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Security and a Sustainable World

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Abstract

This article explores how issues of security, conflict, violence and the military are considered in the sustainability literature. Despite these issues not being particularly well developed within the sustainability setting, various approaches are identified, critiqued, and compiled into a preliminary typology framed around reformist and transformational approaches to a sustainable world. The analysis also reveals how efforts to link military activity to concepts of economic, social, and environmental sustainability are creeping into sustainability narratives at the political level to justify continued militarism under the guise of sustainability language. Footprint analysis is also used to support an argument that without decisive action, including a substantial reallocation of society's resources away from the military to sustainability focused initiatives, competition over natural resources is likely to intensify in the future and the long standing tradition of exploitation by the rich and powerful of the poor, future generations, and other species with which humans share the planet, is likely to continue.

Keywords: Sustainability, Security, Human security, Ecocentric security, Military, Conflict, Violence, Footprint analysis

1. Introduction

This article reviews different approaches to security as evident in the sustainability literature, where sustainability has to do with humans living in a manner that is consistent with the flourishing of life on Earth for what is for all intents and purposes a forever time frame that is, for there to be a sustainable world. In this context, sustainability is considered at ultimately a global level and, although looking at the issue from a human behaviour perspective, takes into account both human and non-human life interests. The article begins with a brief review of the development of current day sustainability discourse and discusses why the concept is so difficult to pin down to a coherent and broadly agreeable definition. A typology is then used to represent what it means for there to be a sustainable world, with consideration given to some of the characteristics of current day sustainability discourse this typology reveals. In particular, reformist and transformational formulations of a sustainable world are identified and some thoughts are offered as to which of these formulations is the most dominant and why this might be so.

The issue of security as evident in the sustainability literature in terms of the reformist-transformational representation is then reviewed. The discussion focuses on four key areas namely (a) what the term 'security' means in the sustainability context, (b) military spending and capability, (c) greening-of-the-military and the military as an economic enterprise, and (d) conceptions of violence including peacetime violence, metaphorical weapons, and surrogate violence. These different approaches to security are then considered using footprint analysis data. Finally, some general observations concerning the reformist and transformational approaches to security within the broader sustainability context are presented.

It is apparent from conducting the literature review for this article that the literature linking issues of security and sustainability is not particularly well developed at this point in time. It is hoped however that this article will help pull together some of the key themes that are evident into an orderly and coherent framework for further development.

2. Sustainability and a sustainable world

Although concern about the damaging impacts of human activity on the environment has a history dating back thousands of years (Hughes, 2001), early development of ideas that gave rise to contemporary sustainability discourse is often dated from the 1880s and the response to environmental damage that paralleled the emergence of the industrial revolution. From this followed a progression of environmental thought through to the advent of the modern day environmental movement in the 1960s (Estes, 1993; Mebratu, 1998; Pezzoli, 1997). Mainstream prominence of the concept, particularly in the form of sustainable development, came about during the 1980's and early 1990's through a series of key publications and events including the 1980 World Conservation Strategy, the 1987 WCED report "Our

Common Future" (the Brundtland Report), and the United Nations (UN) 1992 Rio Conference on Environment and Development (Blewitt, 2008; Mebratu, 1998; Speth & Haas, 2006). Although this modern day sustainability discourse remains concerned with environmental issues, it also encompasses social and economic dimensions to varying degrees giving the concept a richer set of characteristics than may be evident in its historical roots.

Despite numerous attempts to define the term sustainability (or any of its permutations including sustainable development) it remains a vague and ambiguous concept, applied in numerous and varied ways. This is both helpful and troublesome in that it allows buy-in from diverse groups with different ideological positions, but also allows the concept to be manipulated to serve self-interest agendas that have little to do with the 'living sustainably on Earth' intent (Manderson, 2006; Porritt, 2005). In trying to make sense of why the concept remains so difficult to pin down to something on which all agree beyond a mere 'yes, sustainability is something we need', a number of authors have pointed to the differing value systems, perceptions of reality, and cultural contexts that underpin interpretations of what sustainability has to do with, making the concept more than simply vague in meaning, but also inherently pluralistic and contested (Gibbs & Krueger, 2005; Osorio, Lobato, & Castillo, 2005). Even the most prominent of the sustainable development definitions, that of the Brundtland Report namely "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 43) is very general in its terminology and open to a wide range of interpretations. In short, problems of contested meaning cannot be solved by trying to develop more complex and extensive sustainability definitions.

Before moving on to consider how the concept of sustainability can be meaningfully represented, one final point will be addressed to aid in the discussion that follows, and that is to clarify usage of the terms 'sustainability' and 'sustainable development' and explain why in this article the sustainable development term is avoided despite its otherwise broad acceptance. The terms sustainability and sustainable development appear throughout the sustainability literature. Some authors use the terms interchangeably (Lamming et al. (1999) is an example) while others make a clear differentiation in one of two main ways. The first sees sustainability as the desired goal and sustainable development as the behaviour or process needed to achieve that goal (authors who use this approach include Doppelt (2003), Dovers (2005), Porritt (2005), and Voigt (2005)), and the second sees sustainability as the desired goal and sustainable development specifically defining this goal in terms of sustaining continued human development (authors who use this approach include WCED (1987), Lele (1991), Gladwin et al (1995) and Gallop (2003)).

Although sustainable development is very general in its meaning and open to broad interpretation, this ambiguity does not rest in what sustainable development seeks to sustain as its primary goal, which is clearly to sustain continued human development. Ambiguity instead rests in what it means to develop and how this development is to be achieved, with the answers to these two questions carrying strong historical bonds to reformist sustainability narratives (Escobar, 1995; Orton, 1990) (see below for a discussion on the reformist approach). Sustainable development can then be viewed as a particular form of sustainability where sustainability does not require, but also does not exclude, continued human development. Sustainable development however not only requires human development but this is itself the primary goal of what is to be sustained, making the 'sustainability as the desired goal' approach (as above) the preferred interpretation of the difference between sustainability and sustainable development. Adopting sustainable development terminology in this or any other discussion on security risks carrying the baggage attached to the sustainable development terminology into the discussion and further risks discounting the importance of alternate views. The use of the more generic sustainability and sustainable world terms in this article is an attempt to avoid this baggage problem.

3. Representing a sustainable world

As an alternate to seeking increased clarity of what it means for there to be a sustainable world through ever more sophisticated definitions, a number of authors have opted for a typology approach based around various principles that are seen to comprise a sustainable world, and identifying for each of these principles the differing viewpoints on how each is conceived (for examples such typologies see Dobson (1996), Handmer & Dovers (1996), Diesendorf (1997), and Naess (2003)). This typology approach has a number of advantages over a definitional approach, in particular it acknowledges a sustainable world's inherent pluralism and does not attempt to condense this pluralism into a definitional singular (Dobson, 1996).

It is not the purpose of this article to discuss in detail the broad set of key sustainable world principles and their various interpretations that are evident in the literature, however a simple typology is presented as table I. This article instead focuses on the security principle and explores this in detail. Before turning to this task however, some elaboration on the content of table I will be helpful in framing the discussion that follows.

Firstly, different formulations of what it means for there to be a sustainable world can, in a general sense, be categorised into two main camps – reformist (or reformism) and transformational. Reformism claims that what is needed to address current problems that see humans living in an unsustainable way is mostly "reforms that do not challenge the basis of our societies but that may lead to changes in emphasis at the margins" (Handmer & Dovers, 1996, p. 499). These changes at the margin to current economic and social systems are mostly to 'green them', and make them more socially

equitable and just. Reformism however also promotes, amongst other things, globalisation, free-trade, and the role of large corporations as key contributors to achieving a sustainable world so in many ways it is not "change in emphasis at the margin" for all societies but rather the global spread of a green and equitable version of key aspects of the neoliberal economic agenda. Reformism is consistent with the main themes of environmental economics, ecological modernisation theory, the sustainable development agenda promoted by the UN and its related bodies, and the sustainable development agenda of key business groups (such as the World Business Council for Sustainable Development). A transformational view on the other hand proposes that reformism simply will not work and it is the current dominant economic and social systems themselves that need substantial restructuring as they are inherently ecologically and socially destructive. Transformational views are consistent with ecological economics (to some extent at least) but more so the emerging field of green economics, treadmill of production theory, and ecocentric approaches to life on Earth such as Arne Naess' deep ecology movement.

Second, at times the distinction between reformism and a transformational approach is seen as a form of continuum where, for various principles, a reformist view sits at one end of the continuum with a transformational view at the other, and along this continuum are a range of intermediate positions. This continuum view is however somewhat misleading in that it can easily be interpreted to mean that the gap between reformism and transformational views is simply a matter of degree. What is mostly the case however is that differences are grounded in fundamentally and incommensurately different world views that are not matters of degree at all.

Next, it is also a misleading to interpret reformism as being the first step towards what will ultimately be a transformational outcome. Although it may be possible for the pursuit of reformism to eventually progress to transformational change, this is not the reformist objective. Reformism is itself promoted as a viable and credible approach to a sustainable world, not merely a stepping stone to embracing a transformational approach. Although some transformational advocates may see reformism as a first step, and some current reformist advocates may be actively pushing that agenda as a first step in a more transformational journey, the lead agenda of the reformist view is that it is itself the end-game.

Lastly, the current dominant espoused approach to a sustainable world is clearly reformist (Gould & Lewis, 2009; Handmer & Dovers, 1996) and there appear to be three main non-mutually exclusive explanations for this. First is that reformism is itself believed to be genuinely capable of delivering a sustainable world outcome, it is superior to the transformational view, and there is no need to expose society to the risks associated with embracing the degree of change inherent in a transformational approach (for examples of narratives that advocate approaches to a sustainable world that are consistent with the reformist view see WCED (1987) and Hart (2007)). Transformational advocates would reject this view.

Next is that reformism is currently the only viable approach to a sustainable world as transformational approaches are too far removed from current political, economic, and social thinking to be accepted as credible. As such reformism dominates as a transformational approach is 'too far out there' to be accepted as a viable and realistic current pathway to a sustainable world regardless of any alternate narratives supporting a preference for a transformational approach (Cato, 2009; McManus, 1996; Robinson, 2004). Transformational advocates may acknowledge this but even if they do, this is not considered a justification for failing to push forward with a longer term transformational agenda.

Finally is a view that reformism is the outcome of capture of the sustainability agenda by the economically and politically powerful elite to allow a more-or-less business as usual approach to current dominant corporate and political activity (Bruno & Karliner, 2002; Mayhew, 1997). In this view reformism is, to a significant extent, the product of powerful economic and political engineering of the sustainability concept to protect the interests of the elite, legitimised through the use of sustainability language. Many transformational advocates probably concur that such capture has in fact occurred.

4. Security and a sustainable world

So where does the security principle fit into the sustainable world typology? A review of the sustainability literature shows that the security-sustainable world connections are not particularly well explored, however in what follows this issue is considered based on narratives that are evident with the discussion grouped under four main topics:

- a) What does 'security' mean?
- b) How is military spending and military capability considered?
- c) What current activities are evident that seek to incorporate sustainability themes within the military?
- d) How is violence conceived?

4.1 Security

The dominant approach to security from both an historical perspective and what is currently being practiced today is in the form of national security (Archer, 2005; WCED, 1987). This approach sees the unit of focus and the dominant actor

as the nation-state, with emphasis on the military as the means by which national security is achieved. Under this model people are considered in terms of their status as citizens of a nation and their security is achieved through the achievement of national security. There is however no support evident in the sustainability literature for this national military-focused approach to security as being consistent with sustainable world objectives either in its view of how security should be conceived or how security for a nation is best achieved. Instead the national military-based approach is heavily criticised for draining society's financial, human, and natural resources away from addressing human and ecological wellbeing initiatives. This draining of resources is seen to fuel underlying conflict drivers such as weapons proliferation (Dhanapala, 2001; UNGO, 2008), resource scarcity (Archer, 2005; Renner, 2008) and inequality (Chua, 2004; Gould, Pellow, & Schnaiberg, 2008). Further the national military-based approach is seen to be focused on the wrong thing in that it fails to consider the broader aspects of what really matters in the security context.

Although it is true that there is a significant focus of attention on military spending and capability in the world today, it is important not to overplay the dominance of this approach over all other national security focused policies of governments. Going hand-in-hand with militarism is an insatiable appetite by virtually all national governments to progress their national security agenda, and the security and wellbeing of their citizens, through continued economic growth which is seen as both important from a power and influence perspective and as a key to solving virtually all of society's ills (Bruno & Karlner, 2002; Daly, 2005). For many nations, population growth or at the least a non-declining national population is another mainstream strategy for advancing national security objectives (Engelman, 2008; UN, 2008).

A broader view of security is that of human security which is commonly framed around the freedom-from-want and freedom-from-fear double. This approach focuses on a range of threats to the security and wellbeing of people and communities not just externally created national threats, and includes threats from economic ills such as loss of job opportunities, from organised crime, the drug trade, terrorism, disease, pollution and environmental degradation, deprivation, and oppression (Archer, 2005; UN, 2000; UNDP, 1994). This view makes clear the reasons for inclusion of security as a sustainable world principle whereby the flourishing of human life is inconsistent with a world where people are subjected to continued insecurity and exposure to harms. Human security then is clearly a necessary, although not sufficient, condition for there to be a sustainable world.

The general characteristics of the human security approach are well covered in the literature however a few key observations are important to this current discussion. Firstly, this view of security as human security is just that, a human security discourse. Some authors have attempted to promote a broader perspective incorporating the security needs of other species as what can be termed ecocentric (or life-centered) security (Davion (2004) is an example), but the human security approach remains dominant. This human focus does not mean that ecological impacts of militarism and the importance of ecological wellbeing for the achievement of human security are not well covered in human security discourse, but rather the general theme remains anthropocentric (i.e., human centered and where non-human species are mostly seen in terms of their instrumental value to humans). Needless to say, and as argued by Davion (2004), extending consideration of interests to non-human species in other than mere human instrumental terms makes the justification of military conflict or activities such as military exercises and weapons testing virtually impossible to justify in any context.

Second, the human security focus seeks to address the underlying drivers of human insecurity rather than merely addressing symptoms such as civil unrest and conflict (Archer, 2005; Jolly, 2004). This address-the-symptoms approach is supported by a general call for reduced military spending and the application of the resulting peace dividend to initiatives focused on progressing issues linked to sustainability objectives including poverty reduction, improving overall equity between and within nations, and addressing problems of ecological degradation. This call for application of the peace dividend can be found in both reformist focused sustainable development discourse (UNDP (1994) and WCED (1987) are examples) and also those advocating a more transformational approach to sustainability (ECC (2000) is an example).

4.2 Military spending and capability

Within this collective sustainability discourse of the drivers of insecurity, military spending, and application of the peace dividend, two main themes concerning military spending and military capability are evident. The first is a clear call to reduce military spending coupled with active measures to enforce current weapons treaties, pursue and achieve the non-proliferation and, preferably, elimination of weapons of mass destruction, and to control small arms proliferation. These narratives, particularly evident in UN sustainable development documents (such as The Brundtland Report and a recent UN Security Council press release (UNSC, 2008)), tend to be somewhat reserved in their calls for broad-scale disarmament and demilitarization, although quite forthcoming in the call for the resulting peace dividend from the advocated reductions in military spending to be applied to sustainability, or more commonly sustainable development, initiatives. In this article, this approach will be termed 'conservative disarmament'.

The other narrative is one that is openly bold in its call for disarmament and demilitarisation to the point of national non-provocative defence capability only, including the total elimination of all forms of weapons of mass destruction including nuclear, chemical, biological, and any other form of toxic weaponry. Under this model no nation would have the military capacity to wage aggressive military action against any other nation, with stronger peace keeping forces placed under international control (Holdren, Daily, & Ehrlich, 1995). In this article this will be termed 'broad-scale disarmament'. Despite this narrative lacking dominance in current day sustainability discourse, it has a long history dating from the 1941 'freedom speech' by US President Roosevelt (Roosevelt, 1941):

"[t]he fourth is freedom from fear — which, translated into world terms, means a world-wide reduction of armaments to such a point and in such a thorough fashion that no nation will be in a position to commit an act of physical aggression against any neighbor — anywhere in the world".

The irony of course is that the US is now the nation most capable of committing acts of military aggression against any other nation.

Both the conservative and broad-scale disarmament perspectives call for the application of the resulting peace dividend to sustainable world initiatives. What is inconsistent with any sustainable world narratives as evident in the literature is for an achieved peace dividend to not be applied directly to sustainability initiatives of poverty reduction, ecological protection and renewal, and reducing inequality. A case in point is the peace dividend that arose from reduced military spending during the post Cold-War period being used to support economic growth in the North which some authors claim was a lost opportunity to promote the broader collective good (Archer, 2005; Jolly, 2004). Jolly (2004) however makes the point that some claim this application to economic growth in the North did in fact drive further global economic activity with positive flow-through effects for all. It is beyond the scope of this article to debate this claim in detail other than to say many would argue (as does this article's author) that this claimed flow-through benefit has not materialized in any meaningful way and the accelerated growth in the North has in many ways brought more harm to the world (socially and ecologically) than good. It is worth noting however that despite no apparent open support in the sustainability literature for such an approach, application of a (significant) proportion of a peace dividend to driving economic growth in the North is not necessarily inconsistent with a reformist approach to a sustainable world although it is unlikely to get any support from transformational advocates.

4.3 Current activities

This discussion has so far focused on narratives in the sustainability literature that call for change from the way things are now, where the current state of play from a security perspective is characterised, amongst other things, by broad-scale increased military spending in the face of continued ecological decline and persistent poverty, and little progress (in some areas, regression) on the reduction in stocks and proliferation of both of weapons of mass destruction and small arms. In parallel with these calls for change, two streams of thought are evident in the literature that deal with current actions – things that are being done now, not just talked about – that are of particular interest to this security-sustainability discussion namely the 'greening of the military' and the military as a legitimate economic activity.

Greening-of-the-military refers to efforts to incorporate environmental concerns into the activities of the military, the services it provides, and the products it uses. Examples of this approach include that of the Australian Defense Force which has a stated goal of making its military's activities more consistent with the objectives of ecologically sustainable development (AGDD, 2006), and the US military which espouses an objective to make itself more environmentally sustainable (ENN, 2008) by incorporating a triple-bottom-line approach covering "Mission, Environment and Community" (US Army, 2007). Some of these greening strategies include general initiatives linked to day-to-day operations such as reducing green-house gas emissions, green procurement policies, recycling, and contamination clean-up (AGDD, 2006; ENN, 2008; Parr, 2009), the military encouraged to conform to national environmental norms in relation to the treatment and disposal of hazardous waste (UN, 1992a), and actions to protect the environment in times of armed conflict (UN, 1992b). Incorporating environmental concerns into military activities is also at times framed within a win-win dialogue whereby initiatives that are seen to be pro-environment and socially responsible are presented as a positive for sustainability and a positive for the military (Parr, 2009; US Army, 2007).

In critiquing this approach however, Parr (2009) sees greening-of-the-military as failing to address the fundamental conflict between the military as an institution structured to inflict violence, and the flourishing-of-life principles of sustainability. In particular, Parr sees greening-of-the-military initiatives conducted within a setting of continued military expansion and/or use of the military to engage in hostile acts as little more than a deliberate exercise to conceal this fundamental conflict and give a sustainability legitimacy to militarism as a worthy national pursuit. In short, it seeks to present a claim that militarism is a social good as it not only provides national security but it does so in an environmentally sustainable way. This of course does not mean that the military should in any way hesitate to act decisively in reducing its harmful impacts on the environment. The problem is the use of greening narratives to legitimise and gain social support and licence for governments to pursue militarism as a worthy social goal.

The second issue is the linkage between military spending and economic activity, where two main issues are evident. The first is the outsourcing of military activities in both the manufacture of military equipment (which is a long-standing tradition (Fredland, 2004)) and increasingly in more recent times the contracting to private military companies of various services that might otherwise have been traditionally undertaken by national military institutions themselves (such as logistics, security services, and physical combat engagement (Avant, 2004; Fredland, 2004; Singer, 2005)). Arguments in favour of this outsourcing to the private sector include lower costs, improved functionality, and providing governments with alternate means of progressing national objectives. Critics however paint a different picture in both rejecting that many of these claimed advantages actually materialise in real life but more importantly, point to the fundamental disconnect between seeking reductions in military spending and the achievement of a peaceful world, and clear self-interest economic and profit making incentives for this to not come about.

A similar problem arises where governments seek to use military activities as a tool for economic activity. An example is an Australian state government that has targeted the defense industry as a key plank of its economic policy with a year 2013 goal of increasing defence industry employment from 16,000 to 28,000, and doubling the defence industry contribution to the state's economy from \$1 billion to \$2 billion (SAG, 2007). This goal is actively supported by the creation of a unit to promote the state's defence industry capability (for details, see SAG (2008)), and the issuing of regular public statements from the government celebrating the opportunities for, and securing of, new defence contracts (for examples, see McPhedran (2009), and SAG (2009)). It might be argued that this is a defence, not aggression, issue, and that it would be foolhardy for a government such as this to simply ignore these economic opportunities when defence contracts will be awarded anyway and someone will get them. But this is hardly the point. It is difficult to see how the government in question here, or any other government body in a similar position, could at the same time engage in any public dialogue, let alone forceful dialogue, that actively calls for reductions in military spending and otherwise publicly denounce continued militarism. But for society to progress to a sustainable world someone has to make a stand. Continued flight to the 'if we don't take advantage of this opportunity someone else will' argument is not going to get us anywhere but will instead reinforce the business-as-usual allocation of a substantial portion society's resources to the military that could otherwise be spent on helping to address some of the core drivers of our currently unsustainable way of life.

From a sustainability perspective, and as perverse as it may seem to many (including this article's author), it is possible to construct an argument to bring together these economic and greening narratives to provide legitimisation for the continued pursuit of military spending in that it adds to economic growth which contributes to economic sustainability, provides jobs which contributes to social sustainability, and can (supposedly) be done in environmentally responsible ways which contributes to environmental sustainability. This form of argument has not yet (to the author's knowledge) found its way into the sustainability literature and hopefully it won't, but there are signs that it is (regrettably) gaining some political traction.

4.4 Violence

The final issue of focus in this section deals with how violence inflicted on others is conceived. Violence, from a national security perspective, but also to a noted degree for human security (although human security clearly does take a broader view) is mostly considered in terms of physical harm, often caused by armed conflict of some form. But violence also has many other dimensions including the notion of peacetime violence, the use of metaphorical weapons, and the use of surrogate violence.

Peacetime violence is a form of non-military violence that inflicts harm (with harm considered in a broad sense) on humans and on non-human life in various ways, that comes about as a result of human behaviours. Shiva (2005) for example, talks of two main forms of peacetime violence namely economic violence resulting from economic activity that in particular favours the rich over the poor, and cultural violence that is imposed by dominant cultures that destroy local cultures. Rees & Westra (2003) in a similar vein talk of violence in the form of high and unsustainable levels of resource consumption by the rich, especially the North, that appropriates resources from the poor, damages the ecosystems on which the poor are reliant, and drives dispossession of land and the means of livelihood of the poor. Also picked up in the notion of peacetime violence are actions of organisations, particularly but not limited to large corporations, in knowingly inflicting harm on humans and other species in order to pursue profit making agendas. This form of corporate violence manifests itself in many ways including the sale of harmful products, the deliberate withholding of information demonstrating product harm in order to maintain sales, the exporting of harmful substances banned in home (mostly developed) countries to less developed countries, the enclosure of commons for private ownership and profit, and the use of child and slave labour to produce goods and services for the wealthy (for examples of these forms of corporate violence, see Shiva (2005) and Michaels (2008)). Peacetime violence can also be extended to incorporate violence by humans against non-human species and ecosystems including their systematic degradation, destruction, and extinction.

Metaphorical weapons are described by Archer (2005) as non-material weapons used to achieve national and/or corporate objectives without reverting to what would otherwise be seen as military based conflict. They include the imposition of sanctions of some form, pressure to repay debts, threats to cut off aid or trade arrangements, and the conduct of commercial activities that harm local citizens and the local environment.

Surrogate violence is a term used in this article to refer to violence, both military and peacetime violence, that is in some way funded, armed, supported, or encouraged by one party that otherwise seeks to remain removed from the violence itself. This can manifest itself in many ways including governments engaging military or metaphorical weapons to further the interests of corporations, private military companies used as mechanisms to further the foreign policy objectives of home nations, and governments funding military groups in other nations in order to overthrow existing regimes (for examples of the use of metaphorical weapons, see Tucker (2000) and Klein (2007)).

The point being made here is that just as the concept of security needs to be expanded beyond mere national security in order to capture what is important from a human (and other species) well-being perspective, so too does the concept of violence. Of particular importance is that the forms of violence discussed above mostly centre around the activities of the economically and politically powerful elite over the poor and less powerful, with an ultimate goal of securing resources necessary to further the elite's own self interests, an issue that will be explored further below.

One final point before moving on is that for critics of the reformist approach to sustainability, the neoliberal principles incorporated in reformism such as the pursuit of globalisation, free-trade, economic growth as a principle tool for curing society's ills, and the key role for multinational corporations in pursuing these agendas is, in its current form, inherently violent in ways consistent with the three forms of violence discussed above. For transformational advocates, this violence is not something that can be solved simply by attempting to 'green' these traits or attempting to make them more socially just.

4.5 Security and a sustainable world

Pulling the key points from the preceding discussion together, different perspectives of security within the sustainable world context can be summarised as shown in table II. In this typology:

- a) The 'human security focused - conservative disarmament' approach is consistent with reformism.
- b) The 'human security focused – broad-scale disarmament' approach is consistent with a transformational view from a disarmament perspective but with reformism in other respects, especially its anthropocentric focus and its links to mainstream sustainable development discourse.
- c) The 'ecocentric security focused – broad-scale disarmament approach' is consistent in a complete sense with a transformational sustainable world view.

5. Looking to the future

Although this summary of the main approaches to security within the sustainable world context that are evident in the sustainability literature may be useful in its own right, what is more important is to consider what humanity should be doing about this and why. In this section, these 'what' and 'why' questions will be considered using insights that footprint analysis can offer from a future natural resource usage and availability perspective.

The history and general characteristics of footprint analysis are well documented in the literature (for details, see the Footprint Network web site at www.footprintnetwork.org). In brief however footprint analysis involves the calculation of an Ecological Footprint (Footprint) measure, a measure of available biocapacity, and comparing the two to determine a measure of ecological credit or deficit. In doing so it presents a measure of a sustainability bottom-line – the need for humans to live within the reproductive capacity of the Earth's natural systems.

The Footprint is a measure of human impact on the Earth's ecosystems, expressed in standardised units of global hectares, mostly as global hectares per capita (ghpc). It shows the biologically productive land and water area that the unit of focus (say, a person, nation, or all of humanity) uses to produce the resources consumed and assimilate the wastes generated, regardless of where consumed goods are made. Biocapacity is a measure, also expressed as ghpc, of the actual productive capacity of land and water that is available to provide resources and assimilate wastes to meet human demands and to meet the needs of other species with which humans compete for resources.

At a global level, an ecological deficit (i.e., Footprint exceeds available biocapacity) means that humans are living beyond the Earth's natural resource regenerative capacity or in simple terms, humans are living on nature's capital base as opposed to limiting resource consumption and waste assimilation to renewable capacity only. This is how things are now where, at a global level, humanity has an average Footprint of approximately 2.7 ghpc compared to available biocapacity of about 2.1 ghpc (Footprint Network, 2008). Drawing down on renewable natural capital however carries a price, and in this case the price is paid by future generations who will inherit a degraded environment, the poor who mostly suffer as a result of resource exploitation by the rich, and other species with whom humans share this planet.

At a national level, an ecological deficit means that citizens of a nation are not able to live off the nation's natural resource renewal capacity even if they wanted to. A nation in ecological deficit can only maintain its resource consumption levels by depleting its own natural capital, exploiting the global commons (such as the atmosphere for CO₂ emissions), or by exploiting the resources of other nations. Dissection of footprint analysis data to show the current state of rich as compared to poorer nations (see table III) helps to illustrate this point. What table III shows that is of particular interest for this article is that high-income countries (comprising countries of the industrialised West, plus Japan and a few other highly developed nations) comprise about 15% of the world's population but consume about 40% of the available global biocapacity. More importantly however is that these high income countries consume more biocapacity than is available within their collective national borders – about 74% more. What this means is that current lifestyles in these nations is funded by additional externally sourced resources unless these nations are happy to run down their own natural capital, something they seem reluctant to do and actively seek to limit through the enactment of environmental protection laws. These countries get their additional resources from two areas namely the global commons but more so from the less developed countries where such exploitation is a long standing and well documented tradition, particularly by the developed West but also by other nations such as Japan and China. It is here that we see a history of direct military violence, peacetime violence, the use of metaphorical weapons, and the application of surrogate violence, as means to secure resources for the economically and politically powerful at the expense of the poor and weak.

Looking forward however, the picture is more worrying. One way to look at the future from a natural resource (i.e., biocapacity) usage perspective is by application of the I=PAT identity. I=PAT, first introduced by Ehrlich and Holdren in the 1970's (Holdren et al., 1995) presents human impact on the environment 'I' (Ecological Footprint), as a product of population 'P', consumption/production per capita 'A' (or affluence, usually as per capita GNP), and the impact per unit of consumption/production 'T' which is often referred to as technology but is really a catch-all for everything not captured in 'P' and 'A'. In its basic format however, I=PAT does not show what the relationships are between 'I' and the 'P', 'A' and 'T' elements that is, does a change in one element (say, 'P'), produce a straight multiplicative change in 'I' or are the relationships more complex? This issue is not well researched at this point in time however work to date suggests that a business-as-usual one-to-one relationship is a credible view (i.e., a 1% increase in 'P' or 'A' produces a 1% increase in 'I', although some evidence suggests an exponential 'I'-to-'A' relationship) in the absence of deliberate and effective interventions in 'T' to decouple 'I' from increases in 'P' and 'A' ^{(i) (ii)}.

Allowing for UN mid-range projected global human population growth to 9 billion by 2050 (UN, 2007), real economic growth net of the population growth effect of say 1% pa (although the Brundtland Report calls for annual economic growth of 3%-4% in the North and 5%-6% in the South! (WCED, 1987)), and assuming one-to-one 'P'-'I' and 'A'-'I' relationships, by 2050 the global average Footprint will be in the order of 4 ghpc compared to available biocapacity of about 1.5 ghpc. The 1.5 ghpc is however not all available for human use and needs to be shared with other species. How much should be set aside for other species is a debated issue but something in the order of 50% is often proposed as necessary to preserve biodiversity and prevent continued species extinction ⁽ⁱⁱⁱ⁾.

The end result of this is that reliance only on 'T' in the I=PAT formulation, as is the case for a reformist approach to a sustainable world, requires technology and behavioural change to decouple increases in the Footprint from population and economic growth, plus produce a real reduction in the current Footprint, collectively amounting to Footprint reduction of about 65% by 2050 as compared to a business-as-usual outcome. Allowing for the needs of other species (at 50% biocapacity sharing) sees this reduction impact of 'T' become about 80%. An optimist will of course state that humans are creative and competent problem solvers and this challenge is well within our ability to achieve. But a good dose of reality is needed here as the level of decoupling between Footprint and the twins of population and economic growth that is needed to see humans use natural resources within the Earth's renewable capacity is simply showing no signs of being achievable in the foreseeable future. We can of course argue error margins in the Footprint and biocapacity numbers that have been shown here, and whether the reduction in 'T' needs to be 65%, 85%, or something else, but this is a distraction from the core issue that humans are utilising natural resources faster than they can be renewed, the upward pressures on resource exploitation are substantial, and environmental degradation is continuing to worsen.

What the footprint analysis data means, and why it is relevant to the issues considered in this article, is that current trajectories paint a picture where competition for resources is most likely to become increasingly severe and the various forms of rich-world resource appropriation of the past and present will intensify in the future, not abate. Proponents of both the conservative and broad-scale approaches to security and a sustainable world propose that, by application of the resulting peace dividend, sufficient human, financial, and natural resources can be released to address the most pressing problems of poverty, environmental decay, and inequality. The extent to which this is true has yet to be proven simply because it is not being attempted, but the hope is that such action will dampen underlying drivers of conflict and help lead an orderly and peaceful transition to a sustainable world.

But which of the conservative or broad-scale approaches to security should we favour? The conservative approach is certainly more desirable from a sustainable world perspective than the current national-military approach which may very well see a future world that brings about a need (from the perspective of the rich and powerful) for the very military capability it currently supports. The conservative approach also seems to take a bet each way in that it seeks to free up some of society's resources for application to sustainable world initiatives, but at the same time leaves nations with military capacity sufficient to act unilaterally in securing for themselves resources outside of their national borders. The risk here is that the conservative approach is simply inadequate to achieve a transition to a sustainable world with a resulting reversion to militarism in order for the rich to secure resources for themselves at the expense of the poor.

The broad-scale approach seems to offer two main advantages over the conservative approach. The first is that the extent of disarmament and demilitarisation it advocates offers a greater potential for substantial resources (financial, human, and natural) to be freed up for application to sustainable world objectives. The hope, and probably a justified hope, is that such a dramatic shift in resource allocation will see a significant downward impact on conflict pressures and also make major inroads into addressing the serious social and ecological problems humanity is creating for itself. The second advantage is that the broad-scale approach leaves nations with non-provocative military capacity only, giving some hope that the sharing of the Earth's resources can be done in a cooperative and equitable way rather than through the use of force to benefit the powerful over the weak.

6. Conclusion

In conclusion, what can be said about the security typology presented in this article in reference to various claims concerning the sustainable world typology shown as Table I?

Firstly, are the reformist and transformational views presented simply points on a continuum or fundamentally different and incommensurate paradigms? The human security and ecocentric security views are most certainly paradigmatically different, reflecting substantive differences in what has value in the world. The human security conservative and broad-scale disarmament views also differ on more than simply matters of degree on the extent of disarmament, but rather present fundamentally different views on what military capacity any one nation should be able to hold, and how greater peace keeping capacity is to be secured. It seems then that we are dealing with views that are different in substance, not just degree.

Next, is the human security conservative view presented as merely a first step toward human security broad-scale disarmament, and then to ecocentric security broad-scale disarmament as the end result? There is little evidence in the sustainability literature supporting this progress line. Narratives presented by human security conservative disarmament advocates seem devoid of 'these are first steps' statements, and human security broad-scale disarmament advocates show little if any indications that society needs to move to an ecocentric view. This of course does not mean that broad-scale disarmament advocates do not see a conservative approach as a first step of a journey that encompasses more substantive change, which they most probably do.

Lastly, why is conservative disarmament the current dominant approach to security within the sustainability literature? Whether this approach is genuinely capable of delivering a sustainable world outcome cannot of course be considered independently of other initiatives that society might pursue to achieve this end so the answer to this point needs to be framed within the broader reformist narrative as discussed earlier in this article. In one sense though the conservative approach can be seen as a controlled risk strategy as it offers individual nations, especially the rich, continued capability for using military capacity to secure resources and maintain current lifestyles. On the other hand, it can be seen as risk enhancing (as compared to a broad-scale approach) in that it does not offer the release of resources for sustainable world initiatives to more thoroughly address conflict pressures than is available under a broad-scale approach. From a current political, economic, and social thinking perspective, it is probably true that the broad-scale approach is unlikely to be embraced to its full extent in rapid time. It is hard enough trying to get agreement on any reductions in global military spending and capacity build up, let alone the dramatic change proposed by broad-scale disarmament, but this does not mean that this stronger narrative should not be openly advocated as a worthy goal. Finally, does the conservative approach represent a capture of the narrative to protect the interests of the economically and politically powerful elite? There are probably good reasons to suspect that this is to some degree the case for at least two reasons. One, as discussed above, is that economic self-interest is an integral part of the current global military machine for both government and the private sector, and it is hard to see how these powerful bodies will let lucrative self-interest political and profit making opportunities slip away without a fight making a broad-scale disarmament approach simply untenable to these interests. The other is the extent to which militarism is fundamental to various ideological agendas, an example being that of neoconservatism which, in reference to the US, Harvey (2005) describes how neoconservatives

"emphasize militarization as an antidote to the chaos of individual interests. For this reason, they [neoconservatives] are far more likely to highlight threats, real or imagined, both at home and abroad, to the

integrity and stability of the nation. In the US this entails triggering 'the paranoid style of American politics' in which the nation is depicted as besieged and threatened by enemies from within and without. This style of politics has had a long history in the US. Neoconservatism is not new, and since the Second World War it has found a particular home in a powerful military-industrial complex that has a vested interest in permanent militarization" (pp. 82-83).

It is again difficult to see how the security aspects of such political ideologies of the elite will willingly be surrendered to the uptake of broad-scale disarmament.

So can we realistically envision a world where, in the foreseeable future, either of the conservative or broad-scale disarmament approaches to security become a reality? Without wishing to resort to simple and well rehearsed platitudes, it is true to say that to give up hope is to ensure that such change will not come about. If anything has been reinforced from this review of the sustainability-security literature it is that the case for disarmament and peace dividend application is not well covered and not forcefully argued so as to create a coherent, believable, and desirable pathway for society to progress to a better and sustainable world. The open and robust legitimisation of these narratives in the sustainability context is surely needed, to which this article hopefully makes a positive contribution.

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Notes:

- Note 1. For examples of projections of the Footprint in the context of the I=PAT identity, see York, Rosa & Dietz (2007) and WWF (2006).
- Note 2. There is little evidence that such a decoupling of 'I' from 'P' and 'A' pressures is occurring at the moment when 'I' is viewed in a broad global impact perspective (Rothman, 1998; York et al., 2007).
- Note 3. Estimates of the amount of biocapacity needing to be set aside for the needs of other species range from a minimum of 10% to 50% or more, although lower estimates are seen by some authors to be insufficient to prevent continued biodiversity loss (CABS, 2003; Soulé & Sanjayan, 1998).

Table 1. A sustainable world

Sustainable world principles*	Perspectives (Different meanings/perspectives given to each of the sustainable world principles)	
	Reformist orientation	Transformational orientation
Primary goal	Weak anthropocentrism: The flourishing of life on Earth where human interests, based on considered human preferences, dominate (i.e., considers issues such as long term human interests, inter-generational equity, and human interests beyond mere material satiation). Non-human life is considered mostly, but not always, in human instrumental terms.	Ecocentrism: The flourishing of life on Earth where human interests (based on considered human preferences), and non-human interests, are given consideration – humans interests do not take automatic preference. Non-human life has value beyond mere human instrumental value.
Satisfying of interests	Equitable weak anthropocentric orientation: First: Equity for <u>all</u> humans in meeting needs necessary for a fulfilling and meaningful life; when achieved, then Equity in opportunity to meet human wants. Interests of non-human species are based mostly, but not always, on their ability to satisfy human interests.	Equitable ecocentric orientation: First: Equity for humans and non-human species in meeting needs necessary for a fulfilling and meaningful life that is relevant to each species, then Equity in opportunity to meet human wants.
Human population	Manage a sustainable world to population Population settles to a 'natural limit'; reduce very high rates of growth; prevent reductions in some (mostly developed) countries; orientation to maximizing the human population that can be sustained within sustainable world criteria.	Manage population to a sustainable world Current human population seen as too high and unsustainable and an issue for all countries to address; a long term reduction strategy is required through collective non-coercive and non-discriminatory choice; such a reduction will benefit both humans and other species.
Resources	Weak sustainability Sustainability as human interests satisfaction requires that the aggregate value of natural (K_N) and human forms (K_{HF}) of capital is sustained. Capital types are substitutable beyond minimum critical values.	Strong sustainability Sustainability as human interests satisfaction requires K_N and K_{HF} to be maintained separately. K_N and K_{HF} are mostly complements and only marginally substitutable. An alternate form of strong sustainability sees it reconstructed to incorporate ecocentric principles. K_N as nature rather than defining K_N as merely aspects of nature useful to humans; K_{HF} incorporates values beyond mere forms of capital.
Growth and development	Sustainable growth human wellbeing, including elimination of poverty and the resolution of ecological problems, is achieved through equitable and ecologically sustainable, unlimited, and global GDP growth supported by free-trade, market-based sustainability incentives, and where the business sector, especially multinational corporations, play a key role. Technology and human ingenuity are the keys to overcoming any apparent limits to growth and in resolving problems that might otherwise be caused by growth.	Qualitative development and sufficiency human wellbeing is progressed through equitable and ecologically sustainable qualitative development and consumptive sufficiency, achieved through a steady-state economy (that is, one where resource throughput is non growing and contained within ecological limits), internationalisation not globalization, and a preference for consumption from local production. Continued consumptive growth is seen as being not sustainable and is a primary cause of both ecological problems and of poverty. Poverty is resolved through resource reallocation not more global-level throughput growth. There are absolute limits to resource throughput growth that must be respected.

** Notes:*

Intergenerational equity is not listed in this table as a sustainable world principle as it is mostly seen in the sustainability literature as a defining feature of what it means for there to be a sustainable world, whereby all other principles need to support intergenerational equity objectives and intergenerational equity is achieved if the requirements these other principles are met.

Intragenerational equity is also a key sustainable world principle evident in the literature but for the purposes of this table, it is picked up in the satisfying of interests and growth and development headings.

Table 2. Security and a sustainable world typology

Elements	Security approaches to a sustainable world reformist.....transformational			Inconsistent with any formulation of a sustainable world
	Human security focused – conservative disarmament	Human security focused – broad-scale disarmament	Ecocentric security focused – broad-scale disarmament	
Security	Human security focus addressing root causes of insecurity.	Human security focus addressing root causes of insecurity.	Ecocentric security focus addressing root causes of insecurity.	National security and military based focus.
Disarmament	Enforcement of current treaties; reductions in military spending; non-proliferation and preferably elimination of weapons of mass destruction; control and non-proliferation of small arms.	Broad-scale disarmament to national non-provocative defense capacity only; stronger peace keeping capacity under international control; total elimination of weapons of mass destruction.	Broad-scale disarmament to national non-provocative defense capacity only; stronger peace keeping capacity placed under international control; total elimination of weapons of mass destruction.	Continued high levels and/or escalation of military spending and capability. Failure to make progress on disarmament and arms control initiatives, especially in relation to weapons of mass destruction and small arms proliferation.
Peace dividend	Applied to human development, especially issues of poverty and inequality, and to environmental protection.	Applied to human development, especially issues of poverty and inequality, and to environmental protection.	Applied to the wellbeing of all human and non-human species consistent with ecocentric principles.	Where any reduction in military spending is achieved, a failure to apply the resulting peace dividend directly to the progress of sustainability initiatives focused on human and ecological wellbeing notably poverty reduction, reducing inequality, and progressing ecological repair and renewal.
Violence	Incorporates to some extent concepts of peacetime violence, metaphorical weapons, and surrogate violence, but mostly considered mostly in anthropocentric terms.	Incorporates in a comprehensive way concepts of peacetime violence, metaphorical weapons, and surrogate violence, but mostly considered in anthropocentric terms.	Incorporates in a comprehensive way concepts of peacetime violence, metaphorical weapons, and surrogate violence, but considered in ecocentric terms.	Conceived in limited terms mostly as deliberate and clear physical harm, and ignoring issues of peacetime violence, metaphorical weapons, and surrogate violence.
Economy	The military remains a	The military is not a	The military is not a	Economic and

	legitimate economic activity for both government and private enterprise, however strategies are adopted to counter economic incentives that might drive increased military spending.	desired area of economic focus but for activities that are undertaken, strategies are adopted to sever the link between military spending and profit generation.	desired area of economic focus but for activities that are undertaken, strategies are adopted to sever the link between military spending and profit generation.	corporate profit incentives being structured such that they drive increased spending on the military.
Environment and social	Decisive efforts to make the activities of the military consistent with principles of ecological and social sustainability, framed within anthropocentric and reformist sustainability principles.	Decisive efforts to make the activities of the military consistent with principles of ecological and social sustainability, framed within anthropocentric and, for the most part, reformist sustainability principles.	Decisive efforts to make the activities of the military consistent with principles of ecological and social sustainability, framed within ecocentric principles.	Pro-environmental and social initiatives of the military being mostly used as a mechanism to legitimise militarism.
Economy and population	Green and equitable economic growth, and maintaining population levels, important to maintaining human security.	Green and equitable economic growth, and maintaining population levels, important to maintaining human security.	Security for humans and non-human species enhanced through steady-state economy and reduced human population.	Ecologically damaging and/or inequitable economic growth, and maintaining population levels, to benefit the rich over the poor.

Table 3. Footprint analysis data – grouping by national wealth

	World	High Income Countries	Middle Income Countries	Low Income Countries
Population (millions)	6,476	972	3,098	2,371
% of pop'n	100%	15%	48%	37%
Current EF (ghpc)	2.7	6.4	2.2	1.0
Total EF (millions of gh)	17,444	6,197	6,787	2,377
% of total EF	100%	40%	44%	15%
Current biocapacity (ghpc)	2.1	3.7	2.2	0.9
Ecological deficit (ghpc)	0.6	2.7	0.0	0.1
% overshoot	31%	74%	2%	14%

Constructed using data from the Footprint Network (2008)



REDDy or not? The Effects on Indigenous Peoples in Brazil of a Global Mechanism for Reducing Emissions from Deforestation and Degradation

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Abstract

Deforestation in the tropics accounts for one-fifth of global greenhouse gas emissions. For this reason, the preservation of remaining tropical forests is an integral component of any international climate change mitigation policy. Indigenous peoples are crucial actors for the success of such a policy given the large amount of forestland in indigenous hands, their historical and cultural role in the management of forests, and their relative success at sustainable forest stewardship.

The aim of this research is to contribute to the academic literature and to the ongoing international debate over a mechanism for reducing emissions from deforestation and forest degradation (REDD), scheduled to culminate in December 2009 at the Copenhagen Climate Conference. This article aims to answer the question: What will be the effects on indigenous peoples in Brazil of an international policy mechanism for REDD? It draws upon research conducted using a qualitative prospective policy evaluation method to describe the possible risks and opportunities to indigenous peoples and to make recommendations for improving REDD on the variables of scope, financing, and the process of negotiation and governance.

Although the article concentrates on the effects of a REDD policy on indigenous peoples in Brazil given its status as a leading-edge case on this issue, it aspires to offer lessons for the other countries of the Amazon basin.

Keywords: Avoided deforestation, Brazil, Clean Development Mechanism (CDM), Climate change, Deforestation, Forest carbon, Indigenous peoples, Kyoto Protocol, Reduced emissions from deforestation and forest degradation (REDD)

1. Introduction

As governments grapple with the risk of grave climate change, the preservation of tropical forests is increasingly considered an integral component of any mitigation policy. It is in this policymaking context that indigenous peoples (Note 1), who have long been the most effective stewards of tropical forests, are emerging as potentially crucial actors.

The Kyoto Protocol, the global climate treaty negotiated in 1997, excluded deforestation-related sequestration as an eligible activity in the Clean Development Mechanism because of concerns about the permanence of carbon stocks in forests, the technical difficulty of monitoring and measuring forest carbon, and a perception among rainforest nations that inclusion would intrude on sovereignty. The countries of the world will meet in Copenhagen in December 2009 to negotiate a successor treaty to the Kyoto Protocol, which expires in 2012. Since the 1997 Kyoto negotiations, major developments have put deforestation on track to be included in the successor treaty: the emergence of new climate policy and financial mechanisms to enforce deforestation prevention commitments, improved measurement and monitoring technology, and the appearance of a coalition of rainforest nations willing to include deforestation in a way that does not intrude on sovereignty. In addition, recent scientific research demonstrates that preventing tropical deforestation is one of the most impactful actions available to mitigate climate change. This conclusion, plus economic research indicating the relative affordability of carbon sequestration via REDD compared to other mitigation methods, have put it at the top of the agenda for the Copenhagen Climate Change Conference. Incorporating indigenous peoples into the post-Kyoto treaty is important because of the large amount of forestland in indigenous hands, indigenous peoples' historical and cultural role in the management of forests, and their relative success at deforestation prevention vis-à-vis non-indigenous groups.

It is in this context that this article was researched and written. Although it focuses on the effects of REDD on indigenous peoples in Brazil, it aspires to offer lessons for the other Amazon basin countries of Bolivia, Colombia, Ecuador, Peru, Guyana, and Venezuela. The demographic, cultural, and political situations vary significantly across

these countries, yet all are home to substantial indigenous populations who will be affected by REDD. Brazil was selected as a leading-edge case because it contains far more remaining tropical forest – and, consequently, more carbon sequestered in biomass – than any other country in the world. It also exhibits the second highest rate of deforestation and deforestation-related carbon dioxide emissions next to Indonesia. Brazil's indigenous populations, in general, are better organized and enjoy more secure land rights than their counterparts in neighboring countries.

Given the recent tensions between indigenous peoples and countries at the international level, the goal of this work is to move beyond non-communication toward engagement. Specifically, by focusing on objective policy design questions, it identifies possible pathways to agreement. In this way, this article may facilitate negotiations in Copenhagen.

2. Literature review

From the eighteenth century until 1950, the main sources of greenhouse gas emissions were the burning of fossil fuels (wood, coal, and oil) and the clearing of northern temperate forests that accompanied economic growth in Europe and North America. Since then cropland expansion has stabilized in the developed world but greatly accelerated in Latin America, Africa, and Southeast Asia (Forester et al., 2007). The locus of forest loss has shifted to the tropics, but deforestation remains an urgent problem if the world is to address climate change as it contributing 20 percent of global GHG emissions.

The reason the overuse, degradation, and wholesale clearing of forests have a pernicious climate change impact is because of the chemical makeup of plant life. Up to 50 percent of a tree's biomass is stored carbon. When a tree (or, to break it down, a trunk, branches, foliage, and roots) is destroyed, the stored carbon is released. Because large-scale deforestation is often conducted by the use of controlled fires, carbon that had been stored in plant matter literally goes up in flames – and settles in the atmosphere. Of course, this principle works in the other direction, making a standing rainforest one of nature's best defenses against rising atmospheric carbon dioxide. In the absence of human interventions, tropical forests and the biosphere generally sequester carbon dioxide from the atmosphere through photosynthesis and release it through respiration (Mahli, 1998; Foley & Ramankutty, 2004). Compared to other zones, tropical forests are especially carbon dense; they contain approximately 60 percent of the total carbon stored in the biosphere (Sabine et al., 2004; Streck & Scholz, 2006).

Forests' capacity to sequester large quantities of carbon dioxide makes them one of the best tools available to prevent drastic climate change. They provide two key services with regard to climate change: (i) as they grow absorbing the anthropogenic emissions from other sources, like fossil fuel combustion, thereby "subsidizing" against even more severe climate change, and (ii) storing large reservoirs of carbon – at least double the amount of carbon in the atmosphere is stored in tropical forests – whose release during deforestation triggers alarming increases in carbon emissions (Canadell & Raupach, 2008).

It is clear that tropical forests have a crucial role in the carbon cycle and that deforestation contributes to climate change by elevating atmospheric carbon dioxide levels. But solving the problem of emissions from forest loss is complicated by political and policy hurdles. There disagreement over how to slow deforestation through international and domestic climate change policy. We now examine why deforestation was excluded from the Kyoto Protocol.

Despite their relevance to climate change, forests were poorly incorporated in the Kyoto Protocol. During the protocol's negotiation in 1997, the parties could not reach consensus on how to create an avoided deforestation mechanism. Efforts to include provisions in the Kyoto Protocol to allow avoided deforestation projects in the CDM were undermined by concerns about the permanence of forests, the technical difficulty of quantifying carbon stored in biomass, and forest accounting failures (Canadell & Rapauch, 2008; Streck & Scholz, 2006). The protocol nominally permits afforestation and reforestation projects to participate in the CDM but the methodologies for developing these projects are so burdensome that they have practically prevented any widespread development of afforestation or reforestation projects (Note 2). A total of eight afforestation or reforestation projects have been successfully added to the CDM registry, comprising 0.35 percent of total projects through October 2009 (United Nations Framework Convention on Climate Change, 2009).

The permanence concern arises from the fundamental difference between projects that reduce emissions by altering land use and reduction projects in other sectors (Streck & Scholz, 2006). Simply, the difference is that carbon sequestered by land use management remains a benefit only as long as it remains sequestered, whereas other emissions reductions projects remain a benefit in perpetuity. Consider the distinction between a project that stores carbon in a forest grove, which could be felled by fire, insects, or log poachers, and a technology installed in a power plant that immediately and permanently reduces the amount of carbon dioxide the plant emits. Reaching political agreement on the permanence risk of land use projects, and forestry projects in particular, proved impossible at Kyoto.

The second difficulty that undermined forestry at Kyoto was the technical difficulty of measuring the amount of carbon stored in biomass. Measuring the carbon stored in forests was controversial and difficult until recently (for an example, consider debate in the scientific literature between Brown & Lugo and Fearnside in the 1990s).

The third important concern that the literature identifies concerns forest accounting failures. Deforestation is principally driven by logging, population growth and migration, biofuel production, and agricultural expansion; preventing one of these activities from occurring in one place might simply move it to occur in another (Murray, 2008). This concept, called leakage, explains that carbon credits generated by forestry projects might represent false reductions if the prevented deforestation goes on to take place elsewhere.

At Kyoto and in subsequent negotiations, deforestation was a divisive issue. As Streck and Scholz (2006) document, European environmental NGOs were the most visible campaigners against including deforestation, a position that ultimately influenced the stance of the EU countries. In their view, "Climate change is a problem that should be addressed primarily through reducing the world's dependence on fossil fuels," explained Streck and Scholz (2006). Including forestry would undercut that priority. Fossil-fuel reduction, renewable energy and energy efficiency projects were often viewed as more "effective." Non-tropical countries were concerned that including forests would let heavily forested countries off the hook when it came to serious emissions reductions, especially because the magnitude of the carbon stored in forests is so large. Likewise, Canada and other developed countries anxious about climate change impacts worried that a flood of cheap, weakly-regulated credits from forest projects would flood the market, driving down the price of carbon credits and crowding out more meaningful activities (World Wildlife Foundation, 2003). Attempts to include deforestation were further hindered by Brazil, which argued that a strong international policy on deforestation would interfere with domestic environmental policy-making and sovereignty (Ritvo, 2008).

It was in this context that deforestation was left out of the Kyoto Protocol's CDM when it was negotiated in 1997. But since then, three major developments have boosted the likelihood that deforestation will be included in the successor treaty to the Kyoto Protocol, which expires in 2012: technical progress on carbon measurement and rainforest monitoring, the development of new climate policy and financial mechanisms, and the emergence of a coalition of rainforest nations expressing willingness to include deforestation in a way that does not intrude on sovereignty (Gullison et al., 2007). These developments appear to address the crucial stumbling blocks at Kyoto.

New scientific literature raises the stakes on the drive to include forests in the treaty, making the case that their preservation is even more important than initially imagined. We have always known that tropical forests provide important services such as preserving biodiversity, wildlife habitat, and water. But recent ecological studies show climate change eroding these benefits. On the topic of biodiversity, the findings of Miles et al. (2004), for example, imply an urgent need to preserve tropical forests. Their simulation of climate change impacts on the Amazon basin found that, under a scenario assuming a 1 percent annual increase in carbon dioxide emissions, 43 percent of plant species will become non-viable. And a potentially paradigm-changing recent article by Jackson et al. (2008) that indicates the unambiguous climate benefits of preserving tropical forests compared to other ecosystems. In it, they argue that research (and policy-making) on climate has largely ignored the biophysical factors of forests, such as reflectivity and evaporation, even though these factors have a larger influence on temperatures than carbon sequestration. For example, because forested areas are darker than pastures or snow-covered surfaces, they increase the absorption of sunlight, leading to local warming. With lighter surface colors (because of grasses, snow cover, or cloud cover, for example) comes a greater albedo effect, meaning that less sunlight is absorbed as heat, thereby reducing warming. As such, Jackson et al. (2008) are cautious about increasing reforestation efforts in temperate and especially boreal forests, since darker surface patterns may in fact be detrimental (because in these areas new forests might be displacing snow). In the tropics, however, Jackson et al. (2008) conclude that reforestation and prevented deforestation will have a cooling effect not only through prolific carbon sequestration but also through evaporation and the build-up of clouds. Jackson et al. (2008) write,

[A]voided deforestation, forest restoration, and afforestation in the tropics provide the greatest value for slowing climate change. Tropical forests combine rapid rates of carbon storage with biophysical effects that are beneficial in many settings, including greater convective rainfall.

The ecology literature is not alone in identifying that tropical forests, perhaps more than any other ecosystem or sector, have the greatest value in slowing climate change. Recent work in economics also shows that preserving rainforests represents one of the largest and least expensive GHG abatement strategies. Canadell and Rapauch (2008) note that approximately 500 million tons of carbon dioxide can be sequestered per year through forest activities (including not only avoided deforestation but also reforestation) at a cost of US\$20 per ton. Nepstad (2007) uses a different methodology than the one referenced by Canadell & Rapauch (2008), only examining avoided deforestation potential, and predicts that a price of US\$5.50 per ton of carbon would be sufficient to preserve all of the remaining tropical forests in Brazil and, consequently, the estimated 47 billion tons of carbon they contain. That compares with the current price of carbon dioxide on the regulated European market of US\$16 per ton. This economics literature is synthesized in a recent draft for the Union of Concerned Scientists by Boucher (2008) that concludes that half of world emissions from deforestation can be reduced at a third of the current market prices for carbon. Although there is not perfect harmony in

the economics literature on the price of carbon from avoided deforestation, there is broad agreement that, at least initially, it is an inexpensive option compared to reducing emissions from fossil fuels (Note 3).

To this point, we have identified the aggravating role deforestation plays in climate change. We now explore the relevance of indigenous peoples to forest management. But rather than relying on any cultural assumption about indigenous peoples' effectiveness or ineffectiveness at forest stewardship, we examine the ecological literature for an answer. Anecdotal evidence of indigenous tribes taking poor care of the land on which they live created a skewed perception. In the early part of this decade, several studies suggested that the ability of indigenous peoples to prevent deforestation on their lands was diminished as population densities increased and as they adapted to the national society's market orientation (Terborgh, 2000; Redford & Sanderson, 2000). Yet more recent studies are driving a paradigm shift toward recognizing and embracing indigenous and local land management practices (Kothari, 2008). One important study, by Ferreira et al. (2005), refuted the widely-held hypothesis that protected areas and indigenous lands in Brazil do not correspond with improved forest conservation. The study assessed deforestation that occurred within or near protected areas and indigenous reserves in the states of Mato Grosso, Rondônia, and Pará and that made up 90 percent of the deforestation that occurred in the region from 2001 to 2003. The results showed that deforestation was 10 to 20 times less within indigenous lands and protected areas than in adjoining areas. In other words, indigenous lands and federally protected areas act as an effective buffer against deforestation. A subsequent study by Nepstad et al. (2006) reinforced and added depth to these findings. This showed that the indigenous lands that do exhibit high rates of deforestation are located within the active agricultural frontier – often along a road – and that the deforestation was caused by exploitation or invasions by outsiders. In contrast to the earlier studies, data from Nepstad et al. (2006) indicate that it is possible for indigenous peoples to have connections with the national society and still maintain their forest resource. The indigenous tribes that successfully inhibit deforestation, even if their reserves are located within the agricultural frontier, are those that enforce legal restrictions on non-indigenous forest exploitation. In recent years, some tribes have done so by defending land with force, taking intruders hostage to demand reserve demarcation, or simply soliciting government assistance with border protection.

To summarize, new consensus is emerging that indigenous lands are effective buffers against deforestation. Where deforestation does occur on indigenous lands, it is at the hands of non-indigenous intruders. And the indigenous lands with the least deforestation are those settled by tribes who defend their territories against illegal takings. In short, indigenous peoples can be the most effective stewards of the rainforest. Nepstad et al (2006) conclude that “the ecological integrity of the indigenous lands will ultimately depend upon cultural factors and on the economic alternatives that are available to indigenous peoples” (p. 71). This is all the more reason for a well-designed REDD mechanism that creates economic opportunities for indigenous peoples in sustainable forest management.

3. Research Methods

3.1 Study Method

The research that informs this article was a prospective policy evaluation, reflecting the forward-looking nature of the question. The purpose of prospective research is to provide an understanding ahead of time of how a policy is likely to work. This article seeks an understanding ahead of time how a REDD proposal is likely to work in practice for indigenous peoples in Brazil. The research involved: (i) textual analysis of the policy proposals, (ii) collection of original data through qualitative interviews with key informants using the interview guide approach, and (iii) content analysis of the collected data. The original data were collected through qualitative interviews with “experts or key informants [who were] selected primarily or solely by considerations such as knowledgeability and appropriate diversity” (GAO 1990, p. 87). Prospective policy analysis is fundamentally a time-driven approach, reflecting the need to generate conclusions about a policy proposal currently under consideration.

3.2 Study Sample

Over 12 percent of Brazil's land area – more than 1,055,000 square kilometers – is demarcated as indigenous reserves, and nearly all of that remains as pristine forest. Wunder (2007, p. 53) identifies four reasons why indigenous tribes preserve the forest:

Their forest clearing does not exceed regrowth because population density is low, human mortality is high, production technology is rudimentary, and because they treasure the forest for its cultural values.

In short, this article focuses on indigenous peoples because of their role in rainforest stewardship and based on the assumption that their effective participation will augment the possibility of success of any future policy.

The decision to study the indigenous peoples of Brazil was made because Brazil is a “snowball” case in the debate over an international policy for deforestation, a leading-edge case likely to influence the larger body. Brazil is a leading-edge case because of its size, outsize share of remaining tropical forest, and influence in the international climate negotiations. Ultimately, this article aspires to improve the way REDD is designed to create better outcomes for indigenous peoples across the Amazon Basin. Although 60 percent of the Amazon rainforest lies within Brazil, it also reaches into Bolivia,

Colombia, Ecuador, Peru, Guyana, and Venezuela. Each of these countries is home to a substantial indigenous population.

Study participants included 12 individuals identified as experts on this issue. All participants were selected for their issue expertise; none were drawn from the study population. The criteria for selection were familiarity with both indigenous peoples in Brazil and with the ongoing negotiations over REDD policy. The majority of participants represented research non-governmental organizations (NGOs) or universities.

3.3 Limitations

The narrowness of my study population, indigenous peoples in Brazil, limits the generalizability of my findings. Brazil's size, property rights regime, economic and political situation, and other factors make it unique. The findings here will not necessarily hold true in all other Amazon countries.

Since the majority of participants were educated or based in Western, developed countries, there is a clear over-representation of certain cultural tendencies. This might bias my findings toward particular types of anticipated problems or policy options. This is mitigated somewhat by the fact that, of the Western participants, the majority spend significant portions of their working time in Brazil and/or in the field. In general, relying on elites reduces the heterogeneity of expertise and experience included in a study. The participants represented at least five nationalities and were based in four countries. Even so, interviewing elites runs the risk drawing on only one shared viewpoint. Additionally, because of the qualitative nature of the interviews, the answers elicited may be subjective or speculative. Taken together, these weaknesses limit the completeness of my conclusions. This article is not only prospective but also exploratory in nature. In seeking to answer one question, it raises ten more that merit future consideration.

4. Discussion

This section places the themes that emerged from the interviews in four categories.

4.1 Incentives

If the aim of a REDD scheme is to prevent emissions from deforestation, the policy might only include stands of forest that are at immediate risk. Forests on indigenous territories are often the least threatened of all. This is one of the largest impediments to the inclusion of indigenous peoples in a system for avoided deforestation projects and was the theme most commonly mentioned by participants in the interviews for this article. If the policy insists on a strict test of additionality in which only clearly threatened areas are eligible, many indigenous lands would be excluded. As one participant noted, "Paradoxically that ends up focusing your attention on bad behavior." Crucial challenges in REDD policy design are to prevent deforestation without creating a perverse incentive to threaten forests and to reward successful forest stewards like indigenous peoples.

4.2 Risks to communities

- Five participants said that the greater levels of engagement with the external world necessitated by a REDD project could cause cultural deterioration for tribes. Two participants said that such a view was paternalistic; policy should instead focus on ensuring that when contact does happen, it is more productive.
- Because indigenous peoples clear forest to cultivate food and raise cattle, REDD could force communities to move away from traditional agricultural practices that involve the destruction of forest. Ideally REDD projects should change agriculture in positive ways, e.g. encouraging a tribe to use previously cleared land more efficiently rather than clearing new land.
- There is a risk that tribes enroll such a high amount of their territory in REDD projects that they not only abandon their traditional agricultural practices but are legally unable to engage in them. Under this scenario, REDD payments could end up compensating indigenous communities not to cultivate plants or to raise livestock at all. They would effectively import all of their food, thereby becoming dependent upon REDD payments and external producers.
- The way the policy is designed could also create new pressures on indigenous land. The adoption of a REDD scheme would suddenly assign a tremendous amount of economic value to a resource that has been in many places close to worthless. This shift would increase the risk of illegal land grabbing, border disputes, and the loss of land for indigenous groups living on land for which they do not hold clear title.
- The sudden increase in forests' economic value could create internal conflict over how to control the resource. Other governance risks raised by participants include internal abuse, corruption, and embezzlement by firms or the government. Almost all participants thought these would be potential concerns but ones that could be addressed with the right suite of safeguards.

4.3 Benefits to communities

Despite the catalogue of risks above, participants were on the whole largely positive about REDD's implications for indigenous peoples. Many participants echoed this comment: "I think [indigenous peoples] have a lot to gain by a REDD policy. I think they have a fair amount to lose in the sense of lost opportunity if a REDD policy is *not* implemented." Beyond ownership of a newly valuable asset, these participants pointed to benefits such as new streams of income, improved public goods such as health and education, new skills in forest monitoring and business administration, and recognition of their stewardship role as benefits that indigenous peoples stand to receive. Perhaps most importantly, indigenous peoples' desire to preserve their forest lifestyle will be reinforced as future threats to deforestation are minimized.

4.4 Design and implementation process

Participants talked about communication, education, and capacity building as crucial procedural steps in the design of a REDD policy. There was divergence on whether communities should be engaged at a grassroots level or if engagement should be at a higher level. Said one: "High level capacity building and engagement needs to take place [to] strengthen core groups of negotiators from some of the representative indigenous organizations" to create institutional experience among indigenous communities. One participant made it clear that the process should not confuse consultation with participation. As they have been demanding all along, indigenous peoples should be included in the design, governance, and distribution of benefits of a REDD mechanism. Another participant called for a negotiation process that does not assume all knowledge is flowing in one direction. If indigenous peoples have been so successful at preserving forests, perhaps market-oriented societies could learn from indigenous practices. Besides, at a cultural level, indigenous peoples respond to reciprocity, an observation that could help facilitate negotiations. Indigenous groups might be less antagonistic if "states could behave a bit like individuals in terms of thinking about their carbon responsibilities."

5. Policy recommendations

This section identifies the implications for policy of the themes discussed above. The principal recommendations concern REDD scope, financing, and process. Scope refers to the types of forest management activities included in the REDD regime, financing refers to the mechanisms for delivering funding to REDD projects, and process describes the procedure for negotiating and governing a REDD mechanism.

5.1 Policy recommendations for scope

In leading proposals under consideration at Copenhagen REDD is variously defined in three ways, each one representing a marginally wider scope. These alternatives are labeled RED, REDD, and REDD+.

- **RED** would credit only those projects that reduce emissions from deforestation
- **REDD** would allow projects that reduce emissions from deforestation and forest degradation
- **REDD+** would consider projects that reduce emissions from deforestation and degradation as well as those that enhance the carbon stocks in forests, such as reforestation and afforestation (Note 4)

Among participants, there was near universal agreement that RED is the alternative with the least possible net benefits to indigenous peoples and REDD+ is the alternative with the greatest potential. Because forests on indigenous territories are not under threat of full-scale deforestation, the effects of a RED policy on indigenous peoples would be minimal. They would not stand to benefit directly.

There would be some project opportunities under REDD because some degradation activities occur on indigenous lands, such as, according to one participant, clearing for pastures or gardens, allowing loggers to enter the reserve, and loggers entering illegally and taking high-value trees.

The broadest alternative, REDD+, would bring not only all of the effects noted earlier for the other alternatives but also greater income potential because indigenous peoples would have the opportunity to engage in projects that reforest tracts of land. (Voluntary REDD+ projects piloted by NGOs and indigenous groups are already occurring.) Risks of the REDD+ approach include worries about locked-in land use obligations. A reforestation project that is agreed to without a complete understanding of its meaning could obligate a tribe to maintain the forest at the expense of agriculture and nutrition.

These are the effects on indigenous peoples of the different alternatives for scope. This article offers the following recommendations to improve the scope alternatives from the perspective of indigenous peoples.

- To address the risk that projects might inhibit tribes' land use, a policy should include a carefully considered definition of both degradation and reforestation. The ideal policy would encourage tribes to conduct agriculture efficiently (that is, without having to degrade as much land) and sustainably. Similarly, reforestation should be defined as projects that restore forests to their natural state using native species. No REDD policy should allow commercial tree plantations or reforestation projects with non-native species.

- To reduce the risk that indigenous peoples will abandon traditional subsistence activities and become dependent upon REDD payments, policy should be designed to foster new revenue-generating activities, such as sustainable timber logging, agroforestry, and the commercialization of non-timber forest products (like growing fruits, nuts, and coffee within a standing forest).
- To best meet the interests of indigenous peoples, the broadest alternative possible, REDD+, should be adopted. With a broader scope come more risks like land use obligations and dependency, but each of those risks could be mitigated through policies like strict definitions of degradation and reforestation.

5.2 Policy recommendations for financing

The second major policy variable asks: where does the funding for projects come from? The three basic alternatives for financing are:

- A **direct market approach** that allows firms in developed (“Annex 1”) countries to purchase credits from REDD projects to meet their domestic requirements under a trading scheme; this could include offsetting.
- A **government fund approach**, under which REDD credits are not offsets. Instead, developed country governments or firms make transfer payments to tropical country governments which then develop REDD projects domestically.
- **Voluntary funding** that is provided by governments, firms, or individuals to REDD projects without a reciprocal exchange of a credit to meet any compliance target.

In identifying the ideal financing policy from the perspective of indigenous peoples in Brazil, participants were largely divided between a direct market approach and government fund approach. Those who preferred a direct market said it would generate greater potential funding because of its tie-in with trading (or similar emissions reduction) regimes in Annex 1 countries. Additionally, since REDD projects would be developed independently in a direct market, buyers would have choices. The flexibility of choice could bring “gourmet” buyers (i.e. those interested in projects with social co-benefits) to indigenous peoples. Finally, while a direct market would bring some cultural and corruption risks for indigenous peoples, these could be mitigated with strong standards and excellent capacity building.

Challenges associated with a direct market include:

- It is an offset market by design and indigenous peoples are skeptical about policies that allow developed countries to offset their emissions rather than making real reductions.
- The potential for one-time payments that are not sustained over time. Beside the governance risks of a lump sum transfer to a rural subsistence community, the concern is that the communities would then have no sustained incentive to preserve.
- The negative cultural influence of engagement with external, market-driven actors.

To address these concerns, there are three specific policy recommendations to improve a direct market approach.

- There is little natural incentive for transparency among sellers of REDD credits, especially given the time, resources, and technical expertise necessary for developing a REDD project. This lack of transparency could be injurious for indigenous tribes if developers use unfavorable contracts. The government of Brazil should prepare a publicly available sample contract that would include the highest standards of community engagement and protections. This contract would be the default contract for projects involving indigenous peoples and could directly address some of the risks noted earlier such as corruption, cultural degradation, and commercial confidentiality.
- A second recommendation is the need for some level of regulation. To be credited, every project should be required to prove it was developed with authentic stakeholder outreach, that the community is included in the distribution of benefits, and that abusive relationships with indigenous peoples and other local peoples are prevented.
- A final policy recommendation is to include a mechanism for sustained payments over time with the goal of increasing community capacity, reducing corruption, and ensuring forest permanence. Payments should be made over the entire course of the contract, whether 15 or 90 years. All participants familiar with indigenous communities said that sustained, low-value funding would be better than one-time, high-value funding.

Although the direct market approach would have the potential to mobilize greater amounts of money for forest conservation, there is no guarantee those funds would reach indigenous peoples. For indigenous peoples, therefore, a government fund approach might be more beneficial. The Brazilian government (Note 5) would receive transfer payments from foreign firms and countries and direct those monies to REDD projects in Brazil. The government could prioritize indigenous lands even if not under immediate threat. However there is significant potential for corruption, embezzlement, and government inefficiency.

For its proponents, the government fund approach is attractive because it would protect indigenous peoples from the worst elements of the market and enable them to work consultatively to develop projects at their own speed. Tribes are accustomed to interacting with FUNAI, the Brazilian Indian Agency. Unlike the direct market, which would be populated by price-driven buyers seek to minimize a project's development and community training costs, the government's goals are broader than simply cost-consciousness and it could be a better partner for tribes.

Despite its benefits, the government fund approach would not generate the same levels of funding and might not be as sustainable over time, especially if it is not tied to an offset mechanism. For indigenous peoples looking to REDD as a solution for protecting the Amazon basin in perpetuity, a government fund might disappoint. Corruption, embezzlement, and government inefficiency are other risks.

Policy suggestions to improve a government fund approach include:

- To reduce corruption and embezzlement risk, rather than conceiving of the government fund as a simple federal program, it should draw upon a number of stakeholders. This regulatory intermediary would be jointly administered by the government and civil society. One model could be the UN Development Program's Small Grants Program, which has a national steering committee with a non-governmental majority (e.g. members from academia, NGOs, the private sector, indigenous communities themselves).
- Other ways to promote the equitable and efficient use of funds include oversight by the UN and required disclosure accounting for how funds were used. One idea is to have tropical countries compete for REDD financing on the idea that those with the most efficient systems would rise to the top. Governments would be judged on a dollar-to-acres-saved ratio; the governments that are most effective in using funds for forest protection would be rewarded. This is an idea that the government of Brazil has supported.

The final financing alternative would be to rely on a purely voluntary market in which individuals, firms, and governments support REDD activities for reasons of conscience, charity, or image. The voluntary market is what has existed to date (Note 6).

Under a voluntary market, the risks to indigenous peoples would be fewer and the quality of the projects higher, although the amount of available funds would be drastically less than under the other alternatives. The voluntary market is not directly relevant to the negotiations over an international REDD policy and independently it is not a long-term solution to deforestation. It is valuable in so far as it allows the development of pilot projects. Pilot projects help indigenous communities, as well as state and national governments, learn lessons and anticipate possible challenges of working with REDD projects. The voluntary market will be complemented by whatever REDD policy is agreed to at Copenhagen; between December 2009 and the expiration of the Kyoto Protocol in 2012 it will be an important laboratory for refining the new mechanism. Beyond 2012 voluntary projects, especially those with high biodiversity or community benefits, will continue to exist simultaneously and to attract "gourmet" buyers.

In this section, we considered the three alternatives for REDD financing. In looking at the financing mechanisms independently, however, we miss an important point: it is possible, perhaps even likely, that the ultimate policy will allow some combination. Aside from the continued existence of the voluntary market, it is possible that the Copenhagen conference may agree to a hybrid of the market and government approaches. The government fund approach may be an intermediary step as countries develop their internal capacity to oversee project quality and prevent leakage, and as communities and interested parties grow their understanding of REDD.

5.3 Policy recommendations for the process of negotiation and governance of a REDD regime

Indigenous peoples have been largely excluded from the design of a REDD policy to this point and demand inclusion because it is highly relevant to them. The recommendations in this section are more political in nature, drawing upon the theory of negotiation.

The Poznań Climate Conference in December 2008 was meant to prepare parties for the real work at Copenhagen a year later. As at Bali in 2007, it was apparent at Poznań that REDD policy is highly important to indigenous peoples and that they felt excluded from the process of negotiating it. The nature of the international governance system is such that national governments are the only official parties to the climate treaty negotiations. Indigenous representatives at Poznań protested in the hallways after Australia, Canada, New Zealand, and the United States refused to include a commitment to the UN Declaration on the Rights of Indigenous Peoples in the draft agreement.

To incorporate indigenous voices into policy design and implementation process, this article recommends:

- Recognize the rights of indigenous peoples through text targeted to address specific concerns rather than vague language. At Poznań, leading countries opposed including guarantees that REDD policy would comply with the relatively broad-ranging UN Declaration on the Rights of Indigenous Peoples (UNDRIP). The United States, Canada, Australia, and New Zealand have substantial indigenous populations, although they do not live in tropical forests. These countries' rationale in opposing inclusion of UNDRIP guarantees was that doing so

could contradict existing domestic laws regarding indigenous peoples and that UNDRIP has “nothing whatsoever to do with climate change” (Curry & Mittelstaedt, 2008).

- Indigenous groups at Poznań were outraged and today some activists still refuse to proceed in the REDD process without a guarantee that their rights will be protected. To overcome this impasse, look to the Convention on Biological Diversity, an international treaty for the conservation of biodiversity and the equitable sharing of its genetic resources that was adopted in June 1992. Not only was the design process of CBD inclusive of indigenous peoples (e.g. they were permitted to hold the floor and to participate in debate), but the document itself includes two clauses that deal directly with indigenous peoples (Note 7). Article 8, Clause J calls for the respect and preservation of the “innovations and practices” of indigenous communities and “the equitable sharing of the benefits arising from the utilization of such knowledge, innovations, and practices.” Article 10, Clause C protects encourages “customary use of biological resources in accordance with traditional cultural practices.” A similar middle ground should be sought for REDD policy.
- Rather than being prevented from participating, indigenous peoples should be allowed to participate in discussions, understanding that they will not be eventual signatories but are important parties with a stake in the outcome.
- Once a REDD policy has been adopted, indigenous peoples should be included in its governance. For the most part, indigenous people see REDD as a positive opportunity and want to be a part of the ultimate regime. The earlier example of the UNDP Small Grants Program, in which national steering committees include representatives of all interested parties, could be a good model.
- Indigenous people should be trained in advanced forest monitoring so that they can conduct these activities themselves. One of the critical success factors from the indigenous perspective is that the ultimate REDD policy include resources devoted to this sort of capacity building.
- Finally, the governance process should include a mechanism for facilitating land tenure claims. A key risk identified in the research for this article is that a REDD policy will assign tremendous economic value to forest assets, and that pending or disputed land claims would be ignored, forcing indigenous peoples without legal title off their heritage territory. Land tenure issues are not as pressing a concern for indigenous peoples in Brazil as for indigenous peoples elsewhere. The interests of indigenous communities worldwide would be furthered if the REDD policy encouraged preserving the integrity of existing land titles, fast-tracking pending land claims, and protecting indigenous communities from land expropriation, without infringing on national sovereignty over land use decisions.

6. Conclusion

This article is based on the understanding that any serious climate change policy must address deforestation because of its significant greenhouse gas emissions. Indigenous tribes are relevant primarily because of the large amount of remaining tropical forest they control. As one interview participant explained, “REDD will never succeed...without the involvement of the [communities] that are making decisions every day as to whether to cut a tree down or leave it standing.”

Drawing upon qualitative policy research, this article explored the possible effects on indigenous tribes in Brazil of an international mechanism for reducing emissions from deforestation and degradation. It provided a prospective outlook of potential problems and benefits of various policy options and recommendations to improve them. Although the focus is indigenous tribes in Brazil, it hopes to inform policymaking in other countries of the Amazon basin.

More research is warranted on the implications of REDD for indigenous peoples and how to best incorporate them into the global climate change treaty. This remains largely unexplored terrain. For example, a program evaluation of voluntary REDD projects that have been implemented around the world to date would yield highly useful findings. Beyond questions related to the climate change treaty, future work might also investigate the sustainable forest management practices of indigenous people with the goal of offering lessons to non-indigenous societies.

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Notes

Note 1. This article uses the term “indigenous peoples,” instead of “indigenous people,” to conform to internationally accepted language as codified in the 2008 UN Declaration of the Rights of Indigenous Peoples.

Note 2. We use “reforestation” to mean restoring degraded lands to their prior state as forests and “afforestation” to mean creating forests in areas that were not previously forested.

Note 3. The Nepstad (2007) estimate should be lower because it includes only the opportunity cost. Looking at the Canadell and Rapauch (2008) predictions alongside the Nepstad predictions is an apple to oranges comparison.

Note 4. The Marrakesh Accords (2001) define deforestation as the direct human-induced conversion of forested land to non-forested land. To be considered a forest, the area must be greater than 0.05 hectares, have a tree cover of over 10 percent, and have trees that at maturity reach a minimum height of 2 to 5 meters. In other words, deforestation is the depletion of forest to below 10 percent tree cover. Degradation, by contrast, includes all activities that deplete forests to a point above total tree cover of 10 percent. Enhancement of carbon stocks includes activities that increase the carbon density of the land, often through reforestation of previously degraded forest. These are working definitions and must be defined more specifically in the post-Kyoto treaty.

Note 5. The Brazilian government is one of the original proponents of this approach. In July 2008, with a pledge of up to \$1 billion from Norway, President Lula da Silva launched the Amazon Fund to invest in pilot REDD projects. The fund has not yet disbursed any monies and is working with a state-controlled development bank to design the REDD process.

Note 6. There is no precise count of how many voluntary REDD projects have been conducted in Brazil because broader philanthropic rainforest-protection donations have a long history in the country. In recent years, several pure REDD projects have been developed by international environmental NGOs with corporate backing, but that activity has slowed as corporate donors await the results of Copenhagen conference.

Note 7. Importantly, Canada, Australia, New Zealand, and the United States supported the CBD.



Mulling over the Climate Debate: Media Education on Climate Change

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Abstract

Media education is an important tool to increase public understanding about wide ranging and complex issues such as sustainable development or climate change. This article discusses experiences gained from the production of media education material called "Mulling over the climate debate". The project was carried out in Finland as part of the Finnish contribution to the EU-wide climate change communication campaign. The main aim of the project was to produce educational material for upper secondary schools. The project developed a framework consisting of ten clusters of questions that encourage the student towards critical evaluation of the contents of the news. It is concluded that a participatory approach is a key success factor for small-scale educational projects operating with limited financial resources. On a more general level, media education is highlighted as a key factor that can trigger efficient responses to current environmental problems.

Keywords: Climate change, Finland, Media education, News coverage

1. Introduction

1.1 Ecological literacy and media literacy

Sufficient ecological literacy of the public has been highlighted as a precondition for developing and implementing effective social responses to environmental problems (Jordan et al., 2009). The printed media and television are the most important sources of environmental information for the public in industrialized countries (European Commission, 2008; Statistics Finland, 2007). Thus, media publicity is a key factor influencing environmental awareness of the population. However, media publicity is far from perfect: Poorly justified assertions, various biases, occasional errors and misunderstandings can be found in many media messages related to climate change and other environmental issues (e.g. Henderson-Sellers, 1988). One key problem is that media publicity can highlight both true warnings and false alarms, and there is no easy way of separating these from each other (Mazur 2004).

High quality news coverage describing climate issues is clearly needed (McBean and Hengeveld, 2000; Moser and Dilling, 2007). For example, a study focusing on school children in Finland showed that misconceptions related to climate change are common, partly because of news coverage that does not provide adequate information to the children (Nevanpää, 2005). However, it is unrealistic to expect the quality of climate change coverage to improve drastically, despite various efforts to educate the journalists (e.g. Bird et al., 2008). Therefore, tools to improve media literacy of the public are important. Media education is defined as the process of teaching and learning about the media (Buckingham, 2003). Media literacy is the outcome of this learning process. Better media literacy helps people make sense of the news describing complex environmental issues. Furthermore, media education aims to develop not only critical understanding but also active participation (Buckingham, 2003).

1.2 Climate change and the media

Climate change is currently the most debated environmental issue in mass media (Boykoff and Mansfield, 2009). Researchers, environmental activists, journalists, politicians, citizens and other actors are actively contributing to debates ranging from the long-term development of global climate to human behaviour at a local level. Convincing evidence is accumulating to show that global warming is a real phenomenon and a growing threat caused mainly by human actions (e.g. Oreskes, 2004; IPCC, 2007). However, many uncertainties still exist. Furthermore, new uncertainties and previously unknown risks are likely to emerge. Consequently, the efforts to find solutions to climate problems are faced with complex and partly uncertain information.

Various uncertainties of climate science are reflected in the public discussion. The large-scale public debate on climate change, or global warming, started in the late 1980s, especially in the United States (Fleming, 1998). Since 2006, there has been an upsurge of climate news in several countries, including e.g. United States (Mazur, 2009), Japan (Sampei

and Aoyagi-Usui, 2009) and European countries such as Finland. Currently a wealth of information about climate change is mediated by television, radio, newspapers, internet and other media. Hence, one key problem of climate communication is how to deal with this information overload, which also contains exaggerations, oversimplifications and misunderstandings (Moser and Dilling, 2007). More specifically, what information presented in the news can be considered reliable and how it is possible to deal with conflicting information?

1.3 The Finnish case

Several recent studies have focused on the effects of climate change news coverage on public awareness (e.g. Boykoff and Roberts, 2007; Mazur, 2009; Sampei and Aoyagi-Usui, 2009). Here the focus is on news consumption. This article presents and discusses experiences from the production process of media education material called "Mulling over the Climate Debate". The project was carried out in Finland during 2005–2006 and it was coordinated by the Finnish Environment Institute. The project was part of the Finnish Climate Change Communication Programme (FCCCP, 2007) that was also a national contribution to the EU-wide climate change communication campaign. The main purpose of this small-scale project was to develop a tool for media education, concentrating on news coverage on climate change. The main target groups were teachers and students at Finnish upper secondary schools. Other target groups included secondary schools, vocational schools and vocational high schools.

In the following, the production phase of the media education material is described and the composition of the material is presented. Then the framework for media education based on ten clusters of questions is presented, followed by a discussion about the importance of a participatory approach and conclusions related to media education.

2. Producing and disseminating the media education material

2.1 Production process

Various kinds of partners were involved during different phases of the project. The work was guided by a steering group including experts representing climate research, communication professionals and the education sector. The steering group provided comments on the substance of the drafts of the material. The members of the steering group also commented on the suitability of planned approaches. The most important partners during the preparation phase of the material were the pupils and teachers who participated in the testing of the material.

The production process of the material started in spring 2005. The first drafts of the material were tested at a Nordic Environmental Youth Camp in July 2005. The camp was organised by the Finnish non-governmental environmental youth organisation, "Luonto-Liitto". Based on comments gained from the attendees, the material was developed further and tested again in four upper secondary schools during autumn 2005.

2.2 Dissemination

The final material produced included a 30-page booklet presenting various questions aimed at guiding the student towards critical reading of the climate news (Lyytimäki and Mela, 2006). The booklet described concisely the scientific basis of climate change, based on the scientific consensus as reported by the International Panel on Climate Change (IPCC, 2001) and on more recent international research and national studies describing the Finnish situation. Furthermore, the booklet shortly introduced the main news criteria (what is considered as newsworthy) especially from the perspective of environmental and climate news.

The booklet was distributed to all Finnish secondary and upper secondary schools in autumn 2006. The main partners during the dissemination phase were the National Association of Biology and Geography Teachers and the Association of Finnish Language and Literature Teachers. These associations posted the leaflet to their members. The material was also included in the European Union climate campaign, launched on June 5th 2006. All materials produced by the project are available at the project web page <http://www.ymparisto.fi/syke/ilve> (in Finnish).

The booklet was published both in printed format and on the Internet as a PDF-file. Despite considerable additional costs, printing of the leaflet was considered to be necessary because material published only on web-pages face the risk of gaining only little attention. For example, an e-mail advertising a new web-product is easily neglected compared to a personally addressed printed letter from a well-known and trustworthy institution. The printed booklet also serves as a physical reminder of the electronic material.

3. Result of the project: Questions to evaluate and reframe the climate debate

3.1 Framework for media education

The general idea of the project was to promote students to think actively about the complexities and uncertainties of climate issues and to encourage young people towards critical yet constructive media consumption. The aim was not to provide the students with complete or "right" answers to the questions relating to climate change, but rather to provide them with a tool to analyse the multifaceted debate and to find the most relevant arguments.

The tool developed by the project consisted of several questions addressing different aspects of the climate debate. The questions were aimed at giving the students a coherent framework to analyse climate news. The questions were clustered according to different themes that guide the reader towards issues such as trustworthiness of the news, uncertainties involved, omissions made and viewpoints highlighted or understated. The questions were organised under the following ten clusters, each cluster including two or three questions:

- Questions addressing the basic features of the news item.
- Questions dealing with the viewpoints presented and stakeholders included in the news.
- Questions about the negative and positive impacts of the climate change mentioned in the news.
- Questions about the temporal perspectives presented by the news.
- Questions addressing the uncertainties and risks highlighted by the news.
- Questions dealing with representations of responsibilities to cut greenhouse gas emissions.
- Questions about the possibilities of different actors to influence climate change.
- Questions about the objectivity, saliency and potential influence of the news.
- Questions about the trustworthiness of the news.
- Questions motivating the student to self-evaluate the impact of the news on her/himself.

The main focus of the material was on the news presented by the press, but the material is suitable for media education focused on all types of media reporting on climate issues. Although electronic media have gained popularity, printed media still has a strong position in Finland (Statistics Finland, 2007). News articles from the press or news printed from electronic sources are also easy to acquire and they can be analysed with simple tools in school class rooms.

The questions were presented and explained in the booklet (Lyytimäki and Mela, 2006). In order to increase the usability of the material, selected questions were also re-organised into separate Power Point presentations suitable for different teaching situations. There was a condensed set of questions suitable for short education sessions and presentations tailored for the geography education and for media education. The focus of one presentation was on the issues of power and influence related to climate policy, whereas another presentation concentrated on responsibilities and uncertainties presented in climate news. Finally, there was a presentation encouraging and guiding the student to write a letter to the editor of a newspaper. These Power Point presentations were made freely available on the project's web site.

3.2 Importance of uncertainties

The goal of the project was also to show that in some cases answers cannot be found. For example, it may be impossible to evaluate the trustworthiness of the news just by looking the news item, if the news is inadequately or inaccurately presented (see Bird et al., 2008). In these cases, the answer may be a new set of well formulated and more detailed questions, motivating to continue the evaluation and thinking process. Straightforward answers may also not be found because information on climate change is unavoidably incomplete, many uncertainties are involved and different stakeholders are taking part in debates. There may be several well reasoned answers from different perspectives and these answers may vary drastically depending on the facts and viewpoints that are taken into consideration and the spatial and temporal scales that are chosen as a basis of discussion.

Despite the many conflicting views, various complexities and uncertainties, it is possible to make sense of climate change. As the testing phase of the material had already showed, the public comprehension is possible even without deep understanding about the various scientific uncertainties related to climate issues. What is needed is the basic knowledge about climate change, the ability to evaluate the contexts of the media contents and, most importantly, openness to new ideas and information that may contradict one's prevailing knowledge.

4. Discussion: Importance of a participatory approach

Reaching and raising interest among potential users – in this case, schools and teachers – is often a difficult task. In this case, the participatory approach involving representatives from various organizations was a key success factor for developing and disseminating the material.

One difficulty is that teachers are confronted with an ever-increasing work load. In industrialized countries such as Finland also the information overload is also a pressing problem. There is abundant information dealing with issues such as climate change, but teachers often face difficulties in finding the most relevant and up-to-date knowledge suitable for education purposes.

If new material requires much time to familiarize, it may not be used at all. On the other hand, if the new material is based on familiar methods and approaches, it may not be found as interesting and inspiring. Balancing between these

challenges is difficult. In this case, a decision was made to keep the format of the media education material as simple as possible, in order to avoid the need for any additional training of the users.

Importantly, not experimenting with state-of-the art communication technologies allowed allocation of the project's limited resources to the development of the content, dissemination of material and communication with potential users. Saved resources could also be used for visualisations, increasing the visual appeal of the material. A professional cartoonist was assigned to make illustrations related to climate issues and news production processes. The use of visual images is increasingly important in all education, including environmental education, because of the growth of the use of visual images in communication. The illustrations used in the booklet also serve as a tool to help the student develop his/her understanding about the various roles of visual images (see e.g. Seppänen and Väliverronen, 2003).

5. Conclusions: Media education for a sustainable future

In addition to better ecological literacy, better media literacy is also needed. Media education focused on environmental issues can teach people to evaluate and reframe climate change coverage and to meaningfully compare the significance of different environmental issues with other issues. Furthermore, combining media education and environmental communication creates opportunities to actively support and stimulate public interest in environmental issues.

As was noted by Kates, Parris and Leiserowitz (2005), real-world experience has shown that achieving agreement on sustainability values, goals and actions is often difficult and painful work, as different stakeholder values are compared and contrasted, criticized and debated. Media education can serve as a tool allowing different interests, values and interpretations to meet fruitfully.

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Cultural Sustainability and Heritage Tourism: Problems in Developing Bun Festival Tourism in Hong Kong

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Abstract

This study contributes to the debate on tourism and local development through evaluating an ambivalent case of traditional festival revival and tourism development in Hong Kong: Bun Festival tourism in Cheung Chau Island. The significance of this case is that it will put into relief the significance of ‘cultural sustainability’— an evaluative factor that is very insufficiently emphasized and theorized in current critical studies of tourism development. I will show although the most often mobilized critiques against heritage tourism development — including cultural inauthenticity, commercialization, lack of local economic development, and local disempowerment — can be applied to the case of the Bun Festival tourism, particular social circumstances weaken the force of these critiques in the Hong Kong case. Many local residents of the Cheung Chau Island approve the neoliberal direction of current tourist development and derive economic benefits from it. Even critical commentators in Hong Kong are not entirely against it. This study will point to evidence and arguments that uncover a serious and neglected problem in Bun Festival tourism: that neoliberal exploitation of heritage tourism resources threatens the cultural sustainability of historically rooted local practices of the Bun Festival and in turn threatens the viability of Bun Festival tourism in the long run.

Keywords: Festival tourism, Heritage tourism, Tourism development, Cultural authenticity, Cultural commodification, Cultural sustainability, Bun Festival

1. Introduction

The relationship between tourism and local development is one of the most debated issues in tourism studies. Some implicitly assume that when tourism generates wealth, that wealth will gradually promote development of local places and trickle down to local residents. Critical scholars of tourism, however, doubt that tourism development, especially in its current neoliberal forms, can bring about genuine and sustainable development for localities. Through numerous case studies and analyses of empirical data, they have shown that tourism often hurt localities in economic, environmental, socio-political, and cultural ways, and that the only real benefactors are often the national state and global capital (eg. Harrison, 2001).

This study contributes to the ongoing debate on tourism and local development through evaluating an ambivalent case of tourism development based on a traditional festival revival in Hong Kong: Bun Festival tourism in Cheung Chau Island of Hong Kong (Note 1). The significance of this case is that it will put into relief the significance of ‘cultural sustainability’— an evaluative factor that is very insufficiently emphasized and theorized in current critical studies of tourism development (Throsby, 2007). I will illustrate that although the most often mobilized critiques against heritage tourism development— including cultural inauthenticity, commercialization, lack of local economic development, and local disempowerment— are applicable to the case of Bun Festival tourism, particular social circumstances weaken their force in the Hong Kong case. Many local residents of the Cheung Chau Island approve the neoliberal direction of tourist development and derive substantial economic benefits from it. Even critical commentators in Hong Kong are not entirely against it. This study will reveal a serious and neglected problem in Bun Festival tourism: that neoliberal exploitation of heritage tourism resources threatens the cultural sustainability of historically rooted local practices of the Bun Festival and in turn threatens the viability of Bun Festival tourism in the long run.

2. Social historical context of Bun Festival’s revival

Since there are not yet any English language studies of the Bun Festival, I provide here a brief historical context of it as a background for analysis in the substantive parts of this essay. What is currently called in the English language as the ‘Bun Festival’ is the ‘*Tai ping Qing jiao*’ (sacrificial ceremony of peace and purity) ceremony organized by the local residents of Cheung Chau Island in Hong Kong (Choi 2002; Choi 2007). There are similar ‘*Dajiao*’ (Daoist sacrificial

ceremony) festivals in other parts of Southern China and Taiwan, but that of Cheung Chau is currently one of the most well-known one because it features exotic and spectacular elements such as the Bun Scramble event. The mythic origins of Bun Festival of Cheung Chau Island was that it started over 200 years ago when the gods helped local people to survive either a plague or a group of vicious pirates. The Bun Festival currently takes place in early May each year and lasts for five consecutive days. A long list of activities take place in the five days. Aside from the two biggest tourist attractions — the Bun Scramble and the Floating Children Parade — there are also other parades, street cleansing, burning of paper effigies, lion and dragon dances, vegetarian meals, Cantonese opera, and other activities that tourists can watch.

The term 'Bun Festival' was inspired by the steamed buns used in the Bun Scramble event. The Bun Scramble features competitors (who used to be exclusively local residents of Cheung Chau Island) racing upward along 60-foot bamboo tower covered with thousands of steamed buns in order to snatch the bun on the very top of the tower. In 1978, more than 100 people were injured when one of the bun towers collapsed during the race. The government banned the Bun Scramble event after that incident. In the late 1990s, the Island's local tourist revenue dwindled sharply under a confluence of factors including the Asian Financial Crisis and the Island's turning into a notorious suicide spot for Hong Kongers. In 2003, *Tai Ping Qingjiao* happened to become the first local festival to occur immediately after the SARS epidemic subsided in Hong Kong. It gained great success as citizens visited the Festival to relax after experiencing the threat of the lethal epidemic for months. Because of the Festival's success in 2003, local leaders of Cheung Chau Island negotiated with the government to revive the Bun Scramble event. The Hong Kong government, which completely embraces neoliberal discourses regarding tourism development, promptly accepted the proposal and subsequently tried to construct the Festival into one of Hong Kong's cultural tourist attractions. In 2005, the Bun Scramble was revived and the tourism discourses on Hong Kong started to market it as the centerpiece of the Festival (Chiu and Tang, 2005). The Festival has been attracting between 40,000 to 50,000 of domestic and international tourist visits to the Cheung Chau Island each year since 2004 (Hui, 2004).

3. Cultural authenticity

Cultural and heritage tourism in developing localities tends to be plagued by the problem of inauthenticity. In the commercialized marketing of a local place, its cultural tradition, artifacts, architecture, people, and commodities, the imperative of cultural authenticity often is de-emphasized for the purposes of expedience and cost-effectiveness. Additionally, inauthentic cultural products are manufactured in order to attract the largest number of tourists to consume a locality's culture. This inauthenticity can undermine a locality's heritage directly and indirectly; it displaces the authentic heritage tradition, misinforms tourists, and trivializes cultural differences.

Similar to other cases of heritage tourism, Bun Festival tourism reproduces numerous components of its heritage in distorted and inauthentic ways. A controversial example of its inauthentic cultural reproduction involves the buns used in the Bun Scramble. In the past, edible steamed buns made of flour were stacked on bamboo poles to constitute bun towers. Since 2007, the government and local elites agreed to use plastic buns instead of real, edible ones. The plastic bun, which was subsequently named '*pingan bao*' (bun of peace), came to be successfully promoted as the talisman and trademark image of the Bun Festival. The plastic buns used on the bun towers were given as souvenirs to tourists. And a wide range of souvenirs themed with image of bun of peace are designed, manufactured, and sold to tourists. There was a small scale public debate in Hong Kong surrounding the adoption of plastic buns (Choi, 2007; Fung, 2007; Kwan, 2008; Lee, 2007). Critical commentators especially point to the irony and sacrilege in the elevating of a recently invented artifact (the plastic bun) into the trademark of the traditional festival.

Another example of cultural inauthenticity is the sanitization and sportification of the Bun Scramble event. Although less discussed by the public than the issue of plastic buns, this example is no less illustrative. The Bun Scramble, at least during its past few decades of existence, performed a social function beyond its religious ritual role. It constituted an arena of competition among different major clans and secret society groups on Cheung Chau Island. These different groups showed off their bodily strength, which in turn correlates to social power in the semi-underworld environment of the Island. The scramble for the top bun was a test of the muscle power of each group and a struggle for social power among the groups (Choi, 2001; Leung, 2007). This social function of the Bun Scramble is not particular conducive to promoting tourism, however. Moreover, its partial connections to organized crime and underground societies could tarnish the civilized image of Hong Kong and the administrative authority of the Hong Kong government. That is why the Bun Scramble has been increasingly reconceived and re-organized as a sports event after its revival in 2005. Participation of the Scramble is widened to the Hong Kong public and international community of sport lovers. The event is reported and televised in the news. Strict safety standards are implemented in the building of towers. For example, a steel structure substituted the traditional bamboo structure since 2005. The Bun Scramble is being marketed to the international public as a unique, ethnic kind of rock climbing sport. The event is thoroughly sanitized: with global participants and international tourist spectatorship, it can no longer function as a competitive arena among clan factions and local secret societies.

The expedient transformation of steamed buns into plastic buns and the sportification of the Bun Scramble are doubtlessly a manifestation of the general problem of cultural inauthenticity observable in tourism development across the globe. They are different, however, from the worst cases of cultural inauthenticity in that there are tenable arguments that justify them. The use of plastic buns is more environmental friendly, hygienic, and economical (to the local community) than real, edible ones. Using a great deal of food for props is wasteful. Very few participants and tourists would want to eat the buns after the Scramble. This is not simply because steamed buns without fillings are unremarkable staple food that is seldom eaten in contemporary Hong Kong. The buns used in the event have to be made in advance and hence are a few days old when the Bun Scramble activities conclude. Moreover, in rainy and humid weather, the buns can go moldy, decompose, and fall off the bun tower. It happened once and the local festival committee had to spend extra money to purchase new buns to replace them. As the Festival and the Bun Scramble event grew, the number of buns required and the money needed to purchase them also increased. It has already reached a point where getting sufficient funding to purchase buns for the bun towers became a heavy burden on the local festival committee. Government funding for the Bun Festival remain very limited — the amount (100,000 Hong Kong dollars; USD 1 = HKD 7.8) is not even enough for purchasing steamed buns for the three bun towers. Plastic buns provide a solution to many of the problems that edible buns cause. Plastic buns are immune to weather changes. They cost two times more than edible buns but because they can be reused for several years at least, they are more affordable in the long run. That is why many local residents, local businesses, and local festival organizers gladly joined hands with the government to make the switch to plastic buns despite its deviation from traditional practices (Chan, 2007).

The sportification and sanitization of the Bun Scramble was in practice motivated by neoliberal and governance imperatives more than anything else (Sofield and Sivan, 2003). However, there are three reasons that compel local people and critics to tolerate if not support the transformation. The first reason to tolerate the present form of sportification and sanitization is its abandonment of the social exclusionary structure of the previous form. Women were informally excluded from the event. Outsiders, including Hong Kong citizens who were not from the Cheung Chau Island and foreign visitors, were also excluded. Since 2005, the Bun Scramble event has become formally opened to both groups (Editorial, 2005).

The second reason to tolerate sportification and sanitization is that the social competitive function of the original event has already become less meaningful to natives of the Island in the contemporary period. The Island was much more socio-political isolated from Hong Kong a few decades ago than now. Dominant local clans and underground societies indeed enjoy a great deal of socio-political control over the Island's residents. But historical social factors have already undermined the control of clans and underground societies over the Island. They include globalization, advanced communicative technologies, demographic changes of the Island (a small influx of new non-local residents and out-migration of young natives), a post-Handover government that is less tolerant of alternative socio-political organizations, and local business efforts to develop the Island into a domestic tourist spot in the past two decades. The contemporary socio-political landscape of the Island renders the local competitive function of the event obsolete and anachronistic. It is likely that even without government imperative and policy intervention, the event would be still be transformed in a direction that is similar to present changes as its original local socio-political function fades.

The third reason to tolerate sportification and sanitization involves the personal safety of participants of the Bun Scramble event. When the event functioned primarily as an arena of local factional competition in the past, injury of participants was not a problem to any parties. Because the Scramble was supposed to be a display of bodily power, masculinity, and kung-fu expertise of the participants, it was against participants' own interest to complain about injuries incurred in the event. It also made no sense to sue the organizers if someone was hurt because most participants were connected to the organizing committee. When the Scramble is opened up to participants other than local residents, liabilities increased and safety precautions had to become stricter. The local community has become the host rather than the sole consumer of the Scramble event. Injured outsider participants — who did not join the event to war against any local factions — have no reason to withhold criticism or lawsuits against the event if their injury was caused by the organizers' neglect.

4. Commercialization, commodification, and their local economic impacts

Local tourism development in the contemporary world always involves commercialization and commodification; neoliberal directions of local tourism development that the Hong Kong government pursues encourage rampant commercialization and commodification. Local cultural heritage, services, local spaces, community relations, and anything that can be made to create economic profit become targets of commercialization. In the few years after the Bun Festival was targeted as a focus of tourism development, commercialization has already become very salient and commodifying processes are already powerfully re-shaping the contents of the Festival. I will analyze an example of these processes and then assess local economic impacts of commercialization and commodification.

Apart from the spectacular Bun Scramble event, the most widely reported aspect of the Bun Festival in the domestic news of Hong Kong is its souvenir products. Numerous souvenir products have been designed to take advantage of Bun

Festival tourism since 2005. They include cushions, wallets, tee shirts, fans, edible bun gift sets, key holders, mobile phone accessories, and other gadgets themed in the form of the Bun, the talisman of the Festival (Chan, 2008). Some of the products, such as 'Bun-Man' dolls and electronic game pens, are innovative in terms of design but glaringly irrelevant to the Festival. But disneyization of the Bun Festival cannot do without the production and consumption of such themed and merchandized goods though (Bryman, 2004). Similar to Disneyland, Cheung Chou Island during the Bun Festival offer themed events, themed goods, and themed food. To the majority of domestic tourists, shopping for such products constitutes the only concrete experience of participating in — instead of being a simple spectator of — the Bun Festival.

The fact that innovative, lucrative, and themed souvenir products are generated for a local tourist spot is nothing new or unusual. Similar processes can be observed elsewhere in the world. But the speed with which this process took shape and became established in the case of the Bun Festival is noteworthy. In only three years of time, a large product range is produced and well known brandnames were established on the basis of these goods. The production of these souvenirs is organized by small businessmen, some of whom are natives of the Island. In popular media discourses, emergence of these products are portrayed entirely in neoliberal narratives — small entrepreneurs successfully harnessing creativity and innovative instincts to generate wealth. The earliest and most commercially successful entrant to this market was Studio 8.5 and it is praised in these terms (Wu, 2007). One of Studio 8.5's three owners is a native of Cheung Chau who resided in the Island until he was 19 years old (Anon, 2007a). The company built up its brand by selling cushions and other well-designed souvenirs products in 2006. By 2009, it is selling a larger range of souvenirs, steamed buns, and specialized Cheung Chou food products including shrimp paste. Another successful brandname, 'Mr Bun,' is founded by a native born artist who sells tee shirts.

The distribution of souvenirs relied on retail shops and flea market stalls opened in the duration of the Festival. Many of the souvenir products are retailed through consignment terms — Hong Kong producers supplying the products and the Island's local retailers providing retail space and service. Powerful players such as Studio 8.5 set up their own flea market stalls to sell their products, however. Most local retail shops and restaurants are run by locals but most flea market stalls are not.

The previous example illustrates that commercialization is progressing at a fast pace in Bun Festival tourism. Commercialization can hurt cultural authenticity. The inundation of tourists' festival experience with bun-themed souvenirs and non-traditional food products clearly undermine cultural authenticity. But because cultural authenticity is different to measure and critique of cultural inauthenticity has its own theoretical problems, critics of commercialization often focus on another important problem brought about by commercialization: whether commercialization is achieving its major positive mission in tourism development — the support of the local economy and enrichment of local residents. In the Bun Festival case as well as others, a central factor to answering this question is whether the profits resulted from commercialization flow largely to corporations outside the locality or to local entrepreneurs and residents.

Currently, most of the retail shops, motels, and restaurants are locally owned. Many motels witness full house or substantial occupancy increases during the period of the Festival (Ng, 2008; Hao, 2009). Additionally, hotel operators outside of the Island cannot easily encroach on this market. Restaurants and food shops greatly benefited from the 50,000-strong tourist traffic. The leading local bakery, Kwok Kam Kee Cake Shop, sell approximately 70,000 buns and gained 420,000 Hong Kong dollars (USD 1 = HKD 7.8) of revenue during the Festival period. Kwok, the owner, thinks that competition from the outside does not pose a challenge to his business (Anon., 2008a). Food businesses from outside the Island are devising different plans to encroach on the Bun Festival food market and share the profits. But they have to compromise with local business elites in order to achieve this. For example, Studio 8.5 (partly owned by a Cheung Chau native) has to made deals with local businesses and back off from the bun market. Instead it will focus on non-traditional foods and promote specialized dried foods produced by local residents (Anon, 2008b). The McDonald's restaurant on the Island also sells vegetarian food in order to theme itself, attract tourist consumption, and pay respect to local practices.

The making and retailing of souvenir goods is the area which businesses from outside the Island can encroach on the market without much local elite interference. A significant part of the merchandize has to be distributed to tourists through local retail shops in the Festival duration. But non-local business can also set up independent flea market stalls — which are permitted and organized by the Hong Kong government — to sell their ware (Anon., 2007b). Studio 8.5 is said to have made over HKD 100,000 of profits this way in 2007's Festival duration (Fat, 2008). Studio 8.5 is also selling Bun Festival souvenirs and themed food products from the Island in retail outlets across Hong Kong (ie. outside of Cheung Chou Island) all year long. By doing this, it on the one hand drains revenues from the Island's tourist business and on the other hand helps to market the Island's produce and the Island to a broader consumer base. Although businesses from outside Cheung Chau Island are sharing the profits generated by the Festival, they have not been able to suppress local businesses and are not likely to be able to do so in the near future. Local entrepreneurs from the Island are as knowledgeable as others Hong Konger about running small business. Moreover, they are well

positioned geographically and politically to capture the economic profits generated by the Festival.

Total expenses required by the Festival amounted to approximately HKD 1,300,000 each year in the past few years (Chan, 2008). Government subsidy was around HKD 100,000 per year. Local residents, businesses, and elites had to spend HKD 1,200,000 each year to cover the difference; gifts from commercial sponsors amounted to around HKD 200,000 in 2008 (Kwan, 2008). This means local businesses have to make at least a million HKD in profits in order to turn the Festival into an independently profitable event. While no detailed and reliable statistics of profit figures of local business are available, the Festival is likely to be independently profitable to locals. Kwok Kam Kee alone is booking over HKD 200,000 of profits and the tiny operation of Mr Bun made the local artist around HKD 50,000 (Anon, 2007b). 4,000 electronic game pens were sold in 2007, making the local businessman approximately HKD 40,000 in profits (Yeung and Chik, 2008). Each medium sized local restaurant can earn around HKD 6-70,000 of revenue per day in the peak days of the Festival (Yeung and Chik, 2008). Added to these the profits of local motel operators and restaurants, the total profits of the Festival duration are likely to exceed a million Hong Kong dollars.

5. Local disempowerment or empowerment?

From the perspective of local residents affected by festival and heritage tourism, cultural authenticity and commercialization may not be the most relevant or urgent problematic (Hampton, 2005). Instead, they may care more about whether tourism development is empowering or disempowering them (Cole, 2007). However, because empowerment involves multiple dimensions including the economic, the social, the political, and the self, it is not often easy to measure the local empowerment impact of tourism development. The case of Bun Festival tourism illustrates this complexity.

Viewed from a political angle, the local residents of Cheung Chau Island were not particularly empowered by Bun Festival's revival and tourism. They may actually have been disempowered by it. In the course of government orchestration of the Festival's revival and subsequent development, the reach of the state is concretely extended. Decisions regarding details of the Bun Festival used to be relatively autonomously decided by the local festival committee, but they can be compromised by government imperatives and considerations in the present. For example, to facilitate and simplify the police's work of keeping order during the Festival duration, historical routes of parades have to change and certain local areas are designated as restricted zones. To minimize the liability of the Floating Children Parade, the government pressured the organizers to spend an exorbitant amount of money on buying insurance for the floating children performers. The sanitization of the Bun Scramble and other aspects of the Festival also reflects the undermining of local self-governance and extension of state power. Of course, the government does not always manage to have its way in its formal and informal negotiations with local residents. For example, when the government wanted to reschedule the Bun Scramble event to the daytime to make it more convenient for governance and more user-friendly to tourists, the local festival committee adamantly refused to deviate from the historical practice of starting the event at midnight. The bureaucrats eventually had to back down. On the whole, however, power being ceded to the state from the local elite seems to be the main trend.

Viewed in social terms, whether there is local empowerment or local disempowerment is also unclear. Social integration and identity forging are two of the major social functions of traditional festivals. The revival of the Bun Festival contributes to achieving these two goals for the local community. The subsequent development of the Festival into a widely participated and news worthy event could have weakened the social integration function to some extent. The presence of too many outsiders, the strong need to put on a good show for tourist-spectators, and rampant commercial activities tend to distract from intra-community social bonding. Yet these new circumstances can also contribute to the identity forging function. Local identities are often strengthened by heightened outsider attention and symbolic boundary construction between locals and outsiders.

Viewed from the economic perspective, however, Bun Festival tourism has unmistakably promoted local empowerment. A significant part of the economic profits of the Bun Festival are reaped by local businessmen, as discussed in the previous section. The economic dimension of local empowerment complicates the overall picture of local empowerment in the Bun Festival case by a great deal. This complexity may be explicated through a stakeholder analysis. The major stakeholders of the Festival include the Hong Kong government, local residents of Cheung Chau Island, citizens of Hong Kong, domestic (Hong Kong) tourists of the Festival, and international tourists. In typical cases of heritage tourism development, each stakeholder has a different set of interests and is differently positioned so that they potentially conflict with each other on a range of issues (Ritchie and Inkari, 2006). We also expect to find such conflicts in Bun Festival tourism. For example, one would expect local residents to disagree with Hong Kong's government and citizens on certain issues regarding the Festival. For example, while local residents traditionally see the Festival as their socio-religious heritage, Hong Kong's government and citizens are gradually seeing the Festival as a profitable cultural property of Hong Kong. One expects antagonism between the host (local residents) and guests (international and domestic tourists) to be present, though it may not be very significant due to the short duration of the Festival. One would also expect casual tourists from Hong Kong to try to shape the Festival in ways that are very different from

sophisticated cultural tourists from abroad.

Despite potential conflicts among these stakeholders, there exists an important consensus among the most of them. Because of this consensus, potential conflicts are greatly alleviated and many local residents feel personally empowered by festival tourism rather than disempowered by it. The consensus is the prioritization of neoliberal economic development and generation of profits above all else by Hong Kong's bureaucrats, local residents of Cheung Chau Island, citizens of Hong Kong, and domestic tourists. There are probably members of these four overlapping groups who do not prioritize neoliberal development of the Bun Festival over preserving the local heritage of the Festival, but they are a very small minority. Ranked the freest and most business-friendly economy on Earth for the past fifteen consecutive years, Hong Kong is one of the most neoliberal places in the world. Financialization and real estate speculation have since the 1980s been the most common themes in the daily discourses of Hong Kongers and their mass media. Local residents of the Island live under the same discursive environment. They have also been developing their Island into a holiday resort for the young and lower-middle class since the 1980s. While Cheung Chau Island remains a relatively secluded community populated mostly by the native-born, it is also located at 90-minute's ferry ride from the busiest central business district of Hong Kong.

Only a handful of domestic critics, scholars, and journalists raised objections against the neoliberal revival of the Bun Festival. International cultural tourists, who should be disappointed by excessive neoliberal transformation of heritage, have not yet expressed any negative sentiments because Bun Festival tourism is still new. There are older local residents of the Island who view the commercialization of their festival heritage with ambivalence, but most locals do not. Becky Chan (2008), who is a native of the Island, interviewed many local residents in 2008 and found that the young, the socio-political elite, and businessmen among them largely welcomed recent transformations of the Festival and the consequences of heritage tourism. While they may not approve all changes brought about by neoliberal tourism development, they think that the financial gains from Bun Festival tourism are substantial enough to justify the undesirable socio-political changes. Many also think that the financial gains are helping to maintain heritage activities that were slowing dying anyways. These discourses show that locals of the Island, similar to other Hong Kongers and residents of developing localities, tend to strongly equate economic benefits with personal empowerment (Oviedo-Garcia, Castellanos-Verdugo, and Martin-Ruiz, 2008). Political and social empowerment is not terribly important in their agenda. That is why local residents have been very proactive in partnering with the Hong Kong government to develop the Festival and no local collective action against Bun Festival tourism has been reported.

6. Cultural sustainability

Environmental and ecological sustainability does not appear to be a serious problem in the case of Bun Festival tourism. The Festival's duration is sufficiently short. The Festival is certainly economically sustainable as most of the major stakeholders focus on it. Social sustainability could be a problem in certain aspects, as previously discussed in association with social empowerment. However, local residents' local identities are not particularly threatened by Bun Festival tourism. The younger generations and the elite of the Island have long been exposed to urbanized, modernized, and cosmopolitan influences from the global city of Hong Kong.

But cultural sustainability is a real problem. It is being threatened by current ways of developing Bun Festival tourism. There are three ways that a neoliberal direction of tourism development is undermining cultural sustainability in the Bun Festival case. Firstly, sportification, commodification, and commercialization encroach on and eclipse the heritage dimension of Bun Festival tourism. This problem overlaps to a small extent with that of cultural authenticity, except that the focus here is on the loss of historical elements of heritage rather than the loss of authenticity. This is a subtle difference. Because traditions are indeed constructed and ever-evolving, it is problematic to interpret contemporary transformations of Bun Festival heritage as any less authentic than, say, the Festival's form in the 1970s. The 1970s version of the Festival was likely a greatly modified version of the early 20th century version anyhow. It is doubtful, for example, that steamed buns had been used profusely in the early 20th century when Hong Kong was less prosperous or that social competitive functions had been as prominent when the Island was much less populated. However, the cultural sustainability critique of erosion of historical heritage elements in the Festival's contemporary form is not predicated on the critique that contemporary transformations of the Festival are inauthentic.

It is an observable and empirical fact that certain historical elements of the Bun Festival are displaced or replaced by contemporary elements. Examples include the turning of Bun Scramble into a rock-climbing sport, the wearing of contemporary costume by floating children, the broad serving of modern Western foods such as cotton candy, or the proliferation of contemporary bun-themed products such as electronic game pens. One can remain entirely agnostic about the authenticity and normative status of these changes, while pointing to the practical problems they create for Bun Festival tourism in the longer run. The Bun Festival is marketed as a cultural heritage tourism event. If tourists find that its contents contain too few historical elements, they may lose interest in the Festival. The contemporary elements may well be as fun or meaningful as historical ones. But they inevitably lack the sense of exoticism, the effect of local cultural immersion, and the intellectuality of historical depth — qualities that centrally appeal to cultural tourists. For

example, imagine how the Bun Festival's heritage tourism can be tarnished if suggestions like that offered by the Secretary for Home Affairs, Ho Chi-ping, were implemented. Ho proposed in 2005 to stage the Bun Scramble all year round and place dolls and cakes on the bun towers in order to turn it into a tourist attraction for all seasons and also a new kind of sport (Anon, 2005). If the introduction of contemporary elements to the Festival is left completely unchecked, the status of the Bun Festival as a historical heritage tourist occasion will become culturally unsustainable in the not very distant future.

Secondly, commercialization, the emphasis on spectacles, and sanitization tend to homogenized tourist products. The tourist products presently offered through Bun Festival tourism are limited and not very distinctive. They include the shopping for bun-themed souvenirs, the eating of vegetarian food and steamed buns, and spectatorship of spectacular performances (the Bun Scramble, floating children, lion dances, parades, Cantonese opera, and traditional acrobatics). The Festival has a potentially much larger repertoire of tourist products to offer. Examples include the watching of religious rituals, tours of historical sites and architecture, interaction with local hosts, and participation of festival activities instead of spectatorship. Instead of developing a variety of products, bureaucratic coordinators, commercial tour organizers, and public relations discourses of the Festival focus almost exclusively on originally marginal (but entertaining) aspects of the Festival for mass tourist consumption. Perhaps the majority of tourists are satisfied with such arrangements at present. But this is only the very beginning of global marketing of the Festival. As time goes on, tourists are likely to get tired of the limited variety of non-distinctive products. This applies to mass tourists who are not highly culturally knowledgeable as well as serious cultural tourists. The refusal to branch out from the most readily profitable, mass-appealing tourist products can therefore render Bun Festival tourism culturally unsustainable in the longer run.

Thirdly, because neoliberal tourism development places little policy weight on cultural heritage preservation and supplies minimal resources to it, the traditional know-how, technology, and historical knowledge that are required to reproduce the Festival year after year are in danger of dying out (Du Cros, 2007). It is reported that very few local residents are motivated to inherit the skill and technology of making floating children platforms and bun towers (Anon, 2006; Chan, 2008). Although a significant share of profits generated by Bun Festival tourism is channeled to local hands, they are captured mainly by the local business elite rather than the cultural producers who directly produce the cultural contents of the Festival. Of course the local business elite is informally forced by the local festival committee to contribute funds to ensure that the Festival take place yearly. However, they have no incentive to pay over the bare minimum of operating expenditures. The cultural work of making floating children platforms and of re-enacting other historical religious aspect of the Festival are supposed to be non-commercial, not-for-profit, and voluntary. But they are absolutely indispensable for the high profit parts of Bun Festival tourism — the selling of souvenirs, food, and tours. The Floating Children tradition of Yakou village in Guangdong province has been recognized as a provincial level intangible cultural heritage item by the Chinese government in 2008, for example (Ji, 2008). Similar recognition is not forthcoming in Hong Kong for Cheung Chau Island's Floating Children parade or Bun Scramble. If the government and businesses keep the lion share of benefits without even trickling them down to cultural producers, Bun Festival tourism could become culturally unsustainable as the cultural producers and their skills die out in the future.

Cultural sustainability is admittedly difficult to define and measure (Throsby, 2001). Unlike biological or ecological damage, there is not an objective way to determine how badly the cultural basis of a certain instance of heritage tourism has been undermined. Despite that, the cultural basis of heritage tourism is similar to the natural environment of tourism in an important aspect: they are being recklessly exploited as an externality for private profit and personal consumption. In the case of Bun Festival tourism, the unsustainable exploitation of culture is led by three major stakeholders. The government provides contextual support including reductionist global tourism PR discourses and neoliberal coordination of the Festival. Local and domestic businesses supplied homogenous and fast profit oriented products. And domestic tourists supply the economic demand through consuming the Festival in a mass touristic way. The only forces aligned against culturally unsustainable exploitation of the Festival are sophisticated international cultural tourists, critical intellectuals in Hong Kong, and older local residents of the Island. Yet with major stakeholders colluding with one another to push Bun Festival tourism towards a neoliberal direction, it is difficult to envision how the development of Bun Festival tourism could be transposed to a more culturally sustainable path in the near future.

7. Conclusion

The previous analyses show that problems that are common to heritage tourism development in developing localities are present in the case of Bun Festival tourism. They include the undermining of cultural authenticity, rampant commercialization and commodification, and local disempowerment. However, I have also mobilized arguments and documented evidence to show that a critique of Bun Festival tourism based on these problems is not neither adequate nor powerful. Some of the most controversial, cultural inauthentic innovations of the current form of the Festival are found to be historical legitimate and locally orchestrated revisions of tradition, or inevitable results of introducing personal safety or social justice in the Festival. Commercialization and commodification, though rampant, are found to

have economically benefited local residents more than corporations from outside the Island. Local residents, generally embracing the neoliberal ideology of Hong Kong society, think the economic benefits they are gaining from the commercialized and commodified Bun Festival largely justify their negative consequences. Local residents also feel sufficiently empowered by economic profits even though they are political and social disempowered in moderate ways.

I suggest that a more convincing critique of the neoliberal orientation of Bun Festival tourism can be launched in term of cultural sustainability. The neoliberal development policies, management, and marketing discourses of the Bun Festival encouraged three serious problems: eclipsing of the heritage dimension of heritage tourism, homogenization of tourist products, and dying out of cultural producers, knowledge, and technologies that physically reproduce the Festival year after year. These are not merely abstract, intellectual problems of legitimacy and authenticity. Their impact is practical — they can greatly lower the profitability of Bun Festival tourism. More culturally sustainable policies and management are crucial for preventing Bun Festival tourism from going into the decline phase of its lifecycle as quickly as other over-exploited heritage tourist destinations do.

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Notes

Note 1. I thank Becky Chan for discussing with me on a range of issues regarding the local residents of Cheung Chau Island and the Bun Festival.

Note 2. Floating children are also featured in a number of other *Dajiao* festivals in Taiwan and China.



Regional Analysis: Differences in Emission-Intensity Due to Differences in Economic Structure or Environmental Efficiency?

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Abstract

The economy is a complex system with many aspects having different interrelated dimensions. Many of these different aspects of the economy may have consequences for the quality of water. Therefore a clear but complex link exists between the economy and the quality of water. This relationship is currently an important issue in estimating the costs of implementing the Water Framework Directive. There are many mechanisms by which the Water Framework Directive affects water quality and the economy. The Water Framework Directive sets water quality targets at river basin level. This is partly explained by the fact that water pollution is very much a local environmental problem. Between river basins exist large differences in emissions to water and economic activity. As a result, the emission-intensity, here defined as the ratio between emissions and value added, differs between river basins. This paper tries to give an answer to why there are differences in emission-intensity between river basins in The Netherlands. In doing so, we will focus on differences in economic structure and environmental efficiency.

Keywords: Water pollution, Water accounts, Emission-intensity, Economic structure, Environmental efficiency

1. Introduction

Sustainable economic development is an increasingly important issue among policymakers and the public. There is thus a high demand for statistics that can support the measurement and analysis of sustainable development. The system of integrated environmental accounts, also known as SEEA (UN, 2003), is a useful tool for monitoring, measuring and analyzing the relationship between environmental policies and the economy by providing consistent time series of data, tables and accounts. The SEEA is a satellite system of the System of National accounts. It brings together economic and environmental information in a comprehensive framework to measure the contribution of the environment to the economy and the impact of the economy on the environment. Specific accounts cover natural resources such as oil and gas, material flows, air emissions, water emissions, waste, and environmental expenditure. At international level the water accounting framework 'the *System of Environmental-Economic Accounting for Water*', commonly referred to as SEEAW, has been prepared by the United Nations Statistics Division (UNSD, 2006). The SEEAW is a conceptual framework for the organization of physical and economic information related to water using concepts, definitions and classifications consistent to those of the *System of National Accounts 1993* (UN, 1993). The SEEAW framework is an elaboration of that in the handbook *Integrated Environmental and Economic Accounting 2003* (UN, 2003).

In the Netherlands, the economic framework National Accounting Matrix (NAM) has also been extended with satellite accounts for the environment. These satellite accounts describe the relationship between environmental pressure and added value for different economic sectors in the economy (NAMEA). A further specification of NAMEA (De Haan, 1994) for water issues is the satellite account Water Accounts, also known as NAMWA (De Haan, 1997) (Note 2). NAMWA provides information about the connection between the physical water system and the economy at national and river basin scale. NAMWARIB is developed in order to provide information at river basin level (Brouwer et al.,

2005). NAMWARIB provides economic and environmental related information at the level of four main river basin districts in the Netherlands; Rhine (Rijn), Meuse (Maas), Scheldt (Schelde) and Ems (Eems). In view of the fact that the Rhine basin covers approximately 70 percent of the entire Dutch territory, this basin is furthermore split into four sub regions: North, West, East and Centre. The Dutch river basin districts are presented in figure 1.

In this paper we make use of the emission accounts at river basin level which provide information on the release of pollutants in wastewater in physical units and of the economic information at river basin level which are both provided by NAMWARIB. The importance of these accounts is strengthened by the introduction of the European Water Framework Directive (WFD). The WFD states that all domestic waters should meet certain targets by 2015, as well in quality as in quantity.

In this paper the differences in emission-intensity, here defined as the ratio between emissions and value added between regions, are investigated. Data has been used on emissions and economic variables for 58 different sectors in the economy. We will try to indicate whether the differences in emission intensity can be traced back to differences in structure of the economy or to differences in environmental efficiency of industries. This analysis is done with use of the so called 'shift share methodology'. This methodology has been used in the 1960s to explain regional differences in productivity and employment (Dunn, 1960). Here we want to explain regional differences in emission-intensities. The specific method we used is based upon the work of Mazzanti & Montini (2009) and Esteban (2000).

First, we will concentrate on macro figures on emissions and value added. Subsequently, we will have a look at the data on sector level. Next we will present the methodology used to trace back differences in emission intensity due to economic structure and/or environmental efficiency. After presenting the results we get to the conclusion.

2. Data on emissions and the economy at macro and sector level

The two most important groups of substances causing environmental problems are heavy metals and nutrients (phosphorus and nitrogen). Heavy metals, like arsenic, cadmium, chrome, copper, mercury, lead, nickel and zinc are natural to some extent, but are toxic in high concentrations. An excess amount of phosphorus and nitrogen in the water causes algae and duckweed to grow disproportional, which can cause certain species of fish, high water plants and other organisms to die off (CBS, 2008). In the NAMWA, the emission of nutrients and heavy metals to the water are allocated to the economic activity which they cause, based on the 'residents' principle. One important pillar for making reliable water emission accounts is the availability of a consistent time series of water emission data. In the Netherlands, these data on water emissions are compiled by a number of governmental institutions working together in the framework of the Pollutant Release and Transfer Register (PRTR). Statistics Netherlands is one of the partners in this project. The database of the PRTR is situated at the Netherlands Environmental Assessment Agency and contains all identified emissions to water, air and soil within the Netherlands territory. Emissions can be presented for a large selection of sources like industry branches, consumers, transport traffic and agriculture. The database facilitates presentation of regional data; for water emissions in particular per water quality management authority (water board) or per Water Framework Directive (sub) river basin. The regional data are accessible for the general public via the website www.emissieregistratie.nl. Part of total emissions is reported by the companies themselves via environmental reports and part of the emissions is estimated by means of calibrating techniques. The mentioned website supplies information on methods for estimating emissions to water.

In figure 2, value added and emissions to water in 2005 for the various river basins are presented. The largest part of value added in 2005 is created in Rhine-West (50 percent of total value added) while the smallest parts are created in river basins Ems and Scheldt (only less than three percent). Rhine-West is responsible for 45 percent of total emissions while the river basins Ems and Scheldt are responsible for 6 and 7 percent of total emissions in the Netherlands.

Viewed nationally, the emissions of heavy metal equivalents (Adriaanse, 1993) to water by companies in the Netherlands have decreased constantly in the period 1995-2005. At the same time, the economy has grown quite rapidly. As a result, the emission intensity had decreased substantially. In other words, environmental performance of companies and institutions has improved substantially in this time period. However, with regard to the river basins, there are large differences between economic growth and emissions of heavy metals. In figure 3, growth in value added and reduction in emissions for the different river basins is presented. In the period 1995-2005 economic growth in the river basin Rhine Central was 39 percent, while in the Ems river basin it was only 8 percent. In the Ems area emissions of heavy metals fell only slightly, while emissions in Rhine West dropped considerably. As a result, the emission intensity dropped the most in the Rhine West area. In spite of high economic growth in this region, emissions decreased substantially. One reason for this was the reorganisation of the fertiliser industry in the area. This industry emitted large amounts of heavy metals. The decrease in emission intensity was smallest in the Ems river basin. The emission-intensity is calculated at river basin level for 1995 and 2005 and this is presented in figure 4.

The emission-intensities of the different regions can be deducted with the emission-intensity of the Netherlands (based upon the sum of the regions). It then becomes clear how the region is doing in terms of emission-intensity in

comparison to the national average. Figure 5 displays the difference in emission-intensity of the regions compared with the Netherlands for the period 1995-2005. Most regions are not performing as well as the national average. These regions are Scheldt, Ems, Rhine-East, Rhine-Central and Rhine-North. The regions Rhine-West and Meuse are performing better than the Dutch average.

It is even more interesting to look at sector level by analysing why emissions are high in some river basins and low in other river basins. The distribution of value added and emissions to water over economic sectors differs a lot between river basins. Tables 1 and 2 give a clear picture of the share of value added created by a particular sector in the economy and the related emissions to water (measured in heavy metal-equivalents).

3. Methodology

The main question in this paper is how differences in emission-intensity between regions can be explained and to what extent certain economic sectors play a role in explaining these differences. In explaining differences in emission-intensity, we concentrate on economic efficiency, economic structure and different sectors.

Data is used on emissions and economic variables for 58 different sectors (aggregated to 3 sectors) in the economy. Then we will try to indicate whether the differences in emission intensity can be traced back to differences in structure of the economy or to differences in environmental efficiency of industries. This analysis is done with use of the so called 'shift share methodology'. This methodology has been used in the 1960s by Dunn to explain regional differences in productivity and employment. Here we want to explain regional differences in emission-intensities. The specific method used here is based upon the work of Mazzanti & Montini (2009) and Esteban (2000).

This formulated problem is mathematically written as follows:

$$D_{r-nl} = X_r - X_{nl}, \text{ stand for the difference in emission intensity between a region and the Netherlands}$$

where,

$$X_r = \sum_{in} P_r^{in} X_r^{in}, \text{ emission-intensity region } r$$

$$X_{nl} = \sum_{in} P_{nl}^{in} X_{nl}^{in}, \text{ emission-intensity Netherlands}$$

$$X_r^{in} = \frac{E_r^{in}}{Y_r^{in}}, \text{ emission intensity industry } in \text{ in region } r$$

$$X_{nl}^{in} = \frac{E_{nl}^{in}}{Y_{nl}^{in}}, \text{ emission intensity industry } in \text{ in the Netherlands}$$

$$P_r^{in} = \frac{Y_r^{in}}{Y_r}, \text{ share in total value added of industry } in \text{ in region } r$$

$$P_{nl}^{in} = \frac{Y_{nl}^{in}}{Y_{nl}}, \text{ share in total value added of industry } in \text{ in the Netherlands}$$

where,

- X_r = emission intensity region r
- X_{nl} = emission intensity the Netherlands
- E = emissions to water E
- Y = value added in basic prices
- nl stands for the Netherlands
- r stands for region r
- in stands for industry
- Empirical model for explaining differences in emission-intensity between regions:

$$D_{r-nl} = \beta_1 Q_r^A M_r^A + \beta_2 Q_r^I M_r^I + \beta_3 Q_r^S M_r^S + \beta_4 Z_r^A P_r^A + \beta_5 Z_r^I P_r^I + \beta_6 Z_r^S P_r^S + c$$

Where,

$$M_r^A = \sum_A (P_r^A - P_{nl}^A) X^A, \text{ represents the industry mix effect of agriculture.}$$

The industry mix effect of manufacturing (I) and Services (S) is calculated using the same line of reasoning as for agriculture (A) (see appendix 1).

$P_r^A = \sum_A P_{nl}^A (X_r^A - X_{nl}^A)$, represents the efficiency effect of agriculture.

The efficiency effect of manufacturing (I) and Services (S) is calculated using the same line of reasoning as for agriculture (A) (see appendix 1).

$Q_r^A = \frac{E_r^A}{E_r}$, represents the share of emissions of agriculture in total emissions in region r .

This share of emissions is also calculated for manufacturing (I) and Services (S) (see appendix 1).

$Z_r^A = \frac{Y_r^A}{Y_r}$, represents the share of value added of agriculture in total value added in region r .

This share of value added is also calculated for manufacturing (I) and Services (S) (see appendix 1).

The data entered in the model are the emissions to surface water and waste water over the years 1995, 2000, 2004 and 2005. The emitted heavy metals are arsenic, cadmium, chrome, copper, mercury, lead, nickel and zinc. The emitted nutrients are phosphor and nitrogen. The included river basins are Meuse, Scheldt, Ems, Rhine-West, Rhine-East, Rhine-North, Rhine-Centre. Data on emissions and economic variables is available for 58 different economic sectors. This results in 280 ($10 \times 4 \times 7$) unique data points.

4. Results and discussion

Differences in emission-intensity are explored using two tools, namely the regression analysis, whose results are presented in table 3, and a more intuitive graphical tool. This graphical tool represents emission-intensities at sector level (heavy metal equivalents). This has been done for three sectors: *Agriculture*, *Manufacturing* and *Services* (aggregated from the 58 sectors). Together these sectors form the total economy of a particular region. These sector-specific emission-intensities can also be deducted with the Dutch average for the particular sector under consideration. By means of these tools, the differences in emission-intensity between river basins are explained. This explanation is at sector level. Agriculture, manufacturing and services will subsequently be discussed hereafter.

4.1 Agriculture

Differences between regions in the economic structure of agriculture can have a significant influence on the difference in emission-intensity between regions. Agriculture can be represented by a lot of horticulture in one region (e.a. Rhine West), while in the other region arable farming is strongly represented (e.a. Rhine North). Arable farming is on average more emission-intensive than horticulture. In order to explain differences in overall emission-intensity, differences in the structure of agriculture can sometimes be a significant explaining factor for some toxic substances. For the substances copper, lead, nickel, phosphorus and nitrogen the structure of agriculture is a significant factor in explaining differences in emission-intensities between regions.

A difference in environmental efficiency is also an explaining factor for differences in emission-intensities between regions. At industry level, one can compare environmental efficiency between regions. For example, arable farming in region A emits per euro value added more emissions to water than arable farming in region B. Accordingly, arable farming in region A is performing in a less environmental friendly way than arable farming in region B. In other words, environmental performance of arable farming in region A is worse than in region B. For the substances cadmium, lead, nickel, zinc, phosphorus and nitrogen holds that differences in environmental performance is a significant explaining factor for the differences in emission-intensity between regions.

The graphical tool for agriculture is presented in figure 6. This figure presents pollution per euro added value for different river basins in the years 1995, 2000 and 2005. Considering agriculture, the emission-intensity in the Meuse region is smaller than the Dutch average. In the Meuse region, environmental regulation related to manure treatment is very strict (LEI, 2006). This is because there are a lot of sandy soils in the Meuse region which are very vulnerable for run-off of heavy metals and nutrients. Life stock activities in this area are very intensive and are responsible for a lot of value added in this area. A large part of the produced manure is transported to areas other than Meuse (CBS, 2007). The manure intensive sector, life stock farming, thus transports its environmental problems to other regions.

In Rhine West, the emission intensity is lower than the Dutch average as well. This is explained by the large horticulture sector in this area. This sector is creating a lot of value added while emissions to water are relatively small. In contrast, arable farming is relatively large in the Ems and Rhine North areas. This sub sector of agriculture creates relatively little value added while the activities go along with a lot of emissions to water indirectly by the run-off of agricultural land to surface water.

4.2 Manufacturing

Differences between regions in the economic structure of manufacturing can have a significant influence on the difference in emission-intensity too. Manufacturing can strongly be represented by for example the chemical and metal sector in one region while in the other region printing and publishing is strongly represented. The chemical and metal sectors are more emission-intensive than for example printing and publishing on average. In order to explain differences in emission-intensity, differences in the structure of manufacturing can be a significant explaining factor. For the substances arsenic, cadmium and copper hold that the structure of manufacturing is a significant factor in explaining differences in emission-intensities between regions. For the other substances hold that differences in the structure of manufacturing is not significantly explaining the differences in emission-intensity. For the substances cadmium, mercury, lead and phosphorus holds that differences in environmental performance in manufacturing is a significant explaining factor for the difference in emission-intensity.

The graphical tool for manufacturing is presented in figure 7. This figure presents pollution per euro added value for the various river basins in the years 1995, 2000 and 2005. The manufacturing sector in river basin Meuse is less emission intensive than the Dutch average (see figure 7). However, the environmental advantage of river basin Meuse has declined over time. This is displayed by the conversion of Meuse's emission-intensity to the Dutch average over time. Emission intensity in Rhine West was higher than the Dutch average in 1995, but hereafter Rhine West's emission intensity improved due to the reorganisation of the fertiliser industry. Emissions reduced sharply while value added declined only slightly. Manufacturing in river basins Ems and Scheldt emitted more emissions to water per euro value added created than the Dutch average. This is due to fact that the chemical sector is quite big and very emission intensive in these two regions. The emission-intensive metal sector is also quite large, especially in the Scheldt region. This is partly explained by the favourable locations of industrial zones nearby important shipping routes in these river basins. Indeed, the metal- and chemical sector produce a lot for foreign consumption (exports). Manufacturing in Rhine East, Rhine North and Rhine Central has a less emission-intensive character. Many manufacturing activities in these regions are represented by less emission-intensive industries. The bad environmental efficiency in Scheldt and Ems is partly explained by more flexible environmental regulation directed by local authorities. The emission permissions issued by 'Rijkswaterstaat' (Dutch water regulator) are more flexible in these regions. The license holder fine tunes the permission in accordance with the impact on the aquatic system. The aquatic system in large outside waterways is less vulnerable than small river aquatic systems. Environmental efficiency may have been bad in these regions but the expected environmental performance (i.e. the impact on water quality) could indeed be reasonable. Apparently, the companies in these regions took advantage of these flexible permissions. The analysis done here is based upon initial emissions to water, not on the final impact on water quality.

4.3 Services

Lastly, differences between regions in the economic structure of services can have a significant influence on the difference in emission-intensity between regions. Services can strongly be represented by the environmental services or health services in one region while in the other region financial services, retail -and wholesale trade are strongly represented. Environmental services and health services are more emission-intensive than for example financial services, retail -and wholesale trade on average. In order to explain differences in emission-intensity, differences in the structure of services can be a significant explaining factor. For the substances chromium, copper, mercury and nickel hold that the structure of services is a significant factor in explaining differences in emission-intensities between regions. For the other substances hold that differences in the structure of services is not significantly explaining differences in emission-intensity. For the substances arsenic, cadmium, mercury, nickel, phosphorus and nitrogen hold that differences in environmental performance in services is a significant explaining factor for the difference in emission-intensity.

The graphical tool for services is presented in figure 8. This figure presents pollution per euro added value for the different river basins in the years 1995, 2000 and 2005. With regard to the services sector, the emission-intensity in the Scheldt area is extremely high compared to the Dutch average and the other areas. This is explained by the fact that there exists a lot of transport over water in this river basin. Transport over water causes a lot of copper and cadmium emissions due to the anti fouling paint used on boats. A lot of toxic substances are emitted in the Scheldt river basin, while the responsibility for this emission burden, at least for the biggest part, does not lie on Dutch residents but on foreign residents. A lot of these foreign transport boats are crossing the Dutch part of the Scheldt river basin on their way to Antwerp (Belgium) and back. For now, these emissions are attributed to transport over water in the Scheldt river basin. On the other hand, the economic value of the transport activities is based upon the resident principle (in line with the National Accounts) instead of upon the territory principle. This leads to an extremely high emission-intensity of the transport over water sector in the Scheldt river basin. This emission-intensity must be interpreted very carefully because the ratio is based upon two different principles. In the future a method for differentiating 'residents emissions' and 'non-residents emissions' needs to be developed in order to correct for this statistical mismatch related to emissions of

transport over water. The emission-intensity of river basin Meuse is also quite high. This is explained by the relatively low emission efficiency of the environmental services sector.

5. Conclusion

Differences in economic structure have an important role in explaining the variance in emission-intensity between regions. Even if one corrects for differences in economic structure, differences in emission intensity remain. This leads us to believe that a difference in environmental efficiency of industries between river basins also plays an important role. In this paper it has been tested which factors play a significant role in explaining differences in emission-intensity. It is important to note that differences in emission-intensities between river basins are very large, especially in agriculture. The differences in emission-intensities for the sector agriculture are much larger than the differences seen in manufacturing and services. This indicates that the structures of the agricultural sector as well as the environmental performance of a particular sub sector of agriculture are both very important indicators for the overall emission intensity of a particular region.

The emission-intensity for the sector agriculture in Rhine-West is lower than the Dutch average, which is explained by the large horticulture sector in this area. This sector is creating a lot of value added while emissions to water are relatively small. In contrast, arable farming is relatively large in the Ems river basin. This sub sector of agriculture creates relatively little value added while the activities go along with a lot of emissions to water. Here the economic structure plays an important role in explaining overall emission-intensity. Transportation of produced manure is a way to improve environmental efficiency of agriculture in one region. Still this measurement creates an environmental problem for another region.

Manufacturing in Ems and Scheldt emit more to water per euro value added created than the Dutch average. This is explained by the large chemical sector which is quite emission intensive in these two regions. The metal sector is also quite large here, especially in the Scheldt region. This is partly explained by the favourable locations of industrial zones nearby important shipping routes in these river basins. Bad environmental efficiency of manufacturing in Scheldt and Ems is partly explained by more flexible environmental regulation directed by local authorities.

With regard to the services sector, the emission-intensity in the Scheldt area is extremely high compared with the Dutch average and the other areas. This is explained by the fact that there exist a lot of transport over water activities in this river basin. Here a statistical problem needs to be solved. The economic value of the transport activities at river basin level is based upon the resident principle while the calculation of emissions is based upon the territory principle. A recommendation would be to construct a method for differentiating 'residents emissions' and 'non-residents emissions' related to emissions of transport over water at river basin level.

Differences in emission-intensity are explained by various factors. Some factors have significant impact while other factors don't explain the difference in emission-intensity significantly. The factors which explain the differences are very 'substance' dependent. What holds for substance X does not necessary hold for substance Y. This conclusion leads to the recommendation that emissions to water and water quality should be analysed at river basin level and at substance level. Problems related to water emissions cannot properly be analysed if one looks at national data and to emissions of heavy metal equivalents and nutrients equivalents only. Data at river basin level can help to get a better picture of the problems in the river basin and can ultimately help in developing better water quality measurements for the river basin. Data at national level alone is not sufficient in developing these policies. The availability of economic and emission data at river basin level is vital in developing and implementing emission reduction programmes at minimum costs to society as a whole.

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Notes

Note 1. Both authors are statisticians at the Dutch Bureau of Statistics, CBS. The views expressed in this paper are those of the authors only and do not necessarily reflect the opinion of Statistics Netherlands.

Note 2. The NAMWA is developed in close cooperation with the Water Service (former RIZA).

Table 1. share in total value added per river basin

River basin	Agriculture	Manufacturing	Services
Meuse	3%	31%	66%
Rhine-West	2%	17%	80%
Scheldt	5%	42%	53%
Ems	3%	33%	64%
Rhine-East	4%	29%	67%
Rhine-North	6%	34%	60%
Rhine-Central	3%	19%	78%

Table 2. share in total emissions per river basin (heavy metals, see appendix 2 for data at substance level)

River basin	Agriculture	Manufacturing	Services
Meuse	13%	24%	63%
Rhine-West	18%	15%	67%
Scheldt	18%	23%	59%
Ems	23%	48%	30%
Rhine-East	31%	16%	53%
Rhine-North	53%	12%	36%
Rhine-Central	28%	12%	61%

Table 3. Results of linear regression analysis

	Agriculture	Beta	T-value	Sig	Manufacturing	Beta	T-value	Sig	Services	Beta	T-value	Sig
Industry mix	Arsine	0,065	0,580	0,568	Arsine	0,469	3,546	0,002*	Arsine	0,308	1,728	0,099
	Cadmium	0,024	0,736	0,470	Cadmium	0,177	6,223	0*	Cadmium	0,003	0,083	0,934
	Chrome	-0,221	-0,411	0,685	Chrome	-0,482	-1,709	0,102	Chrome	0,601	2,271	0,034
	Copper	0,283	3,744	0,001*	Copper	0,458	8,461	0*	Copper	0,879	8,232	0*
	Mercury	-	-	-	Mercury	-0,042	-0,552	0,586	Mercury	0,325	3,027	0,006
	Lead	0,486	4,833	0*	Lead	-0,049	-0,612	0,547	Lead	-0,068	-0,743	0,466
	Nickel	0,343	2,556	0,018	Nickel	-0,060	-0,424	0,676	Nickel	0,533	3,630	0,002*
	Zinc	-0,100	-0,605	0,551	Zinc	-0,013	-0,088	0,931	Zinc	0,281	1,188	0,248
	Phosphorus	0,064	2,881	0,009	Phosphorus	0,014	0,739	0,468	Phosphorus	0,009	0,389	0,701
Efficiency	Nitrogen	0,683	14,968	0*	Nitrogen	0,025	0,590	0,562	Nitrogen	0,014	0,321	0,752
	Arsine	-0,071	-0,519	0,609	Arsine	0,186	1,754	0,094	Arsine	0,407	3,530	0,002*
	Cadmium	0,187	3,718	0,001*	Cadmium	0,765	13,718	0*	Cadmium	0,138	4,422	0*
	Chrome	0,055	0,110	0,913	Chrome	-0,025	-0,124	0,902	Chrome	0,172	0,524	0,606
	Copper	-0,148	-1,206	0,241	Copper	-0,009	-0,147	0,885	Copper	-0,074	-1,333	0,197
	Mercury	-	-	-	Mercury	0,896	13,734	0*	Mercury	0,772	6,767	0*
	Lead	0,547	5,066	0*	Lead	0,214	3,069	0,006	Lead	-0,028	-0,368	0,716
	Nickel	0,359	2,458	0,023	Nickel	-0,007	-0,055	0,956	Nickel	0,564	3,694	0,001*
	Zinc	0,551	2,059	0,052	Zinc	0,950	0,967	0,345	Zinc	0,233	1,866	0,076
	Phosphorus	0,571	7,550	0*	Phosphorus	0,156	6,764	0*	Phosphorus	0,362	4,956	0*
	Nitrogen	0,432	6,974	0*	Nitrogen	-0,016	-0,372	0,714	Nitrogen	0,134	2,587	0,017

Results of linear regression analysis



Figure 1. The Dutch main river basin districts (Source: website CBS)

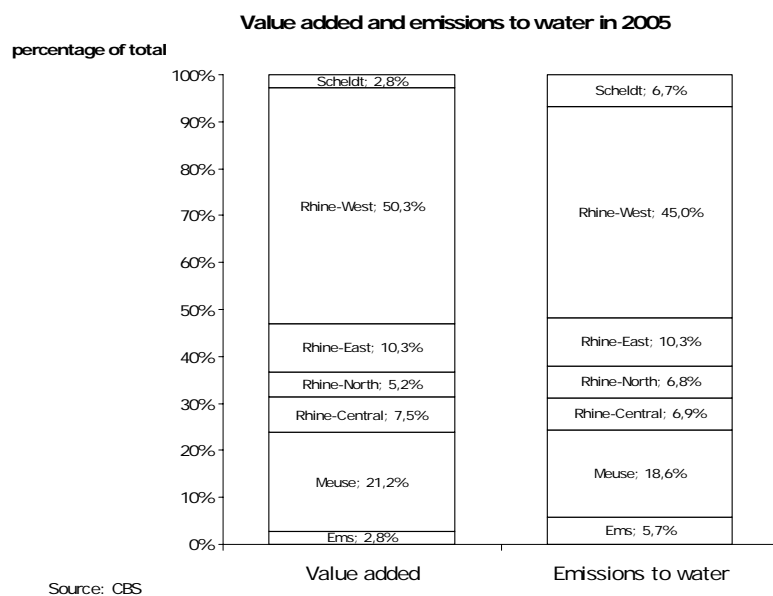


Figure 2. Value added and emissions to water in the various river basins, 2005

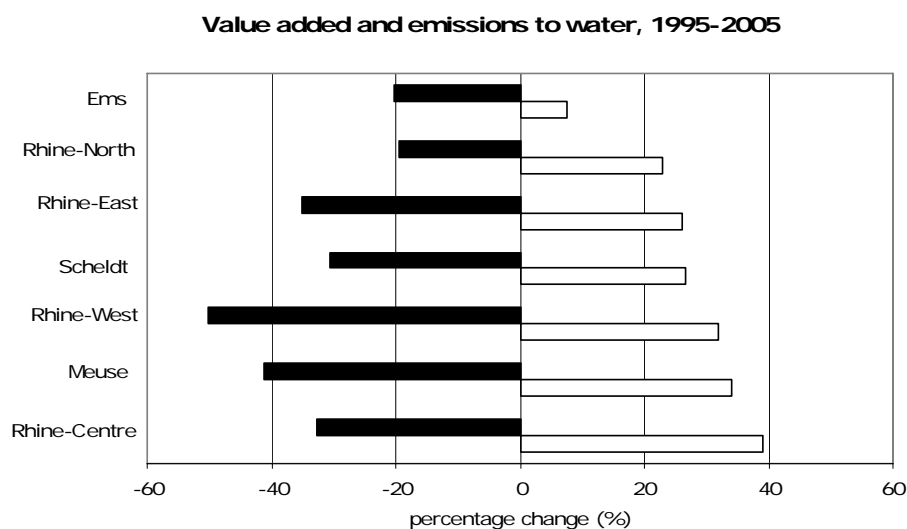


Figure 3. Value added and emissions to water in the various river basins, 1995-2005

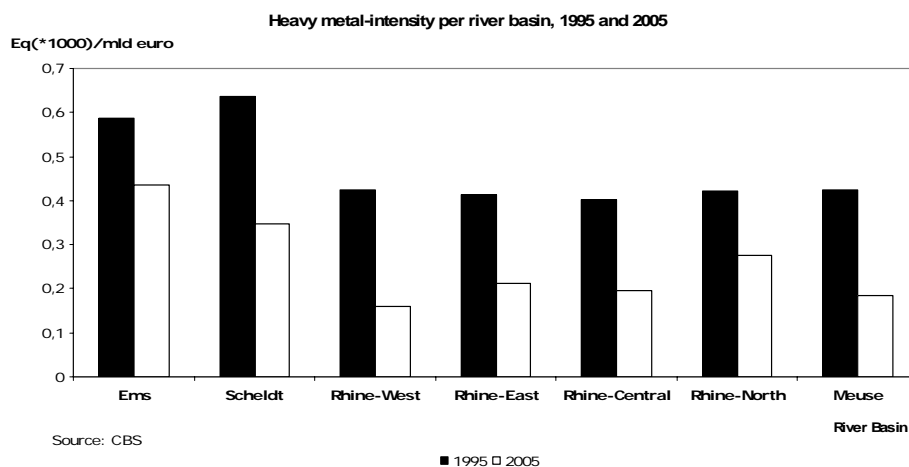


Figure 4. Emission intensity in the various river basins, 1995 and 2005

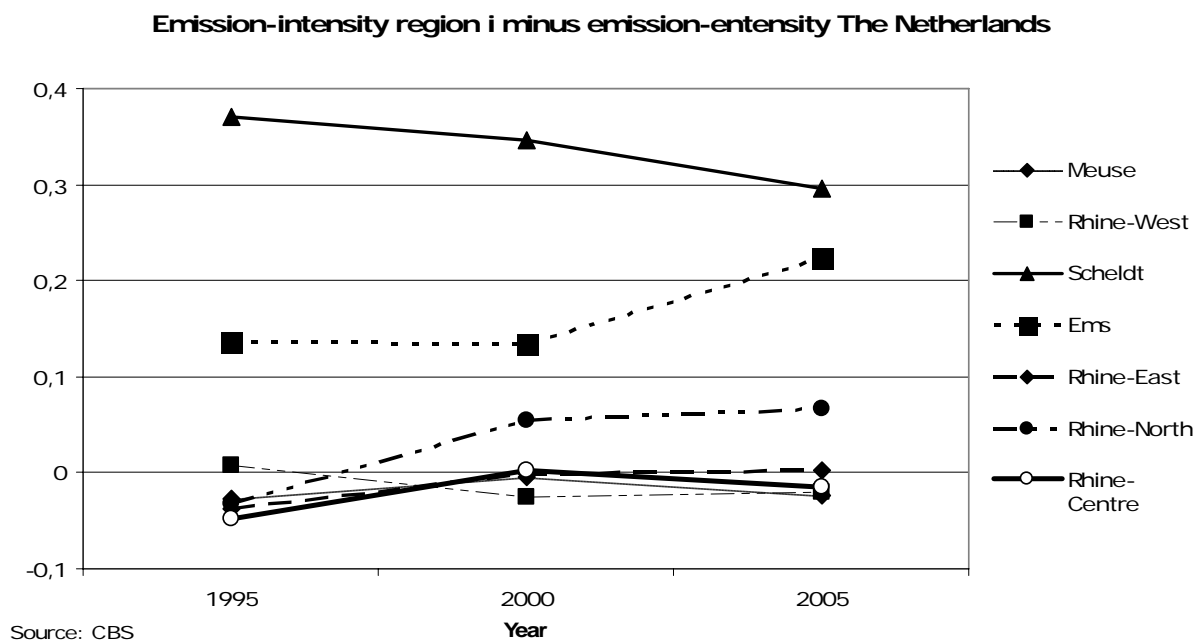


Figure 5. Emission-intensity of the various river basins 1995-2005

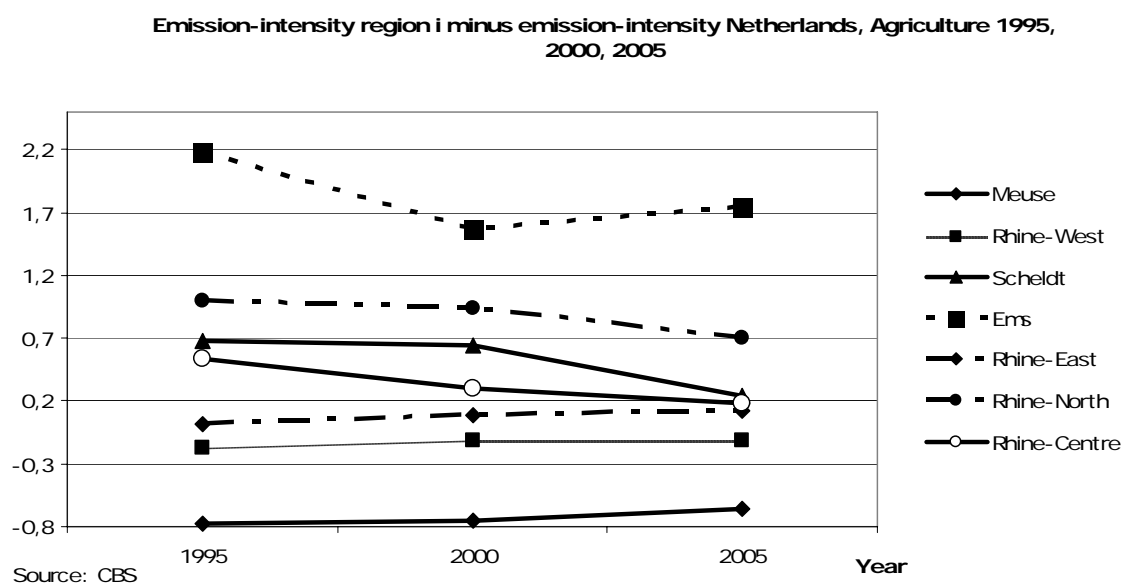


Figure 6. Pollution per euro added value for the various river basins in the years 1995, 2000 and 2005, agriculture

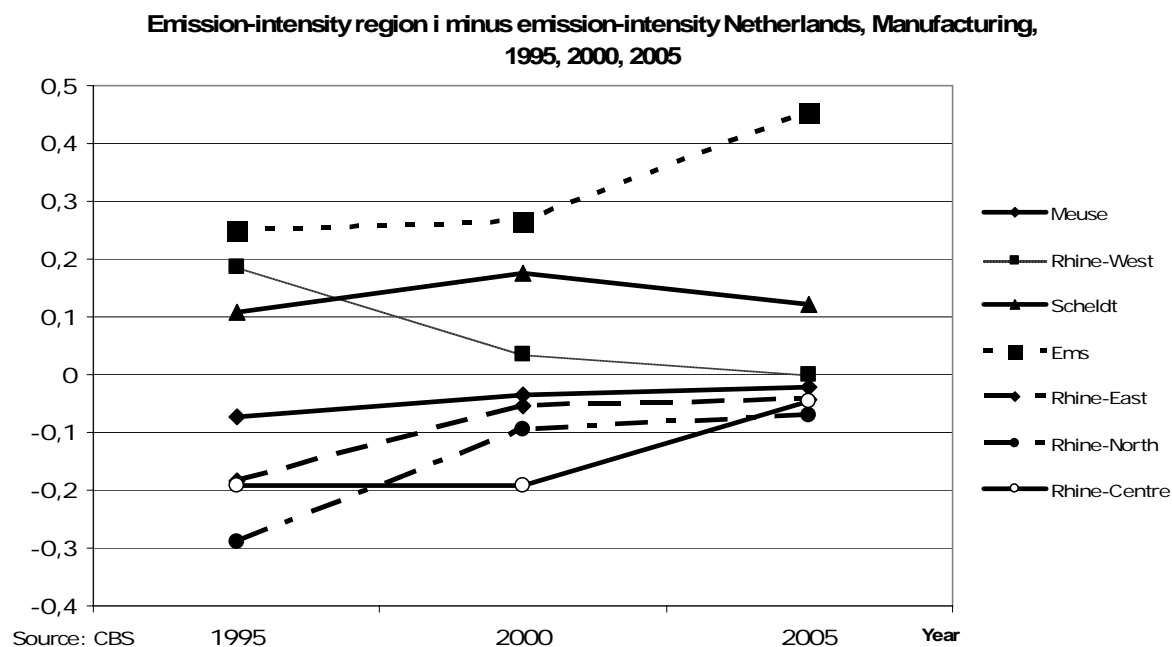


Figure 7. Pollution per euro added value for the various river basins in the years 1995, 2000 and 2005, manufacturing

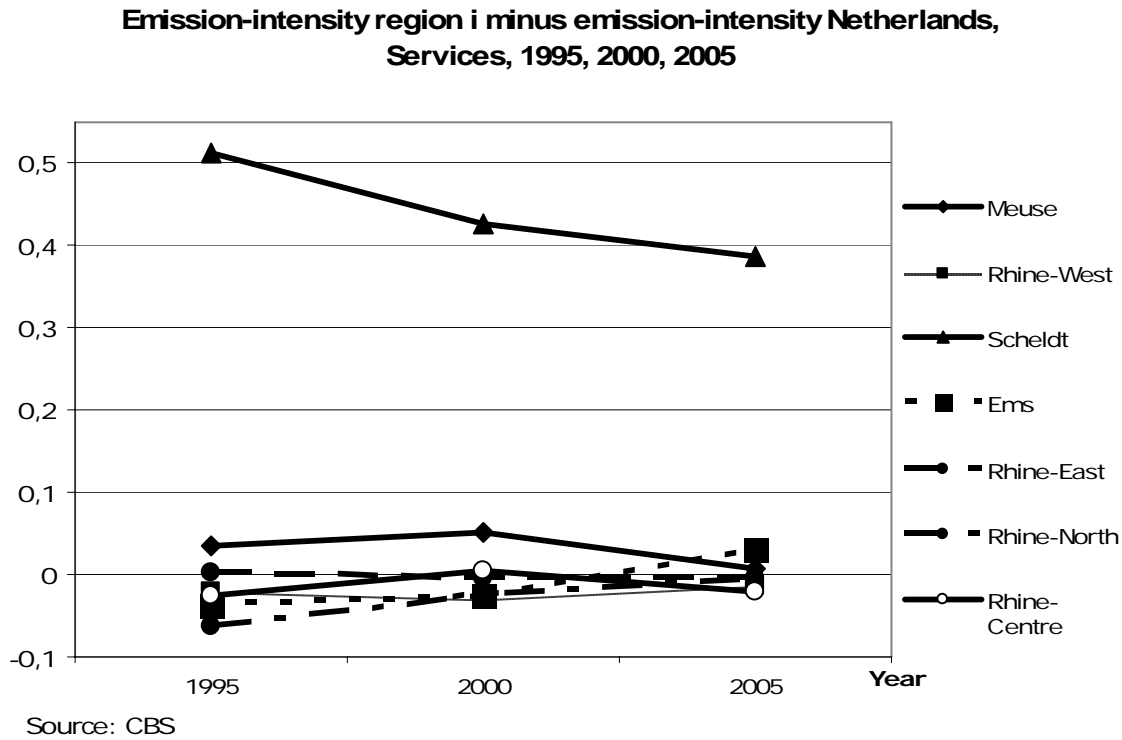


Figure 8. Pollution per euro added value for the various river basins in the years 1995, 2000 and 2005, services

Appendix 1

$$M_r^I = \sum_I (P_r^I - P_{nl}^I) X^I, \text{ industry mix effect of manufacturing}$$

$$M_r^S = \sum_S (P_r^S - P_{nl}^S) X^S, \text{ industry mix effect of services}$$

$$P_r^I = \sum_I P_{nl}^I (X_r^I - X_{nl}^I), \text{ efficiency effect of manufacturing}$$

$$P_r^S = \sum_S P_{nl}^S (X_r^S - X_{nl}^S), \text{ efficiency effect of services}$$

$$Q_r^I = \frac{E_r^I}{E_r}, \text{ share of emissions of manufacturing in total emissions in region } r$$

$$Q_r^S = \frac{E_r^S}{E_r}, \text{ share of emissions of services in total emissions in region } r$$

$$Z_r^I = \frac{Y_r^I}{Y_r}, \text{ share of value added of manufacturing in total value added in region } r$$

$$Z_r^S = \frac{Y_r^S}{Y_r}, \text{ share of value added of services in total value added in region } r$$

Appendix 2

Share in total emissions per river basin (data at substance level)

Substance	Maas_Agriculture	RijnWest_Agriculture	Schelde_Agriculture	Eems_Agriculture	RijnOost_Agriculture	RijnNoord_Agriculture	RijnMidden_Agriculture
Arsenic	0%	0%	0%	0%	0%	0%	0%
Cadmium	41%	20%	11%	19%	67%	71%	37%
Chromium	0%	0%	0%	0%	0%	0%	0%
Copper	13%	5%	17%	18%	31%	55%	34%
Mercury	0%	0%	0%	0%	0%	0%	0%
Lead	70%	38%	82%	71%	84%	87%	77%
Nickel	15%	8%	37%	38%	52%	71%	52%
Zinc	19%	9%	24%	42%	50%	78%	41%
Phosphorus	27%	15%	43%	58%	38%	55%	72%
Nitrogen	54%	37%	69%	58%	69%	77%	72%
Substance	Maas_Manufacturing	RijnWest_Manufacturing	Schelde_Manufacturing	Eems_Manufacturing	RijnOost_Manufacturing	RijnNoord_Manufacturing	RijnMidden_Manufacturing
Arsenic	18%	11%	28%	43%	3%	1%	3%
Cadmium	14%	14%	56%	66%	6%	2%	10%
Chromium	80%	87%	79%	91%	84%	77%	85%
Copper	38%	17%	24%	57%	29%	20%	19%
Mercury	3%	11%	35%	10%	5%	0%	0%
Lead	8%	8%	3%	19%	3%	1%	3%
Nickel	44%	32%	42%	49%	28%	17%	29%
Zinc	20%	10%	12%	38%	10%	4%	8%
Phosphorus	31%	19%	34%	10%	24%	28%	9%
Nitrogen	20%	15%	11%	13%	13%	10%	9%
Substance	Maas_Services	RijnWest_Services	Schelde_Services	Eems_Services	RijnOost_Services	RijnNoord_Services	RijnMidden_Services
Arsenic	82%	89%	72%	57%	97%	99%	97%
Cadmium	45%	69%	33%	15%	27%	26%	53%
Chromium	20%	13%	21%	9%	16%	23%	15%
Copper	49%	61%	59%	24%	41%	25%	47%
Mercury	97%	89%	65%	90%	95%	100%	100%
Lead	22%	26%	15%	10%	14%	12%	20%
Nickel	41%	17%	21%	13%	20%	11%	20%
Zinc	61%	57%	65%	20%	40%	18%	51%
Phosphorus	42%	36%	24%	33%	38%	16%	19%
Nitrogen	26%	41%	20%	28%	17%	13%	19%

Appendix 3

Output for the Scheldt region in 2005 (other river basins for all years available on request)

Total economy 2005		Xr	Xnl	Xr-Xnl	Difference (%)	m	p	a	m+p+a	sector	year
103	Arsenic	0.005478	0.002232	0.003246	145%	0.000947	0.002435	-0.000137	0.003246	Total economy	2005
104	Cadmium	0.024422	0.010324	0.014098	137%	0.014568	0.005299	-0.005769	0.014098	Total economy	2005
105	Chromium	0.004271	0.003092	0.001179	38%	0.0031	0.00333	-0.005251	0.001179	Total economy	2005
109	Copper	0.260757	0.095475	0.165282	173%	0.093475	0.215098	-0.14331	0.165263	Total economy	2005
110	Mercury	0.065325	0.051539	0.013785	27%	0.005471	0.010649	-0.002335	0.013785	Total economy	2005
111	Lead	0.011537	0.007204	0.004332	60%	0.005801	0.00802	-0.00949	0.004332	Total economy	2005
114	Nickel	0.2309	0.135039	0.095861	71%	0.107983	0.28396	-0.00949	0.382454	Total economy	2005
120	Zinc	0.134558	0.040587	0.093971	232%	0.032916	0.117648	-0.056598	0.093967	Total economy	2005
302	Phosphorus	49.21718	22.25355	26.96363	121%	17.95157	25.03855	-16.02649	26.96363	Total economy	2005
303	Nitrogen	43.14165	23.45792	19.68374	84%	15.58417	38.72549	-34.62593	19.68374	Total economy	2005
ZMEQ	Heavy metalequivalents	0.506347	0.210454	0.295894	141%	0.156278	0.362481	-0.22289	0.295869	Total economy	2005
NEQ	Nutrientsequivalents	92.35884	45.71147	46.64736	102%	33.53574	63.76404	-50.65242	46.64736	Total economy	2005

Agriculture 2005		Xr	Xnl	Xr-Xnl	Difference (%)	m	p	a	m+p+a	sector	year
103	Arsenic	4.01E-07	5.09E-07	-1.08E-07	-21%	-8.72E-08	-1.17E-08	-8.79E-09	-1.08E-07	Agriculture	2005
104	Cadmium	0.051445	0.107291	-0.055846	-52%	0.021563	-0.013638	-0.063771	-0.055846	Agriculture	2005
105	Chromium	6.4E-06	8.13E-06	-1.73E-06	-21%	-1.4E-06	-1.87E-07	-1.4E-07	-1.73E-06	Agriculture	2005
109	Copper	0.910747	0.763125	0.147622	19%	0.422352	0.615863	-0.890593	0.147622	Agriculture	2005
110	Mercury	0	0	0	0%	0	0	0	0	Agriculture	2005
111	Lead	0.189245	0.182335	0.006911	4%	0.022265	0.163299	-0.178653	0.006911	Agriculture	2005
114	Nickel	1.710241	1.99441	-0.284168	-14%	0.379503	1.160311	-1.823982	-0.284168	Agriculture	2005
120	Zinc	0.634748	0.490429	0.14432	29%	0.096053	0.659495	-0.611228	0.14432	Agriculture	2005
302	Phosphorus	421.1687	314.8025	106.3662	34%	85.67536	414.6826	-393.9918	106.3662	Agriculture	2005
303	Nitrogen	593.683	453.5693	140.1136	31%	21.78354	682.9827	-564.6526	140.1136	Agriculture	2005
ZMEQ	Heavy metalequivalents	1.786193	1.543188	0.243005	16%	0.562231	1.425018	-1.744245	0.243005	Agriculture	2005
NEQ	Nutrientsequivalents	1014.852	768.3718	246.4799	32%	107.4589	1097.665	-958.6444	246.4799	Agriculture	2005

Industry 2005		Xr	Xnl	Xr-Xnl	Difference (%)	m	p	a	m+p+a	sector	year
103	Arsenic	0.003677	0.00124	0.002436	196%	0.001775	0.001301	-0.00064	0.002436	Industry	2005
104	Cadmium	0.032881	0.011476	0.021405	187%	0.022683	0.011694	-0.012972	0.021405	Industry	2005
105	Chromium	0.008074	0.01085	-0.002776	-26%	0.003005	0.011575	-0.017356	-0.002776	Industry	2005
109	Copper	0.147997	0.09815	0.049847	51%	0.054513	0.409256	-0.413967	0.049802	Industry	2005
110	Mercury	0.054559	0.018007	0.036552	203%	0.010538	0.054074	-0.02806	0.036552	Industry	2005
111	Lead	0.000757	0.00188	-0.001123	-60%	0.002052	-0.000162	-0.003016	-0.001125	Industry	2005
114	Nickel	0.230526	0.190239	0.040287	21%	0.044646	0.930546	-0.934905	0.040287	Industry	2005
120	Zinc	0.03754	0.022344	0.015196	68%	0.026393	0.168679	-0.179885	0.015186	Industry	2005
302	Phosphorus	39.73077	21.39916	18.33162	86%	10.59508	30.9378	-23.20127	18.33162	Industry	2005
303	Nitrogen	11.8523	14.1614	-2.30909	-16%	8.496041	64.31296	-75.11809	-2.30909	Industry	2005
ZMEQ	Heavy metalequivalents	0.285485	0.163947	0.121539	74%	0.120959	0.656417	-0.655896	0.12148	Industry	2005
NEQ	Nutrientsequivalents	51.58308	35.56055	16.02253	45%	19.09112	95.25076	-98.31936	16.02253	Industry	2005

Services 2005		Xr	Xnl	Xr-Xnl	Difference (%)	m	p	a	m+p+a	sector	year
103	Arsenic	0.007394	0.00265	0.004744	179%	0.000954	0.002908	0.000882	0.004744	Services	2005
104	Cadmium	0.015302	0.006008	0.009294	155%	0.001943	0.003958	0.003392	0.009294	Services	2005
105	Chromium	0.001704	0.000657	0.001047	159%	0.000139	0.000745	0.000163	0.001047	Services	2005
109	Copper	0.287916	0.067492	0.220424	327%	0.056612	0.134776	0.029036	0.220424	Services	2005
110	Mercury	0.079822	0.064694	0.015128	23%	0.019835	-0.003245	-0.001462	0.015128	Services	2005
111	Lead	0.003332	0.001852	0.00148	80%	0.00032	0.004417	-0.003258	0.00148	Services	2005
114	Nickel	0.092934	0.041354	0.05158	125%	0.008861	0.035071	0.007648	0.05158	Services	2005
120	Zinc	0.163444	0.028346	0.135098	477%	0.016522	0.078819	0.039758	0.135098	Services	2005
302	Phosphorus	21.85045	10.66068	11.18976	105%	2.27481	7.276407	1.638546	11.18976	Services	2005
303	Nitrogen	16.0814	9.066465	7.014934	77%	1.971723	4.133045	0.910166	7.014934	Services	2005
ZMEQ	Heavy metalequivalents	0.558915	0.1717	0.387215	226%	0.096326	0.222378	0.068511	0.387215	Services	2005
NEQ	Nutrientsequivalents	37.93184	19.72715	18.2047	92%	4.246533	11.40945	2.548712	18.2047	Services	2005



Investigating the Psychological Effects of Sustainable Buildings on Human Life

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Abstract

As the environmental impact of buildings becomes more apparent, a growing field called sustainable design is leading the way to reduce that impact at the source. Sustainable design is the practice of creating healthier and more resource efficient models of construction, renovation, operation, maintenance, and demolition. Nowadays architects are seeking to construct more sustainable buildings whereas there is still little research on social response and human behavioral interactions in sustainable buildings. This paper addresses the psychological benefits that affect the occupant's life in green buildings. The social, psychological and applied behaviors of occupants in these structures are also investigated.

The results show that behavioural aspects of sustainability and how people interact with these structures can be important in sustainable design. Therefore these issues are needed to be addressed in facility management of sustainable buildings.

Keywords: Social issues, Applied behaviour, Sustainable buildings, Psychological responses, Solutions

1. Introduction

Constructing and operating buildings requires enormous amounts of energy, water, and materials and creates large amounts of waste. Where and how they are built affects the ecosystems around us in countless ways. And the buildings themselves create new indoor environments that present new environmental problems and challenges. As the environmental impact of buildings becomes more apparent, a growing field called sustainable design is leading the way to reduce that impact at the source. Sustainable building is in fact creating environmentally sensitive, energy conscious and healthier developments. Generally one of the important points of green buildings is called "Quality of life", that means improving our living space through reduced indoor air pollution, smarter designs and improving environmental conditions for future generations. Since quality of life is essential part of green buildings, it is important to understand the relationship between technological sustainable development in different buildings and the impacts on the occupants and buildings owners. However there is still limited research on the relationship between these developments and the psychological response of buildings users. In this paper social and psychological issues in green buildings are investigated in addition to applied behavior of occupants in these structures.

2. The psychological impacts of sustainable structures on human life

The world-wide phenomenon of migration from agricultural to urban communities (World urbanization prospects, 1998) and increased awareness of environmental problems related to urban sprawl (Schmidt, 2004) created the motivation for development of large scale urban projects. This tendency is supported by technological advancements especially in tall buildings that have made their construction easy and less costly. However these modern buildings have always been

criticized for separating their occupants from the green nature. About a decade ago the term Sick Building Syndrome (SBS) was coined to describe the condition where people became ill simply by occupying a particular building (Edwards, 1999). Table 1 shows some effects of such buildings on human life in addition to some probable causes and solutions.

The symptoms of SBS (headache, nausea, stress, sore throats, asthma attacks, etc.) can cause genius distress in some, and mild discomfort in others. SBS is generally seen as a problem caused by combination of factors such as poor thermal, visual and aural comfort condition. SBS is exacerbated when occupants of buildings lack the ability to perceive natural conditions (daylight) and are unable to control their own internal environmental conditions. Many studies have shown the significant effect of nature on human life. Haber (Haber, 1977) founded that primary concerns of occupants in tall buildings were the great sense of disconnection from the nature. As he demonstrated the separation from the nature in large urban projects and tall buildings may have significant negative effects on human life and may threaten social health in different aspects (Haber, 1977). Kaplan's (Kaplan, 1995) Attention Restoration Theory (ART) posits that natural settings provide an easy fascination that can help people recover from the mental fatigue caused by the more effortful attention often required by work. Wilson (Wilson, 1984) addresses that humans have an innate need for contact with the natural world and in particular seek to occupy and recreate in settings those are similar to those from our evolutionary past. Ulrich (Ulrich, 1993) reviews studies supporting hypotheses that humans have innate negative and positive associations with various elements of the natural world.

Nowadays psychologist found that that spending time in natural environment can have positive psychological effects on human mind (Hartig et al, 1991) Kuo and Sullivan (Kuo, Sullivan, 2001) have extended these findings by showing that the presence of vegetation in public housing sites is significantly associated with reduced levels of aggressiveness and crime. They even show that residents living in "greener" surroundings report lower level of fear, fewer incivilities, and less aggressive and violent behavior (Kuo, Sullivan, 2001). The hypothesis about the restorative function of natural environment has been tested in many empirical studies. Ulrich (Ulrich, 1994) for example founded that hospital patients who could look out on trees and nature from their windows recovered more quickly than whose views restricted to buildings. Schroeder (Schroeder, 1991) has shown that natural environments with vegetation and water induce relaxed and less stressful states in observers compared with urban scenes with no vegetation. This ability of natural elements to function as "natural tranquilizers" may be particularly beneficial in urban areas where stress is an all too common aspect of daily living (Berg et al, 1998). Later studies have lead to similar results, strengthening the assumption that natural environment have positive influence on psychological and mental health. Not only green areas have significant effect on human behavior, but also natural features seem to affect emotional well being. For example an evaluation of day lighting in schools showed that students in day lit classrooms were happier than those with minimal day lighting in other classrooms (Heschong et al, 1998). Improving air quality can also create healthy life. Fisk et al (Fisk et al, 2002) suggested that 16–37 million cases of colds and flu could be avoided by improving indoor environmental quality, resulting in \$6–\$14 billion annual savings in the United States. The symptoms of SBS might also be reduced 20–50%, resulting in \$10–\$30 billion annual savings in the United States (Milton et al, 2000). Similarly, people seem to experience more headaches, dizziness, and tiredness when toxic materials are present (Wargocki et al, 1999). Therefore, occupant health is greatly related to the natural features. Generally green buildings that provide natural day lighting, appropriate ventilation, use of none toxic materials, natural landscape views and vegetation inside the building can improve human health and have positive psychological effect on occupant's mind (Wise, Betch, 1999). In addition to the mentioned advantages of green buildings on human life, considering environmental issues in such structures could have other benefits as shown in Table 2.

3. Understanding occupant's actions in green buildings

Not only sustainable building provides a shelter from elements to support human activities, it can fulfill different behavioral and psychological needs. Designing a successful green building, architects should predict what human activities are required more than others; also they should use this knowledge to design facilities to support their predictions. It is important that different places require various facilities. For example an industrial factory must provide enough space for manufacturing equipment and processes, attending to acoustic and lighting needs, facilities for employee meetings, breaks, and meals. If the space is to be used as a hotel, it must support different room size, lightning requirements, public lobby, waiting hall, management room, good ventilation and enough fresh air. In 1996 the problem of stress and eye strain associated with Visual Display Units (VDU) and other office machines was very serious. To solve the problem, the European Commission (EC) introduced Directives "Display Screen Equipment" and "Workplace" (Edwards, 1999). The Directives address the balance between general internal environmental standards and the specific standards at the workstation. In the process they put the control of the lighting environment more in the hands of the office worker by requiring the installation of blinds, curtains and individual lamps. A Gallup report in 1990 "Productivity Loss in the office" (Beer, 1994) found that companies are losing 15 percent of productivity every year due to light-induced stress and illness. This amounts to more than \$2500 per employee per year, a sum more than adequate for the cost of adapting most working environments to the new standards. There are dangers in the directives from an

energy point of view. The need to fit blinds on every office window could lead to higher levels of artificial lighting in the core of the building. As lighting in offices is often the major source of heat, this will add the pressure to mechanically ventilate the building (with increased energy costs). A naturally ventilated office with opening windows is to some extent undermined by having to pull blinds and curtains. In addition, the screening of daylight at windows will inevitably block views with the possibility of adverse psychological effects.

The energy consumption in buildings is also related to construction design methods (Table 3). Hence, an important concerning factor about occupant's action in green buildings is that architects should estimate how much energy and water will be consumed, when determining the required technical performance.

Occupants make behavioral choices that affect these systems, such as when to increase their personal comfort by adjusting thermostats, opening or closing windows, lowering or raising blinds and drapes. These occupants' choices are critical in determining how well and efficiently building system performs. In some countries traditional green buildings are typically planned to be efficient in these respects, but there are still not enough anecdotal experiences or formal evaluations of sustainable modern buildings in order to determine how effectively they respond to variations in human needs.

In 1998 Heerwagen and Wise (Heerwagen, Wise, 1998) studied about the benefits of green buildings and building performance to occupants' behavior as well, they addressed a green factory in Michigan through their studies. This factory was found to be operating sub-optimally in several respects. For example, energy consumption was higher than expected, and workers kept large bay doors open for the fresh air and for the beautiful landscape that these doors provided. While the original design had allowed for better ventilation and good views, high shelving was added after initial occupancy that blocked the vents and views, encouraging occupants to open the bay doors. This study shows that all facilities in green buildings should be very sensitive to variety of user behavior and could suffer greatly if the actual usage varied significantly from that predicted in the designing stages. Generally if occupants were unable to conform to high standards, such as taking brief showers, turning down thermostats in the winter or buying minimally packaged products, the building's performance could fall below initial predictions. Developers believe one of the main reasons that passive solar designs did not become widely used by the end of the 20th century can be the perceived demands they made on occupant time and effort (Case, 1984). On the other hand, when sustainable building equipped with strong technology, heavy insulation, wise system for controlling lighting and temperature, it might be less sensitive to variations in occupant's behavior. It is an important point in determining the ability of the sustainable structure to meet its goals.

Level of tenant's knowledge and training is the other points in sustainable buildings that should be investigated. It is essential that tenants are informed well about the facilities in sustainable buildings and the appropriate ways they can utilize from them. If the occupants are not informed enough about how to use the facilities, sustainable buildings lose a great amount of its performance.

In recent years, designers are integrating recycled water into their buildings. They founded that the major water consuming appliances in buildings are taps, water closets and in larger buildings, urinals (Board, 2000). Figure 1 shows that in the typical building the two largest uses of water are personal washing (taps) and toilet flushing (WC). There are additional uses such as maintenance of heating systems, watering of plants and car washes. In modern sustainable buildings, many technologies have used to reduce the water consumption of appliances range from simple modifications to existing sanitary ware to novel system aimed at eliminating the use of water completely (Board, 2000). In this case psychological and cultural responses may be particularly important and the success of these measures is significantly dependent on user perceptions and response, for instance, if architects install low-flow showerheads, water consumption may remain high if users bathe for an extremely long period of time. Therefore, early generation low-flow toilets often result in an unexpected water savings because of public perceptions of problems with their use (Miodonski, 2009).

Although only 2 percent of water supplied to dwellings is used directly for drinking (Board, 2000), it may convert to the majority of water in large buildings. Designers try to use the recycled water for drinking purpose in green buildings that is not very pleasant for tenants and still remains controversially between occupants and sustainable building designers (Po et al, 2004). Results from a survey conducted in Australia on recycled water users and suppliers show that individuals are concerned about water reuse because of microbiological components, salinity, aggregate components such as potential of Hydrogen (pH), varying quality and organic components (Higgins et al, 2002). Therefore, that acceptance of recycled drinking water must rely on public awareness campaigns as well as the implementation of enough technologies to address potential contaminates. Some water utility officials believe that negative public perceptions of recycled drinking water will change by passing time (Hanna, 2001)

4. Attending to sustainable actions in green buildings

Water and energy are the two primary resources for the construction industry, impacting directly upon questions of comfort, health and the means of attaining sustainable development. Behavioral issues including sustainable design

have been addressed in existing research on the impact of human behavior and action on energy and water recycling and their conservations.

Social - psychological studies and applied behavioral analysis are two significant approaches on conservation matters in psychological research. The former provides attempts to understand and change attitudes, and the latter, which describes critical behavioral contingencies. Logically, social-psychological studies are based on the intuitive notion that attitudes underlie behavior, and these two items are related to each other. It means that, by changing the former, the latter will change too. A brief review on social-psychological studies shows there is often little correspondence between attitudes and behaviors and that in some cases attitudes follow behavior changes rather than preceding them (McKenzie-Mohr, 2000).

Another point that might be effective on occupant's behavior is training and conservation education. Many studies have shown there is a lasting effect on tenant's attitude when some strategies elicit public commitment to a pro-environmental action (Winter, 2000). Psychologists founded that there is a complex relationship between environmental attitudes and behaviors. In fact, the behaviors involve with a variety of personal and contextual factors such as social and demographic factors, incentives and constraints, knowledge, values and commitment. What is important is that changing any one element may not be sufficient to effect behavioral change (Stern, 2000). Therefore some psychologists point out that it may be necessary to address specific situational barriers that inhibit change if they want to approach to effective policy change. For example, McKenzie-Mohr through his studies about sustainable behavior in community indicated a combination of psychological approaches and marketing strategies to reduce water consumption. (McKenzie-Mohr, 2000)

For approaching to a clear conservation behavior, scientist divided the applied behavioral analysis into 2 parts:

- 1) Events that precede and cue or prompt the actual target behavior, called antecedents.
- 2) Reinforcing or punishing results of a behavior that determines its likelihood of being repeated, called consequences. (Geller et al, 1982).

Applied behavioral analysis of energy use by consumers suggests that the nature of both the antecedent and consequent conditions in most buildings often consume greater energy use while discouraging conservation behavior (Geller et al, 1982). What is significant in behavior theory is that the consequences of a behavior need to be urgent in order to be effective. Nearly all the events that might discourage energy use appear after a significant and very long delay. For example, the cost of energy, which is typically presented in the form of a bill arriving days or weeks after the thermostat, can constrain a tenant from turning up the level of air conditioning in the summer or the heat in the winter. If there are enough reminders to focus tenant's attention on the cost of energy and encourage them to conserve it, a great amount of energy will be saved. Unfortunately, there are still few obvious signals in most buildings that might serve to remind consumers of the costs of energy and prompt them to conserve.

Changing the occupant's behaviors and actions can provide prompts for conservation at the behavioral decision point. For example, Becker and Seligman (Becker, Seligman, 1978) placed a light in the kitchen that went on when the air conditioner was operating but outside temperatures were cool. Others have offered residents daily written information on the amount of electricity used or installed prominently placed and easy to read meters that show energy costs in real-time (Kohlenberg et al, 1976). Evaluations have suggested that these techniques may result in a significant reduction of overall energy use or during peak time use (Geller et al, 1982). Sometimes consumer behavior and its consequences are particularly disconnected such as in large buildings where those who pay the energy bills are not the ones controlling energy use. Occupants whose estimated utility costs are included in the monthly rental fee have no monetary incentive to be efficient in their energy and water use. It is important that consumers ignore conservation behaviors when the only possible negative financial impact will come months or years after that the new lease is determined.

Mayer et al through their studies about allocation billing program have shown that main savings in energy or water consumption are produced by installing sub-meters that directly monitor individual gas, water, electric costs (Mayer, 2003). Accessing to an effective sustainable building need to encourage tenant's conservation behaviors and developers should change the occupant's attitude in the way they attend to sustainable actions in these buildings.

5. Conclusion

This study examines the importance of occupant's psychological behavior and actions in green buildings. The results of the study indicate that social, psychological and behavioral issues can lead the designing process in a different way. Moreover understanding the appropriate ways attending to psychological needs can improve the success of meeting the sustainability goals. Therefore, designers should attend to the strategies that encourage occupants to observe sustainable behaviors.

As discussed in this paper, separation from natural elements, often occurs in large buildings, has a negative psychological effect on human life. Since there is an increasing attention paid to larger building projects, architects should pay more attention to occupant's needs in green buildings. In the following part, some points are suggested in order to design optimum green buildings.

6. Suggestions and Solutions

1) Cost of energy: There should be obvious cues in large buildings and offices that remind occupants of the cost of energy and prompt them to conserve.

2) Flexible design: For reducing the occupant's stress in residential buildings and workstations, the building design could easily be modified in an adaptable condition. In other words, the building design should encourage tenant's motivation to control his or her own environment and provide a comfortable condition. For example, in a workstation for solving the problem of employees such as stress and eyestrain associated with computers, following principals can be useful:

1.2) Room lighting should ensure an appropriate contrast between the screen and the background environment.

2.2) Disturbing glare and reflections on the screen shall be prevented by co-ordination workplace and workstation layout with particular regard to the artificial light source.

3.2) Workstations shall be designed so that sources of light such as windows and brightly colored fixtures cause no direct glare and no reflections on screen.

4.2) Windows shall be fitted with adjustable covering (blinds, curtains, etc.) to attenuate the daylight falls on the workstation.

5.2) The lighting at each workstation shall be individually controlled.

3) Sharing natural environment in building: Designing a mini nature in the different part of the building can increase peacefulness, comfort, and satisfaction on and reduce SBS in buildings. Generally, SBS would be reduced if building were:

1.3) Constructed, finished and furnished using natural rather than man-made materials.

2-3) Lit and ventilated by natural means.

3.3) Managed so that the cleanliness of air-conditioning and mechanical ventilation systems is maintained.

4.3) Managed so that cleanliness of the interior is maintained.(with particular regard to dust mites)

5.3) Designed to give occupants control over their interior environment.

6.3) Located where external air quality is high.

4) Educational strategies: Designers should attend to the strategies that increase commitment levels from group and individuals in determining reasonable level of energy use. For achieving to sustainability goals occupants should be trained and educated on conservation behaviors.

5) Careful about grey water : If designers want to recycle the grey water for drinking purpose , they should be careful about the obvious contaminates currently found in the drinking water, and create a bad psychological effect on occupant's mind.

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Table 1. Effects of sick buildings on human life [Authors]

Some Effects of sick buildings (SBS) on human life		
Symptoms	Causes	Some Solutions
<ul style="list-style-type: none"> -Headache -Nausea -Stress -Sore throats -Asthma attacks -Aggressiveness and crime -Etc. 	<ul style="list-style-type: none"> -Poor thermal, visual and aural comfort -Not perceiving natural conditions (daylight) -Disconnection from the nature -Absence of vegetation in public housing sites -Etc. 	<ul style="list-style-type: none"> -Natural day lighting -Appropriate ventilation -Use of non toxic materials -Natural landscape views -Vegetation inside the building -Etc.

Table 2. Benefits of environmentalism to construction Industry [Authors]

Benefits of environmentalism to construction Industry
<ul style="list-style-type: none"> -Cost savings -Ensuring legislative compliance -Anticipating future legislation -Reduced environmental risk -Improved relations with regulators -Improved public image -Increased market opportunities -Enhanced employee productivity

Table 3. Factors which have significant impact on energy consumption in housing [Authors]

Factors which have significant impact on energy consumption in housing
<ul style="list-style-type: none"> -Built form(the benefits of compact development) -Building construction(the use of thermal capacity to absorb solar radiation and delay nighttime temperature falls coupled with high levels of insulation) -Orientation (layout to maximize exposure to sun and minimize exposure to prevailing winds) -Micro-climate(use building layout to create shelter working with planting design) -Transport(site buildings to reduce vehicular movement and increase density at transport nodes)

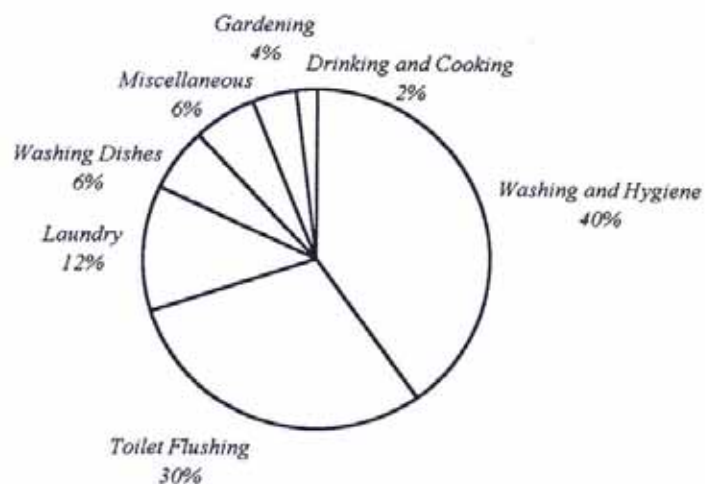


Figure 1. In the typical building the two largest uses of water are personal washing and toilet flushing (Board, 2000)



Kinetics of Indigenous Isolated Bacteria *Bacillus mycoides* Used for Ex-Situ Bioremediation of Petroleum Contaminated Soil in PT Pertamina Sungai Lilin South Sumatera

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Abstract

Bioremediation of petroleum sludge was done by using land farming method in micro scale; the samples were taken from PT Pertamina Musi Banyuasin district of South Sumatra. This process applied *Bacillus mycoides* bacteria which isolated and selected from the contaminated soil. The research aim is to evaluate the performance of the *Bacillus mycoides* bacteria in degrading petroleum sludge pollutants. The initial TPH concentrations of soil contaminated sludge samples were set up at; 4.18, 6.60, 9.82, 10.87 and 13.42%, which were diluted from the main contaminated soil sample with a concentration of Total Petroleum Hydrocarbon (TPH) of contaminated soil was 71.16%. Every sample is inoculated by *Bacillus mycoides* bacteria as much as 10 % v/w and stirred homogeneously. The incubation time was 14 days, and then the samples were analyzed for the TPH content. The results were 3.68, 4.51, 5.91, 6.02 and 8.00% respectively. The rate of the biodegradation process was determined by using differential method. The results of data analyses show that the reaction order is first order. The rate of biodegradation constant was determined by using integral method. The initial concentration of the sample was 9.82 %, and then it had been inoculated by *Bacillus mycoides* bacteria during 14, 17, 22, 26 and 31 days. The TPH concentrations decreased 5.91, 4.59, 4.05, 3.72 and 3.29% respectively. The results of data analysis show that the biodegradation was a first reaction order with a biodegradation reaction constant of 0.0361 day^{-1} . The chemical kinetics model of the bioremediation model is $y = -0.0362.x + 2.2448$. So, by using this model; the bioremediation process will be completed after 62.5 days. The qualitative analysis was done by using GC-MS to investigate the components of compounds changed during the bioremediation process; the samples were analyzed in the initial and final states of process. The results show that the *Bacillus mycoides* could degrade 99.32% of $\text{C}_{19}\text{H}_{40}$, $\text{C}_{21}\text{H}_{44}$, $\text{C}_{24}\text{H}_{50}$, and $\text{C}_{28}\text{H}_{58}$ compounds in 31 days.

Keywords: Bioremediation, Degradation, Microbia, *Bacillus mycoides*, Petroleum sludge pollutant

1. Introduction

The amount of oil-contaminated soil generated in the oil production process has been increasing by thousands of tons every year in South Sumatra (Yudono et al., 2006). Parts of the contaminated soil are dehydrated oil sludge, separated from the mixture of oil, water and soil. Most of the oil sludge is piled up outdoor next to the production site without any treatment, and poses serious environmental problems. The hydrocarbons in the sludge penetrate from the top soil into the subsoil slowly, presenting a direct risk of contamination to subsoil and groundwater. On the other hand, the light hydrocarbons in the oil sludge vaporize, leaving behind a layer of oil-containing dust of soil which blows upwards to pollute the air. These contaminations of soil, water and air pose serious risks for the environment and human population. Therefore, the oil sludge should be treated to prevent harm to environment. Although burning of the sludge may be simple and easily adaptable, this technique has undesirable hazard in air pollution. Bioremediation of the oil sludge is

believed to be an efficient, economic and versatile alternative to physiochemical treatments if sufficient space and time are available (Jackson et al. 1996; Venosa et al. 1996; Salanitro et al. 1997). Acceptance by the general public is another major advantage of this technology (Skladney and Metting 1993). Indigenous microorganisms can utilize the total petroleum hydrocarbons (TPH) of crude oil as source of carbon and energy and break them down to simpler non-toxic compounds such as CO₂ and H₂O. But bioremediation takes a long time as the degradation efficiency of the bacteria is considerably low under natural conditions (Del'Arco and de Franca, 1999; Chaîneau et al., 2003).

Therefore, some engineering processes such as addition of nutrients, watering, tilling and addition of suitable microbial flora are necessary to improve the rate of biodegrading of hydrocarbons (Jorgensen et al. 2000; Vasudevan and Rajaram 2001; Barathi and Vasudevan 2003; Kuyukina et al. 2003). Many efforts had been done to remedy oil containing sludge by the mixed culture of microbial in South Sumatra in an industrial scale (Yudono, et al. 2006). The time needed was too long around 240 days

1.1 Research Objectives

Land farming is one of bioremediation method for treating the oil sludge was conducted on small scale. The samples were taken from a South Sumatra oil-containing pit disposal station, PT Pertamina oil fields. The research aim is to evaluate the performance of the *Bacillus mycoides* bacteria in degrading petroleum sludge pollutants. The *Bacillus mycoides* bacteria was isolated and selected from the contaminated soil. This bacterium is one of the major microorganisms responsible for biodegradation of petroleum hydrocarbon (Atlas and Cerniglia 1995; Alexander 1999; Boonchan et al. 2000).

The environmental Indonesian affair called UU no. 23/1997 and PP No. 18/1999 stated that the petroleum sludge pollutants are included hazardous material. It could not be kept too long, at least 90 days; these materials should be treated into non hazardous material (Mursida, 2002).

Handling petroleum pollutants can be done in many ways; physics by using burning process, however it will produce air pollution. Chemistry; the pollutants are attracted by using dispersant such as non ionic detergent. The pollutants will be bounded with dispersant then percolated into the water basin. This precipitation is difficult to degrade, so it will be hazardous for natural life. Chemically and physically pollutants handlings are suitable to reduce petroleum pollutants in water surface (Kadarwati et al. 1996).

Bioremediation is alternative technology for treating petroleum pollutant which the most accepted environmentally and should be considered for the future. Bioremediation process uses the ability of microbiology to degrade organic substances into simple substances or demineralization process. It will be an important remediation process for contaminated land, so it will save for living things (Udiharto, 1992:1).

This research evaluated the performance of microbial *Bacillus mycoides* in degrading petroleum sludge pollutant. It is calculated as the decreasing rate of TPH concentration per time unit. Furthermore, the degraded components of petroleum oil sludge were investigated by using GC-MS.

2. Materials and Methods

2.1 Site and Experiment Scale

Bioremediation experiments of petroleum oil sludge were undertaken on small scale of 25 Kg, the ratio is 1: 100 from the actual bed of field scale process. The thickness of the dehydrated sludge in the prepared bed was 10 cm.

2.2 Pretreatment of the Oil Sludge

The petroleum oil sludge collected from the storage pit was put into the prepared bed. The oil sludge had heavy clay texture and low oxygen diffusivity. In order to enhance aeration and water-holding capacity of the sludge, organic and inorganic bulking materials (wood particles and sandy soil) were added. The content of wood particles in the sludge was 10.0% (w/w) and that of sand was 10% (w/w). Urea was provided as a nitrogen source, and potassium dehydrogenate phosphate as a phosphorus source. The ratio of C, N and P in the oil sludge was 100:10:1 after the fertilizers had been added. The initial TPH concentrations were 4.18, 6.60, 9.82, 10.87 and 13.42%, which were diluted from the main contaminated soil sample. The concentration of Total Petroleum Hydrocarbon (TPH) of contaminated soil was 71.16 %.

2.3 Bioremediation Process

Microorganism obtained from petroleum oil sludge contaminated soils in petroleum oil sludge pit PT Pertamina South Sumatra Indonesia (indigenous bacteria). The *Bacillus mycoides* bacteria was isolated and selected from the mixed culture, purified and enriched in BHMS medium which consist of Mg₂SO₄·7H₂O 0.2 g/L, CaCl₂ 0.02 g/L, KH₂PO₄ 1 g/L, K₂HPO₄ 1g/L, NH₄NO₃ 1 g/L, FeCl₃ 0.05g/L dissolved in 1 L aquadest.

The application amount was approximately 10 % of treated soil. Over the course of the experiment, the land farming cells were tilled twice a week to maintain high level of oxygen in the sludge. Water was added after tilling to maintain a moisture level of 40% in the sludge.

2.4 Analytical Methods and Data Analysis

Oil sludge was sampled at different stages of bioremediation. Five samples were taken for treatment; it is described diagrammatically in the Figure 1. The oil content in sludge samples were determined gravimetrically in amount of TPH extracted by diethyl ether (Christofi et al. 1998; Capelli et al. 2001).

The differential method of data analysis was used to determine the reaction order, and the integral method of data analyzes to determine the constant of reaction rate. Oil fraction analyses were performed using a Gas chromatography-Mass Spectrometry (GC-MS).

The method of dilution plating on agar plates was used to monitor the number of bacteria in the sludge samples (Mesarch and Nies 1997).

The method of most-probable-number was used to count the number of hydrocarbon degrading microorganisms and that of aromatic hydrocarbon degrading microorganisms (Wrenn and Venosa 1996).

3. Results and Discussions

3.1 Kinetics Approach of Biodegradation of Petroleum Contaminated Soil

Total Petroleum Hydrocarbon (TPH) represents measurement to calculate the total of hydrocarbon content in the sample. The initial concentrations of samples were set as 4.18, 6.60, 9.82, 10.87 and 13.42 % w/w. The TPH analysis was conducted by using extraction and gravimetric methods.

Nutrients were added to the samples to support the initial growth of bacteria *Bacillus mycoides* before the bacteria could degrade the hydrocarbon as its carbon metabolism resource. The C: N: P ratio for the optimal biodegradation process was 100:5:1.

Before the bacteria were inoculated into samples, the conditions were set up at pH 5.8-6.0, soil humidity 40 %, and the temperature 25 °C. The samples were stirred twice a week to maintain oxygen diffusivity.

After 2 weeks inoculation, the TPH concentrations of each sample were measured, the results were shown in the Table 1. The data was studied to determine the reaction order of biodegradation of petroleum oil sludge pollutants. The data was analyzed by using differential method.

Microbial growth on pollutant mixture is an important aspect of bioremediation treatment. However, efforts to develop mathematical models for mixed substrate kinetics have been limited. When individual microbial species are considered, simple competition for the growth substrate is the only interaction included (Reardon et al. 2002). The general formula of the first-order kinetic that can describe the rate of TPH reduction is:

$$r = \frac{dC}{dt} = -kC^n \quad (1)$$

where:

r : reaction rate (concentration unit/time unit)

t : time (day)

C : remaining TPH concentration (mg/l) at any time

n : reaction order

k : first order kinetic constant (1/day)

In Eq. 1, it is assumed that the microbial concentration remains constant over the entire experimentation period. Therefore, the effect of microbial concentration on the kinetics constant can be neglected.

The linearization results of the experimental data are graphically presented in Figs. 2. and is derived from Equation 1

$$\ln r = \ln k + n \ln c \quad (2)$$

If Equation 4 $\ln r$ vs $\ln c$ are plotted, it will be straight line graph with the slope is n and the intercept is $\ln k$. The rate reaction constant will be more accurate when it is determined by using the integral method, this will be discussed further.

The data was plotted into graph described as Figure 2, the graph shows that the slope is 1.037 and the regression constant square is 0.93. It proved that the biodegradation process of petroleum oil sludge by using bacteria *Bacillus mycoides* is a first order reaction.

3.2 Determination of rate reaction constant by using Integral Method

The integration of Eq. 5 leads to the known formula of the first-order kinetics

$$C = C_0 e^{-kt} \quad (3)$$

where C_0 is the initial concentration (mg/l) or TPH₀

In order to experimentally calculate the kinetic constant k , Eq. 2 is linearized using the following equation

$$\ln \frac{C_0}{C} = kt \quad (4)$$

$$\ln TPH = -kt + \ln TPH_0 \quad (5)$$

The initial concentration of sample was 9.82 %; it was inoculated by using *Bacillus mycoides* bacteria. It had been observed during 14, 17, 22, 26 and 31 days, the decreasing concentration of samples were 5.91, 4.59, 4.05, 3.72 and 3.29 % respectively. The first-order kinetics is said to be valid if a linear relationship is achieved upon plotting the logarithmic part of Eq. 7 versus time. Analysis of the rates of hydrocarbons removal showed that most compounds obeyed first-order kinetics (Greene et al., 2000). The slope of the line represents the first-order kinetic constant k . By using the first order reaction equation; $\ln TPH = -kt + \ln TPH_0$, the data was plotted $\ln TPH$ vs t . The graph is shown in Figure 3.

The slope of graph is -0.0361 day^{-1} , it represents the rate reaction constant. The intercept of the graph is 2.2448. So the equation of reaction rate is $y = -0.0362x + 2.2448$. The progress of bioremediation process can be predicted by using this chemical kinetics equation, for example to reach the TPH concentration below 1%, the bioremediation process will take place as long as 62.5 days. These results are well fitted in a great extent with the results achieved in previous studies (Hutchins et al. 1991; Hwang et al., 2001; Antizar-Ladislao et al., 2005).

3.3 GC-MS Analyzes

The changed composition of compounds from initial to final conditions of bioremediation process was identified by using GC-MS. Figure 3 and Figure 4 show initial and final compositions respectively.

Every peak in the chromatogram represents a component of compound in the petroleum oil sludge, and the peak area represents the concentration of the component. The identical retention time in the both chromatograms show the identical compounds. The different shape of the peaks area is caused by the bioremediation process. The predicted compounds were drawn from MS Library. The data analyses were conducted at every identical retention time. The chromatograms show that *Bacillus mycoides* bacteria could almost completely degrade $C_{19}H_{40}$, $C_{21}H_{44}$, $C_{24}H_{50}$, and $C_{28}H_{58}$ compounds as can be seen in the Table 2.

The data show that the *Bacillus mycoides* bacteria could effectively degrade the long chain hydrocarbon compounds. However, it is needed to investigate closely the structure of the compounds which were degraded during the bioremediation process by using more detail separation technique.

4. Conclusions

The following conclusions can be drawn from this research;

- 2) *Bacillus mycoides* bacteria could degrade the petroleum oil sludge with initial TPH concentrations 4.18, 6.60, 9.82, 10.87 and 13.42 % to 2.37, 4.51, 5.91, 6.02 and 8.00 % respectively after 14 days incubation. The average decreasing TPH concentration was 39.48%.
- 2) *Bacillus mycoides* could degrade hydrocarbon compounds; $C_{19}H_{40}$, $C_{21}H_{44}$, $C_{24}H_{50}$, and $C_{28}H_{58}$, the average of decreasing concentration was 99.32% in 31 days.
- 3) The reaction order of the biodegradation was first order and the constant of rate reaction was 0.0361 day^{-1} .
- 4) The kinetics model of biodegradation is $y = -0.0362x + 2.2448$
- 5) Decreasing the TPH concentration from 9.82 % to below 1 % can be predicted by using chemical kinetics equation in 62.5 days.

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Table 1. Biodegradation of Petroleum sludge after 14 days process

Initial	% TPH	After 14 days, % TPH	Percent of decreasing concentration
4.18 %		2.37 %	41.18
6.60 %		4.51 %	31.64
9.82 %		5.91 %	39.84
10.87 %		6.02 %	44.59
13.42 %		8.00 %	40.14

Table 2. The GC-MS data analyzes

No	Suggested compounds	Retention Time	Peak Area		% Decrease in Peak Area
			Initial	Final	
1	C ₁₉ H ₄₀	19.27	11532410	51086	99.55
2	C ₂₁ H ₄₄	20.27	12235678	62664	99.48
3	C ₂₄ H ₅₀	21.23	10924657	161593	98.52
4	C ₂₈ H ₅₈	23.01	8595758	22005	99.74
Average % Decreasing Peak Area = 99,3225%					

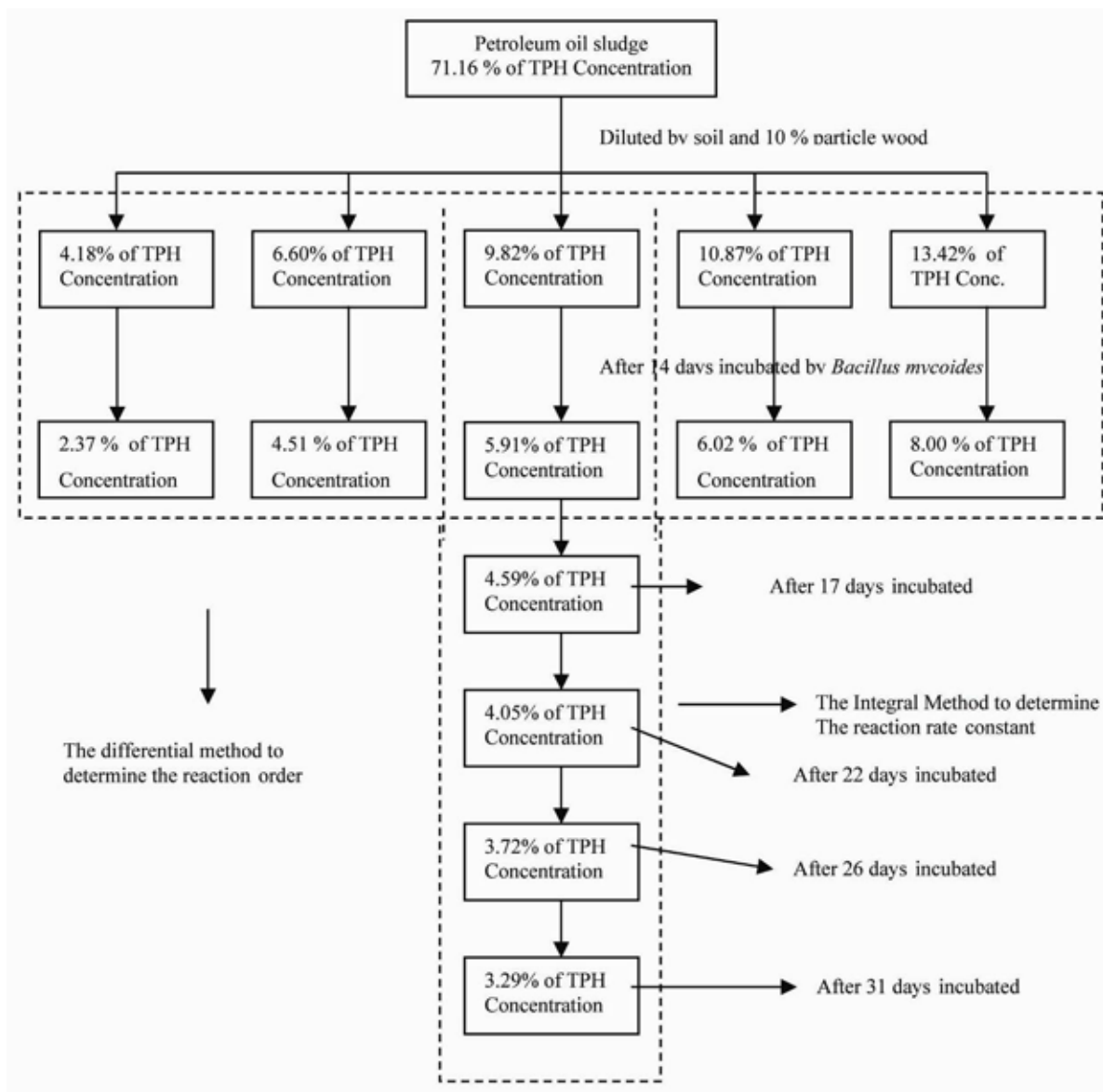
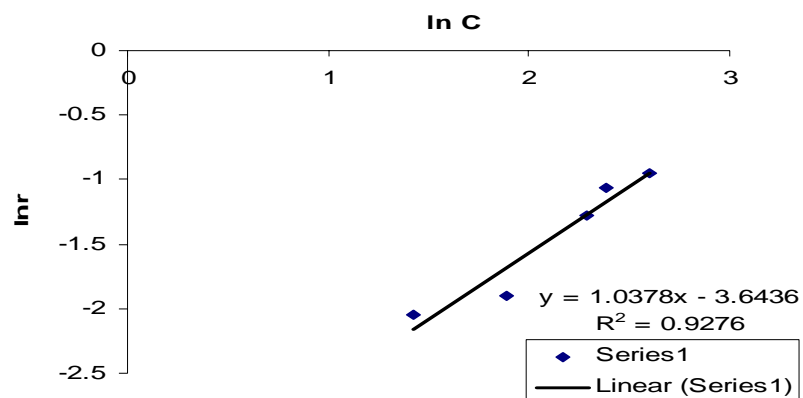
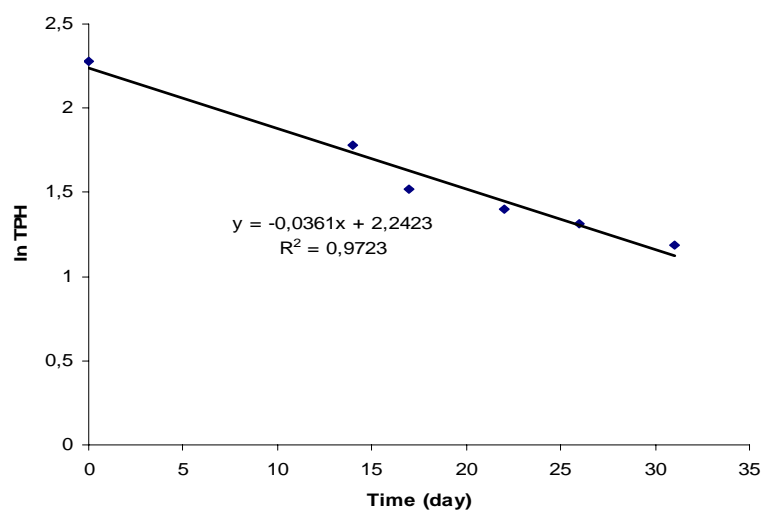
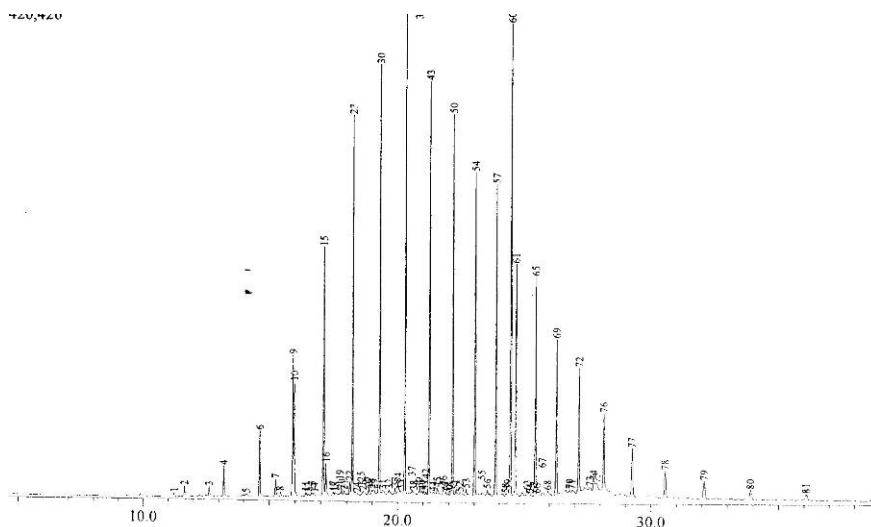


Figure 1. Diagram of The Differential Method and Integral Methods of Kinetics

Figure 2. Graphic $\ln r$ vs $\ln C$ to determine reaction orderFigure 3. $\ln \text{TPH}$ vs Time to determine the constant of reaction rateFigure 4. Chromatograph of initial condition before incubated by *Bacillus mycoides* bacteria

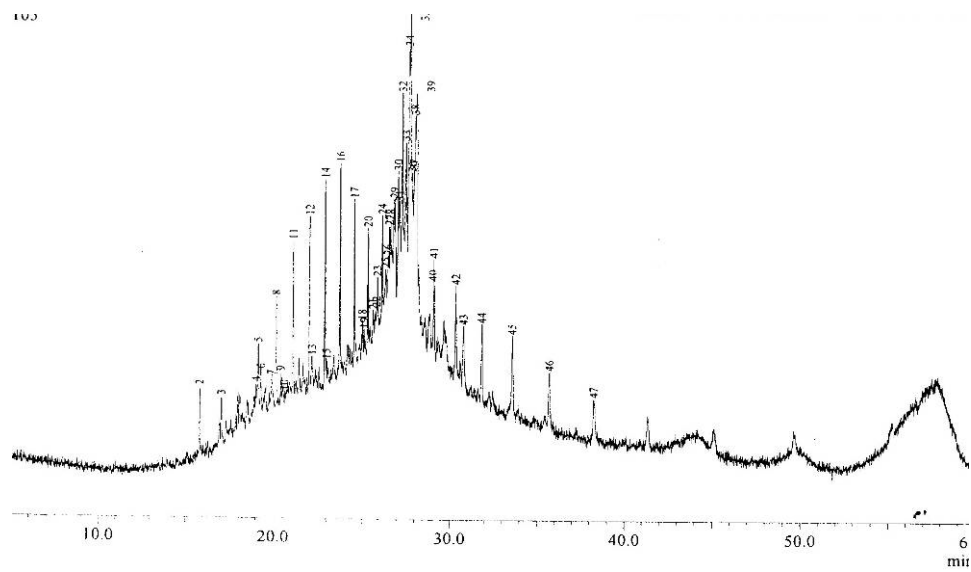


Figure 5. Chromatograph of initial condition after 31 days incubated by *Bacillus mycoides* bacteria



Criteria for the Establishment of an Accounting and Management Services Business in Small Commercial Towns

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Abstract

This article examines the economic rationale for contracting the services of an accounting or management firm by the potential clients in the locality of small towns in Malaysia. Classifying the clients based on different small towns in the country identifies the potential demand of host clientele. Polarisation of clients based on ethnic grouping within the localities of small towns is to look at the differences in the results of this study so that any decision for a new venture may or may not be affected by the choice of small town with businesses being dominantly populated by certain ethnic group. There appears to be evidence of significant ethnic and business locality effect in term of the demand for the types of services provided by the accounting or management services firm. Thus, in making the choice of setting-up accounting or management services firms in small towns, due consideration must be given to the influence of these two factors. Furthermore, this study highlight the importance and priority given by clients to the various patronage factors as a guide aiming at ensuring the going concern of a newly set-up accounting or management services firms in small towns in this country.

Keywords: Patronage, Survivability, Small towns, Provider and clientele

1. Introduction

Starting an accounting services business can be a very difficult move for a qualified individual especially in today's environment of trade globalisation. Ensuring survivability of the business may become impossible especially faced with tough competition from the more established firms not to mention the well-known "Big Four" namely PricewaterhouseCoopers, Deloitte Touche, KPMG and Tohmatsu Earnst & Young. However to ensure the plans to encourage more local businesses to flourish, efficient strategies have to be developed to facilitate new entrants into the market place. The study will focus on the development of the strategies to establish accounting and management services business. All aspects of business fundamentals such as the type of services, target market, clients' needs, fee structures, market competition and marketing strategy will be analysed including possible start-up problems.

The changes in the approach and technology are a new dimension in the management of the businesses in order to enable the businesses to sustain and to compete and remain competitive in business. Indeed, the fiercer level of competition is not only by the industry where the business is in, but also the business system. The current stiff competition has pushed the business units into much greater income sharing oriented. Thus, the industry has been transformed from the traditional staid image to that of a vibrant and dynamic environment (Turnbull and Gibbs, 1989). Malaysian businesses face even more challenges since they have to compete not only among themselves and other sectors within and outside the industry, but also to compete with competitors that offer similar services.

The issue of globalisation is another point of great concern to the Malaysian business. Developing countries, like Malaysia, are at the eternal mercy of the big powers and their multinational corporations (Boateng, 2002). The boundaries

of trade between nations have vanished and more competition exists with the accessibility of businesses offering their trade and services throughout the world through the Internet.

Globalisation has opened wider market to trade but at the same time creating wider and stiffer competition. In order to have a tiny share of the business pie, effort to establish own business has to be made. Creating a niche and business reputation has to start somewhere. It may be practical to start small size firm in a small town but with the objective of growing steadily into a growing number of branches into other smaller towns.

This study analysed twenty-four factors as listed in Table 1 as the variables that could influence the accounting and management services businesses in small towns in Malaysia in the era of trade globalisation and liberalisation. In a simple statement, is to look at the patronage factors of clients of accounting and management services businesses in this country. This study firstly aimed at identifying the factors that might influence and attract clients to patronise the services of an existing or a newly established accounting firm. Secondly, identifying factors in order to maintain the loyalty of clients and finally, strategising the placement of services required by the potential clients of accounting and management services firms.

2. Theoretical frameworks

Various empirical researches using different methodologies and approaches have been applied in various parts of the world in foreign countries to examine the criteria, which motivate potential clients in selecting their business associates. Some of the instruments used were adopted in this study. Tan and Chua (1986) support the findings by Anderson et al. (1976) in their research conducted in Singapore. Tan and Chua found that advice of friends, neighbours and family members has strongly influence on customers' decisions, compared with other variables in selecting banking services. This finding is consistent with the ethos of oriental culture, which emphasises social and family ties. However with increasing numbers of businesses offering accounting services in the market, accounting firms have to actively seek new clients in order to grow or even maintain stable revenue. More and more accounting firms are turning to marketing to cope with this competitive situation (Marts, Honeycutt and Kenan 1989). Accounting firms can no longer survive on word of mouth but have to depend on the firms' ability to encourage business growth and profit by carefully determine the demands of clients and striving to meet them. (Kestigian 1992).

Shepherd (1997) developed a framework for developing a strategic marketing plan for the accounting practice. This framework is important in ensuring that all marketing efforts are linked to the objectives of the firm. This scenario may not be necessary in the rural area since the survey conducted by Delany and Johnson (1997) in Queensland, Australia showed that selection of accounting firms is based on personal recommendation or social contact. Small accounting firms may be reluctant to embark in marketing practice particularly in the early stage of developing a practice due to fear of not having sufficient technical knowledge to serve new clients in every area or being rejected during their marketing efforts (Schiff et al, 1998). Schiff et al (1998) suggested several tactics to overcome this problems including establishing professional relationship with other individuals or organisations with the needed proficiencies.

Several researches conducted world-wide has shown that there are a shift from the traditional accounting services i.e. audit and tax, to consulting services, investment advisory services and financial management services (Demery, 1997; Delany and Johnson, 1997; Reeves, 1998; Whisenant, 2001). Therefore the small accounting services firms will have to be sensitive to clients' needs in order to maintain the existing clients and to capture potential new clients. Furthermore Delany and Johnson (1997) identified that patronage factors for accounting firms in rural area include accountant's level of expertise, easy access to the accountants, knowledge of the local businesses and regular contact with accountants. Demery (1997) further stressed the needs to have dialogues session with clients to find out whether the firm has met the needs of clients. These sessions will enable the accounting firm to know more about the client and will open opportunities to provide ideas for more services to be provided to the clients. A value-added approach to offering accounting services, support the move from the traditional firms-centred to clients-centred approach (Chandra et al, 2000). This study confirmed the previous study made on patronage factors of accounting and management services businesses in small towns in Malaysia was carried out in 2004 by Noormala Ahmad and Mohd Nasir bin Mohd Yatim.

3. Methodology and data analysis

Scientific approach to research by way of employment of both the quantitative and qualitative methods is adopted in this study. The qualitative approach is borne out of the premise that data does not have to be cold, rational and sterile to be of value (Patton, 1980). Analysis may be difficult since responses are neither standardised nor systematic. In achieving this, open-ended questions are the most elementary form of qualitative data. Observation is another common form in describing this study using the descriptive approach of the research to complement this empirical study so as to produce a concrete form of findings.

This study will specifically employ survey method of questionnaires cum interview. This method is necessary because most of the respondents are unable to understand the answers to the questions or how to respond to the questionnaires. Most of these respondents may not be wholly aware of the type of services provided by an accounting firm. The

questionnaire contained three sections of which the first section is designed to gather information about the sample's background including demographic and economic characteristics. In the second section, the questions cover the background information on the respondents' current choice of accounting firm.

The final section of the questionnaire was designed to generate data concerning the perception of customers towards the level of usefulness of services offered by the management services firm for their businesses. The perceived level of usefulness of these services is measured on a five-point Likert scale. The scale ranged from *very important* to *not important at all*. The services offered were identified from the studies made by Delany and Johnson (1997), Reeves (1998), Whisenet (2001) and Schiff (1999). Questions that measure the perception of respondents towards the services provided by accounting and management services firms are then designed.

3.1 Sampling and Data Gathering

Samples of 66 business units in Gemencheh town are surveyed out of the population of about 88 business units in the town. More than half of the population of businesses are non-Bumiputra status comprising 35 business units while Bumiputra business status is 31. The selection of the samples will be based on convenience sampling. Furthermore the researchers are familiar with the town population, which made it easier to get their co-operation in answering the questionnaires and interview. This will ensure goods response and overcome the problem of not having enough sample observation to validate this study.

In addition another survey exercise is also conducted in another small town of Muadzam Shah. The choice of the town of Muadzam Shah is to enable comparison to be made between predominantly Chinese small businesses in Gemencheh and predominantly Malay small businesses in Muadzam Shah. It was anticipated that there might be possible differences in responses from the two major ethnics in Malaysia. The two chosen towns thus represent the commercial environment for the local community in the Malaysian small township. The data for this study are then collected through self-administered questionnaires distributed personally by a research assistant.

3.2 Data processing and analysis

Data analysis included both univariate and bivariate statistics. Univariate techniques were used to identify the overall attitude of businesses towards management services firm and the usefulness of its services. Descriptive univariate statistics such as frequency, mean, standard deviation, mode and median will be used. Further analysis using bivariate analysis such as cross tabulation, chi-square test, Mann-Whitney, Wilcoxon-W, t-test, Spearman rank test and ANOVA will be used to study possible relationship between variables. T-test will be used to test the statistical differences between the means for selection factors between sole-proprietorships, partnerships and companies types of businesses and significant difference occurred for some of the factors. Statistical package SPSS will be used to process the data gathered for this study.

4. Survey results

The host client population in both towns, Gemencheh in Negeri Sembilan and Muadzam Shah in Pahang are 88 and 64 units respectively totalling to 152 units. Attempt to conduct the survey on the whole population for this study in both towns was attended. However, the number of successful respondents feedbacks collected are 66 and 32 for Gemencheh and Muadzam Shah respectively, totalling to 98 only representing 64.5% of the targeted population. The overall feedbacks' percentage is considered representative of the entire population. The rate of feedbacks received from distributed questionnaires in Gemencheh is 75.0% and for Muadzam is 50.0%. Since the rates of feedbacks received are considerably high, the researchers of this study considered that the opinions of the respondents are representing the views of the whole population of host businesses in both towns. Therefore, their views on the various variables in this study could be theorised from the relevant hypothesis through generalisation process is considered reliable.

5. Characteristics of host clients

The overall composition of the host clients is Bumiputra (61.2%) and non-Bumiputra (38.8%). The nature of host clients in this study is sole-proprietorship representing 68.4%, partnership (14.0%) and Sendirian Berhad (13.0%). The major portion of the host clients involves in services (45.9%) and trading (36.7%) sectors. The revenue earning, 35.0% of the host clients earn revenue of at least RM120, 000 annually. In term of profitability, 12.2% of the host clients made profits of at least RM120, 000 annually. The host clients also contribute to offering employment opportunities in the employment market in those towns. It is found that 24.7% of the business units employed at least five workers to operate the business activities. On top of that, 4.1% employed more than 20 workers in their enterprises.

The sizes of the host clients in term of paid-up capital are quite large for small businesses as 64.2% of the business units have invested at least RM10, 000 in their businesses as the initial capital employed. Further, 27.4% have invested more than RM40, 000 initially. Individuals' ownership in the businesses is 85.6% and at least 60.2% of the businesses have been in operation for a term of more than 5 years. Some of the host clients (32.6%) have been in operation for more than 10 years. Further study revealed that only 41.8% of the businesses use the services of accounting and management firms in

both towns. The remaining viewed that such services are not applicable to them since they are not subject to the statutory requirements, in particular, the Companies Acts of Malaysia, 1965 simply because their existence are only as sole-proprietors and partnerships.

However, 42.9% of those potential and existing clients stated that, they got to know their accounting services firms through family members or friends. Results of further analysis shows 37.8% of the existing users (41.8%) have experienced changing their accounting and management services firms for various reasons. The reasons for shifting of firm to a new one is due to unsatisfied services obtained (25.5%), cheaper fees (3.1%) and not client-oriented (2.0%). This phenomenon gives rise to another research issue of analysing the unprofessional of the professionals in this country. The major portion (86.7%) of the host clients of accounting and management services firms viewed that, getting the services provided by these firms is important. Thus, they understand the need for the existence of these firms. Results of frequency analysis on reasons for using existing firm's services shows as statutory requirements (15.3%), need the expertise of the providing firm (14.3%) and not able to do report (10.2%). The results also show that 43.9% of the respondents are keen or having in new services provider firm. Thus, they are the readily potential clients to any newly set-up firm in either town in this study.

6. Criteria for establishment of a new accounting and management services business

Further analysis, showed that, factors influencing the engagement of new firm by the host clients are confidence of better service (43.9%), cheaper fees (18.4%), getting the expertise of provider (15.3%) and not having any providing firm yet (14.3%). This indicates that the quality of services should be of a high standard so as to enable to project it as the competing niche to a new entrant in this kind of venture by the potentially interested qualified individuals. The results of frequency analysis also show that 79.6% of the potential and existing host clients perceived that reasonably high efficiency level as important to ensure their needed services and expectation are met. Another factor is sensitive to clients' need, which also shows the same percentage in term of its importance. However, for efficiency level, 29.6% perceived as very important and 57.1% as important. On the other hand, for sensitive to clients' needs, 23.5% viewed as very important and 56.1% as important.

On compliance to statutory requirements, 61.2% of the respondents viewed as important to avoid from unnecessary costs to be incurred (Noormala A and Mohd Nasir bin Mohd Yatim, 2004). Another variable analysed is easily accessible by clients. In relation to these, the valid percentage of frequency indicates 91.8% as important criteria when making the choice of a provider firm for the accounting and management services. Another crucial factor studied is the influence of socio-ethnic-cultural values. In this regard, almost one half of the respondents (49.0%) indicate it as an important factor for their choice of the provider firm. In looking into the supporting services needed by the potentially and existing host clients from the provider firms are identified during the process of designing the instruments for this study and the results show that, 88.8% of the respondents viewed that they need the services to help in ensuring the accuracy of receivable, 73.2% of the respondents viewed that they need the services for maintenance of inventory, 87.7% of the respondents indicated that the services are needed to ensure the accuracy of current liabilities records, 90.8% stated for accuracy in cash handling, 90.8% stated for accuracy of expenditure records. Even though, the valid percentage is the same as for accuracy of cash handling, the combination of views are different. As in cash handling, 43.9% stated as very important and 46.9% as important. Whilst, in the case of accuracy in expenditure recording, 34.7% perceived as very important and 51.1% as important. 89.8% viewed that the providers' services are important to help in the preparation of financial statements. 74.3% stated that it is important to help in preparing budgeting.

Apart from the above-discussed factors, the respondents' views on the provider's services that are normally offered are also sought to look at their perceived importance to the potential and existing clients. For simplicity, frequency tests are again used here and the results show on the importance of audit services as 87.8% of the respondents perceived as important, Internal auditing services: 64.3%, Financial accounting services: 90.8%, Financial management services: 76.5%, Taxation services: 77.5%, Secretarial services: 35.0%, Business project advisory services: 48.0%, Training services: 49.0%. Other characteristics of the accounting and management services firm studied are knowledge in clients' business, overcoming clients' difficulties in finding appropriate or suitable staff, frequent visit and discussion with clients as well as the providing firm's expertise. Results of analysis indicated as important are 85.7%, 55.1%, 51.1% and 82.6% respectively.

In any empirical research, the validity of the result are emphasised and thus strengthening the findings of the study. Priority patronage factors analysed as shown in means ranking **Table 1**, indicates that the primary priority factors on accounting and management services businesses are accredited to arising need for accuracy in cash handling of the clients' businesses and easy accessibility by clients. It is then followed by the need on firm's expertise, ethnic status of firm's ownership and need for ensuring the accuracy of receivables. The means of the variables seemed to be a reasonable basis to rely on when measuring the ranks of priority since almost all of the means are deviated within less than one standard deviation from their recorded means.

Further analysis by considering socio-cultural-values of clients by comparing priority ranking of both the Bumiputra and non-Bumiputra potential and existing clients perceptions on the duly identified factors, shows that Bumiputra clients give priority to arising need for accuracy in cash handling, followed by ethnic status in firm's ownership. Providers' knowledge of clients' business and then to help in maintaining the accuracy of expenditure records as well as easy accessibility by clients. In comparison with the overall priority ranking, the need for accuracy in cash handling, easy accessibility by clients and firm's ownership status are in agreement with what has been perceived by the Bumiputra clients. On the other hand, the non-Bumiputra clients placed easy accessibility by clients followed by firm's expertise, need of statutory audit services, preparation of financial statements and accuracy in cash handling. Therefore, the researches' finding in this regard is that, there is an existence of socio-cultural-values in the support given by the clients on management services business in small towns in Malaysia. The detail results of the analysis are as shown in the following **Table 2**.

However, when comparison is made based on the location of small towns, clients in Gemencheh town gave preference for the expertise provided by the firm, followed by statutory requirements and due to not able to prepare financial statements. On the other hand, clients in Muadzam Shah, gave the first preference as statutory requirements, followed by not able to prepare financial reports, need of normal routine records keeping and expertise of firm. As such, the finding is that there is no significance effect in term of views of clients based on different small towns in Malaysia. The factors influencing engagement of a newly established firm are also studied. Both the Bumiputra and non-Bumiputra clients are in agreement as regard to the factor of confidence in ability to provide better service. Subsequently, Bumiputra clients prefer cheaper fees and to get the expertise of the provider firm. Whilst, the non-Bumiputra clients without services firm will engage the new firm if new services firm can provide services with cheaper fee.

It seemed that, the choice on confidence in ability of offering better services are in agreement between clients of different ethnic groups as well as clients of different location of small towns. The same is applicable for cheaper fees and need for expertise of the providing firms. In looking at main reason for the potential of probable shifting of clients to a newly started firm, it is indicated that such phenomenon could happened should the existing clients are not satisfied with the existing services of the provider regardless of the location of the small towns.

Pearson Chi-square tests indicate mix results as shown in the following **Table 3**. These tests are conducted to look at whether there is any presence of influence of socio-ethnic-cultural values within an ethnic group that might have been offered in the views given relating to the patronage factors for accounting and management services businesses. Based on the results of the tests, there are cases where the presence of significant influence of ethnic values on some of the perceived factors exists while in some other there is no significant influence of the variable tested. The factors with $p\text{-value} \leq 0.05$ as highlighted with * show existence of ethnic influence. Out of 28 patronage factors tested, 13 show significant correlation with ownership status. Therefore new services firms or the existing firms will have to take into consideration of these factors when offering services to Bumiputra or Non-Bumiputra clients. Pearson Chi-Square tests show larger number of patronage factors has significant correlation with location of the business. Whereby, out of the 28 factors tested, 21 show significant results as shown in **Table 4** below. Therefore any new firm wanting to set up business in Malaysia will have to consider the locality of business because the results suggest different locality has different perceptions toward accounting and management services. However there is a possibility the results of correlation with business location are influenced by the composition of the business ownership in the respective locality.

Non-parametric tests such as Mann-Whitney and Wilcoxon-W are performed in this study. These tests are to validate the existence of correlation between different locality and ethnic group of potential and existing clients and the patronage factors identified in the Pearson Chi-Square tests earlier. The results testing the existence of influence of different locality are shown in **Table 5** below. The null hypothesis relating to related variables is rejected when the significance (2-tailed) $p\text{-value}$ is < 0.050 at 95% level of confidence. Therefore, if the $p\text{-value}$ of the related variables are ≥ 0.050 , then the null H_0 should not be rejected and thus be theorised in this study. Based on the results of the non-parametric tests, the researchers concluded their finding as, generally all the hypotheses that are tested have resulted in their $p\text{-values} \leq 0.050$. The hypotheses that are related to variables of importance such as firm's efficiency, sensitive to clients' need, compliance to statutory requirements, ethnic status of ownership, accuracy of receivable, maintenance of inventory, accuracy of current liabilities records, accuracy of expenditure records, preparation of monthly financial statement and costing, importance of auditing services, importance of internal auditing services, importance of financial accounting services, importance of financial management services, importance of knowledge of clients' businesses and importance of practitioners' expertise are significant. Therefore the location of the accounting and management services firm has influence on the clients' view on these patronage factors.

Table 6 shows the results of the non-parametric tests on the presence of influence of the different ethnic group on the identified patronage factors. Surprisingly, fewer factors show significant results compare to influence of business location earlier. The patronage factors that are significantly influenced by client ethnic group are 'interest in newly established firm', 'importance of getting accounting services', 'firm's ethnic ownership', 'firm accuracy of cash handling and expenditure records' and 'knowledgeable in client's business'. Finally, t-tests to determine the importance of the patronage

factors to the clients are performed. The results convincingly show that all patronage factors identified in this study are significantly important (at 95% confidence interval) to the clients except for provision of secretarial services. The results are shown in **table7** below.

7. Conclusion

The issue of accounting or even management information has been of interest to academics, researchers and even industry experts due to its strategic implication for firm value that reflect the credibility of the business units. Despite the concerns shown in developed economies, very little efforts appear to have been made in Malaysia to examine such a basic issue in this fast growing economy. This study suggests that, in order to ascertain the determinants of providers of accounting and management services in term of patronage factors of their clientele based businesses. The rank analysis, non-parametric tests, t-tests, means, standard deviations and frequency tests were used in the data analysis.

The findings of this study suggest that accounting and management services providers need to focus on the prevailing priority patronage factors in order to ensure the survivability as well as providing competitive edge to their businesses. The clients of these firms determine their varying needs of services from their contracted providers. The findings suggest priority should be given to factors such as ensuring the accuracy of cash handling of clients' businesses, easy accessibility by clients, provider firms' expertise and ensuring accuracy of receivables. However due consideration should be given when clients comes from different ethnic background or the client business situated in certain locality of small town. These two elements will influence how the clients perceived the desirability of contracting services from the accounting and management services firm. Furthermore, a newly set up firm has to convince clients that it can provide better services as compared to existing firms as well as able to offer its services at competitive price to attract clients.

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Table 1. Priority of clients' patronage factors on accounting and management services

Patronage factors	Ranking	Mean	Standard deviation
Efficiency level of the provider of services	12	4.13	0.686
Sensitivity to the client's need.	15	3.94	0.746
Compliance to legal requirements.	19	3.64	0.911
Ethnic status in ownership of firm.	4	3.28	1.087
The need at ensuring the accuracy of receivable.	5	4.24	0.648
The arising need for maintenance of inventory.	17	3.78	0.836
To help in maintaining the accuracy of current liability record.	11	4.14	0.675
The need arising for accuracy in cash handling.	1	4.34	0.646
To help in maintaining the accuracy of expenditure record.	8	4.20	0.737
To seek the service of preparing monthly financial statements	6	4.22	0.697
To help in the preparation of budgeting.	16	3.87	0.923
The need of statutory audit services.	7	4.21	0.832
The need for internal audit services.	18	3.68	0.929
The need for financial accounting services.	9	4.19	0.627
The need for financial management services.	13	3.96	0.932
The need for taxation services.	13	3.96	0.808
The need for secretarial services.	24	3.09	1.065
The need for business project advisory services.	22	3.31	1.080
The need for training services.	23	3.29	1.153
Easy accessibility by client	1	4.34	0.700
Knowledgeable in client's business.	9	4.19	0.748
As a solution to overcome the difficulties in seeking appropriate employees.	21	3.44	1.128
The frequent visit and discussion made with clients.	20	3.51	1.098
The practitioners' knowledge and expertise in the services provided.	3	4.31	0.817

Table 2. Comparison on the importance of factors on the need of services provided by the management services firm by the ethnic groups of clients

Factors	Overall clients	Bumiputra		Non-Bumiputra	
	Ranking	Ranking	Mean	Ranking	Mean
Efficiency level of the provider of services	12	9	4.18	10	4.05
Sensitivity to the client's need.	15	12	4.10	15	3.82
Compliance to legal requirements.	19	18	3.77	18	3.47
Ethnic status in ownership of firm.	4	2	4.40	6	4.08
The need at ensuring the accuracy of receivable.	5	21	3.53	24	2.92
The arising need for maintenance of inventory.	17	15	3.87	16	3.68
To help in maintaining the accuracy of current liability record.	11	9	4.18	6	4.08
The need arising for accuracy in cash handling.	1	1	4.42	5	4.16
To help in maintaining the accuracy of expenditure record.	8	4	4.30	11	4.03
To seek the service of preparing monthly financial statements	6	8	4.25	4	4.18
To help in the preparation of budgeting.	16	15	3.87	14	3.92
The need of statutory audit services.	7	11	4.17	2	4.21
The need for internal audit services.	18	17	3.80	17	3.63
The need for financial accounting services.	9	6	4.28	6	4.08
The need for financial management services.	13	13	3.98	12	3.97
The need for taxation services.	13	14	3.93	6	4.08
The need for secretarial services.	24	24	3.02	23	3.18
The need for business project advisory services.	22	23	3.30	19	3.37
The need for training services.	23	22	3.37	20	3.34
Easy accessibility by client	1	4	4.30	1	4.29
Knowledgeable in client's business.	9	3	4.33	12	3.97
As a solution to overcome the difficulties in seeking appropriate employees.	21	20	3.57	21	3.26
The frequent visit and discussion made with clients.	20	19	3.60	21	3.26
The practitioners' knowledge and expertise in the services provided.	3	6	4.28	2	4.21

Table 3. Pearson Chi-Square results on the existence of correlation between ownership status and various patronage factors.

Factors	Pearson Chi-square value	Degree of freedom	p-value (95% level of confidence)
Interest in newly established firm.	4.116	1	0.042*
Factor influencing engagement of new firm	5.948	4	0.203
Importance of getting accounting services.	1.411	3	0.703
Importance of firm's efficiency level.	2.432	3	0.488
Sensitive to client 's needs	13.297	4	0.010*
Compliance to statutory requirements.	3.505	4	0.477
Easily accessible to client.	8.047	4	0.090*
Choice of service firm based on firm's ownership.	11.909	4	0.018*
For accuracy of receivable	2.601	2	0.272
For maintenance of inventory.	10.209	4	0.037*
For accuracy of current liability records.	6.493	3	0.090*
For accuracy of cash handling.	13.186	4	0.010*
For accuracy of expenditure records.	12.126	4	0.016*
For preparation of monthly financial statements.	14.149	4	0.007*
Preparation of costing.	7.575	4	0.108
Auditing services	7.602	4	0.107
Internal auditing services.	4.165	3	0.244
Financial accounting services.	4.705	3	0.195
Financial management services.	3.434	4	0.488
Taxation services.	3.698	3	0.296
Secretarial services.	13.480	4	0.009*
Business project advisory services.	7.270	4	0.122
Training services.	2.791	4	0.593
Easy excess	1.281	3	0.734
Knowledgeable in client's business.	6.639	3	0.084*
Overcome the difficulty in identifying appropriate staff.	8.716	4	0.069*
Frequent visits and discussion with clients.	14.371	4	0.006*
Practitioner's expertise.	2.472	3	0.480

* Significant at 95% confidence interval

Table 4. Pearson Chi-Square results on the existence of correlation between location of business and various patronage factors.

Factors	Pearson Chi-square value	Degree of freedom	p-value (significant) at 95% level of confidence
Interest in newly established firm.	3.483	1	0.06
Factor influencing engagement of new firm	10.095	4	0.039*
Importance of getting accounting services.	8.507	3	0.037*
Importance of firm's efficiency level.	7.774	3	0.051
Sensitive to client's needs	11.721	4	0.020*
Compliance to statutory requirements.	6.093	4	0.192
Easily accessible to client.	2.960	4	0.564
Choice of service firm based on firm's ownership.	12.459	4	0.014*
For accuracy of receivable	4.539	2	0.103
For maintenance of inventory.	11.653	4	0.020*
For accuracy of current liability records.	11.719	3	0.008*
For accuracy of cash handling.	7.693	4	0.104
For accuracy of expenditure records.	13.954	4	0.007*
For preparation of monthly financial statements.	11.463	4	0.022*
Preparation of costing	12.662	4	0.013*
Auditing services	16.342	4	0.003*
Internal auditing services.	15.082	3	0.002*
Financial accounting services.	9.199	3	0.027*
Financial management services.	10.621	4	0.031*
Taxation services.	13.480	3	0.054*
Secretarial services.	23.825	4	0.000*
Business project advisory services.	10.769	4	0.029*
Training services.	9.953	4	0.041*
Easy excess	3.543	3	0.315
Knowledgeable in client's business.	7.232	3	0.065*
Overcome the difficulty in identifying appropriate staff.	12.350	4	0.015*
Frequent visits and discussion with clients.	13.380	4	0.010*
Practitioner's expertise.	10.955	3	0.012*

* Significant at 95% confidence interval

Table 5. Results of Non-parametric tests on the differences in views between client businesses in Gemencheh and Muadzam

Factors	Mean Rank		Z-value	P-value (2-tailed)
	Gemen-cheh	Muad-zam		
Interest in newly established firm.	52.13	42.34	-1.857	0.063
Factors influencing engagement of new firm	42.98	52.45	-1.699	0.089
Importance of getting accounting services.	47.42	53.78	-1.359	0.174
Importance of firm's efficiency level.	45.22	58.33	-2.413	0.016*
Sensitive to client's need.	44.14	60.56	-2.989	0.003*
Compliance to statutory requirements.	45.10	58.58	-2.358	0.018*
Easily accessible to client.	46.77	55.14	-1.530	0.126
Firm's ownership.	45.05	58.67	-2.320	0.020*
For accuracy of receivable.	45.73	57.28	-2.104	0.035*
For maintenance of inventory.	58.56	44.29	-2.358	0.009*
For accuracy of current liability records.	43.85	61.16	-3.191	0.001*
For accuracy of cash handling.	46.21	56.28	-1.825	0.068
For accuracy of expenditure records.	43.74	61.37	-3.257	0.001*
For preparation of monthly financial statements.	45.30	58.16	-2.345	0.019*
For preparation of costing.	45.2	56.72	-2.038	0.042*
Auditing services	43.14	62.63	-3.505	0.000*
Internal auditing services.	42.46	64.02	-3.728	0.000*
Financial accounting services.	44.31	60.20	-2.991	0.003*
Financial management services.	44.42	59.98	-2.725	0.006*
Taxation services.	47.26	54.13	-1.226	0.220
Secretarial services.	48.44	50.14	-0.292	0.770
Business project advisory services.	46.91	54.84	-1.346	0.178
Training services.	46.06	56.59	-1.773	0.076
Easy excess	46.22	56.27	-1.821	0.069
Knowledgeable in client's business.	44.70	59.41	-2.640	0.008*
Overcome the difficulty in identifying appropriate staff.	46.95	54.77	-1.327	0.185
Frequent visits and discussion with clients.	46.24	56.22	-1.691	0.091
Provider's expertise.	44.74	59.31	-2.582	0.010*

* Significant at 95% confidence interval

Table 6. Results of Non-parametric tests on the differences in views between Bumiputra and Non-Bumiputra clients

Factors	Mean Rank		Z-value	P-value (2-tailed)
	Bumiputra	Non-Bumiputra		
Interest in newly established firm.	45.02	55.18	-2.018	0.044*
Factors influencing engagement of new firm	47.52	43.46	-0.757	0.449
Importance of getting accounting services.	49.89	48.88	-0.224	0.018*
Importance of firm's efficiency level.	51.16	46.88	-0.818	0.413
Sensitive to client's need.	52.55	44.68	-1.487	0.137
Compliance to statutory requirements.	52.64	44.54	-1.473	0.141
Easily accessible to client.	52.78	44.32	-1.607	0.108
Firm's ownership.	55.93	39.34	-2.936	0.003*
For accuracy of receivable.	50.70	47.61	-0.586	0.558
For maintenance of inventory.	51.48	44.99	-1.236	0.216
For accuracy of current liability records.	51.27	46.71	-0.873	0.383
For accuracy of cash handling.	51.27	40.95	-2.630	0.009*
For accuracy of expenditure records.	55.03	40.78	-2.734	0.006*
For preparation of monthly financial statements.	52.36	44.99	-1.397	0.162
For preparation of costing.	49.79	47.72	-0.379	0.704
Auditing services	50.93	47.24	-0.691	0.490
Internal auditing services.	51.63	46.13	-0.989	0.323
Financial accounting services.	53.01	43.96	-1.769	0.077
Financial management services.	50.51	47.91	-0.473	0.636
Taxation services.	48.20	51.55	-0.622	0.534
Secretarial services.	48.44	50.14	-0.985	0.324
Business project advisory services.	48.69	50.78	-0.367	0.713
Training services.	50.04	48.64	-0.244	0.807
Easy excess	49.89	48.88	-0.190	0.849
Knowledgeable in client's business.				
Overcome the difficulty in identifying appropriate staff.	54.54	41.54	-2.424	0.015*
Frequent visits and discussion with clients.	52.52	44.74	-1.372	0.170
Provider's expertise.	53.22	43.63	-1.688	0.091
	51.10	46.97	-0.760	0.447

Significant at 95% confidence interval

Table 7. Results of t-test to determined the importance of patronage factors

Factors	Mean	t-value	P-value (2-tailed)
Importance of getting accounting services.	3.98	18.063	0.000*
Importance of firm's efficiency level.	4.13	15.732	0.000*
Sensitive to client's need.	3.99	12.783	0.000*
Compliance to statutory requirements.	3.65	7.110	0.000*
Easily accessible to client.	4.28	16.114	0.000*
Firm's ownership.	3.30	2.746	0.007*
For accuracy of receivable.	4.24	19.162	0.000*
For maintenance of inventory.	3.79	9.298	0.000*
For accuracy of current liability records.	4.14	15.452	0.000*
For accuracy of cash handling.	4.32	17.597	0.000*
For accuracy of expenditure records.	4.19	14.865	0.000*
For preparation of monthly financial statements.	4.22	16.089	0.000*
For preparation of costing.	3.89	9.239	0.000*
Auditing services	4.18	13.353	0.000*
Internal auditing services.	3.73	7.954	0.000*
Financial accounting services.	4.20	19.065	0.000*
Financial management services.	3.98	10.423	0.000*
Taxation services.	3.99	12.565	0.000*
Secretarial services.	3.08	0.783	0.436*
Business project advisory services.	3.33	3.042	0.003*
Training services.	3.36	3.025	0.003*
Easy excess	4.30	17.128	0.000*
Knowledgeable in client's business.	4.19	16.249	0.000*
Overcome the difficulty in identifying appropriate staff.	3.45	3.959	0.000*
Frequent visits and discussion with clients.	3.47	4.316	0.000*
Practitioner's expertise and knowledge.	4.25	14.772	0.000*

* Significant at 95% confidence interval



MATLAB Based Modelling and Performance Study of Series Connected SPVA under Partial Shaded Conditions

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Abstract

In a solar photovoltaic array (SPVA) spread over vast area, it is likely that shadow may fall over some of its cells due to tree leaves falling over it, birds or bird litters on the array, shade of a neighboring construction, passing clouds etc. Under partial shaded conditions the PV characteristics get more complex with multiple peaks. It is important to understand and predict them to get maximum possible power from the SPVA. This paper presents a MATLAB-based modelling and simulation scheme suitable for studying the characteristics of a series connected SPVA under partial shaded conditions. The conventional model is modified to include the effect of shading in the SPV module parameters for simulation study. The simulation of MPPT algorithm to track the global maximum is also presented. The model is practically validated using electronic load.

Keywords: Solar PV array, Partial shading, Improved model, Electronic load, Matlab

1. Nomenclature

I_{PV} , V_{PV}	- Solar PV module Current (A) and Voltage (V) respectively
I_{ph}	- Photo current SPV module (A)
I_r	- Diode reverse saturation current in the equivalent circuit (μA)
R_{se}	- Series resistance in the equivalent circuit of the module ($m\Omega$)
R_{sh}	- Parallel resistance in the equivalent circuit of the module (Ω)
R_L	- Load resistance
D	- Diode used in the equivalent circuit
n	- Diode ideality factor ($1 < n < 2$ for a single solar cell)
q	- Electron charge ($= 1.602 \times 10^{-19} C$)
k	- Boltzman's constant ($= 1.381 \times 10^{-23} J/K$)
T	- Temperature (Kelvin)
V_t	- Thermal voltage ($= nkT/q$)
G	- Insolation level (at reference condition $G=1000 w/m^2$)
α	- Short circuit current temperature co-efficient
I_{sc} & V_{oc}	- Short circuit current and open circuit voltage of the module respectively
V_{mp} & I_{mp}	- Maximum power point voltage and current respectively
PV_{max}	- Maximum power
D_b	- Bypass diodes used in the series array configuration
ref	- Additions subscripts indicate the parameters at reference conditions

- 1,2,3 - Additional subscripts indicate the parameters of Panel-1, Panel-2 & Panel-3 respectively
- V_{11}, V_{12}, V_{13} - Operating points of Panel-1 in series connection
- V_{21}, V_{22}, V_{23} - Operating points of Panel-2 in series connection
- V_{31}, V_{32}, V_{33} - Operating points of Panel-3 in series connection
- I_1, I_2, I_3 - Operating point currents of series connected SPVA
- P_1, P_2, P_3 - Power at operating points

2. Introduction

Global warming and increasing prizes of fossil fuels have drawn more attention towards the usage of renewable energy sources particularly solar energy because of its well known advantages. A great deal of research has been conducted in this field over the last few decades. Solar PV panel is a power source having non linear internal resistance. A major challenge in using a SPV source containing a number of cells in series is to deal with its non-linear internal resistance. The problem gets all the more complex when the array receives non-uniform insolation. Cells under shade absorb a large amount of electric power generated by cells receiving high insolation and convert it into heat. This heat may damage the low illuminated cells under certain conditions. To relieve the stress on shaded cells, bypass diodes are added across the modules. In such a case multiple peaks in power-voltage characteristics are observed under non uniform illumination. Classical Maximum Power Point Tracking (MPPT) methods are not effective due to their inability to discriminate between local and global maxima (Eftichios Koutroulis et al, 2001; K. H. Hussein et al, 1995; S. Jain and V. Agarwal, 2004). Nevertheless, it is very important to understand the characteristics of SPV under partial shaded conditions to use PV installations effectively under all conditions. Analog models of SPV sources at varying temperature, insolation and partial shaded conditions were presented in the literature (G. Walker, 2001). This paper presents the improved model of SPVA which takes care about the dependence of all the parameters in the model with respect to insolation and temperature (Gow.J.A. and Manning.C.D., 1996; H. Kawamura et al, 2003; M. C. Alonso-Gracia et al, 2006; Karatepe et al, 2006; Ramaprabha and B.L.Mathur, 2009). The model was simulated using Matlab software. The developed model was validated with experimental results. To capture the characteristics under constant insolation and temperature conditions, the experimental characteristics were obtained using linear MOSFET as an electronic load (Yingying Kuai and S. Yuvarajan, 2006; Ramaprabha and B.L.Mathur, 2008).

3. Improved Model of SPVA under Partial Shaded Conditions

The equivalent circuit model of a solar cell consists of a current generator and a diode plus series and parallel resistance as shown in Figure 1. The mathematical equation expressing the output current of single cell is given by equation (1)

$$I_{PV} = I_{ph} - I_r \left[\exp \left\{ \frac{V_{PV} + I_{PV} R_{se}}{V_t} \right\} - 1 \right] - \frac{(V_{PV} + I_{PV} R_{se})}{R_{sh}} \quad (1)$$

To get the improved model, the effect of insolation and temperature on each parameter has to be evaluated. For this, the following five reference parameters are required. They are V_{tref} , I_{tref} , I_{phref} , R_{seref} , and R_{shref} are required. To find the reference parameters it is important to know the following parameters. (Ramaprabha and B.L.Mathur, 2009)

At short circuit current: $I_{PV} = I_{sc0}$, $V_{PV} = 0$ (given in datasheet)

At open circuit voltage: $I_{PV} = 0$, $V_{PV} = V_{oc0}$ (given in datasheet)

At the maximum power point: $I_{PV} = I_{mp0}$, $V_{PV} = V_{mp0}$ (given in datasheet)

At the maximum power point: $dP/dV_{mp} = 0$

At short circuit: $dI_{sc}/dV = -1/R_{shref}$ (can be obtained from the characteristic curve given in datasheet)

Under reference conditions equation (1) can be rewritten as,

$$I_{PV} = I_{phref} - I_{tref} \left[\exp \left\{ \frac{V_{PV} + I_{PV} R_{seref}}{V_{tref}} \right\} - 1 \right] - \frac{(V_{PV} + I_{PV} R_{seref})}{R_{shref}} \quad (2)$$

$$I_{sc0} = I_{phref} - I_{tref} \left[\exp \left\{ \frac{I_{sc0} R_{seref}}{V_{tref}} \right\} - 1 \right] - \frac{(I_{sc0} R_{seref})}{R_{shref}} \quad (3)$$

$$0 = I_{phref} - I_{tref} \left[\exp \left\{ \frac{V_{oc0}}{V_{tref}} \right\} - 1 \right] - \frac{(V_{oc0})}{R_{shref}} \quad (4)$$

$$I_{sc0} = I_{phref} - I_{rref} \left[\exp \left(\frac{V_{mp0} + I_{mp0} R_{sref}}{V_{tref}} \right) - 1 \right] - \frac{(V_{mp0} + I_{mp0} R_{sref})}{R_{shref}} \quad (5)$$

$$\frac{d(I_{PV} V_{PV})}{dV} = 0, \text{ under Maximum power point condition} \quad (6)$$

$$\frac{d(I_{PV})}{dV} = -\frac{1}{R_{phref}}, \text{ at short circuit point} \quad (7)$$

The five reference parameters (I_{phref} , I_{rref} , V_{tref} , R_{sref} and R_{shref}) can be obtained by simultaneously solving Equations (3) through (7). In the improved model, the effect of ideality factor, series and shunt resistance with respect to insolation and temperature has been added. From literature, the following relations can be obtained:

$$I_{ph} = G \times I_{sc} \quad (8)$$

$$I_{sc} = I_{scref} \left[1 + \alpha (T - T_{ref}) \right] \text{ and } I_{scref} = I_{phref} \quad (9)$$

$$I_r = I_{rref} \left(\frac{T}{T_{ref}} \right)^{\frac{3}{n}} \exp \left[b \left(\frac{1}{T_{ref}} - \frac{1}{T} \right) \right] \quad (10)$$

$$V_t = V_{tref} \left[\frac{T}{T_{ref}} \right] \quad (11)$$

$$G \left[\frac{V_t}{I_r} \exp \left(\frac{-(V_{mp} + I_{mp} R_{se})}{V_t} \right) + R_{se} \right] = \left[\frac{V_{tref}}{I_{rref}} \exp \left(\frac{-(V_{mpref} + I_{mpref} R_{sref})}{V_{tref}} \right) + R_{sref} \right] \quad (12)$$

$$R_{sh} = R_{shref} \quad (13)$$

The above equations are used to simulate the model of existing solar panel (Solkar-Monocrystalline type) which consists of 36 cells in series. The simulation is carried out using Matlab software (Hiren Patel and Vivek Agarwal, 2008; www.Mathworks.com).

As with the connection of cells to form panels, a number of panels can be connected in series string to increase the voltage level, in parallel to increase the current level or in a combination of the two. The exact configuration depends on the current and voltage requirements of the load. Matching of the interconnected panels in respect of their outputs can maximize the efficiency of the array. The conventional PV panel is constructed of several PV cells (normally 36 cells) connected in series. In the PV power generation system, multiple PV panels are generally connected in series in order to obtain sufficient dc voltage. If there is one shaded panel in a series connected array, it can then act as a load to the array. It may cause damage to the panel due to the heavy current passing through it in the reverse direction. To prevent this damage, bypass diodes are connected in anti parallel with each panel, and, in case of the panel being shaded current flows through the bypass diode rather than through the panel. In series connected array, even the slightest shadow falling on a PV panel causes a significant drop in generation power. For this study, three panels connected in series have been considered. The same concept can be extended to a number of panels connected in series. Figure 2 shows that the series connection of three panels with bypass diode (Shimizu et.al, 2001).

Figure 3 shows the typical V-I and P-V characteristics of three series connected panels with same illumination. The maximum power is 110.9 watts. The maximum power produced by all the panels is equal as they are equally illuminated. When they are connected in series all the panels contribute power to the load. That is the maximum possible power produced by the PV array consisting of three panels each rated at the maximum power of 37.08 watts is 110.9 watts. When these three panels are not equally illuminated the power contributed by individual panels will be different and maximum power contributed by the array will be less than 110.9 watts.

Figure 4.a shows the characteristics of SPVA consisting of three series connected panels where each panel receives different illumination. Say Panel-1 receives 100% illumination; Panel-2 receives 70% illumination and Panel-3 receives 50% illumination. The operating point of each panel is given by the point of intersection operating lines I_1 , I_2 & I_3 . As the load current increases from zero to short circuit current, the operating point of each panel moves as shown in Fig.4.a. i.e. $V_{11} \rightarrow V_{12} \rightarrow V_{13}$ for Panel-1, $V_{21} \rightarrow V_{22} \rightarrow V_{23}$ for Panel-2 and $V_{31} \rightarrow V_{32} \rightarrow V_{33}$ for Panel-3 respectively. The operating points V_{23} for Panel-2 and V_{32} and V_{33} for Panel -3 (both shaded panels) are lying on the negative X axis.

On the operation line I_1 the 50% shaded panel, PV_3 , generates its maximum power, whereas the other two panels do not generate their maximum power yet. But all the three panels are contributing power. When the operation line moves to I_2 , the operation points of PV_1 , PV_2 and PV_3 move to V_{12} , V_{22} and V_{32} respectively. The generation power of PV_1 and PV_2 increases. The operation point V_{32} of Panel-3 moves to negative voltage region because the current generated by other

two panels flow through the bypass diode connected in anti-parallel with Panel-3, and the resultant power generated by PV_3 becomes negative. That is PV_3 cannot generate any power and causes a power loss, PV_{3Loss} . When the operating line moves to I_1 , PV_1 generates its maximum power, but the operating points V_{23} and V_{33} move to negative voltage region consequently cause the power loss, PV_{23Loss} . Hence the output power on the system is decreased to

$$PV_{total} = PV_{1outmax} - PV_{3Loss1} - PV_{23Loss} \quad (14)$$

The generation power is following the relation $PV_{1out} > PV_{2out} > PV_{3out}$ in this case. The total P-V characteristic of the series connected system is shown in Figure 4.b. Figures 4.a and 4.b show the electrical characteristics of SPVA with bypass diodes with $G_1=100\%$, $G_2=70\%$ and $G_3=50\%$. The results are consolidated in Table-1. Though the maximum power goes up to 58.2 watts, the bypass diodes introduce multiple peaks in the characteristics.

Figure 5.a and Figure 5.b show the V-P characteristics of SPVA for different shading with its maximum power point indicated. The shading patterns are selected randomly. The maximum power point algorithm is written in Matlab M-code to indicate the global peak point in the characteristics. The results are consolidated in Table.2

4. Validation of the Model

For this study Solkar panel 3712/0507-Monocrystalline type that consists of 36 cells in series is used. Ratings of the panels used in this experiment are $P_{max} = 37.08$ W, $I_{mp} = 2.25$ A, $V_{mp} = 16.56$ V, $V_{oc} = 21.24$ V and $I_{sc} = 2.55$ A at an insolation level of 1000 W/m² and 25° C. The shading effect is artificially generated by tilting the panels at different angles. The three series connected panels in SPVA are tilted such that they receive insolation levels of $G_1=100\%$, $G_2=70\%$ & $G_3=50\%$ respectively. The insolation level is measured with reference to short circuit current, that is for $G=100\%$, the reference short circuit current is 2.55 A. The Solar panel is tilted till the required insolation level is obtained by measuring the value of I_{sc} . Figure 6 shows the schematic of hardware arrangement for observing the practical characteristics. A linear MOSFET is used as a load resistance. Gate-Source port of the MOSFET is driven by a low frequency triangular wave generator. Voltage of the panel is given to the X-input of a CRO. Voltage proportional to load current is obtained as voltage drop across a small series connected resistance. The current signal is inverted and given as Y-input to the CRO. I-V characteristics of the SPV will be observed on the CRO screen. For good results, the gate signal should be large enough to cover the entire range of the resistance variation of the MOSFET without driving it deep in cut-off or saturation mode. The characteristic is traced on the screen once every cycle of the gate signal. A signal frequency of 1 Hz was used to minimize the transients due to gate-source capacitance. The hardware set up of electronic load is shown in Figure 7. The practical validation of the simulation model for the above said shading pattern using electronic load is shown in Figure 8.

5. Conclusion

In this paper the effect of non uniform illumination on a series connected solar PV cells is discussed in detail using Matlab software. In a series connected SPVA non-uniform insolation can damage poorly illuminated cells. A large proportion of electrical power generated by highly illuminated cells is wasted as heat in poorly illuminated cells. It is observed from the above discussions, the use of bypass diodes can save the poorly illuminated panels from damage and also make this energy available to the load. But the P-V characteristics under non uniform insolation with bypass diodes contain multiple peaks. The magnitude of the global maxima is dependent on the array configuration and shading patterns. It is demonstrated that, if the likely shading pattern on the PV array is known, the simulation model is handy to design the most optimum configuration of the PV array to extract the maximum power. As the developed model in this paper is based on the equations that take care about the model parameter variations with respect to environmental conditions, it can be used readily to predetermine the behavior of any SPV array having different number of cells in series and parallel, different number of bypass diodes and shadow conditions.

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<http://www.Mathworks.com>

Table 1. Consolidated Results for a Particular Shading Pattern

Maximum Power of Panel-1 with G_1 , $P_{\max 1}$	37.02 W
Maximum Power of Panel-2 with G_2 , $P_{\max 2}$	23.89 W
Maximum Power of Panel-3 with G_3 , $P_{\max 3}$	15.61 W
Total Power expected to be produced by series connection, $P_{\max \text{total}} = (P_{\max 1} + P_{\max 2} + P_{\max 3})$	76.52 W
Total power produced by series connected panels without bypass diode	46.45 W
Total power produced by series connected panels with bypass diode	58.24 W

Table 2. Ouput Power for Different Shading Patterns

Shading Pattern	G1	G2	G3	Global Maximum Power (Watts)
SP-1	77	79	19	54.46
SP-2	49	45	64	45.22
SP-3	69	32	95	52.09
SP-4	3	44	38	23.34
SP-5	71	3	28	24.14
SP-6	5	9	83	29.14
SP-7	82	82	72	80.49
SP-8	97	65	80	74.51
SP-9	45	43	83	43.7
SP-10	15	66	52	35.77
SP-11	6	68	4	23.13
SP-12	7	52	9	16.49

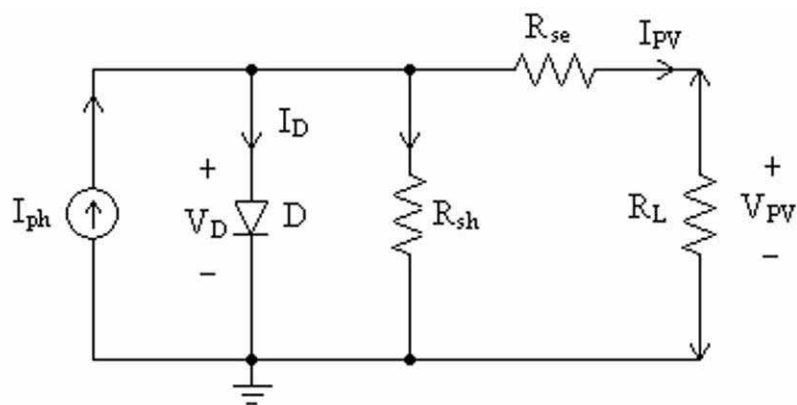


Figure 1. One diode model of Single PV Cell

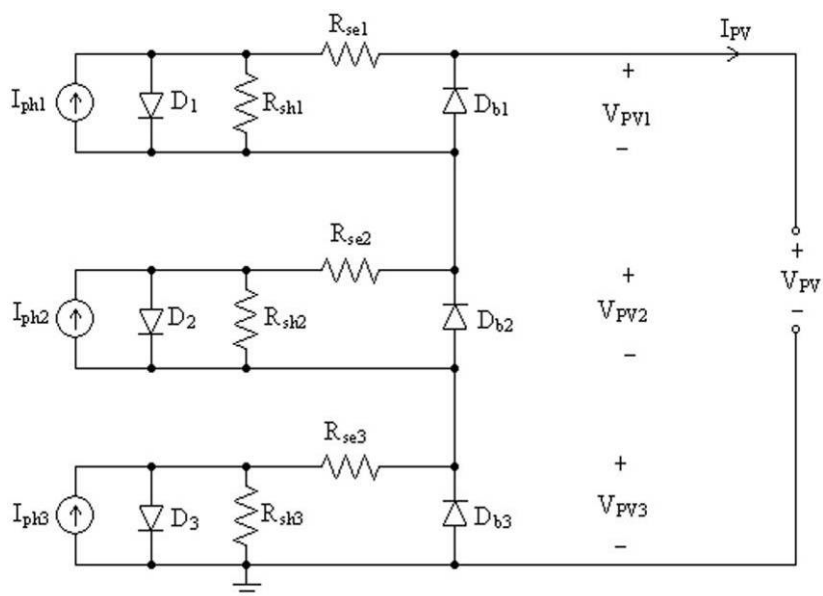


Figure 2. Series Connected SPVA with bypass diodes

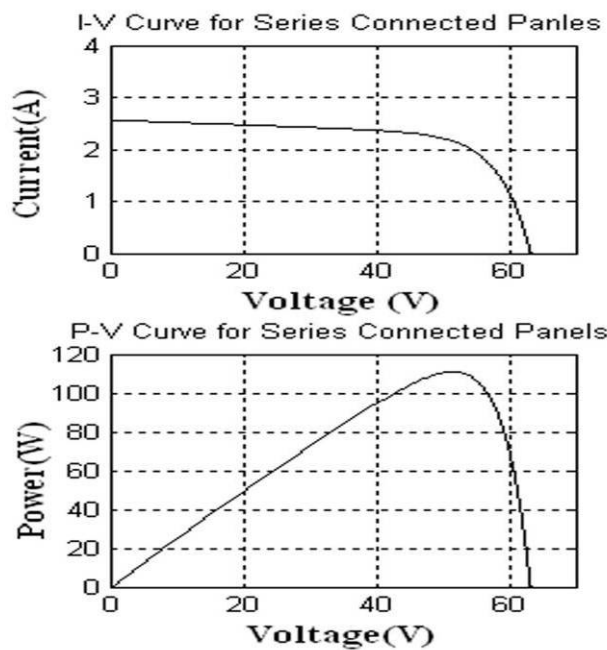


Figure 3. Characteristics of Series connected SPVA with uniform illumination

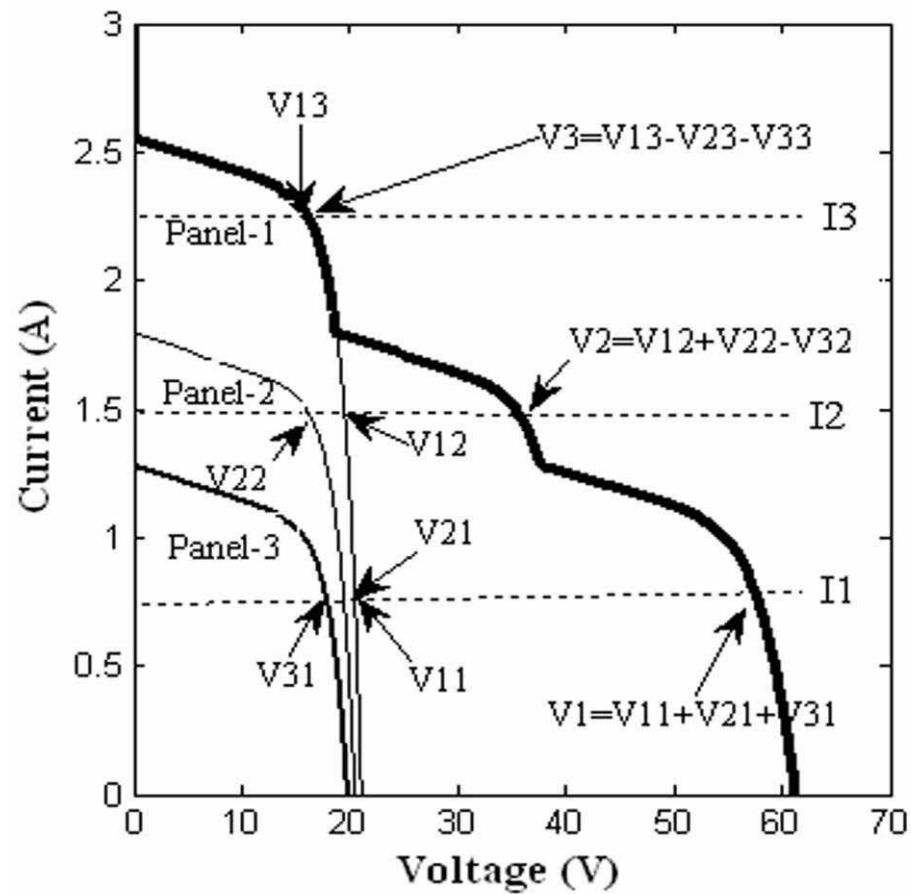


Figure 4. a. I-V characteristics of three series connected panels under partial shading

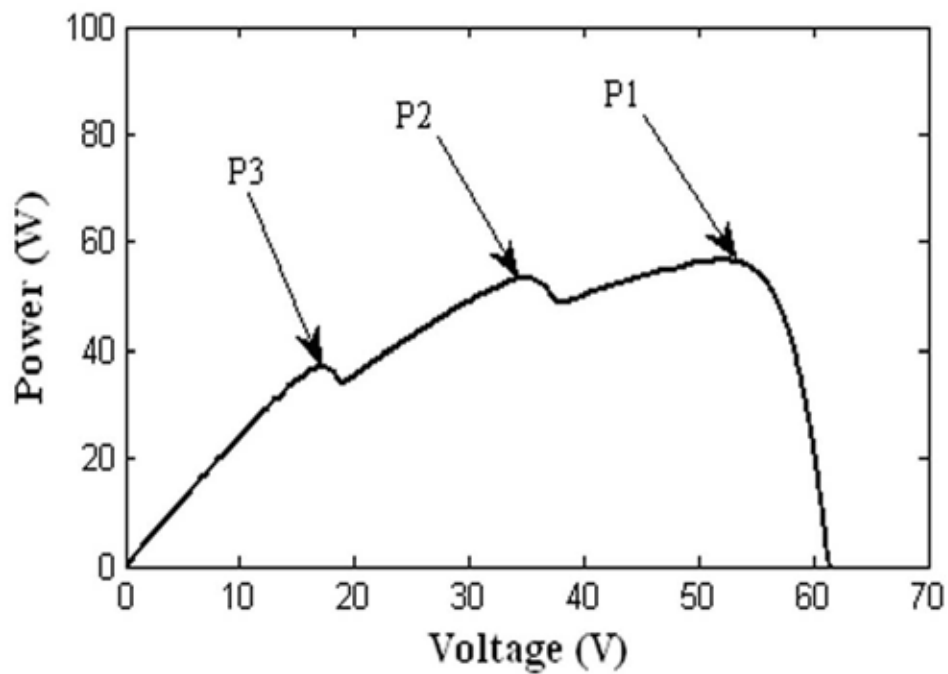


Figure 4. b. P-V characteristics of three series connected panels under partial shading

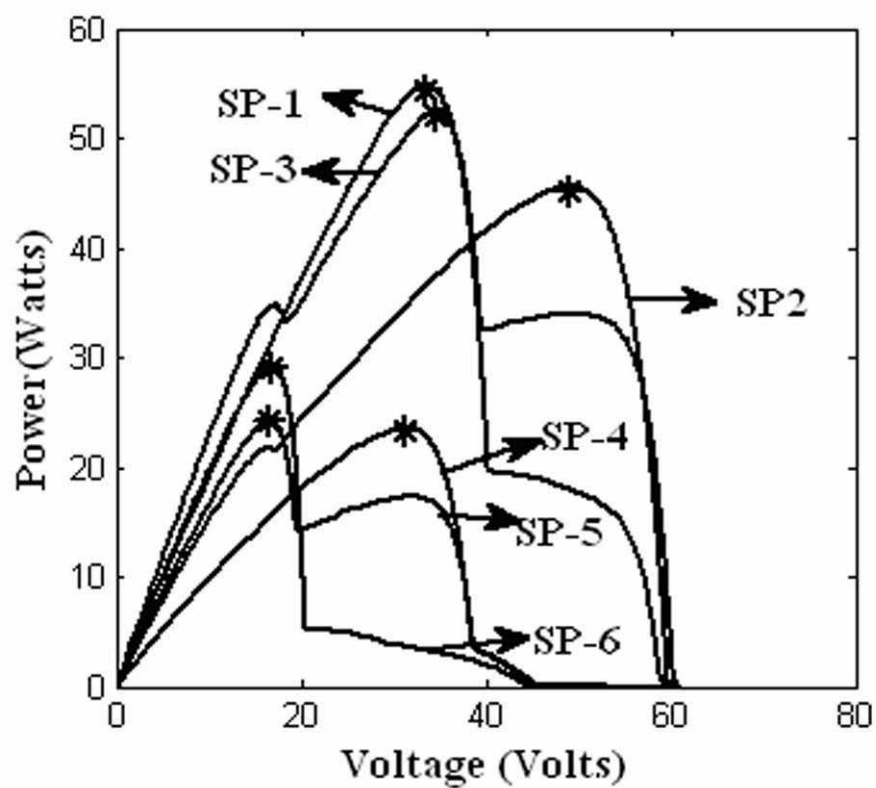


Figure 5. a. V-P curves for five different shading patterns

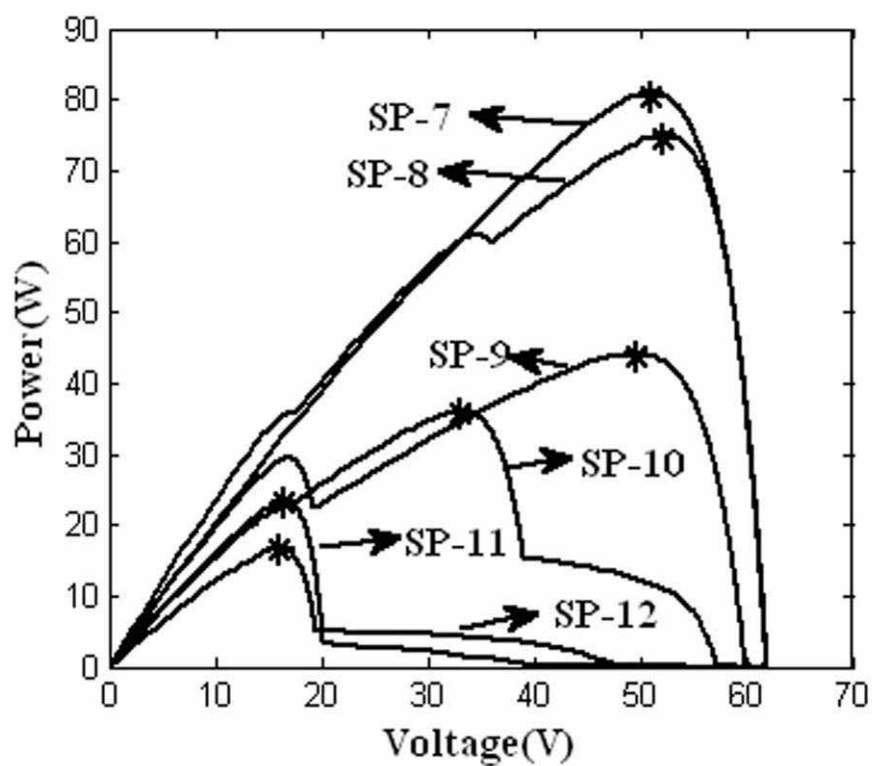


Figure 5. b. V-P curves for other five different shading patterns

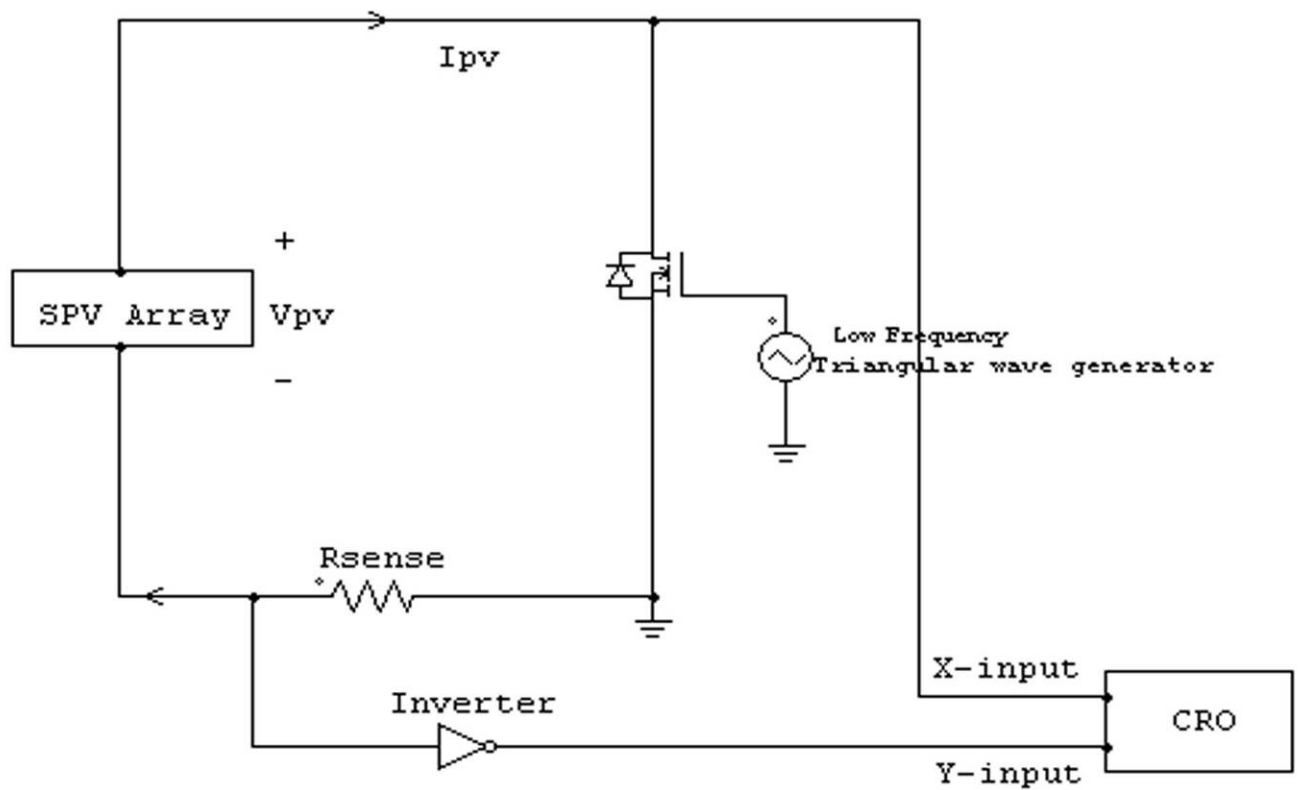


Figure 6. Block diagram for obtaining practical characteristics of SPV array



Figure 7. Hardware setup of an Electronic Load

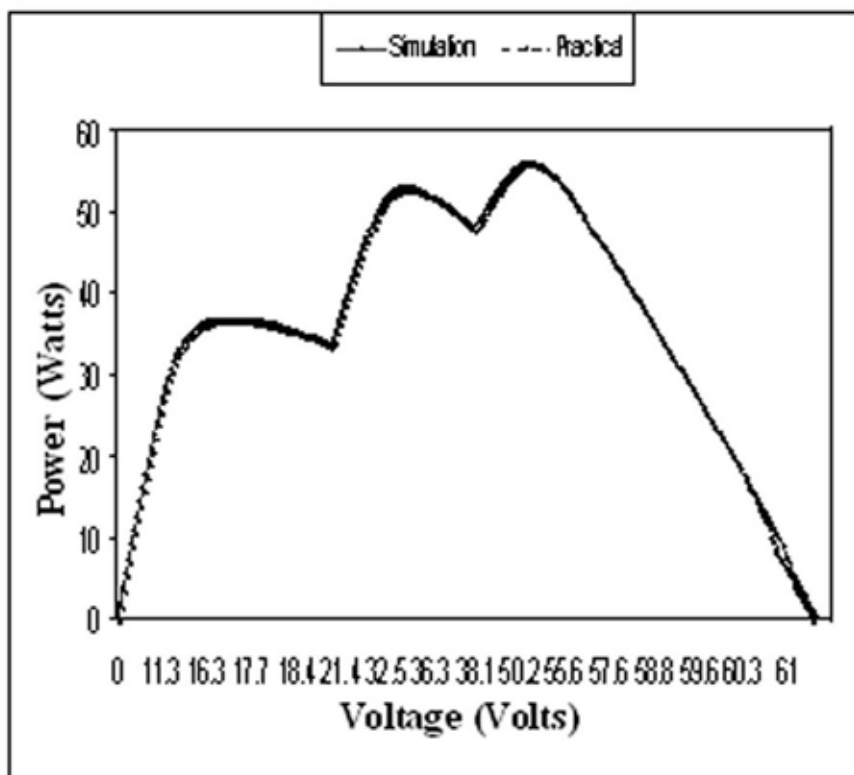


Figure 8. P-V characteristics of SPV array under partial shaded condition with bypass diodes-Validation of the model



Financial Markets Barriers' in Agricultural Sector: Empirical Evidence of Iran

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Abstract

This paper aims to examine the relationship between financial market development and agricultural sector in Iran. The study attempts to answer these questions empirically and try to shed some light on the roles of financial development as well as other conditional variables in agricultural sector. The results of this study shows that the financial market in agricultural sector, however there is some weakness still. The authors come to conclusion that for improving this vital sector in Iran the weakness should be removed or at least reduced as early as possible.

Keywords: Financial market, Agricultural sector, Iran

1. Introduction

Iran is primarily an agricultural country. The agricultural sector makes a significant contribution to the national economy and is an important source of employment. Iran has a total area of 1,648,000 square kilometres, of which approximately 60 million hectares is potentially capable of supporting agriculture. Out of 51 million hectares only 18 million hectares are cultivated at the present time (Yazdani, and Vaezi 2008). In view of the fact, griculture is a significant economic sector in the national development framework of our country and plays a vital role in our national development. Those determinants are required for any further developments. To improving agricultural sector in Iran it is essential to establish some condition such like financial condition or financial market. Financial market plays a crucial rule in economic development process of Iran. It capitalizes entrepreneurs to undertake new investments or adopt new technologies. It helps smooth consumption by providing working capital and reduces poverty in the process. Following the revaluation in 1979 the government adopted various policies, which encourage farmers to improve their productivity and food self sufficiency has been a national priority. Following the 1979 revolution, replacement of the traditional interest based credit system with an Islamic credit system was one of the fundamental changes in Iran to ensure an adequate flow of credit, financial institutions reform was made to increase budgetary allocations. Credit for agriculture is channeled at below market interest rates, through Agricultural Bank, the major supplier of rural credit (80%). The Bank has disbursed in 2001 approximately 1 million credit facilities amounting to 10.7 trillion Rials (14% of agricultural GDP for the same period). Of this amount, 34% was in the form of payments for special projects approved and provided for by the government. About two-thirds of the total credit to the sector is granted to farmers engaged in field crops and horticulture. With a growing recognition of the importance of agri-business activities to promote development in the sector, there has been an increasing trend in the facilities offered to agricultural related industries and services.

The main objective of this research is studying the power of insuring financial & credit needs of rural and agricultural sector and establishing organization that can cover these needs desirably. The main result of this problem is helping to increase the power & potential of rural & agricultural sector & appearance of talent & use their capacities. So, if covering financial needs about insuring machinery, loan, seed improvement, improve fields and etc. This sector will be

able to grow, develop & have sustainable job making like other economical sectors of society. The importance of this study is if needs of rural & agricultural sector that is allocated an important part in population aren't realized, it has been remaining in traditional level & doesn't have any role in self-sufficiency & freedom of country's agriculture. Immigrating to other cities, stopping agricultural activities, depending to imports & increasing of unemployment are effective factors of not attention to this important issue. Improving of financial organizations is one of the necessities of developing rural & agricultural sector that are said before. But, what's very important is improving tools & strategies & coordination between organizations. For example, guess that agricultural bank is paid loan with a low interest rate to farmers for tractor. So far from, farmers predominately don't have the ability of paying deposit & them interest to accept that bank receive their tractor document as deposit. Whereas, various tractor aren't currently pagination by police station & it isn't accepted as loan deposit. So, it has seen that exposure of strategy for removing of these problems is so important. Other example is determining the importance & necessities of this research. One of the most vulnerable groups of society's population is farmers & they are -usually had lower literacy level and awareness than other population. This people generally don't be able to insure their financial problem in planting & harvesting. So, they perform & because of financial pressure borrow money through informal channels & some people like comparators in markets & other people that are be able to insure money for them if they receive deposit & . In the time of harvesting crops according to contract that they are hold it previously, crops are sold & money is paid to people or crops are sold in lower price than other time and get it to solicitor. According to above context whether can we hope to discuss about saving for farmers? This procedure is repeated annually and farmers also become weaker in financial issues each year than previous year. So that, attention to practical formal strategies for insuring financial issue of this people can not be undeniable that existence of agricultural sector in country depend to it.

2. Review of literature

The government also adopted an economic model combining the objectives of food self sufficiency with those of liberalization and private sector promotion.

A Five-Year Socio-Economics Development Plans for reconstruction were launched, which aimed at increasing production, raising productivity in key economic sectors and promoting the non-oil export sector. Economic liberalization was pushed forth in the context of a national structural adjustment program which included correcting price distortions, floating the foreign exchange rate and promoting the private sector. During this period, Iran's agriculture expanded at strong growth rates, and the Plan's ambitious quantitative objectives were achieved to a large extent. A great number of theoretical and empirical studies have explored the sources of economic growth at both national and provincial levels (Yazdani 2001, Chandavarkar 1992, Carter 1988, and Chen and Feng, 2000) and ongoing debate is mainly concerned with which source, factor accumulation or productivity improvement, is the key growth-driving factor. However, unfortunately, the role of financial development in economic growth has till recently often been ignored. Christopoulos and Tsionas (2004) reviewed studies are subject to limitations such that the capital formation is the only additional growth-determining variable incorporated in the framework. Schumpeter (1911) points out the role of financial intermediaries in mobilizing funds, evaluating and selecting projects, managing risk, monitoring entrepreneurs and facilitating transactions as the critical elements in fostering technical innovation and growth. Under the assumption that the size of a financial system is positively correlated with the supply and quality of financial services, Gerdin (2002) documents a positive correlation between the financial development and productivity.

By the way, a large body of empirical studies supports the point of views that financial development may raise savings rate, stimulate investment, avoid premature liquidations of capital, reduce the cost of external finance, enhance the efficiency of capital allocation and insure more productive technological choices (King and Levine 1993, Amable and Chatelain 2001).

There are growth theory models that consider credit sources as a source of growth, Edwards (1993). Development in credit market creates incentives for farmers to improve productivity and results a growth in their GDP" Lal and Rajapartirana (1987).

Yazdani (2008) in the study the long-run relationships among financial development, growth and other key growth factors empirically examined in Iran's agricultural sector. He also the causality between financial development and GDP growth was evaluated. The robustness of his empirical results has been tested using different indicator of financial development. Overall, he found that financial development, capital stock, international trade and real interest have significantly impact on agricultural growth.

3. The history of stock Exchange in Iran

Tehran stock Exchange (TSE) was established in 1967. This organization is started its activities by doing several sales on dividend industrial and mineral bank. After that, Pars oil organization, public portfolio, treasure house documents, and public portfolio of improving industrial ownership organization gone to TSE. Conferment of fiscal excuse of acceptable organizations in stock market has an important role in creating motivation for preferring portfolio. While 11

year the activity of stock market before revolution of Iran the number of organizations, banks and acceptable insurance organizations is increasing from six economical institutions with 6.2 milliards Rials capital in 1967 to 105 institutions with 230 milliards Rials in 1978. Also, the value of exchanging in stock market is increasing from 15 millions Rials in 1967 to 150 milliards Rials in 1978. In the years of after revolution & before the first program of 5 year economic development has made memorably changes in national economic that is included Tehran's stock markets. The first circumstance was authorized of law essay of controlling banks works on 17 in 1979 by revolution council that according to it country's commercial & professional banks in the frame of nine commercial banks and three professional banks are integrated. Some time ago insurance organizations also are integrated together and they are became public ownership & also authorized of law essay of protecting and improving Iran's industrial in 1979, further, it caused that most of acceptable economical institutions on stock market is stopped. So, its number is decreased from 105 organizations & economical institutions in 1979 to 56 organizations on the end of 1988. Therefore, through these years stock market become weaker until the end of 1988. In 1987 the frame of the first program of 5 year economic development repetition activity of TSE is considered as the basis of performing privatization policy. So, politicians are considered that stock market transfer parts of their activity from public sector to private sector, capital absorbing and collecting outspread saving resources and directing it to investment consumption for mobilization of economical development resources and effective motivation of private sector for actively participation in economic activities. At all events, tending through economical macro investments to use activities stock market, increasing the number of acceptable organizations and increasing activities volume is included TSE that according to it over the years of 1988 until this year the number of listed companies in TSE is increased from 56 organizations to 325 organizations. In among a policy about increasing the number of exchanging dividend centre in all part of country is created. So that, stock markets of Mashhad, Tabriz, Isfahan and Ahvaz is established so these centres are communicated directly to Tehran's centre and this local stock markets plus exchange their area dividend has the ability of TSE. This effectiveness is so high that nowadays Mashhad's stock market is parallel with TSE and we can see exchanging volume growing. Acceptable organizations and active organizations in stock market are divided to two groups:

Manufacturing organizations

Investment organizations

Manufacturing organizations usually is produced special goods and they put in active industry in stock market and in stock market organizations and identified with organization name and special code. But, investment organizations is organization that operates as financial mediums that this kind of organizations don't have manufacturing activity or their activity is some thing like activities that perform by financial helps through buying manufacturing and industrial organizations dividend or group of them are investing or producing in this organizations, so according to it nowadays active investing organizations in stock market are 29 organizations and manufacturing organizations are 310. Also, necessities field for attending servicing organizations in stock market are prepared.

Exchanging volume procedure, Tehran's stock market inefficiency and whole market volume:

Expanding culture of investing & participating in one hand and special character of stock market (the ability of absorbing minor capitals) in the other hand are caused growing TSE.

3.1 Local stock market

One of important stock market development programs in lately years is started local stock market out of Tehran. Physical and quantity capital development had an effective role in developing investment culture. So that, according to this situation establishing grounding stock market and goods in various towns and provinces of Iran can be helped to support agricultural and rural sector of Tehran in using existence opportunities.

Agricultural goods stock market

Agricultural goods stock market is started its activity as second goods stock market in Iran on summer of this year and it has effected on activities procedure and developing capital market of Iran and presenting agricultural crops. Agricultural goods stock market is started its activity on 2004 by Jihad ministry & directed by Tehran's stock market through grounding network. This stock market is established for covering all agricultural & rural crops. But, nowadays because this stock market starts its activity lately and it can't expand & develop stock market culture among various population of agricultural & rural society it just can exchange crops such as wheat, rice, oat, maze, white sugar, meal, bean & pistachio in this market. The basis of this stock market is consisted of stock market council, agricultural stock market governing, preceptors and groundings organizations. Agricultural goods stock market has spend a lot of time for changing to goods stock market. Government can protect agricultural stock market in various ways, because government doesn't receive any tax from traditional market activities & if it actively excuses this market from tax, motivation of this people will increase. Government is insured households'. Consumption items that can perform its recommendation through stock market, some of items that exchange in stock market are such as meal & corn that

nowadays our country is imported them that government can create motivation with depreciation in dutiable items & dues for market workers.

3.2 Agricultural regional goods stock market

It must say that for creating centres in regions that present agricultural crops agricultural stock market statute station and deputations in townships that after activation and prosperity of stock market in manufacturing centres some deputations is inaugurated. For that reason, agricultural banks are acted as agricultural stock market. Also, if extensive cooperatives network have gain enough information, agricultural crops can present. The first studies are shown that bank must do feasibility for identifying possible situations. In 2004 agricultural goods stock market is started its activity in Gilan province and Rasht city as the first deputation of agricultural goods stock market. Nowadays agricultural goods stock market is acted just about internal sales and it doesn't act for imports and exports. But, it is able to create healthy atmosphere for imports & exports of agricultural goods, so external investors can provide its goods from this market. And how, from starting agricultural stock market there isn't any external volunteer from abroad but, the ability of this kind of exchanging in stock market is created & there isn't any proscription for external customers in stock market. Existence of this kind of customers is necessary for stock market but its better that internal outgoings enter to markets themselves & do this kind of business. Presenting goods are guided customers to one centre. This situation for agricultural goods stock market is one of the positive points that are caused competition and transparency the real price of goods. One of the agricultural stock market problems is high presentation & low demand. The result of this problem does not know about stock market works & existence of traditional market.

4. Objectives of the study

The main objective of this study as follow:

- 1) Recognition and awareness of farmers financial difficulties in rural of Iranian environment and exposure this problems to organizations that have the role of performing supportive policies of agricultural sector for insuring of doing better service to this sector.
- 2) Necessity of establishing and introducing micro financial markets in rural place of Iranian environment.
- 3) Recognition and awareness of farmers about creating micro financial systems in rural place spontaneously
- 4) Creating necessary fields'; for informing about how farmers can use bank resources and feasibilities.

Changing in general view of to this sector & this part is the most necessary & important multi sectors of country.

5. Research questions

Micro-credit financial organizations (non-bank organization that have the ability of covering financial needs of rural sector of country and improving this sector can effect on improving rural and agricultural sector of country) have formal, informal nature and in Iran most of the time we can see informal nature of them. These questions will help to receive the goal of research. So, these questions are:

- 1) Whether country's improving financial markets in rural & agricultural sector and improving monetary and financial organizations in this sector can cause to improve and grow this sector?
- 2) Whether improving monetary markets will have a role in improving Iranian rural and agricultural sector?
- 3) Whether improving financial markets will have a role in improving Iranian rural and agricultural sector?

Which financial markets have more roles in improving Iranian rural and agricultural sector?

Whether non bank organizations (micro) have the ability of covering financial and credit needs of country's rural and agricultural sector?

6. Research hypotheses

According to above research problems and literature the hypotheses which postulated in this study are as follows:

Financial market covers rural and agricultural financial needs in Iran.

Development in financial market causes enrichment in Iranian agriculture sector.

Agricultural sector if eligible take loans vey easily.

Long term process at the time of taking loans cause to weakness of financial market in Iran.

Lack of awareness of financial market service leads to decrease in financial supporting of agriculture sector in Iran.

7. Research methodology

The research methodology used in this study is based on both survey and description methods. So far accurate answer to the research questions, the authors design and developed a questionnaire which it is the most suitable for this study. A survey questionnaire was completed by the agricultural sector at the end of March 2009. The questionnaire contains two

parts namely (A) bio-data and (B) this section includes several questions regarding to the quality of services which rendering in Iran. Five-Point Likert's Scale questionnaire was employed in this research. The Five-Point Likert's scale having the ratings of "strongly disagree" (1) and "strongly agree" (5) were used.

First the researchers must determine sample size among member of statistical population. For that, all villages of Tehran province are considered according to population information of townships of Tehran province in 13 townships. After that, we choose 11 villages and 80 villages are chosen for final sample. For choosing villages of each township is used random sampling so, each village has the equal chance in its group for choosing. For that, at first the names of villages of each township are written on cards & put them on bung & pull 5 cards out of bung randomly. In total, 650 questionnaires were distributed among the farmers in various villages in Tehran province. Out 650 questionnaires, 582 useable questionnaires were returned by farmers (89.54 per cent). So, the interest of participants stood at 89.54% which it seemed high. Table 1 shows bio data and general information of participants.

As Table 1 shows the majority of participants are male with 74.05 per cent and the least number of participants are female 151 participants. Regarding to educational background, majority of participants have got Diploma (300 numbers) followed by illiterate fellows 31.79 per cent. Moderate number of participants has got B.S which stood at 13.92 per cent. It is interesting to note that the least part of participants has got M.S. It is because of either they graduated in agricultural field or because of unemployment they have to do this kind of works.

Insert Table 1

Regarding to participants' age, majority of participants' ages were between 30-40 years old which stood at 35.74 per cent, followed by the participants with ages of 41-50 which stood at 34.36 per cent. Least number of participants had more than 51 years old which stood at 12.37 per cent.

Regarding to per month salary least number of participants had more than \$500 per month; moderate number of participants had \$ 301to 400 per month; followed by 34.71 per cent had \$201-300 per month. In is also interesting to note that 19.07 per cent of participants had salary about \$100-200 per month. To conclude, majority of participants were male; they got diploma degree; majority were young fellow with middle salary per month.

8. Testing of hypotheses

In order to testing of five hypotheses in this survey, the fittest test to study were employed, in other words, T-test were employed in this study, further to better catching the heart of the each hypothesis point's, Mean value and Standard Deviation (S.D) of each hypothesis is calculated. Table 2 shows the results of testing hypotheses.

H1: Financial market covers rural and agricultural financial needs in Iran.

The first hypothesis is directed to the ability and effectiveness of financial services which renders by financial markets to rural and agricultural sector in Iran. As it shown in Table to the mean degree of this hypothesis is stood at 2.15, S.D is 0.699. The result of T test is 39.836 and the significance level is 0.000. So, according to these results the first hypothesis is strongly accepted and null hypothesis is rejected. In other words, Iranian financial market is covers several needs of rural and agricultural sector in Iran.

H2: Development in financial market causes enrichment in Iranian agriculture sector.

Second hypothesis is related to financial market affection to Iranian agricultural sector which Table 2 shows the results of testing second hypothesis.

According to below table, Mean value of second hypothesis stood at 2.48, S.D is 0.721.

The result of T test stood at 31.236 and significance level is 0.000 which according to those results this hypothesis also strongly accepted. In other words, development of financial market has positive correlation with Iranian agricultural sector. So, it can conclude that for developing agricultural sectors besides other factors, we can improve financial market also.

H3: Agricultural sector if eligible take loans very easily.

Third hypothesis is related to period of loan requesting to loan taking by agricultural sector. According to the results of Table 2, mean value of third hypothesis is 2.32, S.D is 0.701. The below table also reveals the results of T test for third hypothesis stood at 18.301 which significance level is 0.000. According to these results the third hypothesis is strongly accepted and null hypothesis rejected. As it mentioned earlier Iran is agriculture country and it has preference in some agricultural items in the world. One way for improving Iranian economics is enlarging as well as enriching agricultural sector in Iran. For this purpose the agricultural sector should finance in short time and easily; according to the result of third hypothesis is it happening in Iran.

H4: Long term process at the time of taking loans cause to weakness of financial market in Iran.

The fourth hypothesis is directed to bureaucracy and formality process of loan taking and its difficulties. According to the results of fourth hypothesis this hypothesis is also strongly accepted; in other words, from the view point of participants, the major problem is formalities at the time of taking loans.

Insert Table 2

Last not the least the authors come across with testing the fifth hypothesis which is:

H5: Lack of awareness of financial market service leads to decrease in financial supporting of agriculture sector in Iran.

According to the results of Table 2 the mean value of fifth hypothesis was 2.68; S.D was 0.719 and T test result stood at 21.361 with significance level of 0.000. With reference to these results this hypothesis also accepted and null hypothesis is rejected. In other words, the lack of awareness of financial market services by users leads to decreases in financial supporting of agricultural sector in Iran.

9. Conclusion

Agriculture is an important component of Iran's economy. The agricultural sector accounts for one fifth of GDP, and employs one third of the labour force. Food processing (particularly sugar refining and vegetable oil production) also is an important industrial sector. With its large population and limited arable land, Iran is not self-sufficient in food, and is a major food importing country in the region.

However, Iran enjoys a wide diversity of climate and terrain, enabling its farmers to produce the traditional staple cereals (wheat and barley), rice, sugar beets as well as tobacco and tea. It is the world's largest exporter of high-quality pistachio nuts. Over the last decade, as part of a policy to generate non-oil export earnings, the government has promoted the expansion of export-based specialty products such as pistachios, dates, and flowers by bringing large-scale irrigation projects online. These and other efforts sustained a healthy economic growth in the agricultural sector in the 1985-1998 period, marked by increased yields and additional land put into cultivation. By the mid-1990s, Iran was importing just 5% of its wheat, rice, vegetable oil, sugar, and meat needs. According to the results of this survey, Iranian government is emphasising to agricultural sector which the main proof is developing financial market to this area. The results of test of hypotheses showed that this financial market also plays very important role in developing agricultural sector in Iran. By the way, the results also indicated that there is still some weakness in such a financial market. The authors came to conclusions that for removing or at least reducing such weaknesses at first stage the bureaucracy of taking loan as much as possible should be reduced and second more advertisement is needed by such financial market to the users; in whole to the Iranian society.

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Table 1. General information of participants

Item	Sex	Frequency	Percentage
Gender	Male	431	74.05%
	Female	151	25.95%
Educational Background	Illiterate	185	31.79%
	Diploma	300	51.54%
	B.S	81	13.92%
	M.S	16	2.75%
Age	Less than 30	102	17.53%
	Between 30- 40	208	35.74%
	41-50	200	34.36%
	Above 51	72	12.37%
Salary (per month) in US \$	100-200	111	19.07%
	201-300	202	34.71%
	301-400	200	34.36%
	Above 500	69	11.86%

Table 2. The results of testing hypotheses

Hypotheses	Frequency	Mean	S.D	T- Test	Sig.	Results
H1	582	2.15	0.699	39.836	0.000	Accepted
H2	582	2.48	0.721	31.236	0.000	Accepted
H3	582	2.32	0.701	18.301	0.000	Accepted
H4	582	2.81	0.739	19.412	0.000	Accepted
H5	582	2.68	0.719	21.361	0.000	Accepted



Research on the Parameters of Environment-Friendly Recycled Road Materials

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Abstract

The feasibility of propagating road materials in the use of contracture wastes especially contented great amount waste bricks were researched in three aspects: Performance of recycled aggregate, mechanical properties of renewable road materials, compression - splitting indexes. Conclusions are as following: recycled aggregates contenting great amount waste bricks in place of natural aggregates are feasible from the point of view on technical and technological. The performances of recycled aggregates have a significant impact on properties of renewable road material. Whether it is cement stabilized RCA material or cements stabilized RCBA material, age and cement in the age-dose studies, with the increase in cement dose, mechanical properties growth trends are similar. Compared to unconfined compressive strength and resilient modulus, splitting strength is much closed in terms of growth trends or Growth value at the cement doses or ages. Good Relevance correlation are existed among resilient modulus, compressive strength and splitting strength: $\sigma_{sp90} = 0.17R_{c7}$, RCA: $\sigma_{sp90} = 0.20R_{c7}$.

Keywords: Road engineering, Recycled road materials, Experimental research, Basic properties, Relevance

1. Introduction

With the development of urban construction, and the Construction of substantial reconstruction, Extension, Conversion and New Projects, on the one hand, large amounts of construction waste inevitably produce inevitably from the demolishment of existing buildings. On the other hand, a large number of building material is necessitated for the construction of large amounts new buildings. Therefore, how to resourceful disposal these construction wastes is one pressing problem. In recent years, Resource Utilization of construction waste is considered as one of the most important attempt of sustainable development(Nik D Oikonomou, 2007). a large number of experiments and practice proved that recycled aggregate has a good pavement performance(ZHANG Chao, 2002, Chi Sun Poon, 2006) the Utilization of recycled aggregate in road engineering is one of effective ways to deal with construction waste. However, compared with natural aggregate as a result of the exit of large amounts of old cement mortar, pores and micro-cracks, recycled aggregate has certain characteristics. Especially, the e abrasion value and Moisture Content of recycled aggregate is much higher than the natural aggregate(Sumeda Paravavithana, 2006), which caused certain adverse effects for the properties of road material.

In recent years, some studies on application of recycled aggregate in road engineering have been made and have made some research results, For example, Degroot DJ (1998) successfully used the recycled aggregate in highway construction, construction waste was successfully applied in the construction of an office building, P. Gribl, et al(1998) research shows that the building had a goodperformance. But all these researches only limited in the simple application of higher intensity waste concrete block (ZHU Hai-yan, 2006, Farid Debieb, 2008, B Juric, 2006, Nik. D. Oikonomou, 2005), large-scale, resourceful treatment of crushed brick which is one of the major components of construction waste was seldom involved. Based on the joint use of recycled concrete aggregate (hereinafter referred to as "RCA") recycled brick aggregate (hereinafter referred to "RCBA"), recycled road materials had been prepared to back for the actual project. And studying its strength properties and Conversion Relations among its mechanical properties and through a complex analysis, the distribution of strength properties of recycled road material will be studied.

2. Study on characteristics of recycled aggregate

In accordance with the relevant norms or standards, the studies of performances were done to aim at the two types of RCA, RCBA (m crushed brick: m waste concrete = 1:1). Experiment results are given in Table 1 below.

Table1 Performance parameters of recycled aggregate

Fig.1. Curve of performance of recycled aggregate and its size and original concrete strength

As show in figures 1(a), 1(b), 1(c) and 1(d), they can be concluded that:

(1) To some extent, wear value of recycled aggregate can reflects the relative content of the old cement. It can be seen from table 1, about 1/3 old cement mortar exists in RCA. Akash Rao, etc (2006) found that RCA had about 30%old cement mortar in weight. This research result much closed to this article's. The strength of cement mortar is little lower than aggregate's. From this point, the strength of recycled aggregates should lower than natural aggregates'.

(2)Results indicate that the crushing value of recycled coarse aggregate decreased as the strength of original concrete increased (fig.1 (a)). With the original concrete strength increased, the quality of recycled aggregate is better.

(3) As a result of the erosion of rain or wet weather, construction wastes often contain substantial moisture with long-term piled up. Recycled aggregate prepared from construction wastes also contain some moisture in the stacking process, which would impact optimum moisture content of mixture and water consumption of recycled road materials. Thus, it is necessary to test moisture content of recycled aggregate. As can be seen from table 1, moisture content of RCBA is slightly higher than RCA's, it mainly due to the more pores in the internal of crushed brick, which pay the role of natural "reservoir" in humid environment.

(4) Aggregate size itself and gradation of original concrete combined effect the water absorption of recycled concrete coarse aggregate of (Figure 1(b)). Under circumstances of the same aggregate size, water absorption of RCBA higher than RCA's, it mainly due to its incompact structure, the strength is lower than RCA's. The grade of original concrete used in construction is generally lower than C30, in the intensity levels; the water absorption of recycled aggregate is generally high and shows an uncertain regularity.

(5) (i) Apparent density of coarse aggregate is greater than the apparent density of fine aggregate; (ii) Apparent density of RCA is higher than the apparent density of RCBA. The apparent density of recycled aggregate has business with original concrete strength and aggregate size. As can be seen from Figure 1c, the apparent density of recycled aggregate increased as the aggregate and the strength of original concrete size increased.

(6)As show in table 1, mud content of recycled coarse aggregate much larger than natural coarse aggregate's. According to the recent study, mud content of recycled coarse aggregate decreased as the strength of original concrete increased (Figure 1d). It is worth noting that the mud particles in the old cement mortar is different from those which contained in natural coarse aggregate, which have certain activity to participate in hydration (J.M.Khatib,2005).

3. Mechanical properties of recycled road material

The main materials used in this research were construction wastes generated from the building removal in Kunming city, China. After crushing, screening process, construction wastes were prepared into two types of recycled aggregate (performance parameters in Table 1), that is, RCA, RCBA (m crushed brick: m waste concrete = 1:1). The main use way is given in table 2 below.

Table2Use table of recycled aggregate

3.1 Optimum gradation

(1)Optimum gradation of recycled Subgrade material: $m_{37.5-53mm}:m_{19-37.5mm}:m_{4.75-19mm}:m_{<4.75mm}=2:3:1:4$;

(2)Optimum gradation of recycled Subbase material: $m_{19-37.5mm}:m_{4.75-19mm}:m_{<4.75mm}=4:3:3$;

(3)Optimum gradation of recycled Base material: $m_{19-31.5mm}:m_{4.75-19mm}:m_{<4.75mm}=4:3:3$.

3.2 Compaction characteristics of mixture of recycled aggregate

Dosing 4% cement dosage, Compaction Tests were made in use of RCA and RCBA according with Gradation designed in §2.1. Through parallel experiment, the test result is shown in fig.2, fig.3.

Fig.2 Moisture content - dry density curve of recycled Subgrade material

Fig.3 Moisture content - dry density curve of recycled base material

As shown in fig.3, the maximum dry density of recycled base materials is $1.99g/cm^3$, and the optimum water content is 8.7%; the maximum dry density of recycled base materials is $2.11g/cm^3$, and the optimum water content is 8.1%. With the content of crushed increased, the value of maximum dry density and maximum dry density of mixture become smaller. Therefore, the maximum dry density and optimum water content of Cement Stabilized Recycled Aggregate mixture are related to the water absorption of aggregate, the greater the water absorption of aggregate, the greater of the

maximum dry density and optimum water content of cement stabilized recycled aggregate mixture.

3.3 Influence factors research and comparative analysis of compressive strength

As shown from fig.4, there was a good linear regression relationship between the unconfined compressive strength of Cement stabilized recycled aggregate in 7d, 28d age, the Regression Equation is shown in table 3.

Fig.4 Linear regression trend intensity growth of recycled road materials

Table3 Regression relationship between compressive strength and cement dose

As shown in fig.4, with the cement dosage increased, unconfined compressive strength in both 7d and 28d age has a tendency to increase, and for recycled road materials prepared by RCBA, the growth trend of compressive strength in 28d age greater than 7d age's; but for recycled road materials prepared by RCBA, the growth trend of compressive strength was basically identical. This may be because high porosity in crushed brick and hydration of unhydrated cement in recycled fine aggregate.

3.4 Influence factors research and comparative analysis of rebound modulus

As shown from fig.5, there was a good linear regression relationship between the resilient modulus of Cement stabilized recycled aggregate in 7d, 28d age, the Regression Equation is shown in table 4.

Fig.5 Linear regression trend resilient modulus growth of recycled road materials

Table4 Regression relationship between rebound modulus and cement dose

As shown from fig.5, in the research scope of age and cement dose, with the cement dose increased, either Cement Stabilized RCA or Cement Stabilized RCBA, the growth trend of rebound modulus is similar to compressive strength's, that is completely in conformity with the Features of cement-stabilized materials.

3.5 Influence factors research and comparative analysis of splitting strength

The test results of splitting Strength in 7d and 28d age can be seen from fig.6.

Fig.6. The growth trend of recycled road materials

As shown from fig.6, in the research scope of age and cement dose, with the cement dose increased, either Cement Stabilized RCA or Cement Stabilized RCBA, the rebound modulus increases linearly (the regression equation can be seen from table 5), and the growth trend is similar to compressive strength's and rebound modulus', this results confirm the correctness of this three experiments.

Table5 Regression relationship between splitting strength and cement dose

Founded in the experiment, regression relationship between the splitting strength and ages is Suitable for power function regression, the Regression Equation is shown in table 6.

Table6 Regression relationship between splitting strength and age

4. Complexity analysis of unconfined compressive strength

As shown in figure 7, test-point spread from 2 to 10 MP, every strength value in 60 Specimens is different, showing a state of maximum complexity. The statistical analysis of test results can be seen from Table 7, Statistics interval is MP, and statistical frequency is 60. We can see from Figure 8, in the Interval of test results, compressive strengths are in line with the laws of Extreme Value Distribution.

Fig.7 Scattergram of unconfined compression strength test

Table7 Reset of statistical analysis

Fig.8 Extreme value distribution of unconfined compression strength test

According to the most complicated principle, normal distribution expression is derived as follow:

$$C = - \int N f(x) \ln f(x) dx \quad \dots \quad \dots \dots \dots \dots \dots (1)$$

Thinking average value of variable is limited, then:

$$u = \int_a^b xf(x)dx \dots\dots\dots (2)$$

Integral of the percentage of every strength value of specimens in overall specimens' strength specimens is 1, that is:

$$1 = \int_a^b f(x) dx \dots \dots \dots (3)$$

The Conditions of shape functions is:

$$1 = \int_a^b \exp\left(-\frac{x}{\beta}\right) f(x) dx \dots\dots\dots (4)$$

Constructing new function F :

$$F = -\int f(x) \ln f(x) dx + k_1 \left(\int x f(x) dx - u \right) + k_2 \left(\int f(x) dx - 1 \right) + k_3 \left[\exp \left(-\frac{x}{\beta} \right) \int f(x) dx - 1 \right] \dots \dots \dots (5)$$

Where, k_1, k_2, k_3 are undetermined coefficient.

$$\frac{\partial F}{\partial f} = \frac{\partial \int f(x) \ln f(x) dx}{\partial f} + k_1 \frac{\partial \left(\int x f(x) dx - u \right)}{\partial f} + k_2 \frac{\partial \left(\int f(x) dx - 1 \right)}{\partial f} + k_3 \frac{\partial \left[\int \exp\left(-\frac{x}{\beta}\right) f(x) dx - 1 \right]}{\partial f} = 0 \quad \dots (6)$$

The new function F is the compound of complex degree expression and all constraint conditions. It is clear that when F Reaching the Maximum, so is the complex degree C . F is functional of unknown function f , f can be obtained through Partial derivative of F on f , and makes it equal to zero, that is:

$$-(\ln f(x)+1)+k_1x+k_2+k_3\exp\left(-\frac{x}{\beta}\right)=0 \dots\dots\dots (7)$$

$$\ln f(x) = (k_2 - 1) + k_1 x + k_3 \exp\left(-\frac{x}{\beta}\right) \dots \dots \dots (8)$$

$$f(x) = K \exp \left[k_1 x + k_3 \exp \left(-\frac{x}{\beta} \right) \right] \dots\dots\dots (9)$$

Where, $K=k_2-1$. Simultaneous equations (9) and (1)-(3), coefficient k_1, k_2, k_3 can be determined, and The ultimate expression can be obtained as follow:

$$f(x) = \frac{1}{0.1\beta} \exp \left[-\frac{x}{\beta} - \exp \left(-\frac{x}{\beta} \right) \right] \dots\dots\dots (10)$$

If the distance from extreme peak to 0 is α , then, placing variables $x-\beta$. Then:

$$f(x) = \frac{1}{0.1\beta} \exp\left[-\frac{x-a}{\beta} - \exp\left(-\frac{x-a}{\beta}\right)\right] \dots\dots\dots (11)$$

Combining with the Characteristics of recycled aggregate, α , β can be obtained by curve fitting, that is $\alpha=49.13$, $\beta=10.57$. Then:

$$f(x) = \frac{1}{1.06} \exp \left[-\frac{x-49.13}{10.6} - \exp \left(-\frac{x-49.13}{10.6} \right) \right] \dots\dots\dots (12)$$

Extreme value distribution is a skewed distribution, content of crushed brick are taken into account in the data analysis. All test pieces of recycled concrete aggregate strength concentrated in the extreme value distribution of the peak, the intensity value of its 5 MP, statistical probability of 0.367; 4 ~ 6MP in the test block of the statistical probability of 0.7 intensity; the remaining strength of test block, although more than 6 MP belonging to extreme value distribution but the right side of the tail, statistical probability of only 0.2. Therefore, it can be concluded that the path of renewable materials unconfined compressive strength value of 4 ~ 6 MP mainly, of which nearly 5 MP test the strength of the most representative pieces.

5. Correlation analysis of compression-splitting index

In order to find the inherent relationship among the strength indexes of recycled road materials for calculating indirectly other mechanical indicators after obtaining one index which more easily measured. From the comparative analysis of three strength indexes got from a lot of test, the paper found that good correlation exist among the three strength indexes regardless of ratio of mixture and length of curing age(as shown in fig.9). And the correlation can be analyzed in linear regression.

Fig.9 Regression relationship between compressive strength and modulus rebound, spilt intensity

The relational expression of compression rebound Modulus (E0) and compressive strength (Rc) is as follow:

$$E_o = 539.94 + 374.93R_c \text{ (Correlation coefficient: } r=0.9507) \dots (13)$$

The relational expression of splitting strength (σ_{sp}) and compressive strength (Rc) is as follow:

$$\sigma_{sp} = -0.042 + 0.104R_c \text{ (correlation coefficient: } r=0.9478) \dots\dots\dots (14)$$

For RCBA, splitting strength in 90d age / compressive strength in 7d age is in a ratio of 0.14-0.22, the average ratio is 0.19, Standard deviation is 0.03. Considering the probability of 90%, comes to the formula as follow:

$$\text{RCBA: } \sigma_{sp90} = 0.17R_{c7} \dots\dots\dots (15)$$

For RCA, splitting strength in 90d age / compressive strength in 7d age is in a ratio of 0.17-0.24, the average ratio is 0.21, Standard deviation is 0.04. Considering the probability of 90%, comes to the formula as follow:

$$\text{RCA: } \sigma_{sp90} = 0.20R_{c7} \dots\dots\dots (16)$$

Through relationship above, splitting strength in 90d age can be calculated from compressive strength value in 7d age, which can reach the purpose of shortening test cycle and accelerating the design progress.

6. Conclusions

The performances of recycled aggregate and those influencing factors were studied systematically in this paper. And the author has studied the affection of performances of recycled aggregate to road materials. Through the complexity analysis of compressive strength, the paper holds that compressive strength of recycled road materials based mainly on 4-6 Mp. According to the study, regression relationship between the unconfined compressive strength, rebound modulus and cement dose is suitable for linear regression; splitting strength and ages is suitable for power function regression. Having given a correlation analysis for compression-splitting index, Good Relevance correlation are existed among resilient modulus, compressive strength and splitting strength: $\sigma_{sp90} = 0.17R_{c7}$, $\text{RCA: } \sigma_{sp90} = 0.20R_{c7}$, which reached the purpose of shortening test cycle and accelerating the design progress. For the further study, I personally think that the main research work can be carried out from the following three aspects:

- (1) Shrinkage properties of recycled base material are worth further studying, for founding the effective measures to control them.
- (2) Study thoroughly the affection of internal pore distribution of concrete on strength of recycled concrete, durability and other properties.
- (3) Exploring the fracture model of this kind of materials for the practical use of recycled research.

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List of table captions

Table 1. Performance parameters of recycled aggregate

<i>Name</i>		<i>wear value</i>	<i>crushing value</i>	<i>moisture content</i>	<i>water absorption</i>	<i>apparent density</i>	<i>mud content</i>
RCA	CA	34.39%	17.12%	4.07%	6.46%	2420 kg/m ³	5.8%
	FA	/	/	/	9.22%	2090 kg/m ³	/
	Water absorption of this gradation: 7.29%						
RCBA	CA	48.56%	24.55%	4.15	9.02%	2390 kg/m ³	/
	FA	/	/	/	10.72%	2010 kg/m ³	/
	Water absorption of this gradation: 9.70%						
NA	CA	18.8%	9.6%	/	3.6%	2630 kg/m ³	1.4%
	FA	/	/	/	7.6%	2620 kg/m ³	/

Table 2. Use table of recycled aggregate

<i>Subgrade material</i>	<i>Subbase material</i>	<i>Base material</i>
RCBA	RCA	RCA(Down) *NA(Up)

Note: "*" indicates that the project is not the content of this experimental study

Table 3. Regression relationship between compressive strength and cement dose

<i>Regression Equation: $y=a+bx$</i>	<i>RCBA</i>		<i>RCA</i>	
	7d	28d	7d	28d
a	0.096	0.164	0.720	0.545
b	0.857	1.138	0.840	1.321
s	0.155	0.223	0.126	0.173
r	0.9977	0.9973	0.9955	0.9791

Note: y—compressive strength(Mp); x—cement dose(%)

Table 4. Regression relationship between rebound modulus and cement dose

<i>Regression Equation: $y=a+bx$</i>	<i>RCBA</i>		<i>RCA</i>	
	7d	28d	7d	28d
a	125.857	175.030	41.464	117.404
b	414.501	495.447	529.088	636.243
s	175.957	240.207	64.927	161.146
r	0.9875	0.9896	0.9989	0.9955

Note: y—rebound modulus (Mp); x—cement dose (%)

Table 5. Regression relationship between splitting strength and cement dose

Regression Equation: $y=a+bx$	RCBA			RCA		
	7d	28d	90d	7d	28d	90d
a	-0.016	0.004	-0.274	-0.009	-0.058	-0.227
b	8.016	11.387	23.143	8.312	14.037	26.451
r	0.9984	0.9935	0.9981	0.9849	0.9934	0.9914

Note: y—splitting strength (Mp); x—cement dose (%)

Table 6. Regression relationship between splitting strength and age

Regression Equation: $y=ax^b$	RCBA				RCA			
	3%	4%	5%	6%	3%	4%	5%	6%
a	0.135	0.154	0.214	0.264	0.139	0.145	0.195	0.261
b	0.268	0.335	0.301	0.294	0.299	0.372	0.367	0.347
r	0.9712	0.9923	0.9961	0.9556	0.9945	0.9857	0.9702	0.9934

Note: y—splitting strength (Mp); x—age (d)

Table 7. Reset of statistical analysis

Compression strength(Mp)	Frequency	Statistical probability
2	1	0.0167
3	2	0.0333
4	10	0.1667
5	22	0.3667
6	10	0.1667
7	6	0.1
8	3	0.05
9	3	0.05
10	3	0.05

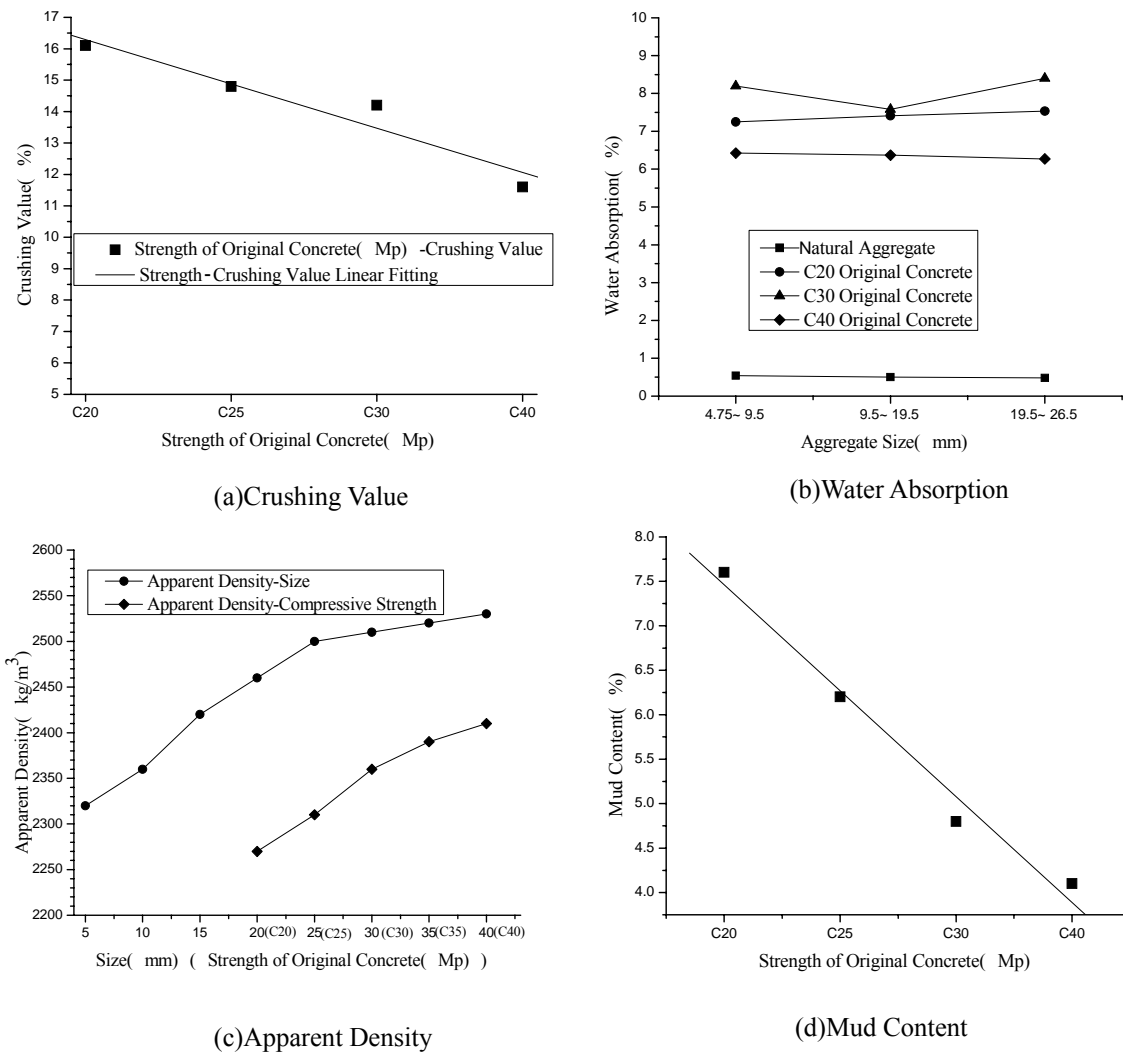


Figure 1. Curve of performance of recycled aggregate and its size and original concrete strength

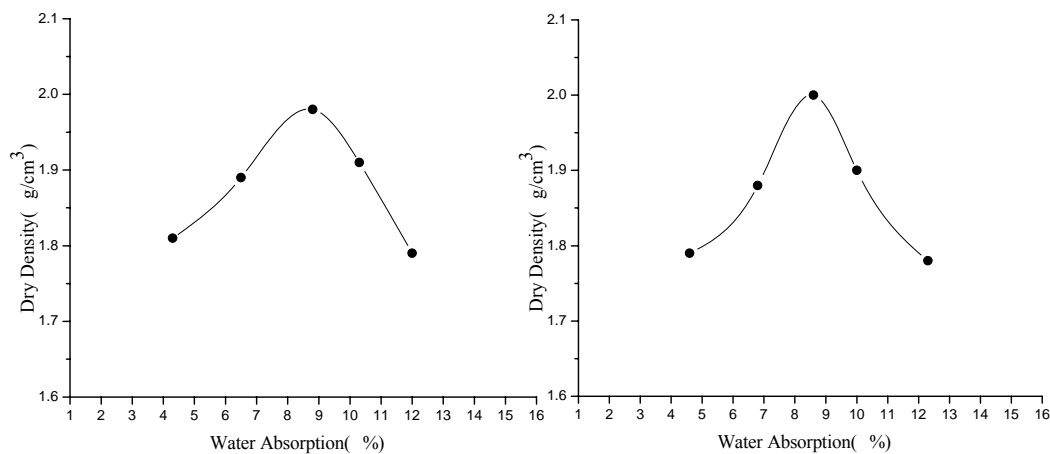


Figure 2. Moisture content - dry density curve of recycled Subgrade material

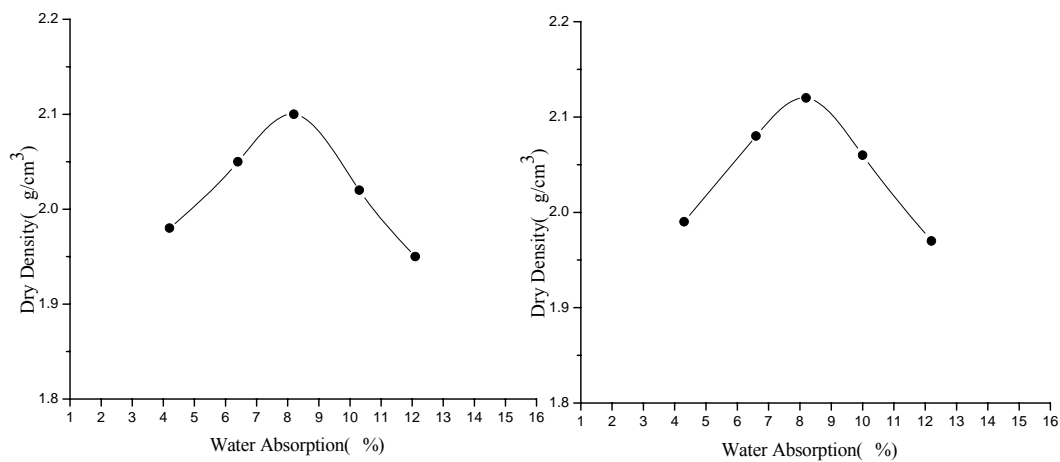
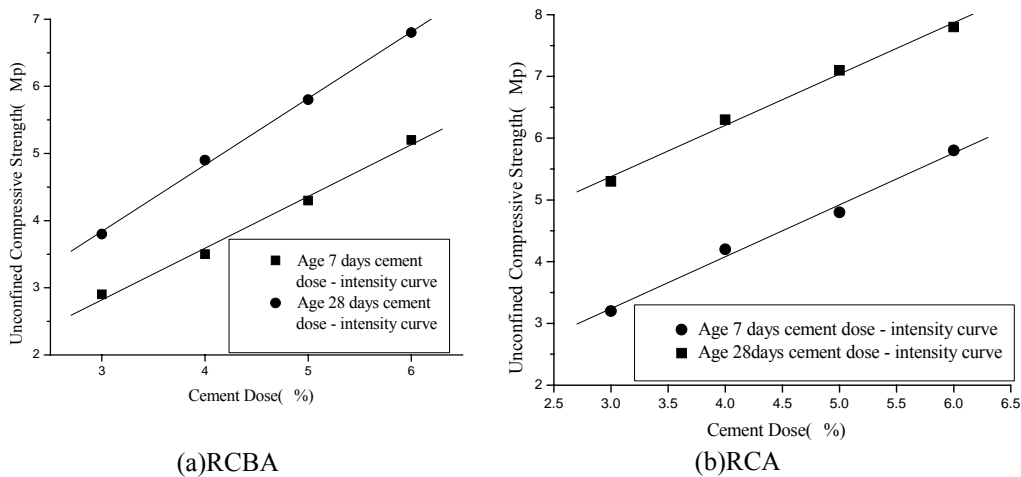


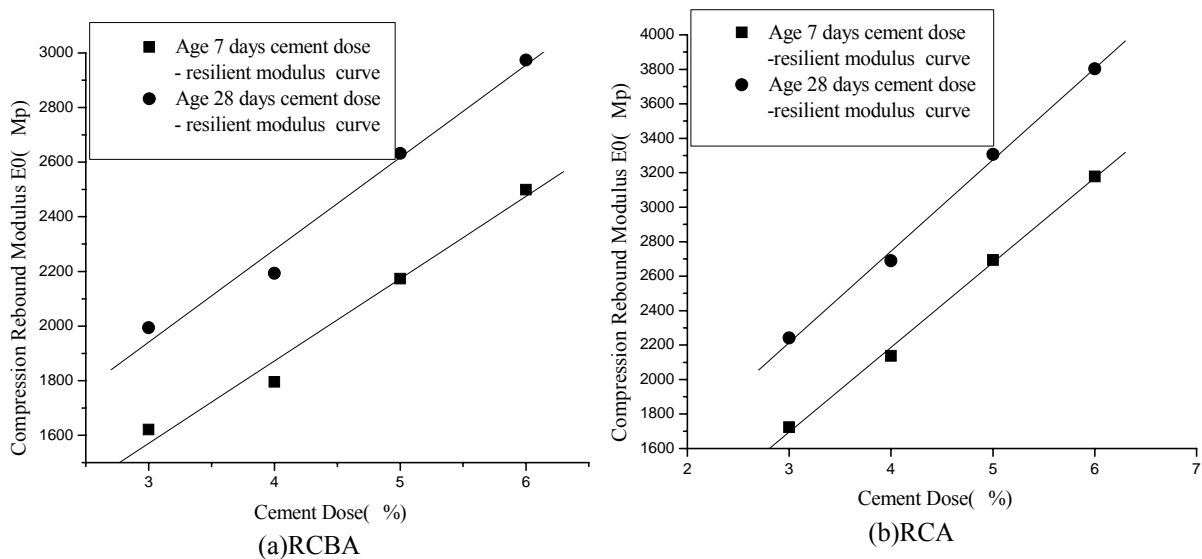
Figure 3. Moisture content - dry density curve of recycled base material



(a)RCBA

(b)RCA

Figure 4. Linear regression trend intensity growth of recycled road materials



(a)RCBA

(b)RCA

Figure 5. Linear regression trend resilient modulus growth of recycled road materials

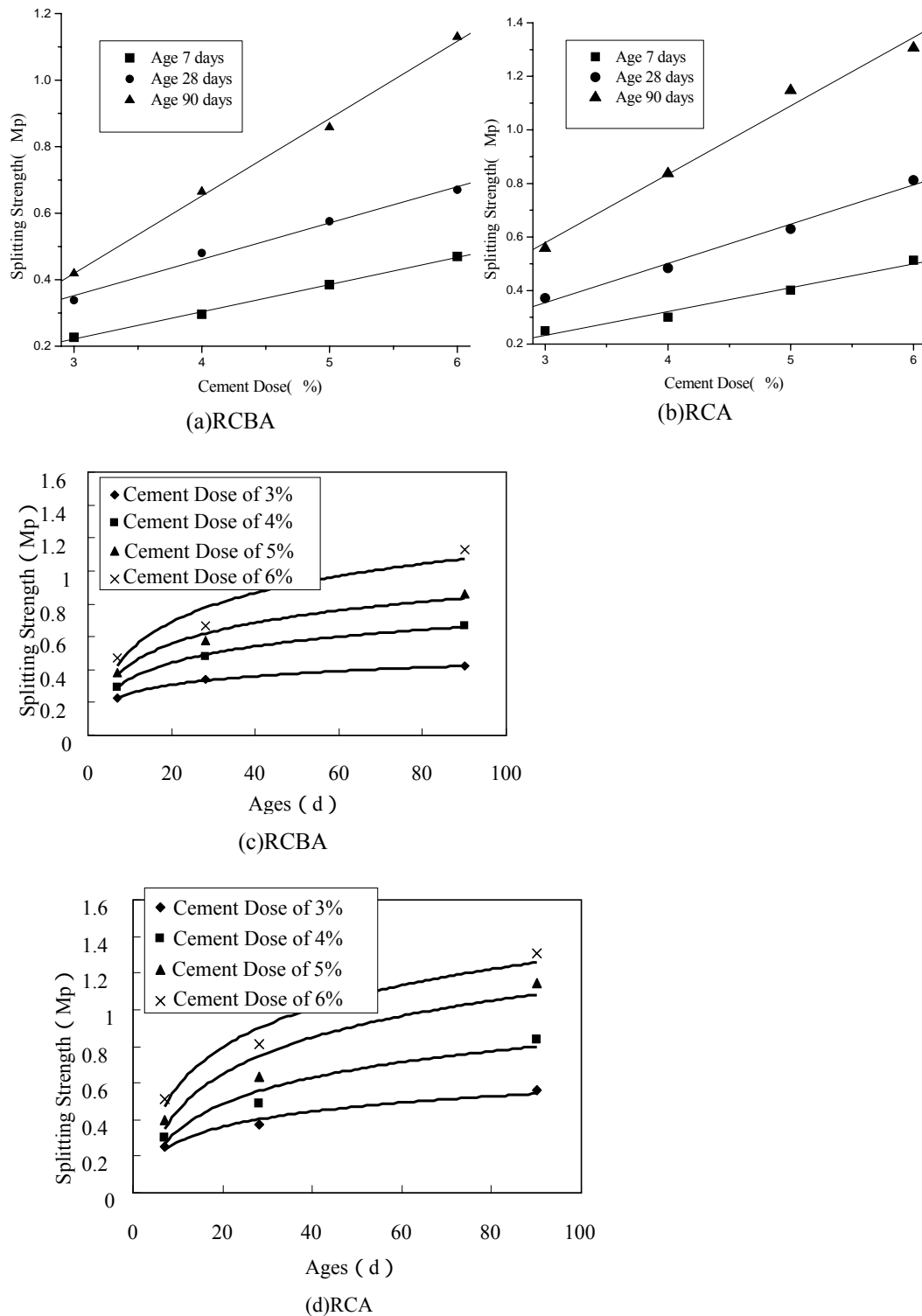


Figure 6. The growth trend of recycled road materials

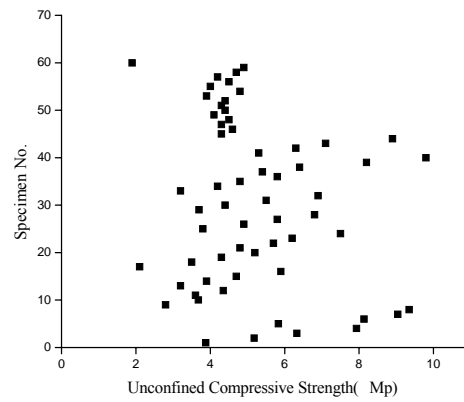


Figure 7. Scattergram of unconfined compression strength test

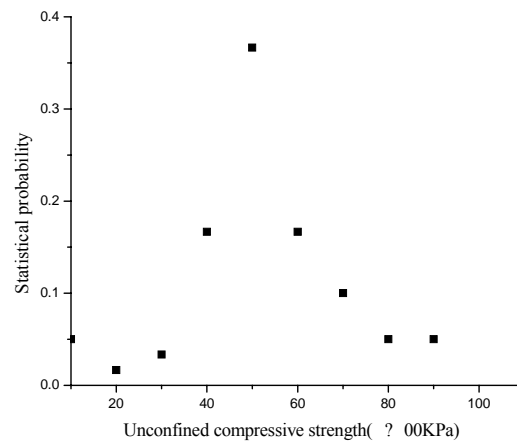


Figure 8. Extreme value distribution of unconfined compression strength test

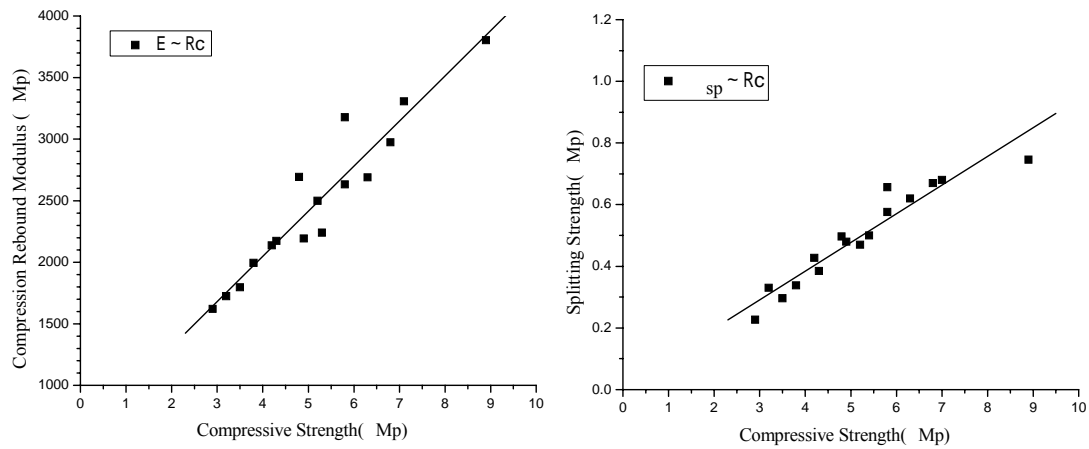


Figure 9. Regression relationship between compressive strength and modulus rebound, split intensity



Financial and Economic Analyses of Conventional and Reduced Impact Harvesting Systems

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Abstract

This paper examines the various committed new technology and improve logging activities ascribed in the 'Logfisher' Practice (LP) rather than Conventional Practice (CP). The result of cost analysis shows that the cost constitutes under LP is higher than under CP. Incremental average per ha total cost rose by 46.86% to RM13,576/ha. While the incremental average per m³ total cost increased by 57.41% to RM267.80/m³. Hence, CP was slightly more profitable and exceeds the Net Present Value (NPV) of LP. Similarly, the Benefit-Cost Ratio (BCR) for CP is better than LP. On the other hand, the result of the economic analysis of 40-year period showed that the LP system (NPV = RM9302/ha) provided a higher level of overalls benefits and welfare to the society as a whole as opposed to CP (NPV = RM8497/ha).

Keywords: Logfisher Practice (LP), Conventional Practice (CP), 'Logfisher', Net Present Value (NPV)

1. Introduction

In Peninsular Malaysia, the Dipterocarp Forest of the production forest of the Permanent Forest Estate (PFE) is managed through two management systems, which are the Modified Malayan Uniform System (55-year cutting cycle) and the Selective Management System (30-year cutting cycle). In brief, the Modified Malayan Uniform System consists of removing the mature crop in one single felling of all trees down to 45 cm diameter at breast height (dbh) for all species while the Selective Management System (SMS) entails the selection of optimum management (felling) regimes based on pre-felling forest inventory data. Forest harvesting in the inland forest in Malaysia is generally carried out by a combination of crawler tractor-winch lorry. Under this harvesting system the crawler tractor skids the logs from the felling sites to the skid trails where the winch lorry continues the transportation to the roadside landings. In Malaysia, the skidder generally does not pick up its load from the felling site because of adverse soil and terrain conditions. In the early nineties, reduced impact logging (ground skidding) was being carried out in some forest areas in Peninsular Malaysia and in the state of Sabah, while low impact logging (helicopter logging) was being carried out in the state of Sarawak (Gan *et al.*, 2006).

The recent technology which is called "Logfisher" has been developed. It was mainly deployed to retrieve logs from rocky and deep narrow ravine which was deemed uneconomical, difficult and dangerous for the crawler tractor to

undertake. It was gravely introduced as a commercial and viable alternative to other reduced and low impact technologies like Skyline, Mobile Tower Yarder, and Helicopter in the middle of 1999. According to Gan *et al.* (2006), the New Ground Base Reduced-Impact Logging (NGB RIL) System, featuring a combination of crawler tractor and 'Logfisher' became fully operational in July 1999 in Block C, Compartment 54, Jengai Forest Reserve in the state of Terengganu, Peninsular Malaysia. The site was provided by Kumpulan Pengurusan Kayu-Kayan Terengganu, the largest forest concessionaire in Peninsular Malaysia. Prior to the harvesting operation, planning for the implementation of the system was conducted earlier after careful study and field planning to include marking of trees to be felled and simple tree location mapping.

Availability of more appropriate harvesting cost data can help nations in the planning of the implementation of forest management activities. The knowledge and awareness on the area will influence actions that have potential impacts on financial and economic viability. The purpose of this paper is to present financial and economic costs that incurred in new logging system activities.

2. Literature Review

2.1 Financial and Economic Cost of Logging Operation

Past studies on logging cost in Malaysia indicated that the average logging cost range from RM117.02/m³ to RM284.93/m³ (Ahmad Fauzi *et al.*, 2002; Mohd Shahwahid *et al.*, 1999; Awang Noor & Mohd Shahwahid, 1997; Lehuji, 2003; Badrul Hisham, 2001; Awang Noor *et al.*, 2007). A study by Mohd Shahwahid *et al.* (1999) indicated that the average fixed cost constitutes about 83% of the total logging cost which is RM237.67/m³. However, it was found that the component of fixed cost in logging operation is relatively lower compared to variable cost component that constitute about 46% of RM56.98/m³ of the total logging cost (Badrul Hisham, 2004). In addition, recent studied by Awang Noor *et al.* (2007) found that the mean total logging cost in Pahang was estimated at RM204.65/m³, in which, the fixed cost and the average variable cost comprised at about 53.1% (RM108.63/m³) and 46.9% (RM96.01/m³) respectively. The divergent of fixed and variable cost of logging operation reflects different logging operation, government policy and other factors.

In economic language, the relevant measure is now Total Economic Valuation (TEV) from the different possible land uses. TEV comprises use and non-use values and both are capable of expression in monetary terms by estimating the relevant willingness to pay (WTP) for those function (McNally and Mohd Shahwahid, 2003). The basic argument is that, even if Reduced Impact Logging (RIL) is 'worse' than Conventional Logging (CL) in financial terms, if the WTP for the incremental non-timber benefits of RIL exceeds the financial deficit, RIL will be preferred from a national perspective. For example Dagang *et al.* (2005) carried out the financial and economics analyses in RIL system by incorporating with several advantages which namely discount rate, harvesting cost, logging intensity of the first harvest, certification premium and carbon transfer payment through sensitivity analysis. At the financial analysis, CL is typically more profitable than RIL but at economic analysis followed by analysing the sensitivity analysis, they found that the RIL system is more profitable and the Net Present Value (NPV) is greater than CL.

2.2 'Logfisher' Practices in RIL Implementation

The 'Logfisher' system employs a technique of log extraction which combines the function of winching and lifting, performed by a single machine (Gan *et al.*, 2006). The 'Logfisher' actually embodies the body of an excavator and basic structure of a crane. In the winching operation, a cable rope with a total length of 300 meters is pulled out from the drum and dragged to the respective trees which have been felled in the forest. The open end of the cable rope is then tied and hooked on the felled log.

Gan *et al.* (2006) has mentioned about the various functions of the crawler tractor in the current conventional and modified ground based RIL in Table 1. Altogether e functions are identified in the conventional system involving 4 processes and over 4 sites. The 4 processes consists of clearing, leveling and cutting of earth; clearing, cutting and blading of earth; winching logs from the forest and skidding to log landing. Meanwhile the four sites are namely; skid trial, log landing, feeder road and main road. In comparison, Table 2 highlights the functions of the crawler tractor and 'Logfisher' in the NGB RIL combining both machines. In this new system, under the 4 similar processes (from process 1 to 4), the crawler tractor functions have been reduced to 4 as compared to the original 8 functions in the current conventional and modified ground based RIL. The 'Logfisher' needs only to conduct one function and an optional two processes involving 4 additional functions are not possible with the current systems using only crawler tractors. Therefore the new system provides a better and more specific distribution of functions best suited to the individual machines in terms of minimal impacts to the environment. The residual stands are best suited in the implementation of RIL. The working sites in the new system have also being reduced from 4 to 3. Thus further minimising the forest areas to be opened or damaged. The particular site that has become obsolete is the one involves in the construction of skid trials, which apparently is considered as one of the most destructive activities in the current conventional, and modified ground based RIL system.

3. Methodology

3.1 Costs account

The analysis will focus on the costs to be incurred with and without compliance to 'Logfisher' activities. The conceptual framework for obtaining the incremental or additional cost of conducting each of the harvesting activities when implementing the 'Logfisher' is shown in Figure 1. Each of these activities occurs within the license time periods. The costs of these activities were compounded to the year harvesting conducted in 2007 as the reference base period.

The combined system is termed as the NGB RIL System and requires only minor adjustment to the current conventional and modified ground based system which utilises only crawler tractor to extract logs from the forest. In the NGB RIL, the crawler tractor undertakes all the previous planned functions involving construction and skidding of logs to temporary log landings. However, log extraction using this system is limited to areas not more than 30-50 meters from the planned roads, beyond which will be carried out by the 'Logfisher'.

This system makes planning much easier and less time consuming by removing the need to plan, mark, measure, map, construct and rehabilitate the extensive network of skid trails associated with the conventional and modified crawler tractor RIL System. The NGB RIL system has been effectively and consistently applied since 1999, incorporating the application of RIL planning procedures and processes in road alignment and construction, marking and mapping of trees to be felled and protected trees, directional felling, marking and mapping of protected areas and buffers in the preparation of a comprehensive harvesting plan.

Cost-benefit analysis was used by two categories. First, the financial analysis was conducted from an enterprise perspective and dealt with actual cash flows. Only traded good and services were considered and valued by applying market prices. Second, the economic analysis was conducted from society perspective. It considered traded and non-traded costs and benefits. Shadow pricing was used to adjust financial costs and benefits to reflect their economic values.

3.2 Economic Indicators and Sensitivity Analysis

The economic indicators selected were the net present value (NPV) and the benefit-cost ratio (BCR). A sensitivity analysis was carried out to estimate how changes in key technical and economic parameters would alter the economic performance of the two harvesting systems. The parameters that would probably be considered such as discount rate, timber price, carbon credit, harvesting cost and harvesting volume are adopted from Dagang *et al.* (2005).

3.3 Data Collection

The data for this case study were collected from primary sources. They were provided by the concessionaire from Compartment 220, Sungai Betis Forest Reserve, Gua Musang, Kelantan which under RIL using 'Logfisher' Practice (LP) and in Compartment 109, Nenggiri, Gua Musang, Kelantan which under Conventional Practice (CP). Several types of questionnaires were designed according to the needs for capturing the specific information under this case study. In certain cases, the loggers were also interviewed in seeking for further clarification of data given.

Timber harvesting was conducted using two systems: the LP in a 90-ha research plot and the CP which was conducted in a 100-ha. Table 3 shows the basic characteristics of the study sites. Total timber productions from the LP and CP plots were 4560 m³ and 5430 m³ respectively. Theoretically, both plots were bound by the Selective Method System (SMS). Hence, buffer areas along rivers and steep slopes were marked and protected from harvesting. Thus, the timber volumes not harvested in both the LP and CP plots were 101 m³ and 103 m³ respectively.

For the sensitivity analysis, this study will use the cost of tropical forestry carbon offsets with range about US\$2-10 per ton of carbon, averaging about US\$8 by Stuart & Costa (1998). In order to account for different economic non-timber forest products (NTFPs) values and biodiversity values under different forest management options, a percentage-based valuation was applied from Sander (2000). For the recreational values, it was assumed that the net operable areas managed under CL have no recreational value. The recreational value on non-production areas was set at RM19 ha/year (Pearce *et al.*, 1999).

4. Results and Discussion

Table 4 provides for the present value per hectare cost of harvesting activities conducted at Compartment 220 and 109 under LP and CP options respectively. The overall harvesting present value per hectare costs were RM13,576/ha under LP and RM9,244/ha under CP. This table focuses on distribution of the cost among the pre-felling, felling proper, additional timber harvester activities, and foregone timber revenues.

Additional machine was required to operate the LP activities that are called 'Logfisher'. This took up a big proportion of the total cost. The pre-felling activities comprise of pre-felling inventory of commercial timber trees, compartment boundary demarcation, proposed road alignment, tree tagging and road planning. The cost of pre-felling activities was higher under the CP option (7.24%) than that under LP option (4.95%). Tree tagging is usually conducted by a team of

contract workers who are supervised by a field staff from the Forestry Department and normally the rate charged is RM3/tree tagged.

The felling activities constitute road construction, felling & bucking, skidding, log loading, short distance haulage, log yard administration, 'Logfisher' premium and royalty and cess. In aggregate, these activities dominated the total harvesting cost under both forest management options taking up 66.07% under LP and 83.15% under CP. Payments for premiums and royalty and cess charges, skidding and administration which includes margin of profit for the contractor were the major cost elements. Cost of road construction was low under CP (14.83%) but high under LP (30.51%) owing to the need to follow road specification. This had caused the need for additional rental of 'Logfisher' and longer work time to abide to the more rigid road specification listed in the RIL technique.

This specification considers environmental impacts by minimizing movements of heavy equipment in the stand, minimizing the construction of non-permanent feeder roads and cable log trails without soil protection structures, optimizing the lay-out of feeder road and cable log trails, and properly compact and shape road camber. The use of excavator rather than bulldozer in the road formation cut is to reduce unnecessary road corridors and to prevent excessive blading of the soil. In the LP area, the road density was quite high at 60m/ha but the advantage of this practice was there is no need for skid trails. On the other hand, in the CP area, the road density was only within the 40m/ha but there is skid trails at 300m/ha (refer Table 3).

The above elements alluded on direct financial transaction costs. The licensee, contractors and harvesting crews incurred opportunity cost from unearned timber income from buffer areas. The average production cost only rose by 9.35% to RM14,975/ha when the foregone timber revenue from buffer areas were included in the LP option. Conversely, the average production cost increased by 13.96% to RM10,744/ha with the inclusion of these foregone revenues in the CP option. The opportunity cost is computed as potential gross revenue net of direct cost of extraction. These foregone revenues comprised of foregone timber revenue incurred by the licensee and loss of royalty charges not collected by the Government.

Table 5 shows the harvesting cost on per cubic meter basis. Similar trends were observed as on a per hectare basis. This information is useful as the timber harvesting industry is more familiar in measuring financial viability in terms of per volume units. The costs of harvesting were RM295.44/m³ and RM197.76/m³ under LP and CP options respectively.

It was observed that the per hectare present value costs of harvesting activities were consistently higher under LP than CP option mainly due to greater expenditures on improved activities. The incremental proportions of the cost among the various activities were more varied particularly in road construction and 'Logfisher' machine. However, there is zero cost in skidding activity due to the absence of that activity in LP option. In aggregate, compliance to the LP led to an overall increase of RM4330.47/ha or 46.88% and RM97.67/m³ or 57.41% (Table 6).

The higher percentage of increase in terms of per cubic meter under LP option in comparison to the CP option is due to the lower timber yield productivity that raised the average cost. Among the various activities, the increase was only 0.92% or RM1/ha in pre-felling activities; 82.08% or RM1459.37/ha in felling activities and RM3045.33/ha in additional machine of 'Logfisher' (Table 6). The activities with significant incremental costs were road construction and 'Logfisher' machine.

This analysis indicates that complying to the LP for RIL technique lead to an additional cost. The additional cost of shifting from one harvesting practice to another is a burden to the company. The incidence of this burden has been computed in this paper. Consideration of compensation may have to be addressed explicitly to encourage compliance if improved conservation and sustainability of the forest is to be achieved. Instruments of financing these compensations have to be determined.

LP in RIL implementation is an essential element for sustainable forest management of the tropical forest. Therefore, ecological impacts of logging need to be mitigated using economically competitive technology. The context of LP in RIL system has been clearly demonstrated. Felling efficiency can be improved to enable significant reduction of environmental damage especially when there is no skidding activity during the operation. Despite these benefits, full adoption of RIL system in the context of LP in Peninsular Malaysia's forest concessions, still have not been widely accepted.

4.1 Financial Analysis

Table 7 indicates that the total profit of CP and LP is at RM49/m³ and -RM66/m³ respectively in a one-year period. At this point of time, the timber producers will loss because of higher cost and lower revenue in LP option compared to CP option. The lower revenue in LP option was due to the buffer areas and stringent criteria's implemented in their logging activities. For the financial analysis for 40-year period, the NPV and BCR indicate that both management options are profitable (Table 8). CP was slightly more profitable and exceeds the NPV of LP. Similarly, the BCR for CP exceeds the NPV of LP. This means that with regard to the private profitability preference which relies more on financial analysis, it implies CP is more robust.

4.2 Economic Analysis

The economic analysis of 40-year period showed that the LP system (NPV = RM9302/ha) provided a higher level of overall benefits and welfare to the society as a whole as opposed to CP (NPV = RM8497/ha). The result of the sensitivity analysis demonstrated that LP was more profitable than CP if;

- a) A discount rate of less than three percent is applied; or
- b) The harvesting costs are reduced by >30 percent; or
- c) The timber price increases by >15 percent; or
- d) A minimum of RM30/ha of annual carbon trading payments are generated.

The results demonstrate that the LP system is more profitable if the harvesting cost reduced by 10 percent and that the logging intensity during the first cut is increased by 20 percent. Assuming that the concessionaire receives additional revenue of RM15/ha/yr through carbon credit payments, the NPV under LP would increase to RM737, i.e. a 26% percent increase over the CP system.

5. Conclusions

This study has described the cost of logging in Kelantan and calculated the two different cost of logging methods namely 'Logfisher' and conventional logging. The results of the study shows that the cost constitutes under LP is higher than under CP. Incremental average per ha total cost rose by 46.8% to RM13,573/ha. While the incremental average per m³ total cost increased by 57.4% to RM267.80/m³. With the increasing fuel prices and other cost related to labour, the logging cost is expected to increase in the near future. This situation will have adverse effect on the profitability of the practice of sustainable forest management.

The sensitivity of the economic analysis indicates that in the long run, a slight reduction of the harvesting cost and other incentive systems such as price premium, carbon credit, overall benefits and welfare to the society as a whole can also help to facilitate the introduction of LP option. These findings are consistent with Dagang *et al.* (2005) which found that at the financial analysis, CL is typically more profitable than RIL but at economic analysis they found that the RIL system is more profitable. Hence the Malaysian Timber Council (MTC), Malaysian Timber Certification Council (MTCC) and International Tropical Timber Organisation (ITTO) have a role to play to promote such timber markets and non-timber markets among its consuming nation members.

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Table 1. The Crawler Tractor in the Current Conventional and Modified Ground Based RIL Logging System

Processes	Sites			
	Skid trail	Log landing	Feeder road	Main road
1. Clearing, leveling and cutting of earth	Crawler Tractor	Crawler Tractor	Crawler Tractor	Crawler Tractor
2. Clearing, cutting and blading of earth	Crawler Tractor	NIL	NIL	NIL
3. Winching logs from The forest	Crawler Tractor	NIL	NIL	NIL
4. Skidding to log Landing	Crawler Tractor	NIL	Crawler Tractor	NIL

Source: Gan *et al.* (2006)

Table 2. The Functions of Crawler Tractor and 'Logfisher' in the NGB RIL Logging System

Processes	Sites		
	Log landing	Feeder road	Main road
1. Clearing, leveling and Cutting of earth	Crawler Tractor	Crawler Tractor	Crawler Tractor
2. Clearing, cutting And blading of earth	NIL	NIL	NIL
3. Winching logs from the forest	NIL	NIL	NIL
4. Skidding to log Landing	NIL	Crawler Tractor	NIL
5. Construction of bridges and culverts	NIL	'Logfisher'	'Logfisher'
6. Stacking of logs along feeder road and log landing	'Logfisher'	'Logfisher'	NIL

Source: Gan *et al.* (2006)

Table 3. Summary of Study Sites

Options	'Logfisher' Practice (LP)	Conventional Practice (CP)
Area (ha)	90	100
Buffer and protected area (ha)	2	3
Net production area (ha)	88	97
Volume of harvest (m ³)	4560	5430
Volume of harvest per ha (m ³ /ha)	50.7	54.3
Volume of commercial timber not harvested from buffer area (m ³)	101	103
Road density (m/ha)	60	40
Skid trail(m/ha)	0	300

Table 4. Per Hectare Average Present Value Cost of Harvesting Activities

Activities	LP		CP	
	RM/ha	%	RM /ha	%
Pre-felling Pre-felling inventory of trees, boundary, road alignment, tree tagging and road planning.	670	4.95	669	7.24
Felling Road construction, felling & bucking, skidding, log loading, short distance haulage, log yard administration, royalty, cess and premium	8970	66.07	7639	83.15
'Logfisher'	3049	22.43	0	0
Others	890	6.56	936	10.11
Total	13576	100	9244	100
Foregone revenue from buffer areas	1400	9.35	1500	13.96
Grand total	14975	100	10744	100

Table 5. Average Total Cost of Harvesting Activities per Cubic Meter Timber Production

Activities	LP		CP	
	RM/m ³	%	RM/ m ³	%
Pre-felling Pre-felling inventory of trees, boundary, road alignment, tree tagging and road planning.	13.21	4.9	12.32	7.24
Felling Road construction, felling & bucking, skidding, log loading, short distance haulage, log yard administration, royalty, cess and premium	176.91	66.06	140.68	82.69
'Logfisher'	60.11	22.44	0	0
Others	17.57	6.56	17.23	10.12
Total	267.80	100	170.13	100
Foregone revenue from buffer areas	27.63	9.35	27.62	13.96
Grand total	295.44	100	197.76	100

Table 6. Average Changes in Cost by Compliance to New Logging System Activities

Activities	LP		LP	
	RM/ha	% increase	RM/ m ³	% increase
Pre-felling Pre-felling inventory of trees, boundary, road alignment, tree tagging and road planning.	1	0.15	0.89	7.22
Felling Road construction, felling & bucking, skidding, log loading, short distance haulage, log yard administration, royalty, cess and premium	1331	17.42	36.23	2.57
‘Logfisher’	3049	22.44	60.11	0
Others	(46)	(4.9)	0.34	1.97
Total	4332	46.86	97.67	57.41
Foregone revenue from buffer areas	(100)	(6.67)	0.01	0.03
Grand total	4231	39.38	97.68	49.39

Table 7. Cost and Revenue for Harvesting Systems in a One-year Period

Parameter	CP	LP
	[RM/m ³]	
Cost – harvesting	170	267
Revenue – timber	219	201
Total profit	49	(66)

Table 8. Indicators for Financial Analysis of Harvesting Systems*

NPV (RM)		BCR	
CP	LP	CP	LP
584	311	1.4	0.9

*Notes: Discount rate – 8%, calculation period – 40 years, production area = 1

Table 9. NPV of Harvesting Systems After Incorporating with RIL/LP Benefits

No.	Parameter	Unit	CP	LP
1	Discount rate	[%]	-	10(10)
2	Harvesting costs	[%]	-	-10
3	Price premium	[%]	-	10(10)
4	Carbon credit	[RM/ha/yr]	-	15(0)
5	Logging intensity of the first harvest	[m/ha]	33.3 (27.8)	33.3 (27.8)
	NPV	[RM/ha]	584	737

Notes: () refer to original values used for the cost-benefit analysis

Minus 10 in relation to original harvesting costs used in the cost-benefit analysis

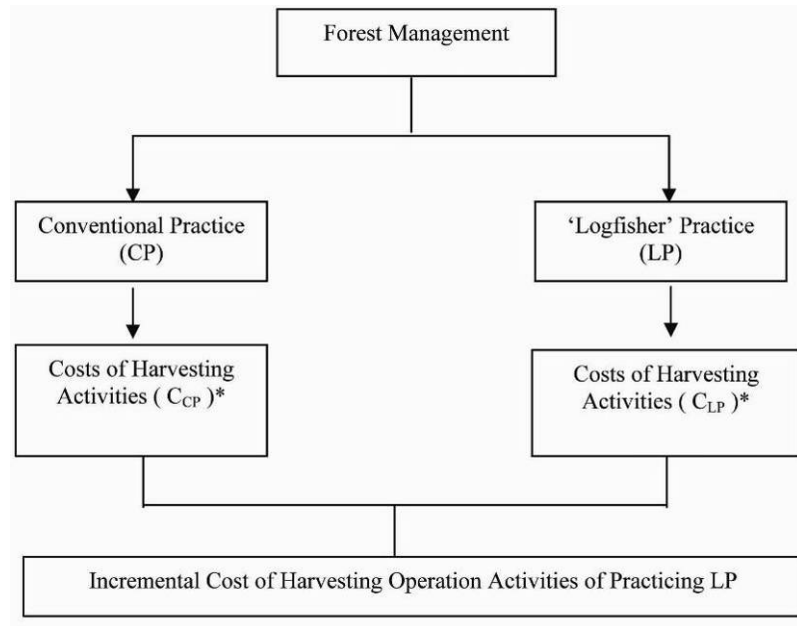


Figure 1. Analytical Framework of Cost Analysis for Harvesting Operations**

$$\text{Aggregate Incremental Cost of Complying to LP} = \sum_j^n C_j / (1 + r)^t - \sum_i^m C_i / (1 + r)^t$$

where;

C_i and C_j are costs of harvesting activities under CP and LP respectively.

r is the interest rate.

t is the year of activity.

Activities include harvesting plan, pre-felling, delineation of compartment boundary and proposed road alignment, tree tagging and 'Logfisher' machine.

* are the identified activities conducted under both CP and LP options.

** are adapted and modified from Ahmad Fauzi *et al.* (2002)

i, j are various itemized activities and m, n are the total number of these activities respectively.

$$\text{Net present value (NPV)} = \sum (B^t - C^t) / (1 + i)^t$$

where;

B^t = Benefit/Revenue for year t

C^t = Cost for year t

i = interest

t = year

$$\text{Benefit cost ratio (B/C)} = \sum \{B^t / (1 + i)^t\} / \sum \{C^t / (1 + i)^t\}$$

where;

B^t = Benefit/Revenue for year t

C^t = Cost for year t

i = interest

t = year