Strategy for Disaster Risk Management

National Adaptation Plan
to Climate Change

4 Strategy for Disaster Risk Management

4.1 Introduction

In Brazil, Civil Defence is organized under the National Civil Protection and Defence System (SINPDEC) comprising various federal, state and municipal bodies, community-based and voluntary organizations. This Chapter was prepared by the National Secretariat for Protection and Civil Defence (SEDEC), focal point for its implementation, in coordination with the Secretariat for Climate Change and Environmental Quality of the Ministry of Environment. Other collaborators include the Ministry of National Integration (MI), the National Centre for Monitoring and Early Warning of Natural Disasters (CEMADEN), the Brazilian Geological Service (CPRM), the Ministry of Planning, Budget and Management (MPOG), the Ministry of Cities (MCid) and the National Institute for Space Research (INPE).

The impact of climate change is regarded as one of the contributing factors to increased disaster risk. Risks stem from the intersection of three factors. Firstly, threat stemming from extreme weather conditions, exacerbated by current climate-change trends. Secondly, vulnerability of populations to disasters, i.e., their capacity to prepare and recover effectively in the aftermath of a disaster. Vulnerability has a multidimensional characteristic, linked to underlying factors such as poverty, schooling levels, risk perception, sensitivity to damage, susceptibility, low capacity to adapt and low resilience. Thirdly, exposure of human systems and settlements in areas susceptible to phenomena such as flooding and landslides, referred to as "risk areas".

Widespread unplanned urban expansion over the past 60 years has resulted in concentration of vulnerable populations in risk-prone areas. Such populations are thus exposed, both to sudden disasters, such as landslides, floodwaters, etc., and to gradual natural processes, such as drought and flooding. Increases in the number of disaster events, in recent decades, can be attributed to the sum of those three factors. Furthermore, it has been scientifically documented that the climate extremes that trigger such disasters are occurring with greater frequency and, all too often, with increasing intensity.

The Intergovernmental Panel on Climate Change (IPCC) Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX - IPCC, 2012) highlights that there is high confidence in asserting that the intensity of extreme climate and weather events and exposure to them tend to be factors more commonly associated with damage caused in major disasters than to vulnerabilities of human systems. However, for less extreme events (with greater probability, less intensity) the vulnerability

of elements exposed plays an increasingly important role in explaining the level of the impacts. Thus, vulnerability is one of the main causes of the increase in adverse effects of non-extreme events, i.e., small-scale recurrent "disasters", which generally attract less attention at the national or local level (MARULANDA ., 2008b, 2010, 2011; UNISDR, 2009a; CARDONA, 2011; UNISDR, 2011).

According to the SREX, even discounting the effects of climate change, disaster risks will continue to rise in many countries, including Brazil, as more people and vulnerable assets (e.g., on the outskirts of large cities or scattered over semi-arid areas) are exposed to natural climatic variability. On the other hand, evidence based on historical series dating back to 1950 suggests that climate change has already altered the magnitude and frequency of some extreme weather events related to climatic conditions in certain regions. Nonetheless, it remains very difficult to attribute individual events to climate change alone.

In this respect, climate change means an additional stress factor for each type of disaster. This Chapter presents information and inputs for this debate, with the aim of outlining strategies for reducing risk and promoting adaptation, in line with Brazilian priorities and needs.

There is a pressing need to invest in scientific knowledge relating to all dimensions of disasters, in line with new 21st century knowledge-society paradigms. In this context, the new post-2015 Sendai Framework for disaster risk reduction, agreed between the UN member countries at the Third World Conference on Disaster Risk Reduction, is based on the following four areas of priority action:

1) understanding of the disaster risk; 2) strengthening of governance; 3) investment in reducing disaster risk and increasing resilience; and 4) improved preparation for disasters.

The main objective of this Strategy is to promote actions targeted at developing capacities for reduction of risks and preparation and response to disasters in the context of climate change.

4.2 Disasters in Brazil and vulnerabilities related to climate-change

Disasters of different types in Brazil are almost always related to hydro-meteorological and climatological events, in which rainfall (shortage or in excess) is principally responsible for triggering physical processes that jeopardise populations and livelihoods. In view of its vast size and environmental, climatic and geological diversity, Brazil is susceptible to a broad array of disasters. These disasters are directly related to socioeconomic and urban vulnerabilities combined with distinct exposure scenarios.

Table 6 provides a summary of these different types of disasters, listing significant aspects to guide proposals for adaptation presented at the end of this Chapter. It is based on data from the Brazilian Atlas of Natural Disasters

(UFSC, 2013) and provides percentages of people affected and reported deaths, by region, caused by adverse events, as a proportion of the total of such events in Brazil, between 1991 and 2012.

Table 6. Regions of Brazil and principal features of disasters

Region	Main types of disasters	% of people affected 1991-2012	% of deaths CEPED (2013)	Relevant and determining characteristics of disaster risk
South	Great diversity, highlighting droughts and dry periods, sudden floods and windstorms / cyclones	22.68	13.43	Severely affected by storms, gales and hail. The only Brazilian region ever hit by cyclones (coastal zone). Affected by many weather instability systems and atmospheric blocking. THREAT is a crucial vector for intensification of current and future risks.
Southeast	Landslides, floods, flash floods and inundation. Droughts in the north and northeast of Minas Gerais State.	22.17	66.56	High population density combined with unplanned settlement in risk areas (high exposure). Great social disparities and high vulnerability of different social groups. The highest numbers (roughly 28.50) deaths/ million pop. The SE region accounts for 79% of recorded landslides in 1991-2012, with the State of MG accounting for 60%.
Central-west	Diversified. Gradual flooding, droughts, flash floods and erosion and recurrent forest fires.	4.09	0.41	Agricultural vocation, low population density (lower exposure). Few historic series for identification of disaster patterns. Merits attention in view of recent development with introduction of new vulnerabilities and increased exposure.
Northeast	Mostly drought,. Flooding (gradual or sudden) causing major impacts.	44.09	15.84	High inter-annual rainfall variability and low water storage capacity pose limitations for local development (threat). Metropolitan regions highly exposed and vulnerable to flooding, displacing many people and causing significant numbers of deaths. Region with the largest numbers of people affected by disasters (47.63%)
North	Flooding (gradual and sudden) and drought	6.97	3.80	Riverside populations strongly affected by flooding (exposure) with associated health risks (social vulnerability). Livelihoods directly impacted by drought (exposure and economic vulnerability)

The events that most afflict humans are flooding and landslides caused by extremely heavy rainfall. Findings of a survey (UFSC, 2013) reveal that, between 1991 and 2012, these two types of disasters alone accounted for 73.79% of disaster deaths in Brazil. The South and Southeast regions lead the ranking of these disasters. The Southeast region, which features large population densities, is also the region with a highest percentage of disaster-related deaths in the 1991-2012 period, accounting for 66.56% of the total reported, and the highest ratio of deaths per million population (roughly 29.5 deaths/million pop.).

On the other hand, a major portion of Brazil is affected by climate events that lead gradual physical processes, such as drought and seasonal flooding. As they tend to cover large areas for longer periods, such events may affect the lives and livelihoods of great numbers of people. The occurrence of these events tends to be cyclic, if not in regular progressions, they often develop incrementally, with gradually worsening effects. In some cases, seasonal climate events are part of natural regional-climate dynamics, for which local populations are capable of preparing, thereby reducing their exposure to the intensity of impacts.

The region most affected by drought and extended dry periods is the Northeast where, all too often, these impacts impose restrictions on local economic development. The North, Central-West, and Northeast combined accounted for roughly 20% of such deaths between 1991 and 2012, but had the largest portion (55.15%) of affected people (UFSC, 2013). The Northeast region alone accounted for 44.09% of the nearly 29 million people affected by such events between 1991 and 2012.

Changes in seasonal weather patterns, especially in rainfall (excess or shortage), anthropogenic factors, and the vulnerability of human systems may induce, facilitate and accelerate the onset of disasters, thereby contributing toward intensification of their impacts. The influence of anthropogenic (non-climatic) factors is variable for each type of disaster. This makes an analysis of the influence of climate change on the increased occurrence of such disasters a complex task and emphasises the need for further knowledge on characteristics of the relationships of their temporal and spatial repercussions.

This rationale and conceptual framework is important for clarification of the role of various factors that increase disaster risk linked to vulnerabilities not associated with climate-change variables. In this context, climate-change effects are considered an additional factor in the disaster risk management. Table 7 presents the relationship between extreme events, climate change, and the occurrence of different types of disaster in Brazil. It also provides information on confidence levels as to each of the impacts of climate change relating to extreme events (threats) and with respect to uncertainties of future climate projections for assessment of disaster typologies, in the light of existing vulnerabilities.

One factor that complicates analysis of the data presented in the Table below is the relatively small number of historical climate change and extreme event studies in Brazil.

Table 7. Synthesis of information on issues relating to types of disasters that afflict the Brazil, extreme events and climate change

[1]	[2]	[3]	[4]	[5]	[6]	[7]	8	9
Type of disaster	**% of people affected**	**% of deaths**	**THREAT triggering climate events of (1)**	**Effects of CC on THREATS presented in (4)**	**Degree of confidence in the response in (5)**	**Probability of effects (5) for future projections**	**Major anthropogenic interferences and vulnerabilities that trigger impacts of the process presented in (1)**	**From analyses of (5), (6), (7) and (8), the relationship between climate change and occurrence of disasters (1)**
Landslides	1,79	15,6	Extreme events of rainfall (those that occur in a few hours as well as those that occur during several days	Increase in the frequency and magnitude of the extreme events listed	HIGH regarding extreme events. LOW for the occurrence of landslides and inundations (little evidences)	HIGHLY PROBABLE	Irregular slope profiles, erosion processes at the base of the slope, deforestation of hillsides, poorly planned storm water systems, overload due to construction in risk areas, among others	Unlikely. However, it is considered very difficult to separately assess due to the various anthropic constraints and also the vulnerabilities because both are temporally and spatially variable. There are few registers and metrics (indicators) to do such an analysis with conclusive results. The increase in exposure is also considered a key-factor for the two types of disasters.
Sudden flash floods, flooding and inundations	20,66	58,15	Extreme events of rainfall over short periods of time (especially in a few hours)				Deforestation of APPs, suppression of ecosystem services (i.e. reduction in the infiltration potential, increase in surface drainage, etc.) degrading land use, deficient storm drains, large surfaces sealed, among others	
Gales and cyclones (wind effects)	7,07	3,74	Storms accompanied by strong winds, sometimes with hail	Increase in the frequency and magnitude of the extreme events listed	LOW (lack of data, complex analysis)	PROBABLE	No direct relation, the anthropogenic effects of GGE emissions and changes in land use and vegetation cover, which are related to the global and regional/ local climate changes	Probable. Even with the uncertainties. The unprecedented occurrences in the South region during the past decade are significant evidence (intensification in the THREAT vector)
Droughts	51,31	7,57	Dry periods, poor distribution of the rain, increase in the temperature (increase in evapotranspiration)	Intensification of the ENSO events, TSM anomalies in the Tropical or Subtropical Atlantic (reduced rainfall) displacement of humidity flows and increase in surface temperatures	MEDIUM for the dry season and LOW for the rainy season. (lack of data and inconsistencies)	HIGHLY PROBABLE for the NE and western Amazon, mainly in the dry season. Note: Highly probable that inter-annual variation is controlled by ENSO events	Changes in land use and vegetation cover. However, "drought" in the context of a disaster, depends much more on VULNERABILITIES of the social groups affected than on climate conditions (Castro, 2002). Degrading land use is also seen as a factor that favours, indirectly, storage of water in the soil and can contribute to this scenario.	Unlikely. But the change in temperature and rainfall patterns from observations and modelling, has been coherent with theoretical understanding of the hydrological response to the global warming, where dry regions become even drier and the humid ones more humid, in a warming world. It is still necessary diligently to evaluate the evolution of disasters to reach significant conclusions.
Heavy rainfall	12,04	13,4	Increase in rainfall in the seasonal regimes	Intensification of the ENSO events, TSM anomalies in the Tropical or Subtropical Atlantic, causing changes in the seasonal rainfall regime (increase)	LOW (lack of data and inconsistencies)	HIGHLY PROBABLE for the South of Brazil and Western Amazon	Engineering works that can either favour or contain (dykes and reservoirs) interferences in the environment, especially changes in land use and vegetation cover that do not appear clearly in the historic registers	

Further studies and evidence are needed to establish a clear link between climate change and the disasters that cause the greatest numbers of deaths (sudden floods and landslides). Although records point to an increase in the number and frequency of extreme events, studies carried out in Brazil show a greater correlation to rising population densities than to climate change (UFSC, 2013). Increasing occurrence of disasters may be a consequence of greater exposure stemming from rapid urbanization patterns and their associated social inequalities and socioeconomic vulnerabilities. In conclusion, adequate land use and planning are the essential elements for reducing disaster risks.

In some cases, it must be acknowledged, exposure to certain types of events cannot be avoided. Territorial planning and sound decision-making as to the location of settlements and economic activities, in such cases, needs to be accompanied by other structural or non-structural approaches to preventing or reducing risks (UNISDR, 2009a; ICSU-LAC, 2010a, b). Approaches of this type that have been pursued in Brazil in recent years are examined in greater depth in the Chapter on the Strategy for Cities.

Droughts and flooding are mainly attributable to El Niño Southern Oscillation (ENSO) events, which are likely to intensify with climate change. For drought, especially in the Northeast of Brazil, climate predictions derived from climate modelling (Volume I of this NAP) indicate a trend toward more extended periods without rain. Indeed, increased desertification is yet another of the inherent risks of climate change. However, the occurrence of disasters is not conditioned solely to climate factors, but also to local vulnerabilities. Thus, initiatives that foster economic and social development, sustainable land use practices and installation of adequate infrastructure are essential for reducing the climate risk.

Regionalized climate models provide an approach for reducing uncertainties relating to analyses that rely on global climate models for evaluation of extreme events and their relationship to disasters. Such models are capable of presenting the peculiarities of continental atmospheric phenomena in greater detail, thereby considerably improving assessments of rainfall variability. For the Third National Communication to the UNFCCC, a study was conducted to assess, from a climate-change perspective, the vulnerability of Brazilian municipalities to the two types of disasters that cause the greatest numbers of deaths in Brazil: 1) sudden floods, storm runoff, and flooding; and 2) landslides.

This study postulated that, by the end of the 21st century, vulnerability to climate change is likely to rise in many places current considered at high-risk of disasters. Its analysis focused on the increase in frequency and magnitude of extreme events, from a climate change perspective, while keeping other variables constant.

Among the findings of the study were that, for the risk of sudden floods, the South and Southeast were the regions where vulnerability most increased, followed by virtually the entire Brazilian coastline between Rio Grande do Sul and Ceará. For landslide risk, the greatest vulnerabilities can occur: in the States of Paraná and Santa Catarina (especially the Vale do Itajai); in the Serra do Mar and Serra da Mantiqueira; in southern and south-eastern Minas Gerais; followed by certain locations in the Northeast region.

4.3 Overview of the main disaster-risk management initiatives for adaptation

The terrible disaster that hit the hills (*Região Serrana*) of the State of Rio de Janeiro in January 2011 contributed to important changes on disaster-risk management in Brazil. It shifted the public-policy focus from response, post-disaster recovery and reconstruction, to more preventative approaches, targeted primarily at safeguarding human lives. Reflecting this change, the National Plan for Risk Management and Response to Natural Disasters (2012-2014) has allocated 85% of its funding for prevention, targeting:

(1) structural construction works; (2) better understanding of risks, through mapping; and (3) foreknowledge of disaster risks, through the upgrading of the national monitoring and early-warning network.

The National Plan for Risk Management and Response to Natural Disasters (PNGRRD) entrusts coordination and monitoring to the *Casa Civil* (SAM/CC) of the Presidency of the Republic and with representatives of the following federal public institutions: the National Secretariat for Protection and Civil Defence/MI and its National Risk and Disaster Management Centre (CENAD/SEDEC/MI), the National Centre for Monitoring and Early-Warning of Natural Disasters (CEMADEN/MCTI), the Ministry of Cities (MCid), the Brazilian Geological Service (CPRM/MME), the National Water Agency (ANA/MMA), the Ministry of Health (MS), the Secretariat for Planning and Strategic Investments (SPI/MPOG), the Secretariat of the Growth Acceleration Programme (SEPAC/MPOG), the Federal Budget Secretariat (SOF/MPOG), the Department for Control of Airspace (DECEA/MD), the National Treasury Secretariat (STN/MF), the Comptroller-General (CGU), and the Ministry of Communications (MC).

During preparation of the National Multi-Year Plan (PPA 2012-2015) the main agencies involved with the theme of disasters gathered to draft a programme focused on prevention, building upon past experience, academic contributions, civil-society mobilization and the other branches of the government. Based upon this decentralized approach, objectives, goals and initiatives were drafted for the 2040 Programme – Risk Management and Response to Disasters (www.planejamento.gov.br), involving the Ministries of National Integration; Cities; Science, Technology and Innovation;

Mines and Energy; and Environment, with participation of the Ministry of Foreign Affairs (MRE) for international advisory.

Programme 2040 represents a combining of forces on the part of the public administration to promoting integration of to databases and information formerly compartmentalised in different public institutions.

Targeting of actions under Programme 2040 entailed identification of municipalities considered most critically susceptible to disasters. Based on the Atlas of Natural Disasters (UFSC, 2012) 821 critical municipalities, accounting for 94% of deaths and 88% of people affected by disasters between 1991 and 2010, were identified. Of these, special priority was awarded to 286 municipalities that account for 89% of deaths and 55% of people displaced or made homeless (Figure 3).

Figure 3. Location of the 821 municipalities targeted for priority actions under the Programme for Risk Management of Risks and Response to Disasters (PPA 2012-2015)

This approach, involving an array of ministries has proven effective. Moreover, now under the title Programme 2040 – Disaster Risk Management, it was maintained in the Brazilian federal government's main planning instrument (PPA 2016-2019).

4.4 National Protection and Civil Defence Policy and System

The National Policy for Civil Protection and Defence (PNPDEC) brought into effect by Law 12608 of 10th April 2012, States that it is the duty of the Union, states, Federal District and Municipalities to adopt measures necessary for reducing disaster risks, and that these may be applied in collaboration with public, private or civil-society bodies.

The PNPDEC encompasses actions for prevention, mitigation, preparation, response and recovery, targeted at promoting civil defence. It provides for the National Protection and Civil Defence System (SINPDEC), comprised of federal, state and municipal administrations, and of public and private organizations with significant engagement in the field of protection and civil defence, as shown in Figure 4.

Figure 4. Overall organization of SINPDEC

The Table below describes some innovations that can promote adaptation to climate change and reduction of disaster risks brought in under the PNPDEC.

Integration of policies for territorial planning, urban development, health, environment, climate change, water-resources management, geology, infrastructure, education, science and technology and other sectors, with a view to promoting sustainable development;
A systemic approach to prevention, mitigation, preparation, response and recovery actions;
Closer coordination among federal, state and municipal authorities for reducing disaster risks and providing support for affected communities;
Drafting and implementation of Protection and Civil Defence Plans at the three levels of government;
Creation of the Disaster Information and Monitoring System;
Constant professional training and capacity building for civil defence and protection agents;
Creation of a national register of municipalities with susceptible areas to major landslides, sudden flooding or related geological or hydrological processes; and
Inclusion of the principles of civil defence and protection in elementary and secondary-school curriculums.

Such actions, though primarily targeted at management and reduction of disaster risks, will also help increase the capacity of Brazilian municipalities to adapt to climate change. Moreover, they are necessary for tackling pressing current problems in Brazil and should thus be reinforced, especially in the light of augmented risks foreseen in a context of climate change.

There follows a list of the main national policies and plans referred to in the PNPDEC of crosscutting and synergistic relevance to other sectors:

Cities Statute- Law 10257, of 10th July, 2001;
National Environment Policy - PNMA (Law 6938, of 31st August, 1981; Enabling Decree approved in 1990);
National Environmental Education Programme- PRONEA (2005);
National Education Plan- PNE (2012);
National Climate Change Policy- PNMC (Law 12187, of 29th December 2009);
National Water Resources Policy (Law 9433, of 8th January 1997);
National Regional Development Policy– PNDR.

4.5 Early-warning and monitoring system

The guidelines of the PNPDEC acknowledge that it has become essential to institute an early-warning and monitoring system that brings together scientific and technological expertise from various fields, including meteorology, hydrology, geology and disasters. To address this need, in 2011, the Ministry of Science, Technology and Innovation (MCTI) established the National Center for Monitoring and Early-Warning of Natural Disasters (CEMADEN). Considering that the quality of disaster warnings depends on the capacity to observe the natural phenomena that trigger them, founding of this Centre necessarily entailed implementation of a modern environmental observation network.

CEMADEN currently monitors 957 municipalities where it has mapped areas at risk of landslides and flooding. It also monitors over 1000 municipalities in the semiarid region of Brazil's Northeast for risk of crop failure and food production during extended dry seasons and periods of intense drought.

Current efforts are concentrated on development of numerical models for very short-term rainfall forecasting based upon data from meteorological radar, geotechnical and hydrological models for prediction of landslides, floods and flooding, and models for prediction of crop failure, of family farming in Brazil's semiarid Northeast region.

Within the scope of the PPA 2012-2015, institutional coordination of the CEMADEN with other agencies involved in disaster prevention (such as ANA and CPRM) within the National Protection and Civil Defence System has resulted in generation of new knowledge on the physical environment, processes that trigger major events and areas susceptible to disasters. Such knowledge is applied in the deployment of prevention strategies and shared, through CENAD, with other agencies that participate in the system.

CPRM is the body that provides the largest amounts of information on areas of risk, through mapping and classification of high and very high-risk areas in the 860 priority municipalities identified. In the field of water-resources management, CPRM also performs an important role in partnership with ANA, through operation of 76% of the National Hydro-meteorological Network and issuing of flood-risk forecasts and early-warnings of flooding. CPRM also operates the Groundwater Information and Monitoring Network (RIMAS) under which there is a programme for drilling wells, targeted at municipalities in the semiarid region. In terms of disaster prevention, through land-use management actions, within the scope of the National Protection and Civil Defence System, CPRM drafts maps of geotechnical susceptibility to landslides and flooding for priority municipalities. Moreover, in partnership with the Ministry of Cities, its geotechnical maps are used for determining the suitability of areas for urban settlement, from a disaster perspective.

The National Secretariat for Civil Protection and Defence, through its center

CENAD, consolidate risk-management information, such as data on the occurrence of natural and technological disasters and collateral damage. Management of such information makes it possible to support states and municipalities prepare for disasters and afford protection to more vulnerable communities. It also enables streamlining and optimization of responses and of cooperation with states and municipalities when disaster strikes. CENAD is also responsible for coordination with other technical agencies (e.g., in the fields of hydro-meteorology, geology, hazardous products, etc.) that work with forecasting and monitoring information, to obtain inputs for its protection and civil-defence activities.

4.6 Gaps identified

There follows an assessment of information gaps identified in the sectoral analysis. Filling such gaps is considered one of the main indirect measures for fostering adaptation, since it would enhance public-policy actions underway or foreseen for disaster risk management in the context of climate change:

Details for analysis of vulnerability: For risk management at the municipal level, the level of detail of information needs to be greater than that provided in the census. One alternative is to break down data to the urban-block level. Measurement at this scale is being tested by CEMADEN, in partnership with IBGE.

Implementation failures of the National Policy for Protection and Civil Defence (Law 12608): Though enacted in 2012, the PNPDEC has not been brought fully into effect. Consequently, several of its provisions lack clarity, thereby leaving scope for implementation gaps. Strengthening of SINPDEC, with a view to improving coordination and management of actions for preparation, prevention, mitigation, response and recovery, and protection and civil defence, is one of the benefits that could be achieved by an Enabling Law. The national registry of municipalities with areas susceptible to landslides and flooding has proven an important planning tool for actions targeted at these municipalities. Law 12608 foresees establishment of a Disaster Information and Monitoring System, an instrument of inestimable importance for filling gaps stemming from poor integration among databases on the occurrence of disasters. Gaps left after enactment of Law 12608 include: a) deficiencies in the management structure for coordination of actions provided for in the PNPDEC; b) failure to draft a National Plan and State-level Plans for Protection and Civil Defence, also foreseen in this Law; c) lack of continuity of actions for protection and civil defence, owing to disparities between agencies at the different levels, and d) failure to implement capacity-building strategies;

Actions relating to urban planning: some progress has been made in recent years with regard to urban planning and measures targeted at reducing disaster risks. Actions supported by the Ministry of Cities, such as drafting of geotechnical urban-development suitability maps from a disaster-risk standpoint, Municipal Risk Reduction Plans (PMRRs), hillside-containment projects, and other infrastructure investments, need to be reinforced. These, however, are covered in the urban-planning section of the Chapter on the Strategy for Cities.

4.7 Guidelines for promoting adaptation

This item covers the priority guidelines for adaptation of the context of this Strategy. At the federal level, significant progress has been achieved in terms of public policies, plans and programmes for prevention, mitigation, preparation, response to and recovery from disasters. These include the Multi-year Plans (PPA 2012-2015 and PPA 2016-2019) and the National Plan for Risk Management and Response to Natural Disasters. In line with these instruments, there follows an account of measures targeted at improving delivery of current initiatives and at developing new as-yet untried approaches for adaptation to climate change.

At the municipal level, there is still a predominance of inadequate land-use and settlement patterns, which exacerbate exposure threats and contribute toward the causes of disasters, thereby increasing the vulnerability of populations. As mentioned earlier, however, and for purposes of this NAP, approaches for dealing with these problems are presented in sections devoted to urban planning in the Chapter on the Strategy for Cities.

For Disaster Risk Management, the first guideline addressed in this Chapter is to bring Law 12608 on the National Policy for Civil Protection and Defence fully into effect. The PNPDEC provides guidelines which could directly promote reduction of disaster risks while, at the same time, fostering adaptation to climate change on a variety of time-frame and territorial levels.

Another guideline is was the establishment of a Federal Committee dedicated to management of disasters risks, comprised of representatives of federal government agencies with expertise in related fields. This Committee would, as its first mission, be entrusted with improving coordination and performance of the SINPDEC through better integration of management actions for protection and civil defence at the federal level. Improvements of this nature would lead to strengthening of governance, thereby contributing directly to implementation of other guidelines proposed in this NAP.

The National Policy for Protection and Civil Defence established that the drafting of the National Plan for Civil Protection and Defence is one of the responsibilities of the federal authorities, which should seek to determine measures for management of disaster risk, and for planning of short, medium and long-term risk reduction, to be carried out at the national and regional levels. Measures under this Plan should thus be considered from a climate-change perspective.

As presented in item 7.6, there is a pressing need for greater integration of databases and of systems used for assessing disaster risks. A number of bodies at the federal, state and municipal levels have their own systems for recording disaster events. However, there is a lack of integration among them, which compromises their capacity to share information. Progress in this area is essential: 1) for drafting of optimum strategies and targeted public policies; and 2) as inputs for studies and

multi-year diagnoses for different regions and municipalities.

Another important guideline relates to fostering of studies on the application of Ecosystem-based Adaptation (EbA) measures for disaster-risk management. This approach is imminently suitable for tackling water-related issues such as droughts, prolonged dry seasons, flooding and landslides, since ecosystem services not only contribute toward reduction of disaster risk, but also to the adaptation strategies of other sectors. Environmental services relating to water production provided by forests increase soil permeability, thereby facilitating infiltration and reducing surface runoff. They also play a significant role in regulating the hydrological cycle in micro basins and in strengthening the stability of hillsides. These examples suffice to demonstrate the crosscutting nature and importance of EbA approaches to various sectors, such as water resources, cities, infrastructure, and transport, covered in other Chapters of this NAP.

Once such studies have been concluded, implementation of their recommendations needs to be evaluated by public authorities at the federal, state and municipal levels, with the participation of sectoral committees, organized civil society and research institutions, to adapt them to local needs and possibilities. It can thus be concluded that the conduct of specific EbA-related studies will provide scientific and technical inputs and contribute toward the design of better strategies for disaster risk management.

Adaptation strategies for reducing disaster risks that need to be pursued are: Monitoring of extreme climate events and of disaster precursor variables; accurate weather forecasting and prediction of disaster risks are measures that, alongside fostering of research on climate change themes and simulation of likely future climate and adaptation scenarios.

Moreover, disaster early-warning systems provide important inputs for assessment of climate risk and for reducing damage to vital physical infrastructures. The major infrastructure projects need to be carried out with awareness that, due to climate change, weather and rainfall series have become much less predictable. For planning of infrastructure for water supply, hydro-electricity, transmission lines, highways, wastewater systems, bridges, irrigation, aqueducts, oil and gas pipelines, and port terminals, effective adaptation measures are of vital concern, in view of the likelihood of more volatile climatic extremes and of their inherent risks.

Research also needs to focus upon promoting a better understanding of disaster risks and on reducing uncertainties of various types, with a view to identifying vulnerability hotspots where disasters are most likely to occur.

Incentives should be offered for climate-change studies that explore its relationship with extreme events on various scales. Other fields of study that merit support include: environmental change, modelling of socioeconomic scenarios, and the effects on various forms of vegetation cover. Also important is stimulus for

formation of more research groups on such themes that have, as yet, received scant attention in Brazil, owing mainly to the small number of research institutes qualified to work with climatic projections. Support and encouragement needs to be provided for new postgraduate-level courses focused specifically on disasters. As a means of strengthening these guidelines, modelling data on future climate projections should be widely shared through inter-institutional technical cooperation agreements.

From a broader perspective it should be stressed that reducing social disparities is among the best approaches for reducing vulnerability to disaster risks. Reducing inequality needs to be considered as a crosscutting theme to all Strategies of this NAP, permeating all government planning and policies, targeted at increasing not only the resilience and adaptive capacity of specific groups, but also at reducing their vulnerabilities.

Table 8 presents a summary of the guidelines proposed in this Chapter, offering a preliminary timeframe, monitoring indicators, and suggestions for its adoption by institutions. SEDEC/MI and the CEMADEN/MCTI are the main focal points for promotion and implementation of these guidelines and are the bodies responsible for reporting to the NAP coordination.

Finally, the crosscutting nature of themes relating to disaster risk management must be stressed. Within the context of the actions proposed under this NAP, it is vital that effective integration and coordination be maintained with such other sectors as cities, health, infrastructure and urban mobility, water resources, agriculture, biodiversity, ecosystems, and coastal zones.

Table 8. Guidelines for Adaptation to climate change for the Disaster Risk Management sector

Adaptation Guidelines	Target vulnerabilities/ Opportunities	Agencies and executive bodies	Indicator	Status	Framework
Implementation of the National Policy for Protection and Civil Defence – Law 12608 and fulfilment of actions provided for thereunder.	Several improvements to the sector already provided for in the Law, highlighting: creation of a National Disaster Monitoring and Information System , national registry of municipalities with areas susceptible to landslide and flooding, promotion of State Plans for the Prevention of Disasters, among others	MI/SEDEC	Monitoring of guidelines specified in the Law 12608	To be implemented	Short term for implementation. Medium term for fulfilment of actions provided for.
Ecosystem-based Adaptation (EbA) Measures	Implementation of actions targeted at increasing environmental services provided by forest (replanting or preservation) and soil conservation, related to water and stability of hillsides	MMA, ANA, MCid, MI, State and municipal secretariats, basin committees	Number of EbA actions implemented. Number of beneficiaries. Hectares reforested, preserved and soil conserved	To be implemented Could be interconnected to municipalities and states with a pre-existing or on-going Payments for Environmental Services (PSA)	Long term
Consolidation of an Early Warning System	Reduction of the risk posed by climate threats by increasing disaster prediction capacity, raise awareness of risk and promote related studies.	MI/SEDEC, CEMADEN, INMET, CPTEC/INPE, ANA State institutions among others	Monitoring of the expansion of Brazil's observational network. Number of municipalities monitored	Consolidate and strengthen existing actions. Implement new actions	Short term Medium term
Mechanisms for insurance or transfer of risk	Transfer of risk of the most exposed and vulnerable population through payment of insurance premiums when impacted.	MI, MF, MMA, MCid, MAPA, State Secretariats	Number of policyholders. Total value of premiums paid	To be implemented	Long term
Stimulus for research focused on the understanding of disaster risk	Improve the capacity for research and understanding of disaster risks on different scales, especially at the local level. Indirect inputs for research related to the CCs as a means of reducing uncertainties	MI, MCTI, MEC, Research Institutes, Universities	Number of post-graduate lines of study. Number of Thematic Projects Number of publications	Consolidate the current situation and promote improvements	Short term Medium term