INPUT PAPER

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INTERCONNECTED, INTER-DEPENDENT TECHNOLOGICAL AND ENVIRONMENTAL RISKS IN THE CONTEXT OF CLIMATE CHANGE

Allan Yu Iwama[1], Leonardo R. Teixeira[1,2], Mateus Batistella[1,3], Lúcia da C. Ferreira[1]

[1]Center of Environment Studies and Research (NEPAM/UNICAMP); [2]Brazilian Institute of Environment and Renewable Natural Resources (IBAMA); [3]EMBRAPA Satellite Monitoring

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1. Introduction

This paper is set in the context of the Hyogo Framework for Action (HFA) 2005-2015: *Building the Resilience of Nations and Communities to Disasters* conceived to promote a global work and strategy for disaster risk reduction (DRR) reducing vulnerabilities and risks to hazards and show a progress in DRR while providing strategic policy guidance to countries and the international community. Specifically, this working paper analyses the emerging area of 'Interconnected and inter-dependent risk'.

The main question of analysis is: what is the relationship or interconnection between environmental hazards or risks and the influence of the megaprojects (oil and gas industry - the pre-salt Santos basin, Brazil)? The megaprojects are potential drivers for risk amplification? This work presents a framework to identify, rethink and find possible solutions to the interconnected and inter-dependent risks in the coastal zone of São Paulo state, Brazil.

Considering the importance of the debate on the topic of disasters related to landslides, flooding and technological risks, internationally and more recently in Brazil, this work analyses the situations of vulnerable risk areas on the coastal zone of São Paulo, Brazil. The situation refers to the effects of the implementation of large infrastructure projects relating to oil and gas on the occupation of risk areas to landslides and flooding hazards, besides considering the technological risks inherent in these megaprojects.

The analysis showed that the buffer zones of the megaprojects are disputes related to the process of land occupation, especially among different land management instruments at the municipal, regional and national level. This work pointed to an increase in local conflicts and pressures generated by the megaprojects, an increase in immigration and commuting, speculation, conurbation, and the use and occupation in disorderly manner, problems that amplify the risks and disasters.

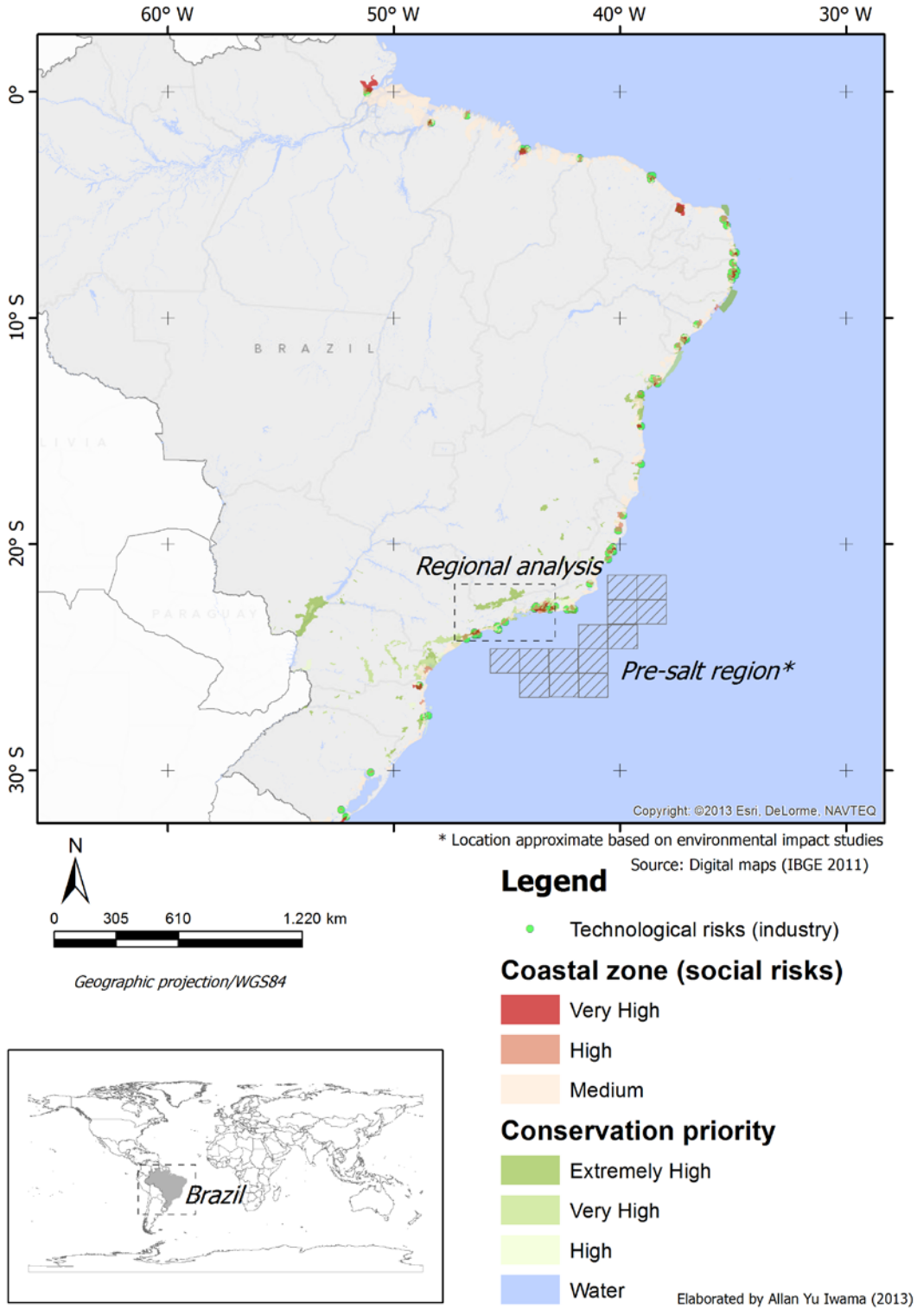
The proposed method was based on survey studies and reports environmental impacts of major developments in the study area as well as obtaining spatial data for territorial management. A geospatial analysis indicating areas of overlap between environmental and technological risks and areas was defined for the implementation of megaprojects.

The results indicate the need to articulate the different levels of action of the government to minimize the recurring problems of human occupation on risk areas and environmental protection. The weak linkage between land management instruments has generated a spatial segregation in the context of the increase in extreme weather events. This may potentiate the indirect impacts of megaprojects of oil and gas industry in areas recognized as a risk to urban density. We proposed a framework of investigation and analysis of the Inter-dependent technological and environmental risks.

2. Environmental and technological risks, the megaprojects and environment degradation: the risk amplification

Our analysis was based on a selection of three regions on the coastal zone of Southeastern Brazil with very similar conditions – all are located in a region considered a hotspot for conservation (MYERS et al., 2000; LAURANCE, 2009). The region has remnants of Atlantic

Forest with great importance for biodiversity and a great heterogeneity within the landscape /environment, which requires urgent action for their conservation and restoration (METZGER, 2009; RIBEIRO et al., 2009). This same region has been repeatedly threatened by the historical settlement process without considering the environmentally preserved areas and areas of enviromental risks (see map 1 and box 1.1).



Map 1 : Social, technological risks and areas for conservation in coastal zones of Brazil

Box.1.1 Protected areas and risk areas

Landslide on the 'Morro do Baú'- Ilhota-SC in 2008 (MMA, 2011; F. Fáraco)

Mudslide in 'Morro do Baú' – Ilhota-SC in 2008 (MMA, 2011; F. Fáraco)

Protected areas, including the Permanent Preservation Areas (APPs) and Conservation Units have the function of :(a) preserving water resources,(b) preserving the landscape,(c) preserving the geological stability. In particular, the protection of APPs to protect soil and geological stability prevents siltation of water bodies and the occurrence of landslides, which contributes to ensuring the safety of residents. There are at least two important examples that demonstrate the connection between these factors and how they are inter-dependent: the disaster that struck the mountainous region of Rio de Janeiro (in 2011) resulting in 916 dead and over 300 missing as plus another which occurred in Vale do Itajai in Santa Catarina region in 2008 (over 130 dead). These situations included economic losses and loss of life, which result from or were exacerbated by the occupation of such areas with agriculture, buildings or infrastructure such as roads (see more details MMA, 2011) .

Nova Friburgo-RJ – building in the slopes and landslides risks (MMA, 2011; W. Schaffer)

School affected by a mudslide in a APP – Teresópolis-RJ (MMA, 2011; W. Schaffer)

The Region of Campo Grande – Teresópolis-RJ (MMA, 2011; M. Rosa)

This region, whilst having a rich vegetation of mangroves, dense rainforests and sandbanks, on the other hand, has a concentration of people in search of work opportunities in industries such as the Port of Santos and Cubatão (metropolitan region of Santos), Port of São Sebastião and Caraguatatuba Gas Treatment Unit (Northern Coast region of São Paulo). Recently at the Rio de Janeiro, the Petrochemical Complex (COMPERJ), with facilities in Itaboraí and external facilities and dependents throughout the territory of Rio de Janeiro (Duque de Caxias industry - REDUC, Anticipation Plan Gas Production - PLANGAS, ducts, Itaguai Port, highway construction).

These aforementioned situations involve technological risks (fire accidents, oil spills, explosions) usually connected with the facilities of megaprojects (see box 1.2) related to the oil and gas industry, combined with aggravating environmental degradation, social risks and vice versa. This generates a domino effect of problems, which we call the interconnected risks. The attraction of population to these industrial centres in coastal areas generates a growing migratory movement, and this migratory process associated with a lack of strategy for territorial occupation, inefficiency or lack of maintenance of sanitation infrastructure and transport strategy, amplifies risks already observed. This generates increasingly precarious conditions for those who live in situations of multiple and interconnected risks (social, technological and environmental) and reduces their capacity to respond or adapt to disasters. The global disaster risk is disproportionately concentrated in low-income countries with weak governance (UNISDR, 2009) and recent work in the coastal zone of São Paulo has

demonstrated this reality (see MARTINS and FERREIRA, 2011a,b; FERREIRA, et al., 2011; BARBI and FERREIRA, 2013).

Box.1.2 Megaprojects and cascading impacts

Megaprojects are defined as large infrastructure projects with budgets exceeding 1 billion dollars and substantial capacity to generate social, environmental and economic impact, attracting great popular attention (FLYVBJERG et al., 2003) . These megaprojects have been severely questioned in their cost-benefit ratio. According to Merrow (2011), an analysis of over 300 large infrastructure projects in various countries showed that 65% of those showed failures in reaching their goals . According to Flyvbjerg et al. (2003) and Flyvbjerg (2009), the megaprojects would be part of an unhealthy cocktail of several billion dollars, involving underestimated costs, overestimated revenues, under valued environmental impact and over valued economic development effects . This model would be replicated to a greater or lesser extent throughout the world, supported by a process of misinformation of Parliament, the public and the media with the objective of having the projects approved and developed. The risks (social, environmental , economic and technological) associated with the presence of megaprojects tend to grow in an inter-dependent and interconnected way, especially where megaprojects are imposed in areas where there is not enough infrastructure to absorb them (TEIXEIRA, 2013). This generates a cascade of impacts the extent to which there is an event associated with a natural disaster.

In this sense, seeking to contribute to the implementation of the Hyogo Framework for Action (HFA) 2005-2015 we believe that the emerging theme 'interconnected and inter-dependent risks' should be included in environmental management and environmental impact assessment, (as already mentioned in previous reports - see UNISDR (2007; 2009; 2011; 2012; 2013) as well as subsidizing instruments associated with the environmental licensing of megaprojects, and also including in risk and planning management.

3. Interconnected risks: progress and challenges

Vulnerability and exposure to disasters is increasing as more people and assets locate to areas of high risk. Since 1970 the proportion of people living in flood-prone river basins has increased by 114% and on cyclone-exposed coastlines by 192%. More than half of the world's largest cities, with populations ranging from 2 to 15 million, are located in areas of high earthquake risk. Rapid urbanisation will increase exposure to natural hazards, especially in coastal zones (UNISDR, 2009; 2011).

In this context, for effective integration of disaster risk considerations into sustainable development policies, planning and programming at all levels, a strategic goal statement should be implemented. In that sense there has been strengthening of policies in Brazilian states and municipal institutions, and community civil defense agencies to address the reduction of effects of climate change (UNISDR, 2010; UNISDR, 2013).

3.1 Progress by integration of disaster risk reduction in Brazil

At the national level, we can highlight this progress through the creation of centres and programs for articulation, strategy and structuring in order to reduce hazards and disasters

(see Table 1). These plans or programs seek to integrate, in different spheres (multi-sectoral) or levels, environmental, technological and geological risks and climate change.

Level	Plans or programmes	Objective	Year
National (multi-sectorial)	National Center for Risk Management and Disaster (CENAD)	Law 5.376/2005 - (1) Articulation, strategy, structuring and continuous improvement and (2) Continuous action, monitoring, alerting, informing, mobilizing and responding.	2005
	National Climate Change Plan (PNMC)	implementation of adaptation to climate change by national, regional and local levels	2009
	National Center for Monitoring Natural Disasters and Alerts (CEMADEN)	monitoring 56 priority municipalities in the South and Southeastern regions, and begin monitoring 34 priority municipalities in the Northeast.	2011
	National Policy on Protection and Civil Defense (PNPDEC)	advises that the management of risks and disasters should be focused on prevention, mitigation, preparation, response and recovery and other sectoral policies	2012
National and regional (multi-sectorial)	National Plan for the Prevention, Preparedness and Response to Environmental Emergencies with Dangerous Chemicals (P2R2)[1]	Law 5098/2004 - preventing the occurrence of accidents with hazardous chemicals and improving the system preparation and response to chemical emergencies in the country	2004
	Individual Emergency Plan (PEI)[2]	CONAMA 398/2008 - response to incidents strategy. It defines the set of measures to determine and establish the responsibilities and actions to be implemented immediately after a possible incident of oil spill on the environment.	2008
	Area Plan (PA)	CONAMA 398/2008 - document that contains the information, measures and actions for the concentration of organized ports, harbours, terminals, pipelines or platforms, integrating the PEI	2008
	Emergency Plan for Oil Spill in Geographical area of the Santos Basin (PEVO)[3]	actions and complementary response that are adopted outside the boundaries of the premises (at offshore or on land), complementary to PEI	2008
Local[4]	Preventive Plan for Civil Defense (PPDC) - 114	prevention of risks associated with landslides, to reduce the possibility of loss of life	NI (114 cities of São Paulo, 17,7%)
	Mapping of Risk Areas - geological and hidrological hazards (2004-2011)	rapid implementation of prevention and mitigation in priority areas by the municipality	NI (65 cities of São Paulo, 10,1%)
	Municipal Plan to Risk Reduction (PMRR) [5]	action by the Ministry of Cities to support municipalities with risk analysis	NI (cities in prep.)

Table 1 : Plans and programmes of disasters risk reduction (DRR) in last 10 years NI (No information for all)[6]

[1] P2R2 : http://www.mma.gov.br/estruturas/sqa_p2r2_1/_arquivos/proposta_do%20_P2R2.pdf
[2] PEI : http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=575
[3] PEVO : http://licenciamento.ibama.gov.br/Petroleo/
[4] Examples in São Paulo state - see Amaral and Gutjahr (2011)
[5] See Contingency Plan of Rio de Janeiro (2012): http://www.preventionweb.net/english/countries/americas/bra/
[6] Also, see Plans and Programmes of Brazil (2011): http://www.preventionweb.net/files/25667_brazil.pdf

Under the National Plan Risk Management and Response to Natural Disasters (2012 - 2015), the Geological Survey of Brazil (CPRM[7]) has played a key role in the production of geological and geotechnical knowledge in municipalities with high and very high risk of landslides and floods hazards (in scale variation of 1:1000 and 1:2000 and cartographic maps of 1:25000), in the context of four themes - (1) mapping, (2) prevention (3) Monitoring and (4) Alert and Response. The result was the sectorization of geological risks in 286 Brazilian municipalities, with the Southeast more affected in terms of housing (47.4%) and population (44.1%) in areas of landslide risks and flooding (see Table 2).

Brazilian Region	Landslides+Flooding Risk Mapping (municipalities) - 2012, (%)	Settlements affected (n, %)	Population affected (n, %)
North	37 (12.9)	54,650 (13.8)	205,945 (15.6)
Northest	63 (22.0)	77,692 (19.6)	317,074 (24)
Midwest	6 (2.1)	11 (0.0003)	52 (0.004)
Southest	105 (36.7)	187,752 (47.4)	582,431 (44.1)
South	75 (26.2)	76,348 (19.3)	214,001 (16.2)
Total	***286 (100.0)***	***396,453 (100.0)***	***1,319,503 (100.0)***

Table 2 : Risk Mapping of hazards to landslides and flooding, settlements and people affected in 2012. Based on data from CPRM (see SAMPAIO et al., 2013)

3.2 Framework to interconnected risks analysis and challenges

Initiatives at the national level are relatively recent when compared with institutions operating at the state level, such as the Geological Institute of the State of São Paulo (IG/SMA-SP[8]) or the Institute for Technological Research (IPT[9]), as well as the CPRM which works in partnership with CENAD.

However despite the existence of pioneering agencies acting at state or regional levels on disaster risk reduction, at least in the State of São Paulo - in many regions of Brazil, which for over 25 years, have had some public policies to address situations of risk events related to disasters, damaging consequences continue to occur (BROLLO and TOMINAGA, 2012).

What we have observed are segregated analyses, without considering the cumulative effects of impacts (see TEIXEIRA, 2013), and the interconnected and inter-dependent risks.

The Strategic Environmental Assessment (AAE) seeks to define the process of environmental impact assessment on policies, plans and programs and is portrayed as a planning tool and to support decision making (DALAL-CLAYTON and SADLER, 2005; FISCHER, 2007) but it has been implemented late in developed countries (LEMOS, 2007; OLIVEIRA and BURSZTYN, 2001). The Integrated Environmental Assessment (AAI) appeared to broaden the scope of the AAE, with the inclusion of social and economic issues as well as technical, institutional

[7] Geological Survey of Brazil (CPRM) was created by 1969 (Law 764/1969 and Law 66058/1970) and since 1970 have been the Brazilian systematic geological mapping.

[8] The start of actions by the Geological Institute of the State of São Paulo related on Natural Disasters Reduction and Prevention is considering the report 'Instability of the Serra do Mar in São Paulo - risk situations' in 1988 (BROLLO, 2009).

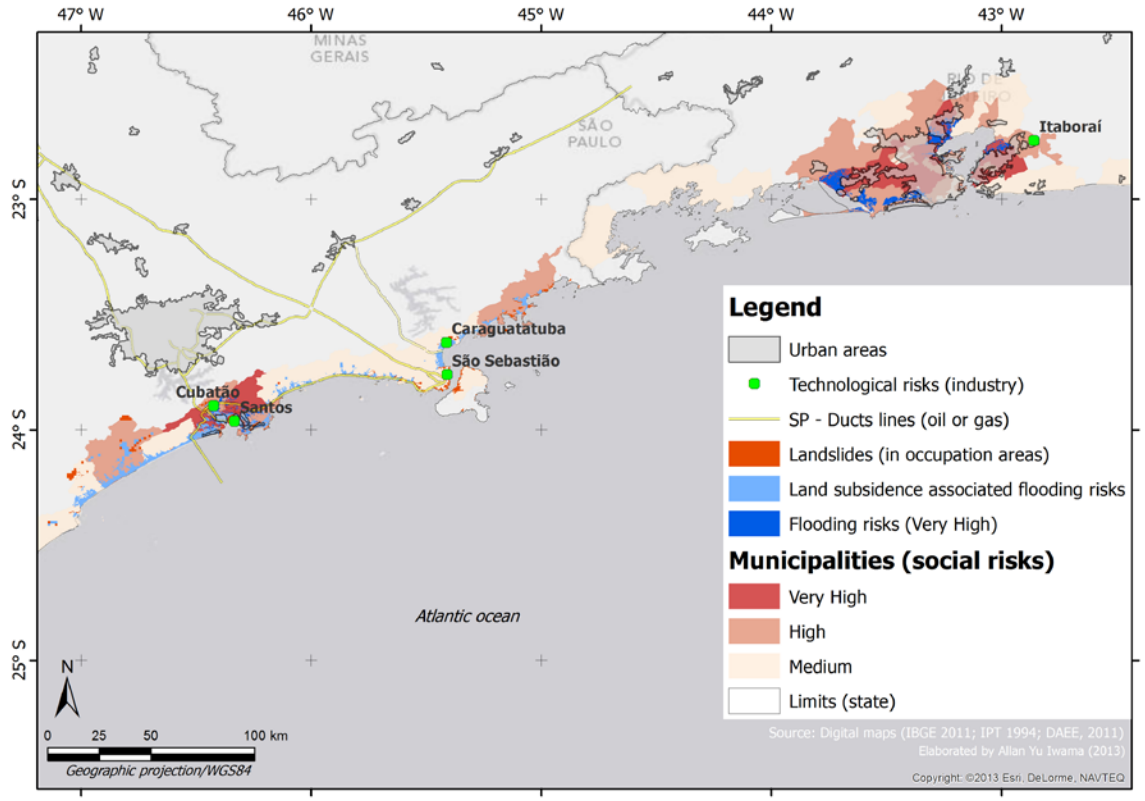
[9] Established in 1899 and transformed in to the Institute for Technological Research (IPT) in 1934, the IPT has one of the first records of technical research for landslide survey in Santos in decade of 1950 (Available in : http://www.ipt.br/hotsites/linha_digital/index.html).

and financial aspects, characterizing an "integrated" approach (FISCHER and SEATON, 2002; KJÖRVEN and LINDHJEM, 2002; PELLING et al., 2011; WORLD BANK, 2008) . However, even though there are many plans or programs and instruments for disaster risk reduction, there is little experience in the construction of diagnostics and few prospects for incorporation in the scope of analysis on the subject of interconnected or interdependent risks.

3.2.1 Coastal zone of Brazilian Southeast coast: some examples interconnected technological and environmental risks

We mentioned that there are positive aspects in relation to the inclusion of new instruments and management in the disasters risk reduction.

In this topic we will look a more detailed analysis into how risks are interconnected and inter-dependent, especially the influence or cumulative effects of impacts caused by megaprojects. The three regions addressed are: (1) the Petrochemical Complex of Rio de Janeiro (COMPERJ), located in Itaboraí city, (2) the metropolitan region of Santos, in particular the cities of Cubatão and Santos, (2) the region of the Northern Coast of São Paulo, which through geospatial analysis and Environmental Impact Assessment documents, we developed an approach to identify the overlap of environmental and technological risks and their implications. Map 2 shows these three regions analysed.



Map 2 : Technological, environmental and risks in three regions of Brazilian Southeast coastline.

3.2.1.1 Petrochemical Complex of Rio de Janeiro (COMPERJ)

Recently inaugurated, the Petrochemical Complex of Rio de Janeiro (COMPERJ) which has an estimated investment of $25 billion dollars and area of 45 km², will produce products derived from first and second generation oil. The initial stage of the project aims to implement a

refinery with the capacity to process 165,000 barrels of oil per day, supplying the market with diesel oil, naphtha, airplane fuel, GLP (cooking gas) and fuel. COMPERJ is part of a set of infrastructures, such as construction and port expansion in Itaguai together with the expansion of the logistics of the Metropolitan Ring road, which connects the Port to the Petrochemical Complex of Rio de Janeiro - COMPERJ (Itaboraí city) - see more details FIRJAN (2008, 2012a, 2012b).

Like any project of this size, the mega-investment will exert social and economic influence on the Itaboraí region. Over the past two years, the city has increase 50,000 residents and the current population is 218,000, according by IBGE (Brazilian Institute of Statistical and Geography). The expectation is that in 10 years, that number will exceed 600,000 residents. The increase equates to a population growth of 175%. The increase is mainly due to the migration of workers from Minas Gerais, Espírito Santo and the states of Northest of Brazil (CREA report , 2012). Moreover, COMPERJ impacts 31 protected areas along with mangroves important for the functioning of ecosystems in the region and for artisanal fishing (FAUSTINO and FURTADO, 2013).

COMPERJ represents a significant change not only in the geography of the region, but mainly in the economy. The establishment of hotels, condominiums and shopping malls has changed the landscape of Itaboraí, bringing a transformation of the profile as a 'Visitor City' to a hub for investments. As in Itaboraí, other cities have experienced accelerated development. Macaé city, also in the state of Rio de Janeiro, has presented an economic growth of 600% in the last ten years. The population increase, caused mainly by the coming of the oil industry in the region, is only one aspect of the process. Although local authorities claim that sectors like education, health and transport have better results every year, the chaotic traffic reflects how difficult it can be to live in an increasingly populated city.

Also in the installation and deployment process one can already see regional and local changes in Itaboraí, where a similar characteristic to the examples cited in the state of São Paulo can be observed: the same developments that generate thousands of jobs, directly and indirectly may also be responsible for the uncontrolled growth of a region, with serious implications for environmental degradation, the increase of technological risks and the combination of these with environmental and social vulnerability. This is producing a cascade of interconnected problems.

This situation remains, whilst Environmental Impact Assessment evaluate the licensing of each project, without considering the impacts in an integrated way, and therefore creating inter-dependent risks (e.g. investment for setting up infrastructure, COMPERJ, reflects the need for the implementation of other infrastructure - construction of a port, structure for highways, leisure structures, and their inherent technological or environmental risks). These are not correctly evaluated in a segregated analysis.

Faustino and Furtado (2013) observed that a considerable part of the infrastructure projects, known as "external infrastructure associated with COMPERJ " was and/or is being licensed separately, a process that not providing an analysis of all the synergistic, cumulative and indirect impacts .

Box.1.2 'COMPERJ' – Itaboraí city (1984)

Data from EIA (2010) - COMPERJ

The scenario where megaprojects are installed in regions with inefficient basic infrastructure, associated with poor governance and weak local-regional-national dialogue, has shown the following: lack of studies duly supported technically to predict and treat the impact of production has consequences that have been repeated in many parts of Brazil, such as irrational land use dynamics. This manifests itself in real estate speculation, and also in the 'favelização' or 'periferização' of the population, particularly in risk areas and those with restricted access. This is known to promote the environmental degradation and (in)quality of life. According to Faustino and Furtado (2013), megaprojects such as the COMPERJ are installed in poverty territories in favour of private interests, violating the human rights of those most vulnerable to the impact produced by these enterprises.

EIA (2010) – COMPERJ region

Data from EIA (2010) - COMPERJ

3.2.1.2 Coastal zone of São Paulo

Between 1978 and 2006 CETESB registered 6,700 incidents involving dangerous goods in the State of São Paulo, with the shipping transport industry accounting for only 5% of cases in absolute numbers. The terminals where chemicals such as petroleum are stored were a source of 2.6% of accidents. In this period, the attentio was the road transport with 38.8% (of accidents) in the state of São Paulo (POFFO, 2008). According to the history of major incidents involving oil or derivatives on the coast of Sao Paulo between the years 1974-2010 (see Table 3), 64% of the accidents took place in São Sebastião, due principally to the large movement of ships with liquid load and pipelines that connect the Petrobras Terminal (TEBAR), to refineries in the state. This in volume represents approximately 84% of all oil spilled in marine ecosystems in the state of São Paulo in this period.

Source: cause (1974-2010)	Year	Cities	Oil spill (m^3)
'Takamyia Maru' ship: collision with submerged rock	1974	São Sebastião	6000
'Brazilian Marina' ship: collision with submerged rock	1978	São Sebastião	6000
'Visconde de Cairu' ship: collision with pier and explosion	1978	São Sebastião	NE
'World Galla' ship: operation failed	1981	São Sebastião	60
'Arabean Sea' ship and 'Carmópolis' ship: collision	1983	São Sebastião	300
Pipeline of 'TEBAR/RPBC': rupture	1983	Bertioga	2500
Pipeline in 'Vila Socó': rupture and burning	1984	Cubatão	NE
Terminal of São Sebastião: operation failed and burn in 'Outeiro' river	1984	São Sebastião	NE
'Gisela' ship in 'Alemoa IV' complex	1984	Santos	420
'Cairú' ship: operation failed	1985	São Sebastião	100
'Marina' ship: collision with pier	1985	São Sebastião	2500
'Estrela/Gisela' ship: collision with wreckage of 'Ais Giorgius'	1986	Santos	140
'Hamilton Lopes' ship: rupture	1986	São Sebastião	220
Terminal of 'Alemoa'	1986	Santos	160
Terminal of 'Alemoa'	1990	Santos	265
Ship collision	1991	São Sebastião	280
'Alina P': explosion	1991	São Sebastião	NE
Pipeline of 'TEBAR/RPBC': rupture caused by landslide in 'Costão do Navio'	1994	São Sebastião	2700
'Smyrni' ship and 'E. Rickmers' ship: collision between ships	1998	Santos	40
'Maruim' ship: rupture	1998	São Sebastião	15
'Vergina' ship	2000	São Sebastião	86
'Nortic Marita': operation failed	2003	São Sebastião	25
Pipeline of 'TEBAR/RPBC': rupture by corrosion	2004	São Sebastião	233
Tug 'Pegasus': collision	2007	Santos	1,5
'Rio Blanco': operation failed, burning	2008	Santos	2

Table 3 : Accidents and technological and environmental risks in coastal zone of São Paulo [10]

3.2.1.2a Metropolitan region of Santos

Despite these numbers there were recurring accidents in the petrochemical terminals near the Port of Santos, and the ducts in Cubatão, accidents that caused a series of environmental liabilities and deaths (see box 1.1 and box 1.2). These were related to the disorderly land occupation process and the weak position of the governance on the megaprojects in the region no considering the cumulative impacts or cascading effects. Such incidents have been recurrent in the region, as was the case in 1994 with the rupture of a Terminal Petrobras oil pipeline caused by landslides, which had implications for environmental degradation and amplified the risk for the locals.

[10] Available in : http://www.cetesb.sp.gov.br/userfiles/file/emergencias-quimicas/panorama-geral/25-Principais-ocorrencias-quadro.pdf

Box.1.3 'Vila Socó' – Cubatão city (1984)

Data from CETESB (1984)

Data from CETESB (1984)

Data from CETESB (1984)

In February 1984, residents of Vila Socó, Cubatão/SP, noticed a gas/petrol leak in one of Petrobras's pipelines connecting the 'Presidente Bernardes' Refinery to the 'Alemoa' Terminal. The pipe went through a swamp region (with potential flood risk) opposite the village that was constructed on stilts. An operational failure during the transfer of gasoline to a pipe that was found to be closed, caused high pressure and a rupture and spread about 700 gallons of gasoline through the mangroves. Many residents, trying to get some money by selling fuel, collected and stored part of the product that had leaked in their homes. With the movement of the tides the flammable product spread throughout the flooded region and about 2 hours after the leak a fire started. The fire spread throughout the wetland surface, superficially covered in gasoline, burning the stilts. The official death toll was 93, though some sources cite the number to be in excess of 500 fatalities (based on the number of students who failed to attend school and the death of entire families where no one claimed the bodies. Dozens were injured and the village partially destroyed (see CETESB, 1984; POFFO , 2008) .

Box.1.4 Port of Santos – Santos city (1998)

Data from CETESB (1998)

Data from CETESB (1985); POFFO (2008)

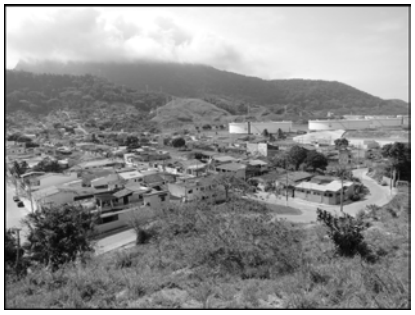
Official data from CETESB shows that between the period 1980-2006 there were 424 records of accidents involving oil spills, fires, and collisions of ships in the vicinity of the complex of the Port of Santos (POFFO, 2007). In September 1998 there was a fire in the petrochemical terminals on 'Barnabé' Island, on the left bank of the Port of Santos, which burnt around 300 m² of mangroves, as well as forming a burning slick in the estuary. The black smoke, due to the burning of solvents, generated carbon dioxide and carbon monoxide, which spread into the atmosphere. The situation caused panic in the region, and the accident was considered extremely serious by the Environmental Agency of São Paulo (CETESB, 1998; POFFO, 2007; 2008).

3.2.1.2b Northern coast of São Paulo

For a detailed analysis of overlap of instruments of land use and territorial management were selected the area of Caraguatatuba and São Sebastião citty, both located on the Northern of coast of São Paulo. In Caraguatatuba it can be observed that areas with trend for urban expansion and industrial occupation in the region, towards the district of 'Porto

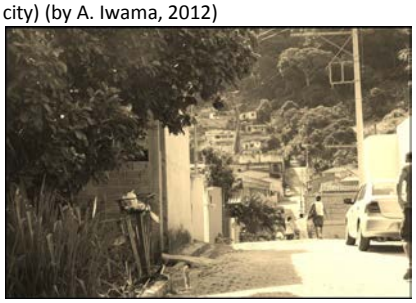
Novo' (see Map 3). About 24% of the area with potential for urban expansion in Caraguatatuba is overlapped with the Area of Direct Influence of megaprojects (large projects associated with dependent infrastructures: pipelines, highways, ports). In this area we also observe d areas of direct influence from UTGCA, North and South sector and the Mountain sector of 'Tamoios' road project, two pipelines where there are possible impacts related to pollution emissions, noise, property safety, risk of accidents and increased vehicular traffic.

Box.1.5 Northern coast of São Paulo: risk amplification and interconnectedness



Petrobras terminal (TEBAR): technological risks and environmental (by A. Iwama, 2011)

Debris flow: Camburi district (São Sebastião city) (by A. Iwama, 2012)

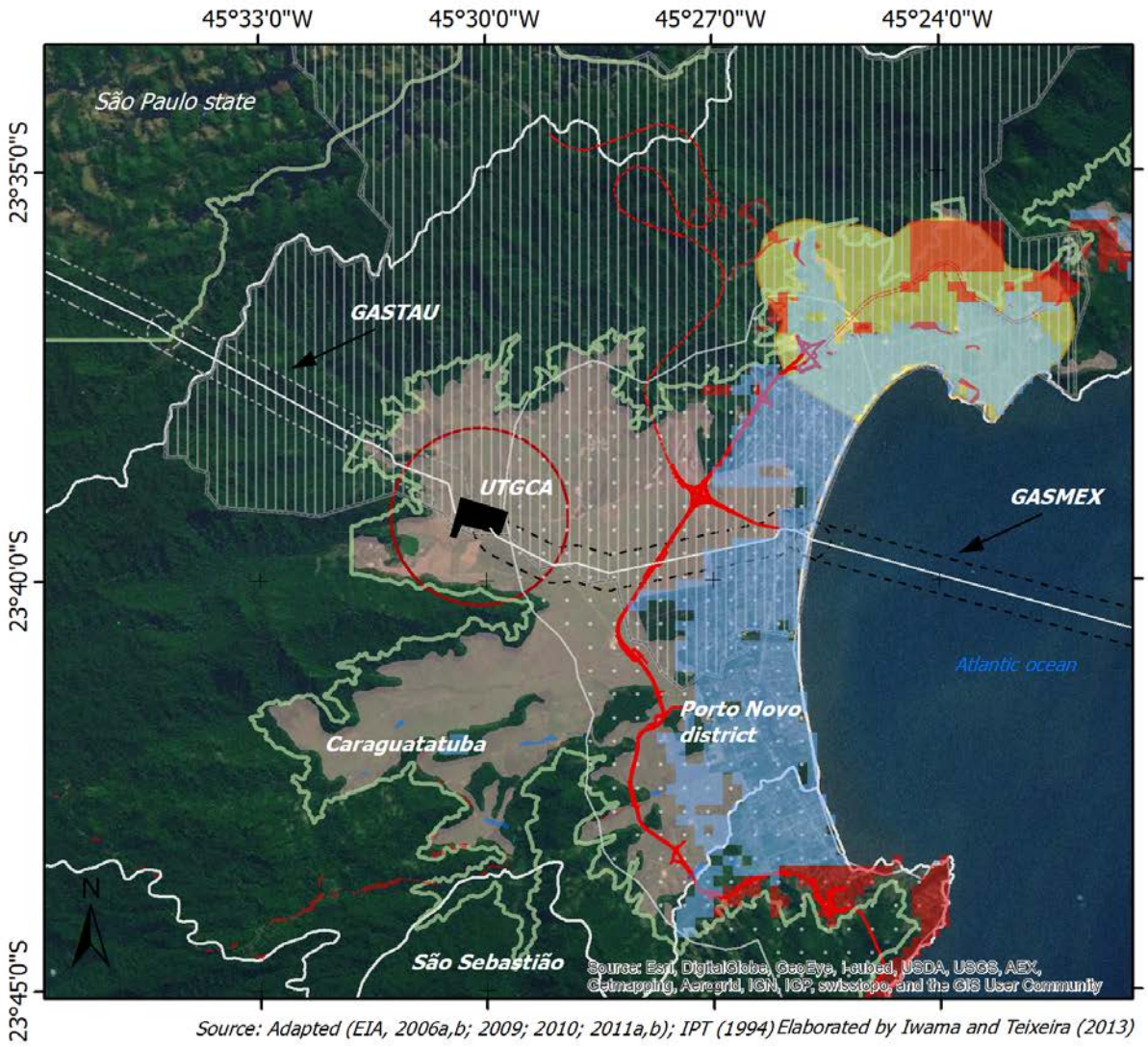


Topolândia district (São Sebastião city) (by A. Iwama, 2011)

The relation between a megaproject and environment aspects is complex and the situation analysed in São Sebastião and recently in Caraguatatuba illustrates how the process of urbanisation disordered can occured in some districts. The 'Itatinga', 'Olaria' and 'Topolândia' districts have arisen as a result of the Petrobras Terminal facility in the 1960s. Currently, it is predicted there will almost 400 expropriations as a result of the new road network ('Tamoios' sector road project). It is interesting to note that the districts affected by megaprojects installed in previous decades are today being looked at to understand the problems in installing new infrastructures projects. The population movements arising from the installation of large projects were not properly included in mitigation programmes for these megaprojects. These situations are cyclical and will always put the population in a situation of risk amplified, not only environmental or technological risks, this situation also raises a series of implications on the social structure of vulnerable residents.

Rio do Ouro district (Caraguatatuba city) (by M. Stasiak and A. Iwama, 2012)

Morro do Algodão district (Caraguatatuba city) (by R. Souza, 2010-2012)



Source: Adapted (EIA, 2006a,b; 2009; 2010; 2011a,b); IPT (1994) Elaborated by Iwama and Teixeira (2013)

0 1,5 3 6 km

Geographic Projection/Datum WGS84

Legend

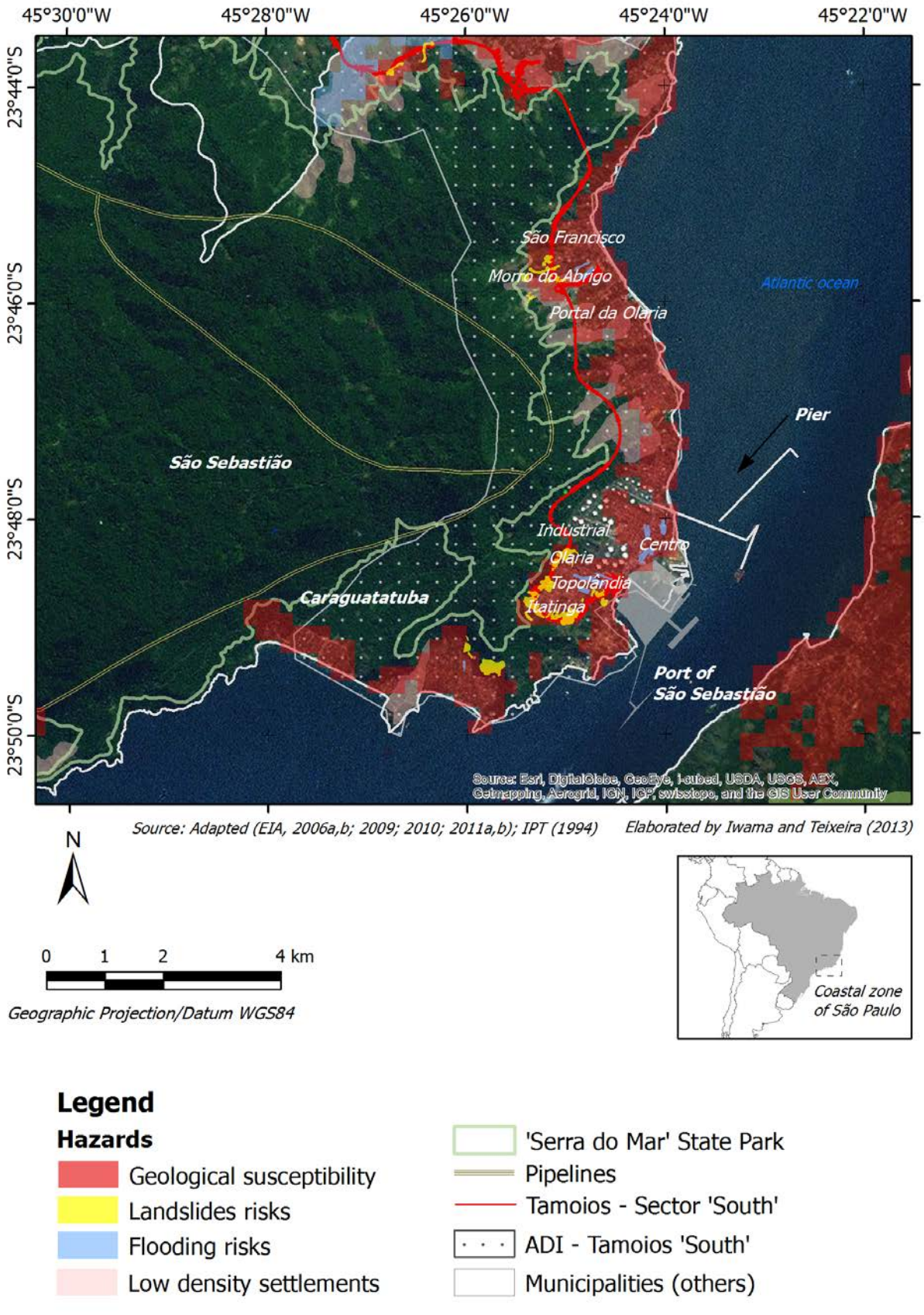
Hazards

- Landslides or erosion
- Land subsidence or flooding
- Low density settlements
- 'Serra do Mar' State Park
- Gas pipelines
- Tamoios - Sector 'Mountain'
- Tamoios - Sector 'North'
- Tamoios - Sector 'South'
- ADI - Tamoios 'Mountain'
- ADI - Tamoios 'North'
- ADI - Tamoios 'South'
- ADI - UTGCA (r=2 km)
- ADI - GASTAU (r=400m)
- ADI - GASMEX (r=400m)
- Municipalities (others)

Map 3 : Megaprojects influence: pipelines (GASTAU – gas pipeline of Taubaté, GASMEX – gas pipeline of Mexilhão), station of gas treatment (UTGCA), complex of roads (Tamoios road – SP-099) and technological, environmental risks in Caraguatatuba region. ADI: area of direct influence of infrastructure projects.

An important aspect is the limited assessment by EIAs with important consequences in the process of the land use process, which generates of the population expectations. Most expectations are linked primarily to three fronts: the generation (even if temporary) of jobs, increase the local circulation of financial capital and new opportunities for private businesses. It is important to ratify that often expectations are not related to the actual impacts of the projects but however still heavily affect areas such as the housing market, normally driven by long-term uncertainty. This housing market speculation begins to generate expectations on the part of local people and an increase in property prices and rents develops in the more central areas of cities, pushing a portion of the low income population to areas more peripheral. In addition, there are expropriations/removals of residents generated by the implantation of the South sector of 'Tamoios' road project. In Caraguatatuba the removal of 413 houses is predicted, with only 73.8% of them in 'Tinga' district (situated between the Mountain sector and the South sector of 'Tamoios' road project), generating social and environmental conflicts.

In São Sebastião, the area (see Map 4) encompasses the port and industrial areas and the districts of 'Topolândia', 'Itatinga', 'Olaria', 'Amélia' Village, 'Porto Grande', 'Praia Deserta' and the Historic Centre (see Map 4).



Map 4 : Megaprojects influence: Port of São Sebastião and pier expansion, pipelines, technological-environmental risks and geological risks in São Sebastião region. ADI: area of direct influence of infrastructure projects.

Several authors have shown this effect of social vulnerability of certain social groups associated with areas known to have geological, environmental or technological hazards (see details in ACOSTA, 2005 ; QUARENTELLI and DYNES, 1977; QUARENTELLI, 1997; 2007; PERRY and QUARENTELLI, 2005; VALENCIO et al., 2009; 2011 ; VALENCIO, 2010; 2012a,b). This situation indicates the difficulty in reducing the effects of interconnected risks, and the vulnerability of individuals (or groups of individuals) and their capacity to respond especially with an increase in extreme weather events (see ADGER et al., 2009; 2013 ; BLAIKIE et al., 1994; CUTTER, 1994; 1996; CUTTER et al., 2003 ; 2009 ; FOTHERGILL and PEEK, 2004 ; KELLY and ADGER, 2000 ; MASOZERA et al., 2007 ; O'BRIEN et al., 2004b; 2007 ; PEACOCK et al., 2000; SMITH, 2013 ; WISNER et al., 2004; 2011).

In the area affected by the Port of São Sebastião, it was observed that there were 220 incidents involving oil spills between 1974 and 1999 on the Northern coast of São Paulo (POFFO et al. 1996; POFFO, 2008). The causes of these events ranged from operational failures during loading and unloading activities to the collision of ships and damage of pipelines. According to the Preliminary Environmental Report presented as part of the licensing process for new pier of TEBAR (RAP, 2011) , the installation of this structure in the São Sebastião Canal should have considered minimizing accidents with impact classified as positive for the environment. An exsiting project to expand the Port of São Sebastião estimates a growth of 2,140% in the number of ships bound for the public port between 2008 and 2035 , from 69 to 1,477 ships per year. The EIA (2009) identifies and highlights a specific impact related to increased risk of a collision between ships. Given the uncertainty of occurrence and prevention programs adopted, in which the possibility of an accident and environmental damage is always mentioned, this is considered low magnitude and of small significance . This fact clearly demonstrates that the segregated analysis of impacts deos not assume interconnectivity between the risks in each technical study, and doesn't consider the overlap of these risks and their cascading effects.

The weak integration among the State agencies in planning in different levels, as well as between the public and private organisations, keeping the market logic as a goal for decisions, at least two relevant situations emerging: (1) substantial increase in financial risk due to loss of public and private investiments in the execution of projects with similar objectives, (2) unnecessary environmental impacts and unpredictable cumulative effects (since in Brazilian laws there is no requirement to present a study of cumulative impacts). This may generate problems to navigation, the dynamics of coastal sedimentation, water quality and human-being of local residents.

Looking for the Hyogo Framework for Action (HFA) post -2015, we pointed out that there has been progress in relation to governance and instruments for disaster risk reduction (DRR). Furthermore, we suggest that integrated analysis on inter-dependent and/or interconnected risks is considered in the conception of these instruments of territorial management, especially when related with effects of megaprojects.

In general, we observed a progress in the collected and communication of information by emergency removal of residents in risk areas. Furthermore, these aspects should be analysed in the historical context of land use dynamics, which not considered environmentally preserved and potential environmental risk areas. This topic associated with a weak multi-sectoral governance probably keep on acting focusing in an emergency situation and not in a large risk management (see Image 1).

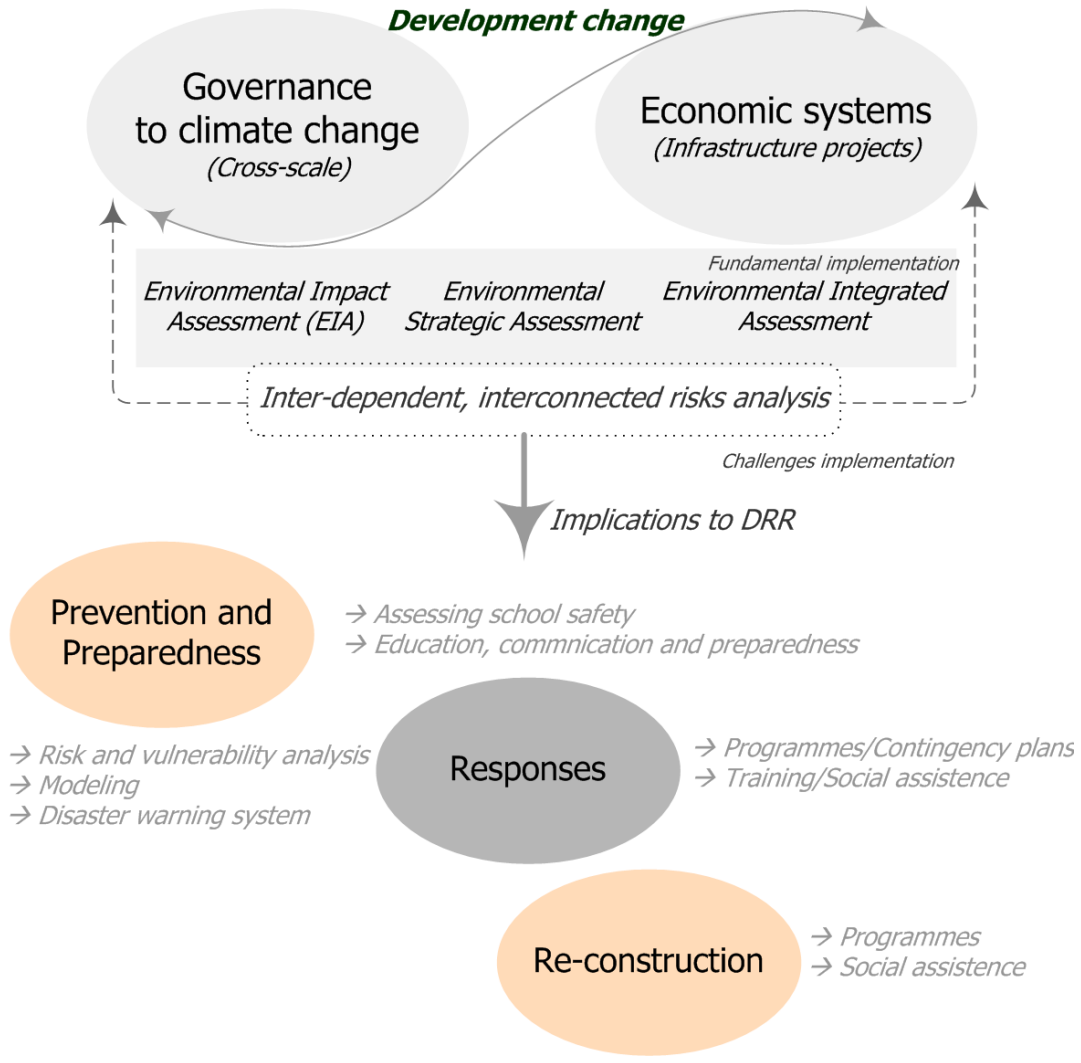


Image 1 : Framework – governance to climate change by cross-scale and infrastructure projects: inter-dependent and interconnected risks analysis in to land use and territorial management.

4. Concluding remarks

The current Brazilian scenario for preparation of disaster risk reduction (DRR) to climate change has progress, considering last ten years. Along this period , important programs and and plans to reduce risks and vulnerability to a different hazards, especially in the context of increasing of climatic extremes.

Furthermore, the multi and cross sectors of public publicy for a integrated risk management, as the public and private investment are still recent, particularly in relation to investments in infrastructure projects associated with the oil and gas industry. In this sense, even though there are important tools such as Environmental Strategic-Integrated Assessment are still not enough to avoid the problems that have occurred most frequently: heavy rainfall, increasing for risks of flooding and lanslides hazards. Besides, the effects of the implementation of large infrastructure projects relating to oil and gas (and the technological risks inherent in these megaprojects) on the occupation of theses risk areas are interconnected with environmental degradation and social vulnerability, amplifying the environmental and social risks.

The risk analysis of interconnectedness and interdependence risks should be encouraged in land use management and impacts of megaprojects, seeking to understand and reduce the cumulative impacts (environmental, social and technological).

The mapping risks should be identify to exposed vulnerable areas, but still are limited to identify social, economic, technological risk amplifiers. The possible solutions are: (i) transform governance and economic systems to address the interconnected risks, with new paradigm, (ii) Deploy creative communications infrastructure across all nivels , the transport, water and power infrastructures, (iii) to establish collaborative partnerships to disaster risk reduction (DRR) and (iv) reduce the poverty.

In the context of the Hyogo Framework for Action, the inter-dependent and interconnected risks have the high priority for action and should be an important topics for an integrated analyses.

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