43

DKKV publication series

Adaptive Disaster Risk Reduction

Enhancing Methods and Tools of Disaster Risk Reduction in the light of Climate Change

Editor:
German Committee for Disaster Reduction (DKKV)

DKKV

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Publication Details

Graphic Design: F R E U D E ! design, Rendel Freude, www.rendel-freude.de

ISBN 978-3-933181-49-7

Photo Credits: Title: Kaufhold/Welthungerhilfe, Boethling/Welthungerhilfe, Bolesch/Welthungerhilfe; p. 4, DKKV; p.5: UNU-EHS; p. 6: Keijser/Hollandse Hoogte/laif; p. 10: Liu Yang/ChinaFotoPress/laif; p. 12: Hahn/laif; p. 14: Sean Gallagher/laif; p. 18: Bindrim/laif; p. 23: Martinet/LookatSciences/laif; p. 28: Omar Dario; p. 40: Riccardo Venturi/laif; p. 43: Pennarts/Hollandse Hoogte/laif

Front page: pictures showing Disaster Risk Reduction projects of Welthungerhilfe in Mali, India and Nicaragua.

Acknowledgments

We would like to gratefully acknowledge the valuable feedback and support received by many during the compilation of this study. First of all, we highly appreciate the continuous guidance and dedication to this study of UNU Vice Rector in Europe and Director UNU-EHS Dr. Jakob Rhyner as well as the stimulant discussions we had with our colleagues at UNU-EHS.

Our sincerest words of thanks are extended to the following international experts who answered to our questions and took the time to discuss with us the issue of adaptive disaster risk reduction: Thorsten Klose, Maarten van Aalst, Juan Pablo Sarmiento, Arthur Webb, Maxx Dilley, Alice Balbo, Melissa Stults, Marcus Oxley, Kristie Ebi, John Harding, Ingrid Hartmann, Michael Siebert, Xianfu Lu, Milen Dyoulgerov, Bernardo Sala, Gianluca Azzoni, Carlos Alberto García, Juan David Arango, Omar Dario Cardona, Fernando Mejía, Jorge Julián Vélez, Blanca Adriana Botero, John Alexander Pachón Gómez, Francisco Ignacio Ocampo Trujillo. We would like to extend our appreciation to the following institutions in Colombia that willingly shared their knowledge and data to support the case study Manizales: Institute for Environmental Studies of the National University of Colombia, Environmental Agency Authority of Manizales (Corpocaldas), Mayor's Office for Disaster Prevention and Attention Manizales, PROCUENCA Project.

In addition, we are grateful to the experts who joined the workshop in beginning of February 2011 and discussed with us the preliminary findings of the study, namely Saut Sagala, Atta Muhammed Durrani, Antonio Queface, Dak Martin Doleagbenou, Laban Ogallo, Aslam Perwaiz, Franz Stössel, Sabine Dier, Justin Ginnetti, Florian Wieneke, Robert Grassmann, Miwa Kato, Gottfried von Gemmingen, Sven Harmeling and Peter Mucke.

Furthermore, we would like to thank Karl-Otto Zentel for his review and valuable comments as well as his colleagues at DKKV for their organizational support.

Finally, we are grateful for the financial support of the German Federal Foreign Office.

Citation: German Committee for Disaster Reduction (Ed.), 2011: Adaptive Disaster Risk Reduction. Enhancing Methods and Tools of Disaster Risk Reduction in the light of Climate Change. DKKV Publication Series 43, Bonn

Acronyms:

CC	Climate Change	**IPCC**	Intergovernmental Panel on Climate Change
CCA	Climate Change Adaptation	**UNDP**	United Nations Development Programme
DRR	Disaster Risk Reduction	**UNFCCC**	United Nations Framework Convention on Climate Change
EW	Early Warning	**UNISDR**	United Nations International Strategy for Disaster Risk Reduction
EWS	Early Warning System	**UNU-EHS**	UNITED NATIONS UNIVERSITY Institute for Environment and Human Security

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Contents

Preface

The Cancun Framework for Adaptation finally recognised adaptation to the negative impacts of Climate Change as equally important to mitigation. In this context a work programme has been agreed upon which opens up new possibilities to more closely link Disaster Risk Reduction and Climate Change Adaptation.

Gerold Reichenbach
German Committee for Disaster Reduction,
Chairperson

This linkage is of crucial importance as Climate Change is expected to lead to an increase in weather-related extreme events. Disaster Risk Reduction at the same time aims at mitigating the impacts of those extreme events and therefore needs to become an integral part of Climate Change Adaptation.

Reducing global warming, mainly by cutting greenhouse gases, is a global task. In contrast to that, adaptation to the negative impacts of Climate Change always has to be regionally anchored in accordance with the structures and the specific needs of the different levels of action. Therefore information on the expected developments of extreme weather conditions on a regional level needs to be included in Disaster Risk Reduction measures, as well as information on particularly vulnerable groups of persons or exposed areas and infrastructures.

This is the only way to offer a systematic and effective contribution to risk reduction, based on priorities. Furthermore, in order to guarantee effective planning and action over a longer period of time, the dynamic development of risks must be taken into account. There are still many uncertainties remaining in this context which are also illustrated within this study. But it is of imperative to clearly address them in order to enable a realistic and transparent decision-making process. Thereby the involvement of all actors – including the endangered population – is a key factor for success.

It is time to move beyond generic statements and think of concrete measures. Therefore this study adopts an approach which prioritises tools and methods of disaster risk reduction, such as risk and vulnerability assessment and Early Warning, always focussing on the usefulness for Climate Change Adaptation. Structural aspects at national level are addressed and the potential of existing National Platforms for disaster risk reduction is discussed. Also concrete recommendations on necessary framework conditions are provided, for example anchoring adaptation and risk reduction projects in bilateral and multilateral agreements as a precondition for funding.

This study is one important step towards our final goal: utilizing established synergies and merging existing knowledge of different communities by integrating Disaster Risk Reduction into Climate Change adaptation. Still, there will be many steps to follow.

Gerold Reichenbach
German Committee for Disaster Reduction,
Chairperson

Foreword

Jakob Rhyner
Director UNU-EHS
UNU Vice-Rector

The importance of strengthening the linkages between Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) has been acknowledged by both communities, for example in recent documents of UNFCCC, the IPCC, and UNISDR.

However, despite the importance of this general acknowledgement, it is essential to develop the discussion further and to improve the understanding of how exactly the experiences of DRR can inform CCA strategies and tools. That means researchers as well as practitioners need to identify the most relevant and effective DRR methods and tools which should be seen as a priority for Climate Change Adaptation and the adaptation to extreme events.

Through expert interviews, international expert workshops, and literature reviews UNU-EHS has explored different methods and tools of DRR that can also inform Climate Change Adaptation. Although the specific applicability and usefulness of specific methods and tools of DRR for CCA have to be examined on a region and context-specific basis, the study has identified certain key areas where a close link between DRR and CCA should be addressed as a priority. These methods and tools include particularly: a) risk and vulnerability assessment methods and tools, b) Early Warning and preparedness strategies for the so-called "last-mile", and c) framework conditions that need to be improved to foster effective synergies between DRR and CCA.

The study also acknowledges the connectivity between different methods and tools of DRR and the need to apply various methods and tools in combination to address different risk factors. However, the areas mentioned above are seen as key issues that should be dealt with as a priority. Also, framework conditions need to be addressed more carefully. For example, the study recommends establishing multi-stakeholder platforms for adaptation that should be linked to national platforms for disaster risk reduction which have, in many cases, been shown to form an important mechanism to ensure a multi-stakeholder dialogue and a multi-disciplinary approach.

Additionally, the issue of Early Warning and preparedness (last-mile) is a key area where synergies between DRR and CCA need to be strengthened. New challenges for Early Warning Systems and preparedness strategies deal particularly with the integration and monitoring of combined effects of creeping and sudden-onset hazards in the light of Climate Change. Moreover, Climate Change Adaptation requires that Early Warning Systems extend their focus from saving lives in the short term to securing livelihoods in the medium and long term. This extension will become more important when creeping hazards, such as sea-level rise and salinization processes, erode coping and adaptive capacities of communities exposed to sudden-onset and slow-onset hazards.

In terms of framework conditions it is also important that international documents and declarations mention specific methods and tools of DRR that are highly relevant for Climate Change Adaptation in order to ensure that international funding can be made available for their application. Consequently, it is essential to promote framework conditions that strengthen the appropriate application of methods and tools of DRR to deal with climate-related hazards and the so-called extreme events. It will be important to move from a general and meta-level discussion towards a precise assessment of the applicability and usefulness of selected methods and tools under specific regional and local circumstances.

The study "*Adaptive Disaster Risk Reduction, enhancing Methods and Tools of Disaster Risk Reduction in the Light of Climate Change*" is a contribution to this debate, and other researchers and practitioners are invited to critically review the recommendations and findings as well as to further elaborate quality criteria for strengthening the linkages between DRR and CCA.

Dr. Jakob Rhyner
Director UNU-EHS
UNU Vice-Rector

Executive Summary

THE NETHERLANDS:

Hoek van Holland, storm-surge barrier.

Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) are interconnected thematic areas which both deal with common themes and address similar issues such as the impact of extreme weather events on vulnerable people as well as aim to reduce this vulnerability. However, both communities often still operate in parallel without sufficient exchange and collaboration.

The further intensification of extreme weather events in the context of Climate Change (see for example IPCC Special Report SREX (IPCC website), GAR 2009, UNFCCC 2010) call for improved risk reduction and adaptation to such changes. Disaster Risk Reduction is today an important task that will need to receive even more attention in the light of Climate Change, particularly due to the combination of expected increases in extreme weather events and stresses that emerge from creeping changes.

In this regard the UN International Strategy for Disaster Reduction (UNISDR) and the UN Framework Convention for Climate Change (UNFCCC) have stressed the need to improve synergies between goals, strategies, frameworks, measures, tools, methods and funding mechanisms of DRR and CCA.

Adaptation to recent and expected Climate Changes implies three tasks in particular: first adaptation to gradual changes, such as changes in average temperature and sea-level rise, secondly reducing and managing the risk linked to extremes weather related events, such as cyclones, floods etc. Thirdly, address the shifts of climate zones which might subject some regions to risks which previously had not been experienced.

Effective adaptation and risk reduction need to be based on the expected changes of the hazards and the vulnerabilities of communities and regions exposed. In this regard, Climate Change information is to be translated into risk profiles and concrete options to act at different administrative levels as well as spatial and temporal scales. Challenges in terms of linking DRR and CCA encompass particularly institutional issues, problems related to risk identification and mismatches of different response strategies and measures to extreme events and creeping changes as well as in the development of validation criteria to monitor the linking of DRR and CCA.

The study takes up the challenges outlined above and formulates recommendations in order to strengthen practical linkages between DRR and CCA. The study emphasises the importance of DRR tools for improving adaptation to extreme weather events in the light of Climate Change. It formulates key recommendations on how to enhance selected tools and methods of DRR at different levels and for specific stakeholders. For example the need to include specific DRR tools useful for CCA in multilateral and bilateral agreements is outlined. Likewise there is a need to improve risk identification in DRR and CCA. The study proposes that national and local stakeholders prepare a set of Climate Change and social development scenarios in order to translate general Climate Change information into risk profiles that can serve as a basis for policy making in DRR and CCA.

The current study focuses on specific tools and measures of DRR and their applicability for CCA. It is based on expert interviews and expert workshops (see list of experts in the annex), literature analysis and the examination of selected case studies. The case studies include the city of Manizales in Colombia which is exposed among other hazards to landslides, heavy precipitation, floods as well as the Seychelles which are particularly exposed to tropical cyclones and future sea-level rise.

The analysis of tools takes into account the following four key areas of the Hyogo Framework for Action (HFA 2005-2015) and its implementation progress assessment:

1) Risk identification and understanding,
2) Reduction of underlying risk factors,
3) Disaster preparedness and emergency management, and
4) Institutional capacity and financial mechanisms.

Overall, the expert interviews, the literature analysis, the expert workshops and the evaluation of selected case studies give a varied picture which makes it difficult to produce a universal list of priorities for tools and methods that would cover all regions and hazards. However, it is clear that many tools and methods for DRR are also useful for, and relevant to CCA. Special priority was given to methods and tools involving risk and vulnerability assessment (risk identification and understanding), Early Warning (preparedness and emergency management), planning and social development (underlying risk factors) and tools such as national policy and legal frameworks (institutional capacities).

Issues such as stockpiling and logistics were, by comparison, ranked as less important tools for enhancing CCA by the experts interviewed. Although many tools and methods are interlinked, and would have to be applied in tandem in the longer term, the research provided evidence that the following tools and methods should be seen as key areas for the development of further synergies between DRR and CCA:

a) Early Warning
b) Risk and vulnerability assessment
c) Framework conditions (e.g. national platforms for DRR and CCA, improving framework documents)

Specific challenges and recommendations for selected tools and methods are as follows:

Early Warning

A key tool and related methods where synergies between DRR and CCA need to be strengthened is the area of Early Warning (EW) and Early Warning Systems (EWS). EWS are important tools, given their robustness and flexibility compared to structural measures. EW in this regard does not simply involve a warning system. It also deals with knowledge, identification, understanding and communication of risks. As well as major innovations such as new technologies and applications for detecting and communicating risks and warnings, greater emphasis needs to be placed on multi-hazard warning systems which also take into account hazards related to Climate Change. Creeping hazards in particular, such as salinization and sea-level rise, are often not taken into account sufficiently in EWS for coastal hazards.

Furthermore, the medium and long-term outlook for Climate Change could also mean that EWS need to be improved so that they not only provide information to help evacuate people and save lives, but also contribute to securing livelihoods at risk from the gradual changes due to Climate Change. By integrating existing information about climatic change, EW could be extended to provide medium and long-term solutions. The implications of this concept are promising, but it needs to be explored in the future. In this respect, new sectors such as urban planning, land use planning, water management, health and agriculture need to be integrated. Information about changes in hazard patterns needs to be combined with knowledge and scenarios about the development of vulnerabilities. The combination of the two will provide the basis for high quality EWS. However, it would also be important to assess the country specific boundaries and constraints of such a multi-hazard EWS and the different requirements of various stakeholders and end-users.

Considering both the short and long-term prospects this opens up new potential for using EWS at all levels and for developing improved links between DRR and CCA. Conceptually, the perception of an EWS as an EW chain needs to shift to a system of different interconnected components running in parallel. Moreover, EWS and their effectiveness should be reviewed in the light of new creeping and sudden-onset hazards linked to Climate Change. New approaches for people-centred EW and anticipated response strategies may need to pay particular attention to the extent of affected areas, such as the new challenges which arise when large areas of low-lying delta regions are affected by storm surges in a situation already aggravated by sea-level rise. For this reason, new strategies are required for the so-called "Last-Mile" to help develop EWS in the context of extreme events. Other challenges involve integrating different types of knowledge in EWS, particularly in terms of linking scientific and traditional knowledge.

Overall, people-centred EWS is a key issue where effective cooperation and integration of DRR and CCA are needed, and this should be treated as a priority tool.

Risk and Vulnerability Assessment

Risk and vulnerability assessments act as a basis for coordinated and effective action for reducing risk linked to Climate Change and extreme events. They are the basis for coordinated, effective and targeted action for CCA and DRR and also for an optimization of EWS. Although many stakeholders in DRR and CCA are already using hazard scenarios which take into account climatic changes in the next 30, 50 or even 100 years, less progress has been made in developing scenarios for vulnerability pathways for the short and medium-term future. This therefore presents a major challenge in enhancing DRR tools and methods for CCA, and there is a need to develop methods for improving vulnerability scenarios for different time scales and spatial scales to inform integrated risk assessments. Global trends such as urbanization and ecosystem degradation in many regions will greatly modify the vulnerability of today's population, and these trends should therefore be considered when dealing with risk assessment in the context of Climate Change.

Furthermore, Climate Change scenarios need to be translated one stage further, into risk and vulnerability assessments and respective risk profiles in order to provide sufficient basis for decision-making. This means that a general increase in the mean temperature of 2 to 6 degrees can have very different impacts on societies and ecosystems depending on the vulnerability of each system. Particularly in societies and regions where climate-related hazards and vulnerable conditions will become more problematic, risk may increase over time. Appropriate decision-making processes and preparedness strategies can be developed on the basis of an improved understanding of risk and vulnerability scenarios. If climate scenarios alone are used to modify the hazard component, without taking into account societal and economic pathways, assessments will fail to provide a sound information base for decision makers and practitioners. Uncertainty in climate scenarios is an obstacle for risk quantification. The information needed to entice action and measures differs largely between endangered groups extending differently over different landscapes, their social structure but also according to different spatial scales. Decision makers and populations at risk need different types of information at different times. Thus, uncertainty of climate forecasts can be defined only after all end-user requirements necessary for the shaping of disaster reduction are considered.

Requirements for Institutional Capacities and Financial Mechanisms.

Aspects of DRR and CCA differ in some respects, though large parts are in common. The organizational structures for DRR are given with the national UNISDR-platforms and the responsible national authorities. In the light of the recent political decisions on the implementation of a global Climate Change Adaptation fund, on the national level a bundling of the appropriate expertise is necessary as an important prerequisite.

To achieve optimization it is necessary to set up a national body addressing Climate Change Adaptation projects and structures. The proximity to the Disaster Risk Reduction platforms is evident and should be made use of. The detailed administrative and organizational structures fulfilling these two tasks may differ from country to country. It is clear however, that the tasks of the Climate Change Adaptation-body would be to promote, execute and coordinate the national Climate Change Adaptation plans and projects and to strengthen the link between national and local initiatives.

Improving the framework will also involve a greater emphasis on the application of tools and methods in practical planning and development strategies. This can be achieved by asking for implementation activities to be incorporated into international conventions and protocols. In addition, quality criteria could be introduced for tools which are considered to be particularly important, such as tools for EW and risk assessment, as outlined above. Some organizations, such as the German Development Cooperation, already encompass mandatory climate-proofing in their strategies. Criteria and quality standards for specific tools and measures should also be provided here, in order to give both donor countries and receiving countries (e.g. developing countries or countries at risk) a clear checklist of what to take into consideration when they apply these measures and tools. Lastly, it will be important to strengthen frameworks for integration by taking account of interdependencies between different areas and regions, particularly in terms of climatic, social and economic conditions. Many regions are interconnected, and adaptation measures in one region can therefore affect other regions. Here, elements of the framework need to be reinforced where they encourage communication between the interdependent regions and ensure that any negative consequences of adaptation measures in one place do not harm other places or regions.

Key Recommendations

- Improve exchanges (i.e. joint mechanisms for tracking lessons learned and finances) between UN agencies, international organizations, national authorities and civil society, and develop common DRR/CCA projects with the aim of coordinating information from different organizations into easily understandable, clear language for all stakeholders in countries and communities at risk;
- DRR and CCA need to be integrated into bilateral and multilateral agreements in order to create the necessary precondition of receiving funding;
- The effectiveness of Early Warning Systems should be reviewed in the light of new creeping and sudden-onset hazards linked to Climate Change. For example, the compendium "Developing Early Warning Systems: A Checklist" (an outcome of EWCIII 2006) be updated in view of CC (integrating Climate Change as a concern as well as incorporating performance measures for EWS);
- Multisectoral platforms for DRR should be reinforced, and community participation should be promoted to achieve a sustainable system of interlinked DRR and CCA at a number of different levels. For example, national DRR platforms and committees should include CC specialists, CCA experts and environmental delegates in the decision-making process, and vice versa;
- National governments need to improve decision-making processes by using vulnerability and risk assessments which acknowledge CC and CCA. They should be mainstreamed into ministries, sectoral plans, policies and public investment. In addition, effective management will require DRR and CCA tools to be integrated into existing programmatic tools and methods (i.e. vulnerability & risk assessments in the context of CCA as part of environmental impact assessments and development plans);
- Strengthen DRR and CCA (e.g. scenarios for vulnerability) links between rural and urban areas in terms of practices in agriculture, water sectors, etc., and in terms of reinforcement, building new infrastructures, land use and territorial and emergency planning;
- The effects and impacts of Climate Change should be acknowledged in emergency and reconstruction plans as part of disaster preparedness and emergency management systems. To build adaptive capacities, local governments need to be flexible in reviewing and updating these plans on a regular basis;
- Scientific communities should prepare a set of Climate Change and social development scenarios in collaboration with the national government in order to translate general Climate Change scenarios into risk profiles that can serve as a basis for policy-making on different scales;
- Enhance the scientific knowledge on how Climate Change scenarios translate into hazards, modified exposure and risk distribution and development of risks.

Introduction

CHINA:

Farmers rebuild reservoir to protect against the drought in Yunyang County of Chongging.

Disaster Risk Reduction (DRR) in the context of natural hazards has been an important issue in academic, institutional, political and practical spheres for some decades, and is evidence of the environmental conflicts which are affecting susceptible communities around the world. Socio-economic and cultural approaches, as well as community-based experiences, have recognized the importance of reducing vulnerability in order to reduce the risk of disasters.

Moreover, Climate Change and Climate Change Adaptation (CCA) became the subject of particular attention in the wake of the IPCC Fourth Assessment Report (AR4) in 2007, which confirmed that the geographic distribution, frequency and intensity of natural hazards will be significantly altered by Climate Change. The AR4 report called for strategies for adaptation to Climate Change, and made reference to the increase in disasters and the relevance of disaster risk management. On the other hand, in the last few years, the UN International Strategy for Disaster Reduction (UNISDR) and the UN Framework Convention for Climate Change (UNFCCC) have stressed the need to link goals, strategies, frameworks, measures, tools and funding at the institutional and political levels.

In fact, some experts and academics have remarked that there is a risk of duplicating work between these two fields, as noted by Schipper and Pelling: "*The Climate Change community is … in danger of wasting time and money re-inventing the wheel if this knowledge is not soon translated from disaster risk reduction into Climate Change Adaptation.*" (Schipper and Pelling, 2006).

In general, the countries which have difficulty addressing the underlying risk drivers are also those which are poorly adapted to existing climate patterns. "*If the underlying drivers can be addressed, then disaster risk will be reduced and at the same time the magnifying effect of Climate Change will be lessened. Similarly, strengthening capacities to address the underlying drivers of disaster risk will strengthen capacities to adapt to Climate Change.*" (UNISDR, 2009b).

Although there are important differences and challenges in integrating these two issues primarily on a spatial, temporal and functional level (see Birkmann and Teichman, 2010), existing experience in implementing Disaster Risk Reduction can nevertheless inform policy, institutional approaches and the technical methods and tools required for adaptation (Birkmann et al., 2009, UNISDR, 2009a). These include the development of legislation, national multi-stakeholder platforms, technical networks, approaches to community capacity building, hazard and vulnerability assessments, land use planning and environmental protection, construction of protection works, Early Warning Systems, community education and resilience programmes (UNISDR, 2009a).

In fact, places have already been identified where it is possible to analyse the convergence between DRR and CCA, including Pune (India), the Maldives, the Andean Highlands in Peru, the Philippines, Samoa, Overstrand (South Africa), London (UK), Vietnam, Indonesia and vulnerable areas of Bangladesh (UNISDR, 2009a; Birkmann et al., 2009).

The purpose of this research is to identify and analyse tools and methods used in DRR, and to propose how they can be modified or improved in enhancing CCA.

1. The need for improvements in linking Disaster Risk Reduction and Climate Change Adaptation

ETHIOPIA:
Erosion Control in Debre Tabor.

According to the United Nations Climate Change Conference in Cancun, COP 16 / CMP 6, 2010, there is a long and growing list of vulnerable nations in terms of Climate Change. "*Tuvalu, Maldives, Kiribati, Vanuatu are seeking ways to evacuate their entire population because of salt water intrusion and rising sea level. Sooner or later, island nations will have to seek refuge in other countries less vulnerable to rises in sea level. The floods that devastated Pakistan, Venezuela and Colombia in 2010, the wildfires that gripped Russia, the hottest summers to date in Japan and China in 2010, are all a wake-up call for the rest of the world*" (Christiana Figueres' opening speech at the COP16/CMP 6).

The Global Assessment Report on Disaster Risk Reduction (GAR) in 2009, the UNISDR initiative for monitoring risk patterns, trends and progress in Disaster Risk Reduction, states that these changes in the amount, intensity, frequency and type of precipitation can be associated with the growing extent of areas affected by drought, an increase in heavy daily precipitation that leads to flooding, and increases in the intensity and duration of certain types of tropical storms (GAR, 2009).

Although the countries mentioned in the review are demonstrating progress towards DRR in terms of implementing the Hyogo Framework for Action, there is still a great deal to be done around the world to reduce the risks of disasters. Often neither governments nor individuals are committed to investing in prevention. An abundance of policy and institutions at national level is not reciprocated at local level, and there are few mechanisms to facilitate the effective transfer of funds to implement activities in communities.

Comments made by interviewees about DRR methods and tools include the following: "*You cannot manage risks from development without taking CC into account because the behaviour of the climate system is already showing signs of changing. These changes pose risks and these risks need to be addressed.*" (Interviewee 5, 3rd December 2010). *"I don't see Climate Change Adaptation as a separate set of activities from DRR."* (Interviewee 2, 7th December 2010).

Birkmann et al. (2009) have identified challenges on a spatial, temporal and functional scale in linking DRR and CCA. These were used to define general recommendations and quality criteria for linking DRR and CCA. There are also geographical issues such as the difficulty of incorporating CCA into urban areas because of the complexity involved, and the challenge of coordinating platforms and actors at regional and local levels to build resilience. The local level was identified as the most important geographical scale for improving DRR tools as practical solutions for projects, as it is where policies are implemented and tested to address specific problems.

In terms of timescale, the difficulty of making accurate long-term projections for CC risks creates problems in adjusting DRR planning tools, and in moving gradually from short to longer-term hazard assessment, awareness, planning and response.

At the functional or institutional level, an important factor is that the international agenda on DRR and CCA has been polarized within the UN, and there are strong arguments in favour of the UN being the organization to initiate and reinforce linking and integration.

Also other studies have discussed the need for enhancing DRR tools in the light of Climate Change (see DKKV, 2006), however these studies often focus on a specific geographic or national context.

2. Methods of Analysis

CHINA:

Xinjiang Taklamakan desert. Sand-fixing plants aimed at preventing the spread of the deserts.

2.1 Disaster Risk Reduction, Hyogo Framework for Action

Disaster Risk Reduction (DRR) includes a wide range of activities aimed at minimizing disaster risks and related vulnerabilities. These involve efforts to prevent the risk of disaster and to limit the adverse impact of hazards when they occur, through disaster mitigation, preparedness and response (UNISDR).

The strategic goals for disaster reduction, according to the Hyogo Framework for Action (HFA) are as follows: to incorporate DRR into **sustainable development** policies and planning, to develop and strengthen institutions, mechanisms and capacities in order to build resilience to hazards and to incorporate DRR approaches systematically into the implementation of emergency preparedness, response and recovery programmes.

Tools linked to the above aims (strategic goals for disaster reduction) can be better understood and evaluated by grouping them into thematic components. In this context Cardona et al. in 2005 proposed an index that is intended to be policy relevant and is divided in four components: risk identification, risk reduction, disaster management and financial protection, each one composed of indicators which are assessed through a qualitative performance level evaluation (Cardona, et al., 2005).

A more recent evaluation of the sets of tools and methods used in DRR activities was made in 2009 in the Global Assessment Report on Disaster Risk Reduction (GAR). Five priorities were used for assessing the progress of HFA implementation as follows:

Priority 1: Ensure that Disaster Risk Reduction 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 developments, four components of tools and methods are therefore used in the analysis. 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 and (4) institutional capacity and financial mechanisms.

Risk identification and understanding

The identification and understanding of risk refers to the activities, tools and instruments involved in obtaining a better knowledge of the hazards which affect a community and contribute to its vulnerability. It also acknowledges the different 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.

A key factor in Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) is the concept of **vulnerability**, which is defined by the IFRC as follows: "*For practical purposes such as policy design, the distinction between natural variability (including extreme events) and incremental variability due to Climate Change is trivial – the key is to recognize and address underlying factors causing vulnerability*." (IFRC/RCS, 2010).

"*Vulnerability is the most important aspect of DRR. It is a development issue. Vulnerability reduction and DRR should be key issues in development*." (*Interviewee 15, 27th December 2010).*

The set of tools proposed in this study for identifying and understanding risk includes:

- National and local risk assessments: holistic (comprehensive) vulnerability assessment, risk assessment and risk communication to stakeholders (e.g. indicators, networks, sharing information);
- Systems for monitoring hazards, vulnerability and risk (evolution);
- Regional/ trans-boundary risks included in national and local risk assessments;
- Multi-risk assessments;
- Cost-benefit analysis;
- Inclusion of concepts in school curricula, educational material and training, particularly public education;
- A 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 reduction of underlying risk factors also addresses the reduction of the impacts of hazards when and where possible. One way of achieving this is to integrate planning and action across environmental policies and plans, to reduce socio-economic fragilities and/or susceptibilities and to reduce exposure by including risk assessments in the planning process, defining accepted levels of risk and the ability to cope.

The specific tools and methods for reducing underlying risk factors in the context of CCA are as follows:

- Disaster Risk Reduction as an integral objective of environmental policies and plans;
- Social development policies and plans to reduce the vulnerability of populations most at risk, poverty reduction;
- Policies and plans to reduce the vulnerability of economic activities (livelihoods);
- Incorporation of Disaster Risk Reduction into planning, including enforcement of building codes.

Disaster preparedness and emergency management

Disaster preparedness and emergency management involve tools, methods and actions before and after disasters for improving response, recovery, rehabilitation and reconstruction phases. Birkmann et al. (2009) highlight the importance of these tools and methods for Climate Change Adaptation. Their study, "*Addressing the Challenge: recommendation and quality criteria for linking disaster risk reduction and adaptation to Climate Change*" specifically recommends incorporating into Early Warning Systems (EWS) coastal floods, sea-level rise and creeping hazards such as salinization. Comprehensive risk assessments should be included in the development of emergency and evacuation plans in the event of extreme events linked to Climate Change.

As a response, key recommendations include giving information on anticipated climate-related changes as part of response strategies. Other recommendations involve developing flexible structures and concepts that can easily be changed or adjusted during transition phases after the introduction of humanitarian assistance, and improving capacities on the basis of the latest scientific knowledge, especially in regions severely affected by Climate Change (Birkmann et al., 2009).

In terms of recovery and reconstruction, the main recommendations are that suitable micro-insurance and microfinance schemes be developed and adapted to support recovery processes, that information on Climate Change be taken into consideration in reconstructing and building temporary and permanent shelters after disasters, that Climate Change factors be incorporated into medical care programmes (e.g. distribution of information about new health threats due to Climate Change, such as risk of malaria in areas which have not been affected in the past (high altitude)) and that Climate Change Adaptation be taken into account in water and sanitation infrastructure (Birkmann et al., 2009).

The set of tools selected for this are as follows:

- Disaster preparedness plans at all administrative levels and at regular training drills. These include emergency plans, recovery plans, stockpiling and reconstruction plans;
- Early Warning Systems (EWS);
- Financial reserves to support effective response and recovery;
- Procedures for exchanging relevant information during disasters and for assessing performance after the event.

Institutional capacities and financial mechanisms

Institutional capacity is another key factor, although its importance is not often fully understood. Institutional capacity can be viewed as the ability to mobilize and/or adapt institutions to address a policy issue such as DRR and Climate Change. Institutions should be seen broadly as sets of rules, processes and practices that prescribe behavioural roles for actors, constrain activity and shape expectations (Keohane, 1988). Institutions therefore pervade society. They not only include discrete organizations, which are often called "institutions", but also all formal or informal rules, processes and practices in society. The set of tools for institutional capacity and financial mechanisms take into consideration the administrative capabilities that enable collective action at different levels.

The specific set of tools is as follows:

- Strengthening of governance;
- National policy and legal framework for Disaster Risk Reduction;
- A national, multi-sectoral platform for Disaster Risk Reduction, and inter-institutional arrangements;
- Internal institutional arrangements (technical and institutional capacities) for DRR, and educational and training programmes for employees;
- Accessibility to resources for DRR plans and activities:

assessment of probable losses for public properties, services and vulnerable populations, creation of public funds to support projects, programmes and activities, application of financial incentives (e.g. tax reduction) for private property and activities to promote DRR, external financing for national and local programmes / projects;
- Community participation

2.2 Expert Interviews, Case Studies and Expert Workshop

The process of analysis for the improvement of DRR tools and methods specifically involved literature and document analysis, international expert interviews conducted from October 2010 to January 2011 and the examination of practical aspects of linking DRR and CCA in selected case studies.

The first part of the analysis examined the constraints, limitations, challenges and synergies involved in linking DRR and CCA. The second part of the analysis reviewed and focused on the tools and methodologies used in DRR, on their importance in the context of CCA and on their role in linking DRR and CCA. The third part examined the improvements needed in DRR tools and methods to allow them to be incorporated into CCA. The final analysis explored practical examples of the use of DRR tools and methods in CCA.

The interview process involved 23 international experts from different academic institutions, UN agencies, intergovernmental organizations and civil societies (see Annex for list of interviewed experts). In addition, a range of literature, documents and local interviews were used to examine case studies from selected countries, containing specific details of DRR/CCA tools and methods.

In early February 2011, German Committee for Disaster Reduction (DKKV) organized a one-day international expert workshop in Bonn, in collaboration with the United Nations University for Environment and Human Security. The workshop contributed valuable information in terms of further discussions, examples of case studies from key countries, short interactive activities and recommendations for improving the study where relevant.

3. Analysis of methods and tools for Disaster Risk Reduction, and how they can be improved for Climate Change Adaptation

GERMANY:

Third International Conference on Early Warning (EWC III), Bonn 2006.

Part of the analysis process involved the experts ranking the relative importance of DRR tools and methods in terms of CCA. Rankings from 1-5 were used, where 1 is the less important and 5 the most important. For the purposes of simplicity and representation, the ranking was averaged between ranking intervals (i.e. most important, **4 ≤ Ranking ≤ 5** and less important, **1 ≤ Ranking ≤ 2)** as indicated in Table 1, page 22.

It is important to note that some experts have argued that ranking DRR tools and methods in terms of CCA is case and context specific. Another important point to bear in mind is the use and interpretation of tools and methods for the decision-making process. For example it has been noted that: *"It is not so much about the tools but their use and how to interpret them. It is about institution alignment…the tools are there but they have not been factored in over the long-term. We are currently trans-managing the country adaptation profile. For example, with the South Africa flood, we found that the tools used are exactly the same but they have not factored in the long-term prediction from the Global Circulation model (GCM) or the treatment of uncertainty. How can that be done in a practical way? Otherwise I have yet to see something that it is used in CCA that has not been used in DRR",* (Interviewee 11, 21st January 2011).

Overall, the analysis shows that most of the DRR methods and tools are also important for CCA. The reason behind it is that an ideal DRR strategy for many regions means to integrate and apply various tools and activities simultaneously. However, in the light of CCA the experts and the expert workshops also underlined that some priorities can be identified. Risk and vulnerability assessment, Early Warning Systems, underlying risk factors, institutional capacities and important framework conditions (multi-stakeholder platform, quality criteria for tools and methods etc.) are seen as most urgent areas where synergies between DRR and CCA should materialize.

3.1 Identification and Understanding of Risk

The analysis of the expert interviews showed that the tools and methods which were a higher priority for CCA included holistic vulnerability and risk assessment, hazard monitoring, risk communication, development and research for multi-risk assessments and public awareness strategies to stimulate a culture of resilience. On the other hand, regional trans-boundary risks, and the development and research of cost-benefit analysis were perceived as less important DRR tools in terms of CCA. In the following section, we examine some specific aspects of the different tools and methods highlighted by the experts:

Vulnerability assessment

Vulnerability assessment is seen as an essential element in risk assessment. There are different approaches to evaluating or measuring vulnerability. One vulnerability assessment that has taken CCA into account is the Red Cross tool known as "*Vulnerability and Capacity Assessment* (VCA)". The fact that VCA is used at the local level shows that it is possible to link DRR and CCA at this level.

The UNFCCC defines the vulnerability assessment as a commonly-used tool, *"which seeks to determine where the damages from climate-related events are likely to take place. It also helps to identify measures to enhance resilience to lessen their impacts. Focusing on vulnerability assessment may provide common ground for adaptation and DRR perspectives (Dilley, 2002). However, although vulnerability assessments are integral to both adaptation and DRR, there are differences in how they are studied. DRR-based vulnerability assessment usually begins with the historical and current situation though they are future-oriented."* (UNFCCC, 2008). Therefore, the development of vulnerability projections or "scenarios" poses a challenge for CCA studies.

Risk assessment

From the perspective of DRR vulnerability assessment is an integral part of risk assessment, while for the Climate Change community vulnerability identification is often the final outcome.

In general, most of the experts interviewed noted that risk assessment (hazards, vulnerability) needs to be re-adjusted for use in CCA. However, it is not clear exactly how this can be done. At different levels and in different countries, the information available is not sufficient to deal with long-term Climate Change scenarios and predictions.

Nevertheless, much more attention should be paid to improving risk assessment. It is usually the starting point and baseline for the use of other tools such as planning, emergency, recovery and construction plans in the wake of disasters. Therefore, if risk assessment methodologies are adjusted to include Climate Change risks, other tools, methods, instruments and activities will also be systematically improved.

In this regard, risk and vulnerability mapping is an important pre-requisite for effective prevention strategies such as the integration of risk zones in urban and spatial planning. Particularly, there is a need to strengthen the use of different Climate Change scenarios as well as vulnerability scenarios in formal planning tools, such as land-use plans or zoning plans. However, it has to be noted that the translation of very different Climate Change scenarios into risk maps remains a challenge for many regions and localities.

Monitoring

Monitoring hazards, vulnerability and risk is also an important starting point for reducing other disaster risks, and it is a core element in Early Warning and Early Warning Systems. An important point has been raised about the need to pay attention both to realised and unrealised risks in the monitoring process. This is captured in the following statement: *"Realized risks are facts, data that can be collected through observation to tell you where the event was and how big it was through actual loss data. This information is very important for calibrating the less certain information about unrealized risk, because predicting the future is uncertain…"* (Interviewee 5, 3rd December, 2010).
The statement underlines that in the context of Climate Change, predictions of risk are characterised with a high degree of uncertainty. While past loss and damage data might explain risk hotspots in the past, it is still an open question whether and how data of past events and prevailing conditions can sufficiently function as a basis to predict hazard and risk in the future, particularly for hazards that are modified by Climate Change.

Risk communication

One risk communication strategy involves communicating scientifically-assessed risk factors to other institutional actors and the community in a clear, simple and understandable way. Improving risk communication also means to integrate DRR and CCA actors and to strengthen the interactions with communities exposed. One expert for example underlined that "*each scientific community should enter into an integration process. The difficulties are basically in interaction with the non-scientific community, and this involves participation and negotiation. However, the DRR scientific community has been developing stronger interaction with diverse actors and the community.*" (Interviewee 3, 26th November 2010).

Education and training

Making disaster risk education part of national primary and secondary school curricula fosters awareness and better understanding of the immediate environment in which children and their families live and work. We know from past experience that children who are taught about natural hazard risks play an important role in saving lives and protecting members of the community in times of crisis (UNISDR 2007). Including the concepts of disaster risk in school curricula and education provides strong links with environmental issues related to Climate Change and the understanding of Climate Change Adaptation. Although this is a long-term process aimed at obtaining results, it is important as a basis for sustainable and human development. *"If you want progress, you have to start at school."* (Interviewee 14, 21st January 2011).

3.2 Reduction of Underlying Risk Factors

The experts we interviewed considered all the tools and methods in this group very important for CCA**.** To reduce the underlying factors of vulnerability, complex processes generally need to be taken into account when formulating plans and policies. These processes range from social development at all institutional levels to the enforcement of building codes and uncertainties about the availability of resources.

Environmental policies and plans

Where DRR becomes an integral part of environmental policies and plans, DRR initiatives and activities become more effective and sustainable. It is an opportunity to incorporate CCA and DRR into the same strategies. For example, in the case studies in Manizales, Colombia and Seychelles, the environmental agency includes DRR in its policies, plans and specific projects in each case. It is considered useful to link CCA into current DRR projects.

Another point of view is that DRR and CCA are basically development issues, and that they *"should be integral to development policies and plans. You cannot make a development policy in good faith without experiencing the impact of Climate Change. Whenever we hear about hurricane and floods ripping away over 6% of the GDP of a country, you ask yourself what kind of development you are talking about unless you have DRR integrated into development. If one considers CC as an environmental issue, then Disaster Risk Reduction as an integral objective of environment policies and plans would mean something else."* (Interviewee 14, 21st January 2011). The argument for DRR and CCA becoming an integral process in environmental policies and plans, as opposed to an integral component of development polices and plans, will be examined in more detail in the case studies, but it is a topic for ongoing debate and discussion.

Social development and economic activity plans

Although this is one of the most important activities where risk should be addressed, a number of challenges remain for DRR in social development, economic activities and implementing plans and policies. The relationship between poverty reduction, unemployment and economic activities is an important factor in vulnerability, and needs to be taken into account and addressed in national development plans. These, in turn, need to be integrated with land use and territorial planning.

This was noted as follows: "*Most of the development plans still don't have knowledge of the potential risks that could affect the planning process in the short-term. They don't include DRR or CCA. For example, in Africa development plans might*

mention the word "climate", but they do not really consider Climate Change issues which are part of the Millennium Development Goals, such as epidemics and diseases. There is a focus on how Climate Change is going to be in the future, but there is a lack of consideration of the important current risks." (Interviewee 5, 3rd December, 2010).

3.3 Disaster Preparedness and Emergency Management

In terms of disaster preparedness and emergency management, having emergency plans and Early Warning Systems ranked highest in terms of importance for CCA. Recovery and reconstruction plans ranked second highest, along with procedures to exchange relevant information during disasters and undertake post-event assessment of performance. Interestingly, stockpiling was seen as less important tool for CCA.

Emergency, contingency and reconstruction plans

Emergency, contingency and reconstruction planning should consider vulnerability and multi-hazard risk assessments and Climate Change related effects that modify the hazard components. The risk and vulnerability assessment and respective maps should on one hand be used to identify appropriate locations for shelters, relocations, debris accumulation, water supplies, communication roads and food reserves in case of a crises. On the other hand, risk and vulnerability maps are also a pre-requisite for spatial and urban planning, particularly in terms of risk zoning and keeping areas free from urbanization that are highly exposed to future hazards. Preventive measures like zoning and improved building codes are also key tools for reducing underlying risk factors.

3.4 Institutional Capacity and Financial Mechanisms

Amongst the institutional tools and methods identified as having the greatest importance for CCA were a national multi-sectoral platform for Disaster Risk Reduction, inter-institutional arrangements, accessibility to resources for implementing Disaster Risk Reduction plans and activities at all administrative levels, external financing for national and local programmes or projects and community participation. The second most useful tools and methods identified for CCA were strengthening governance, creating national policy and legal frameworks for Disaster Risk Reduction with decentralized responsibilities and capacities at all levels, assessment of probable losses for public properties, services and vulnerable populations, providing public funds to support projects, programmes and activities and offering financial incentives (e.g. tax reduction) for private stakeholders to promote DRR. On the other hand, the least importance was given to internal institutional arrangements (technical and institutional capacities) for disaster risk management, and to educational and training programmes for employees.

The key challenges identified for governance, institutional capacities and financial mechanisms were related to their sustainability and their inclusion in medium and long-term policies and projects. Sustainability requires strengthening technical and practical administrative capacities in institutions, such as project financing and management. An example of how important it is to develop institutional capacities and financial mechanisms is given by Manizales in Colombia, where the local administration is heavily involved in the management of projects and resources for DRR. This gives them access to new financing strategies to continue improving DRR and allows them to include other aspects such as CCA. This was confirmed by the assessment of the Disaster Risk Management Index (DRMI) in Manizales in 2007, a methodology developed by Dr. Omar D. Cardona of the Institute of Environmental Studies at the National University of Colombia in Manizales. This index was also applied to other cities in Colombia to show improved performance in governance and financial protection.

In other rare cases, there is an urgent need to build a level of governance and institutional capacities: "*In Somalia, good management and governance does not really exist. The government is not recognized outside the city. A national, multi-sectoral platform for DRR does not exist. It is only a word in this place. There is no national- international participation because Somalia is not internationally recognized and the local capacities of NGOs are weak. DRR, CCA, UNFCCC, UNISDR are largely unknown.*" (Interviewee 11, 21st December 2010).

Integration of institutional and legal frameworks

It is generally agreed that the international agenda on DRR and CCA at UN level has been polarized, and there is a strong argument that the UN will need to be the organization that initiates and strengthens integration. Part of the rationale for this argument is that there are different understandings, concepts, multi-level bodies, frameworks, policies, treaties and concerns about DRR and CCA, and that these differences need to be harmonized more effectively.

DRR and CCA can be integrated through the mechanisms of individual platforms. National DRR platforms should include Climate Change and CCA. The National Disaster Risk Management Committee can easily accommodate representatives from the CC community and vice versa. This means that national DRR and climate strategies should be based on common frameworks and principles of good governance.

The local level has been recognized as a key area for DRR; however, many activities of CCA have primarily been addressed at the national level. Overall, experts agreed that the local level is the most important level to link DRR and CCA. For example, some agencies are developing the so called resilience framework within the communities that combine scientific knowledge on Climate Change and local and traditional knowledge about risk reduction and societal adaptation. Predominantly the experience and the needs of local communities can be articulated and considered within tools and methods at the local level.

3.5 Overall importance of DRR tools in Climate Change Adaptation

Reducing underlying risk factors was seen as the most important element in enhancing CCA, followed by solid institutional backing and the support of financial mechanisms. Identification and understanding of risks, and being prepared for disasters and emergencies were ranked slightly less but were also considered very important.

Most important **4 ≤ Ranking ≤ 5**	**Moderately Important** **Ranking = 3**	**Less important** **1 ≤ Ranking ≤ 2**
• Reducing underlying risk factors	• Institutional capacity and financial mechanisms	• Identification and understanding of risk • Disaster preparedness and emergency management

Table 1: Relative importance of tools and methods by group

4. Tools and Methods selected for Modification and Improvement for use in Climate Change Adaptation

BENIN:

Monsoon research within the frame-work of the international programme AMMA (African Monsoon Multi-Disciplinary Analyses) for improving meteorological forecast models.

This chapter provides further discussion on DRR tools and methods selected for use in CCA. The specific tools and methods were selected on the basis of how they were ranked for importance in Climate Change Adaptation by the experts we interviewed and by those who attended the expert workshops. The selected tools and methods include risk and vulnerability assessment (identification and understanding of risk), integration of DRR into planning activities (reducing underlying risk factors), Early Warning Systems (disaster, risk preparedness and emergency management) and external financing mechanisms (institutional capacities and financial mechanisms).

4.1 Risk and Vulnerability Assessment

Practical experience shows that most institutional actors address natural hazards such as floods, tropical storms and weather-related hazards such as heavy precipitation and heat waves. On the other hand, although there are a number of studies on the subject, much less attention is paid to slow, creeping hazard processes such as rises in sea level and salinization. Even less attention is paid to accumulated shocks from non-extreme events.

Nevertheless, one interesting initiative, spearheaded by the UNDP's Bureau for Crisis Prevention and Recovery (BCPR), along with the Bureau for Development Policy / The Energy and Environment Group (BDP/EEG) is investigating "Climate Risk Management technical assistance support". The aim of this project is to analyse the risks to development posed by climate variability and change, in order to define and prioritize short and long-term risk management measures. Analysis generated by the project will contribute to greater coherence in national strategies for managing climate variability and change, and the effort will help to bring about more unified climate-risk management between the government, UN agencies and the donor community.

The Red Cross Vulnerability and Capacity Assessment (VCA) also incorporates Climate Change and CCA into its evaluation process, which attempts to find common ground between community knowledge on Climate Change and external knowledge. This external knowledge approach is an initiative of the Red Cross Climate Centre. The process focuses on local experience of changes in weather and associated issues. The objective is to seek potential solutions and factor them into the community risk reduction plan (IFRC/ Climate Centre, 2007).

On the basis of the literature analysis and the expert interviews, we were able to make the following recommendations for modifying risk and vulnerability assessment for Climate Change Adaptation:

- Climate Change projections should be made to the highest available resolution for each region, in order to identify hot-spot areas and the potential impacts of Climate Change on societies and socio-ecological systems.
- Increases in exposure to the effects of Climate Change (e.g. sea-level rise, flood patterns, etc.) and other global trends (e.g. urbanization) should be analysed.
- The increase in social vulnerability and multiple-interacting systems should be taken into account when estimating risk and vulnerability on a local or national scale (indirect Climate Change impacts on human security, i.e. security of food and livelihoods, at different levels).
- The potential effects of Climate Change on coping and adaptation capacities should be examined (effects of climate variability, increase in frequency, etc.).
- Vulnerability and hazard scenarios should be developed and used for reasonable timescales, such as for the next 20 to 50 years.

4.2 Integrating DRR into planning activities

Integrated planning is a strategic activity that should be included in future risk management. Similarly, Climate Change projections and scenarios help to understand future risks and their potential management. With this in mind, O'Brien et al. note that *"long-term changes to land use are likely to be required (affecting agriculture and forestry, the use of coasts, estuaries and river resources and settlement patterns and infrastructure). It may be necessary to instigate a process of managed retreats from those areas that will become unusable, involving relocation to areas that offer security and opportunity."* (O'Brien et al., 2006).

The World Disaster Report 2010 illustrates that reducing negative effects and impacts of Climate Change means also to take into account Climate Change and CCA in local planning and DRR. One aspect is the consideration of Climate Change when building new, infrastructures, such as the provision of water, sanitation and drainage, which under climatic changes might have to be modified or have to incorporate flexibility for future adjustments. "*Improving housing and getting basic infrastructure in place is a priority for adaptation*" (IFRC/RCS, 2010). Good zoning and planning regulations are also seen as an important tool that can help to provide appropriate and safe locations for low-income households while reducing their exposure to natural hazards, such as flooding, landslides, etc.

Another issue involves applying building codes and standards which are relevant and affordable at the local level. These building codes can be used to make housing more resilient to **extreme weather conditions**, while enabling poor residents who live in self-built or artisan-built con-

structions to upgrade to an appropriate space at a suitable cost (IFRC/RCS, 2010).
Important factors to bear in mind when incorporating DRR into planning and development are as follows:

- Identify areas exposed to the effects of Climate Change, using Climate Change scenarios and their potential effects on development strategies for these regions.
- Make use of projections and scenarios which analyse anticipated future change, such as fluctuations in population and economic growth, environmental deterioration, unemployment levels, etc.
- Improve the use of prospective risk management, taking medium-term plans into consideration in schedules.
- Maintain flexibility and a dynamic mode of planning, where local authorities do not simply plan for the worst case scenario without revising the plan during the five year period, but where they continue monitoring across different time scales. "*This is partly an approach for dealing with uncertainties in a changing climate. It can be considered adaptation to Climate Change, but it is not adaptation in the sense that the adaptation science community might view it, looking at a long-term Climate Change scenario and then working backwards from there in a top-down fashion.*" (Interviewee 2, 7th December 2010).

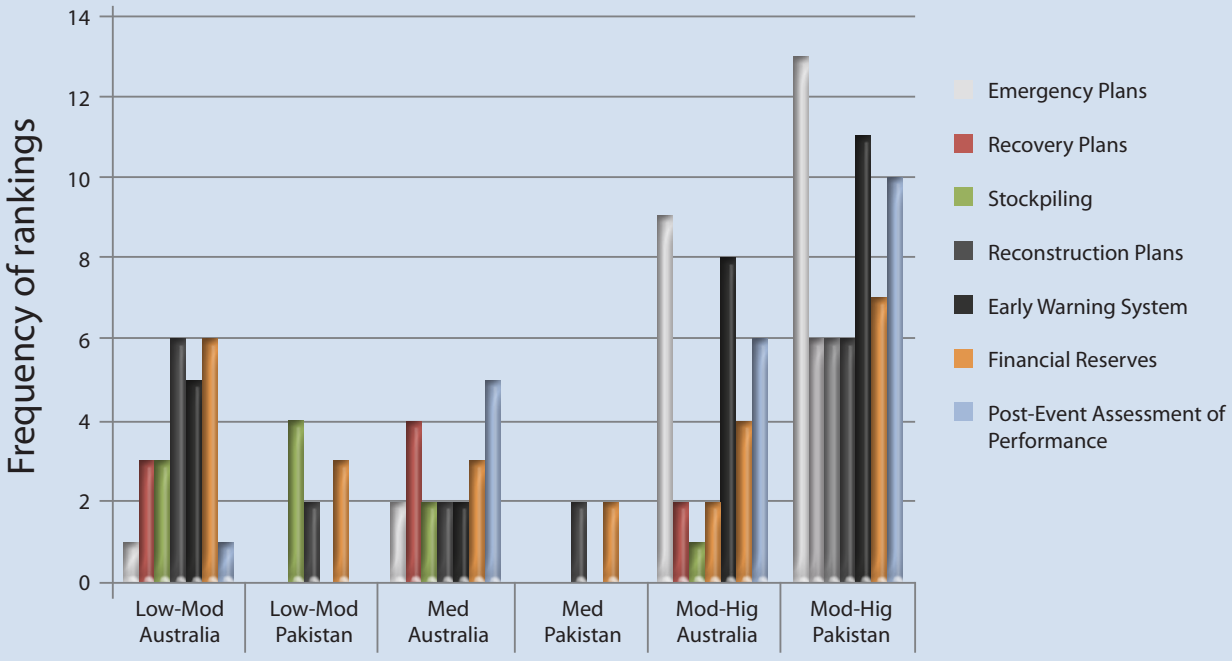
4.3 Early Warning Systems

Early Warning Systems (EWS) are a major tool in Disaster Risk Reduction, and are considered important for bridging DRR and CCA. Compared to structural measures that are often difficult to modify once implemented, Early Warning Systems are robust and flexible at the same time. However, the information base for setting up and implementing Early Warning Systems differs substantially for each hazard and in different countries. One of the experts we interviewed commented:

"*In Somalia, a technical Early Warning System is completely absent; a local indicator system based on mist, fog, flora, animal behaviours (turtle) is employed as Early Warning information. A local calendar of these indicators is used or adapted for monitoring in the absence of scientific knowledge and information. It is mainly used for seasonal seeding of plants, farming and livestock management.*"
(Interviewee 11, 21st December 2010).

The international expert interviews indicated that EWS is a very important tool in disaster preparedness and emergency management. The expert workshop held during the study also concluded that, particularly in terms of the

Figure 1



Findings from an international expert workshop: ranking the relative importance of DRR tools (focusing on disaster preparedness and emergency management) in planning for Climate Change in Australia and Pakistan

floods in Pakistan, the improvement of various tools and methods of DRR is needed, while in Australia tools such as reconstruction plans, stockpiling, recovery and financial reserves were ranked low to moderate priority (Figure 1, page 25). Overall, the discussion revealed that both countries will need to modify and improve their EWS frameworks to deal more effectively with hazards related to Climate Change (ranked as very important).

Moreover, the expert discussion and the literature review also emphasized that EWS still lack an end-to-end and people-centred approach, and that they consequently do not tend to address sufficiently the so-called Last-Mile (IEWP, 2006). In addition, there are major weaknesses in governance and institutional arrangements for Early Warning (UNDP, 2004). It is clear that an integrated and comprehensive framework is required (proper framing) for analysing, understanding and designing an improved EWS (Chang Seng, 2010). On the other hand, in terms of DRR, EWS concepts and frameworks have evolved from the traditional three phases (monitoring, warning and dissemination) to a more complex and integrated framework characterized by additional elements such as participation and feedback from different actors and the community (Basher, 2006). New challenges for Early Warning Systems linking DRR and CCA include governance and the resilience of the ecosystem. Actors, architectures, and management systems need to be considered for an effective and sustainable EWS (Chang Seng, 2010). Furthermore, risks and disasters are becoming more and more complex, and require an innovative, integrated and problem-solving approach. The question is how to modify and improve current EWS frameworks as a tool for Climate Change Adaptation. Which new elements and criteria will be required for improving EWS so that it is able to cope with rapid and extreme events as well as creeping hazards and threats related to gradual climatic changes?

Systems for Climate Change detection and EW are, in effect, emerging in a number of places, funded by different agencies, but without an overall plan or design (Travis, 2010). An important point to emphasize is that the effectiveness of EWS is not only determined by the accuracy and timeliness of the prediction but also by other factors, particularly the available response options, knowledge about how to respond and the recognition that a response is required (part of the so called Last-Mile). These issues were also highlighted in the expert workshops conducted within the framework of the study. The emerging ad-hoc system may require a good deal of attention before it can be modified into an effective Climate Change EWS. According to Travis (2010), the next steps for Climate Change warning should include: (1) putting more effort into documenting and profiling the segmented variation of climate events that should be the focus of early detection and warning (Lenton et al., 2008); (2) developing links between climate events (i.e. increases in storm intensity), socially-relevant impacts and user needs, and (3) enlarging and assessing the effectiveness of potential responses, including those which are not dependent on predictions.

Case studies presented at the expert workshop in Bonn on Togo and Mozambique highlighted the fact that local, community-based EWS frameworks are mainly being developed in rural communities. However, there is an increasing demand for improved EWS in urban areas for example as illustrated by the case study of the city of Manizales. Particularly, the mega-trend of urbanization and the increasing urbanization of coastal areas that are highly exposed to hazards influence by Climate Change calls for an increasing attention of urban EW strategies.

The specific challenges of Early Warning and preparedness strategies for the Last-Mile will therefore need to be addressed more precisely in an urban context in future, especially if we take into account the likelihood of sea-level rise and increasing urbanization processes in coastal zones globally. The example of flood Early Warning in Togo underlines the need to strengthen low-tech warning systems through trained volunteers and a network of flood warning poles. These mean that imminent risks can be communicated up and downstream by a flood EWS. To improve the effectiveness, sustainability and relevance of the local EWS approach, local warning and preparedness strategies need to link in with national and global systems of Early Warning. This also means that local systems can make use of scientific data, and address potential communication failures and other issues. Overall, experts suggested that EWS frameworks for situations related to Climate Change particularly need to consider the following issues:

Directly related to CC

- Scientific understanding of the effect of different CC scenarios on hazard types, intensities and frequencies
- Climate indices for specific locations and analysis of extreme events

Not directly related to, but enhanced by CC:

- Ecological indices and improved real-time monitoring;
- Improved communication channels at all levels and scales;
- Monitoring, awareness and sensibilization of people at risk;
- Research, innovation and technology;
- Global input to the regional, national and local EWS;
- Feedback and evaluation (EWS performance assessment for accountability);
- Network building, collaboration with other sectors and committed partnerships;
- Local knowledge and ownership to build first response for EW;
- Linking with scientific organizations;
- Making use of social indices i.e. poverty index;

- Understanding relationships and links;
- Promoting synergies between EWS frameworks at different levels (local-national-international)

A recent study carried out in 2010 by DKKV and Partners entitled 'Emerging Challenges of Early Warning Systems in context of Climate Change and Urbanization' identifies several key issues such as linking long-term forecast and prediction with Early Warning, communicating uncertainties to the beneficiaries in a transparent way and integrating a number of sectors into EW. This would link them with traditional EW actors in civil protection and humanitarian assistance. It would facilitate the integration of potentially changing risk patterns into EW. In addition, it will be important to link local, national, regional and global approaches and stakeholders who are active in, and responsible for Early Warning. Moreover, Early Warning needs to be able to account for specific user needs more adequately, e.g. by adapting EW messages to the needs of people and communities in an integrated and sustainable way. Lastly, the communities at risk that will benefit from an EWS should also be involved in long-term governance, making use of new expertise and new partnerships.

It is equally important to ensure that existing tools and methods, such as guides and checklists, are revisited and updated. For example, Climate Change issues should be included in updates to risk information and Early Warning in the Guide for Implementing the Hyogo Framework for Action, published by UNISDR. Likewise, it is important to ensure that the compendium "Developing Early Warning Systems: A Checklist" (an outcome of EWCIII 2006) be updated in view of CC (integrating Climate Change as a concern as well as incorporating performance measures for EWS).

4.4 External financing

Methods and tools used in Disaster Risk Reduction cannot be adequately modified to enhance Climate Change Adaptation if additional funding is not made available. In order to improve DRR methods and tools for dealing more effectively with extreme events and Climate Change Adaptation, sources of funding will need to be found. In other words, the following issues need to be addressed:

- Funding will be required to adapt and improve DRR methods and tools for use in CCA.

- This also means that bilateral agreements should include a commitment to take advantage of the existing knowledge available in DRR to enhance Climate Change Adaptation. Specific examples of DRR tools should be given, along with their respective quality criteria.

- Funds should be made available on a flexible basis. One example, related to disaster preparedness and emergency management, is the creation of a disaster response emergency fund at the International Federation of the Red Cross in Geneva, which makes funds available for relatively small-scale responses to smaller disasters without having to go through a formal, international process to request humanitarian assistance from the donor community. Donor community funds are annual contributions which do not allow a fast response. One interviewee notes that, "*these kinds of funds are already adapted to Climate Change, I'd say, as they have more of those flexible mechanisms for targeted assistance.*" (Interviewee 2, 7th December, 2010).

- Additionally, in some big disaster events large donations are made and in some cases these could be handled with a higher flexibility, that means allocating a part of the money for less visible disasters and crises.

- Funds should be distributed fairly to different activities, such as prevention, awareness, mitigation, preparedness and response. Cost-benefit analysis at national and local level can help to orient these decisions.

5. Case Studies

COLOMBIA:

Erosion control and stabilization work in Manizales.

Two cases studies are proposed to analyse the improvement of tools and methods of DRR from different perspectives and in a variety of contexts. The first case study, in Seychelles, illustrates a relatively long-term experience of CC. This has led to activities which focus on anticipated signs of local vulnerability caused by sea-level rise resulting from Climate Change, and these are contrasted with recent and emerging experiences in DRR and ongoing efforts to integrate it into planning. The second case study focuses on Manizales, Colombia. It begins with their experiences of DRR in combating the variety of hazards which affect the locality. They have been able to integrate disaster management into institutions and organizations with a great deal of success, and have also been able to show how the actual variability in climate is leading to ways of integrating CC and CCA into DRR tools and methods already in use.

5.1 Seychelles

The Seychelles archipelago is the most extended in the Indian Ocean. It consists of 115 islands, scattered over an exclusive economic zone covering an area of 1,374 million square kilometres. It is situated in the western part of the Indian Ocean between 4 and 9 degrees south of the Equator. The archipelago is divided into two distinct groups of islands: the granitic group, 43 islands in all, with mountainous peaks and narrow coastal lands, and the low-lying islands, all 72 of which are coralline.

In the early 1990s, the vulnerability to CC of Seychelles was a major concern. As a small island state, it stood to lose more and more coastal infrastructure due to sea-level rise. The anticipated socio-economic implications were potentially enormous, so a variety of principles, tools and methodologies were adopted to deal with the uncertainty and risks connected with Climate Change (INC, 2000). These are briefly discussed below.

Kyoto Protocol and UNFCCC

The tools and methods used to address the challenges of Climate Change were based on the agreement signed at the United Nations Conference on Climate and Development (UNCED) in Rio de Janeiro in June 1992. Seychelles was one of the 151 countries that signed the agreement, and a few months later, on September 22nd 1992, it became the second country to ratify the Convention. The Kyoto Protocol was signed on 20th March 1998, and once again Seychelles was amongst the first ten countries to do so. The principles adopted involved mitigation of Climate Change by identifying areas where GHG emissions could be reduced by adapting policy and technology.

Environment Management Plans

Government activity on mitigation and adaptation strategies is also covered in the Environment Management Plans (EMP). The first EMP (1990-2000) did not address Climate Change issues but the second one (2000-2010) considered Climate Change to be a cross-sector issue, which involved mainstreaming it across all priority programmes. Little appears to have been implemented, however, as the institutional changes required for implementation are still in process (Payet, 2009).

The National Climate Change Committee

The National Climate Change Committee (NCCC) was formed in August 1992 to provide overall coordination for the development and implementation of the national climate programme, and to act as an interface between this programme and the government. The NCCC involves professionals from a number of socio-economic sectors, such as agriculture, fisheries, police, health, education, press, transportation, marine services, NGOs, visiting experts and private individuals in their professional capacity. The primary objective was to build national capacity to combat the adverse effects of Climate Change. The NCCC was formed under the joint aegis of the Meteorological Services and the Environmental Division, which was part of the Ministry of Foreign Affairs, Planning and Environment (INC, 2000). However, all activities have generally been coordinated by the Meteorological Services and have now been taken over by the Policy and Planning Services Division within the Ministry of Transport and the Environment. This is because the Seychelles National Meteorological Services have been transferred to the Department of Environment. According to Payet (2009), this has facilitated the relationships and negotiations between the World Meteorological Organization (WMO), the Intergovernmental Panel on Climate Change (IPCC) and the UNFCCC, as the Ministry was already involved in a number of international environment conventions.

National Communications

National communications play an important role in the Climate Change Adaptation process. In Seychelles, the Initial National Communication (INC) focused on studies based on historical data. These addressed the vulnerability of the islands in terms of socio-economic key sectors which were likely to be affected by Climate Change. The INC provided a better understanding of the specific challenges and attracted the attention of both policymakers and financial institutions.

However, adaptation activities suggested in the INC were complex and difficult to implement (Payet, 2009). Secondly, the INC did not place much emphasis on issues of vulnerability, adaptation and capacity-building. A major omission in the INC was that no Climate Change scenarios were implemented at regional or local level. Consequently, the possible impacts of Climate Change on the different sectors were rather general and vague, and were based on the global projections of the third assessment report (Chang Seng, 2009). Therefore, in an effort to address this challenge, it was necessary to assess the current climate conditions and develop regional-local Climate Change scenarios as a tool and method for Climate Change Adaptation. These tools were developed in the Second National Communication (SNC) using the IPCC recommended tools and methods, and were streamlined in the Climate Change Adaptation activities in the Second National Communication (SNC).

Climate Change scenario projections

According to Chang Seng (2008), for mid-range emission with a mid-range climate sensitivity, the mean air temperature for the main island Mahé will *more likely than not* be warmer by +3.0 °C by the end of this century. The relative rate of warming will occur mainly during the cooler south-east monsoon. The warming ranges are +0.4 to +0.7; +0.9 to +1.4 and +1.8 to +2.9 °C respectively for the years 2025, 2050 and 2100. On the other hand, the maximum increase in seasonal rainfall for Mahé is +12.4 % (+38.6 mm) in the DJF (December, January, February) season, while a decrease of -36.3% (-31.1 mm) is expected during the south-east monsoon in 2100. The range of percentage change in annual rainfall is -2.4 to +5.0 %; -4.8 to +8.5 % and -8.6 to +16.3 % for the years 2025, 2050 and 2100 respectively. Thus, the rainy season is *more likely than not* to be wetter, while the dry season is *more likely than not* to be drier. The following sections provide an insight into the adaptation activities, tools and methods used in the various parts of the SNC project.

New areas for adaptation

Climate–water sector

To help in the evaluation of the local impacts of Climate Change in the water sector, one study involved an integrated climate, socio-economic and technological change impact assessment on the water resources, and used a new decision support tool recommended by the IPCCC (Chang Seng, 2008). Strategies for demand and supply policy scenarios were simulated to provide a guide on how to mitigate these or adapt them to anticipated stressors in the water sector.

Another project activity involved understanding the leading causes and mechanisms of severe droughts. As part of the EWS process, the activity developed multivariate statistical models as predictive tools (EWS) for droughts and extreme rainfall.

Another activity involved a pilot rain-harvesting project in one of the national schools, with the aim of raising awareness about Climate Change, given that rainwater harvesting is a tool for water conservation, flood control and erosion. Keen interest and demand from other schools meant that the pilot project has been transformed into a national programme with additional support from the United Nations Environment Programme's CC DARE (Climate Change and Development Adaptation by Reducing Vulnerability) project.

Tourism

The impact of Climate Change on tourism in Seychelles has also been assessed (Payet 2007). Climate scenarios indicate that coral reefs may be under severe threat by the year 2040. Increased wave intensity is likely to cause erosion on many of Seychelles' most economically-productive beaches. The assessment concluded that there are increasing signs of direct human pressure on the ecosystem, which is becoming less resilient. It also suggested that revenue from tourism be reinvested in restoring the ecosystem and put towards other adaptive measures in the long-term, involving the private sector and other stakeholders.

Fisheries sector

Temperature is an important parameter for monitoring and assessing changes to marine ecosystems. Seychelles was severely affected by the 1998 coral bleaching event caused by El Niño in 1997-1998. Ocean temperature data are important for a wide range of research applications in Seychelles, and involve studies on reef fish, turtles, sea birds, whale sharks and other species. The authorities recognized that coordination was essential in addressing national priorities and monitoring as much of the archipelago as possible. The project formed a network of agencies and programmes with direct or indirect interest in ocean temperature data. The implementation of this project and the establishment of the Sea Surface Temperature Monitoring Network have built adaptive capacity for monitoring and assessing near-term climate-mediated changes to the marine ecosystems of Seychelles. The fisheries sector also carried out a separate assessment of the impact and consequences of climate variability on fisheries in relation to other sectors in the country (Robinson et al., 2009).

Agriculture sector

A feasibility study for a Seychelles National Agriculture and Fisheries Disaster Insurance Scheme (SNDIS) was explored from 2005, following the December 2004 tsunami (Moustache et al., 2009). At the time, farmers and fishermen were

forced to turn to government bodies for relief whenever disaster struck. The new insurance scheme is aimed at providing timely relief in the event of losses caused by such disasters. The scheme was approved by the cabinet at its sitting in December 2010. The two main insurance providers have been approached, and have expressed their interest in managing the insurance on behalf of the government, in return for a fee. A separate assessment informed farmers and policymakers about the likely impacts of Climate Change and the risks for crops, with implications for national food security in the country (Chang Seng et al., 2009).

Coastal Zone sector

The country's coastal zones are threatened by the impacts of sea-level rise, extreme events such as abnormality in the sea surface temperature, extremes of precipitation and storm surges. If Seychelles is to cope with these types of impact, the country must be equipped with effective sustainable coastal adaptation measures to cater for both present and future needs.

A technical assessment was carried out on current physical drainage and flood control measures throughout the country (De Comarmond et al., 2008). It assessed the adequacy of existing drainage infrastructures and the current institutional approach to national drainage and flood management. Key recommendations have been proposed on how to improve existing institutional capacities and attend to inundation problems by implementing adaptive strategies. These range from hard to soft coastal measures.

Health sector

An assessment of the impact of Climate Change was carried out with the aim of gathering evidence for, and understanding the ways Climate Change will affect human health (Payet & Julienne, 2009). The assessment also put forward proposals for policies to mitigate and adapt to the effects of Climate Change on health.

The study developed an index of mosquito vector density by region for the main islands. It concluded that currently, government ministries, agencies and institutions involved in health management do not have the capacity to cope with the consequences of a major epidemic, especially one that would require hospitalization, such as cholera or malaria. The healthcare infrastructure is currently inadequate, with insufficient human, physical and financial resources. There is a lack of medical workers compared to the relative size of the population, as well as a lack of medical structures (hospitals, beds etc.) and limited storage for medicines and vaccines. The adaptation measures identified as most important for building resilience in the health sector include strengthening the public health infrastructure, public health training programmes, research to develop and implement more effective surveillance and emergency response systems, health education programmes and prevention and disease control initiatives.

Seychelles National Climate Strategy

The National Climate Strategy (NCS) is an important policy tool that will shape the governance of mitigation and adaptation activities in the wake of Climate Change in the Seychelles. It was timed to coincide with negotiations in Copenhagen in 2010. According to Payet (2009), the first Climate Change strategy was developed mainly through consultation and workshops, following the recommendations of the International Meeting of Small Island States in 2005, and using activities and tools developed in the SNC and EMPS 2000-2010. The plan will provide a coherent and consolidated approach to new Climate Change-related policies and to programmes and projects to address the key risks and opportunities of Climate Change. It will also build a resilient approach to mitigating and adapting to the impacts and consequences of Climate Change. There is a general feeling that, because climate activities are nested within the Ministry of the Environment, this will give the NCCC the structure and capacity to work with other sectors at the technical level and to access political support. One of the two key proposals is to strengthen the NCCC and to develop mechanisms to engage support at the highest political level, especially in implementing key cross-sectoral activities in the strategic plan and in engaging appropriate stakeholders to ensure decisions have the required support at operational level.

However, the National Climate Change Strategy has a number of weaknesses and shortfalls in addressing complex and uncertain risks associated with Climate Change. Overall, it lacks a forward-thinking approach, as the adaptation strategies were formulated on the basis of current ability to implement actions through existing institutions and current solutions on the ground. It also focuses heavily on a top-down approach, and pays little attention to legitimizing a more bottom-up approach in national polices and plans. Moreover, the strategic plan attempts to address dynamic pressures rather than the root causes of threats, and this results in weaknesses in adaptation capacities (i.e. loss of human resource capacity, poor enforcement and lack of consistent implementation of policies and laws, and limited involvement from the private sector in adaptation activities).

The strategy proposes five broad strategic priority objectives, but on the whole it fails to link or integrate Disaster Risk Reduction and Climate Change Adaptation between sectors and at all levels. In other words, there is no contingency planning for possible failure of CCA in the Seychelles National Climate Strategy, nor does it address ways of coordinating and linking DRR and CCA.

The National Climate Strategy recognizes the need to include Climate Change Adaptation in mainstream national policies, strategies and plans for sustainable development. It also acknowledges the role of the country's planning authority in coordinating multi-sectoral involvement. It nevertheless falls short of recommending concrete institutional change or arrangements for integrating DRR and CCA into development policies and plans, despite the fact that risk, disaster and Climate Change are not merely environmental problems but a core development issue.

Disaster Risk Reduction

Seychelles experiences relatively few major natural disasters, and Disaster Risk Reduction is a relatively new concept there. It has only emerged recently, and is gaining ground at national and community levels in the wake of the December 2004 Indian Ocean tsunami (Chang Seng and Guillande, 2008). Following this event, Seychelles initiated a project as part of the flash appeal financed by UNDP, to develop a comprehensive Early Warning and Disaster Management System and to build capacity for DRR. Existing projects to improve key tools, methods and interventions in DRR are detailed below.

Disaster management committee

A National Disaster Committee (NDC) was established in the late 1990s. NDC membership is restricted to government officials, with the exception of the Red Cross Society of Seychelles. The NDC only generally meets when a disaster occurs. Despite some very recent project interventions, the structure and composition of the NDC has not changed significantly. It is still a top-down arrangement with high-ranking representatives from the government authorities. There are no professional citizens and private participation in the steering committee. This type of participation closely reflects the old paradigm of disaster management.

Department of Risk and Disaster Management

In 2007, the Department of Risk and Disaster Management (DRDM) was established under the Office of the President. The DRDM hosts a number of committees which include a variety of stakeholders. The DRDM Secretariat also manages the day-to-day activities of the National Disaster Committee. The DRDM was recently transferred from the Office of the President to the Vice President's Office. In 2010, the DRDM eventually settled within the Ministry of the Environment. This institutional shift within the government gives the initial impression that DRR has become an integral part of environmental policies, plans and sustainability. However, the lack of a DRM law or supporting regulations diminishes the authority of the DRR department, and the fact that it is embedded within the larger superstructure of the Ministry of the Environment threatens its capacity, as it lacks the financial resources to carry out its task effectively.

National and district platforms

A national platform for DRR was launched in October 2005 in the presence of UNISDR. District platforms have also been created, which provide an initial response to emergencies and disasters and ensure an immediate response at the local level. However, if there is to be adequate coordination of response, relief and rehabilitation during emergencies and disasters, substantial, legitimate disaster management organizations will be required at national and local level (i.e. national and regional emergency operations centres), supported by clear standard operating procedures.

Disaster management policy and law

An initial draft of Disaster Management (DM) policy was written in 2006, and was revised in February 2008 by an external consultant under the auspices of the UNDP Early Warning and Disaster Management System project. The government will need to adopt and implement this DM policy, which should guide the establishment of a permanent disaster management process in the country, where risk identification and reduction, preparedness, mitigation and recovery are planned, implemented and evaluated. A DM law has also been drafted, but its actual status and stage of implementation is unclear. Other legislation within the sector contributes to DRR, including the Regulation on Petroleum Product Act, the Police Act, the Public Health Act, the Seychelles Ports Authority Act, the Civil Aviation Act, the Forest Conservation Act, the State Land and River Reserve Act and the Meteorological Act.

Contingency planning

A UNDP assessment concluded, with very few exceptions, that there are no contingency planning tools or methods in the country. Good plans were designed in the past, but are now obsolete or lost, or they are not followed in the event of an emergency. There have been recommendations for implementing a contingency planning framework and a permanent contingency planning process which will produce, update, test and follow contingency plans. Recommendations have also been made for contingency planning for each of the emergency response functions.

Insurance and funding mechanisms

Currently, only the insurance scheme developed by the National Communication Project would provide any timely relief in the event of disaster-related losses. The DRR project, however, recommends the establishment of a National Disaster Trust Fund to give prompt assistance to areas and people affected by emergencies and disasters, and to provide clear and adequate criteria and mechanisms for accessing and using the National Disaster Trust Fund when a disaster occurs in the country.

Identification and Understanding of Risk

The UNDP project has conducted a first comprehensive risk assessment in Seychelles for a number of hazards and how they are likely to be modified under Climate Change conditions (Chang Seng & Guillande, 2008). For example, analysis shows the extent of flooding in the islands caused by the effects of global warming, Climate Change and rises in sea level. The assessment will help to improve disaster management activities in Seychelles.

Disaster preparedness and emergency management

To stimulate a culture of resilience to disaster, a public awareness strategy was initiated and developed in 2005 under the leadership of the National Meteorological Services (NMS), in the wake of the tsunami disaster. Education and awareness activities started with national events which were open to the public, workshops, school competitions, posters, leaflets, national TV programmes, etc. The participation of the Red Cross through a 1991 directive has become an important asset in disaster preparedness and emergency management in the country.

District contingency planning during the UNDP project equipped all districts on the main islands with a community-based disaster plan, and an exercise was simulated in each district (Hasan, 2009). The main activities involved a number of agencies such as the Police, schools, health authorities, and the District Administrator for Community Development.

Early Warning Systems

The National Meteorological Services act as the official national Early Warning centre for hydro-meteorological hazards such as cyclones. The Meteorological Office plays a key role in issuing prompt and punctual warnings to the Department of Risk and Disaster Management for operational purposes. Following the Indian Ocean tsunami, an interim Multi-Hazard Colour Warnings System tool was developed and implemented after capacity-building training in Japan. This proved an effective and successful tool when an intense tropical cyclone made direct landfall for the first time on the outer islands, and a group of inhabitants had to be evacuated by air at night. However, a group of six men were instructed to remain on the island. They took refuge in a drained concrete water tank (Figure 2). On another island, eight workers had to survive the ordeal of the tropical cyclone as they could not be evacuated by air.

Following this intense tropical cyclone disaster, EWS tools were systematically improved under the UNDP project by carrying out a risk and disaster assessment, paying close attention to the potential effects of Climate Change. This allowed a revision of hazard thresholds (i.e. tropical cyclone maximum wind speed, probable maximum rainfall) for Early Warning processes and development planning. EWS emergency procedures and simulation exercises were also improved with the help of the Asian Disaster Preparedness Centre (ADPC).

Figure 2: Concrete water storage tank, drained to create a shelter from intense cyclone Bondo | Source: DRDM, 2007

However, despite these project interventions and the adjustment of technical tools, the NMS lacks authority and resources, as it became a small section within the Ministry of the Environment when it was transferred from the former Directorate of Civil Aviation in the Ministry of Transport and Tourism in the late 1990s. A critical lack of specialized human resource capacities, legitimate institutional structures and proper observation systems make it difficult to create an effective and sustainable multi-hazard EWS. Moreover, the NMS has not evolved structurally or in the way it provides services to its clients. Its location inside the restricted area of the International Airport decreases its visibility and capacity to function as a modern centre capable of outreach to different target groups and the general public.

Reduction of underlying risk factors

In Seychelles, Disaster Risk Reduction is seen as an integral part of environmental policies and plans. The responsibilities of the Environmental Protection Act include preventing hazards that could harm the environment and reducing underlying environmental risk factors. There is general consensus that DRR activities are linked to the National Development Plan, 2006 – 2010, and the EMPS, 2000 – 2010, which advocate sustainable economic growth and involvement of all stakeholders in the development process. In this capacity, the Town and Country Planning Act is also an important instrument in limiting the impact of disasters on development. Project interventions have recommended that guidelines for development within zones of known risk be integrated into the planning process. For example, one policy recommendation strongly advocates that the government build bunkers on outer islands threatened by natural hazards such as cyclones and strong winds, for the safety of visitors and workers on those islands. However, these policies are weak and are not properly enforced. The key problem is that risk and disasters are increasingly viewed not as an environmental problem but as a core development issue. The actors and institutions involved in planning and development require stronger institutional tools to reduce underlying risk factors and to allow proper mainstreaming of DRR in reconstruction plans and development. Existing structural and institutional arrangements are not adequate for addressing current and future problems or challenges. The government needs to establish proper organizational and legal frameworks, supported by proper guidelines for Disaster Risk Management.

Summary of Seychelles case study and recommendations

Some of the experiences of Climate Change Adaptation in Seychelles could be transferred to Disaster Risk Reduction and vice versa. Donor project interventions have provided a window of opportunity for developing new tools and methods to build resilient and adaptive capacities, especially in terms of hazard, climate impact assessments, national education and awareness. Overall, however, links between DRR and CCA remain weak and need to be strengthened institutionally, especially in terms of addressing core development issues. Most of the existing tools and methods need to be modified and improved for use in CCA.

5.2 Manizales, Colombia

Manizales is a city in the Colombian Andes, 2,100 metres above sea level, with 380,000 inhabitants (Figure 3). It is characterized by volcanic soils, high slopes, high precipitation influenced by the Intertropical Convergence Zone (ITCZ) and seismic activity. The population has become more vulnerable by expanding onto the surrounding slopes (Figure 4), driven by increasing population pressure. As a consequence, ever more frequent and widespread landslides have been affecting the city, endangering not only the poorest neighbourhoods but also economically medium and upper class areas.

There have been a number of other disasters in Manizales, such as earthquakes, floods, and ash clouds from volcanic eruptions. The city has developed a variety of DRR strategies and tools for combating these hazards. Historically, the problem of earthquakes has been addressed by using resistant construction methods, by integrating construction codes into planning, by accomplishing studies and works for erosion control or hillside protection, by creating the Municipal Office for Disaster Prevention and Attention (OMPAD), and through the work of the universities in the city. As a result, DRR strategies have been developed continuously from 2003 to the present.

Alongside this, stronger relationships have been established with the environment, such as traditional coffee growing in the region, the use of bamboo (*guadua*) and wood for traditional constructions (*bahareque*) and recognition of the importance of protecting water resources at the institutional level. 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 vari-

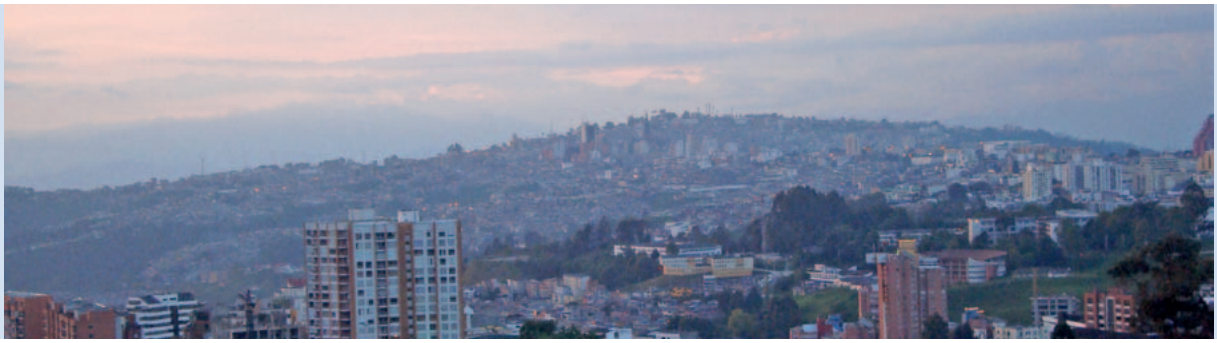


Figure 3: View of Manizales | Source: Dora C. Suarez

Figure 4: Settlements on the hillsides | Source: Dora C. Suarez

Figure 5: Erosion control and stabilization work in Manizales | Source: Dora C. Suarez

ables 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.

DRR tools and methodologies identified in Manizales

A number of programmes, activities and instruments have been developed connected with climate-related hazards in Manizales (i.e. landslides and floods in some areas of the city), and these can be considered tools and methods for DRR. They are outlined as follows:

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 '90s, 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 nearly 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 funding the automatic rainfall observation system, as it is an essential component in Early Warning processes. The network of hydro-meteorological stations consists of 16 rural stations and 2 rural-urban stations (11 of these are funded by the Mayor's Office, two by the University of Colombia, one by Enterprise for Waste Management and two by the regional environmental agency).

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.

Prevention and regulation in urban planning (local government):

Studies of areas vulnerable to landslides have been incorporated into the Territorial Ordering and Land Use Plan (POT), an instrument used by the Mayor's Office for creating legislation on land use and construction in the city. These

Figure 6:
Field Work within the "Guardians of the Hillsides" Project. | Source: Lina María Trujillo Gálvez.

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*", addressing hillside problems by developing erosion control and hillside protection works.

When a state of emergency was announced in the city in 2003, the regional environmental agency and the national government financed studies and implemented better erosion controls and protection works (Figure 6). 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.

«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 DRR. The Guardians are a group of 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.

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

Figure 7

EMERGENCY RESPONSE

RESCUE AND SECURITY	HEALTH AND SANITATION	SOCIAL ASSISTANCE	INFRASTRUCTURE AND ENVIRONMENT	EMERGENCY MANAGEMENT	LOGISTICS
INSULATION AND SECURITY	PRE-HOSPITAL MEDICAL ATTENTION	CENSUS	EVENTS MONITORING	INTER-INSTITUTIONAL COORDINATION	EQUIPMENT AND PROPERTIES
SEARCH AND RESCUE	HOSPITAL ATTENTION	TEMPORAL SHELTER	EDIFICATION DAMAGE ASSESSMENT	PUBLIC INFORMATION	COMMUNICATIONS
FIRES CONTROL	MENTAL HEALTH	FOOD AND SUPPLIES	RUBBLE	LEGAL ISSUES	TRANSPORTATION
TECHNOLOGICAL RISKS	ENVIRONMENTAL SANITATION	COMMUNITY WORK	VITAL LINES	FINANCIAL ISSUES	INFORMATION SYSTEMS
EVACUATION	EPIDEMICS CONTROL		ENVIRONMENTAL IMPACTS	WARNINGS	DONATIONS AND SUPPLIES
	MANAGEMENT OF DEAD BODIES				VOLUNTEERS MANAGEMENT

Emergency planning scheme in Manizales, Colombia

process did not imply forced relocation, but rather was carried out on a voluntary basis.

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

The Local Emergency Committee was established in 2000, in accordance with the National Office for Disaster Prevention and Attention (1989). The committee consists of the Mayor, heads of local government Secretariats (planning, public works, health and education), 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 (see Figure 7). 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 300mm of cumulative precipitation, an orange alert to thresholds between 300 and 400mm, 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.

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 DRR activities in Colombia, because of its integrated and inter-institutional approach.

Multi-hazard 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.

Climate Change in Colombia and activities in Manizales

Colombia approved the United Nations Framework Convention on Climate Change (UNFCCC) through National Directive 164 in 1994, and approved the Kyoto Protocol in 2000 through National Directive 629. The country has had two national communications on Climate Change, the first in 2001 and the second in 2010.

According to IPCC projections, the annual mean warming in the A1B scenario from 1980 to 1999 and from 2080 to 2099 varies in the Amazonia region from 1.8°C to 5.1°C, with half of the models within 2.6°C to 3.7°C and a median of 3.3°C. It is not clear how annual and seasonal mean rainfall will change over northern South America, including the Amazon Rainforest. In some regions, there is qualitative consistency between simulations (rainfall increasing in Ecuador and northern Peru, and decreasing at the northern tip of the continent and in the southern part of North-East Brazil) (IPCC, 2007a).

Climate Change projections made by the Institute for Hydrology, Meteorology and Environmental Studies (IDEAM) for the first national communication in 2001 show an increase in the annual mean temperature of between 1 and 2°C, a variation in precipitation of $\pm$ 15%, 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 a rise in sea level of about 40 cm on the Caribbean coast and 60 cm on the Pacific coast. 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.

Climate Change mitigation: The "Procuenca" reforestation project

The project covers 15,000 ha in rural lands around the Manizales urban area, and includes other municipalities located in the Chinchiná River Basin. *Procuenca* started in 2000 as an inter-institutional programme coordinated by FAO, and was developed as an agricultural and social alternative for the region around Manizales. It was approved in 2010 as the first Clean Development Mechanism (CDM) in the country to earn Certified Emission Reduction status (CER). The primary aim of the project was to promote reforestation and improve land use. As the forest grows, it will protect these areas by regulating the quantity and quality of fresh water in the region.

Activities have focused on agreement processes with landowners (i.e. peasants, urban investors and other owners of productive lands in rural areas), administrative and legal procedures for agreements between the landowners and the programme, technical support, development of a landowners' association and training for the communities involved in the programme. The director of this project recognizes that there are CCA elements within mitigation actions such as hydrological cycle recovery, biodiversity conservation, awareness and land use change.

Climate Change, monitoring impacts: the retreat of glaciers

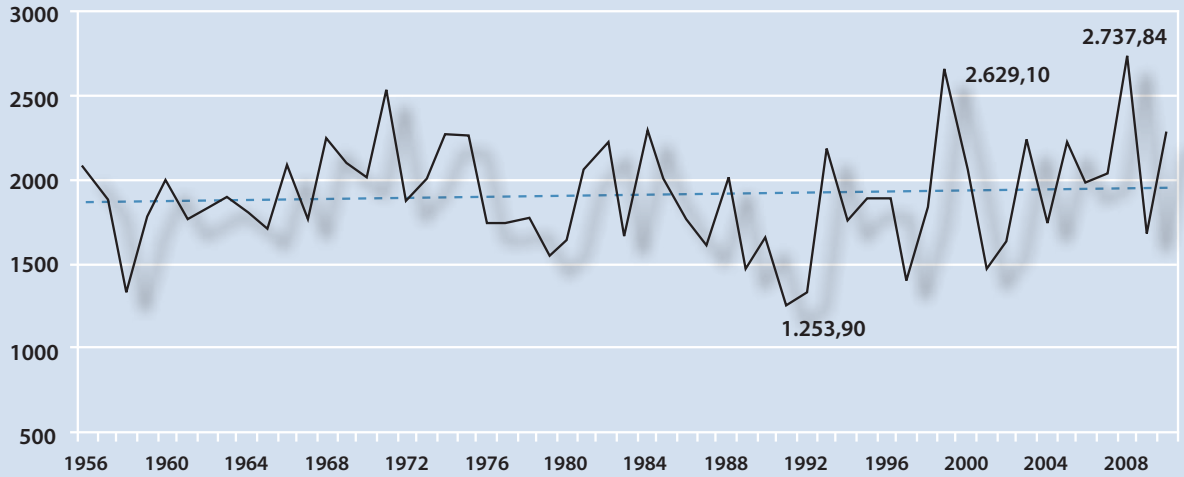
Glaciers have been disappearing from the peaks of volcanoes in the *Los Nevados* (meaning " snow-covered volcanoes") National Natural Park in the Andes, 28 km from Manizales. The glacier retreat is being monitored, and the Institute of Environmental Studies (IDEA) in Manizales has been working on the installation of monitoring stations. The data is collected directly by *Corpocaldas* (the regional environmental agency). The agency recognizes that it needs to develop more activities for analysing data specially regarding the effects on the region's water supply. At national level, institutions such as universities and the Institute for Hydrology, Meteorology and Environmental Studies (IDEAM) have also been studying the retreat of the glaciers in this natural park.

Climate variability or Climate Change impacts?

There is ongoing discussion about the way in which Climate Change currently impacts on weather patterns in Colombia. El Niño and La Niña affect seasonal and annual rainfall. In the case of El Niño, rainfall is lower than normal, whereas it is higher than normal during La Niña. A lack of historical data makes it difficult to establish whether recent events

Figure 8

Annual Cumulated Precipitation (mm) from 1956 to 2010, Manizales – Colombia



Annual cumulated rainfall from 1956 to 2010, Manizales, Colombia | Source: data from the Institute of Environmental Studies (IDEA)

have been driven by Climate Change. This can be observed in Manizales, where the annual cumulated precipitation from 1956 to 2010 (Figure 8) shows an increase in annual precipitation, with annual cumulated precipitation extremes in 1999 and 2008.

In fact, in May 2008 the city suffered its worst 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, and an inter-institutional workshop held in the area identified future challenges. One of the lessons was to consider the possibility of taking Climate Change into account in assessing impact on rainfall in rainy seasons.

However, at national level, awareness and understanding of risk differs from the situation in Manizales. In 2010, La Niña extended the rainy season in Colombia from September 2010 to January 2011, and increased precipitation levels, causing massive flooding and landslides in the country.

The Ministry for Internal Affairs, through the Disaster Risk Management National Office, reported 1,609 emergencies, with 284 human fatalities, 267 people injured, 62 people missing, 2,155,386 people affected (443,888 families), 3,173 homes destroyed and 310,351 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) by a tornado. Overall, 702 municipalities were affected in 28 departments. The disaster was considered the worst rainy season in Colombia, and the President linked it to the effects of Climate Change. The response effort and reconstruction plan have posed a real challenge for the national government.

Challenge of DRR tools in Manizales regarding CCA

On the basis of its experiences, the city of Manizales has built a certain level of resilience to a number of natural hazards and disasters. It has the potential capacity to adapt to Climate Change too. A key point is the historical process embedded in the disaster risk practices and tools, as this has facilitated the improvement of traditional construction, the development of institutional capacities, inter-institutional co-operation and multi-sectoral work, and has built coordination and trust at local level.

The interviews with actors and researchers highlighted the key challenges to be considered in future:

- **Hydro-meteorological monitoring** at the university: It will be important to analyse changes in extreme rainfall events and redefine work for protection and control of erosion curves (periods of return, security factors);
- **Regional environmental authority agency**: Analysis of data collected on melting glaciers on the snow-capped volcano El Ruiz will help determine probable future risks;
- **Inter-institutional Early Warning**: Thresholds for accumulated precipitation and particular rainfall events should be discussed and redefined to improve warning information (yellow, orange and red);
- **Climate Change mitigation programme**: Seek ways to integrate the *Procuenca* project into CCA activities, starting by developing indicators with the regional environmental agency to assess improvements in disaster reduction and hydrological cycle regulation;
- **Urgent need to improve internal awareness** about Climate Change and CCA, and to reinforce public communication through education and awareness activities on DRR and CCA as part of the environmental education process.

6. Mechanisms, criteria and indicators for enhancing and monitoring the linking process

KENYA:

Mau Forest Nakuro Province. A provincial school involved in the Green Belt Movement Reforestation Project.

This chapter builds on the results presented earlier, and addresses ways of identifying important mechanisms, quality criteria and recommendations on how to improve tools and methods currently used in Disaster Risk Reduction (DRR) for use in Climate Change Adaptation (CCA). The first part of the chapter deals with general mechanisms which should be considered when improving the links between DRR and CCA, and the second part presents an initial list of criteria for determining the quality of tools for monitoring improved links between DRR and CCA.

6.1 Mechanisms for enhancing the linking process

Mechanisms for enhancing effective cooperation and linking between DRR and CCA involve common issues which are seen as important underlying aspects, and which can help to bridge the gap between DRR and CCA.

Multidisciplinary approaches, exchanges and learning

Improved mechanisms for exchange and learning between different stakeholders in DRR and CCA involve interactions at different levels and scales, and encompass a cross-section of experts in a variety of fields, from social science to natural science and engineering. These experts come together to share knowledge and experiences through meetings, conferences, global platforms and web-based tools. Compared to existing national DRR platforms, CCA strategies lack these multi-stakeholder platforms. New mechanisms should also promote an institutional structure where these multidisciplinary exchanges and learning processes can take place. In this respect, it will be important to ensure that national platforms for CCA are closely linked to existing national platforms for DRR.

Institutional settings to integrate DRR and CCA

Another mechanism or option to enhance the linking process between DRR and CCA can also be seen in the integration of DRR into environmental policies and plans. Particularly the case studies of Manizales and Seychelles have shown that through the integration of DRR issues into the environmental administration synergies between CCA and DRR could be realized. Furthermore, the integration of DRR and CCA in the overall development planning and development plans can also be a vehicle to enhance the linking and joint application of adaptation and risk reduction.

Financial mechanisms

Financial mechanisms for DRR at country level basically involve public investment processes and reserve funds to address emergencies and complementary risk transfer strategies.

Specific projects can apply for sector-specific funds through international organizations and agencies (donors). These external funding sources can help to adapt a project to Climate Change more effectively by promoting continuity from short to medium-term at policy level, and also by extending the budget and funding schemes into a longer-term arrangement. Financial mechanisms could also be improved by providing adaptation funds and establishing common financial mechanisms to support local actions, build local capacities, improve infrastructure and restore the environment. The experts we interviewed identified the need for improved common financial mechanisms: "*…. In Cancun, DRR was recognized as an integral part of adaptation, which means that programmes and plans for adaptation funding can include DRR activities. It has to be recognized as part of the political framework... so now the call for adaptation action plans in Cancun will systematically involve DRR in these plans.*" (Interviewee 10, 21st December, 2010).

Other ideas include the creation of a direct CCA fund for improving infrastructure and for environmental restoration, as well as a banking system for livestock management that will ultimately make the area more resilient.

Insurance

Insurance mechanisms are considered as an important tool for CCA by most of the experts interviewed. Challenges still exist in the evaluation of the practical efficiency and applicability of such tools in developing and least developed countries. Particularly the low capability of people in least developed countries to pay additional fees is seen as a limiting factor. Moreover, it is important to take into account that better insurance policies can be applied when scientific studies can define **probable losses** in different hazard scenarios. However, such studies are difficult and expensive to develop. In general it can be concluded, that risk transfer is an important tool among others. Furthermore, according to the expert interviews, there is a weather index insurance based on temporal recurrence of climatic events. This new tool is promising and could be important for climate risk management, but it is still in the experimental stage.

Effective communication strategies

There are different levels of communication between Disaster Risk Reduction and CCA activities. Communication between scientific communities (scientific actors, government authorities, communities at different levels and geographical scales) needs to be clear and easily understandable. This was emphasized in the expert interviews: "*…once a year there is more or less one international workshop with the NGO heads, however, the heads of NGOs have limited knowledge of the local conditions and capacities. They lack capacities for communicating and disseminating the information. Very short consultation with international actors is inadequate. There is a need for more in-depth fieldwork to understand local conditions and to support staff in promoting, disseminating and communicating knowledge and information through some kind of communication expert.*" (Interviewee 11, 21st December 2010).

On the basis of the above outline, the following section will summarize important findings in terms of quality criteria for improving linkages between DRR and CCA (see Table 2).

6.2 Criteria and indicators to monitor the linking of DRR and CCA

Table 2 presents an overview of key criteria and recommendations identified in the expert interviews, the literature analysis and the expert workshops conducted within the scope of the study.

Components of DRR	Criteria
Identification and understanding of risk	• Multi-risk assessment with consideration of Climate Change; • Scenarios of hazard and societal development in the light of Climate Change (hazard and vulnerability scenarios for different time and spatial scales); • Urban and rural linkages (improved consideration of interrelations between rural, peri-urban and urban areas in terms of risks and adaptation);
Reduction of underlying risk factors	• Reinforcement of infrastructures and consideration of climate "proof" characteristics in housing; • Flexibility in planning and development strategies (ensure the ability of readjustment when Climate Change might manifest differently); • Integration of DRR measures into development plans that include CCA aspects;
Disaster preparedness and emergency management	• Multi-hazard EWS (slow- and sudden-onset hazards and their interaction or combination); • Consideration of Climate Change impacts on strategies for the Last-Mile; • Multi-Hazard contingency planning;
Institutional capacities and financial mechanisms	• Common funding sources and mechanisms; • Multi-level frameworks (cooperation between different actors– national–local and multi-level commitments to DRR and CCA); • Multi-stakeholder participation (Existing DRR platforms also provide an institutional structure for bringing together CCA stakeholders from different institutions); • Multi-disciplinary approach in DRR and CCA strategies; • Good governance in DRR and CCA (Transparency, accountability etc); • Financial tracking of project financed by DRR and CCA;
Cross cutting issues	• Effective communication (Feedback mechanisms between actors and the communities); • Multi-level linkage; • Exchange and learning (Best practices between regions, countries and communities); • Ensure that international documents also mention specific tools of DRR for CCA in order to promote the allocation of funds for its implementation.

Table 2: Criteria and indicators to monitor linking between DRR and CCA

7. Summary and Recommendations

THE NETHERLANDS:

House construction adapted to rising water levels.

The study has provided important insights into tools and methods used in Disaster Risk Reduction, and how they can be improved for Climate Change Adaptation. Tools and methods that address underlying risk factors, and that deal with risk identification and improve risk communication and Early Warning, are seen as core issues for Climate Change Adaptation. It will also be important to strengthen institutional capacities (framework conditions) in order to improve the links between DRR and CCA. However, it would have to be acknowledged that the specific value of methods and tools also differs from region to region and also depends on the hazard in question. In addition, the experts we interviewed emphasized that it does not depend so much on the tools, but on how they are used and how they are interpreted in the decision-making process. Likewise, if we are to manage them effectively, we should be careful not to put forward too many tools and methods, but rather seek ways to streamline them into existing mechanisms.

Key criteria have been identified for monitoring progress in linking DRR and CCA (see Table 2). However, the particular criteria for linking DRR and CCA methods and tools will also depend on the specific country, its historical context and the anticipated Climate Change risk in which DRR and CCA have developed (see case study examples). Taking into consideration the various stakeholders and users who are in a position to apply the criteria, we can make the following recommendations:

For international organizations and donors:

- Improve exchanges (i.e. joint mechanisms for tracking lessons learned and finances) between UN agencies, international organizations, national authorities and civil society, and develop common DRR/CCA projects with the aim of coordinating information from different scientific organizations into easily understandable, clear language for all stakeholders in countries and communities at risk;
- Donors need to consider extending the timescale for DRR funding schemes;
- DRR and CCA need to be integrated into bilateral and multilateral agreements. This is a precondition of receiving funding;
- The effectiveness of Early Warning Systems should be reviewed in the light of new creeping and sudden-onset hazards linked to Climate Change. For example, the compendium "Developing Early Warning Systems: A Checklist" (an outcome of EWCIII 2006) be updated in view of CC (integrating Climate Change as a concern as well as incorporating performance measures for EWS).
- It will be important to include Climate Change issues for improving risk information and EW in the UNISDR 'Guide for Implementing the Hyogo Framework for Action'.

Multilateral organizations (e.g. World Bank (global facility For Disaster Risk Reduction), Asian Development Bank, Inter-American Development Bank, etc.)

- Improve distribution of funding, and to increase public investment at national level, promote cost-benefit analysis at country level, and probable loss analysis for multiple risks from Climate Change. This information is particularly useful for the development of risk transfer strategies and insurance policies;
- Timescales should be extended for DRR and CCA projects, loans and funding;
- Links and synergies between DRR and CCA need to be strengthened. Adaptive DRR should be added as a new dimension in existing programmatic tools and methods. This will also mean standardizing the norms used to account for Climate Change risk (e.g. norms for climate proofing, vulnerability and capacity assessment (VCA) etc.) in different measures and programmes.

National government

- National governments should strengthen both agendas in their national policies and support them with adequate institutional capacities (i.e. appropriate legal frameworks, guidelines, structures, financial incentives and mechanisms) at all levels as a continuous and interrelated process for both DRR and CCA;
- Multisectoral platforms for DRR should be reinforced, and community participation should be promoted to achieve a sustainable system of interlinked DRR and CCA at a number of different levels. For example, national DRR platforms and committees should include CC specialists, CCA experts and environmental delegates in the decision-making process, and vice versa;
- National governments need to improve decision-making processes by using vulnerability and risk assessments which acknowledge CC and CCA. They should be mainstreamed into ministries, sectoral plans, policies and public investment. In addition, effective management will require DRR and CCA tools to be integrated into existing programmatic tools and methods (i.e. vulnerability & risk assessments in the context of CCA as part of environmental impact assessments and development plans);
- National and local stakeholders should prepare a set of Climate Change and social development scenarios in order to translate general Climate Change scenarios into risk profiles that can serve as a basis for policy-making on different scales;
- In addition, national and local risk and vulnerability assessments should be based on scenarios which take into account potential pathways of climatic conditions at local and regional level, and also the impact on different types

of hazard. As well as developing hazard scenarios for Climate Change, it will be equally important to reinforce methods and tools for developing scenarios for social and socio-economic development pathways, in order to identify trends and scenarios for vulnerability. Integrated risk assessment for Climate Change can only be successful if a combination of hazard and vulnerability scenarios is used.

- It will be necessary to improve the visibility and acknowledgement of bottom-up approaches in national policies, as policies and programmes are validated in terms of their effectiveness and relevance at the local level.
- Improve risk communication between national experts/agencies and local communities. Bottom-up and top-down approaches need to be considered;
- Strengthen DRR and CCA links between rural and urban areas in terms of practices in agriculture, water sectors, etc., and in terms of reinforcement, building new infrastructures, land use and territorial and emergency planning.

Local government and communities

- Good experiences should be shared, replicated and extended to other communities, regions and countries;
- Collaborate and strengthen cooperation with universities in terms of information about hazards, vulnerability and appropriate risk assessments for EWS frameworks (as indicated in the Manizales case study);
- Make use of different types of knowledge in Early Warning Systems, particularly in terms of linking expert and local knowledge;
- The effects and impacts of Climate Change should be acknowledged in emergency and reconstruction plans as part of disaster preparedness and emergency management systems. To build adaptive capacities, local governments need to be flexible in reviewing and updating these plans on a regular basis.

Scientific communities

- Scientific communities should prepare a set of Climate Change and social development scenarios in collaboration with the national government in order to translate general Climate Change scenarios into risk profiles that can serve as a basis for policy-making on different scales;
- To enhance the scientific knowledge on how Climate Change scenarios can be translated into hazard profiles, modified exposure and risk distribution and development of risks;
- To improve tools and methods used in DRR for use in CCA, there is a need to consider Climate Change scenarios in risk and vulnerability assessment and to conduct multi-hazard assessments on a longer timescale as part of the risk identification process;
- International scientific communities need to seek ways of analysing how information on Climate Change and vulnerability can be better used and applied, and ways of looking for opportunities to link it with other results from different disciplines.

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9. Annex

9.1 Experts interviewed

The comments of the experts are their personnel expressions of their opinion and not represent in anyway their institutional point of view.

Thorsten Klose (22nd November): Advisor for Disaster Risk Reduction for the Red Cross Germany; Berlin, Germany.

Maarten van Aalst (7th December): Climate Specialist at the Red Cross Climate Centre, one of the lead authors for the WGII AR5 of the IPCC; the Hague, The Netherlands.

Juan Pablo Sarmiento (26th November): He is now managing the program Florida International University, FIU-USAID, OFDA, for disaster risk reduction; Florida, USA.

Arthur Webb (30th November): Program Manager for the Program Oceans and Islands, at SOPAC (Pacific Island Applied Geosciences Commission); Suva, Fiji Islands.

Maxx Dilley (3rd December): He has a background in risk assessment (Hot spots report). He is leader of the Disaster Risk Reduction and Recovery Team at the Bureau for Crisis Prevention and Recovery, BCPR, at the UNDP; Genève, Switzerland.

Alice Balbo (6th December): Conference and Project Officer, she has been involved with the resilient cities program, cities and adaptation to Climate Change, at ICLEI (Local Governments for Sustainability; Bonn, Germany.

Melissa Stults (12th December): Climate Adaptation Manager at ICLEI (Local Governments for Sustainability); Washington D.C., USA.

Marcus Oxley (14th and 16th December): He is chairman of the Global Network of Civil Society Organizations for Disaster Reduction which is a major international network of civil society organizations committed to working together to influence and implement disaster risk reduction policy and practice at the local, national and international levels through a network of 600 people from 300 organizations in 90 countries are already involved; Teddington Middlesex, UK.

Kristie L. Ebi (17th December): Researcher on the impacts and adaptation to Climate Change. Lead author on the "Human Health" chapter of the IPCC Fourth Assessment Report (AR4), and head of the Working Group II Technical Support Unit for the AR5; Los Altos, USA.

John Harding, (21st December): Head of ISDR's Policies and Practices Unit; Genève, Switzerland.

Ingrid Hartmann (21st December): Affiliations and representative at the CRIC Sessions of the UNCCD (Convention to Combat Desertification) in Rome and Bonn for World Resources Institute and various NGOS; Berlin, Germany.

Michael Siebert (27th December), GTZ: Head of DRR program, coordinator of capacity building for the German Indonesia tsunami Early Warning System program; Bonn, Germany.

Xianfu Lu (25th January, 2011): UNFCCC Secretariat, implementation for Nairobi program. She has a back ground in climate risk assessment, climate scenarios for vulnerability adaptation assessments; Bonn, Germany.

Milen Dyoulgerov (21st January, 2011) World Bank: He is responsible for strengthening the synergy between Climate Change Adaptation and the Disaster Risk Management in Bank operations; Washington D.C., USA.

Bernardo Sala and Gianluca Azzoni (21st January, 2011), Europe Aid, Directorate General for Development and Cooperation (DG DEVCO) of the European Commission: Policy officers; Brussels, Belgium.

Carlos Alberto García, (28th December): Director of the Major Office for Disaster Prevention and Attention, OMPAD; Manizales, Colombia.

Juan David Arango, (27th December): Director of the Environmental Agency Authority at the regional level, Corpocaldas; Manizales, Colombia.

Omar Dario Cardona, (23th December): Disaster Risk Management expert, researcher at the National University of Colombia, international consultant for IDB and WB, one of lead authors at the WGII AR5 of the IPCC; Manizales, Colombia.

Fernando Mejia, (13th December, 2010): National University of Colombia, Institute for Environmental Studies, IDEA: Former Director. He developed the project for the monitoring of rainfall and Early Warning for landslides with the Major Office for Prevention and Attention, OMPAD.

Jorge Julián Vélez (14th December, 2010): National University of Colombia, Institute for Environmental Studies, IDEA: Director of the IDEA and hydraulic laboratory; Manizales, Colombia.

Blanca Adriana Botero (14th December, 2010): National University of Colombia, Institute for Environmental Studies, IDEA: Researcher; Manizales, Colombia.

John Alexander Pachón Gómez (17th January, 2011): National University of Colombia, Institute for Environmental Studies, IDEA: Coordinator of the project "Meteorological Stations Network for Early Warning and Disaster Prevention in Manizales"; Manizales, Colombia.

Francisco Ignacio Ocampo Trujillo (23rd December, 2010): Director of the Project PROCUENCA: reforestation initiative for the Chinchiná basin. This project has been approved as a mitigation mechanism for CC (CDM), being one of first of this type in Colombia; Manizales, Colombia.

9.2 Participants in Day 2 of the Expert workshop in Bonn February 4th 2011

Saut Sagala, Indonesia
Atta Muhammed Durrani, Pakistan Red Crescent
Antonio Queface, Mosambik
Dak Martin Doleagbenou, Togo Red Cross
Laban Ogallo, ICPAC
Aslam Perwaiz, ADPC
Milen Dyoulgerov, GFDRR
Alice Balbo, ICLEI
Franz Stoessel, SDC
Sabine Dier, CARE
Justin Ginnetti, UNISDR
Thorsten Klose, German Red Cross
Florien Wienecke, KFW
Robert Grassmann, Welthungerhilfe (WHH)
Miwa Kato, UNFCCC
Gottfried von Gemmingen, BMZ
Peter Mucke, Bündnis Entwicklung Hilft
Sven Harmeling, VENRO/Germanwatch

Publisher

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