from raw water by direct membrane filtration

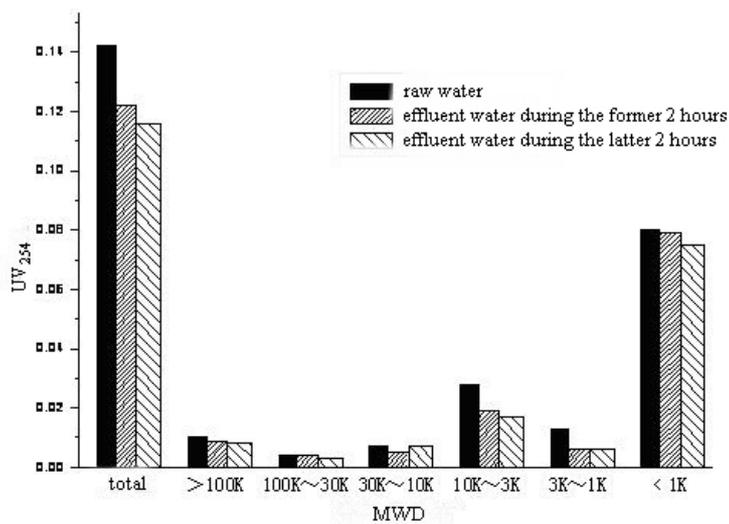


Figure 3. UV₂₅₄ removal from raw water by direct membrane filtration

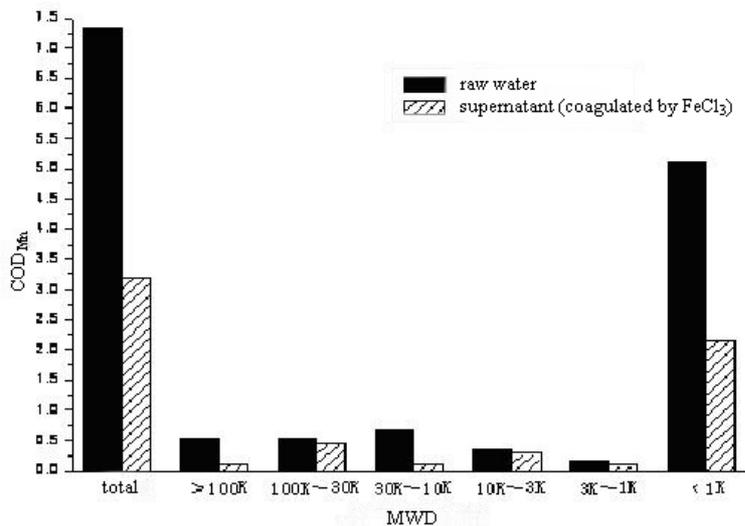


Figure 4. COD removal from raw water by coagulation

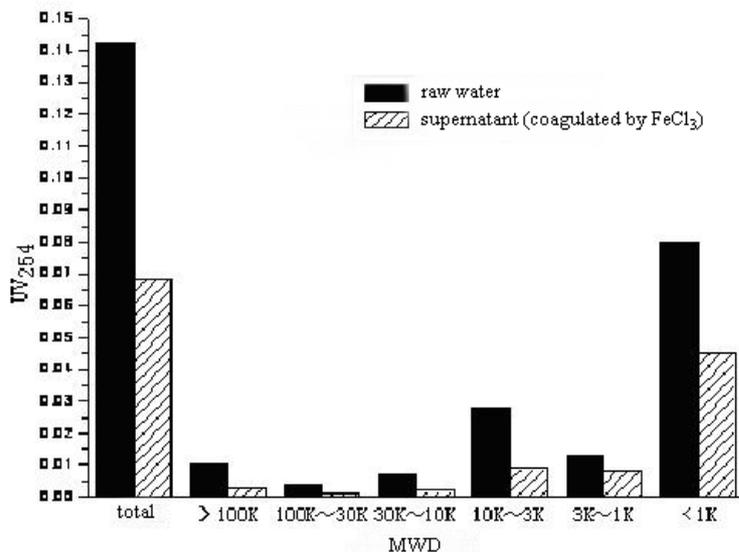


Figure 5. UV₂₅₄ removal from raw water by coagulation



The Study of the Ecological Problems of Eucalyptus Plantation and Sustainable Development in Maoming Xiaoliang

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Abstract

In recent years, the eucalyptus plantation industry develops rapidly in Xiaoliang Soil and Water Conservation Station of Maoming city, Guangdong Province. It has brought enormous economic benefits for regional economic development, and also brings many ecological problems. Based on the analysis about the advantages and disadvantages of the eucalyptus plantation industry development, the researches about the laws of its development and characteristics, and the exploration about good strategies for its sustainable development, this paper has important realistic significance to promote the healthy and steady development of regional economy.

Keywords: Maoming Xiaoliang, Eucalyptus plantation, Ecological problem, Sustainable development

Introduction

Eucalyptus is the general name of the Myrtaceae Eucalyptus species, originated in Australia and nearby islands. Because of its fast-growing, short rotation, desiccation-tolerant, drought-tolerant, adaptable, use of broad, high economic benefits, eucalyptus is known as one of the world's three major fast-growing tree species, which widespread in tropical and subtropical regions. China introduced in eucalyptus since 1989, it has gone through a journey of 100 years from planting before the founding of the People's Republic to its current scale development. Today, the total area of eucalyptus plantations in China have exceeded to 170 million hectares, ranking the second in the world. Eucalyptus has become the fast-growing, high yield, commercial forest tree species in South China (Zhang Junhua., 2006).

In recent years, eucalyptus plantations of Xiaoliang Soil and Water Conservation Station have developed rapidly and achieved significant economic benefits, while there is also a serious ecological problem. Under the guidance of scientific concept of development, combined with the practical production of Xiaoliang, how to carefully analyze the advantages and disadvantages of the development of eucalyptus plantations, study the laws of its development and characteristics, and explore the best methods for their sustainable development, in order to achieve the sustainable development of eucalyptus plantations is an urgent problem should be solved at present.

1. The development status of Xiaoliang ducalyptus plantation (Yang Liu Chun et al, 2003; Fang Daiyou, 2005)

1.1 The development of eucalyptus plantations in the study area

Xiaoliang Soil and Water Conservation Station, located at north $21^{\circ} 27'49''$, east $110^{\circ} 54'18''$, it belongs to subtropical maritime monsoon climate zone, with the annual average temperature of 23° , the annual average rainfall of 1400 to 1700 millimeter, and a noticeable change in wet and dry seasons. Xiaoliang has topography for coastal platform, soil zones for red and laterite, and Natural vegetation is subtropical monsoon forest. Due to human destruction of vegetation and serious soil erosion, Xiaoliang has become to a veritable barren land (Yang Liu Chun et al, 2003).

Zhanjiang Water Conservancy Bureau founded the Maoming, Xiaoliang Soil and Water Conservation in 1957, began to do ecological restoration experiments on this infertile barren land. Using a combination of engineering and biological methods, they planted 266.67 hectares of drought-tolerance, barren-tolerance, fast-growing eucalyptus and pine as a "pioneer forest" which adapted to local conditions, made the initial success of soil erosion. However, single forest form, strong absorption and fat absorption capacity of the eucalyptus, lack of surface litter to contain moisture, thus grass never grow and soil erosion is still very serious. Later, they created an ecological mixed forest and fruit forest, which has basically controlled the soil erosion and partly restored the ecology in Xiaoliang. In recent years, due to poor soil

and poor economic benefits for fruit trees, yet another large-scale cultivation of eucalyptus commences in Xiaoliang Soil and Water Conservation Station. In order to obtain better economic benefits, they cut down the original "pioneer forest" for sale, while expanded the cultivation area of fast-growing Eucalyptus. Now except for retaining some small piece of the ecological forest and a small number of fruit trees, most of the land is planted with fast-growing commercial eucalyptus such as eucalyptus number 5 and number 6. Harvesting period of commercial forest shorten to 3-5 years, and limited artificial fertilizer impoverishes the original low fertilized erosion soil, in which rare plant can grow. Currently eucalyptus cultivation area is accounting for more than 70 percents of the total area, and this number continues to rise, probably reach to more than 90 percents in 3 to 5 years. Then there will be almost entirely eucalyptus plantations except for an ecological protection forest (26.67 hectares). Therefore how to manage the eucalyptus plantations scientifically, is the key point to solve the sustainability development problem of Xiaoliang water and soil conservation station.

Forests are the material basis for subsistence and precious wealth resources of the mankind, and the earliest means of production which exploited by human. With the increase in population, acceleration in urbanization and development in industrial and agricultural production, the human society demand for forest resources is also growing. In order to protect the ecological functions of forests, we should promote the development of fast-growing forests and timber stands. Meanwhile, under the guidance of the sustainable development view, the concept of sustainable use of forest resources has been put forward. Sustainable development of forest resources refers to under a specific period of time and geographical condition, the forest resources should be rational developed, utilized, improved and protected, coordinated the relationship with human beings, in order to meet the needs of the sustainable development of mankind. The sustainable development of Eucalyptus forest is characterized as follows: the ecological performance of non-degradation on the eucalyptus quality, which can be a steady supply of socio-economic development and ecological protection, and the need to maintain a high production capacity; the economic performance of Eucalyptus forest resources for sustained and efficient use, which means receiving high-quality, high-volume products and efficient cost-effective in a limited area, while maintaining eucalyptus forest resources sustainability with high output function; the social performance of fairness between contemporary people and generations on the utilization, improvement and profits of eucalyptus forest resources, namely, the use of eucalyptus forest resources should meet the needs of contemporary people, as well as ensure the future generations' survival and development demand on forest resources(Lin Yihui.,2001). Using the above standards to measure the sustainable development of the eucalyptus plantations production in Xiaoliang study area, the problem is the low sustainability. Xiaoliang sustainable development of production, there is a big problem, the sustainability of current production is very low. Therefore, in order to promote the harmonious development of regional ecological economy, correct understanding and scientific research on the sustainable development problems of Xiaoliang eucalyptus plantation is an instant task.(Wu Qionghui,2006).

2. Strength and weakness analysis of eucalyptus production in the study area

2.1 strength analysis (Yang Minsheng et al, 2006)

Xiaoliang Town is predominant in developing eucalyptus plantations, which has lots of advantages, such as superior natural conditions, increasingly mature cultivation technique and broad market prospects, which provides favorable conditions for the development of eucalyptus.

(1) Superior natural conditions for eucalyptus plantations production

Xiaoliang Town of Maoming city is located on the transition zone between the tropical and subtropical, and is strongly influenced by monsoon climate, with the climate feature of the north tropical - south subtropical. The climate here is resource-rich of heat, and abundant rainfall. The annual average temperature is 23 . Annual mean precipitation is 1442mm. It is one of the richest natural resource of water,heat and light area in China.

The climate conditions here is similar to the origin of eucalyptus, suitable for wide development enjoys exceptional climate conditions advantages. At present, eucalyptus planting area in Maoming city is only 38000 hm², which is an area lesser. It means there is great potential for further development of eucalyptus.

(2) Eucalyptus plantations produce sophisticated cultivation techniques

Guangdong is not only one of the earliest provinces introduction of Eucalyptus in China, but also the cultivation of an area of eucalyptus plantations. The one-century cultivation history has accumulated rich experiences and has laid a good foundation for the rapid development of Eucalyptus. Maoming is close to the Guangdong province's largest eucalyptus plantation production areas - Zhanjiang, which provides sophisticated cultivation techniques and experiences for the development of xiaoliang eucalyptus plantations. And at the same time lays the base for xiaoliang became the basis of eucalyptus plantations

In recent years, through the researches about eucalyptus' determination of optimal rotation, techniques of eucalyptus' high-yielding, techniques of forest's fertilization etc., Guangdong Province is gradually adopting techniques of afforestation, such as asexual breeding, reasonable site preparation, scientific fertilization, in-time tending etc., making

the development of eucalyptus plantation toward to the scientific, intensive management progressively.

The vast market prospect of eucalypt-plantation

With the rapid growth of the national economy and improving quality of people's life, the consumption of lignum has leaped sharply. To protect the forestry ecological efficiency, the commercial eucalypt-plantation has developed fast in Guangdong province. There are more than twenty thousand forestry corporations where employees amount to over three million, annual production value is nearly three hundred billion and the annual consumption of lignum has increased by 19.6 fold from 1978 to 2004. However, the autochthonic one is only three million cubic metres to supply the market in Guangdong, and the more depend on other provinces and overseas. The imported lignum up to five million metres every year, and the imported wood pulp and waste paper exceed four million ton. Owing to the large supplying gap of lignum in Guangdong, eucalypt which is the excellent trees to make paper and man-made board has brilliant and broad prospect.

2.2 Weakness Analysis (Xie Zhixing, Yan Daibi., 2006; Xie Yaojian, 2003)

Eucalyptus has many advantages and it is popular, but the problem of artificial eucalypt forest also outstanding. Like other artificial forests, artificial eucalypt forest has their faults in common, at the same time it has its own characteristics

(1) the artificial eucalypt forest eucalypt forest soil fertility declination

From the beginning of the 19th century, people have noticed the artificial eucalypt forest soil fertility declination is a common phenomenon, and its reason is various.

Firstly, eucalyptus is a fast growing tree. It absorbs a lot of nutrition and water from the soil in a unit of time, which cause nutrients and water continuous loss.

Second, the reason of soil fertility declination is artificial forest measures or site management. The major reasons are burning, destroying the soil nutrient; complete-tree utilization and shortening rotation length; the production of sod mud; land preparation, water loss and soil erosion.

The main reasons of soil fertility declination in XiaoLiang are land preparation, water loss and soil erosion; complete-tree utilization and shortening rotation length. It makes the land poorer and poorer, that other plants cannot live in this zone.

(2) bio-diversity decrease

Eucalyptus plantations bio-diversity decrease is a common phenomenon, which is mainly embodied in the reduction in the genetic diversity, species diversity, ecosystem diversity. The consequences of eucalyptus bio-diversity decrease is aggravated soil erosion and land degradation, forestland productivity decline, ecological environment deterioration, ecological poor stability and so on. Eucalyptus plantations bio-diversity decrease is not only due to natural environment factors, but even more to the effect of human factors.

As an alien species, eucalyptus is difficult to form a more complete eco-system with the local native trees; the consequence of anthropogenic interference is even more serious, multigenerational trees planted causes a serious decline in soil fertility. With increase of planting and times, floor vegetation of eucalyptus plantations and species diversity will decrease with each generation.

On the other hand, a considerable portion of forest used for planting eucalyptus is hilly, hills, plateaus, seaside in Guangdong province, where forest vegetation scarce, the composition of community is simple. What's more, power farming and opening up too much forest lead to the further destruction of vegetation. After the trees have been planted, it is hard to have a luxuriant growth of weeds under the forest.

(3) single structure of community

Due to the community between the composition of community and bio-diversity, so a decline in community biodiversity will inevitably lead to a single community level, vertical structure trend. Community structure is formed by a certain species, species in terms of quantity, the advantages of extent, distribution uniformity, etc. directly regulate the complexity and diversity of the community structure.

In the origin, under the first dominant layer of eucalyptus sclerophyll, there is a complete nanophanerophyte, grass, ground-litter. The area where has humid climate even has a sub-layer, showing the appearance of various kinds of complex ecological system, which is completely different from the several kinds of species of plantation communities in the origin, and the monotonous level.

3. Eucalyptus Plantations Sustainable Development countermeasure (Qi. Shuxiong., 1989)

Chen Shaoxiong, 2005)

3.1 Reasonable zoning and introduction of afforestation Zoning is to identify regional afforestation direction and planning purposes, to determine the proportion of the main forest tree species, to take corresponding measures for

afforestation technology is conducive to regional guidance, the progressive realization of regionalization, industrialization, production-oriented in order to adjust the layout of forestry to play a local The natural advantages, to improve forest productivity.

Introduced eucalyptus tree species selection need highly technical. Firstly, we should investigate the origin and the introduction to the similarity of rainfall conditions and analyze the introduction to the potential ecological limiting factor, and then we should consider ways to cultivate it with the purpose of use. Now as to the number 5 and 6 Eucalyptus that Xiao Liang planted, which were in the absence of research, they grown slow and ecological and economic benefits are not high, In our opinion, it should be rational planning, correct introduction under the guidance of scientific concept of development.

3.2 change the traditional site preparation methods and predatory business

Guangdong have serious damaged the soil structure for they use too much mechanized farming full-cultivated soil preparation methods, which is the right reason resulting in the loss of a large number of surface soil, and thus difficult to restore understory vegetation, so that within the eucalypt plantation surface runoff can not be effectively inhibited, prone to soil erosion and nutrient loss. Therefore, mechanized farming methods with site are better than the former methods, whether from an economic point of view or an ecological point of view.

The main way to change predatory business is to protect the eucalyptus plantation the litter layer and to prohibit the use of the whole tree. Post-harvest rotting tree stump to take the way to retain the stump of the nutrient elements. All of the branches, leaves and bark should remain in the woodland to add nutrients to the forest after a process of water-moisture and rot after some time.

3.3 Implementation of the mixed, crop rotation or interplanting

Xiaoliang eucalyptus due to many generations, even in pure forest, leading to soil fertility obviously retreat, become an obstacle to their development of the main problems or potential problems. It is proved that eucalyptus plantations mixed, may form a good stand structure, improve forest productivity and achieve sustainable business results.

Species of resistant barren, shallow root depth, preferably with a nitrogen-fixing function, full of falling objects and nutrient can be selected as the mixed species. It is found that Acacia is a good mix of eucalyptus tree species after a long trial. Mixed Eucalyptus and Acacia, in particular, between the lines mixed with the best results, it can improve soil, improve soil fertility and eucalyptus forest's productivity. Also, people were studying on crop rotation or interplanting of eucalyptus forests and crops (watermelon, peppers, etc.), to restore soil fertility, increase economic efficiency, achieve sustainable development.

3.4 Rational fertilization and correct planting

Eucalyptus is a fast-growing species, fast growth, per unit time consumption of soil water, fertilizer excessively is inevitable. Therefore, Fertilization becomes the key of eucalyptus plantations' fast-growing and high yield. In the fertilization, we should pay attention to the use of several elements and balanced fertilization, eucalyptus is the early fast-growing trees, it's important to fertilizer, preferably use controlled-release which suitable to the growth of Eucalyptus.

Proper cultivation of eucalyptus is very important. From the ecological and economic point of view, eucalyptus planting density should not be too dense (up to 400 / mu), too dense will cause not only can not harvest but also soil fertility decline, undermining the balance of the natural environment.

To sum up, eucalyptus as an important industrial timber species, which has three main benefits - eco-efficiency, economic and social benefits. Ecological needs has become the first needs of the community forestry. So Xiaoliang in the Eucalyptus plantation development should follow the "people-oriented, eco-first" principle, Take the scientific concept of development as guidance, go to the priority of forest ecological construction, ecological and economic sustainable development's road.

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Development of a Spacer for the Diluting Compartment of EDI-LB (Electrodeionization-Layered Bed) Device

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Abstract

With the product water from a one-stage reverse osmosis (RO) process as the feed water, ultrapure water has been prepared by a self-designed module for one-stage one-pass RO/EDI/LB filtration system (the thickness of spacer for diluting compartment is 10 mm). This paper evaluates the changes in voltage-current, resistivity of product water and conductivity of concentrate water, and achieves a proper spacer for diluting compartment. This spacer ensures an even distribution of fluid in diluting compartment, effectively avoids the intermixing between different layers, and realizes the deep removal of ions. It indicates that the resistivity of product water is higher than 17 MΩ·cm, water output per effective membrane area reaches $5.5 \times 10^{-5} \text{ m}^3/(\text{cm}^2 \cdot \text{h})$, and power consumption per ton water is less than 0.7 kW·h when the module is assembled with the modified spacer.

Keywords: Electrodeionization, Ion exchange membrane, Structure of diluting compartment, Layered bed, Ion migration

1. Preface

EDI (electrodeionization), an advanced membrane separation technology, has been widely applied in the preparation of ultrapure water. At present, EDI process mainly consists of mixed bed EDI and layered bed EDI. Ion exchange resins in diluting compartment of mixed bed EDI module are mixed packed, which leads to adverse effects on the desalination efficiency, output of product water, tightness and etc.; whereas, ion exchange resins in LB-EDI module are layer packed, which results in positive effects on the resistivity of product water, product flux per effective membrane area, tightness and etc.. Therefore, more and more attention is being given to the development of LB-EDI technology (Kunin, R et al, 1950, p. 109; Walters, W R et al, 1955, p. 61-67).

The design of spacer for the diluting compartment is one of the essentials of EDI technology. Reasonably designed spacer has good hydrodynamic performances, ensures uniform contact between the fluid and resin, eliminates the channeling, improves the ion exchange properties, minimizes the adverse effects on ion exchange caused by alluvial sediments of resin, avoids the blockage of the channel entrance and exit by resin particles, and increases the tightness of ion exchange membrane. The strict control on the length, width and thickness of compartment and subcompartment, as well as the structure of catchment channel network play important roles in the design of spacer for the diluting compartment (Giuffrida, A J et al, 1986; Ganzi, G C et al, 1987, p. 43-50; Kitty, K S et al, 1988; Keith, A P, 1989; Parsi, E J et al, 1991). As for LB-EDI process, besides the above-mentioned requirements, the spacer should have no intermixed area among various resin layers under the force of the current so as to ensure the stratification of bed. This paper compares the different spacers, and achieves a reasonably designed spacer, which is valuable for broader applications.

2. Experiment device and process flow

2.1 Experiment device

EDI module: a self-designed one-stage one-pass module and a diluting compartment.

Spacer for the diluting compartment: blind pass, loop-free, 325.44 cm² of effective membrane area, 10 mm of thickness, and ABS resin plate as a plating material.

Spacer for the concentrate water compartment: blind pass, loop-free, 4 mm of thickness, and ABS resin plate as a plating material.

Spacer for the electrolyte water compartment: 0.5 mm of thickness, and equipped with in-built inert screen.

Sealing material: silica gel plate of 1 mm thickness.

Cathode: stainless steel plate.

Anode: titanium-plated ruthenium plate.

Ion exchange membrane: low permeability EDI membrane from Shanghai Shinghua Water Treatment Material Co., Ltd.

Ion exchange resins: gel-type strongly acidic cation exchange resins (001×7) and gel-type strongly basic anion exchange resins (201×7), from the Chemical Plant of Nankai University.

2.2 Process flow

Figure 1 is a process flow diagram of the experiment.

Product water from one-stage RO passes through the feed water tank, and splits into two ways which in turn enter into the diluting compartment and concentration compartment of EDI module, respectively. Effluent from the diluting compartment is product water; whereas, effluent from the concentration compartment is concentrate water, i.e. electrolyte water, which passes through anode compartment and cathode compartment, and then is discharged. Two rotameters are used to regulate the concentrate flux and the product water flux, respectively. Voltage and current of the module can be directly indicated on the D.C. display panel. Resistivity of the product water and conductivity of the concentrate water are measured with resistivity meter and EC meter, respectively.

3. Results and discussions

It is difficult for the mixed bed EDI process to form an ion exchange channel, therefore, the spacer for diluting compartment is designed to be thinner, usually 2~3 mm. However, ions are much easier to migrate in resin with same polarity, and it is more likely for LB-EDI process to form an ion exchange channel, therefore, the spacer for diluting compartment can be designed to be thicker, usually 8~10 mm. The increase in thickness of spacer has following advantages: (1) water output per effective membrane area increases, and less cell pairs are needed to produce the same amount of product water; (2) the spacer is enhanced, and effectively resists distortion under high clamping pressures, as a result, the spacer can prevent leakage effectively, and increase the safety of the module; (3) the increase in thickness of spacer causes that the adverse effect of potted component on the ion exchange and module resistivity decreases, therefore, potted components can be inserted between spacers, which makes it possible to increase the pressure of feed water. It can be concluded that thick spacer is much more suitable to the LB-EDI process.

However, it is difficult for LB-EDI process to ensure even distribution of fluid and complete isolation among various resin layers at the same time. In order to solve this issue, we have modified the spacer by inserting three self-designed distributors along the vertical axis against the water flow direction. These distributors divide the diluting compartment into four subcompartments along the water flow directions, each of which is packed with the same ion exchange resin to obtain a completely isolated resin layer.

This paper investigates the effects of five different spacers on the preparation of ultrapure water by LB-EDI process. The structures of these five spacers are listed below.

- (1) Without any distributor, the diluting compartment is directly packed with four layers of ion exchange resins, each of which has a height of 90 mm.
- (2) The diluting compartment is divided by thin plate distributors of 1 mm thickness each into 4 subcompartments, and packed with 4 layers of ion exchange resins, respectively. Each of resin layers has a height of 90 mm. The thin plate distributor has many slits, each of which has a width less than 0.3 mm.
- (3) The diluting compartment is divided by slit-type distributors of 25 mm width each into 4 subcompartments, and packed with 4 layers of ion exchange resins, respectively. Each of resin layers has a height of 80 mm. The slit-type distributor has many slits, each of which has a width about 0.3 mm.
- (4) The diluting compartment is divided by channel-type distributors into 4 subcompartments, and packed with 4 layers of ion exchange resins, respectively. Each of resin layers has a height of 80 mm. The distributor is covered with a 35-mesh polypropylene screen, and has a channel diameter of 4 mm.
- (5) The diluting compartment is divided by screen-type distributors of 35 meshes each into 4 subcompartments, and packed with 4 layers of ion exchange resins, respectively. Each of resin layers has a height of 90 mm.

The corresponding modules for the above-listed diluting compartments are coded with M1, M2, M3, M4 and M5, respectively. The structures of M2, M3 and M4 are shown in figure 2 and figure 3.

The parameters of these five modules are listed in table 1.

3.1 Effect of spacer structure on current change of module

Figure 4 exhibits the *U-I* curves of M1, M3 and M4.

Figure 4 reveals that the current increases with the rise of voltage in all three curves. But it can be seen that the different structures of diluting compartments result in obvious differences among these three curves: (1) The slope of M1 is the largest. It is because without distributor, resin layers in M1 contact closely, and occur obvious intermixing at their interfaces under the force of the water flows, which accelerates the rise of current, especially when the voltage reaches a given value. (2) At the same current value, the voltage of M3 is the highest, and much higher than that of M1 or M4, however, the voltage of M1 is similar to that of M4. It is because M3 is equipped with slit-type distributors made of inert materials, and is much wider than the other two modules, which results in a much higher resistivity and a much lower current. Therefore, it is necessary to increase the operation voltage of M3 to obtain the same current. In addition, M4 is equipped with channel-type distributor, which has a much smaller size and a much better stratification effect than slit-type distributor has. Therefore, the shielding effect of M4 decreases, as a result, the operation voltage of M4 is similar to that of M1 at the same current (Jinwoo Lee et al, 2007, p. 276-285; Songjung Hoon et al, 2007, p. 165-171).

3.2 Effect of spacer structure on resistivity of product water

Figure 5 exhibits the effect of spacer structure on the resistivity of product water under certain operation conditions (listed in table 2).

Figure 5 reveals that curves of M1~M4 change in the same trend and the resistivity of them reaches 18 MΩ·cm in the end. However, the screen-type distributor in M5 becomes deformed under the force of the water flows, which causes the intermixing of resin layers as a result, the resistivity of product water declines to about 1 MΩ·cm, and has no obvious change throughout the operation. It indicates that if resin layers can not be completely isolated by distributors, they will intermix, which will lead to the decrease of ion exchange and water dissociation efficiency, no way to regenerate the resin layers (figure 6), and an obvious decline in resistivity of product water. Therefore, compared with mixed bed, layered bed has obvious advantages.

Among M1~M4, the resistivity of product water of M4 increases the most rapidly, and is the first to reach 18 MΩ·cm. It is because the distributor in M4, through modification based on the former three distributors, realizes the complete isolation of resin layers, improves the stratification effect, increases the ion exchange efficiency, reduces the electric-field shielding, and accelerates the resistivity of product water to reach 18 MΩ·cm and stay stable.

Intermixing of resin layers can be identified by disconnecting the module and observing the color of resin layers. In addition, there is an obvious difference in density between anion exchange resin particles and cation exchange resin particles; therefore, it also can be identified by placing resin layers from the diluting compartment into deionized water, and keeping stationary for a given period.

3.3 Effect of spacer structure on conductivity of concentrate water

Figure 6 exhibits the effect of spacer structure on the conductivity of concentrate water under certain operation conditions (listed in table 3).

Figure 6 reveals that curves of M1 and M4 change in the same trend, the conductivity of concentrate water increases continuously at the beginning of the operation, and reaches the maximum, then declines rapidly to a lower value. However, curve of M3 appears that the conductivity stays stable at a peak value during the beginning period, and then declines continuously to a lower value. Conductivity of M5 keeps stable at a lower value throughout the whole operation.

M1, M3 and M4 are layered-packed, and the conductivity of concentrate water therefrom has the maximum value. It is because the same resin in LB is more concentrated, which promotes the formation of the ion exchange channel, accelerates the ion exchange, increases the desalination efficiency, results in a higher ion concentration gradient in diluting compartment, intensifies the water dissociation, and improves the ion removal efficiency (figure 5). However, resin layers in M5 occur obvious intermixing, which causes M5 to be in a contrary state (figure 5). It demonstrates that effective stratification can increase the ion exchange rate, accelerate the water dissociation, form the regenerated resin bed of a certain height, and increase the desalination rate.

The results of experiment on the modified spacer indicate that the end resistivity of product water is higher than 17 MΩ·cm; water output per effective membrane area is more than $5.5 \times 10^{-5} \text{ m}^3/(\text{cm}^2 \cdot \text{h})$, and power consumption per ton water is less than 0.7 kW·h under the conditions that the voltage is 35 V, product flux is 36 L/h, water recovery rate is 90%, and conductivity of feed water is between $5 \mu\text{S} \cdot \text{cm}^{-1}$ and $20 \mu\text{S} \cdot \text{cm}^{-1}$. Comparing with other similar modules (Colbert, G L et al, 1997, p. 57-61), this modified module has much more excellent performances under the almost same power consumption.

Therefore, the self-designed spacer can realize deep deionization, and has good uniformity of water distribution, wherein, the combination performances of module M4 are much better.

4. Conclusion

As regards EDI, layered package has obvious advantages. However, the key issue involved is to achieve well-layered resins, which in turn promote the formation of ion exchange channel, increase current density and current efficiency, and then realize deep deionization. This self-designed diluting spacer ensures the uniform contact between the fluid and resin, achieves the well-stratified resin layers, avoids the intermixing of various resin layers, and increases the desalting efficiency. Wherein, module M4, based on the modifications of the other modules, completely ensures the uniform distribution of fluid, successfully achieves the well-stratified resin layers, and avoids to the full extent the decreases of effective membrane area and effective bed height resulted from the installation of distributor. The experiment results demonstrate that the improvement on the structure of diluting spacer achieves remarkable accomplishments. For example, the end resistivity of product water is higher than 17 MΩ·cm, water output per effective membrane area reaches $5.5 \times 10^{-5} \text{ m}^3/(\text{cm}^2 \cdot \text{h})$, and power consumption per ton water is less than 0.7 kW·h under the proper conditions.

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Table 1. The parameters of modules

Modules	Diluting compartment	Concentrate water compartment; Electrolyte water compartment
M1	Without any distributor; 4 layers of resins; the 1 st and 3 rd layers are packed with the mixture of anion exchange resin and cation exchange resin; the 2 nd and 4 th layers are packed with anion exchange resin.	All concentrate water compartments are packed with cation exchange resin. Electrolyte water compartment, for circulation of concentrate water, is equipped with an in-built inert screen, and has 0.5 mm of thickness.
M2	4 layers of resins divided by thin plate distributors; the 1 st and 3 rd layers are packed with the mixture of anion exchange resin and cation exchange resin; the 2 nd and 4 th layers are packed with anion exchange resin.	
M3	4 layers of resins divided by screen-covered slit-type distributors; the 1 st and 3 rd layers are packed with the mixture of anion exchange resin and cation exchange resin; the 2 nd and 4 th layers are packed with anion exchange resin.	
M4	4 layers of resins divided by screen-covered channel-type distributors; the 1 st and 3 rd layers are packed with the mixture of anion exchange resin and cation exchange resin; the 2 nd and 4 th layers are packed with anion exchange resin.	
M5	4 layers of resins divided by screen-type distributors; the 1 st and 3 rd layers are packed with the mixture of anion exchange resin and cation exchange resin; the 2 nd and 4 th layers are packed with anion exchange resin.	

Table 2. The operation conditions of M1~M5

Modules	Operation voltage	Product flux	Concentrate flux	Conductivity of feed water
M1	20 V	M1: 24 L/h The others: 36 L/h	M1: 2.4 L/h The others: 3.8 L/h	5~20 $\mu\text{S}\cdot\text{cm}^{-1}$
M2	30 V			
M3	75 V			
M4	35 V			
M5	35 V			

Table 3. The operation conditions of M1, M3, M4 and M5

Modules	Operation voltage	Product flux	Concentrate flux
M1	20 V	24 L/h	2.4 L/h
M3	75 V	36 L/h	3.8 L/h
M4	35 V	36 L/h	3.8 L/h
M5	35 V	36 L/h	3.8 L/h

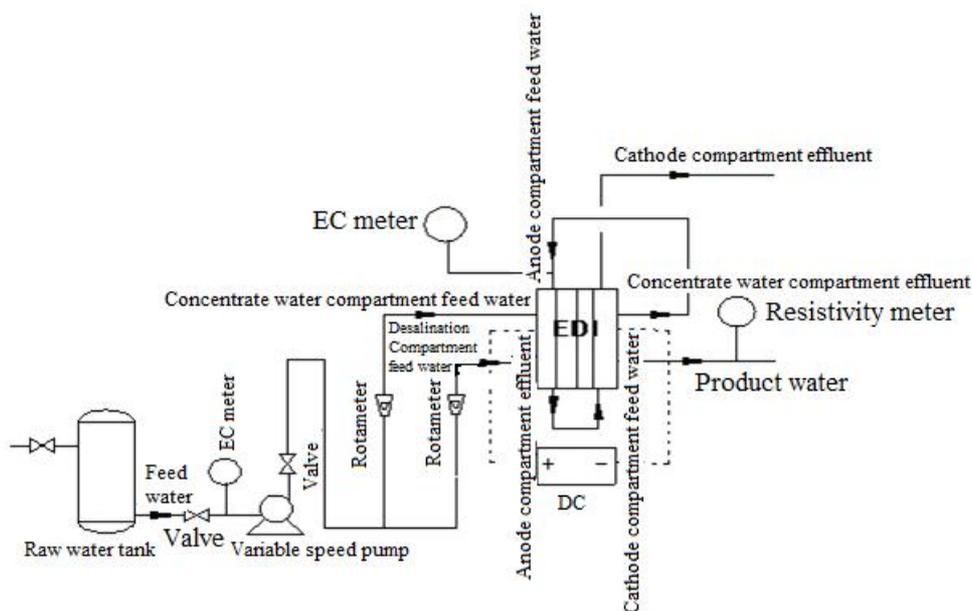


Figure 1. Process flow diagram of the experiment

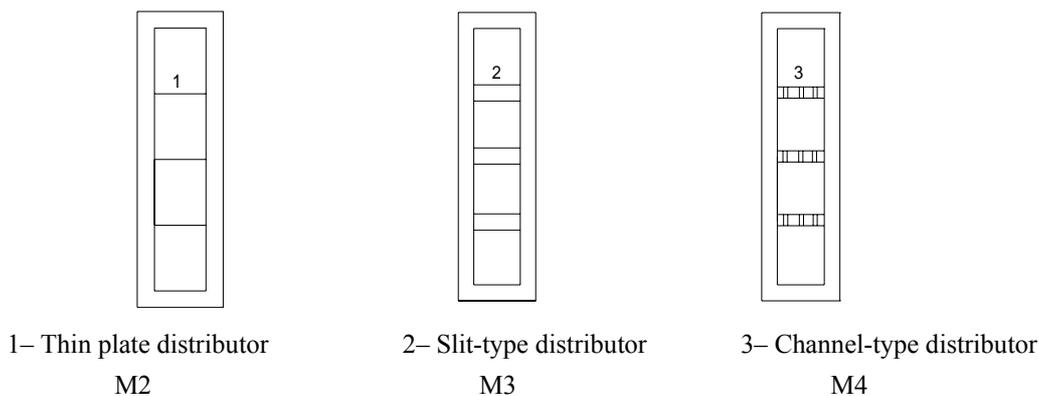


Figure 2. Schematic diagram of spacer for diluting compartment

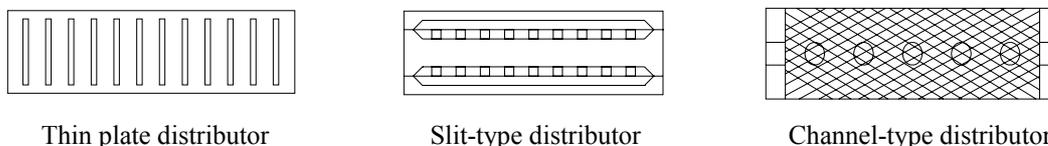


Figure 3. Schematic diagram of distributor

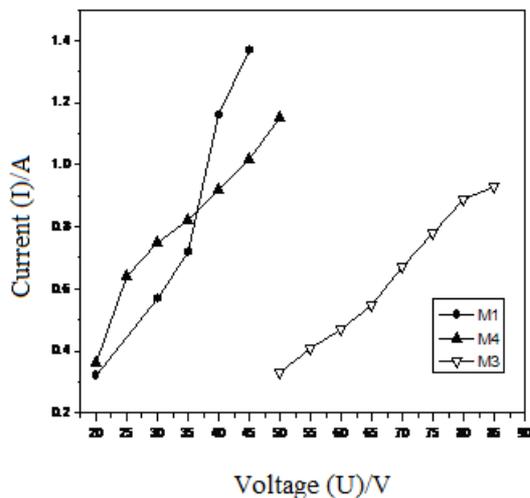


Figure 4. *U-I* curves of M1, M3 and M4

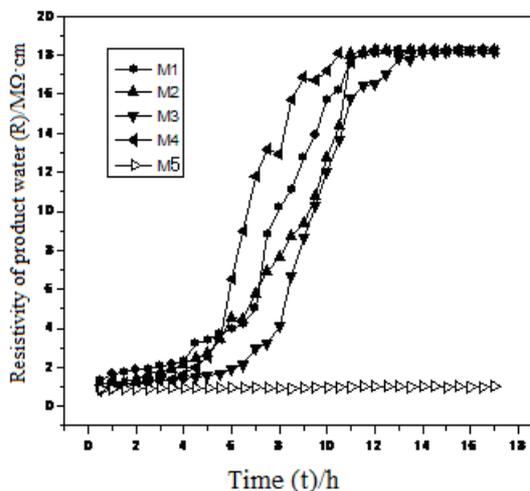


Figure 5. The relationship between resistivity of product water and operation time of M1~M5

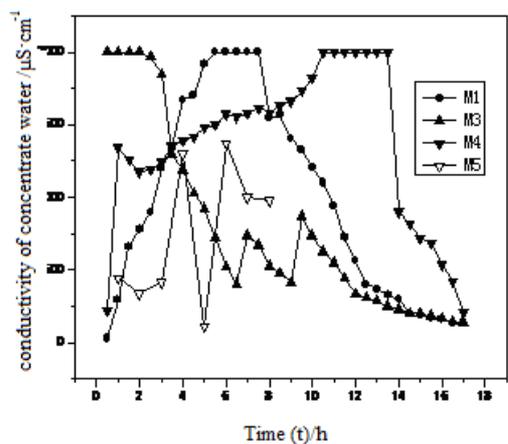


Figure 6. The relationship between conductivity of concentrate water and operation time of M1 and M3~M5

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