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The Floristic Heritage Groups of the French Antilles: Operative Elements in the Planning of Natural Environments (The Example of Martinique)

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Abstract

The primary objective of the details which will be discussed in this article is to set out a general framework necessary to understand the dynamics of the multiple plant ecosystems in relation to the processes of humanisation. This will be within a conceptual orientation of human ecology, biogeography and biological ecology, integrating the time and place, as well as anthropisation and its impacts combined with the data from the studies of the dynamics of the biophysical components of the natural environments. The concepts used to support the arguments are taken from macro-ecology and the human sciences. From an overall perspective, we have highlighted the greatly expanded field of dysfunctions with a view to finding solutions. This allowed us to envisage the possibilities for the reorganisation of the environmental management of Martinique. This future management will make it possible to counteract the factors which are currently contributing to the diminishing resilience of the phytocenoses. This is because the resources associated with the latter should guarantee a sustainable development based on a balance between Nature and Society.

Keywords: martinique, ecosystem, biodiversity, natural resources, land management, land resilience, sustainable development

1. Introduction

The difficulty today in solving environmental problems in many islands which are developed thanks to transfers from the former colonising countries of the Western bloc lies in the conditions that led to their construction. (Leigh et al., 1993; Lobban and Schefter, 1997; Larsen and Simon, 1993; Baban and Wan Yusof, 2001; Baldacchino, 2008; Westercamp and Andreieff, 1989). These conditions are plural and are rooted in the history of occupation and of land use as well as the various phases of the global economy (Srinivasan, 1986; Connell, 2010; McElroy and Parry, 2010). The new world fascinated explorers, as is made clear by the imaginative output of people at the time (Gerbi, 2010; Dew, 2010). This fascination of the discoverers of the Americas was connected to the great opulence of both biological and mineral riches (Graham, 2010). The countries of insular America, in spite of their small size compared to the nearby mainland, were shared up among the great maritime powers of the time (Schmidt, 1997). These territories were the setting for the expansion of the latter. Initially, in the early days of colonisation, the objective related to the use of possible natural resources. Subsequently, the exploitation of the conditions that the islands of America offered, in particular their tropical soils, allowed for the development of a particular agriculture related to the economy of large plantations within a social organisation which was also very specific (the slaveholder society, Higman, 2010; Sheridan, 1974; Carrington, 2003; Adams, 1978; Delawarde, 1935a & b, 1936). The result was the sharp decline of the primitive environments regardless of their characteristics and operating methods, particularly the forest environment predominant on all the island areas (Boudadi-Maligne et al., 2016). The littoral environments suitable for human settlements and agriculture were occupied, as well as much of the middle stage (Joseph, 2015; Alscher, 2011).

From 1848, the unusable areas left to Nature in Martinique were the places to which the newly free populations went. These, added to the small colonists relegated out of the plantations, further increased the pressure on the groundcover. Naturally, the development of human aggregates and the structuring of the societies they construct have continuously harmed the essential elements of the natural environment by relentlessly accentuating the phenomena of deregulation, which today are becoming more and more worrying. Thus, the landscape pattern and the physiognomic model currently to be seen are the consequence of the different spatio-temporal aspects of the anthropogenic drivesince 1635, when the island was taken over.

The loss of ecosystem complexity, the decrease in floral richness, the weakening of the mechanical protection of the soils the corollary of which is an increase in the erosive processes and the loss of regulatory efficiency of the rainfall water are the consequences of the degradation of the vegetation. Added to this are the new degradations associated with industrial production, large-scale civil engineering works, commercial and public buildings which are increasingly visible and unorganised in the general landscape. Often, current planning dynamics are not determined for the purpose of managing the space, which in the current climate from the point of view of size, is a resource in its own right.

2. General Method

The details which will be discussed in this article are a synthesis of the data from old and recent research concerning the Antilles within various disciplines related to macro-ecology, biogeography and human geography (Cohen, 1984; Fiard, 1994; Howard, 1979-1989; Joseph, 2009 & 2014). Their primary objective is to set out a general framework necessary to understand the dynamics of the multiple components structuring the Martinican space (Joseph, 1997; Portecop, 1978). Although the concepts used to support the arguments are not new, they nevertheless allow us to envisage the possibilities for the reorganisation of the management of the island with regard to the environment in particular (Carstensen et al., 2012; Imbert et al., 2000; Joseph, 2012; Baillard, 2016). By considering time and place, it will show the different aspects of the relationship between Nature and Man (Lindborg and Eriksson, 2004; Miettinen, Shi, and Liew, 2011).

3. Issues Related to Integrated Environmental Management

The globe in all its aspects is physical and biological diversity with a structural and functional diversity (Blondel, 2010; Mace et al., 2012; Fahrig, 2003). For a long time the development of societies, especially Western societies, has occurred out without any questioning of the consequences. The concern was only productivity and the improvement of production tools in all the major sectors thereby guaranteeing the quality of life and well-being of populations (Liu et al., 2007). Today, clearly, destructurations and dysfunctions are manifold and a large number of nations are mobilising in order to try to find solutions to the problems generated by developed countries engaged in a frantic technological race for the processing of raw materials (Gómez-Baggethun et al., 2010). Moreover, this is taking place in many areas such as food, the economy, military and transport and with, in most situations, resources taken from outside their territorial boundaries (Christoff, 1996). The leaders of the world economic powers and to a lesser extent those of underdeveloped or developing countries hold regular meetings at which they identify the dangers with regard to the direction civilisation is taking in the world today (Carpenter et al., 2009; Lambin and Meyfroidt, 2010). The major conferences for the protection of the planet (Note 1) denounce and criticise those who contribute, most often knowingly, to the destruction of ecosystems, particularly that of the forest (Note 2), and to the increase of the concentration of carbon dioxide in the atmosphere inducing a more pronounced greenhouse effect - anthropogenic carbon dioxide forcing - in the atmosphere (Costanza et al., 2016; Galli et al., 2012). The result, according to the catastrophic predictions which are unfortunately becoming ever more precise, will be a change in the thermodynamic Sea-Atmosphere mechanism characterised, for the most part, by (Vicente, 1989; Curtis, Brenner and Hodell, 2001; Peterson et al, 2002; IPCC, 2013):

-a rise in the sea level submerging a significant portion of inhabited littoral lands and low islands (Figure 1a),

-an accentuation of the xericity in certain areas resulting in long droughts that are detrimental to agricultural production and the supply of drinking water from natural reservoirs (exceptional drought in relation to the El Niño phenomenon, contributing to the start and persistence of forest fires in the humid tropics, which is normally in contrast with the humid tropical forest environment. It should be said that in this example anthropisation is a factor to consider (Figure 1b),

-increase in atmospheric disturbances such as hurricanes, not to mention related phenomena connected to the geotechnical specificities of the different geographical regions affected, presenting high risks to property and populations (floods, landslides, current turbidity, etc.) (Figure 1c).

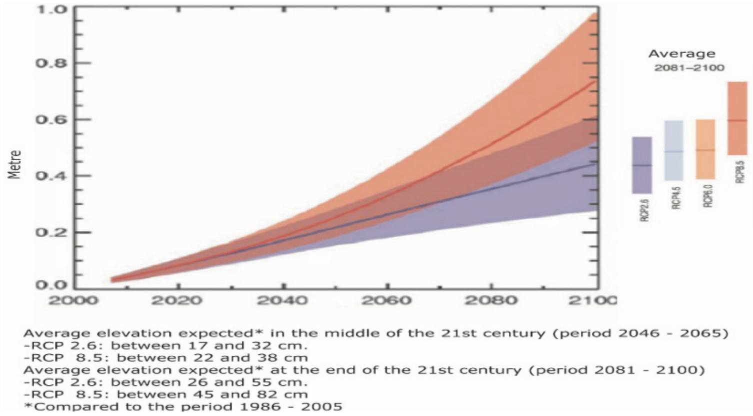

Figure 1a. Evolution of the average ocean level

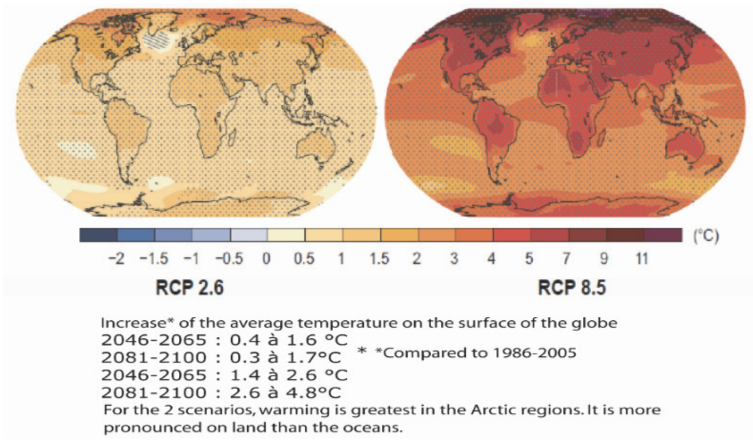

Figure 1b. Average temperature differences in °C for the period 2081-2100 compared to the period 1986-2005

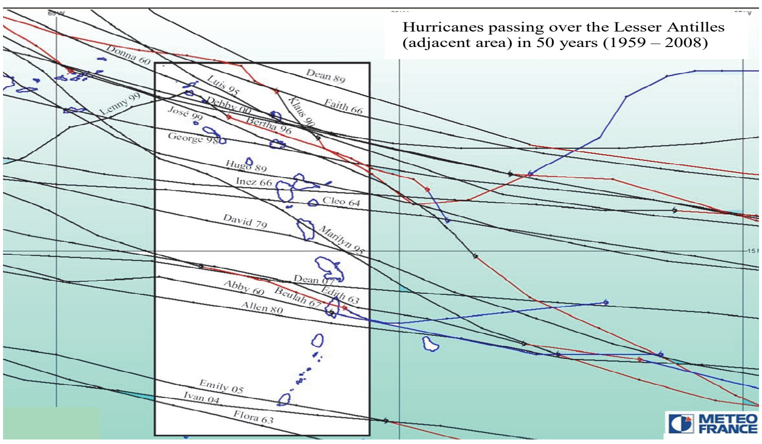

Figure 1c. Trajectories of cyclonic phenomena in the Lesser Antilles from 1959 to 2008

Despite its small size, Martinique, like the other Lesser Antilles, is not immune to global imbalances. It is at risk of experiencing, in a more or less distant future, on top of the current destructurations linked to its anthropogenic history, effects related to the destabilisation of the biospheric system. It seems clear that all the things that can be defined as biological entities, whatever their level of integration, are connected in strict modalities based on particular functions the integrity of which is paramount for the overall balance. From the perspective of human ecology, the inter-facial relationships between man and the environment (the world of interactive things that surround him, in which he is situated as an active element) must be organised, without returning to the pure symbiotic relationship of primitive times, in terms of sustainability taking into account the principles that can sustain natural resources and power in a socio-economic and cultural development (Lambin and Meyfroidt, 2010).

In the future, it is important that we take stock of the fundamental challenge facing Martinique as well as other micro-states of the Caribbean. The legacy of the past means that the Martinique ecosystem is home to great spatial and floristic diversity whose multiple areas and landscapes are markers of the ecosystemic level of the environments. The current pattern of the biocenoses in their structural particularities shows the great heterogeneity of the biological component of this space and reveals the existence of a dense and highly complex factorial make-up. Understanding the mechanisms underlying the specific dynamics of Martinique's land units is an urgent step and a prerequisite for deciphering their various articulations with the desire to find or develop procedures or processes of restoration, rebalancing and spatial readjustment. The estimated constraints deriving from both the evolutionary structure of the human settlements and the profile of the physical (climate, geomorphology, pedology) and biological (phytosphere) elements will be likely to help with the perception of the land use possibilities and to allow, within an overall management perspective, better monitoring and regulation of the progression dynamic of the urban and rural entities. Knowledge of the environment in its positive (it can produce usable resources) and negative aspects (natural constraints presenting real risks to property and people), the involvement of the elected officials in reasonable, visionary and collaborative planning policies, the engagement of the inhabitants in participative behaviours, management differentiated in terms of the systemic analysis, form the basis of real sustainable development. These considerations are not purely theoretical: we are dealing with the survival of human societies here and elsewhere. Consequently, new and uncharted areas of action are made available which are almost inexhaustible and which can serve as challenges or vital tasks for future generations in projects relating to the restoration or betterment of the surroundings, also known as the environment (Figure 2).

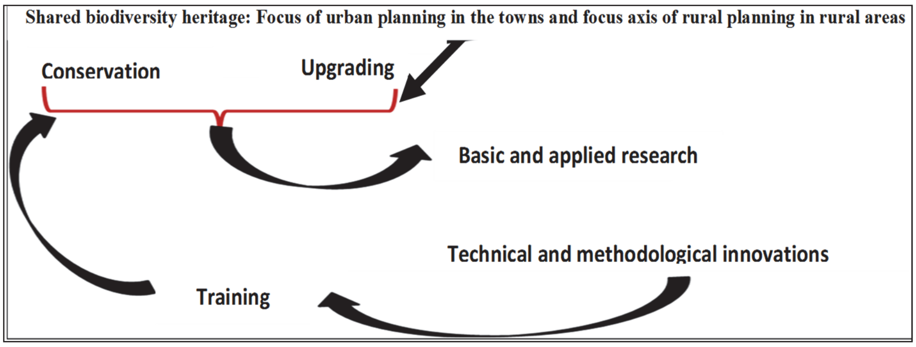

Figure 2. Four pillars in order to sustain natural infrastructures as part of a systemic or comprehensive approach to land development

4. General Features and Situation Regarding the Vegetation of Martinique

4.1 The Principal Traits of Pre-Colonial Vegetation

Taken in its broadest sense, the notion of an ecosystem can be applied to Martinique as a whole. It is an ecosystem which is particularly secondary in some respects, but which nevertheless possesses natural heritage objects of physical and biological character which show a particularly high variability, often unique on the spectrum of the Lesser Antilles. Without making an exhaustive assessment, it seems important to first specify that Martinique is a poly-facies entity home to a plurality of biological organisations both marine and terrestrial. It should also be stated (and this is an assumption) that the optimal terrestrial potentiality is purely forest. This conclusion was possible thanks to the information obtained from earlier naturalist writers and travellers, but also from the data collected following the surveys carried out in what are known as climactic islands, whose primitiveness is not irrefutable. It all leads to the same conclusion, namely that in the pre-Columbian period, the spatial preponderance of the floristic units of the Antillean archipelagic system was forest. The general physiognomy of the groundcover was almost identical in every part of the island, but the sylvatic (Note 3) sets presented a great many aspects and organisations related to the site-specific eco-climatic conditions. The vegetal entities of today's landscape derive from the forest communities of the past, from the littoral edges to the highest altitudes, where forest ecosystems can be established. Thus, as well as the original complexity, we have the complexity of the regressive processes initiated by anthropisation. The anthropogenic regression complex leads to a readjustment of the physical and biological factors meaning that the landscape model of today presents great ecosystemic diversity reflecting the structure of the factor gradients.

The primitive vegetation could have three main characteristics overall:

- maximal homeostasis (or maximal balance) following the culmination of the vegetal succession generating terminal or climactic processions from the most specialised species of the original floristic potential,

- spatial transfers of species from the upper stages to the altitudinally lower stages allowing a territorial extension of the taxa from the main (macroclimatically determined) areas to the marginal areas (microclimatically determined),

- the solidarity between the adjoining sylvan vegetal stages and the imbrications at the interfaces of the different forest areas ensured a mass effect likely to perpetuate the overall integrity necessary for the greatest functional efficiency, both floristic and biocenotic. This particularly high resistance of the primitive forest formations conditioned by the preponderance of arboreal biological types among the most specialised heliosciaphiles and sciaphiles with slow growth (with very dense wood in general), at the end of the temporal dynamics (climactic), guaranteed the continuation of the climactic forest structure in the face of severe climatic variations (hurricanes).

In addition, the enormous structuration and organisation of these pre-Columbian tree species led somewhat to a reduction of the topographical heterogeneities or even a levelling out between the vegetal stages (through transformation of the structure of the factorial gradients). It should also be noted that, despite the sylvatic matrix of eco-units involved in the climactic mechanisms, there were marginal islands in the insular region due to certain factors in the make-up of constraints, notably the instability of the slope, the emergence of andesitic substratums and hydromorphy. Consisting of tree, shrub or herbaceous species in various modalities of association, these marginal phytocenoses, atypical with respect to the evolution of the precolonial roundcover, rreflecting multiple successional states, from which during the course of anthropisation the floristic landscape which is currently analysable was constructed (Figure 3).

It is obvious that in the times preceding the beginning of the human occupation of Martinique, the forest massifs ensured the mechanical protection of the soil while being involved as an epigenetic factor in their structures, textures and hydrous and nutritive operations. This hyperorganism, "the Martinique ecosystem", took a long time, probably dating back several hundred years, to establish highly structured vegetal communities. These homeostatic functional biological systems, of dynamics, which are eminently complex at the level of the primordial components (phytosphere, pedosphere, rhizosphere), are found to be disorganised with restoration sometimes impossible because of the mechanisms of profound and irreversible degradations. The relictual representatives found in the present paint a poor picture of the reality of the time.

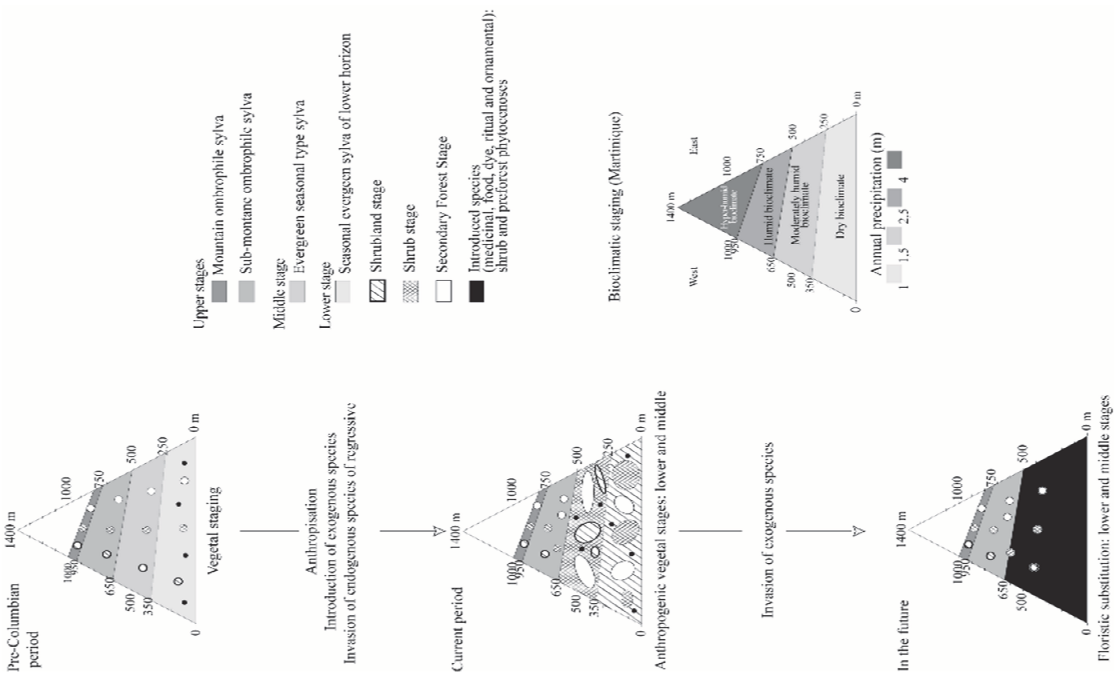

Figure 3. Evolution of the vegetation of Martinique

4.2 The General Organisation of the Present Vegetation (Evolutions under Anthropogenic Constraints)

A large portion of the primitive sylva, whatever the geomorphology of the spatial subsets, has been affected by anthropisation. The contemporary vegetal matrix which is mainly shrub and herbaceous has supplanted the former one which was entirely trees. In its spatial and temporal dynamics in the lower and middle stages, human pressure, which was and is still very accentuated, led to the current floristic pattern. Indeed, the relicts of the former vegetation, some of which are from secondary or advanced secondary sylva (Note 4), despite possessing control vegetal species of primitive terminal associations, are found to be relegated to small sanctuary lands in the upper quarter of the moderately high or low mountain ranges of the South, of the North Caribbean littoral fringe, the centre and the North Atlantic coastline (Figure 4).

These geographic areas have sylvatic potentialities which range from the marine edge, of the tropical seasonal evergreen forest in all its subtypes and facies to the tropical seasonal ombro-evergreen ecotone (interface specific to certain mountainous islands of the Lesser Antilles). This ecotone is an environment of greater richness and complexity because of the interweaving of two sylvatic types under the influence of two contiguous bioclimatic stages. Typically, the secondarisation of these original forest entities endows transitional aspects relating to the phenology, the architecture and the functioning of the multiple floristic combinations. These aspects can be and have been interpreted as characteristics of other forest types demonstrated in the tropical world whose functional modalities are in opposition to the possibilities of constructing the floristic combinations of factorial spaces of the Caribbean islands that are mountainous, flat or low. It is possible to think in this case of semi-deciduous and deciduous types in the tropical dry season (Portecop, 1978).

With regard to the upper stage, which is normally home to humid and hyper-humid forests, although not having suffered severe damage, it was the site for selective sampling of vegetal species of interest recognised precisely for the quality of their wood in relation to construction, joinery and cabinet making (Table 1). Nevertheless, these activities gradually resulted in a decrease in the ecosystemic complexity of these biotopes, increasing their degree of vulnerability (Figure 3). The gradual transition from the total destitution of Antillean societies at the end of the slaveholding system (Note 5) to modernity, while disastrous in many aspects, nevertheless allowed for a plant recolonisation of the spaces formerly inhabited (Note 6) by the small settlers and then by the former slaves who became domestic staff in order to survive. These areas whose topographic features seem unfit for cultivation even on a small scale and for the establishment of hamlets villages such as exposed ridges, the upper parts of small hills, the bottoms of valleys and dales and the areas of high and medium declivity, are vulnerable from the point of view of climatic and geotechnical variations.

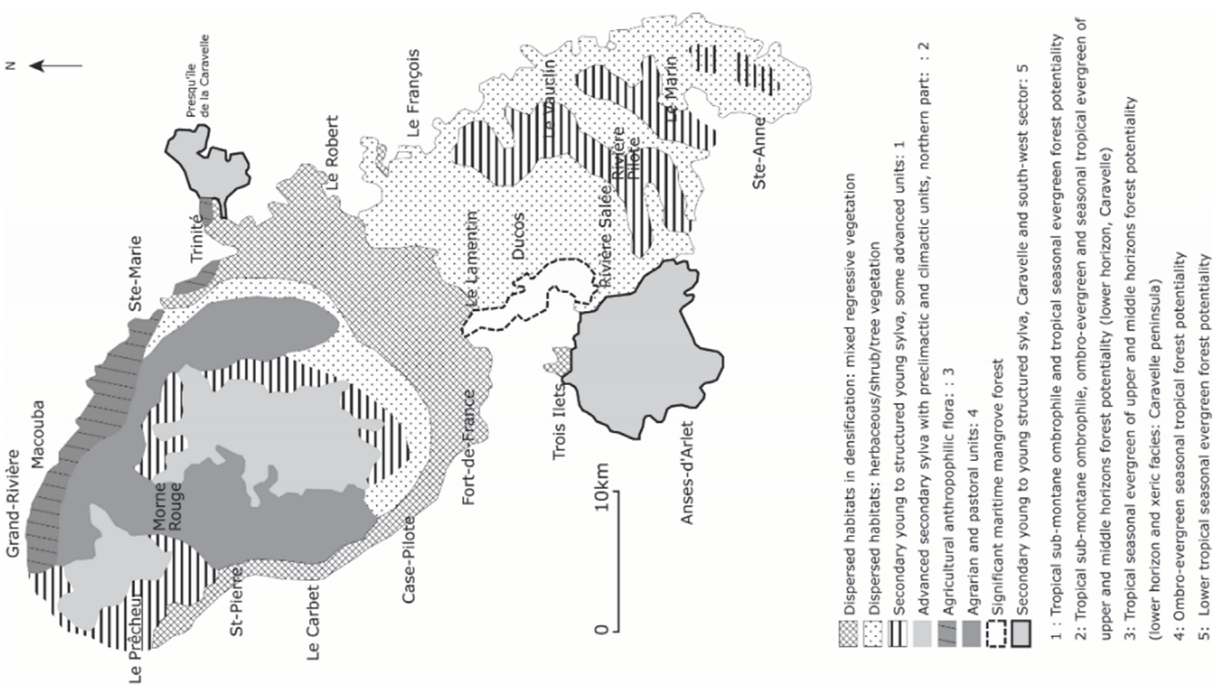

Figure 4. Landscape sets of the present (Martinique)

Table 1. The main forest species used at the beginning of the twentieth century

Species	Vernacular names	Uses
Acacia muricata	Spineless acacia, ironwood	Hard and non-decaying wood, manufacture of stakes, posts, stilts
Adenanthera pavoninia	Red wood	Carpentry, joinery
Andira inermis	Cabbagge angelin	Excellent timber, cartwrighting
Aniba bracteata	Canelillo	Joinery and construction
Bunchosia glandulifera	Peanut butter fruit	Construction
Byrsonima spicata	Locust berry	Construction, joinery
Calophyllum calaba	Galba	One of the best timbers
Catalpa longissima	French oak	Construction (ships), carpentry and cartwrighting
Cedrela odorata	West Indies Cedrela	Cabinetmaking
Chimarrhis cymosa	River wood	Excellent wood for carpentry, woodwork and joinery
Chionanthus compacta	Bridgotree	Construction (hardwood, underground structures)
Chrysophyllum argenteum	Bastard redwood	Excellent timber
Chrysophyllum caïnito	Caimito	Joinery wood
Cinnamomum elongatum	Laurel avispillo	Joinery and construction
Citharexylum spinosum	Spiny Fiddlewood	Construction, joinery, musical instruments
Coccoloba uvifera	Seagrape	Construction, cartwrighting
Cordia alliodora	Cypre	Construction, joinery, cabinetmaking.
Dussia martinicensis	Gamelle wood	Construction
Erythrina corallodrendrum	Coral tree	Fencing
Eugenia gregii	Bastard guava	Tool manufacturing (handles of hoes, shovels)
Eugenia lambertiana	Cherrywood	Construction
Eugenia octopleura	Guépois bastard	Construction
Exostema sanctae-luciae	Quinquina Piton	Excellent timber
Garcinia humilis	Achacha	Carpentry and joinery wood
Genipa americana	Génipa	Rifle butt manufacturing
Guaiacum officinale	Roughbark	Precious wood, used for cabinet making, pulley axles, mortars, lathe work
Guarea glabra	Alligatorwood	Wood sought for construction
Guarea macrophylla	Bullet redwood	Construction
Guatteria caribaea	Corossol Grand Bois	Rafts, masts
Guazuma tomentosa	Elm wood	Excellent timber and cooperage wood
Guazuma ulmifolia	Elm wood	Interior construction
Haematoxylon Campechianum	Longwood	Joinery, underground constructions, railway sleepers, dyewood
Homalium racemosum	White cogwood	Interior construction
Hymenaea courbaril	Jatoba	Shipbuilding, carpentry, joinery
Inga ingoides	icecream bean	Staves
Inga laurina	Sacky sack bean	Construction wood
Inga martinicensis	Gentle mountain bean	Marquetry
Leucaena leucocephala	Lead tree	Marquetry wood
Lonchocarpus pentaphyllus	Broadleaf lancepod	Cartwrighting
Lonchocarpus sericeus	River lancepod	Wood for cartwrighting, construction, marquetry
Mammea americana	Mamey	Construction
Manilkara bidentata	Bulletwood	Very good timber
Manilkara zapota	Sapodilla	Construction, joinery, cartwrighting
Ocotea cernua	Isabelle laurel	Joinery wood
Ocotea dominicana	Gombo laurel	Excellent timber
Ocotea eggerssiana	Black laurel	Construction and joinery
Ocotea leucoxylon	Loblolly sweetwood	Excellent timber
Ocotea martinicensis	Root laurel	Cabinetmaking and joinery

Ocotea membranacea	Sweetwood	Cabinetmaking
Picrasmnia excelsa	Bitter wood	Construction (home interiors)
Pouteria multiflora	Bully tree	Good carpentry wood
Pouteria pallida	Balata wood	One of the best timbers
Pouteria semicarpifolia	Contre- vent wood	Wood sought for construction
Prunus pleuradenia	Antilles cherry	Cartwrighting
Sapindus saponaria	Soap berry	Excellent cartwrighting, joinery and construction wood (mill rolls, hubs)
Sideroxylon foetissimum	False mastic	Excellent timber
Simaruba amara	Bitter ash	Cabinet making (planks)
Sloanea dendata	Large-leaf chestnut	Interior construction
Sloanea dussii	Sweet chestnut	Highly sought after timber
Sloanea massoni	Small-leaf chestnut	One of the best timbers
Styrax glaber	Crump wood	Construction
Symplocos martinicensis	Martinique sweetleaf	Planks and staves
Tabebuia heterophylla	Pink trumpet tree	Construction (rafts, boats), cabinetmaking and cartwrighting
Tabebuia leucoxylon	Ebony wood	Luxury cabinet wood
Talauma dodecapetala	Pine wood	Construction and joinery
Thespesia populnea	Portia tree	Cartwrighting and joinery wood
Tovomita plumieri	Mangrove large wood	Construction
Trichilia pallida	Gaita	Excellent timber and joinery wood
Vitex divaricata	Lizard wood	Excellent carpentry joinery and cartwrighting wood
Zanthoxylum caribaeum	Prickly white	Construction, cabinetmaking
Zanthoxylum flavum	West Indian satinwood	Cabinetmaking, ornamental woodwork
Zanthoxylum martinicensis	Prickly yellow	Construction
Zanthoxylum punctatum	Dotted pricklyash	Torch manufacturing
Zanthoxylum spinifex	Piano wood	Underground construction, sleepers, poles

The empiricism of the populations influenced by the reality of events (natural, social, economic, political) was a determining factor in the choice of settlement and establishment of constructions, although precarious, which were associated with units of food crops (later called Creole gardens). The landscape architecture that is currently visible is the unadulterated product of these unstructured processes of land uses. It (the landscape) is made up of what is the natural vegetation, of areas of recolonisation after the abandonment of speculative crops (such as sugar cane) and secondary units of the anthropogenic primitive sylva (Figure 4). The sectors mentioned above are situated on the dynamic scale at very different levels and make up an essential framework for synchronic analysis, which is necessary to understand the mechanisms of evolution of the vegetation.

At forest level, the Martinique of today, unlike its primitive state, is a system of disjointed entities, of variable size, of multiple traits regardless of the angle considered. This situation is worrying with respect to the small size of the island, the demography and a development that is based far too much on the typical problematics of spatial organisation and socio-economic dynamics of mainland France. In general, local realities are not regarded so much in their social, cultural and economic modalities as in the characteristics of the physical and biological constraints: this in view of the diverse Caribbean aspect and the major American, European and Asian economic federations.

In the centre, the south and the North-Caribbean littoral fringe the forest is represented by entities which are almost marginal (Figure 4). Within the groundcover species of shrub and herbaceous physiognomy are found to be predominant. This reality is diametrically opposed to that of the pre-colonial era when the vegetation was sylvan and primitive. Among the forest groupings of the present, a majority is engaged in intrasylvatic successional processes which are called so-called secondary: either through weakening of original sylvatic constructions or by recolonisation after the discontinuation of certain crops, in particular coffee and cocoa, and much later sugar cane which has become economically unprofitable for sucrose production (Figure 4). This is because of the competition provided by other plants with a sugar-producing aspect, in this case beet. The few marginal sylvatic units, evolved, for the most part, secondary advanced and rarely pre-climactic, are subject to irreversible degradations of anthropogenic and zoo-anthropogenic origin in various aspects. They are introduced within agricultural organisations and/or urbanised areas and show an extraordinary floristic, biocenotic and landscape richness. They are highly complex ecosystems in both spatial and the temporal distribution of which the constituent ecological units can be placed on the dynamic gradient at different phases of intrasylvatic successional processes (Figure 5).

This spatio-temporal heterogeneity is an indication of anthropogenic activity: previously this was the removal of species necessary for the construction of buildings and furniture, but also as an energy source (Table 1). Now, it is mainly for the production of items intended for traditional fishing activities, more precisely the small diameter tree species said to be rot-proof which belong to the Myrtaceae family such as *Myrcia fallax, Myrcia citrifolia, Eugenia cordata, Pimenta racemosa, Myrcia leptoclada*. Pits (anthropogenic holes) for falconry in secondary forests in the south and the northern Caribbean littoral zone contribute to the phenomenon of structural and functional collapse of the forest matrices. Firstly, this collapse leads to permanent dynamics of progression and regression that counteract the carrying out of terminal combinatorial processes which are called what are called climactic and which are more and more complex as one approaches the last ecosystemic phase. Secondly, this collapse counteracts the establishment and development of the most specialised species (heliosciaphilous and scaiphilous). These guarantors of the homeostatic states of end of succession are called primary and secondary structurants (upper forest strata). The forest formations themselves can be likened to a mosaic of vegetal associations with some differences as regards the predominant taxa of the structural organisation and the dynamic stage. This state of affairs is the result of the imbrication of phytocenoses belonging to various chronosequences but not far away on the successional gradient, where species of varied dynamic profile, secondary, secondary advanced, pre-climactic and climactic mix. Nevertheless, the discrepancies observed are not significant enough for the phytocoenoses considered to be identified respectively with a single cortege of dominant species and a single sylvatic type (Joseph, 1997, Figure 5).

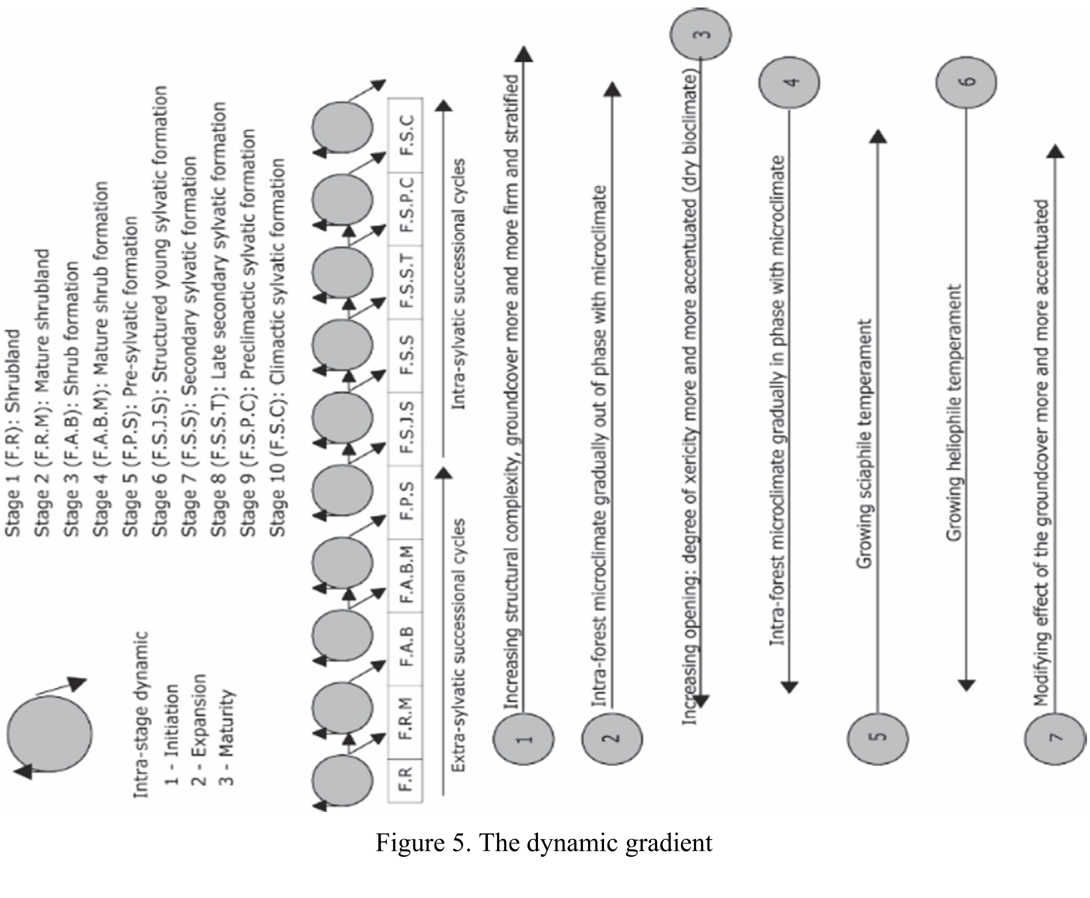

Figure 5. The dynamic gradient

5. Heritage Floristic Units: True Natural Monuments

5.1 The Vegetal Formations of Firm Ground

In the Martinican landscape, the particular character of property, because of the multiplicity of owners, is an obstacle to the protection of these structuring entities of great interest previously described. Individual and collective housing, specifically those which are tourist-oriented and sometimes for social purposes, represent a significant danger that may, in the short and medium term, lead to a weakening of the ecosystemic resilience (Note 7). Added to this in particular is the extension of some agricultural areas intended for small cattle farms, market garden produce and for some years to banana growing which seems to be expanding significantly whose units are increasingly visible in the landscape (Figure 6).

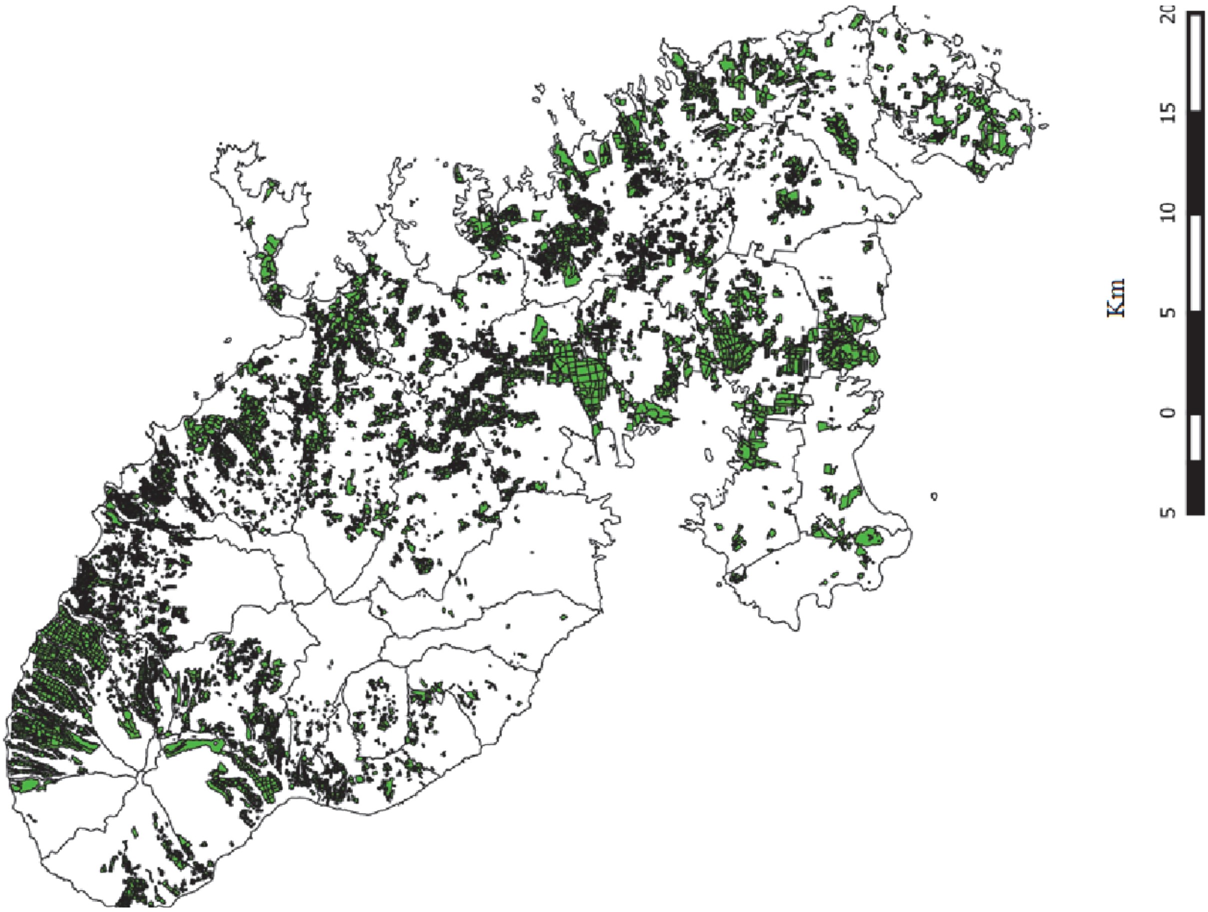

Figure 6. Spatial footprints of Farm Lands in 2014 (Source DDAF (Note 8))

This expansion of agricultural grounds is identified as small plots of land taken on the weakened or particularly regressive relicts of former sylvatic vegetation. Moreover, the modalities of these agropastoral activities are, in many cases, aggravating for the already floristically destructured ecosystem: in this case the edaphic component in which the cultural techniques used (ploughing and furrows in the direction of very steep inclines) potentiate the erosive processes. In order to illustrate the multiplicity of units rich in floristic diversities impacted within or on the periphery by human activities, we can take as an example all the forest massifs which attest to a high biodiversity, an advanced dynamic level and a very complex network of settlement and expansion. They (the forest massifs) cover the upper parts of the hills and mid-altitude mountains (Joseph 1997, Figure 7). The below elements are specific criteria for identification and of great significance:

1) In the south (Atlantic and Caribbean Littoral and Interior of the country (Figure 7, Joseph and Baillard, 2017): the calcerous mountains of Sainte-Anne (Mornes Marguerite, Manioc, Malgré-Tout, Belle Vue, Caritan, Joli Cœur, Belfond, South and North America) and of Marin (Mornes Berry and La Fouquettes), the Morne Aca located between the municipalities of Rivière Pilote and Marin, Rocher Zombi (Rivière Pilote), Morne Préfontaine (Sainte-Luce), Bois La Charles and Morne Monesie (Saint-Esprit), Vauclin Mountain (Vauclin), Morne Valentin and Rocher Leclerc (François), Pointe Larose and Pointe Royale (Francois/Robert), Bois Potheau and Pointe Banane (Robert), Pointe Jean Claude (Trinité), Bassins Alluviaux and Sapeur Mineur (Trinité: Caravelle Nature Reserve), Bois Michel and Morne des Pères (Trois Ilets/Diamant), Morne Du Riz and Pointe Bois d'Inde (Trois Ilets), Mornes Gardier and Fournerey (Diamant), Morne Larcher (Diamant/Anses d'Arlet), Mornes Léone, Baguidi, Réduit and Gros Morne (Anses d'Arlet). These forest ecosystems, as numerous as they are varied, contain

astonishing biological and ecological diversity but they are extremely fragile with regard to dynamics of current development, the demographic and sociological evolution, the way the space is used and the frequent unsuitability of the infrastructure in relation to the size and environmental characteristics of the island.

Figure 7. The main heritage phytocenoses of Martinique (Joseph and Baillard, 2017)

2) In the northern Caribbean (Massifs near the littoral (Figure 7, Joseph and Baillard, 2017): Bois la Roche and Morne Rose (Case Pilote), Petit Morne (Carbet): exceptional natural environments, unique in many aspects, highly evolved from the dynamic point view of dynamic, home to a flora of rare diversity. The size of the massif (Morne Rose and Bois la Roche), the great complexity of the factorial make-up (physical and biological) and the existence of recurrent anthropisation (selective harvesting of wood, pits for falconry), make it a heterogeneous geosystem composed of spatially and floristically different entities which belong to dynamic phases which are also varied (Figure 5). These structurally and architecturally complex phytocenoses are influenced by the geomorphological (and therefore topographical) facies only by way of the site-specific bioclimatic conditions.

3) In the centre (Figure 7, Joseph and Baillard, 2017): the Mont-Gérald forest (Fort de France), a peri-urban forest group, one of the last representatives of a forest type that was once widely distributed in the central region, in the interior of the country, lying between the humid subhumid and the dry subhumid (Figure 3), like the Bois-La-Charles forest in the municipality of Saint-Esprit (South Martinique). This secondarised relict contains an exceptional floristic and phytocenotic richness. Its small size, the proximity of the agglomeration of Fort-de-France characterised by poor land reserve and a development which is often little structured and controlled, especially in the periphery with respect to the habitat, they construct it in a highly vulnerable place, subject to all the degradations due to the lack of management tools. Conflicts of use may in the future be exacerbated and jeopardise an important element not yet taken into account in the planning documents as a structuring unit of planning and a fundamental focus of urban planning: this despite the registration of this forest as a "Protection Forest" in the PLU (Local Urban Planning Scheme) of the Municipality of Fort-de-France.

4) In the humid north, also called the "extreme north" or "the great north" (Figure 7, Joseph and Baillard, 2017), which has mountain massifs of average altitude (mainly the Pitons du Carbet and Mount Pelée), the forest, in

places where it can spread, covers larger areas, usually continuously. The geomorphological characteristics which determine a diversity of classes of topographic units along with multiple and complex eco-climatic and anthropogenic gradients, yield many forest formations. These are influenced by the humid and hyper-humid bioclimates, the large site-specific variations of which condition plural facies. There is, therefore, in this part of the island, a landscape and phytocenotic richness which has not yet been fully assessed, hence the deeply sensitive nature of this area from an environmental point of view. For example, the large sylvatic set located between the municipalities of Grand-Rivière and Prêcheur, from the marine edge to the high foothills of Mount Pelée, via the intermediate volcanic structures (Figure 8, Appendix 1). This extraordinary geosystem has a diversity which is almost unmatched in the archipelago of the Lesser Antilles. It is specified at the same time by the physical, climatic and biological characteristics [great floristic, phenological (thus also physiognomic and landscape) and phytocenotic richness]. The chief interest of this forest massif, particular in all respects, lies in the existence of a continuum of staged vegetation brought about by an altitudinal bioclimatic gradient. All the sylvatic stages of the Lesser Antilles are represented and consist of a complex mesh of forest entities located at multiple positions on the scale of intrasylvatic successional cycles. (Joseph, 1997).

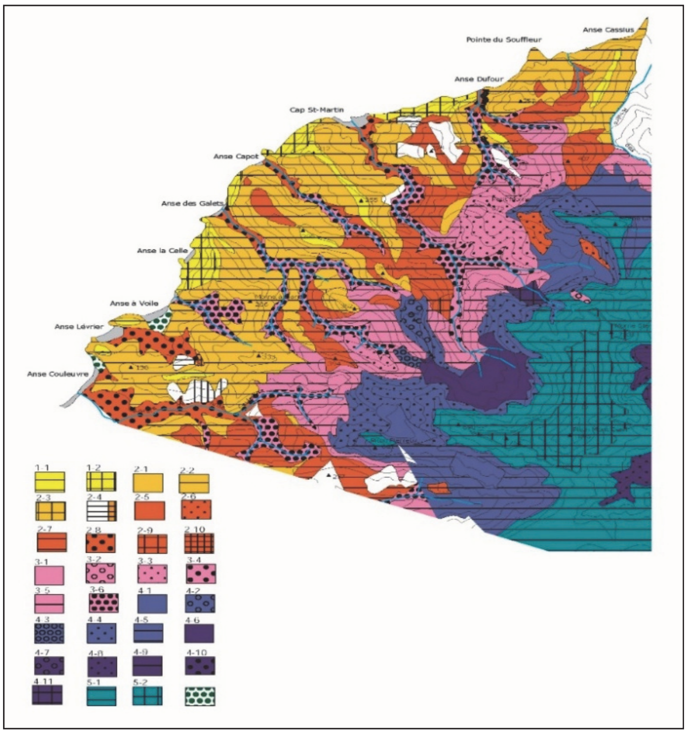

Figure 8. Ecological sketch of the north-west of Mount Pelée (north of Martinique) by J.P. Fiard (1994)/Appendix 1

In these landscapes today, the vegetal formations of spatial distribution and various dimensions belong to secondary structured, advanced secondary, pre-climactic and climactic secondary dynamic stages (Figure 5). It is a true natural laboratory for synchronic studies of the vegetation and to approach in a conceptual way the functioning of the forest groups of pre-Columbian times. Given the impoverishment of the floristic diversity of the primary formations due to anthropisation, the present late secondary floristic entities of this area can be assimilated to the sub-climacticic phytocenoses.

The best relicts of the South of the island (littoral and interior) as well as those of the North Caribbean littoral area belong to the following forest formations respectively:

- Seasonal tropical evergreen forests in their multiple topographic facies, in their various subtypes (upper horizon, lower type and horizon (Note 9)),

- Tropical ombro-evergreen forests (intermediate types or ecotones) in their secondary dynamic structured or advanced (also called late) stages.

Another forest type is known as inversion. The phenomenon of inversion is due to the combination of eco-climatic factors that allow the shifting of a forest type from its biotope of full development, in main area, for an extension in marginal area in an environment where the conditions are normally unfavourable with regard to the macroclimate: for example from the middle stage in humid bioclimate to the lower stage in dry bioclimate. The phenomenon of inversion is often due to zones of confinement, linked to bottoms of valleys or dales which are often called *Grands Fonds* (Great Bottoms) in the Lesser Antilles. As for the humid and hyperhumid north, the sylvatic vegetal communities encountered are tropical montane ombrophilous and submontane tropical ombrophilous. These pluvial formations present a plurality of topographic facies and of secondary structured and advanced secondary stages as well as some auxiliary elements considered subclimactic and climactic. In any case, they differ very little from the quasi-dominant terminal units of the pre-colonial era.

5.2 Units of the Land-Sea Interface

The mangrove forest is a component of the lower stage and in protected bays constitutes the first rampart forest in a more or less humid environment (Note 10) (Figure 9a). Because of anthropisation, the units of mangrove forest no longer assume their role as a natural treatment plant, nor as nurseries or else the phenomenon of "homing" (cyclical return for spawning) is done for some marine species. The hyper-sedimentation due to the degraded slopes and the surface reduction of the mangrove forests lead to the disappearance of the littoral seagrass beds. Given that it initiates less and less the marine ecosystem of the nearby littoral, the mangrove forest as a place of production is inexorably dwindling. The effects brought about are felt as much upstream, where the mangrove forest no longer participates in the mass effect (Note 11), as downstream. This ecosystem no longer retains the terrigenous material involved in hyper-sedimentation, the significance of which has increased since 1635 following the progressive deforestation of the different vegetal stages of the contiguous hillsides.

The mangrove forest is of varied floristic composition and is specified by well-defined adaptive modalities (physiological, anatomical and morphological). Exposed to the harshest aspect of the dry bioclimate, the numerous islets of mangrove forests create very favourable microclimatic conditions with regard to neighbouring interior areas, contributing to the mass effect as with other vegetal stages (Note 12). Although floristically less rich than the mainland forest systems, the maritime mangrove forest is complex in its spatial structure. The primary factorial determinisms are the geometric characteristics of the bay, salinity and hydrodynamism. These particular interface biosystems provide ecological niches and habitats for many representatives of the marine and avian fauna that participate in a specific trophic chain.

With the exception of the mangrove forest formation adjacent to the Baie des Flamands of Fort de France (Note 13), the other small or medium parcels in the extreme south and the south Atlantic littoral (Sainte-Anne, Robert, Trinité) are entities in danger. Some are insignificant in terms of their dimensions and non-functional, but they are floristically and architecturally interesting from the point of view of synchronic study and understanding of their biocenotic ecology and diversity (Figure 9a). It should be pointed out that there is one type of mangrove forest that is currently not widely distributed across the island, also known as "mangrove swamp or marsh forest, Figure 9b". Only one group exists on the municipal territory of Trinité in the north of Martinique, suffering from various degradations related to road traffic, agriculture and surrounding businesses. Formerly this ecosystem was much more present like it is nowadays, for example, in the Grande-Terre of Guadeloupe in the north. Everything suggests that in the pre-colonial period in the flat Martinican country (in the sense of the first chroniclers), located in the perimeter of the towns of Lamentin, Ducos and Saint-Esprit, the predominant phytocenoses were of the type "mangrove swamp". This large, more or less flat area, very low in relation to sea level and crisscrossed by numerous natural and anthropogenic draining channels, undergoes on an annual and multi-annual scale depending on the climatic variations of the particular rhythms of flooding and bank exposure. (Note 14) Moreover, in many places, at the soil level, hydrormorphism is significant. The channels that used to run along the maritime mangrove forest in the littoral and the "mangrove swamp" in the interior have not all disappeared. Some are still partly visible in Lamentin and Ducos (central Martinique). It is quite possible that they allowed for the existence of a definitively vanished fauna of which the *Lamentin* (manatee), a marine mammal, was an important element which is now emblematic in the collective unconscious.

6. What Natural Environment for Martinique in Future Development?

Here, like everywhere else, as soon as it is a question of planning, it becomes an area of oppositions and exacerbated conflicts of use. In general, interests are fiercely defended by the different powers of the social structure. Indeed, this difficulty of humanisation of the space can be related to the worldviews of the multiple populations that constitute nations and the continental and insular federated bodies respectively. There therefore is no strict homogeneity of the various social components, urban or rural, within the same country, because of the variability within a cultural, linguistic and historical matrix that can be considered identical. Often the historical processes of settlement, the natural disadvantages and advantages of the occupied zones, the management of development companies (Note 15) to ensure the growth and security of the population, established the hamlets of yesteryear, which in many cases are the large agglomerations of today. The current landscapes are the result of successive waves of human appropriation of the space and its resources that have shaped entire territories, specifying them in such a way that they have given them their identity, hence certain names such as “terroir” especially in France.

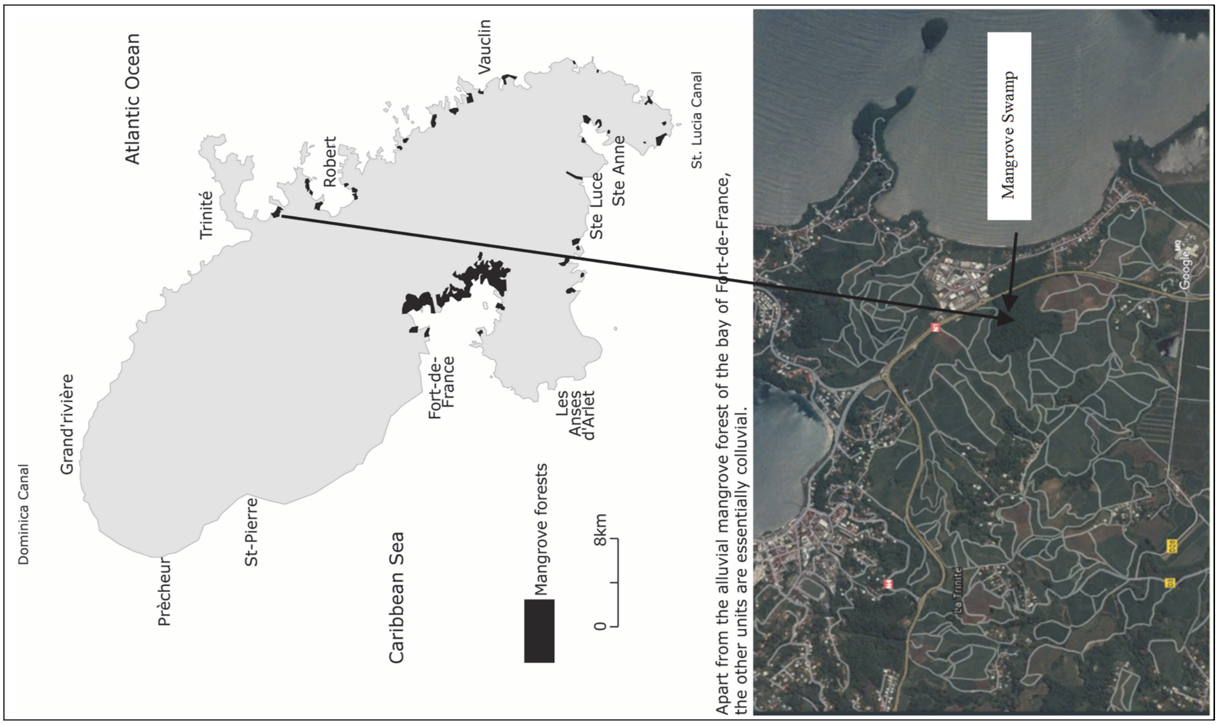

Figure 9. Location of the mangrove forests of Martinique (a) and mangrove swamp relict (b)

6.1 Martinique: A Complex Anthroposystem

Although insignificant in size in terms of North and South America, Martinique, like the other Lesser Antilles, is not immune to this global phenomenon of territorial, cultural and social differentiation (Note 16). Added to this is the remarkable variability of its geomorphology in covariance with a highly diversified biological canvas. It is therefore necessary to make intelligible the current structuring of the island which is endowed, with regard to the sites and the landscapes as much in the littoral as in the interior, with natural objects with a heritage dimension (Figures 7 and 10). Some are of a rare richness and beauty and have characteristics that would see them included them in a heritage on a global scale. In view of the development focuses, both announced and inevitable, mainly related to tourism and taking into account the potential of Martinique, the areas of great interest, in particular ecosystemic and landscape, must serve as bases on which or around which the development of the space will take place for the sake of protection, conservation, restoration and upgrading. Despite the small size of the Martinican territory, the challenges related to planning are enormous because there is often a contradiction between the will to develop with control and the constraints imposed by the geotechnical, biological, seismic, climatic and hydrodynamic modalities. Not to mention the legacies of the past in terms of agriculture, habitats and networks, whose organisational logic is not always in harmony with the physical and biological balance. The space in the sense of its structuring for the human being is a real receptacle of oppositions, conflicts, rivalries and challenges. This state of affairs can be harmful and lead to the aggravation of the current situation characterised by a level of almost irreversible dysfunction. The fundamental markers of this reality are: the decline of the biological diversity, the geotechnical, seismic and hydrodynamic risks (more and more accentuated), the erosive processes of increasing activity with the consequent reduction in the quality of the edaphic component (as regards soil fertility, to be precise), the regulation of water resources and the weakening of the mechanical protection of the soils. For the sake of a planned use of the land, the deregulations stated are so many projects to be carried out in the long run in order to successfully manage, in the course of the development, to really introduce the concept of sustainability (Figure 11).

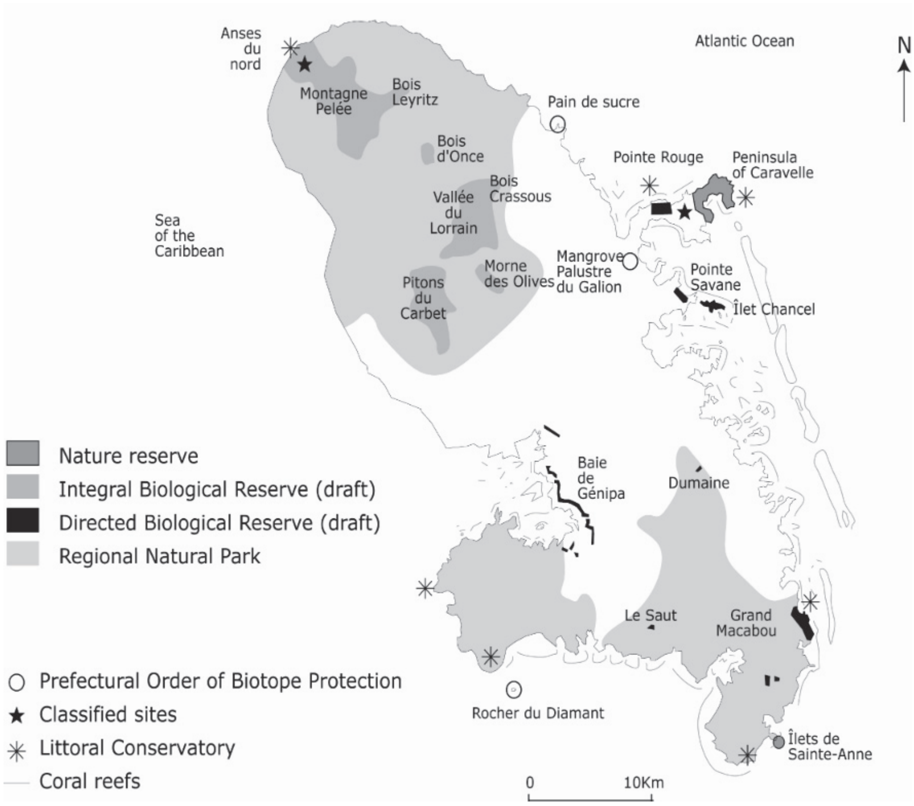

Figure 10. The protected areas of Martinique (Ecological Regions)

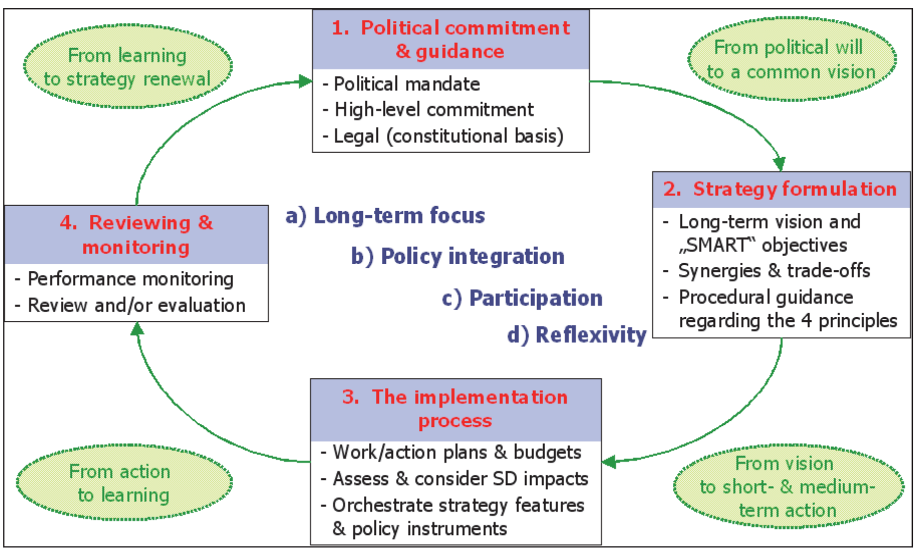

Figure 11. Objectives and Indicators of Sustainable Development in Europe (ESDN Quarterly Report, 2007)

The collaborative and transdisciplinary aspects are essential so that the leaders of the private and public sectors presiding over the destiny of Martinique can solve the equation. Moreover, this is in a world that is becoming globalised with modalities of economic and social pacts which are unsuitable and unsuited to local realities. Transfers in terms of consumption and technology are carried out with inefficient articulation which in many cases is de-structuring for this tropical island environment.

6.2 The Inventory of the Biophysical Characteristics: An Essential Step

Knowledge of the environments, whether they are natural or artificial (agricultural and urban), is an essential step in the assessment of the modes of operation of their constituent elements and in order to appraise their stages of evolution, their spatial dynamics and their degrees of vulnerability in this case in relation to climatic variations. To achieve this goal, the scientific study needs to be carried out in a multidisciplinary framework within which the exact sciences combine with what are called the human sciences, in particular human ecology. The purpose of the latter is to better understand the complex and determining relationships of the coupling of structuring and structured elements, Man/Ecosystems, at all levels of integration and within the set of the spatiotemporal dynamics (Figure 12).

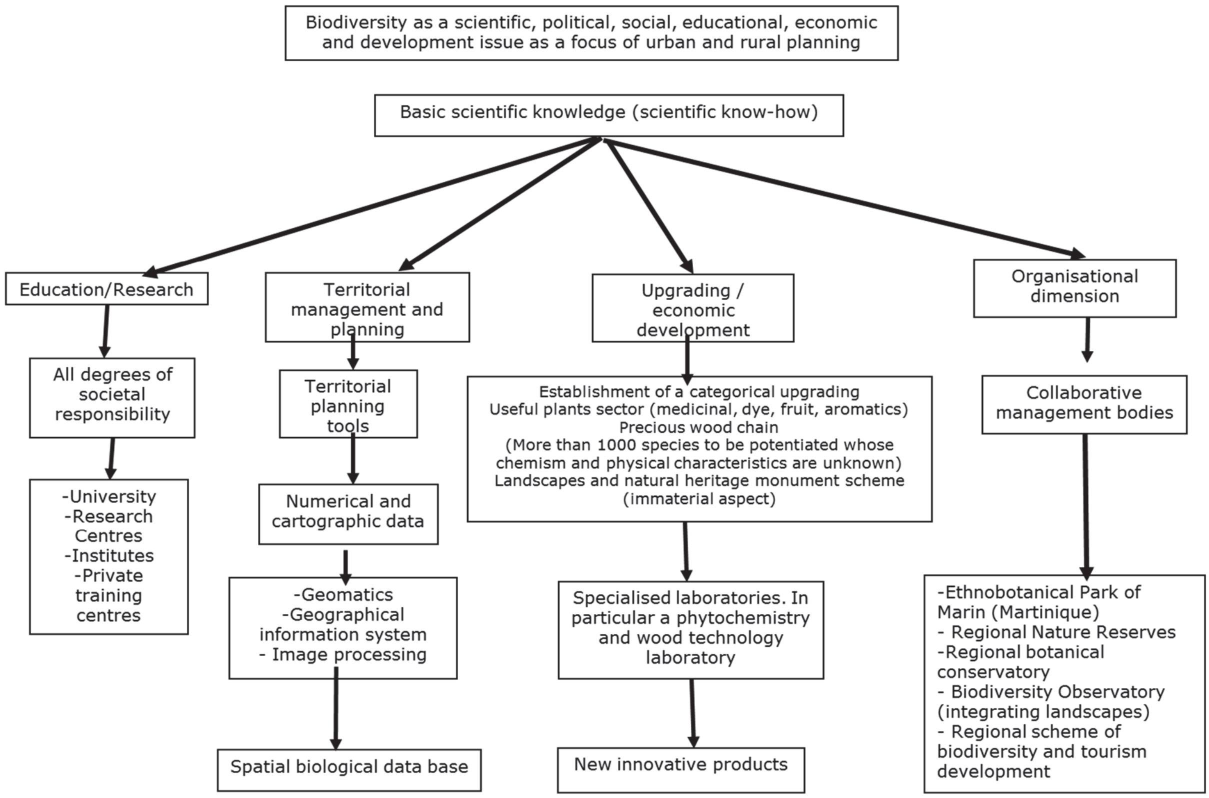

Figure 12. Synoptic diagram of the governance of biodiversity (Important aspect of the dialectic of future development, at the interface of the dynamics between Nature and Society)

The sectoral analysis (at municipal level) needed in order to understand the anthroposystem of Martinique makes it possible to envisage the field of the gradients of physical and climatic factors which define the field of the biological expressions of which the phytocenoses and the physiognomic and landscape units are valuable indicators. This highly anthropised ecosystem (Martinique) is summed up by a geomorphological gradient on which a macro-climatic gradient, a biocenotic gradient (thus of floristic potentials) are superimposed, creating secondarily, according to the successional phases, a gradient of interior environments or microclimates of "intra-vegetation" (especially when the forest stage exists) (Joseph, 1997). In this deeply mosaic system of high fragility with numerous physical and biological subsets (Note 17), any large-scale development intervention must be based on a systemic approach that integrates the protection and conservation of the high-quality natural resources with regard to development, particularly tourism. The highly diversified landscapes are true ecosystemic markers of the multiplicity of biotopes (Figure 13). The landscape units constructed at the level of heritage sites are natural monuments that are representative of all the biotopes of the island. They are distributed in the south, the centre and the north and must therefore be included in all documents and tools of spatial and urban planning as spaces of great vulnerability, serving as lines of urban planning in significant agglomerations and of rural planning in the municipalities of the interior of the country (Figure 13). Obviously, the natural monuments are very diverse and are particular assets within the perimeter of each municipality. If one wishes to stay on the course of ecodevelopment, it will inevitably be necessary to stimulate at the level of each town a micro-development on the basis of a planning which is in keeping with the characteristics associated with their environmental peculiarities (Figure 13). Ultimately, all the micro-developments of the Municipalities will have to take into consideration the environmental concerns with regard to vegetation and natural risks, as mentioned above, from the point of view of the protection, upgrading and restoration especially of the natural vegetal monuments. This approach will ensure the establishment of floristic conservatories that will be true genetic reservoirs and real living laboratories enabling study and greater knowledge of the complexity of factorial determinisms at different spatio-temporal levels (Figure 13).

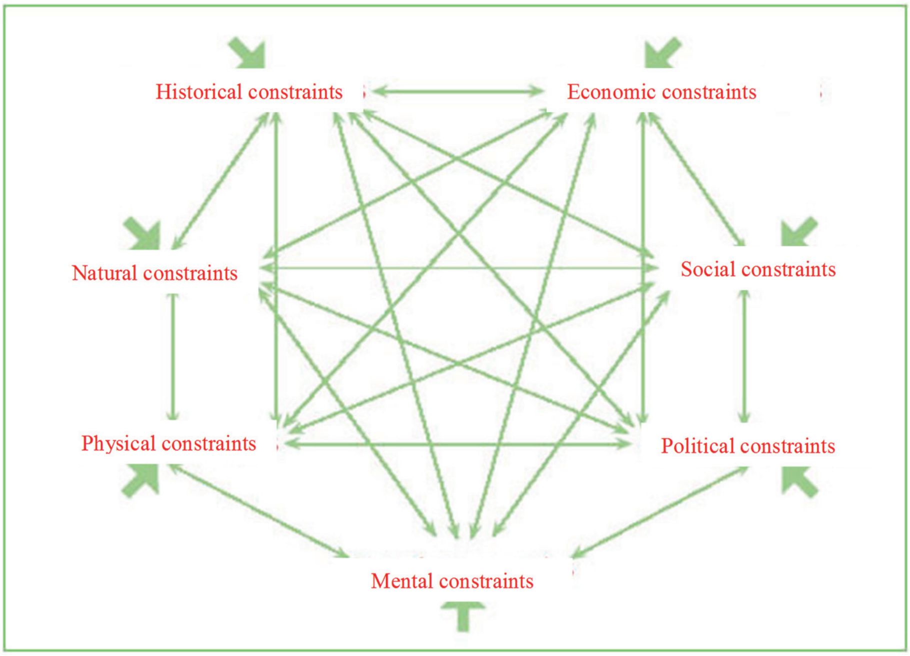

Figure 13. Land within a system of constraints (Marchand, 1986)

Clearly, in order to achieve this goal, work need to be started in the various municipalities of Martinique on integrated studies of the natural and socio-economic environment. In the French framework, laws relating to the protection of eco-complexes give the towns the opportunity to take into account their environmental components as stated development issues that can lead to many actions relating to the air, water, landscapes, biodiversity and natural and technological risks (Figure 13). The data needed to implement this strategy should come from university and public laboratories as well as consulting firms and associations with expertise in ecological systems. This is in order to get a view of the problems with regard to the sources of nuisances and pollution, to evaluate the levels of deregulation in order to propose solutions and compensatory measures when it comes to carrying out planning. The analysis of a territory in all its aspects is a pertinent and unavoidable approach in the direction of sustainable development. The idea would be to establish, beginning with the components recognised as vulnerable, a map of the constraints, resulting from the superimposition of the categorical maps, helping to understand the structural dynamics of the municipality concerned in terms of types of anthropisation, the deregulating effects brought about and problems related to the inefficiency of the articulation of the spatial units which creates significant imbalances. This map should also lead to the specification of new development centres (Figure 14).

7. A Governance Between Sectoral Growth and Systemic Development

Spatial readjustments can only be carried out within the framework of a holistic management procedure, since the opposite is assimilated into the purely sectoral, which is very important nowadays in Martinique and contributes to the continual degradations that inevitably affect the tourism resources generated by the natural monuments (sites, vegetal landscapes, forest ecosystems). The operational phase follows the diagnostic phase and imposes a specific structuring of the space (Figure 14). This then becomes a matter of law, since the legislation in force in France provides almost inexhaustible opportunities as regards protection and management such as laws relating to the littoral, water, mountains and all the other European directives. Apart from the State, the legal powers in the management and planning of space are distributed, with separate modalities and responsibilities, between the executive of the Territorial Collective of Martinique (CTM) and the municipal executives. These are all sometimes involved directly or indirectly and to varying degrees, via financial aid, in public bodies or in associations with recognised scope as regards planning, urban planning and the environment like the Natural Park of Martinique, the Departmental Urban Planning Agency, the CAUE (Council of Architecture, Urban Planning and the Environment), etc. The main problem lies in the imbrication of many of the duties of state guidelines and the local authorities issued by the legislature.

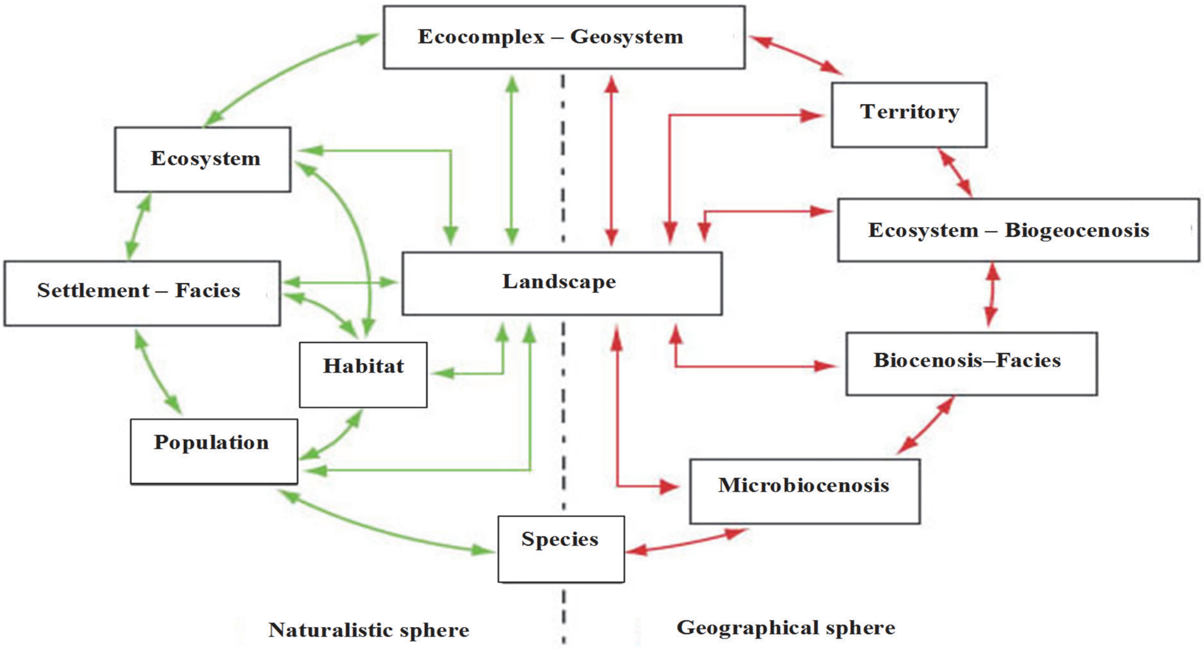

Figure 14. Inter-hierarchical and transdisciplinary function of the landscape in the conceptual classification relating to the naturalistic and geographical study of benthic ecosystems (Musard, Fournier, Marchand, 2007)

Overlapping is much more prevalent than complementarity, not to mention the administrative load involved in briefing on the files and the ease with which some municipal communities can review their key planning tool, the PLU (Local Urban Planning Scheme) which introduces serious concerns related to the protection of the environment. These revisions take place, without a change appearing which is consistent with the systemic concepts. Currently in Martinique few ecosystems enjoy real protection in the form of a biotope decree, yet this island is part of one of the 24 hotspots of global biodiversity: that of the Caribbean. The vast majority of the sites of interest, listed under the ZNIEFF (Natural Fauna and Flora Areas of Interest) programme, are not subject to any protection whereas in the legislation concerning the environment there are many principles and procedures. The difficulty of applying the laws is undeniable for a whole series of reasons pertaining to categorical, corporatist, socio-political and economic conflicts, often in relation with development plans that do not necessarily integrate the directives on the management of the environment and space. Even for acquisitions likely to safeguard heritage ecosystems, which in theory benefit from management services, the results in terms of concrete actions are more than open to criticism (Note 18).

The important work of the Natural Park of Martinique (PNM) which takes into account all the environmental aspects, has not served as a force for proposals for the protection of the forest ecosystems, the landscapes and the heritage sites. This has as a corollary an effective water management, a protection of the soil and the fauna, an upgrading of the rural agricultural activities. We also inherit misguided forestry practices which, due to lack of knowledge, do not take into consideration the operating mechanisms of the main forest types. A few decades ago, the mistakes made by the ONF (National Forestry Office-France) in the farming of mahogany (*Swietenia macrophylla*: Meliaceae) definitively entered the realm of the irreversible with a tangible erosion for Martinique of the ligneous biodiversity. This is to the detriment of the tropical sub-montane obrophilous primitive units that are profoundly diminished by deforestation. Production of this valuable forest species introduced from continental America was not very worthwhile because of numerous pathologies.

As regards ecosystems, degradations can be difficult to restore when the imbalances generated are significant. It will therefore be necessary to measure the extent of the destructuring that will be caused in the future because of planning. It would be unrealistic to imagine that everything can be placed in the category of the protection of nature. However, without resorting to extravagance and gigantism, it would be necessary to find possibilities for use of the soil which are not harmful to the biological balance of the wooded and agricultural North, the sites and landscapes of the littoral, forest or otherwise, regardless of their degree of structuring.

At the present time the efforts concerning the cartographic documents for the needs of the planning are commendable but they are numerous and of questionable operability. Admittedly, the demarcations of the areas proposed for conservation or which may be able to be protected are clearly defined. Nevertheless, what is lacking concern aspects relating to the management and *in situ* monitoring of the natural environments. If we look at the regional planning document entitled SAR (Regional Planning Scheme), it is very noticeable that the main direction taken as well as the logics of organisation of the territory defined, converge unilaterally towards the economic. Environmental concerns are resolved only at one demarcation, ZNIEFF (Note 19) plots, the Littoral and Riparian Shores Conservatory, state forests, departmental forests, biological reserves, ND areas (natural areas to be protected), PLU (Local Urban Planning Schemes), Natural Reserves. The aspect, level of vulnerability and degradations brought about, in particular for areas hosting future developments such as the coast, is not fully integrated regarding its current stage of anthropisation and this is particularly worrying.

Evaluation of the impacts due to the settlements in the near future is largely lacking. In France, in the context of decentralisation, local authorities have an important role to play regarding the environment which reconciles infrastructural development and the intelligent management of the components of the natural environment. The opportunity was given, around the concept of the environment, to bring all the responsibilities at all levels of societal integration of the individual under the remit of the regional structure (Territorial Authority of Martinique), via the residential island, the districts and the municipalities in their various groups and associations. This important task for Martinique must be accompanied by concrete actions and achievements that do not add to those of the existing services of the state whose essential role, particularly at local level, relates to procedural action and overseeing legality which is often fanciful in view of/given their differentiated practices. This environmental responsibility needs to complement all the others that are already active. Its operational nature must be part of the implementation of projects aimed at maintaining by all means a quality of the surrounding environments which in the collective consciousness equates to a quality living environment. Without being exhaustive, there seem to be legal procedures in place related to the protection and management of nature, represented by public partnership, administrative and economic institutions. The Natural Parks are typical examples of this. The Natural Park of Martinique only performs a small part of its original role for four decades, it being more cultural than protective of the environment, while it could and had the sufficient means to undertake a comprehensive and therefore systemic approach to the conservation of ecosystems of interest. One has to imagine that the recent charter of the PNM (Martinique Natural Park) and the new skills acquired by means of the employment of technicians and specialists in landscape and ecology can get things done and move it on from its current inefficiency following the example of many other administrative bodies working for the protection of the Martinican ecosystems. The Regional Conservatory of natural areas is a worthwhile route for the outlining of a policy concerning environmental issues, in the sense of ecodevelopment.

The objective of the regional parks of France mainly concerns the safeguarding of the natural sites and more particularly the conservation *in situ* of the biological richness of the endangered natural or semi-natural biotopes such as the wetlands, the forests, the natural draining channels, the vulnerable agricultural areas from a landscape point of view, habitats of wild flora and fauna. The regional conservatories are subject to specific legal terms (Law of the 1st of July 1901) which permit a coherent property operation, in the interest of the protection of the nature across the entire regional and national territory. For sustainable development the corollaries of which are the control, assessment and follow-up of all the components of the space in its own dynamics, to be endowed with a regional conservatory of the natural space like the conservatory of the littoral and the riparian shores is really a responsible and visionary approach. This is to ensure a quality and even improved environment for future generations and to gauge the economic challenge which resides specifically in the sites, the landscapes and the vegetal, littoral, mountain and interior country ecosystems which are surprisingly numerous, often marginalised in environments plagued by the extreme violence of the anthropogenic drive.

The protection of nature is not negotiable and must rely on the commitment of all the constituent powers of Martinican society so that the principles enshrined in the concept of sustainable development are genuinely applied and exercised. It is reasonable that the modes of use of the space and the techniques employed should be in perfect accord with the biological, physical, social, cultural and economic characteristics peculiar to this island entity. Transport in Martinique, the electrical energy transmission networks, the management of household and industrial waste and the habitat are all elements whose current structure allows us to perceive the extent of the overall dysfunction. Certainly, the aforementioned problems exist everywhere else in the world but they are specific to particular types or development choices. In Martinique as in other DFAs (French Department in America), development has never taken place and is not taking place with regard to local issues, but by transfer of technological and legal objects which are totally unsuitable in a territory where the criteria for development reside only in the infrastructural aspect. The observed environmental degradations associated with complex instigating factors are essentially due to the historical inability to consider this tropical island as a hyperorganism of high fragility whose richness is uniquely represented in the various expressions of its groundcover. Space must also be viewed as wealth and therefore requires rigorous management, in view of current templates for individual homes and certain elements of the road network (roundabouts consuming space). Demographics, in terms of population density, are not the only factor explaining the devastating impact of human aggregates on the natural ecosystems including soils.

Above all, it is this incomprehensible attitude of the leaders, whatever their political persuasion, inclined to apply illogical solutions to problems which remain unresolved and sometimes even unnoticed. Social urgency often prevails over the reasoned exercise of the collective responsibilities whose decisions taken were particularly misguided as regards the environmental equilibrium and permanently threaten the ability to promote the natural heritage, a byword in the islands for the floristic, physiognomic, landscape and ecosystemic diversity. In these conditions of purely sectoral and compartmentalised interventions, dysfunctions follow on from the other despite an increasingly significant human and financial effort by public authorities and organisations. This is if we refer to the part of the budget allocated in particular to the repair and construction of roads, to collective housing programmes, electricity networks, and the prediction and management of climatic and telluric hazards.

Nevertheless:

- the number of privately-owned cars is growing inexorably (about 205,000 cars as of January the 1st, 2014 - Raillard and Bergua, 2015),

- dispersed housing is increasing,

- electricity pylons are increasingly visible in the landscape (even in the strict protection areas registered in the SAR (proposed transversal line in northern Martinique in large forest areas) and the SMVM (Sea Promotion Scheme),

- agricultural plots are being developed at the expense of the soil-protecting forest relicts, specifically in the south of the island for the benefit of banana cultivation, whereas this remarkably subsidised crop is very vulnerable with regard to cyclonic disturbances whatever their scale,

- the protected bays are undergoing hyper-sedimentation and repeated multi-phase pollution, resulting in the disappearance of seagrass beds and the contamination of what remains as biological organisms in the food chain,

- the quality of the water is highly worrying affected by pollutants from multiple sources: insufficiently protected catchment areas of homes and livestock farms (cattle), landfill leachates, mass use of pesticides, partial treatment of wastewater and of organic matter of domestic origin, industrial waste of all kinds, particularly those related to rum and sugar production.

The list of indicators of deregulation is far from exhaustive. It ultimately sets out the level of disorganisation in the management of the environment. Solving the problem of priorities in terms of unavoidable development implies that the latter be articulated both in the international context and in the selected focus areas marked by significant local realities. It is only by taking its natural assets into account that Martinique can develop itself economically with regard to tourism. In no way should one be mistaken, since there are not significant underground riches, only the ecosystems, anthropised or not, indicated by sites and landscapes of rare quality and diversified appeal, will enable the incessantly repeated wishes by the successive decision-makers, of balanced, sustainable or controlled development (Note 20) to be granted. It seems essential and urgent to begin work, under the guise of a strong political will, on the necessary actions for spatial, sub-structural, social and economic readjustments (micro-development). The concrete actions will have to be involved within this framework: the *in situ* protection of the species and the natural monuments (ecosystems of great complexity nevertheless subject to anthropogenic degradation), the sustainability of the surface and underground water resource (better management of catchment areas), mechanical soil protection through agroforestry and forestry projects of valuable wood species of local flora.

In the end, much more education regarding the environment, strengthened by the pooling of all the existing studies and information in the form of an environmental database integrating all aspects or subsets of the Martinique ecosystem, is a primary objective to be achieved. Systemic thinking requires that the particular evolutions of the composite elements of the space be monitored. Consequently, the establishment of a true environmental observatory or an equivalent body which serves as a tool to aid decision-making, in terms of the suitability of the projects, seems to be a must. Otherwise, the current directives concerning the future development of Martinican society through its human, biological and physical resources, marked out on cartographic documents at the municipal (PLU) and regional [SAR, SMVM, ZNIEFF, Littoral Conservatory, PER (plan of exposure to risks)] levels, risk becoming hollow rhetoric adorning beautiful diagrams in excellent decorative reports.

8. Conclusion

The environment in the French Antilles with regard to all that was mentioned above in terms of disadvantages and handicaps is in the end a broad field of investigation for scientists and public and private developers, where the problems related to the trinomial "organisation of space / development / environmental balance" are singularly numerous. It is precisely this interweaving of problems that are difficult to solve which established the need for a different, original, differentiated and responsible vision of the decision-making bodies at all levels of social structuring. This vital challenge, a balanced environment in covariance with sustainable economic, social and cultural progress adapted to the globalising world but which is nevertheless very specific, is an engine for development based mainly on the reality of the physical and biological environments and not on the transfers of concepts, technologies and procedures, beset in part by their unsuitable modes of operation.

References

Adams, J. E. (1978). Union Island, West Indies: An historical and geographic sketch. *Caribbean Studies*, *18*(3/4), 5-45. Retrieved from http://www.jstor.org/stable/25612839

Alscher, S. (2011). Environmental degradation and migration on Hispaniola Island. *International Migration*, *49*(s1), 164-188. https://doi.org/10.1111/j.1468-2435.2010.00664.x

Baban, S. M., & Wan, Y. K. (2001). Mapping land use/cover distribution on a mountainous tropical island using remote sensing and GIS. *International Journal of Remote Sensing*, *22*(10), 1909-1918. Retrieved from https://www.tandfonline.com/doi/pdf/10.1080/01431160119220

Baillard, K. (2016). The Effects of Anthropization on the Coastal Island Vegetation: The Example of the Mangrove Forest of the Bay of Fort-de-France (Martinique). *International Journal of Recent Research and Review*, *9*(2), 1-14. Retrieved from https://www.google.com/search?q=Baillard+&sitesearch=ijrrr.com

Baldacchino, G. (2008). Studying islands: on whose terms? Some epistemological and methodological challenges to the pursuit of island studies. *Island Studies Journal*, *3*(1), 37-56. Retrieved from https://www.islandstudies.ca/sites/default/files/ISJ-3-1-2008-Baldacchino-FINAL.pdf

Blondel, J. (2010). *The Mediterranean region: biological diversity in space and time*. Oxford University Press.

Boudadi-Maligne, M., Bailon, S., Bochaton, C., Casagrande, F., Grouard, S., Serrand, N., & Lenoble, A. (2016). Evidence for historical human-induced extinctions of vertebrate species on La Désirade (French West Indies). *Quaternary Research*, *85*(1), 54-65. https://doi.org/10.1016/j.yqres.2015.11.001

Carpenter, S. R., Mooney, H. A., Agard, J., Capistrano, D., DeFries, R. S., & Díaz, et al. (2009). Science for managing ecosystem services: Beyond the Millennium Ecosystem Assessment. *Proceedings of the National Academy of Sciences*, *106*(5), 1305-1312. https://doi.org/10.1073/pnas.0808772106

Carrington, S. H. (2003). Capitalism & Slavery and Caribbean historiography: an evaluation. *The Journal of African American History*, 304-312. https://doi.org/10.2307/3559074

Carstensen, D. W., Dalsgaard, B., Svenning, J. C., Rahbek, C., Fjeldså, J., Sutherland, & W. J., et al. (2012). Biogeographical modules and island roles: a comparison of Wallacea and the West Indies. *Journal of biogeography*, *39*(4), 739-749. https://doi.org/10.1111/j.1365-2699.2011.02628.x

Christoff, P. (1996). Ecological modernisation, ecological modernities. *Environmental politics*, *5*(3), 476-500. https://doi.org/10.1080/09644019608414283

Cohen, S. (1984). *Formation et évolution des paysages à la Martinique de 1635 à nos jours*. Paris : Université Paris VIII (France), 315 p. (Thèse de 3e cycle).

Connell, J. (2010). Pacific islands in the global economy: Paradoxes of migration and culture. *Singapore Journal of Tropical Geography*, *31*(1), 115-129. https://doi.org/10.1111/j.1467-9493.2010.00387.x

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., & Hannon, B., et al. (2016). The Value of the World's Ecosystem Services and Natural Capital (1997). *The Globalization and Environment Reader, 117.* https://doi.org/10.1038/387253a0

Curtis, J. H., Brenner, M., & Hodell, D. A. (2001). *Climate change in the circum-Caribbean (Late Pleistocene to Present) and implications for regional biogeography.* In Biogeography of the West Indies: Patterns and Perspectives, Second Edition (pp. 35-54). CRC Press. Retrieved from https://www.taylorfrancis.com/books/e/9781420039481

Delawarde, J. B. (1935a). *Essai sur l'installation humaine dans les mornes de la Martinique. Sites et agglomérations dans le nord de l'île, Fort-de-France*. Imprimerie du gouvernement.

Delawarde, J. B. (1935b). *Les défricheurs et les petits colons de la Martinique au XVIIe siècle*. Paris : (s.n), (imp.R. Buffaut).

Delawarde, J. B. (1936). *Le Prêcheur : histoire d'un établissement sur les pentes de la Pelée.* Préface de Théodore Baude. Paris : (s.n), (imp. R.Buffault).

Dew, N. (2010). Scientific travel in the Atlantic world: the French expedition to Goree and the Antilles, 1681–1683. *The British Journal for the History of Science*, *43*(01), 1-17. https://doi.org/10.1017/S0007087409990057

Fahrig, L. (2003). Effects of habitat fragmentation on biodiversity. *Annual review of ecology, evolution, and systematics*, *34*(1), 487-515. Retrieved from https://www.annualreviews.org/doi/10.1146/annurev.ecolsys.34.011802.132419

Fiard, J. P. (1994). *Les forêts du nord de la montagne Pelée et des édifices volcaniques du piton Mont-Conil et du Morne-Sibérie.* Diplôme universitaire de phyto-écologie tropicale et aménagement insulaire. Université des Antilles et de la Guyane (Martinique).

Galli, A., Wiedmann, T., Ercin, E., Knoblauch, D., Ewing, B., & Giljum, S. (2012). Integrating ecological, carbon and water footprint into a “footprint family” of indicators: definition and role in tracking human pressure on the planet. *Ecological indicators*, *16*, 100-112. https://doi.org/10.1016/j.ecolind.2011.06.017

Gerbi, A. (2010). *Nature in the New World: From Christopher Columbus to Gonzalo Fernández de Oviedo*. University of Pittsburgh Pre.

Gómez-Baggethun, E., De Groot, R., Lomas, P. L., & Montes, C. (2010). The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. *Ecological economics*, *69*(6), 1209-1218. https://doi.org/10.1016/j.ecolecon.2009.11.007

Graham, A. (2010). *A natural history of the New World: the ecology and evolution of plants in the Americas*. University of Chicago Press.

Higman, B. W. (2010). *A concise history of the Caribbean*. Cambridge University Press.

Howard, R. A. (1979-1989*). Flora of Lesser Antilles, Leeward and Windward Islands, Monocotyledoneae (Vol.3), Dicotyledoneae (Vol.4: part. 1,2,3*. Arnold Arboretum, Havard University, Jamaïca Plain, Massachussetts.

Imbert, D., Bonhême, I., Saur, E., & Bouchon, C. (2000). Floristics and structure of the Pterocarpus officinalis swamp forest in Guadeloupe, Lesser Antilles. *Journal of Tropical ecology*, 55-68.

IPCC. (2013). *Climate Change: The Physical Science Basis*. Working group I contribution to the fifth assessment report of the intergovernmental panel on climate change, Geneva (Switzerlan).

Joseph, P. (1997). *Dynamique, écophysiologie végétales en bioclimat sec à la Martinique*. Thèse de doctorat (nouveau régime), Université des Antilles et de la Guyane (Martinique).

Joseph, P. (2009). *La végétation forestière des Petites Antilles: synthèse biogéographique et écologique, bilan et perspectives*. KARTHALA Editions.

Joseph, P. (2012). The vegetation of the Lesser Antilles: floristic diversity and ecosystemic dynamics. *International Journal of Environmental Studies*, *69*(5), 816-833. https://doi.org/10.1080/00207233.2012.715384

Joseph, P. (2014). The Influence of Vegetation on the Main Macro-Climatic Factors: The Example of the Lower Vegetal Floor of Martinique (Lesser Antilles). *Open Jounal of Botany (OJB)*, *1*(1), 5-18. https://doi.org/10.12966/ojb.03.02.2014.

Joseph, P. (2015). The Final Stages of Vegetal Dynamics in the Lesser Antilles (A Few Theories). *International Journal of Science and Research (IJSR)*, *4*(11), 1151-1164. Retrieved from https://www.ijsr.net/archive/v4i11/NOV151356.pdf

Joseph, P., & Baillard, K. (2017). Some Elements of Knowledge on the Coastal Floristic Formations of Martinique (French West Indies). *Journal of Geography and Geology*, *9*(2), 39-45. https://doi.org/10.5539/jgg.v9n2p39

Lambin, E. F., & Meyfroidt, P. (2010). Land use transitions: Socio-ecological feedback versus socio-economic change. *Land use policy*, *27*(2), 108-118. https://doi.org/10.1016/j.landusepol.2009.09.003

Larsen, M. C., & Simon, A. (1993). A rainfall intensity-duration threshold for landslides in a humid-tropical environment, Puerto Rico. *Geografiska Annaler. Series A. Physical Geography*, 13-23. https://doi.org/10.1080/04353676.1993.11880379

Leigh, E. G., Wright, S. J., Herre, E. A., & Putz, F. E. (1993). The decline of tree diversity on newly isolated tropical islands: a test of a null hypothesis and some implications. *Evolutionary Ecology*, *7*(1), 76-102. https://doi.org/10.1007/BF01237735

Lindborg, R., & Eriksson, O. (2004). Historical landscape connectivity affects present plant species diversity. *Ecology*, *85*(7), 1840-1845. https://doi.org/10.1890/04-0367

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., & Moran, E., et al. (2007). Complexity of coupled human and natural systems. *science*, *317*(5844), 1513-1516. https://doi.org/10.1126/science.1144004

Lobban, C. S., & Schefter, M. (1997). *Tropical Pacific island environments*. Island Environments Book: University of Guam Press

Mace, G. M., Norris, K., & Fitter, A. H. (2012). Biodiversity and ecosystem services: a multilayered relationship. *Trends in ecology & evolution*, *27*(1), 19-26. https://doi.org/10.1016/j.tree.2011.08.006

McElroy, J. L., & Parry, C. E. (2010). The characteristics of small island tourist economies. *Tourism and Hospitality Research*, *10*(4), 315-328. doi/pdf/10.1057/thr.2010.11

Miettinen, J., Shi, C., & Liew, S. C. (2011). Deforestation rates in insular Southeast Asia between 2000 and 2010. *Global Change Biology*, *17*(7), 2261-2270. https://doi.org/10.1111/j.1365-2486.2011.02398.x

Musard, O., Fournier, J., & Marchand, J.P. (2007). Le proche espace sous-marin : essai sur la notion de paysage. *L'Espace géographique*, 2 (36), 168-185. https://doi.org/10.3917/eg.362.0168

Peterson, T. C., Taylor, M. A., Demeritte, R., Duncombe, D. L., Burton, S., & Thompson, F., et al. (2002). Recent changes in climate extremes in the Caribbean region. *Journal of Geophysical Research: Atmospheres*, Res., 107(D21), 4601. https://doi.org/10.1029/2002JD002251.

Portecop, J. (1978). *Phytogéographie, cartographie écologique et aménagement dans une île tropicale : Le cas de la Martinique.* Grenoble (France), thèse de IIIe cycle.

Raillard, J. P., & Bergua, F. (2015). *Le coût de possession et d'usage d'une automobile Comparatif entre la Martinique et la France*. Ce rapport a été réalisé à la demande de l'Observatoire des prix, des marges et des revenus de la Région Martinique (Rapport final), Syndex-Paris (France).

Schmidt, B. (1997). Mapping an Empire: Cartographic and Colonial Rivalry in Seventeenth-Century Dutch and English North America. *The William and Mary Quarterly*, *54*(3), 549-578. https://doi.org/10.2307/2953839

Sheridan, R. B. (1974). *Sugar and slavery: An economic history of the British West Indies, 1623-1775*. University of West Indies Press.

Srinivasan, T. N. (1986). The costs and benefits of being a small, remote, island, landlocked, or ministate economy. *The World Bank Research Observer*, *1*(2), 205-218. https://doi.org/10.1093/wbro/1.2.205

Vicente, V. P. (1989). Regional commercial sponge extinctions in the West Indies: Are recent climatic changes responsible?. *Marine Ecology*, *10*(2), 179-191. https://doi.org/10.1111/j.1439-0485.1989.tb00073.x

Westercamp, D., & Andreieff, P. (1989). *Carte géologique à l'échelle 1/50 000 : Martinique*. Orléans (France), éditions du BRGM.

Appendix 1. Figure 6 Legend

1-1 Forestry formation in dry subhumid bioclimate on narrow rocky ridges, derived from the evergreen seasonal tropical woods of the lower horizon at the secondary stage structured with *Tabebuia heterophylla* (pear) *Lonchocarpus violaceus* (soap tree) and *Bursera simaruba* (red gum): physiognomy similar to that of the semi-deciduous tropical forest. For islands of the interior under a subhumid wet bioclimate the word "inversion" should be added at the beginning of the description.
1-2: Forest formation in bioclimate dry subhumid forest on slopes and coastal cliffs derived from the evergreen seasonal tropical woods with a lower horizon in its most xeric profile, secondary stage with *Tabebuia heterophylla* (pear), with a physiognomy similar to that of the deciduous forest in the tropical dry season. It should be noted

also that in conditions of unstable sloping soil which do not allow the realisation of all stages of succession, this formation can be considered climactic.
2-1: Forest formation in subhumid-humid bioclimate, peak, evergreen seasonal tropical horizon type, at climactic stage, with *Manilkara bidentata* (balata) *Ormosia monosperma* (red caconnier) *Cassipourea guianensis* (goatwood).
2-2: Forest formation in subhumid-humid bioclimate evergreen seasonal tropical horizon type, secondary stage *Lonchocarpus violaceus* (lilac tree), *Ocotea cernua,* Pisonia fragrans (mapou).
2-3: Forest formation in subhumid-humid bioclimate on steep slopes with skeletal soil with *Tabebuia heterophylla* (pear) and *Myrcia citrifolia* (small leaved cherry). As before, the climatic conditions are specific to the existence of seasonal tropical evergreen forest, here, lower horizon. Topography (steep slopes) and edaphic characteristics (skeleton soils) ensure that the evolution of these vegetation units is extremely slow and ancient anthropogenic and/or natural disturbances are restored on a very long time scale in the absence of notable new destructuring (natural and/or anthropogenic). This formation can be also therefore be considered as a paraclimactic; the physiognomy results from the semi-deciduous or even deciduous tropical dry season woodland (UNESCO).
2-4/2-10: High shrub formation in subhumid-wet bioclimate with *Bambusa vulgaris.* The conclusions drawn above are applicable here. The steep slopes and deforestation promote colonisation of these plant communities that can block for decades the evolution of vegetation cover. Rightly the bamboo (*Bambusa vulgaris*) can be considered as a potential plant pest.
2-5: Forest formation in subhumid peak bioclimate wet, tropical evergreen seasonal upper horizon, at climactic or subclimactic stage with *Manilkara bidentata* (balata), *Ocotea leucoxylon* (Laurier fine), *Prestoea montana* (mountain palm) *Ormosia monosperma* (red caconnier).
2-6: Subhumid bioclimate forest formation of moist valley bottoms and confined areas, evergreen seasonal tropical upper horizon subclimactic stage with *Calophyllum calaba* (Galba), *Ocotea leucoxylon* (Laurier fine), *Andira inermis* (Angelin) (Note 21).
2-7: Subhumid wet forest bioclimate formation, evergreen seasonal tropical higher horizon secondary stage structured with Sapium caribaeum (Bois-la-glu), *Cinnamomum elongatum* (cinnamon laurel), *Ocotea leucoxylon* (Laurier fine), *Lonchocarpus pentaphyllus* (large soap tree).
2-8: Subhumid bioclimate wet forest formation, riparian (slight slopes and riparian terraces), evergreen seasonal tropical secondary stage with *Samanea saman* (samana), *Sapium caribaeum* (Bois-la-glu) *Lonchocarpus domengensis* (river soap tree). This profile is very specific. Climatic conditions in these places are close to those of humid bioclimate where hygrophilous formations develop. Therefore, despite the regression stage expressed, the inversion qualifier is required.
2-9: Subhumid bioclimate wet forest formation on steep slopes in deep soils with *Lonchocarpus violaceus* (soap tree), *Cecropia schreberiana* (bois canon) *Ochroma pyramid* (bois flot). The climatic conditions for the emergence of evergreen seasonal tropical woodland exist, but continuing instability due to deep, steep soils insufficiently protected by root fabric, results in perpetual rejuvenation of the plant ecosystem. Structures described by the author can be seen in some respects as paraclimactic.
3-1: Inversion forest formation in humid bioclimate in valleys and on lower slopes, umbro-evergreen seasonal tropical climactic with *Sloanea dentata* (broadleaf chestnut), *Chimarrhis cymosa* (bois riviere), *Guarea macrophylla* (bois pistolet), *Ocotea leucoxylon* (Laurier fine), physiognomy equivalent to the rainforest. The inversion in this case is due to the development of tropical mountain rainforest species in areas macroclimatically favourable to the seasonal evergreen tropical forest type of the upper horizon (Note 22).
3-2: Inversion forest formation in humid bioclimate on ridge tops and slopes, umbro-evergreen seasonal tropical climactic with *Talauma dodecapetala* (magnolia), *Ormosia monosperma* (red caconnier), *Prestoena montana* (mountain palm). Here inversion is the consequence of the extension of the sylvan tropical evergreen seasonal climactic to higher altitudes, beyond its main area of establishment.
3-3: Forest formation in bioclimate wet umbro-evergreen seasonal tropical stage subclimactic with *Chimarrhis cymosa* (bois riviere) *Sloanea dentata* (broadleaf chestnut) *Guarea macrophylla* (Bois-pistolet), *Sapium caribaeum* (Bois-la-glu). The ecotone currently is achieved by the partial overlapping of near bioclimatic bands.
3-4: Forest formation in humid riparian bioclimate, umbro-evergreen seasonal tropical at climactic stage with *Chimarrhis cymosa* (bois riviere) *Sloanea dentata* (broadleaf chestnut) *Ficus insipida* (white ficus), *Dussia martinicensis* (bois gamelle). Riparian microclimatic conditions make this plant association the most dominant,

especially on hydrophorm soils and with frequent overflows from adjacent watercourses. But they are sufficient due to moisture and water resources for the establishment of submountainous tropical rainforest units.
3-5: Forest formation in wet bioclimate umbro-evergreen seasonal tropical secondary stage *Chimarrhis cymosa* (bois-riviere), *Sapium caribaeum* (Bois-la-glu), *Ocotea leucoxylon* (Laurier fine), *Lonchocarpus pentaphyllus* (large soap tree). This ecotone may be an aspect of the degradation of the tropical montainous rainforest climactic of the lower horizon.
3-6: Riparian forest formation in humid bioclimate, umbro-evergreen seasonal tropical secondary stage with *Sapium caribaeum* (Bois-la-glu) *Ficus insipida* (white ficus) *Samanea saman* (Samana), *Chimarrhis cymosa* (bois-riviere). Ecoclimatic conditions in this topographic unit are similar to those necessary for the election of submountainous rainforest. It is ultimately permanent constraints such as specific "edaphism" (hydromorphic soils) and disturbance due to weather conditions (floods) that will condition both the selection of potential flora species and successional directions.
4-1: Forest formation in humid to hyperhumid bioclimate of the Caribbean basin, submountainous tropical rainforest lower horizon, at climactic stage with *Sloanea caribaea* (Acomat-boucan), *Sloanea dentata* (broadleaved chestnut), *Chimarrhis cymosa* (bois-riviere), *Talauma dodecapetala* (magnolia), *Prestoea montana* (mountain palm).
4-2: Forest formation in humid to hyperhumid bioclimate, southwest slopes of Morne Sibérie, submountainous rainforest tropical lower horizon, climactic with *Talauma dodecapetala* (magnolia), Palm (*Prestoea montana*), *Chimarrhis cymosa* (bois-riviere), *Sloanea dussii* (petit coco chestnut).
4-3: Forest formation in humid to hyperhumid bioclimate at valley bottom, submountainous tropical rainforest lower horizon, at climactic stage with *Sloanea dentata* (broadleaved chestnut) *Pouteria multiflora* (gingerbread) *Chimarrhis cymosa* (bois-riviere).
4-4: Forest formation in humid to hyperhumid bioclimate, submountainous tropical rainforest lower horizon subclimactic stage with *Chimarrhis cymosa* (bois-riviere) *Sloanea dentata* (broadleaved chestnut), *Sapium caribaeum* (Bois-la-glu).
4-5: Forest formation in humid to hyperhumid bioclimate, submountainous tropical rainforest lower horizon secondary stage *Ocotea leucoxylon* (Laurier fine), *Chimarrhis cymosa* (bois-riviere), *Sapium caribaeum* (Bois-la-glu), *Inga ingoides* (hairy sweet pea).
4-6: Forest formation in hyperhumid bioclimate in the Caribbean basin, tropical mountainous type, at climactic stage with *Talauma dodecapetala* (magnolia), *Tapura latifolia* (bois côte), *Sloanea Massoni* (small-leaved chestnut), *Prestoea montana* (mountain palm).
4-7: Forest formation in hyperhumid bioclimate, Atlantic slope submountainous tropical rainforest type, at climactic stage with *Talauma dodecapetala* (magnolia), *Dacryodes exelsa* (white gum) *Sloanea Massoni* (small leaved chestnut) *Prestoea montana* (mountain palm).
4-8: Forest formation in hyperhumid bioclimate, Atlantic slope, derived from tropical mountainous rainforest type, subclimactic stage with *Prestoea montana* (mountain palm) *Talauma dodecapetala* (magnolia), *Chimarrhis cymosa* (bois-riviere).
4-9: Forest formation in hyperhumid bioclimate, Atlantic slope, derived from tropical mountainous rainforest type, secondary stage with *Prestoea montana* (palm), *Chimarrhis cymosa* (bois-riviere), *Ocotea martinicensis* (mountain laurel), *Marila racemosa* (Cachiman grand bois).
4-10: Riparian forest formation in humid to hyperhumid bioclimate, submountainous tropical rainforest lower horizon, at climactic stage, *Chimarrhis cymosa* (bois-riviere), *Slonea caribaea* (Acomat-boucan), *Sapium caribaeum* (Bois-la-glu). This range of species is terminal because of permanent conditions of instability (soil and water).
4-11: Mixed forest formation shrub/grass in hyperhumid bioclimate on steep slopes (50 °) with *Cyathea arborea* (tree fern), *Heliconia bihai* (balisier), *Prestoea montana* (mountain palm). The potential rain here, too, is sufficient for the emergence of sub-tropical mountain rainforest clusters. Limiting factors that oppose the existence of sylvigenetic processes are topographical and cause continual rejuvenation. Successional cycles result in plant communities with mixed physiognomy which in this situation could be considered terminal.
5-1: Bioclimate hyperhumid forest formation, tropical mountain rainforest with *Prestoea montana* (mountain palm), *Micropholis guianensis* (gold leaf), *Myrsine trinitatis* (Caca-Ravet).
5-2: Formations of volcanic crests superior to "Palmiste": Prestoea montana, "Tree fern": Cyathea arbora, "Crécré rouge": Charianthus corymbosus and "Balisier": Heliconia bihai.

Notes

Note 1. Rio de Janeiro Earth Summit (Brazil, 1992), Kyoto Protocol on Climate Change (Japan, 1997), Johannesburg World Summit on Sustainable Development (South Africa, 2002), Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES, 2012), Nagoya World Conference on Biodiversity (COP 10, 2014), Paris Climate Conference (COP 21, 2015), etc.

Note 2. Natural source producing a part of the breathable oxygen and storing a large mass of carbon.

Note 3. The ecological units or eco-units presented an astonishing heterogeneity.

Note 4. Anthropisation reduced the area of the primitive forest climactic groundcover, the periods preceding the discovery of the tropical American islands.

Note 5. Especially for populations with the new status of free men which were nonetheless alienated such as labourers needed for the operation of sugar mills and rum distilleries.

Note 6. Plots not congruent with the extensive cultivation of the glorious days of sugar cane.

Note 7. In Martinique the distribution of structuring units is one of the most unequal: frequently over-density of tourism works are disfiguring forever the dominated littoral sections.

Note 8. DDAF: Departmental Directorate of Agriculture and Forestry.

Note 9. Sometimes in its most xeric facies.

Note 10. Of variable ionic strength or variable salinity depending on its position, relative to the marine edge.

Note 11.The mangrove forest has a protective effect on the vegetal entities close to the mainland.

Note 12. The set acts in cooperation to ensure the integrity of the entire system.

Note 13. Despite its continuous aspect this mangrove forest bears the mark of successive phases of anthropisation and its area has in recent decades greatly decreased.

Note 14. These floods and bank exposures are necessary for the installation of this vegetal formation of wet biotopes.

Note 15. In general, the developmental trajectories are subsequent to the physical and biological modalities of the geographical regions where the different civilisations settled.

Note 16. Particularly socio-economic and socio-professional.

Note 17. The physical and biological subsets give each municipality a unique and singular character as regards the environment.

Note 18. We automatically think of the Caravelle reserve managed by the PNM (Martinique Natural Park which concerns two thirds of the island) the deplorable management of which was condemned as the main cause of the poor results obtained at the meeting of the commission of experts in December 1994.

Note 19. ZNIEFF - Natural Areas of Ecological, Faunistic and Floristic Interest.

Note 20. Especially at meetings for outlining planning guidelines

Note 21. In the lower stage with dry subhumid bioclimate the term "inversion" should be added to the physiognomic indicator at the beginning of the description.

Note 22. Due to the sylvatic climactic microclimate that generates appropriate host sites.