DISASTER RISK REDUCTION IN LATIN AMERICA, IMPROVING TOOLS AND METHODS REGARDING CLIMATE CHANGE:

The case study of Colombia and the city of Manizales

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In the last decades, Latin America and the Caribbean has been an important scenario of natural disasters as well as disaster risk understanding and management. The region has natural, social and cultural dynamics that allows different approaches and academic reflections around environmental issues such as the disaster risk and vulnerability.

In this respect, disaster risk analysis has passed from the focus on the many hazards affecting this area to the understanding of vulnerability as the main core of the problem, pointing out issues such as population growing and concentration into urban areas, land use planning, economical instruments to protect productive activities and infrastructure, among others. Nevertheless, actions to reduce disaster risk still require stronger policies, practices, control and resources. There are many and new challenges, particularly when considering the increasing in frequency and intensity

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of climate-related and weather-related risks, associated to climate variability (e.g. El Niño-Southern Oscillation (ENSO)) and global climate change.

In fact, the last Global Assessment Report on Disaster Risk Reduction (GAR) 2011, from the UN International Strategy for Disaster Reduction, highlighted that weather-related risk for Latin America and the Caribbean, has been increasing as a result of exposure augmentation regarding people and the economic activities. Particularly, the number of people exposed to cyclones has been increasing very fast in the last 30 years, as well as the economic exposure to floods in the last 10 years (UNISDR, 2011).

Additionally, the consideration of scenarios for climate change and its effects on the other disaster risk factors (natural hazards and vulnerability) are becoming an important issue for the international organizations. Projections made by the IPCC for the region detected few changes in the regional atmospheric circulation, such as the intensification of the south Atlantic anticyclone and the shift of the subtropical jet stream in South America to south, which are already impacted by the El Niño-Southern Oscillation (ENSO) and extreme events; though there are no clear long-term trends in mean surface temperature (IPCC, 2007). However, these studies foresee changes in rainfall patterns, disappearance of glaciers, and sea level rise, which would reduce water availability, and would cause more floods, storm surges, erosion and other dangerous coastal phenomena (Europe-Aid, 2009).

In this regard, the present chapter analyse tools and methods of Disaster Risk Reduction and disaster risk management, according to the definition of groups and examples of activities, programs, among others. Some have a potential to be improved at national and local level in the light of climate variability and climate change. They also are based on the regional context, local expertise, knowledge and research. This analysis is made particularly for Colombia, which was highly affected by one of the strongest rain seasons in the last years associated to La Niña phenomena, and the comparison of the same situation in the city of Manizales (Caldas), characterized by multi-hazard disaster risk and historical improvements in disaster risk management.

1. DEPARTING CONCEPTS AND TOOLS FOR DISASTER RISK MANAGEMENT (DRM) AND CLIMATE CHANGE ADAPTATION (CCA)

1.1 DISASTER RISK MANAGEMENT, DRM

Latin America and the Caribbean has been a scenario of conceptual production around the notion of disaster risk and disaster risk management. The acknowledge of this local and expertise background and its advance constitutes a departing point when analysing improvements required to consider climate change adaptation, principally because it involves local socio-economic-cultural readings and experiences dealing with a dynamic environment where disaster risk materialization itself occurs quite often.

In fact, Allan Lavel, from the FLACSO (Latin American Faculty in Social Sciences), in Costa Rica explains that the notion of risk management has been used in the region since 1996 approximately, which has been related to the work of the Social Studies Network for the Prevention of Disasters in Latin America (LA RED). This network was created in 1992, as an interdisciplinary group of disaster risk specialists, from different institutions (governmental and non-governmental, academic and international) and initially from seven countries (Brazil, Canada, Colombia, Costa Rica, Ecuador, Mexico, and Peru).

According to Lavell, the last 20 year discussions around disaster risk in Latin America and the Caribbean, particularly after the hurricane Mitch in 1998, have gone from the focus on the disaster itself to disaster risk; which is the probability of damage and losses in the future. Effects associated to the impact of physical events on the exposed elements, as result of the "human vulnerability" (or predisposition of human beings, livelihoods and infrastructure to suffer losses or damages) (Lavell, 2011).

Vulnerability has been studied from different points of view. One important conceptual approach was developed by Gustavo Wilches-Chaux (La Red, Colombia), who defined as global vulnerability the integration of different dimensions; those that integrate the idea of social structure propensity to suffer damage and to find difficulties in recovery (Lavell, 2003). These dimensions

or components are: physical, environmental, economic, social, educational, political, technical, institutional, cultural, and ideological vulnerability (Wilches-Chaux, 1989, 1993).

On the other hand, Omar D. Cardona (La Red, Colombia) makes a significant contribution to the conceptual framework through the program of Indicators for Disaster Risk and Disaster Risk Management for Latin America and the Caribbean. This program was developed by the Institute of Environmental Studies at the National University of Colombia in Manizales, for the Inter-American Development Bank. In this initiative Cardona posed that vulnerability is tied to social processes, fragility, susceptibility, lack of resilience of the exposed elements, natural and built environmental degradation at urban and rural levels (Cardona, 2003). He suggests that "*degradation, poverty and disasters are all expression of environmental problems and their materialization is a result of the social construction of risk, brought about through the construction of vulnerability or hazard, or both simultaneously. Thus, when seen from a social viewpoint, vulnerability therefore signifies a lack or deficit of development*" (Cardona, 2003). Particularly, for developing countries, vulnerability is related to urban growth and environmental deterioration, which reduce quality of life, increase the destruction of natural resources, landscape, and loss of genetic and cultural diversity (Cardona, 2003).

At this point, it is also important to mention the concepts of extensive risk and intensive risk, addressed by the Global Assessment Report on Disaster Risk Reduction (GAR), which highlight different levels of interventions regarding tools and methods for disaster risk, concerning the spatial distribution and the commitment required for the pertinent institutional level.

Firstly, the extensive risk is related to an accumulative process over time and when it manifest itself becomes a large and rising localized disaster. Extensive risk is associated with storms, flooding, fires and landslides, linked to climate variability. Consequences are higher for affectation of housing, crops, livestock and local infrastructure, low-income households and communities, than in terms of mortality (UNISDR, 2011).

Secondly, intensive risks "accumulates in areas prone to major hazards, such as earthquakes, tsunamis, tropical cyclones or flooding in large river basins". These events have low frequency and high destructive intensity. These kinds of probable major hazard events and risks are generally estimated using sophisticated probabilistic models by insurance industry for the calculation of probable maximum losses. Nevertheless there are still many gaps in knowledge related to the estimation of these disaster risks (UNISDR, 2011).

In addition, Lavell proposed (1998, 2005, 2009 and 2011) that there are two kinds of intervention of disaster risk; the first one is the corrective risk management, actions for risk compensation or mitigation. The second one is the prospective risk management, or proactive actions, which prevent new risk conditions or probable future risk. It is also considered that there are phases or

moments of risk, so it becomes a continuum, in constant movement, changing all the time; corrective or prospective disaster risk management actions can be applied at any of these phases (ICSU-LAC 2010, Lavell, 2011).

1.2 TOOLS AND METHODS FOR DISASTER RISK MANAGEMENT

Disaster Risk Reduction (DRR) and Disaster Risk Management (DRM) comprehend complex and multidisciplinary tools, methods and procedures to reduce or control human vulnerability, hazards (when possible) and finally, reduce risk.

According to Lavell, disaster risk can be reduced or controlled by diverse means such as (Lavell, 2003):

- Reducing the level of exposure of the society through land-use and territorial planning schemes.
- Avoiding the transformation of natural resources into socio-natural hazards by preventing the deterioration of the natural environment.
- Limiting the exposure of society to physical phenomena by means of protective structures such as dykes, terraces, retaining walls, wind barriers etc.
- Increasing the resilience of the society's productive systems when faced with potentially damaging physical phenomena through mechanisms such as agricultural diversification, changes in the sowing and cropping timetables, the introduction of climate-resistant crop species, etc.
- Reducing the fragility or inadequacy of the society in its different structural, social, economic, organizational/institutional and educational dimensions.
- Foreseeing future risks and controlling development norms (prospective risk management).

According to Cardona et al. 2003, it is possible to group tools and methods related to disaster risk management from a political/policy perspective, in order to achieve clear and effective understanding of DRM for the decision-making process. These groups, which are components of a

disaster risk management index, are: risk identification, risk reduction, disaster management and financial protection (Cardona, et al., 2003, BID-IDEA, 2005).

On the other hand, the UN/ISDR formulated five groups for DRM activities called priorities for action, defined for the Hyogo Framework for Action 2005-2015, which have been assessed for the Mid-term progress implementation presented at the Global Assessment Report on Disaster Risk Reduction (GAR) in 2009. These priorities are:

Priority 1: Ensure that DRM is a national and local priority with a strong institutional basis for implementation;

Priority 2: Identify, assess and monitor disaster risks and enhance early warning;

Priority 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels;

Priority 4: Reduce the underlying risk factors;

Priority 5: Strengthen disaster preparedness for effective response at all levels.

Based on these proposals, four components of tools and methods are therefore used in this analysis, which were also considered for the study "Adaptive Disaster Risk Reduction, Enhancing Methods and Tools of Disaster Risk Reduction in the light of Climate Change", developed by the United Nations University Institute of Environment and Human Security for the German Committee for Disaster Reduction (DKKV) (Birkmann et al, 2011). These include: (1) risk identification and understanding, (2) reduction of the underlying risk factors (structural and non-structural measures), (3) disaster preparedness and emergency management (including rehabilitation and reconstruction processes) and (4) institutional capacity and financial mechanisms.

Risk identification and understanding

The identification and understanding of risk refers to a wide concept which intent to assess and reveal risk through the analysis of risk factors (hazard, vulnerability, elements exposed), risk evaluation and risk communication; and considering risk perception and awareness. It also acknowledges actors and stakeholders involved. Both scientific and community-based methods are taken into account, as well as historical reviews and traditional behaviours based on natural indicators.

Examples of these tools are:

- Systematic disaster and loss inventory data

- National and local risk assessments (e.g. holistic [comprehensive] vulnerability assessment, risk assessment and risk communication to stakeholders using maps, indicators, networks, sharing inform systems among others);

- Systems for monitoring hazards, vulnerability and risk (evolution, continuum)(e.g. scientific and technological development, data sharing space-based earth observation, climate modelling and forecasting, statistical information, periodically census of population at risk, analysing risk progression vs. risk management, etc.);

- Regional/ trans-boundary risks included in national and local risk assessments (for example establishing cause-effect situations, risk amplification, inter-institutional and cooperative work);

- Development and research for multi-hazard risk assessments;

- Development and research for cost-benefit analysis of risk reduction;

- Inclusion of concepts in school curricula, educational material and training, particularly public education;

- Public awareness strategy to stimulate a culture of disaster resilience.

Reduction of the underlying risk factors:

Reducing the underlying risk factors involves tools, methods and instruments that address both non-structural measures, such as planning and development programmes, and structural mitigation measures related to engineering works. The principal aim of the reduction of risk is the decrease of socio-economic fragilities, susceptibilities and exposure, defining accepted levels of risk and the ability to cope. It also addresses the reduction of the impacts of hazards when and where possible.

Some selected tools for the representation this group are:

- DRM as an integrated objective of environmental policies and plans, including land use, natural resources management and adaptation to climate change (e.g. protection of hillsides, hydrological basins, wetlands, by conservation of ecosystems, reforestation programs, which allow the control of landslides and floods);

- Social development policies and plans to reduce the vulnerability of populations most at risk; as part of the sustainable development (e.g. poverty reduction, improving health

services and professional attention in areas at risk, promotion of job opportunities for vulnerable communities, increasing education availability for children, and so on);

- Structural measures and engineering works (implementation of hazard-event control and protection techniques) (e.g. dikes, protection works for landslides, hydraulic works, reinforcement and retrofitting of public and private assets, etc.);

- Policies and plans to reduce the vulnerability of livelihoods (e.g. for small scale agricultural, fishery activities);

- Human settlements planning and management, considering risk, risk reduction in by reducing exposure;

- Updating and enforcement of safety standards and construction codes.

Disaster preparedness and emergency management (including rehabilitation and reconstruction phases)

Disaster preparedness and emergency management involve not only tools, methods and actions before and disasters for improving response and recovery (known also as copying capacity) but also strategies after disaster for rehabilitation and reconstruction phases. This means that for the last phases prospective risk reduction actions is applied, transforming previous conditions into a more resilient ones, which are highly related to adaptive capacities after disasters. Birkmann et al. (2009) highlight the importance of this group of tools and methods for Climate Change Adaptation in the study, "Addressing the Challenge".

The set of tools considered for this area are:

- Disaster preparedness plans at all administrative levels, organization and coordination of emergency operations at regular training drills. These include the development of the emergency plans and drills to update and test inter institutional response;

- Risk reduction measures integrated into the development of previous recovery plans and reconstruction plans;

- Early warning systems (EWS) integrated to the emergency response planning;

- Community preparedness and training; implementation of social safety nets

- Endowment of equipment, tools and infrastructure for emergency response organisms and groups (resources, communication equipment, registry systems, specialized equipment and reserve centres, among others);

- Financial reserves to support effective response and recovery when required;

- Procedures for exchanging relevant information during disasters and to undertake post-event assess performance.

Institutional capacities and financing mechanisms

The management and development of activities in DRM require leadership and administrative skills of all governments, which are responsible for the control of the collective disaster risk situations. The promotion of laws and dispositions to apply disaster risk reduction activities, the support and interchange with the technical, scientific and traditional knowledge as well as the consideration of disaster risk perception, funding, coordination of emergencies, among others, are some of the capacities required at the institutional sphere.

Tools involved in this category are:

- Strengthening of governance;

- Existence of national policy and legal framework for disaster risk reduction with decentralized responsibilities and capacities at all levels;

- A national, multi-sectorial platform for DRM, and inter-institutional arrangements to work as a system of DRM;

- Internal institutional arrangements for DRM, including educational and training programmes for employees (e.g. technical and institutional capacities, resources);

- Budget allocation and mobilization, accessibility to public resources for DRM plans and activities at all administrative levels (including negotiation of external financing for national and local programmes and/or projects);

- Assessment of probable losses for public properties, services and vulnerable populations;

- Ensure community participation;

- Insurance coverage and loss transfer strategies of public assets;

- Housing and private sector insurance and reinsurance coverage.

1.3 CLIMATE CHANGE ADAPTATION

The concept adaptation to climate change has been treated and recognized at the international level due to the work of the Intergovernmental Panel on Climate Change (IPCC) and the creation of United Nations Framework Convention on Climate Change (UNFCC). First of all, the IPCC considers climate change as "the change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer", changes result of the natural variability or human activity (IPCC, 2007).

On the other hand, the UNFCCC considers the change of climate as a product of the direct or indirect human activity that alters the composition of the global atmosphere, in addition to natural climate variability observed over comparable time periods (IPCC, 2007).

According to these concepts, the IPCC and ISDR define climate change adaptation as the adjustment on natural or human systems in response to: a) real climatic stimuli, b) foreseen climatic stimuli or c) the effects of such climatic stimuli. Such response moderates the damages expected or takes advantage of possible beneficial situations. This kind of adaptation can be: "anticipated" or proactive (it is adjusted due to foreseen climate changes in the future), "autonomous" or spontaneous adaptation (related to a reaction to the ecological, natural, market or wellbeing changes), and planned adaptation (result of political decisions) (Lavell, 2011).

Nevertheless, adaptation of communities to the effects of weather and climate-related events has been made everywhere and for a long time, reducing their vulnerability to floods, droughts and storms (IPCC, 2007). At this point it is important not only to addition new adaptation measures at regional and local levels, but also to rescue the traditional and local based practises, improving them by addressing the challenges posed by climate variability and climate change.

Examples for adaptation option suggested by the UNFCCC are: behaviour change at the individual level (e.g. sparing use of water in times of drought); technological options (e.g. increased sea defences or flood-proof houses); Early Warning Systems for extreme events; improved risk management including insurances; and biodiversity conservation to reduce the impacts of climate change on people, (e.g. conserving and restoring mangroves to protect people from storms) (UNFCCC, 2010).

In this regard, the Global Assessment Report on Disaster Risk Reduction (GAR) 2011 states that adaptation to climate extremes should increase efforts in the reduction of underlying risk drivers, reducing vulnerability and strengthening risk governance capacities. The climate change effect will be reduced by reducing disaster risk and in this way adaptation will be facilitated. This message is important due to the current tendency to characterise all weather-related disasters as manifestations of climate change, which give a wrong idea about the role of the disaster risk drivers and a wrong direction to national policies and planning (UNISDR, 2011).

2. DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION, OPPORTUNITIES FOR LATIN AMERICA

2.1 DISASTER RISK AND RISK REDUCTION CONTEXT

Latin America and the Caribbean have been affected by multiple natural hazards along its history, including: earthquakes, volcano eruptions, tsunamis, wildfires, floods, droughts, mass movements, storms, hurricanes, epidemics, among others. These natural phenomena make part of the natural dynamism and ecosystem diversity of this region, with abundance of water resources, biological richness, climatic variety due to the geographical configuration and active geodynamics, among others. This environment is constituted also by a diverse population, which is growing very fast particularly around the urban centres, characterized by very high inequity levels, socio-economic and governance problems.

Devastating disasters have occurred in the last 40 years, associated to: earthquakes in Peru (1970, 1981 and 2007), Managua (1972), Guatemala (1976), Mexico (1985), San Salvador (1986, 2001), Costa Rica (1991 and 2009), Colombia (1979, 1983, 1994, 1999), Chile (1960, 1985 and 2010), Haiti (2010); some hurricanes such as Fifí in Honduras (1974), Joane in Nicaragua (1988), Gilberto in Mexico, (1988) Mitch in Honduras, Nicaragua, El Salvador and Guatemala (1998), George in Dominican Republic, Hugo in Puerto Rico (1998); volcano eruptions of el Chinchón in Mexico (1982), el Ruiz in Colombia (1985); among others (Lavell, 1993; Oliver-Smith, 1994; Rodriguez and Troche, 1994). Similarly, small disasters happen often at local levels, reason why most of times they are not known at the international level, but they become an issue to be undertaken by local governments and communities delaying the improvement in life quality.

These disasters, specifically the most devastating ones in the 1980's and 1990's, have pointed out the need of promoting and improving disaster risk policies, national platforms, laws, disaster management, preparedness, etc. at different levels.

Calls for new schemes were particularly addressed at the Inter-American Conference on Natural Disaster Reduction carried out in 1994 in Cartagena de Indias, Colombia. Participants, including representatives of governments, organizations, institutions and agencies at regional and sub-

regional levels, professionals, professors, and researches at public and private entities, elaborated a final statement document called the Declaration of Cartagena de Indias, as a message for the World Conference on Natural Disaster Reduction held in Yokohama, Japan in 1994.

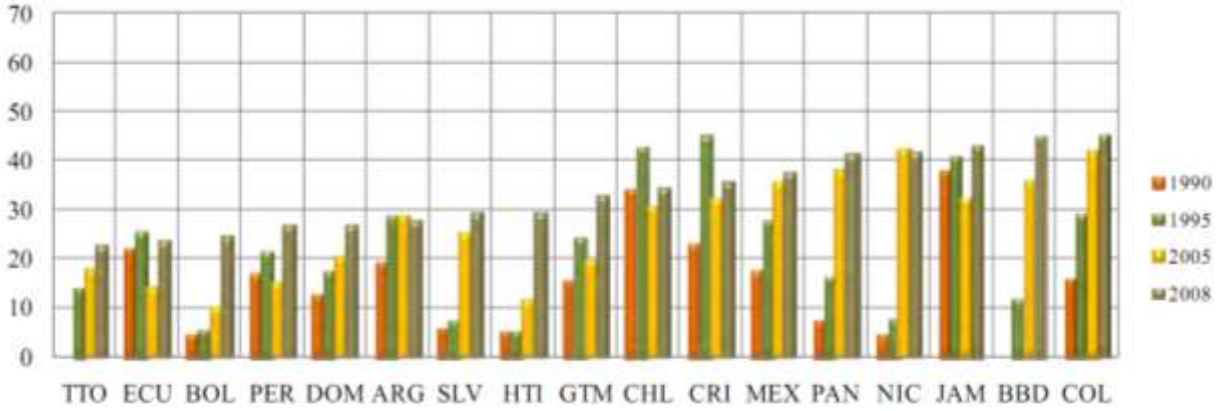
This Declaration emphasized that disasters problems in the region were growing mostly due to the development models adopted for these governments, where population and urbanization growing, land use tendencies, increasing of poverty, as well of the pressure on natural resources, had increased human vulnerability. It was established that scientific and technical approaches lacked of advances due to the separation from social, cultural, economic and local contexts and realities. On the other hand, it was identified a lack of politic willingness in application of institutional models for DRM and the promotion of disaster prevention into the sustainable development strategies (La Red, 1994).

Recommendations regarding the improvement of disaster prevention, disaster risk mitigation and reduction were: monitoring and assessment of vulnerability; improving disaster studies integrating technical, scientific and civil society to governmental organisms; community participation, education and capacitation; promoting politic compromises from the United Nations Agencies; conformation of networks in the region; decentralization of institutions; recompilation of good practices; formulation of policies and laws; financing policies promoting prevention and mitigation into regional development programs; and so on (La Red, 1994).

Changes in the disaster risk management in Latin America can be noticed in Figure 1, a graphic of the risk management index, RMI, developed for some countries of the region, for the Program of Indicators for Disaster Risk and Disaster Risk Management for Latin America and the Caribbean, (IDEA-IDB) in 2003. This index assesses the level of performance (low, incipient, significant, outstanding, and optimal) for four components of disaster risk management: risk identification (RI), risk reduction (RR), disaster management (DM) and financial protection and governance (FP); each one is composed by 6 indicators evaluated by experts and institutions in each country (Cardona et al, 2003). The Figure presents the recent results for different periods of time for 18 countries evaluated in 2008.

In general countries have been improving disaster risk management by the time, but there are cases such as Ecuador, Argentina, Chile, Costa Rica, and Nicaragua, where earlier time periods obtained better qualifications than in 2008. Countries with highest values in risk management are Colombia, Barbados and Jamaica, and the lowest values are for Trinidad and Tobago, Ecuador, Bolivia and Perú.

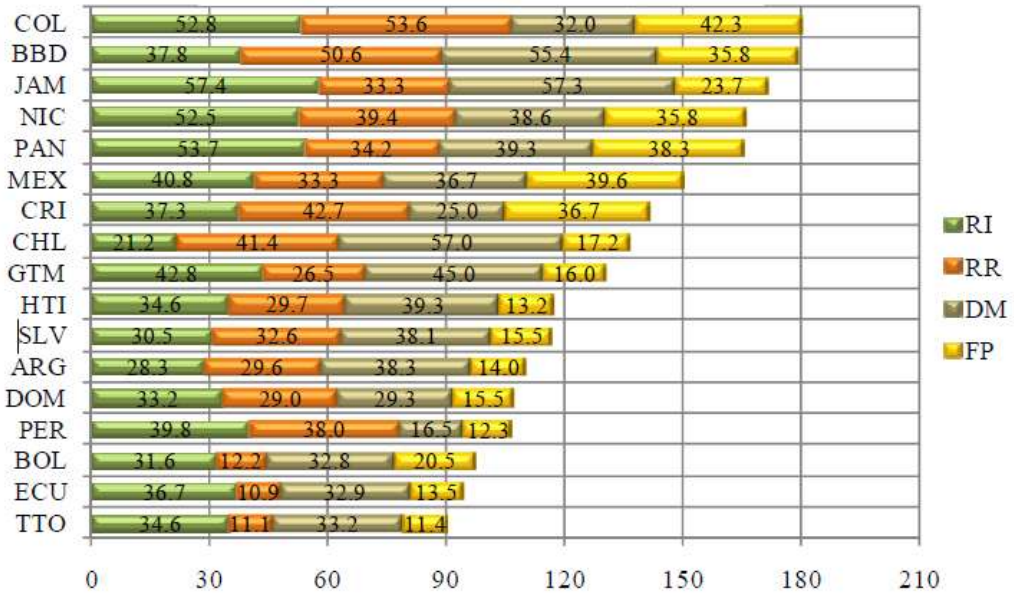
Figure 1. The Risk Management Index (RMI) applied to 18 LAC countries



Source: IDEA-IDB-ERN, 2009a

Results for each component at each year can be also analysed from the report. Particularly for 2008, Figure 2 shows results by policy or component, where in general the lowest efforts have been given to financial protection and governance (FP) followed by risk reduction (RR), such as in Bolivia, Ecuador and Trinidad and Tobago (See: Summary Report, IDEA-IDB-ERN, 2009a). The lowest levels for risk identification are for Chile, Argentina, El Salvador and Bolivia; while in the case of disaster management smallest achievements are for Peru, Costa Rica, Dominic Republic and Colombia.

Figure 2. Aggregate RMI for 2008



Source: IDEA-IDB-ERN, 2009a

Nevertheless, even for countries with greater RMI value, risk management is incipient or significant in the best of the cases; "*therefore, there is still much further to reach an effective disaster risk management in the countries and in the region"* (IDEA-IDB-ERN, 2009a).

2.2 DISASTER RISK MANAGEMENT, CLIMATE CHANGE AND CLIMATE VARIABILITY

Projections of climate change have been made for the region based on an experimental model that foresees an intense effect on the hydrological cycle, changing the distribution of extreme heavy rainfall, wet and dry periods. It is still uncertain how global warming will affect the frequency and intensity of extreme events, but surely will affect weather/climate-related disasters (IPCC, 2007).

The assessment and analysis about climate change in Latin America made by EuropeAid (2009), regarding impacts, vulnerability and institutional frameworks, established that not all countries in the region have the same position in this issue, according to every particular geography, economic interest, vulnerability, dependency to fossil energy resources and/or fragility of ecosystems. The consolidation of a common strategy for adaptation and mitigation programmes should be a first step. Specifically for adaptation, short and medium measures were identified as the most useful and accepted instruments. The evaluation of vulnerability is a key point in order to discuss possibilities in cooperation and financing of projects. "*Integration of potential climate change risks into planning and implementation of development cooperation is fundamental*" *(*EuropeAid, 2009).

Nevertheless, even when it is still fuzzy climate change effects and climate change adaptation action programs, Latin America and the Caribbean have been facing already the impacts of climate variability. This climate variability is understood as the combination of natural permanent changes proper to the Earth's climate (Wilches-Chaux, 2007).

The IPCC acknowledge the ample evidence of climate variability at the different range of time scales all over Latin America, from intra-seasonal to long term. "*In many sub-regions of Latin America, this variability in climate normally is associated with phenomena that already produce impacts with important socioeconomic and environmental consequences that could be exacerbated by global warming"* (IPCC, 2007).

Extremes of the Southern Oscillation are partially responsible for inter-annual scales climate variability; variations associated with manifestations of climate variability are El Niño phenomenon (low phase of the Southern Oscillation) and La Niña (positive phase), that perturb atmospheric circulation patterns (stronger during El Niño than La Niña years) (Salles and Compagnucci, 1995, 1997 in: IPCC, 2007). Latin America is greatly sensible and vulnerable to

ENSO events, from Mexico to Tierra de Fuego, where every country exhibits anomalous conditions associated to it (IPCC, 2007). Between 1997 and 1998 El Niño caused losses for about 100 thousand million dollars. In Ecuador, for instance, losses were around 3.5 and 4 thousand million dollars, 286 people died and 30.000 people lost their homes (CIIFEN, 2007 in: Predecan, 2009).

On the other hand, the awareness to El Niño y La Niña phenomena and their effects have been improving. The research project on Disaster Risk Management and ENOS in Latin America of the Comparative Research Network (created by the Inter American Institute for Global Change Research, IAI) and financed by the National Science Foundation of the United States of America, was developed between 2000 and 2005. The project departed from setting up the framework provided by La Red; then, ENSO and risk patterns in the region were tracked, and a data base on disaster associated to climatic events between 1970 and 2003 was built up using a database and software called *Desinventar* developed by La Red. Finally, a system for administration of all information and documentation was created (Lavell en: Wilches-Chaux, 2007).

The *Desinventar* database, (for its name in Spanish, Disaster Inventory System) was created after the foundation of La Red, by the acquisition, collection, retrieval, query and analysis of information about disasters with small, medium and greater impact, based on pre-exiting official data, academic records, newspaper sources and institutional reports in nine countries in Latin America (today spread to more than 16 and other continents). Events registered are classified into geodynamic, hydrological, atmospheric, biological phenomena and technological events. The concept behind it pretends to make visible disasters at the local scale (town) and facilitate dialogue for risk management between different actors (e.g. institutions, sectors, local and national governments) (Desinventar web page; Cardona et al., 2005).

The United Nations Developing Program (UNDP) and UNISDR are sponsoring the implementation of similar systems in the Caribbean, Asia and Africa (Desinventar web page). *Desinventar* information has been used, for instance, for the development and application of the index called *Local Disaster Index* (LDI) (project IDEA-IDB, 2003) that assesses the concentration of small disasters in a country, and for the analysis of losses from intensive and extensive disasters related to hydrological and meteorological risks in the GAR 2009 and 2011, among others. Additionally, it has been recognized by the UNFCCC under the Nairobi Work Programme as a source for socio-economic data (UNFCCC, 2010).

Other example is the foundation of the International Center for El Niño phenomena research (CIIFEN) in 2003, with the support of the World Meteorological Organization (WMO), the UNISDR, and the Ecuadorian and Spanish governments. This organization has been producing climate information for development sectors in Latin America as well as for institutions related to

climate risk management. Analyses use the information from the Meteorological Services in Argentina, Venezuela, Colombia, Ecuador, Peru, Bolivia and Chile (CIIFEN Web site).

Actions into disaster risk reduction are still a challenge for all countries in the region. Key activities are: the reduction of exposure, the improvement of political compromises, application and control of the laws, policies and practices related to planning and land use (integrating risk reduction and environmental management and protection), more concrete actions regarding sustainable development, poverty reduction, job possibilities, protection of productive sectors such agriculture and local activities, among others. The fast disaster risk reduction be improved the fast countries and the continent will be moving forward climate change adaptation.

Nonetheless, we find these programs an example of how disaster risk management, disaster risk reduction, and in this case risk identification, monitoring of hazards and inventory of disasters and losses, can consider the present climate variability. This information is highly useful for developing risk reduction and climate change adaptation programs and strategies.

Finally, regarding experiences in Latin America and the Caribbean it is possible to say at some point that **going from regional to local means going *from climate change adaptation to disaster risk management***.

3. TOOLS AND INSTRUMENTS OF DISASTER RISK MANAGEMENT, AND CLIMATE CHANGE ADAPTATION AT NATIONAL LEVEL, REFLEXIONS FOR THE CASE OF COLOMBIA

Colombia is located in the north of South America, where the Caribbean Sea, the Pacific Ocean, the Andes and the Amazonia forest are part of the geographical territory. Here we find diversity in climates and ecosystems, plaques tectonic and geological faults activity, the Inter-tropical Convergence Zone, active volcanoes, many rivers and water sources.

The current population is 46'044.601 inhabitants[2], which has been growing in the last years at a rate around 1.01. The 74% of the population is living in urban areas and the principal urban centres are located in the Andean region, Cauca river valley and Caribbean coastal region (IDEA-IDB-ERN, 2009b).

Natural disasters affecting the country are: droughts, earthquakes, epidemics, extreme temperatures, floods, insect plagues, mass movements, storms and volcano eruptions. Data about the most devastating impacts are presented in Table 1, by number of affected and killed people as well as economic costs.

This Table shows the impact of the 2010 rain season of the country, affected by La Niña phenomena, causing floods along the territory. Other significant disasters, which have left a collective memory impact due the magnitude of their respective event, are: the eruption of the volcano El Ruiz in 1985 (provoking an avalanche that destroyed the city of Armero), the coffee growing area earthquake in 1999 (with more damages for the departments of Quindío and Risaralda), and the landslide (mass wet movement) in 1987 in the city of Medellin, which destroyed a whole neighbourhood (Coupé, 1994).

[2] Projection 2011 made from the Administrative National Department of Statistics, Census 2005

Table 1. Top 10 Natural Disasters Reported, 1980 - 2010

Affected People

Disaster	Date	Affected (no. of people)
Flood	2010	2,217,518
Earthquake*	1999	1,205,933
Flood	2008	1,200,091
Flood	2007	1,162,135
Flood	2005	474,607
Flood	2007	443,173
Flood	2004	345,386
Flood	1986	250,000
Flood	2006	221,465
Flood	2004	186,096

Killed People

Disaster	Date	Killed (no. of people)
Volcano	1985	21,800
Earthquake*	1999	1,186
Mass mov. wet	1987	640
Flood	2010	363
Epidemic	1991	350
Earthquake*	1994	271
Earthquake*	1983	250
Mass mov. wet	1986	200
Mass mov. dry	1983	160
Flood	1981	150

Economic Damages

Disaster	Date	Cost (US$ X 1,000)
Earthquake*	1999	1,857,366
Volcano	1985	1,000,000
Flood	2010	1,000,000
Earthquake*	1983	410,900
Insect inf.	1995	104,000
Storm	1988	50,000
Flood	2005	10,000
Earthquake*	2008	10,000
Flood	1981	5,000
Flood	1997	3,000

**: Including tsunami*

Data source: EM-DAT: The OFDA/CRED International Disaster Database, Université Catholique de Louvain, Brussels, Bel. In: Prevention Web[3]

According to the PREVIEW Global Risk Data Platform, 2009 Global Assessment Report (GAR), in Colombia human exposure is higher for droughts (2'187,430 people, around 5% of the population) followed by human exposure to earthquakes (1'969,946 people around 5% of the population), floods (149.876 people), landslides (30,624 people, the 9th country out of 162), tsunami (19,715 people) and cyclones (1,459 people) (PREVIEW Global Risk Data Platform, Prevention web).

Regarding economic exposure (modelled amount of GDP present in hazard zones) this is higher due to earthquakes: US$ 44.52 billion (around the 4% of the GDP). US$ 0.58 billion are exposed to landslides (14th country out of 162), US$ 0.29 billion to floods, US$ 0.01 billion to cyclones and tsunamis. Additionally, the Vulnerability Index (estimated number of people killed per year) is high for to landslides, earthquakes and floods (PREVIEW Global Risk Data Platform, Prevention web).

GAR 2011 accounts also for internal displacement caused by disasters such floods, with low mortality but high number of housed destroyed. For instance, during the period 1970 to 2009 floods destroyed more than 500 houses, and reports for the disaster losses accounted 26,500 houses destroyed, potentially displacing 130,000 people (UNISDR, 2011).

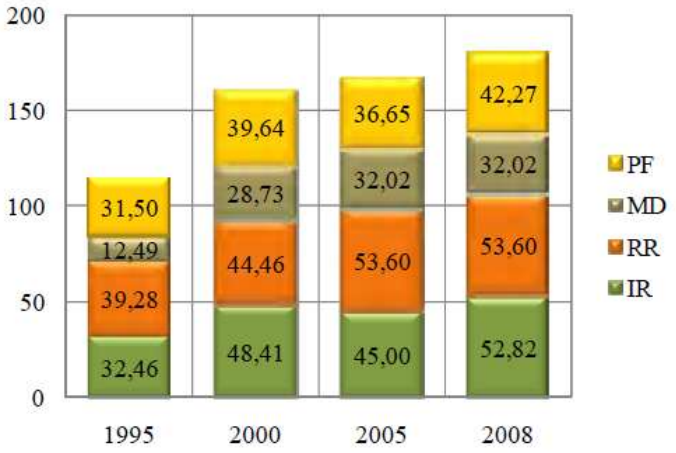
[3] Colombian profile: http://www.preventionweb.net/english/countries/statistics/index.php?cid=37

3.1 DISASTER RISK MANAGEMENT IN COLOMBIA

At the regional level, the country has a leadership in the disaster risk management, which according to the RMI (IDEA-IDB, 2003) has been improving particularly from 1995 to 2005 and 2008 (See Figure 1 and 2).

In Figure 3 it is presented the RMI for Colombia in 4 periods, where it is possible to identify the components or policies of the index: risk identification (IR), risk reduction (RR), disaster management (MD) and financial protection and governance (PF). Results show that risk reduction has been the policy with more level of performance, followed by risk identification and financial protection and governance.

Figure 3. Risk Management Index, RMI, for Colombia



Source: IDEA-IDB-ERN, 2009b

Even when the performance level seems important for the disaster risk management index there are still many activities left behind when comparing with the others in the level of advancement. For risk identification, vulnerability and risk evaluation (RI4), public information and community participation (RI5) and capacitation and education in risk reduction (RI6) have the lowest levels of performance. For risk reduction, the implementation of technical protection and control of dangerous events (RR3), hydrological basin intervention and environmental protection (RR2) and improvement of housing and settlement relocation from prone areas (RR4) are tools less advanced. In the case of disaster management there are still many things to do in planning of the emergency and Early Warning Systems (DM2), equipment endowment, tools and infrastructure (DM3), simulation, updating and testing of institutional response (DM4), community preparation and capacitation (DM5) and rehabilitation and reconstruction (DM6). Finally, for financial protection and governance the last tool is the fund reserve for institutional capacities strengthening (PF2) (See Colombia profile, IDEA-IDB-ERN, 2009b).

According to the assessment made from the World Bank Global Facility for Disaster Reduction and Recovery (2010), the Hyogo Frame work for Action Priorities for implementation advances have been (World Bank GFDRR, 2010):

Priority 1:

The creation of the National System for Disaster Prevention and Attention in 1988, the National Office for Disaster Risk and Attention (currently Direction of Risk Management at the Ministry of Interior and Justice); the National Plan for Disaster Prevention and Attention in 1998; the National Fund for Calamities in 1984 and updated in 1989 (special national account, independence to act for attention of necessities derived from a disaster situation). This System has promoted decentralized disaster risk management responsibilities. Now the challenge is resist pressures to fall back into emergency focus and to address existing disaster risk corrective actions while improving planning processes to avoid new vulnerabilities (World Bank GFDRR, 2010; UNISDR, 2009 in: IDEA-IDB-ERN, 2009b).

Priority2:

Information collection and analytic capacity for early warning and risk mapping have been improved particularly for hydrological, seismic and volcano events. Information flows for disaster vulnerability, risk evaluation and risk reduction programs have been improved, as well as the integration of disaster risk management into research. One specific project is the development of decision making support tools based on probabilistic risk assessment platforms (National Planning Department with support of the World Bank GFDRR) (World Bank GFDRR, 2010).

Priority 3:

Environmental education has been including DRM progressively but there is still a lot to do. Human capital base has an appropriate technical training into the institutions responsible for the disaster risk management in the country (World Bank GFDRR, 2010).

Priority 4:

Investments in disaster risk management, including risk reduction, are done at three levels in Colombia at the core public administration; in addition, agencies dedicated to infrastructure also invest significantly in risk reduction. At the municipal level these are done by some municipal entities. Much work still needs to be done in terms of building awareness and capacities among local governments in smaller municipalities, as well as corrective action to address existing disaster risk (World Bank GFDRR, 2010).

Priority 5:

The disaster response structure has four levels of organization. The National Directorate of disaster prevention and response has been providing training at municipal and departmental levels since 2006. Also drills have been carried out in major cities (the latest and largest exercise was and earthquake drill in Bogota in 2009), but the capacity response of all levels at the same time has been tested only once. Financing and starting faster the recovery phase after natural disasters are the principal challenges for the government. Additionally the country is working on retention and transfer of the residual risk (World Bank, 2010).

Recently, the Ministry of Interior presented to the Congress of Republic a new law project to harmonize, update and modernize the National System for Disaster Prevention and Attention in a new National System of Disaster Risk Management, a new National Policy Law on Disaster Risk Management Project (Law 10 No. 050/2011, and approved as the Law 1523/2012). Now, in this law, accountability is formally for the anticipation of risk and not for the anticipation to disaster. This means institutional liability on anticipation to risk and their determinants (drivers): vulnerability and exposure in prone areas; i.e. an issue of development. It also integrates a wider vision of disaster risk management, where responsibility or risk reduction it's not only for governmental institutions but also to all Colombian citizens.

3.2 CLIMATE VARIABILITY, CLIMATE CHANGE AND CLIMATE CHANGE ADAPTATION

The environmental law of 1993 create the Ministry of Environment and the National Environmental System (SINA), and became the most important reform in the environmental topic in the country because it proposed a new scheme for environmental management, resources and instruments. The establishment of the SINA aims the integration of different public, social and private agents involved in environmental issues, searching of a sustainable development model, decentralized, democratic and participative (MAVDT).

Then, in 1994, Colombia approved the United Nations Framework Convention on Climate Change (UNFCCC), as well as the Kyoto Protocol in 2000. The country has had two national communications on climate change, the first in 2001 and the second in 2010. The First National Communication raised awareness about climate change within the national government, and this enabled the establishment of mechanisms to promote Clean Development Mechanism (CDM) programmes.

Regarding the analysis of trends of climate in the country, and according to IPCC, rainfall has been weak for 1955-1995; river stream flow exhibit decreasing trends, probable due to deforestation. For temperature there are increasing trends in time series for daily series of daily mean and minimum temperature for the past 30 to 40 years, as well as for average monthly dew point and relative humidity (Poveda and Mesa, 1997; Mesa et al, 1997; Pérez et al, 1998; in: IPCC, 2007). Registers from the sea stations in Cartagena (Bolivar, Caribbean Sea) indicate sea level rise of 3.5 mm/year, in Puerto de Cristobal (Panamá) is 2.3 mm/year, in Buenaventura (Pacific coast) is 2.2 mm/year (IDEAM et al, 2010).

Climate change projections made by the Institute for Hydrology, Meteorology and Environmental Studies (IDEAM) for the first communication in 2001 show an increase in the annual mean temperature of between 1 and 2°C for 2050-2060, a variation in precipitation of $\pm$ 15% (difference to the annual value of the period 1961-1990), the increase of the sea level in 40 and 60 cm in the Caribbean and Pacific Coast, respectively (for 2050-2060), the disappearance of 78% of the glaciers on the peaks of the volcanoes and in 56% of the ecosystems at the highest altitudes ("*paramos*"), and the increasing in the sea level rise on the Caribbean coast and Pacific coast (IDEAM et al, 2010).

Results of calculations made by IDEAM and the Department of Geography of the National University (2010) included different models for generation of climate change scenarios from low resolution (IPCC scenarios) to high resolution scenarios (regional models); detecting an increase in the average temperature of the air (with respect to the period 1971-2000) in Colombia: 1.4°C for 2011-2040, 2.4°C for 2041-2070 and 3.2°C for 2071; this would cause reduction of rainfall volumes in the Caribbean and Andean region and increasing in the Pacific region. Relative humidity will reduce in La Guajira, Cesar, Tolima and Huila (Ruiz M., 2010).

Regarding climate variability, vulnerability and impacts of El Niño and Southern Oscillation, events are associated with decrease in precipitation, river stream flows, and soil moisture, whereas La Niña is associated with heavier precipitation and floods (Poveda and Mesa, 1997; Mesa et al, 1997; Pérez et al, 1998; in: IPCC, 2007). It has been found a high positive correlation between the ENSO and the river discharge in Colombia, which is stronger during December-January and weaker during April-May. The influence is stronger in western Colombia and lower in the eastern (IPCC, 2007c).

In 2010, La Niña extended the rainy season in Colombia from September 2010 to April 2011, and increased precipitation levels, causing massive flooding and landslides in the country. The Ministry for Internal Affairs, through the Disaster Risk Management Directorate, reported to June 2011: 475 human fatalities, 576 people injured, 44 people missing, 3.719.033 people affected (860.658 families), 133.468 houses destroyed and 496.031 homes damaged. 58% of the emergencies had been caused by floods, 28% by landslides, 11.3% by strong winds, 11.8% by avalanches and the rest by erosion, hailstorm and (in one case) a tornado. Overall, 702 municipalities were affected in 28 departments of the 32 in the country. The disaster was considered the worst rainy season in Colombia, and the President of the Republic linked it to the effects of climate change. The response effort and reconstruction plan have posed a real challenge for the national government. The government questioned the role of the environmental agencies (autonomic environmental corporations in Spanish), which are part of SINA, due to La Niña presence and the low prevention they had to it.

Recently, the 14th July 2011, the National Planning Department communicate that the National Council for Economic and Social Policies approved the document regarding climate change, where it was identified that this subject hasn't been understood as subject for social and economic development and in this sense it hasn't been part of the planning and investment processes for productive sectors and territories.

The first strategy in the document is the creation of the National System for Climate Change, promoting the integration of the topic into sectors and territories, linking all actions already made and strengthening activities prioritized at the National Development Plan. These activities are:

1. The National Plan for CCA, search for reducing human, ecosystem and productive sectors vulnerability, as well as improving social, economic and ecosystem capacities to respond to climate events and disasters.

2. The Colombian Strategy for low CO2 development, aiming is to obtain international financing, promote technology transfer and be ready to probable commercial barriers.

3. National Strategy for Reduction of CO2 emissions, the idea is to prepare the country from the technical, institutional and social point of view for the implementation of an instrument for financing and territorial

environmental management, in order to reduce, stop or reverse the loss of forest coverture and CO2 associated.

The second strategy pretends the conformation of the Financing Management Committee, to be part of the National System for Climate Change too. This committee will give technical viability and will manage financing resources for projects presented from sectors, territories or agents promoting adaptation and mitigation. The system will be conformed as soon as the law is emitted, during this year, and it will be coordinated by an Executive Commission, integrated by the vice ministry of Agriculture, Mining Industry, Energy, Transportation, Social Protection, External Relations, Housing and Environment, the Treasury and the vice director of Planning (who will preside it) (National Planning Department, 2011).

3.3 IMPROVING DISASTER RISK REDUCTION IN THE LIGHT OF CLIMATE VARIABILITY AND CLIMATE CHANGE

Consistent with the conditions described, the general recommendations for the improvement of DRM and climate change adaptation in Colombia are:

For risk identification and understanding:

The role of IDEAM needs to be stronger into DRM assessment, when analysing local level risks. The development of scientific, technical and technological knowledge at local level has to be encouraged, supported and included into the national net and national assessments to improve resolution of models and climate change scenarios.

The resolution and technical measures for assessment of weather and climate related risks should be improved at the local level.

Human vulnerability due to natural disasters assessment at local level has to be included into climate change vulnerability evaluations at the same levels.

Monitoring of hazards and risk at local level has to advance and spread to lower territorial levels, including community participation and awareness.

The analysis and assessment of weather and climate related disasters that affect extensive areas, including environmental problematic, such as hydrological basins deterioration and floods should be promoted and supported from the national level.

The cost-benefit analysis for local levels required promotion and technical assistance from the national institutions, and using this information for climate change adaptation programs.

Public awareness regarding climate variability, vulnerability, and global climate change should be clear, direct and spread to different sources and media.

For reduction of the underlying risk factors:

Environmental management at local, regional and national level must recognize the disaster risk reduction as one of their goals and activities, particularly at the environmental agencies at the department or sub-national level.

Planning, land use and territorial planning need stronger application and control at urban level and rural areas, searching for longer term alternatives and solutions regarding human settlements in prone areas, using better and more technical risk assessments and climate vulnerability assessment.

The agricultural sector needs more attention of the government, specially the small productions, promoting protection of harvests with financial instruments, implementation of environmental amicable practices, and technical assistance in risks identification integrating traditional knowledge.

The engineering designs have to be reviewed periodically, considering improvements for higher periods of return and security factors, such as for highways and airports are priorities.

For disaster preparedness and emergency management (including rehabilitation and reconstruction phases):

The relocation in the country needs a national plan or programme to orientate local projects, considering sources for financing, re-assessing risks and climate vulnerability, technical dispositions for housing improving, environmental management and sectorial activity, among others.

Emergency plans at local level should be reviewed by the Directorate of Disaster Risk Management and tested with the community, integrating local, regional and national warning and Early Warning Systems.

The recovery phase cannot take so long periods of time, because it increases vulnerability and risks (such as epidemics) for the population. Effective investment of emergency resources will help to give populations better conditions (water supply, food supply, waste management, health attention, etc.), and for that it is necessary to plan as far as possible this step. Corruption control mechanisms for emergencies at local level should be developed.

For institutional capacity and financial mechanisms:

Governance it is always an issue for the country, which accounts with institutional and law background to work properly but it is affected by corruption acts at all territorial levels. The strengthening of governance is still an objective for both DRM and CCA.

There is a high risk in *reinventing the wheel* by creating a whole new National System for a new issue, when there are already the National Environmental System and the National System for Disaster Prevention and Attention, which consider climate change under different activities. In this sense, the National Plan projected for CCA has to consider and share responsibilities with the National Plan for Disaster Prevention and Attention. Policies derived from it have to discuss disaster risk reduction, disaster prevention and emergency management, considering the local level for action.

The National System for Disaster Prevention and Attention should return to the position it had at the national government when it was conformed. That allows more leadership and co-work with all Ministries. Ministries need to understand their roles into disaster risk reduction and disaster risk management subjects, and in particular the Ministry of Environment, Housing and Territorial Development, and the vice ministry of Environment.

The National System for Disaster Prevention and Attention should include IDEAM experts in climate change projections and scenarios into the Technical National Commission, as well as the director for Climate Change Adaptation strategy into the National Committee for Disaster Prevention and Attention.

Community participation is still in general very low, not only of DRM processes but also for environmental issues, such as climate variability effects, climate change and CCA.

Experiences in insurance coverage and loss transfer strategies of public assets, housing and private sectors create potential conditions to spread this studies first to the biggest cities in the country.

4. TOWARDS AN ADAPTIVE DISASTER RISK REDUCTION, THE CASE OF THE CITY OF MANIZALES

Picture 1. Manizales, view from the North-West of the city

Manizales is a city in the Colombian Andes, 2,150 meters above sea level, with 388.525 inhabitants[4]. It is characterized by volcanic soils, high slopes, high precipitation influenced by the Inter-tropical Convergence Zone (ITCZ) and seismic activity. The population has become more vulnerable by expanding onto the surrounding slopes, driven by increasing population pressure. As a consequence, frequent and widespread landslides have been affecting the city, endangering not only the poorest neighbourhoods but also economically medium and upper class areas. Table 2 presents the emergency balance for landslides from 2003 to 2009.

Table 2. Emergency balance in Manizales form 2003 to 2009, due to landslides.

	2003	**2005**	**2006**	**2007**	**2008**	**2009**	**2003-2009**	
Annual Precipitation	2068	2324	2093	2031	2845	1894	2240	mm
Affected families	820	575	1000	535	1095	80	4105	
Wounded	49	0	0	0	15	1	65	victims
Deaths	40	9	0	3	7	1	60	victims

[4] Source: DANE (National Administrative Department for Statistics), projection from Census 2005.

Missing	0	0	0	1	0	0	1	victim
Destroyed	96	14	9	19	11	4	153	homes
Affected	104	13	7	132	470	29	755	homes
Preventive evacuation	635	200	10	200	304	45	1394	homes
Landslides	191	98	1	27	192	10	519	
Unstable hill slope	0	16	0	0	0	0	16	
Yellow alert (A25)	2	0	1	1	0	0	4	
Orange alert (A25)	1	1	0	0	1	0	3	
Red (A25)	0	1	0	1	1	1	4	

Source: IDEA, Vélez et al. (2010)

Earthquakes have been part of the city history, even from the day of foundation (1848), construction types *(bahareque*) and styles had to be used in order to adapt to these tremors; nevertheless, the strongest earthquakes have affected houses, principally to the infrastructure built with different materials (1925, 1938, 1961, 1962, 1979). Fires once consumed valuable part of what is now the historical centre (1920's), and volcanic eruptions had spread ash clouds over the city (1985, 1989). Finally, there are flood areas where streams and rivers pass through.

Picture 2. Manizales north hill

As a consequence, the city has developed a variety of DRM strategies and tools during different periods of time. The first activity was the construction employed, using wood (e.g. bamboo) for columns and a mixture with soil to build walls, giving the house flexibility characteristics. Then, when more materials were available, resistance construction methods were integrated into construction codes and planning.

Other activities have been related to landslides, such as studies and works for erosion control or hillside protection, developed particularly during the 1970's and reviewed/updated in last 10 years.

In 1987 it was established the Local Emergency Committee, and in 2000 the Local Committee for Disaster Prevention and Attention. Universities have been also involved into these processes of disaster risk management by developing research in hazard assessment, risk assessment, probable loss calculation, software production to orientate decision making, and disaster risk management assessment, among others.

Alongside this, stronger relationships have been established with the environment, such as traditional coffee growing in the region (today cultural landscape part of the UNESCO's World Heritage List), the use of bamboo (*guadua*) and wood for traditional constructions (*bahareque*) and recognition of the importance of protecting water resources at the institutional level (by the enterprise for water supply *Aguas de Manizales*). The municipal government has incorporated an environmental agenda, "*biomanizales*", into its planning, which emphasizes protection of hillsides and contains a set of indicators linked to environmental variables and sustainable development. However, environmental control and protection in the area is carried out by the regional environmental agency (*Corpocaldas*), and in many cases the two institutions share responsibilities for environmental programmes and projects.

Picture 3. Manizales rural area, part of the UNESCO Coffee Cultural Landscape

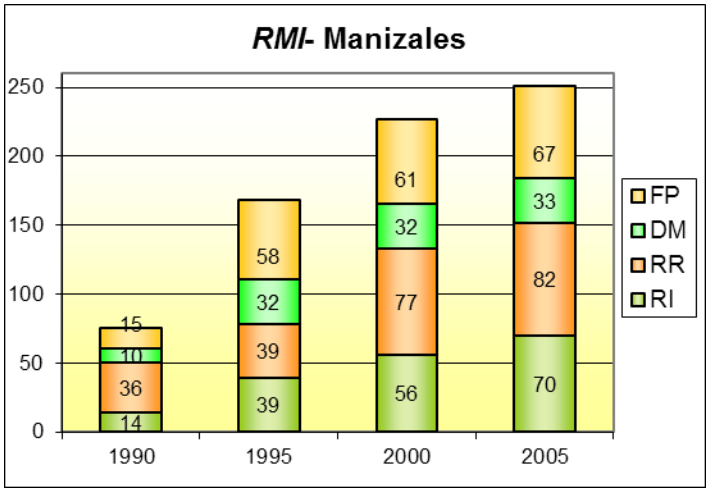
This historical background has made possible to achieve important progress in DRM activities and strategies, especially from 2003 to the present.

4.1 DRM TOOLS AND METHODOLOGIES IDENTIFIED IN MANIZALES

The study: "Urban Risk and Risk Management Analysis for Planning and Effectiveness Improvement at Local Level, the Case of Manizales City" (Suarez, 2008, 2009; Suarez & Cardona, 2008) adapted and applied the methodology for the Disaster Risk and Disaster Risk Management Indicators for America Latina and the Caribbean (BID-IDEA, 2003) to Manizales, the first for a medium size city. Results also contribute, as for the analysis of comparing Latin American countries and the advance in disaster risk components as it was presented for Colombia.

Figure 4 shows the level of performance of risk identification (RI), risk reduction (RR), disaster management (DM) and financial protection and governance (FP) for Manizales at different periods of time: 1990, 1995, 2000 and 2005.

Figure 4. Risk Management Index, RMI, for Manizales



Source: Suárez, D.C. (2008, 2009); Suárez, D.C., Carreño, M.L. & Cardona, O.D. (2007); Suárez D.C. & Cardona, O.D. (2008).

Advances show risk reduction activities had accomplished the highest levels of performance, followed by risk identification activities and financial protection and governance, as happens in general for Colombia's RMI results (See figure 3).

Looking a more detailed analysis of such components, there are number of programmes, activities and instruments which represent the advance; some of them have been developed for climate-related hazards in Manizales (i.e. landslides and floods in some areas of the city). They are outlined as follows:

Risk identification and understanding

Monitoring of hydro-meteorological variables:

Since 1995, the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) has been responsible for national monitoring of hydro-meteorological parameters. However, in the 1980s and 1990s, the Institute of Environmental Studies (IDEA) at the National University of Colombia in Manizales developed a project to establish urban meteorological stations in the city, with data transition and registration capabilities in near real time, and which made use of local expert capacities and technologies. This improved rainfall observation system is vital for monitoring and predicting rainfall-triggered landslides. Since 2003, the Mayor's Office has been financing the automatic rainfall observation system, as it is an essential component in early warning processes. The network of hydro-meteorological stations consists of 16 stations (11 financed for the Mayor's Office, two for the National University of Colombia, one for Enterprise for Waste Management, EMAS and two for the regional environmental agency, Corpocaldas).

This spatial distribution of these automatic rainfall stations facilitates analysis of variability and differences in rainfall intensity and patterns for specific localities and areas of the city. The detailed data collected by the system is an important element in initiating new researches projects, not only for hillside protection works and hydraulic structures, but also for establishing thresholds for landslide warnings.

Hazard assessment:

Studies regarding landslides have included geological and soil analysis, to determine types of erosion, ways of mass movement, natural triggers, and anthropic causes, among others. These have been developed by the environmental agency, *Corpocaldas*.

Reduction of the underlying risk factors

Prevention and regulation in urban planning (local government):

Studies of areas vulnerable to landslides have been incorporated into the Territorial Ordnance and Land Plan (POT), an instrument used by the Mayor's Office for creating legislation on land use and construction in the city. These studies have established priorities for action in these areas, such as settlement relocations, hillside protection works, hydraulic structures, etc.

Erosion control and stabilization work:

Since 2003, the regional environmental agency (Corpocaldas), has been reviewing the work carried out by its predecessor "*Cramsa*" (1970's), addressing hillside problems by developing erosion control and hillside protection works.

When a state of emergency was announced in the city, the regional environmental agency and the national government financed studies and implemented better erosion controls and protection works (Figure). This has become part of the policy of the environment agency, which works in close collaboration with the Mayor's Office through the Municipal Office for Disaster Prevention and Attention (OMPAD). The work of *Corpocaldas* includes technical assessments of areas which have recently become susceptible to landslides, monitoring of existing hillsides at risk, technical support for emergency preparedness and emergency management.

Picture 4. Erosion control and estabilization work example, La Sultana neighbourhood

"Guardians of the Hillsides" Project (Guardianas de la ladera)

The "Guardians of the Hillsides" project is a programme shared between the NGO Corporation for the Development of Caldas (CDC), Corpocaldas and the Mayor's Office. The project has been recognized at international level, within the Andean Community, as a model for DRM. The Guardians are all women, heads of families, who come from the most vulnerable and poorest areas of the city. They have taken responsibility for erosion control and hillside protection works.

They report on possible damage and bad land use (i.e. uncontrolled resettlement, farming, etc.) and also inform the community about the commitment to take care of the works and protect the environment in these areas. They also take part in census counts of the population in high risk areas, and accompany people who have been relocated as a result of a voluntary demolition programme.

Picture 5. Guardians of the Hillsides. Source: Guardianas de las laderas Program.

Relocation

A relocation process has been in operation in Manizales since 1980, and during this time the authorities and communities have discovered limitations and problems, but have also learned a number of lessons and have improved the procedures for practical, administrative, legal and funding activities.

The last important relocation took place between 2005 and 2008 in the *La Playita* area of the city, which was exposed to floods and landslides. The relocation process also encompassed the voluntary demolition program and the relocation of every family into a used property selected by the family themselves, in safe areas. That means the relocation process did not imply forced relocation, but rather was carried out on a voluntary basis.

Disaster preparedness and emergency management

Local Emergency/Contingency Committee and Plan (inter-institutional, coordinated by OMPAD)

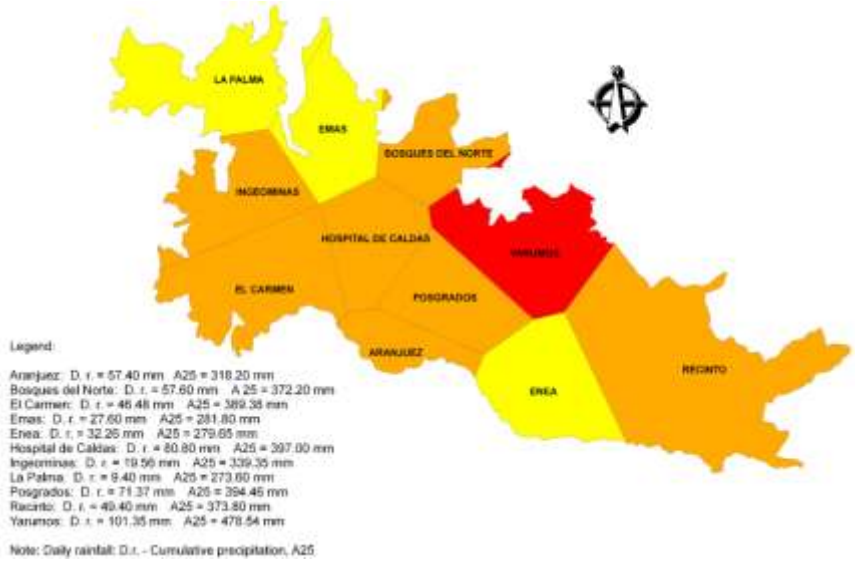
The Local Emergency Committee was established in 2000, in accordance with the national Directive for Addressing and Preventing Disasters (1989). The committee consists of the Mayor, heads of local government departments, planners, public works officials, the Health and Education Secretariats, the Head of District Policy, the Director of *Corpocaldas*, the Head of the Fire Service (based in the Government Secretariat), the Divisional Director of the Red Cross, the Divisional Head of Civil Defence and the Director of the Municipal Office for Disaster Prevention and Attention (OMPAD). An emergency plan was also developed in 2003, defining responsibilities and protocols for different institutions in the event of an emergency. Recent disasters have served as training for the Emergency Committee, providing an opportunity to improve coordination and response skills, to include new technical members (e.g. staff at the volcano

observatory, university researchers, etc.) and to manage the transition towards preventive action, such as evacuation, in order to save more lives.

Early Warning System

The Early Warning System has been designed specifically for landslide hazards, but can be useful for other, related risks caused by rainfall. Accumulated precipitation can be observed in real time, and warning levels are established according to the cumulative precipitation indicator via a semaphore classification system. A yellow alert corresponds to thresholds between 200 and 300 mm of cumulative precipitation, an orange alert to thresholds between 300 and 400 mm, and a red alert to thresholds over 400mm.

The Local Emergency Committee is responsible for declaring formal alerts in Manizales, according to the semaphore classification system. Each level of alerts involves the technical and operative organizations and the community in different actions and response activities.



Picture 6. Example of meteorological monitoring information produced for the Early Warning System in Manizales. Source: IDEA

Institutional capacities and financial mechanisms

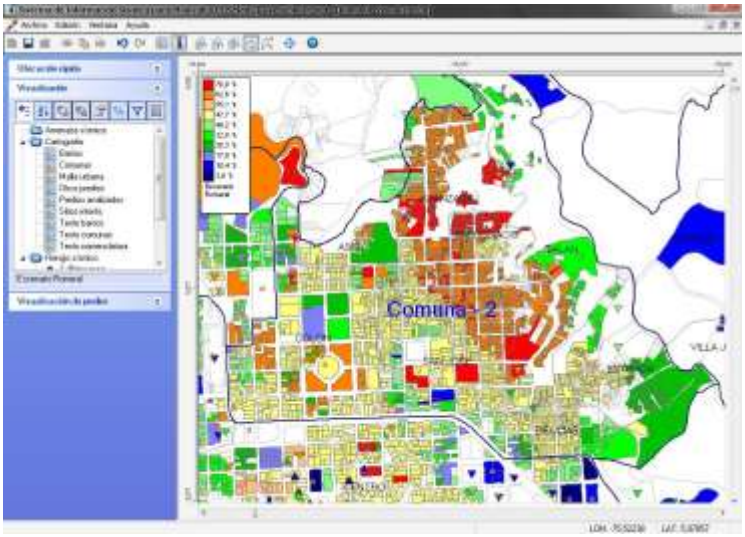
Inter-institutional arrangements

The tools described above are evidence of inter-institutional agreements, especially between the Mayor's Office, represented by the Office for Disaster Prevention and Attention (OMPAD), and Corpocaldas, the

university, the NGOs, humanitarian assistance organizations (Red Cross, civil defence, risk and rescue groups) and technical institutions such as the Volcano Observatory. In 2008, the Project for Prevention of Disasters in the Andean Community, Predecan (Comunidad Andina, 2009) recognized Disaster Risk Management in Manizales as the best example of good practice in DRM activities in Colombia, because of its integrated and inter-institutional approach.

Multi-hazard Risk Collective Insurance Programme

Manizales has an innovative insurance programme, a collective, voluntary insurance policy which protects the lowest socio-economic strata. The programme is an arrangement between the Mayor's Office and an insurance company. The municipal administration facilitates the collection of payments, and the insurance company covers any disaster damage to each property according to its rateable value. The programme has been improved by a scientific evaluation of the probable losses for the city and its inhabitants based on earthquakes scenarios.



Picture 7. Visualization of the SISMAN Risk, used to damage lost evaluation in Manizales

4.2 CLIMATE CHANGE AND CLIMATE VARIABILITY AND DISASTER RISK

Effects of climate change for the region and the department of Caldas (where Manizales is located) are related to the change in precipitation and in association with changes in vegetal cover will affect the hydric cycle. Other phenomenon is the retreat of glaciers. The snowed volcano El Ruiz is very close to Manizales; it has lost the icy area since 1850, and this retreat has increased faster since the last three decades. The reduction in the glacier can produce a decrease in water availability. Changes in temperature and humidity

could affect natural ecosystems, such the *paramo* (in high altitudes) and productive activities, such the coffee growing areas (IDEAM et al, 2010).

Regarding climate change mitigation, there is a program since 2000 in the region called *Procuenca*, executed by the Food and Agriculture Organization of United Nations (FAO), this has been one of the most important Clean Development Mechanisms in the country as the first one to be approved to emission of reduction certificates (CER) (in 2010). The primary objective of this project was to promote reforestation, improving the land use according to the advocacy of these soils. The protection of these areas where the forest increases will generate fresh water quantity and quality regulation in the region.

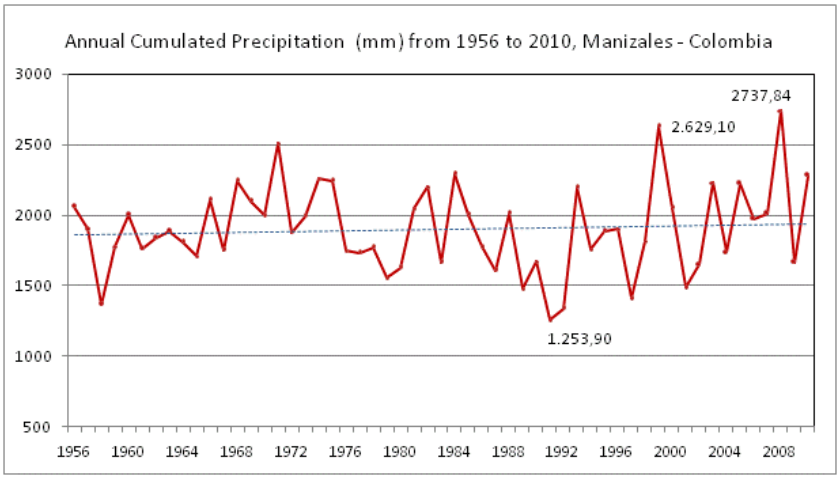
Activities within *Procuenca* haven focused on agreement processes with the land owners (i.e. peasants, urban investors, other owners of productive lands in rural areas), administrative and legal procedures to declare commitment between the owners and the program, technical support, development of a landowner's association and training processes with all the community involved in the program. The director of this project recognizes that there are adaptation elements that come to the mitigation action, such as hydrological cycle recovery, biodiversity conservation, awareness and land use change.

Climate variability

There is on-going discussion about the way in which climate change currently impacts on weather patterns in Colombia. The registration of extreme precipitation events at local level and the extension of the rain season period have had an association to natural climate variability (El Niño, La Niña), and there are still reserves in term of recognizing global climate change affectation due to the lack of historical data.

However, the annual cumulated precipitation in the city of Manizales, from 1956 to 2010 (Figure 5), shows an increase in annual precipitation, with annual cumulated precipitation extremes in 1999 and 2008.

Figure 5: Annual cumulated rainfall from 1956 to 2010, Manizales, Colombia



Source: Institute of Environmental Studies (IDEA), 2011

In fact, in May 2008 the city suffered its highest rainfall for the last 40 years when extreme precipitation caused new problems such as multiple landslides and mudflows in the micro-basins. This emergency was dealt with effectively. Subsequently, an inter-institutional workshop was organized to identify future challenges. One of the lessons learned was to consider the possibility of taking climate change into account in assessing impact on rainfall in rainy seasons.

During the 2010-2011 rain season affected by La Niña, while the country was having emergencies everywhere, Manizales was closely monitoring precipitation values, decreeing warnings and implementing preventive evacuations, avoiding fatal results of landslides. Nevertheless, avalanches and important landslides were presented in different areas of the city, in March 2011 (La Patria, 2011). Preventive evacuations saved the lives of all people, but there were damaged and destroyed houses. The coordination and response were still effective but the magnitude and the unexpected situations (e.g. avalanche) could easily ended in catastrophes.

On the basis of its experiences, Manizales has built a certain level of resilience to a number of natural hazards and disasters. Even though there is a lot of work to do, it has the potential capacity to adapt to the challenges posed by climate variability; the improvement in facing these events (extreme, new hazards) would prepare the city to adapt to climate change too.

4.3 IMPROVING DISASTER RISK REDUCTION AND DISASTER RISK MANAGEMENT TOOLS TOWARDS CLIMATE CHANGE ADAPTATION

Recommendations for disaster risk reduction, risk management and environmental management are made for the city of Manizales, considering specific conditions, institutions, programs, etc. Anyways, more and deeper analysis should be done to go further, in participation of the local institutions and government.

Risk identification and understanding:

Monitoring hydrological basins

The monitoring of changes in stream flow discharge is important in order to detect problems in hydrological basins, such as erosive process in the rural and rural-urban basins. "*Aguas de Manizales"*, the water supply company (part public-part private) has been doing a labour in the lands owned by the company preserving and monitoring water sources from the highest altitudes to the arrival at the water treatment plant. This activity can be an example to do in other basins, with priority to those that already presented mudflows and avalanches, in a partnership between the university, the Mayor Office and the environmental agency (*Corpocaldas*).

Considering probable future risks

Regarding the melting glaciers on the snow-capped volcano El Ruiz, it could be important to analysed and use data collected by IDEA-*Corpocaldas*, and account for tendencies in reduction of water availability in the area, or to consider the case generation of avalanches, as it happened when the volcano erupted in 1985. These two institutions (IDEA, Corpocaldas) could start this study.

Linking local hydro-meteorological monitoring to national forecasting and models and projections for climate variability and climate change:

It will be important to analyse changes in extreme rainfall events tracking for historical tendencies, climate variability, and global climate change, to better understand and foresee how rain would affect the city (activating more landslides, producing floods, mudflows, deteriorating infrastructure, among others).

Previewing and analysing chain of disasters

The long periods of precipitation as well as more frequent and higher extreme events have been causing more and more saturation of soils and hillsides, making them highly susceptible for simultaneous landslides all over the city. Any other detonator could start a multiple landslides scenario, such as an earthquake, or even massive assistance to shows which usually cause ground vibrations. Consequently, more careful monitoring will be required for hillsides, registering inside humidity and cracks for instance.

Risk assessment

Risk assessment for landslides could be more precise and detailed. Vulnerability assessment for example can be better explained and identified. These activities would need more scientific research and the participation of building companies that are also responsible for developing new projects in hillsides. Also the integration into a multi-risk assessment is important for the city.

Reducing underlying risk factors

Review engineering works for slide protection and erosion control:

The analysis of the extreme rainfall events is necessary to identify if climate variability and/or climate change are making them change. If the extremes assumed for a particular period of return is now for a lower because there are higher precipitation values the engineering works have to be re-calculated, and reinforce to accomplish the goals of protection and security. New erosion curves have to develop to be used in this task.

Improving environmental management:

Environmental management activities have been promote and controlled so far for the regional environmental agency and it has been practiced by private enterprises, such as the water supply company. Although, there was a public policy related to the environment (*biomanizales*) the Mayor Office haven't really integrate the environmental management into its work, which will help to improve disaster risk reduction and climate change adaptation, for instance into urban and rural planning and territorial ordering. It is needed a higher compromise into this subject.

This statement is also illustrated by the recent air quality evaluation that found out high levels of pollution out of the range for a medium seize city as Manizales, which means that use of sustainable energies, particularly for transportation, as well as sustainable massive transportation projects should be encouraged to reduce contributions to climate change effect.

Another aspect is the possibility to obtain more additional benefits from the mitigation program *Procuenca*, by searching the integration with climate change adaptation. In this sense, it is very important to reinforce the support from the Mayor Office and *Corpocaldas*, and to allow research, develop of information, indicators, to universities, (e.g. assessing improvements in disaster reduction and hydrological cycle regulation).

Planning and territorial ordering:

The territorial ordering plan needs to use developed tools for disaster risk assessment to improve zoning and management actions. On the other hand, it is required to improve control on application of the territorial ordering plan, avoiding the extension of the urban perimeter. Additionally, building companies should be asked to realize more and detailed technical assessment in disaster risk, climate proof structures, application of updated construction codes, assuming more carefully the responsibility on protecting human lives.

Disaster preparedness and emergency management

Early Warning System:

This activity has improved progressively and it had made possible to save many lives in the city. Nevertheless, the responsibility and pressure due to the last events in the city have been growing and therefore it has to keep working better every time. One of this works has to be related to the redefinition of thresholds for accumulated precipitation and particular rainfall events to improve warnings (yellow, orange and red) from the technical point of view.

Furthermore, the integration of the Early Warning Systems into a multi-warning information centre giving the different warnings due to natural hazards (volcano, landslide, flood, avalanche, etc.) will be helpful for the communication and awareness of the community.

Institutional capacities and financial mechanisms

Continuity of Policies and programs

There is always the risk of reducing efforts in DRM and environmental management due to the change of Mayor and political group in charge of the local governmental institutions. The principal challenge is to maintain political willingness in DRM, and inter-administrative work, particularly between the Mayor Office and the environmental agency.

Moreover, it is quite urgent to improve internal awareness about DRM, climate change and CCA, and to reinforce public communication through education and awareness activities on DRM and CCA as part of the environmental education process.

5. CONCLUSIONS AND RECOMMENDATIONS

Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) are subjects that concerns international institutions, organizations and agencies during the last years and decades, promoting support in policies development, economic resources rising, applying pressure on national governments to get involved. However, the development of concrete instruments, tools, programs and activities have to articulated to regional, national and local contexts, to traditional, expert and political backgrounds to make them work in long period times.

According to this, Latin America and the Caribbean have the potential to develop their own management models and actions for DRM and CCA. This region share some common problems and global environmental issues such climate change; these can bring new linkages and co-work between governments. At this level climate change adaptation could convey stronger regional strategies to improve environmental management, planning and sustainable development.

The approach to national level is the point where disaster risk reduction and climate change find a common point, from the institutional framework point of view, the development of laws and policies, the work with the ministries, the national assessments and national resources, among others. Nevertheless, going into the local level, this relationship becomes fuzzy. **The concrete actions on the field are finally represented by DRM, but in general these are part of the local environmental management.** In Colombia, the value of local knowledge, local research, technical actions, political position, could be helpful to the national platforms. Successful practices should be encouraged and shared with other communities.

Particular DRM tools to be improved are: risk assessment (muti-hazard risk assessment), incorporation of risk and climate change into planning and territorial ordering, environmental management (long-term), inter-institutional work and community participation.

Consequently, going from climate change adaptation to disaster risk management means to keep improving DRM, integrating levels of management, information, cooperation and control.

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