Urban regulations and climate change in low lying coastal cities, State of Pará, Brazil

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Abstract: Studies carried out in the North of Brazil reveal that the low-lying coastal zone has been severely and increasingly impacted by storm floods and erosion processes in the last 25 years affecting the life and socioeconomic activities (fishing, tourism, crab and shrimp collection) of the population. Diverse authors correlate this situation with evidence of climate change and global and relative sea-level rise. In response to these impacts a variety of autonomous and/or planned coastal defense measures and adaptation strategies have been applied in the region, but with only limited success.

Some land-use laws and urban regulations of the coastal zone of the State of Pará - Municipal setback regulations, and urban zoning laws at federal and muncipal levels, such as the 'Non Aedificandi' (no-building) areas, and the 'Terras de Marinha' (marine lands) areas are described. The setback zones's objective is to keep structures away from potential erosion and flooding damage, and protection of the public sight and access to the shore. The 'non aedificandi' areas regulate the land use near the channels and rivers, and the 'Terras de Marinha' are a 33m-wide strip of federal land horizontally measured landward from the position of the average high tide level of 1831 affecting the islands and the coast, river and lake margins, up to the place where tidal influence is observable.

Then, they are analyzed as a planning tool for preventing, discouraging, restricting or prohibiting human activities and development in risk prone areas, as well as in discussion on the potential impacts of future scenarios of changing coastal environment on the implementation and performance of the urban laws and regulations.

Résumé: Des études effectuées dans le nord du Brésil révèlent que la zone côtière basse a été de plus en plus sévèrement affectée par des inondations dues à des orages et que les processus d´érosion au cours des 25 dernières années ont influé sur la vie et les activités socio-économiques (pêche, tourisme, pêche de crabe et de crevettes) de la population. Divers auteurs rapportent cette situation avec les changements de climat et les preuves de la montée globale et relative du niveau de la mer. En réponse à ces effets, plusieurs mesures, indépendantes et/ou planifiées, et des stratégies adaptatives ont été appliquées dans la région, mais seulement avec un succès limité./

Quelques lois et réglementations urbaines sur l´utilisation des sols de la zone côtière de l´état du Pará sont décrites : les réglementations municipales sur les zones de recul, les lois municipales et fédérales de zonage urbain, comme par exemple les zones « Non Aedificandi » ou les « Terras de Marinha » (terres marines). Les zones de recul ont pour objectif de laisser les édifices loin des zones pouvant subir une action érosive des inondations et de protéger la vue et l´accès au public à la plage. Les zones "non aedificandi" régissent l´utilisation des sols prés des canaux et des rivières. Les « Terras de Marinha » sont des bandes de terres fédérales, de 33m de large, mesurées horizontalement en direction des terres à partir de la ligne de rivage de référence (moyenne des niveaux de marées hautes de l´an 1831) s´exerçant sur les îles, les bords de mer, de rivière et de lac jusqu´au niveau où l´influence de la marée est observable.

Ces réglementations sont ensuite analysées comme un outil adaptatif prévenant, décourageant ou interdisant les activités humaines et le développement de zones à risque. Les aspects des effets potentiels de futurs scénarios de modifications de l´environnement côtier dues à la mise en œuvre et aux performances des lois urbaines et des réglementations seront discutés.

Keywords: climate change, legislation, land use, urban geosciences,

INTRODUCTION

In the past few years, no environmental issue has risen so high in scientific, political and public interest and debate as the potential effects of global climate change as a result from the "Greenhouse Effect" (Milliman & Haq 1996). The weather and climate on the earth are naturally extremely variable; however, recent analyses suggest that the current rise in temperature is very unlikely to be due only to natural causes (SwissRe 1996). This effect is the result of recent increasing concentrations in the atmosphere, of the greenhouse gases - carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide. The change in gas concentration is probably a result of human activities (Houghton 1999).

The most widely employed climate change scenarios, based upon highly complex general circulation models of the atmosphere and the ocean, project a relatively smooth path of global average temperature rise of about 2°C to 3.5°C/century (IPCC 2001). These results are still uncertain due to the natural temperature variability, doubts about modeling, and a lack of data on the south hemisphere.

Available observational evidence indicates that global climate changes have already affected a diverse set of physical and biological systems in many parts of the world (Walsh & Ryan 2000; Tucker & Slingerland 1997). According to Berz (1999), global climate change, is increasingly influencing the frequency and severity of natural

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catastrophes. However, it must be highlighted that one of the most important effects of global climate change is sea-level rise.

Although the level of the oceans has always fluctuated according to changes in global temperature, a rising sea level is not only a consequence of the enhanced greenhouse effect (*Steric and Eustatic effect*) (Nicholls & Leatherman, 1995*a*), but also a consequence of the late-Quaternary subsidence movements and the *isostatic* adjustments of the Earth's crust adjacent to regions that have been covered by thick Pleistocene ice sheets (Milliman, Broadus & Gable 1989). However, according to Sterr (2000*a*), thermal expansion and the contribution of melting glaciers and ice caps to the ocean are probably the most significant factors for a climate-driven sea level rise.

Evaluation of historic data sets shows a global average sea level rise for the last 100 to 150 years of 1.4 to 1.8 mm/yr (Gornitz 1995). Compared to the changes in the late Holocene, estimated through well-documented geological records (0.1 to 0.2 mm/yr.), there seems to be a pronounced acceleration in the rate of sea level rise (Gaffin 1997). As the earth's average temperature increases, a scientific consensus has gradually emerged that there is a serious risk that the rate of sea level rise will accelerate during the 21st century in spite of the international efforts to reduce greenhouse-gas emissions (Smith & Tirpack 1989).

The exact global rate of sea level change is unknown so it is not unexpected that a wide range of sea-level change predictions for the next century may be found in the literature, and that the assumed scenarios delineate possible upper and lower envelopes (Lutjeharms & Valentine 1991). One of the most widely accepted results is that in the Intergovernmental Panel of Climate Change (IPCC) models. The estimated sea level rise under the 'Business as Usual' scenario is 60 cm by 2100 (IPCC 2001).

In addition to existing problems of coastal erosion, subsidence, pollution, land use pressures, and ecosystems deterioration, future relative sea level needs to be considered.

Although on actively submerging coasts sea level change problems already exist, these problems will probably become worse in the future. According to Sterr (2000*b*) the analysis of the consequences of sea-level rise on coastal zones requires a comprehensive assessment of primary and secondary effects. First, the hydrodynamic and morphodynamic processes are affected and subsequently, these have a lasting influence on the ecological and socio-economic mechanisms.

Considering the primary effects, many coastal areas are expected to suffer from sea-level rise because it would inundate wetlands and lowlands, accelerate coastal erosion, exacerbate coastal flooding, raise water tables and increase the salinity of the rivers, bays and aquifers (Barth & Titus 1984; Leatherman & Nicholls 1995).

Some studies and reviews have evaluated the potential impacts of sea-level rise on particular biological communities and coastal biodiversity such as mangrove and coral ecosystems (Reid & Trexler 1992; Ellison & Stoddart 1991; Woodroffe 1990; Buddemeier & Smith 1988). The biogeochemical cycles in shallow waters would also change massively because the continuous flooding of low-lying areas with salt water causes the remobilization of nutrients and other mineral compounds (Sterr 2000*b*).

Future greenhouse gas-induced climate change will have implications for global mean climate and sea level, but, more importantly, it will not necessarily raise sea level by the same amount everywhere; there will be contrasting regional variations. A rise or fall of the land surface also causes a relative local fall or rise of sea level respectively (Nicholls & Leatherman 1995*b*).

The stratigraphic distribution and characteristics of the depositional sequences on the NE coastal area of the State of Pará provide a basis for discussing the history of relative sea level fluctuations during the late Cenozoic (Rosseti 2001). Unfortunately, there are insufficient accurate and homogeneous data to analyse the regional changes in the last 100 years in South America, as has been done in the Northern Hemisphere.

Tide records from the last 50 years show a general rise in relative sea-level along the Brazilian coast: Pirazolli (1986) reported a rising trend at four locations for 1950-1970. Aubrey, Emery & Uchupi (1988) reported rates of relative sea-level rise from 0.3 to 3.6 mm/year. According to Muehe & Neves (1995) the high tidal amplitude and the low gradient of the rivers in North Brazil make them particularly sensitive to sea-level rise. They also reported extensive shore erosion along the Brazilian coast. Franzinelli (1982) describes large-scale destruction of mangroves and erosion at the oceanic front in North Brazil. Brazilian mangroves cover a total area of 1.38 million hectares along a coastline of approximately 6800 km (Kjerve & Lacerda 1993). The most exuberant mangrove habitats are found in North Brazil, where similar geomorphological features caused the development of analogous biological units with common fauna and flora and similar patterns of resource exploitation (Szlafsztein et al. 2000). Mangroves develop in low-lying coastal areas, depend on the inter-relationship of sea-level, tidal exposure and sediment accumulation, and are highly susceptible to sea-level rise. Thus, a relative sea-level rise can result in coastal retreat and mangrove swamp migration landward, due to the increase in frequency and spatial distribution of inundation process and erosion rates (Gornitz 1991).

One of the ways to minimize the current and potential impacts of sea level change on ecosystems and human activities is the implementation of a coastal management plan for the region. This requires, in part, the reduction of the regional and local vulnerability through (1) knowledge of the past and present state of the natural and man-made system, in order to predict its evolution under different scenarios and (2) the implementation and execution of prevention, adaptation and mitigation measures in response to changing environmental conditions. These measures include coastal engineering works, activities of civil defense organizations, official and private insurance systems, building regulations and legislation on land occupation and use. The present work describes and analyzes some aspects of the Brazilian legislation on land use and resource utilization at the federal, state and municipal levels, dealing with the impacts and the prevention or mitigation measures of a potential increase of the relative sea level due to global climatic change.

STUDY AREA

North Brazil's coastline is 1,080 km long, extending from French Guyana to the Gurupi River. The Amazon River divides the coastline into two segments. To the north, the platform is smooth, while the southern segment is an irregular "ria" coast. Both segments are characterized by a fringe of muddy sediments covered by mangroves, developed in front of a higher hinterland formed of sedimentary deposits of the Barreiras Formation (Tertiary). The study area is in the southern segment (Figure 1); corresponding to the coastal zone in the north of the Pará State. This has 2 million inhabitants, and is divided in several municipal districts, being Belém the main economical and cultural center. Other districts have a low industrial development and are moderately used for agriculture and cattle farming. Crab collection and fishing and tourism activities are the main sources of income for the inhabitants.

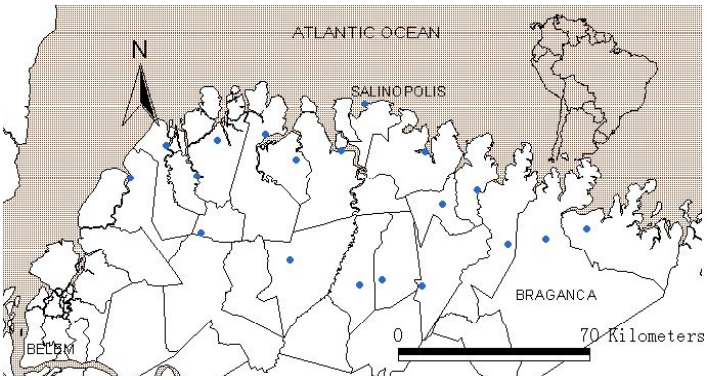

Figure 1. Study area.

URBAN ZONING AND SETBACK REGULATION

The zoning and setback measures are intended to combat development pressure by excluding certain uses in the vicinity of hazard-prone urban areas. The objectives of such setback zones include keeping structures away from the areas of potential erosion and damage by flooding, and protection of the public sight and access to the shore.

In Latin America several countries apply the concept of a "Zona Pública" (public zone), establishing shore land zones based on a specific setback from the shoreline, usually from mean high tide (Clark 1995). In Brazil, the Federal Constitution of 1988 enabled great progress to be made in the management of urban and environmental issues, delegating much of its responsibility to the municipal and state administrative levels (Santos Dias 1996). In this sense, the Constitution of the State of Pará (art. 236) states that the urban policy, elaborated and executed by the State, and principally, by municipal districts, must aim for the complete operation of a city's activities and to guarantee the population's well-being (Brasil 1991). At municipal level, the fundamental laws are included in the *Lei Orgânica* (organic law), which gives a legal framework to diverse municipal policies. Among these, it is important to note the guidelines on urban development strategies, which indicates the requirement to create a "Building code" and an "Urban Master Plan". The latter is a group of rules and technical guidelines related to the physical, economic, social and administrative aspects of the municipal district (Meirelles 1993). Every municipality with more than 20,000 inhabitants must have its own Urban Master Plan, but only few have prepared them in the State of Pará, and only one, Belém, in the coastal area.

All these federal, state and municipal laws explicitly state that all kinds of urban regulations must promote the protection of people against the impacts of hazardous natural processes. To achieve this the urban regulations establish different zones of land use and occupation that vary greatly in configuration and size depending on topography and tidal range. There are zones of variable and fixed dimensions.

Considering the zones of variable dimensions, the Urban Master Plan of Belém (art. 82) divides the city in two areas: "Highlands" and "Lowlands". The first are situated above the topographical level of 4 m., this being the point of historically recorded maximum of water-level (3.86 m), taking into account tidal amplitude and rainfall. The "Lowlands" are located below that topographical level and are affected by permanent or temporary inundation. The fragile character of the "lowlands" is taken into account by the law, designating them "Zones of Special Social Interest", and granting them special rules for urban protection (Belém 1991). Considering the zones of fixed dimensions, these can be divided in three groups, the "Non Aedificandi" areas, the "Terras de Marinha" (*marine lands*)/ the "Acrescidos de Marinha" (*marine reclamation areas*) areas, and the setback lines areas.

i) "Non Aedificandi" areas:

The Urban Master Plan of Belém (art. 88) defines the land use regulations near the channels and rivers. For natural rivers and channels, the "non aedificandi" (no-building) areas cover the width of the channel plus 33 m. on each of its side, starting from its margins. For artificial channels, depending on the drainage basin, the width of the strips can vary from 20 m. to 120 m. In all these areas, occupation and construction is forbidden, and in the case the area is already occupied, it will be recovered through the removal of the existent structures, and a relocation program.

*ii) "Terras de Marinha" (*marine lands*) and the "Acrescidos de Marinha" (*marine reclamation areas*):*

The Federal Constitution of 1988 (art. 20) includes the "Terras de Marinha" and the "Acrescidos de Marinha" as part of the national landmass, establishing thus a federal land use regulation on the coastal zones (Brasil 1991).

The "Terras de Marinha" are a 33m-wide strip of land horizontally measured landward from the position of the average high tide level of 18315 (Figure 2) affecting the islands and the marine coast, river and lake margins, up to the place where tidal influence is observable. In both cases, tidal influence is defined as a periodic oscillation of the water level of at least 5 cm, occurring in any time of the year. The "Acrescidos de Marinha" reclamation areas are those formed natural or artificially at the side of the sea, rivers and/or lakes adjoining to the "Terras de Marinha".

Since 1726 (Royal Orders of December 10), there have been definitions and regulations related to the ownership and use of these areas. However, at present, they show a disordered use and occupation. This situation could be the result of years of numerous, varied and, some times, contradictory regulations and laws. The current Ordinance-law 9760/46, called "The Patrimony Law", definitively transferred to the Federal Heritage Institute (SPU) the administration of all the possessions of the Country (Santos 1985).

The Instruction Normative 1 of 1981 regulates the use and occupation of the "Terras de Marinha" indicating that they can take place under two different frameworks (Ministerio da Fazenda, 1997). (i) By contract, the government grants a person the right to use 83% of the requested area for an equivalent fraction of the current market value (CMV) of the land, but retaining control on the remaining sector for the federal government and, (ii) In fact occupation. The private right affects only the built infrastructure and not the land below it. In both cases the people who use these areas must pay some tax called *Aforo*. The Federal Heritage Institute (SPU) collects taxes of 0.6% of the land's CMV per year from the leaseholder by contract and an annual tax of 2% to 5% of the land's CMV from the occupants.

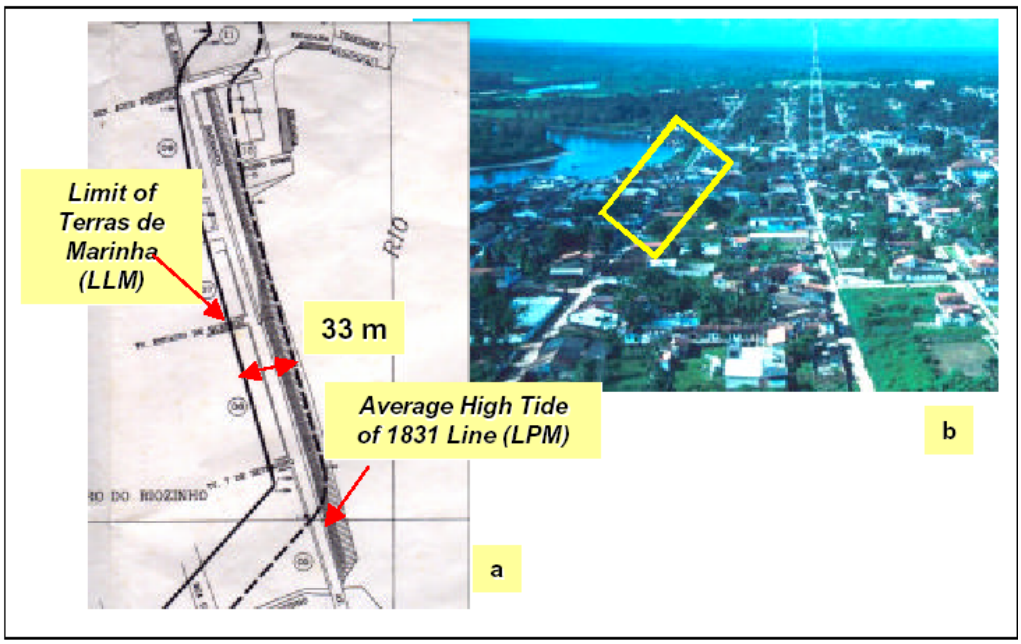

Figure 2. (a) Part of the map of the Bragança City Terras de Marinha, and (b) aerial view of the same area (yellow frame).

iii) Setback lines areas:

They are used to establish a protected buffer zone between the water and the land (Clark 1995). The setbacks should be defined in the Urban Master Plan, but they are still not defined in the coastal municipal districts of Pará. However, considering the magnitude of the impacts of natural processes in areas close to the coastline, many of the Municipal Organic Laws have already established some of these setback lines (Figure 3).

The setback lines, defined as a function of tidal range, do not prohibit the development of these areas but regulates them by limiting the height of construction. The Organic Law of Marapanim (art. 176) prohibits the construction of buildings with more than 2 floors within a 200m-wide strip from the last annual high tide level in the marine, lake or fluvial coasts, and within a 300m-wide strip for buildings with more than 3 floors (Marapanim 1997). In the municipal districts of Magalhães Barata and Maracanã, this second strip is modified (art. 123 of the Organic Laws) considering in this case a fringe of 500m-wide and buildings of more than 6 floors (Magalhães Barata 1990; Maracanã 1990). For some islands and beaches of the municipal district of Belém, it is allowed to construct buildings up to 8 m height within a 200m wide strip from the last annual high tide level, permitting up to 3 floors in the 600m wide strip landward of the 200m strip.

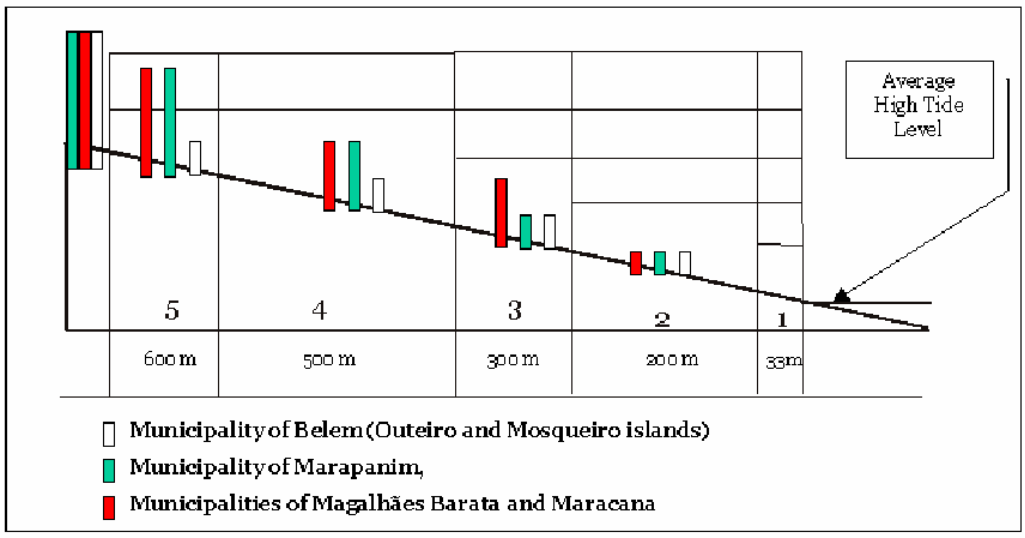

Figure 3. Land use regulations on some coastal municipal districts of Pará. The height of the rectangles is proportionate to the numbers of floors.

POTENTIAL IMPACT ON COASTAL AREAS LAND USE DUE TO SEA LEVEL RISE – CASE STUDIES

Since 1919 there have been examples of the government's difficulty in controlling land use in the "Terras de Marinha"6. Currently, the federal administration continues to face problems completing (a) the demarcation of these areas (strips are only delimited in more than a half of the Brazilian coastline (8,500 km) and in the coastal zone of the state of Pará, only in the cities of Belém, Salinópolis and Bragança); and (b) the inventory of buildings and structures (until the year 2001, only around 500,000 had been registered, paying U$ 65 millions as annual tax ("aforos") in the year 2000) (O Liberal, 2001*c*).

The position of the average high tide line of 1831 (LPM) is determined by the intersection of a horizontal plane, representing the position of the average high tide of 1831 to earth surface. As a consequence of the lack of data, it is necessary to obtain information from the nearest date to 1831 from (a) old plans and documents and (b) tidal level observations (Santos 1985). The first source meets some technical requirements (e.g. topographical contour levels, and indication of the marine border or old buildings) and can be found in public institutions, libraries, religious institutions and other sources of information. The observation of tidal levels is done using the charts prepared by the Hydrographic National Observatory and the Secretary of Hydrography and Sailing (Ministry of the Navy). In the absence of data for the area being considered the closest locality of similar hydrologic situation could be used as the best approximation. The limits of Marinha line (LLM) is a polygon defined by a line drawn 33 meters from the LPM measured horizontally landward (Figure 2a).

This process is a complicated one due to a lack of data (non existent or badly preserved) and has caused an enormous delay in the delimitation of the "Terras de Marinha" in a large part of the Brazilian coastal zone, as well as causing difficulties in urban planning for coastal areas. Consequently, a proposed 'law 7' is under consideration at the National Congress that intends to maintain the strip of 33 m using as LPM the average high tide level line of the year 2000, which can be easily calculated from tidal gauge data measured by the National Hydrographic Service.

According to Aubrey, Emery & Uchupi (1988) and Mesquita (2000) the Belém tidal gauge station has recorded subsidence at a rate of - 0.3 mm/yr to 2 mm/yr. Takinginto account this estimate it is reasonable to assume that the average high tides level line of 2000 is 5 to 33 cm higher than the 1831´s one. Therefore, if the 2000-year line law is approved, what would be the effects on the coastal areas? The "Terras de Marinha" strip will migrate landward affecting new areas and sectors nearer to the sea will change their flooding regime, probably ceasing to be considered as "Terras de Marinha". Depending on the land topography and the position on the 2000 line level, people could be affected more or less by floods or by payment of taxes (Figure 4). Also, the property rights could be changed. The demarcation of the "Terras de Marinhas" would be retroactive, thus any property owner of the new areas considered "Terras de Marinha", even when there is a property contract, would be able to use it, only as a federal government's concession paying the annual "aforo".

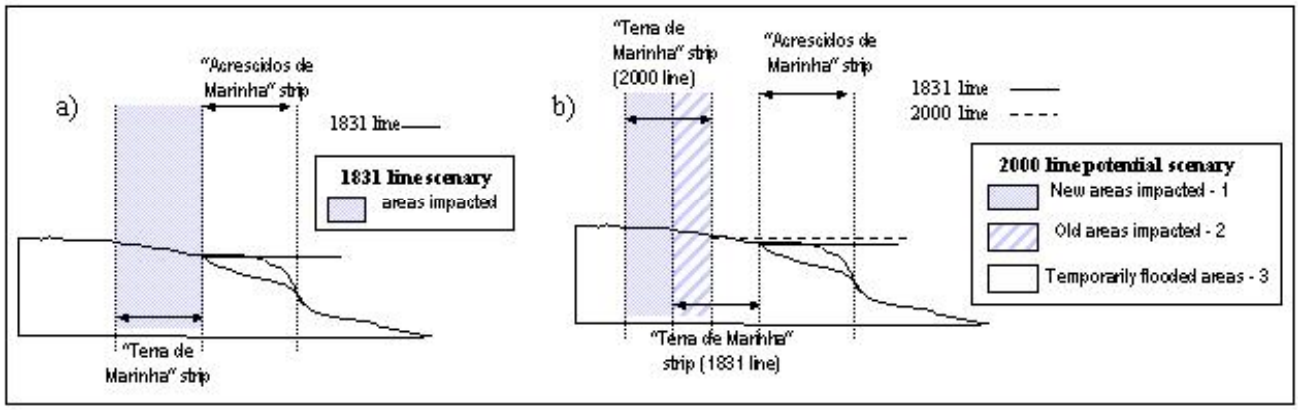

Figure 4. Schematic diagram of the current coastal land use "Terras de Marinha" strip delimited using the average high tide level of 1831 and the potential modifications considering the 2000-year line and a sea level rise scenario.

FINAL CONSIDERATIONS

Many of the adaptation options are likely to be influenced by prevailing social norms, or to be subjected to legislation, principally those that may encourage, restrict or totally prohibit the land use or occupation of coastal areas. In the NE coast of the State of Pará, a great part of the regional and urban land use and occupation is intimately related to natural environmental conditions, and much of its regulation in the coastal areas, is associated with tidal patterns.

The contents of the laws of the state and coastal municipalities could be interpreted as an expression of the authorities awareness of the of effects erosion and flood hazards. Legal zoning or land-use policies and regulations enable an orderly and equitable occupation of, or pullback from, the most vulnerable areas. However, this is clearly not enough to eliminate the risk to the population.

Although there are adequate institutions and legal frameworks to plan and implement adaptive responses, they do not completely fulfil their objectives. Two important aspects contribute to this situation (i) the land and natural resources appropriation in the coastal zone of the state of Pará and (ii) the non-implementation or monitoring of the existent laws.

The Federal Constitution – art. 20 - explicitly considers the coastal areas (maritime beaches, coastal and oceanic islands), the "Terras de Marinha" and their contiguous reclamation areas as part of the Brazilian national patrimony (Brasil 1989). All the other coastal oceanic areas and islands that do not belong to the Nation or to private people are included among the property of the state and municipal districts (art. 26). Therefore, in practice, there is a complex framework of executive ministries, secretaries and organisations that regulate, manage, and control natural resources, land use, and human activities (Table 1). This circumstance frequently produces gaps in legislation and/or contradictions among federal, state and municipal levels, deeply hindering the preparation and execution of adaptation response measures for the effects of natural processes.

Table 1. Levels and organizations that legislate and regulate coastal use and activities.

Administration Levels		
Federal	**State of Pará**	**Coastal Municipal Districts**
Congress	Legislative Assembly	Councilor Chamber
Treasury	State Treasury (SEFA)	Municipal Treasury
Environment Ministry – Federal Environmental Agency (IBAMA)	Science Environment and Technology Secretary (SECTAM)	Environment Secretary
Sports and Tourism ministry – Tourism Institute of Brazil (EMBRATUR)	Tourisms Company of Pará (PARATUR)	Tourism Secretary
Agriculture Ministry	Secretary of Agriculture (SAGRI)	Agriculture Secretary
Science and Technology Ministry (MCT)	Executive Secretary of Urban and Regional Development (SEURB)	
Transport Ministry – National Department of Roads (DNER)	Executive Secretary of Transport (SETRANS)	
The Federal Heritage Office (SPU)	Land Regulation Institute (ITERPA)	
Planning and Budget Ministry		
Navy Ministry		
Secretary of Urban Development		
National Integration Ministry		

The enforcement of law is a crucial problem. According to Anann (1999), disaster and vulnerability reduction legislation is useless if not effectively and impartially enforced. Studying the implications of global change in the Brazilian Amazon area, Laurence (2000) describes the weak enforcement of legislation as a "chronic" problemone that can be extended to the application of restrictions on coastal development (Figure 5). The municipalities in Brazil now enjoy significant territorial zoning and planning autonomy (Diegues 1999), however, the weak enforcement of law can attributed to (i) political aspects through a lack of coordination between government agencies in charge of coastal management, environmental protection or urban planning; (ii) economic characteristics such as the very strong pressure by the lobbies for tourism, land speculation, and construction, and (iii) cultural behaviour of the developing countries, where the rules are enforced only when the people agree to it and believe that it will bring them some benefit.

In spite of these problems, in the coastal area of the State of Pará accommodation strategies based on the land use legislation; prohibition, limitation and/or restriction on vulnerable areas occupation have been observed.

It is certainly unwise to allow development of property that will probably be lost to the sea, especially when the security of buildings so often creates demands for private or public money to be spent on protective works. Therefore, coastal management programs and urban regulations should attempt to have structures located behind a setback line. However, it is important to highlight that, with the exception of the closest strips to rivers and channels in Belém ("*Non Aedificandi*" Areas), there is no legal prohibition from building in vulnerable areas or reconstructing in the same place, once affected. The municipal regulation with regard to the setback line only limits the type of construction, generating a transition zone (buffer) between the water and upland property, within which natural processes may act causing minor damage to property, also anticipating some effects of sea level rise.

If development already exists in vulnerable areas of the coastal zone, private or not, all levels of government have the authority to expropriate the land and property, but only upon providing compensation to the owners of coastal land and property (Brasil 1991; Alepa 2000). Considering the lack of financial resources, with the exception of extreme emergency events, these measures are difficult to implement. Consequently, this approach could only be implemented through the conversion of land ownership into long term or conditional leases which would expire when the sea reaches a certain level.

Another way to prevent and restrict human development in coastal zones is the establishment of protection and conservation units, as mangrove areas. For areas with a low population density and little human development, the IPCC (1990) suggests that the adaptation strategy could be to leave the mangrove areas to their natural processes, enabling them to migrate inland as the sea level rises. This inland migration would possibly have many consequences for the population (Figure 4.35).

Coastal management programs tend to adopt a short-term view, recognizing frequent changes, but are quite unprepared for medium to long-term changes (Pethick 2001). However, considering the narrow relationship with environmental variables, the implications of a global change scenario, and potential relative sea level rise, land use regulations must have flexible limits, which may vary with time (Charlier & DeMeyer 1997). Therefore, Gornitz, Couch & Hartig (2002) suggest that in vulnerable regions in the New York City Metropolitan Area, new constructions would only be permitted landward from the area expected to erode within the next 30 or 60 years. Clark (1995) also states that the setback line may need to be recalculated every 5 to 10 years. The idea of a dynamic and evolutionary urban planning (Meirelles 1993) is also supported on the Urban Master Plan of Belém (art. 2) that recognises that it should be successively adapted to the community's demands and to local development, in a permanent process of

planning. Therefore, it is suggested that adjustment of the technical environmental parameters of the laws to the new scenarios should take place through a periodically revision every 10 to 15 years.

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