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SUSTAINABLE WETLAND MANAGEMENT IN THE FACE OF CLIMATE RISKS IN NIGER: THE CASE OF LA MARE DE TABALAK

Prepared by the International Institute for Sustainable Development (IISD)

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CRISIS PREVENTION AND RECOVERY

This report was commissioned by the United Nations Development Programme's Bureau for Crisis Prevention and Recovery (BCPR), under the Climate Risk Management Technical Assistance Support Project (CRM TASP). The International Institute for Sustainable Development (IISD) implemented the CRM TASP in seven countries (Dominican Republic, Honduras, Kenya, Nicaragua, Niger, Peru and Uganda).

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FOREWORD

Climate change has the potential to exacerbate conflict, cause humanitarian crises, displace people, destroy livelihoods and set-back development and the fight against poverty for millions of people across the globe.

For example it is estimated that over 20 million people in the Mekong Delta and 20 million in Bangladesh could be forced to move as their homes are affected by salt water incursion from rising sea levels. Entire populations of some low lying island states, such as Nauru or the Maldives may have to be relocated. In countries like Honduras, where more than half the population relies on agriculture, climate induced risks, such as Hurricane Mitch in 1998, which caused over US$ 2 billion in agricultural losses, will continue to pose a staggering potential for damage. Similarly, climate risk assessments in Nicaragua show that changes in rainfall patterns, floods and drought could put human health at risk by increasing the prevalence of respiratory and water borne diseases and malnutrition.

Long-term incremental changes will mean that people everywhere must learn to adapt to weather or rainfall patterns changing or shifts in ecosystems that humans depend upon for food. Perhaps more worrying however, is that climate variability and change will also bring unpredictable weather patterns that will in-turn result in more extreme weather events. Heat waves, droughts, floods, and violent storms could be much more common in the decades to come. Climate change is "loading the dice" and making extreme weather events more likely. These disasters will undermine the sustainability of development and render some practices, such as certain types of agriculture, unsustainable; some places uninhabitable; and some lives unliveable.

As climate change creates new risks, better analysis is needed to understand a new level of uncertainty. In order to plan for disasters, we need to understand how climate change will impact on economies, livelihoods and development. We need to understand how likely changes in temperature, precipitation, as well as the frequency and magnitude of future extreme weather will affect any sector, including agriculture, water-use, human and animal health and the biodiversity of wetlands.

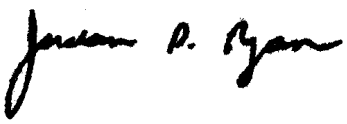
This report is a product of the Climate Risk Management – Technical Assistance Support Project, which is supported by UNDP's Bureau for Crisis Prevention and Recovery and Bureau for Development Policy. This is one in a series of reports that examines high-risk countries and focusses on a specific socio-economic sector in each country. The series illustrates how people in different communities and across a range of socio-economic sectors may have to make adaptations to the way they generate income and cultivate livelihoods in the face of a changing climate. These reports present an evidence base for understanding how climatic risks are likely to unfold. They will help governments, development agencies and even the communities themselves to identify underlying risks, including inappropriately designed policies and plans and crucial capacity gaps.

This series is part of a growing body of climate change adaptation resources being developed by UNDP. The Climate Risk Management – Technical Assistance Support Project has formulated a range of climate risk management assessments and strategies that bring together disaster risk reduction and climate change adaptation practices. The project is designing a common framework to assist countries in developing the necessary capacity to manage climate-induced risks to respond to this emerging threat. The climate risk assessments discussed in this report and others in the series will feed into a set of country-level projects and regional initiatives that will inform the practice of climate risk management for decades to come.

Addressing climate change is one of UNDP's strategic priorities. There is a strong demand for more information. People at all levels, including small communities want to understand the potential impact of climate change and learn how they can develop strategies to reduce their own vulnerability. UNDP is addressing this demand and enabling communities and nations to devise informed risk management solutions. UNDP recognises that climate change is a crucial challenge to sustainable development and the goal of building resilient nations.

As the full effect of climate change becomes apparent, it is assessments such as these that will become the lynchpin of national responses and adaptation strategies for many years to come. Like the threat from many disasters, there is still time to prepare for the worst impacts of climate change in developing countries if we expand our understanding now.

This knowledge must be combined with real preparedness and action at all levels. Only then will we be able to stave off the worst impacts of climate change in the most vulnerable and high risk countries of our world.



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This report, 'Sustainable Wetland Management in the face of Climate Risks in Niger: The Case of la Mare de Tabalak,' was commissioned under the Climate Risk Management Technical Assistance Support Project (CRM TASP), a joint initiative by the Bureau for Crisis Prevention and Recovery (BCPR) and the Bureau for Development Policy (BDP), United Nations Development Programme (UNDP), implemented by the International Institute for Sustainable Development (IISD).

The general methodology and analytical framework of the CRM TASP was conceptualized by Maxx Dilley, disaster partnerships advisor, and Alain Lambert, senior policy advisor, with key inputs from Kamal Kishore, programme advisor, Disaster Risk Reduction and Recovery Team, BCPR, in consultation with Bo Lim, senior climate change advisor, Environment and Energy Group, BDP. Within BCPR, the project implementation process has been supervised by Alain Lambert, Rajeev Issar and Ioana Creitaru, who provided regular inputs to ensure in-depth climate risk assessments and identification of tangible risk reduction and adaptation options. From BDP, Mihoko Kumamoto and Jennifer Baumwoll provided their input, comments and oversight to refine the assessment and recommendations. The overall project implementation has benefitted immensely from the strategic guidance provided by Jo Scheuer, coordinator, Disaster Risk Reduction and Recovery Team, BCPR, and Veerle Vandeweerd, director, Environment and Energy Group, BDP.

The climate risk assessments under the CRM TASP have been undertaken with the funding support of the Government of Sweden.

Building upon the CRM TASP general framework to tailor the process to country-level analysis, IISD developed a more detailed methodological framework for assessing climate risks and identifying climate risk management options in seven countries, including Niger. Within IISD, Anne Hammill supervised the overall project implementation. Julie Dekens supervised all in-country activities in Niger and is the lead author of the present report, with support from Alicia Natalia Zamudio-Trigo and Matt McCandless of IISD and Yahaya Nazoumou, Mahaman Moustapha Adamou and Yacouba Hambally of the University of Niamey.

For their valuable contribution to the project implementation and climate risk assessment process, the project team and lead authors would like to gratefully acknowledge the unstinted support provided by the National Environment Council for Sustainable Development (CNEDD) through the Africa Adaptation Programme (AAP)-Niger, and especially Kamayé Maâzou, Gousmane Moussa, Rouscoua Boubacar, Mahamane Lawali Elhadj and Pierre Bengono of UNDP Niger; Solange Bandiaky from the UNDP Gender team of BDP; the members of the project working group; the communities and officials of Tabalak; and all participants of the workshops.

LIST OF ABBREVIATIONS AND ACRONYMS

AAP	Africa Adaptation Programme
ADPRS	'Accelerated Development and Poverty Reduction Strategy' (document)
BCPR	Bureau for Crisis Prevention and Recovery
BDP	Bureau for Development Policy
CC/SAP	Early Warning System Coordination Unit (Cellule de Coordination du Système d'Alerte Précoce ()
CIA	Central Intelligence Agency
CNEDD	National Environment Council for Sustainable Development (Conseil National de l'Environnement pour un Développement Durable
CRiSTAL	Community-Based Risk Screening Tool – Adaptation and Livelihoods
CRM TASP	Climate Risk Management Technical Assistance Support Project
CVCA	Climate Vulnerability and Capacity Analysis
DNPGCA	National Food Crisis Prevention and Management System (Dispositif National de Prévention et de Gestion des Crises Alimentaires)
EWS	Early Warning System (Système d'Alerte Précoce)
GDP	Gross Domestic Product
HDI	Human Development Index
IFAD	International Fund for Agricultural Development
IISD	International Institute for Sustainable Development
INS	National Institute of Statistics (Institut National de la Statistique)
JAICAF	Japan Association for International Collaboration of Agriculture and Forestry
LUCOP	Nigerian-German Programme to Fight against Poverty (Programme Nigéro-Allemand de Lutte contre la Pauvreté)
MDA	Ministry of Agricultural Development (Ministère du Développement Agricole)
MDG	Millennium Development Goal
MRA	Ministry of Animal Resources (Ministère des Ressources Animales)
NAPA	National Adaptation Programmes of Action
NGO	non-governmental organization
ONAPAD	National Observatory of Poverty and Sustainable Human Development (Observatoire National de la Pauvreté et du Développement Humain Durable)
PDC	'Commune Development Plan' (document)
PPP	purchasing power parity
PRS	'Poverty Reduction Strategy' (document)
SDR	'Rural Development Strategy' (document)
SE/CNEDD	Executive Secretariat of the National Environment Council for Sustainable Development (Secrétariat Exécutif du Conseil National de l'Environnement pour un Développement Durable)
SNC	'Second National Communication' (document)
SWAT	Soil and Water Assessment Tool
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund

EXECUTIVE SUMMARY

Only 12 percent of Niger's land area is suitable for agriculture, which largely depends on irregular rainfall. Since the early 1970s, precipitation levels have fallen at several weather stations, while temperatures have increased at all weather stations studied. At the same time, the country's population currently only uses 1 percent of its water resources, primarily from groundwater. Despite its dry climate and significant spatial and temporal variations in precipitation and temperature, Niger benefits from numerous natural resources, such as wetlands located across the entire country, including in the Sahara zone in the north. These wetlands may be floodplains, ponds, lakes, oasis systems, dallols or basins. They support important agrosilvopastoral systems that are vital in the fight against poverty and food insecurity and in the preservation of biodiversity. This study was conducted to assess climate risks in a specific wetland of Niger and to identify climate risk management options.

The climate risk assessment was conducted in La Mare de Tabalak, in the Tahoua region, 600 km from Niamey in the northeast, in the Sahelian zone. It is a natural freshwater pond, which became permanent in the 1950s, with a surface area of 7,713 ha. It fills during the wet season with surface run-off from a vast watershed that covers around 142,000 ha across six different communes. In 2001 the watershed's population was just under 42,000, with an average population density of 30 people per km^2 and an estimated annual population growth rate of 2.7 percent. Agriculture and livestock farming are the main livelihood activities, and the pond is also one of Niger's 12 Ramsar sites due to its important biodiversity (birds and plants). Data collection and analysis was based on field surveys in three villages in the commune of Tabalak, including 17 focus groups, questionnaires given to 16 households, interviews with 20 households, hydrological modelling using the SWAT (Soil and Water Assessment Tool) model and national stakeholder consultations.

The results highlight that the pond and its inhabitants are highly vulnerable to recurring droughts, which contribute to reduced water levels and, in turn, falling production from all agrosilvopastoral activities and recurring food crises (famines). Although floods damage infrastructure, the local population associates them with an abundant water supply that enables increased production and fishing levels. The negative effects of climate hazards are exacerbated by environmental degradation, population growth, continued silting of the pond, invasive plant species, lack of coordinated resource management across the watershed, conflict and insecurity, and poverty. The SWAT model predicts that the water level in the pond is likely to vary less in the future, because the climate change scenarios are less variable than historical climate records. Further analysis of climate change projections is required to validate this conclusion. Despite these challenges, the pond has a number of assets that help the local inhabitants diversify their livelihoods, develop small-scale irrigation, and perform environmental protection and restoration activities. But these responses are insufficient: local inhabitants often turn to strategies of last resort, which increase the vulnerability of the entire socio-ecological system to hazards (including climate hazards).

Based on these results, key stakeholders at national and local levels identified four priority actions to ensure sustainable management of La Mare de Tabalak and similar wetlands in the context of climate risks:

- Improve governance of the pond through joint resource management by the communes within the watershed.
- Introduce a regular, continuous system to monitor and survey environmental and socio-economic conditions within the watershed.
- Consolidate and accelerate environmental restoration and protection actions.
- Build capacity of relevant actors to support the development, implementation and monitoring of the above actions.

To facilitate implementation of these actions, a strong national governance framework is required, including the need to:

- Consolidate climate risk management capacities and actions at all levels.
- Promote synergies in climate risk management, such as between the National Environment Council for Sustainable Development (CNEDD), responsible for climate change adaptation, and the Early Warning System Coordination Unit, responsible for disaster risk reduction.
- Finalize and adopt the national wetlands policy and develop synergies between this policy and the strategic planning documents currently under revision, such as the 'Accelerated Development and Poverty Reduction Strategy.'
- Implement the Ramsar Convention and broaden the scope of wetland management plans at the watershed level.
- Mainstream gender issues into all climate risk initiatives.

Further research is also needed to provide detailed climate risk assessments focusing on gender-related issues, validation and further analysis of climate projections, and economic assessments of the goods and services of the country's wetlands. The current study could also be replicated in other similar wetlands in Niger and across the region.

INTRODUCTION

Climate risk management (CRM) is the systematic approach to and practice of considering climate-related trends and events in development decision-making to minimize potential harm. Historical experience with climate hazards has been providing, and continues to provide, a base for direction of action, particularly in the absence of written historical data, but it may no longer be a sound basis for evaluating risk. Climate change is altering the nature of climate risk, increasing uncertainty and forcing us to re-evaluate conventional CRM practices. Observable trends and longer-term, model-generated projections must also be taken into account if development is to be truly sustainable.

Recognizing this shifting reality, the Climate Risk Management Technical Assistance Support Project (CRM TASP) of the United Nations Development Programme (UNDP) was designed to strengthen the capacity of developing countries to manage climate risk. The International Institute for Sustainable Development (IISD) was commissioned to implement the project in seven countries, in Latin America and the Caribbean (Dominican Republic, Honduras, Nicaragua and Peru) and in Africa (Kenya, Niger and Uganda), in close collaboration with UNDP Country Offices, governments and other partners.

In each country, the main outputs of the project are the prioritization of climate-related risks, a focused risk assessment for a priority sector or area, and the identification of risk management options for that sector or area. This report summarizes the main results of the research conducted in Niger, where the project stakeholders chose agriculture as the focus sector.

APPROACH AND METHODS

In Niger, IISD worked closely with UNDP Niger and the Executive Secretariat of the National Environment Council for Sustainable Development (SE/CNEDD). CRM project activities were integrated into the Africa Adaptation Programme (AAP/Niger), funded by the Japan International Cooperation Agency and implemented by the SE/CNEDD with the support of UNDP. CRM TASP was officially launched in Niger at a **national workshop** in Niamey in December 2010. There, participants identified the agriculture, livestock and water resource sectors as the priority sectors, and droughts, floods and heavy rain as priority climate hazards (see workshop report: Karami, 2010).

Follow-up meetings took place after this workshop, with select attendees. At these meetings, it was agreed that the forthcoming research work should focus on wetlands, based on the sensitivity of these ecosystems to climate risks and the importance of wetlands for ecosystem goods and services (especially in regards to food security). This decision was further justified by the lack of climate impact studies dealing specifically with wetlands, and the need to go beyond sectoral studies and conduct an integrated, multi-sectoral climate risk study. The climate risk assessment therefore focused on wetlands and incorporated the three key sectors identified: agriculture, livestock and water resources.

In April 2011 the stakeholders selected La Mare de Tabalak, one of Niger's 12 Ramsar sites, as the focus of the case study. This was the only wetland that met all the key criteria selected by the participants: social, cultural, economic and environmental importance; vulnerability to climate risks; data availability; closed water system (no inflow from shared water resources); and interest of local communities and actors. The case study format was chosen to enable a detailed study that could be replicated in other, similar wetlands (at national and regional levels) and that would be able to produce specific, practical recommendations.

In May 2011 a **working group** was formed to allow the stakeholders to contribute to project implementation and ensure that all stakeholders would take ownership of and use the research outcomes. The working group comprised around 20 representatives appointed by the stakeholders at the project launch workshop (December 2010), representatives of the National Ramsar Committee, disaster risk prevention experts, climate change adaptation experts and wetland management experts. The working group met twice in 2011.

The study used both qualitative and quantitative research methods, including field surveys and hydrological modelling. These research methods and the outcomes of the assessment study were detailed in two reports (available in French only) (Nazoumou et al., 2011; Nazoumou et al., 2012).

IISD, with the support of CARE Niger, organized a three-day training session in Niamey (July 2011) to build the team's capacities in local data collection and information analysis tools (CVCA and CRiSTAL, see next paragraph). A mission took place in July 2011 to conduct a detailed analysis of several hydrological models based on available data and in-country capacities. This mission also investigated the possibility of applying a hydrological model that had hitherto rarely been used in Niger.

Field surveys were conducted over 18 days (24 July to 10 August 2011), in three villages in the commune of Tabalak (Tabalak, Boussaragué and Chiliyaga), by a multi-disciplinary team of five researchers.[1] Tabalak was selected as the principal study area. The village of Boussaragué, some 20 km southeast of Tabalak, is a mainly agricultural community. The village of Chiliyaga, to the northeast of Tabalak, has a mainly pastoral population. A total of 17 Hausa-speaking focus groups were set up and used the Climate Vulnerability and Capacity Analysis method developed by CARE International (Dazé et al, 2009) and CRiSTAL (Community-Based Risk Screening Tool – Adaptation and Livelihoods).[2] As well as mixed **focus groups**, some focus groups contained only one type of participant (men, women, young people). The focus group meetings were an opportunity for local communities to discuss their perceptions of the main climate hazards threatening their livelihoods, their vulnerability to climate risks, the nature of other socio-economic changes occurring in their area, and how they were responding (or not) to these challenges. During these meetings, a number of products were developed, such as vulnerability matrices, timelines representing the village's history and seasonal activity calendars. To avoid any bias in the survey, the team did not mention the term "climate change": members of the community mentioned it themselves.

Figure 1. Community consultations at Tabalak. Photo: Yahaya Nazoumou.

Sixteen households, including eight male-led households and eight female-led households, completed a **socio-economic questionnaire**. This questionnaire was used to gather information about household resources and activities, income, and the impacts of current and past hazards on activities, and to elicit individual responses to climate hazards. A total of 20 **individual interviews** were conducted with local and regional authority actors, focusing on current initiatives in the area and the support provided to local communities.

[1] The field team comprised three research teaching fellows from Abdou Moumouni University in Niamey (a hydrologist, an environmental scientist and a rural sociologist) and two research assistants (a geographer and a post-graduate sociology student).

[2] See information on this tool at: http://www.iisd.org/cristaltool.

Hydrological modelling of La Mare de Tabalak was conducted to determine the pond's vulnerability to climate risks and to quantify the impact of future climate change on the wetland's water resources in 2050. The SWAT (Soil and Water Assessment Tool)[3] model was calibrated across the entire watershed to simulate future changes in the wetland's water resources from 2020 to 2050. These calculations were based on the effects of variable precipitation and land management on water resources, using available land-use and climate-projection data. The SWAT model was chosen because of its availability (free access) and ability to account for (a) the rainfall-runoff transfer process in a watershed, (b) the fact that the wetland is used as a reservoir, to simulate the fill level, and (c) the variation in land types and uses and farming practices (where such data are available).

In order to simulate future changes to the pond, climate data (precipitation, temperature, humidity and sunlight levels) measured at the Tahoua weather station were used. These data were calculated using climate models for the period from 2011 to 2050 (Sanda et al., 2011) and for extreme scenarios (dry and wet). The data were then integrated into the model to calculate changes in water resources within the wetland (pond, volume, surface area and sediment transport) during the period concerned. A digital elevation model of the area, based on SRTM 90m data (Jarvis et al., 2008), was used to set the boundary of the watershed. The pond's bathymetry (elevation, surface area and volume) was based on the measurements of a unique survey, conducted in 2000 by STUDI (2001). Land type and occupancy data were based on Waterbase[4] maps (dateless) and remained unchanged throughout the period concerned.

The hydrological modelling process was conducted as follows:

1. A baseline study and collection of available environmental and socio-economic data from national (Ministry for Water Systems and the Environment, National Meteorology Directorate, CNEDD, Regional Hydrological Directorate-Tahoua, LUCOP-Tahoua) and subregional institutions (Regional Training Centre for Agrometeorology and Operational Hydrology and their Applications, African Centre of Meteorological Application for Development).
2. Conceptualization of the watershed and pond by integrating the watershed boundaries and hydrological characteristics into the model.
3. Entry of hydrological and meteorological data into the model (rainfall, temperature, humidity, wetland water levels, etc.).
4. Calibration of the model.
5. Final validation of the model.[5]

The University of Ottawa (Canada) provided technical support for the modelling work and assisted with access to land and vegetation cover data.

The preliminary outcomes of the assessment study were presented at a national workshop in Niamey in October 2011. This workshop was attended by 50 representatives from the village of Tabalak, the commune of Abalak, the Tahoua region, and various government ministries, research institutions and national non-governmental organizations (NGOs). The participants identified the key climate risk management options for La Mare de Tabalak based on the outcomes of this assessment study and using the participatory scenario development approach.[6] The outcomes of this process are summarized in a workshop report (Karami and Danguiwa, 2011).

[3] SWAT was developed by the Agricultural Research Service of the United States Department of Agriculture.
[4] http://www.waterbase.org/home.html
[5] The model is calibrated to adjust the hydrological parameters of the watershed and/or the pond, if necessary, so that the model reproduces the system's observed hydrological behaviour.
[6] For more information about this approach, see Bizikova et al. (2009) and Bizikova et al. (2010).

TABLE 1. KEY PROJECT STAGES AND METHODOLOGIES

STAGE	OBJECTIVE	METHODS USED IN NIGER
1. Engagement	• Raise awareness among key project actors. • Enhance sense of ownership. • Develop synergies with existing initiatives.	Discussions and meetings with key actors.
2. General assessment of climate risks	• Understand and summarize existing climate risk data.	Literature review conducted by a national expert.
3. Identification of priority climate risks I	• Identify shortcomings and priorities in climate risk assessment and management, which may be addressed via a targeted study.	Workshop on current knowledge and research priorities in the field of climate risks (Karami, 2010); wetlands were identified as the priority sector.
4. Targeted assessment of climate risks	• Understand the nature of climate risks in a priority sector or region (La Mare de Tabalak).	Local consultations in three villages of the commune of Tabalak, using the CVCA and CRiSTAL tools (Nazoumou et al. 2012). Hydrological modelling (Nazoumou et al. 2012).
5. Identification of priority climate risks II	• Identify priority climate risk management options based on the outcomes of the assessment study.	Participatory scenario development workshop (Karami and Danguiwa, 2011).
6. Reporting and dissemination	• Produce the final report and validate the outcomes. • Encourage ownership of the outcomes at the national level.	Final validation workshop (February 2012). Publication of the final report.

KEY CONCEPTS

In this report, 'climate risk' refers to the probability of harmful consequences or expected losses resulting from the interaction of climate hazards with vulnerable conditions (UNISDR, 2004). 'Climate hazard' refers to a potentially damaging hydrometeorological event or phenomenon that can be characterized by its location, intensity, frequency, duration and probability of occurrence. This report considers both events with an identifiable onset and termination, such as a storm, flood or drought, and more permanent changes, such as a trend or transition from one climatic state to another, as hazards (Lim et al., 2005).

'Exposure' is a second element of climate risk. It refers to the presence of people and assets in areas where hazards may occur (Cardona et al., 2012). Finally, 'vulnerability' refers to the potential for a system to be harmed by something, and in the CRM TASP this 'something' is a climate hazard. When assessing vulnerability, we need to recognize the hazard specificity of people's vulnerability; indeed, the factors that make people vulnerable to earthquake are not necessarily the same as those that make people vulnerable to floods (UNDP 2004). We understand vulnerability to be a function of a system's sensitivity and its adaptive capacity, as depicted in figure 2.

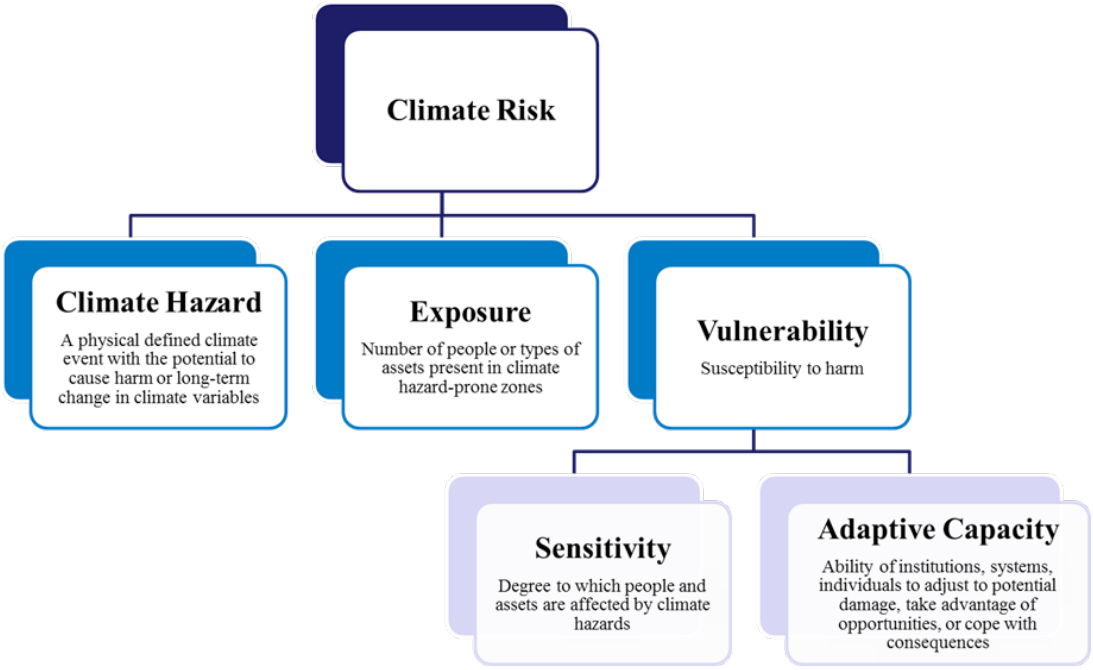

Figure 2. Components of climate risk

REPORT STRUCTURE

This report has six sections. After this introduction, 'Development Profile' (pp. 15–22) describes the current development conditions, trends and objectives, with a subsection (pp. 19–22) on wetlands, which will set the baseline against which climate risks can be assessed. 'Climate Profile' (pp. 23–29), on climate conditions, variability and change, describes mainly the hazard side of the risk equation. Next, 'Climate Impacts and Risks' (pp. 30–42) provides a detailed analysis of climate impacts and risks in the selected wetland, building on the primary research tasks described above. 'Institutions and Policies for Climate Risk Management' (pp. 43–47) looks at existing national institutions, policies and initiatives. Finally, 'Recommendations for Climate Risk Management' (pp. 48–52) concludes with recommendations on actions to reduce the risk of negative impacts in the study region, as well as on necessary changes to institutions and policies to facilitate the implementation of such actions, and directions for further research.

DEVELOPMENT PROFILE

A country's development situation is a key factor in determining its vulnerability to climate variability and change. This section will lay the foundations for climate risk analysis, summarizing the current national development situation, describing trends and challenges, and outlining Niger's future development vision, objectives and priorities. Wetlands are one of the sectors most vulnerable to climate hazards. This fact has a direct impact on other sectors, such as agriculture, livestock and fishing (CNEDD, 2003). This section will therefore focus in particular on the importance and role of wetlands.

NATIONAL DEVELOPMENT CONDITIONS, TRENDS AND CHALLENGES

Niger is the largest country in West Africa. It covers 1,267,000 km^2 and shares land borders with Algeria and Libya to the north and northeast, Mali to the northwest, Burkina Faso and Benin to the southwest, Nigeria to the south and Chad to the east (see figure 3). Niger is divided into eight regions: Agadez, Dosso, Maradi, Tahoua, Tillabéri Zinder, Diffa and Niamey (metropolitan area) (République du Niger, 2010).

In July 2011, Niger had an estimated population of 16.5 million, of which only 17 percent lived in urban areas (CIA, 2011; IFAD, 2011). Some 90 percent of the population is concentrated in a long, narrow strip (around 200 km wide) in the south, near the border, where rainfall is more favourable for agriculture (FAO-AQUASTAT, 2005; World Bank, 2010). Niger has the second-highest population growth rate in the world, at over 3.6 percent per year (CIA, 2011), explained by a high fertility rate (7.1 children per woman (UNICEF, 2007). Despite a slight projected fall in the population growth rate (2.3 percent by 2050), the country's population is estimated to grow to 55 million by 2050 (United States Census Bureau, 2011). This makes population growth one of the country's priority issues (Secrétariat Permanent de la SRP, 2007a).

Poverty and human development

Niger is one of the world's poorest countries, with the highest Multidimensional Poverty Index[7] of any country (93 percent) (UNDP, 2010). In 2009 an estimated 61 percent of the population lived in extreme poverty, compared with 63 percent in 1993, existing on less than US$1 per day. The country also exhibited marked spatial disparities (Secrétariat Permanent de la SRP, 2007a: 20; World Bank, 2010).

Figure 3. Political map of Niger (United Nations, 2004)[8]

[7] The Multidimensional Poverty Index identifies multiple deprivations in health, education and standard of living. It uses micro data from household surveys. These data are then aggregated into the national measure of poverty (UNDP, 2010).

[8] The boundaries and names shown on this map do not imply official endorsement or acceptance by the United Nations.

Poverty is substantially higher in rural than in urban areas, with more than 8.4 million rural people living in poverty in 2009 (IFAD, 2011). Average income per capita in 2008 was estimated at US$330 (World Bank, 2010; IFAD, 2011). Purchasing power parity stood at US$11.05 billion in 2010, equating to US$700 per capita (CIA, 2011). Based on these figures, Niger will not achieve the Millennium Development Goal (MDG) of reducing the proportion of the population living below the poverty line by 50 percent between 1990 and 2015.

The Human Development Index measures a country's achievements in three basic dimensions of human development: long and healthy life, access to knowledge, and a decent standard of living (income) (UNDP, 2010). Niger ranked 167 out of 169 countries on the Human Development Index in 2010 (see table 2).

TABLE 2. HUMAN DEVELOPMENT INDEX IN NIGER AND THE SURROUNDING REGION (ADAPTED FROM UNDP, 2010)

COUNTRY	HUMAN DEVELOPMENT INDEX RANK (2010)	LIFE EXPECTANCY AT BIRTH (YEARS) (2010)	MEAN YEARS OF SCHOOLING (2010)	EXPECTED YEARS OF SCHOOLING (2010)	GROSS NATIONAL INCOME PER CAPITA (2008) (CONSTANT PPP $)
Chad	163	49.2	1.5 (in 2009)	6.0	1,067
Guinea-Bissau	164	48.6	2.3 (in 2009)	9.1	538
Mozambique	165	48.4	1.2	8.2	854
Burundi	166	51.4	2.7	9.6	402
Niger	**167**	**52.5**	**1.4**	**4.3**	**675**
Democratic Republic of the Congo	168	48.0	3.8	7.8	291
Zimbabwe	169	47.0	7.2	9.2	176

**PPP: Purchasing power parity*

Target 1C of the first MDG aims to halve, between 1990 and 2015, the proportion of people who suffer from hunger. In Niger, the proportion of children under five years of age who were underweight fell from 36.2 percent in 1992 to 33.7 percent in 2009 (a decrease of 2.5 percentage points). This is far short of the level required to achieve the target of 18 percent by 2015 (INS, 2010).

The gross primary enrolment rate rose from less than 30 percent between 1996 and 2003 to 62.4 percent in 2009 (FAO-AQUASTAT, 2005; IFAD, 2011). This increase suggests that Niger is capable of achieving a rate of 100 percent by 2015 and, by doing so, meeting the second MDG. However, these figures hide significant gender inequality, with gross primary enrolment at 66.7 percent among boys but only 47.4 percent among girls (UNICEF, 2007). Niger is one of the worst-performing countries in terms of gender equality in education, with three men in higher education for every woman (UNDP, 2010: 47).

Other indicators suggest a more positive trend, particularly for health. Infant mortality rates have dropped substantially over the last 10 years, from 123 per 1,000 live births in 1998 to 74.7 per 1,000 in 2009 (INS and PNUD, 2009; World Bank, 2010; World Bank, 2011a). Niger therefore seems to be in a position to achieve the fourth MDG (to reduce by two thirds, between 1990 and 2015, the under-five mortality rate). The maternal mortality rate, meanwhile, has remained relatively stable (6.52 per 1,000 births in 1992 and 6.48 in 2006). The fifth MDG (to reduce the maternal mortality rate by three-quarters) therefore seems to be a distant prospect (INS and PNUD, 2009; Secrétariat Permanent de la SRP, 2007a).

Niger has already achieved target 6A of the sixth MDG, to have halted and begun to reverse the spread of HIV/AIDS by 2015, with the infection rate falling from 0.87 percent in 2002 to 0.70 percent in 2010 (Secrétariat Permanent de la SRP, 2007a; WHO, 2011). However, the country is highly unlikely to achieve its target in terms of malaria and tuberculosis.

Life expectancy has increased from 46.8 years in 1998 to 52.5 years in 2010[9] (UNDP, 2010; World Bank, 2011b). Niger has a higher life expectancy than the regional average (see table 2).

In 2002 only 46 percent of the population had access to safe drinking water (80 percent in urban areas and 36 percent in rural areas). By 2005 this figure had risen to 68.7 percent, with the MDG target standing at 85 percent (in other words, to halve the proportion of the population without sustainable access to safe drinking water) (FAO-AQUASTAT, 2005; Secrétariat Permanent de la SRP, 2007a).

Economy and politics

Niger had a per capita Gross Domestic Product (GDP) of just US$351 in 2009 and a total GDP of US$5.54 billion (World Bank, 2011a; World Bank, 2011b). GDP growth is weak and highly variable, resulting in significant vulnerability to climate variation and global crises (especially food and financial crises). Niger's GDP shrank by 1.2 percent in 2009 following a drought, after growing by 9.5 percent in 2008 (World Bank, 2010; World Bank, 2011b). Estimated GDP growth for 2011 was 4.9 percent and is forecast to reach 11.5 percent in 2012, due to increasing uranium production (AfricanEconomicOutlook.org, 2011). The energy and mining sectors are major potential drivers of growth for Niger, as the country has significant uranium, oil, phosphate, iron, limestone and gypsum resources (URU Metals, 2011; World Nuclear Association, 2011; Bertelsmann Stiftung, 2010; United States Department of State, 2011).

The country's economy is largely dominated by the agricultural sector, which accounted for 40 percent of GDP in 2003,[10] followed by the growing mining sector (uranium) and informal commercial activities (handicrafts). The industrial sector accounted for 17.3 percent of GDP in 2003, with manufacturing industries representing just 6.4 percent and services 42.7 percent (IFAD, 2011). Economic activity remains highly dependent on and vulnerable to climate conditions, with heavy reliance on non-irrigated agriculture (in a context of falling rainfall levels and more frequent droughts). It is also vulnerable to external financial markets (especially in terms of mining export prices) (World Bank, 2010). In 2010, Niger had a trade deficit of 15.3 percent of GDP, caused by a 20 percent increase in imports (especially cereals) in 2009 (AfricanEconomicOutlook.org, 2011), likely a result of the 2009 drought and the global food crisis.

In terms of rural activities (agrosilvopastoral), livestock farming accounted for 14 percent of Niger's GDP in 2009 and 20.5 percent of total export income. Uranium production, meanwhile, accounted for 64 percent of export income (United States Department of State, 2011). Only 12 percent of the country's land area is suitable for agriculture, making it difficult to achieve sufficient production levels. This is exacerbated by the fact that agriculture depends primarily on rainfall. The most commonly grown leguminous plants are black-eyed peas and peanuts. These are grown alongside millet and sorghum, Niger's two main cereal crops (JAICAF, 2009). Corn and rice are grown in the country's wettest regions, primarily along the Niger River and in the south. Farming is mainly done using traditional methods, often on small, family-run farms of an average of less than 5 ha. Access to cattle grazing lands and suitable farmland is often the subject of rivalries among livestock farmers and between livestock farmers and crop farmers.

The agricultural sector is trending downward, with 2009 cereal crop production down by 27 percent compared with 2008. Production of the country's main crops, such as millet, sorghum, fonio and black-eyed peas, is also trending downward. The exceptions are rice and peanuts, whose production is increasing (INS and SAP, 2010). Fodder crop production levels were low throughout the country in 2009–2010 (due to limited and poorly distributed rainfall in 2009). As a result, many areas of Niger have now become food security–risk areas. These include the regions of Diffa, Tahoua and Tillabéri (INS and SAP, 2010). Changes in food production levels and food demand between 1960 and 2008 show that the country was self-sufficient in terms of staple food production, and was even a net exporter of cereal crops, until the end of the 1960s. Today, Niger has a severe food deficit (Addoh and Ousmane, 2010). Food self-sufficiency is a national priority (Présidence de la République du Niger, 2011).

The country has experienced periods of instability, including a recent conflict and a coup in 2010. Since then, political stability has largely been restored, and Niger is now a democratic republic. Since the 2000s, decentralization has accelerated, though the Government initiated the process in the 1960s. To date, the process still lacks the support it needs to improve coordination and secure funding for the country's decentralized entities (Salifou, 2008). No institution to fund local authorities has yet been created.[11]

[9] According to the World Bank, life expectancy in 2009 was 53.8 years.
[10] To our knowledge, no more recent sources are available.
[11] See http://www.afriqueavenir.org/2011/09/01/dissolution-de-la-caisse-de-prets-aux-collectivites-territoriales-au-niger (available in French only)

Environment

Niger has substantial biodiversity, with a rich and varied fauna of 3,200 animal species. Some 90 percent of the country's large animals are concentrated in Niger's protected areas, which cover more than 80,000 km^2 (Ministère de l'Hydraulique, de l'Environnement et de la Lutte Contre la Désertification, 2005; CC/SAP, n.d.). The Sahara Desert covers around 77 percent of Niger. The country's principal environmental problems are desertification and deforestation, threats to wild animal habitats, and the environmental impacts of mining operations. The country is facing a serious reduction in vegetation cover due to overgrazing, excessive logging for construction and heating, and deliberate bush fires and grass fires to clear land. In the western part of the country especially, logging represents an alternative source of income to agriculture and livestock farming (Ministère de l'Hydraulique, de l'Environnement et de la Lutte Contre la Désertification, 2005). Accelerating soil erosion (northern Niger is one of the most severely wind-eroded areas of Africa) and desertification (as a result of both human activity and climate variability) are also causes of reduced vegetation. The phenomenon is further exacerbated by high population growth (UNEP, 2008: 262). Since 1990, Niger has lost one-third of its forest cover, and the desert is estimated to be advancing by 200,000 ha each year (UNEP, 2008: 263). On top of this, the country's wetlands are silting up significantly.

Despite its dry climate, Niger has substantial water resources. However, the country currently exploits just 1 percent of these (CNEDD, 2009). This is due, in particular, to the difficulty farmers face accessing agricultural credit and inputs, as well as the fact that irrigation is hardly used at all across the country (UNDP, 2011). Most of the population's water supply is drawn from groundwater, although only 20 percent of total groundwater supply is actually used (CNEDD, 2009). The population uses three main sources of water: rainfall during the wet season, which is stored in the shallow aquifer, non-renewable fossil water drawn from wells (artesian or dug), and several permanent or semi-permanent ponds such as Tabalak, Madarounfa and Keita (JAICAF, 2009). Total drinking water resource levels, however, are falling due to natural ponds and lakes drying out and a reduction in the volume of water carried by the Niger River (Sanda et al., 2011). River flow levels have also fallen generally since the 1970s (Sanda et al., 2011). Alluvial groundwater levels have remained highly variable, although in some instances a general upward trend has been observed. Furthermore, 90 percent of Niger's water resources are transboundary (e.g. the Niger River, which is the only permanent river in the country) (FAO-AQUASTAT, 2005). Niger is located within two major transboundary watersheds: the Irhazer-Iullemeden basin and the Chad basin. Niger's *koris*[12] are entirely dependent on run-off, which they receive for just a few days each year during the rainy season (JAICAF, 2009).

NATIONAL DEVELOPMENT VISION, OBJECTIVES AND PRIORITIES

A common aim of all public policies in Niger is to build the capacities of local, regional and national actors as part of the decentralization process. The Government of Niger adopted the 'Poverty Reduction Strategy' (PRS) in January 2002, covering the period from 2002 to 2015. The PRS acts as a frame of reference for the country's development strategy and all other policies. Its aim is to improve the living conditions of the country's poor populations and reduce the number of people living in poverty by at least 50 percent by 2015. The Government's two key priorities remain poverty reduction and food self-sufficiency. In order to achieve these aims, the Government has identified the rural sector as the key driver of the country's economic and social development, focusing on growth in the agrosilvopastoral sectors and promoting diversification among rural households into non-agricultural activities (République du Niger, 2002; World Bank, 2011c).

For the second phase of the strategy (2008 to 2012), the PRS was renamed the 'Accelerated Development and Poverty Reduction Strategy' (ADPRS, which will be replaced by the end of 2012). It features a situation analysis of poverty in the country and sets out how the Government plans to combat it. The ADPRS programme of action is based on the MDGs, with 2015 set as the target date for all indicators. It will be replaced in 2013 by the 'Sustainable Development and Inclusive Growth Strategy Niger 2035,' (Présidence de la République du Niger, 2011; Bokonon-Ganta, 2012). This document is expected to represent a major turning point in strategic development planning in Niger, as it places greater emphasis on sustainability than the ADPRS (UNDP-Niger, 2012).

The 'Rural Development Strategy,' finalized in 2007 and currently under review, is another key policy document. It outlines how the PRS (and consequently the ADPRS) will be implemented in practice in the rural sector and acts as a frame of reference for the implementation of agropastoral development, environmental and antidesertification actions. Its general aim is in line with the MDGs, namely to "reduce rural poverty from 66 percent to 52 percent by 2015 by creating the necessary conditions for sustainable

[12] A *kori* is the equivalent of a *wadi* (a temporary river in North Africa) in Tamashek, the language of the Tuaregs. The term is widely used across Niger.

economic and social development, achieving food security for the country's population and ensuring that natural resources are managed in a sustainable way" (Secrétariat Permanent de la SRP, 2007b: iv) (unofficial translation). To achieve this, the strategy is based on three key strategic principles (Secrétariat Permanent de la SRP, 2007b: iv): (1) "to provide rural populations with access to economic opportunities and, in doing so, to create sustainable economic growth"; (2) "to mitigate ADPRS risks, improve food security and manage natural resources in a sustainable way in order to deliver better living conditions for the country's population"; and (3) "to build the capacities of public institutions and rural organizations to improve rural sector management" (unofficial translations).

THE WETLANDS SECTOR

This analysis is based on available national documentation and is primarily qualitative. This reflects the fact that insufficient quantitative data and research exist to give a true understanding of the role and importance of wetlands. Unfortunately, despite their economic importance, no detailed study of the direct and indirect economic value of wetlands has yet been conducted in Niger, apart from a few estimates of income generated from farming and fishing activities in various wetlands in the 1980s and 1990s. Despite this lack of data, Niger's wetlands undoubtedly have an economic value per hectare that substantially exceeds the value of the surrounding arid lands (Brouwer, 2009).

Characteristics and trends

Niger has been a signatory to the Ramsar Convention on Wetlands since 1987. The country signed up to implement sustainable wetland management and deliver a secure water supply (as well as plant and animal resources) to its population. The mission of the Ramsar Convention is the "conservation and wise use of wetlands and their resources" (www.ramsarconvention.org). The Convention has drawn up a 'List of Wetlands of International Importance.' Signatory countries are required to identify Ramsar sites using nine criteria, which deal primarily with animal and plant biodiversity.[13] The Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres." In Niger, however, wetlands are defined in more general terms as "natural or artificial areas with water that is static or flowing, permanent or temporary: this includes ponds, artificial dams, rivers, flood plains and oasis systems" (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009) [unofficial translation]. Three separate ministries are responsible for applying the Ramsar Convention on Wetlands in Niger: the Ministry for the Environment, the Ministry for Water Resources and the Ministry for Agriculture (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2000).

Despite its lack of rainfall and its continental climate, Niger has a wide variety of wetlands. These wetlands are classified into seven or eight "hydrological regions or units according to their physical and biological characteristics, climate and hydrological regime" (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2000) [unofficial translation]:

1. Flood plains, including those of the Niger River and its tributaries, and the major *koris* (river valleys): the Korama and the Komadougou Yobe.
2. Ponds and artificial or natural lakes, including the section of Lake Chad within Niger and some 1,000 permanent and semi-permanent ponds.
3. Oasis systems, including the Aïr Mountains and the Gueltas (a type of wetland).
4. Dallols and basins, such as the Dallol Bosso and the Dallol Maouri.

Twelve of Niger's wetlands are on the Ramsar 'List of Wetlands of International Importance,' covering a total area of 43,000 km^2 (see table 3), or almost 3.4 percent of the country's surface area. In addition, Niger has many other wetlands throughout the *entire* country (including in the Sahara region; see figure 3). There are, for example, more than 1,000 ponds across the country, of which around 165 are permanent, ranging from 10 to 2,000 ha in area (Centre d'Echange d'Informations sur la Biodiversité du Niger, 2008; Brouwer, 2009). Currently, only three of these ponds are on the Ramsar List, including La Mare de Tabalak.

[13] The nine criteria are listed on the Ramsar Convention website (www.ramsar.org).

TABLE 3. THE 12 WETLANDS IN NIGER ON THE RAMSAR LIST

NO.	WETLAND NAME	REGION	SURFACE AREA (HECTARES)	DATE OF DESIGNATION	MANAGEMENT PLAN
1	Gueltas et Oasis de l'Aïr	Agadez	2,413,237	2005	--
2	Dallol Bosso	Dosso	376,162	2004	2011
3	Oasis du Kawar	Agadez	368,536	2005	--
4	Lac Tchad	Diffa	360,000	2001	--
5	Dallol Maouri	Dosso	318,966	2004	--
6	Parc national du 'W'	Tillaberi	220,000	1987	2005
7	Zone humide du moyen Niger	Dosso	88,050	2001	2008
8	Zone humide du moyen Niger II	Dosso	65,850	2004	--
9	Complexe Kokorou-Namga	Tillaberi	36,000	2001	2009
10	La mare de Lassouri	Zinder	26,737	2005	Under development
11	La mare de Dan Doutchi	Tahoua	25,366	2005	--
12	**La mare de Tabalak**	**Tahoua**	**7,713**	**2005**	--

Data sources: Ramsar Convention on Wetlands, 2000; Ministère de l'Hydraulique, de l'Environnement et de la Lutte contre la Désertification, 2005; personal communication, Col. Abdou Malam Issa and Hassane Zeinabou Ibrahim, Ministère de l'Hydraulique et de l'Environnement, February 2012.

In a Sahelian country such as Niger, which suffers frequent droughts, wetlands are vital in the fight against poverty and the preservation of biodiversity. Wetlands are used for a range of different activities, including agriculture, livestock farming, fishing, apiculture, exploitation of forest products and by-products, handicrafts (earthenware, brick-making, etc.), and tourism. They provide important habitats for 1.2 million migrating birds and fulfil a range of other important functions, including supplying groundwater, preventing floods by holding rainwater, stabilizing banks and combating erosion by supporting plant life, and providing resources the local population can use to drive socio-economic development (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009).

In more specific terms, wetlands are important agricultural sites capable of supporting market gardening, rice crops, fruit growing and even out-of-season and floodland crops, providing the main source of income for local families. Most crops are grown during the dry season. In 1991 the financial yield of crops in wetlands was between US$200 (for beans such as *Lablab purpureus*) and US$4,300 (for onions) per hectare per year (Brouwer, 2009). Wetlands also represent "the ideal pastoral site," where cattle are still able to find grazing land when the rest of the country is at the height of the dry season (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2000) [unofficial translation]. Surface water, such as that found in wetlands, is said to account for one-third of total cattle water supply. In the 1990s, estimates suggested this water supply gave wetlands a value of US$35 million per year, based on livestock production only (Brouwer, 2009). Fishing is the second-most-common economic activity in wetlands, after agriculture. It is primarily carried out in the dry season, when fish stocks have had time to replenish. In the 1980s, estimates put the value of wetland fishing from US$0.9 million (1985) up to US$4.2 million (1978) (Brouwer, 2009). Profits from fish sales are much higher in the country's urban centres, such as Niamey. The ability of wetlands to support these important economic activities explains the high population concentrations around these areas.

Gender inequality remains a major issue in Niger (three-quarters of the country's poor are women, for example) (Secrétariat Permanent de la SRP, 2007b). Due to the division of roles between men and women and the fact that they have different access to resources, women are often more vulnerable to hazards than men. In wetlands, for example, women have specific roles such as selling non-timber forest products, selling fish, producing handicrafts, extracting natron, fattening livestock, gathering water for the family, and growing seeds such as gombo, sesame and capsicum. This calls for adapted climate risk management responses that take gender issues and the unique features of wetlands into account. Despite the country's efforts to introduce wetland management measures, the strategies and policies implemented in this area have failed to address gender issues, even though one of the seven key principles of the ADPRS is to reduce inequality, including gender inequality.

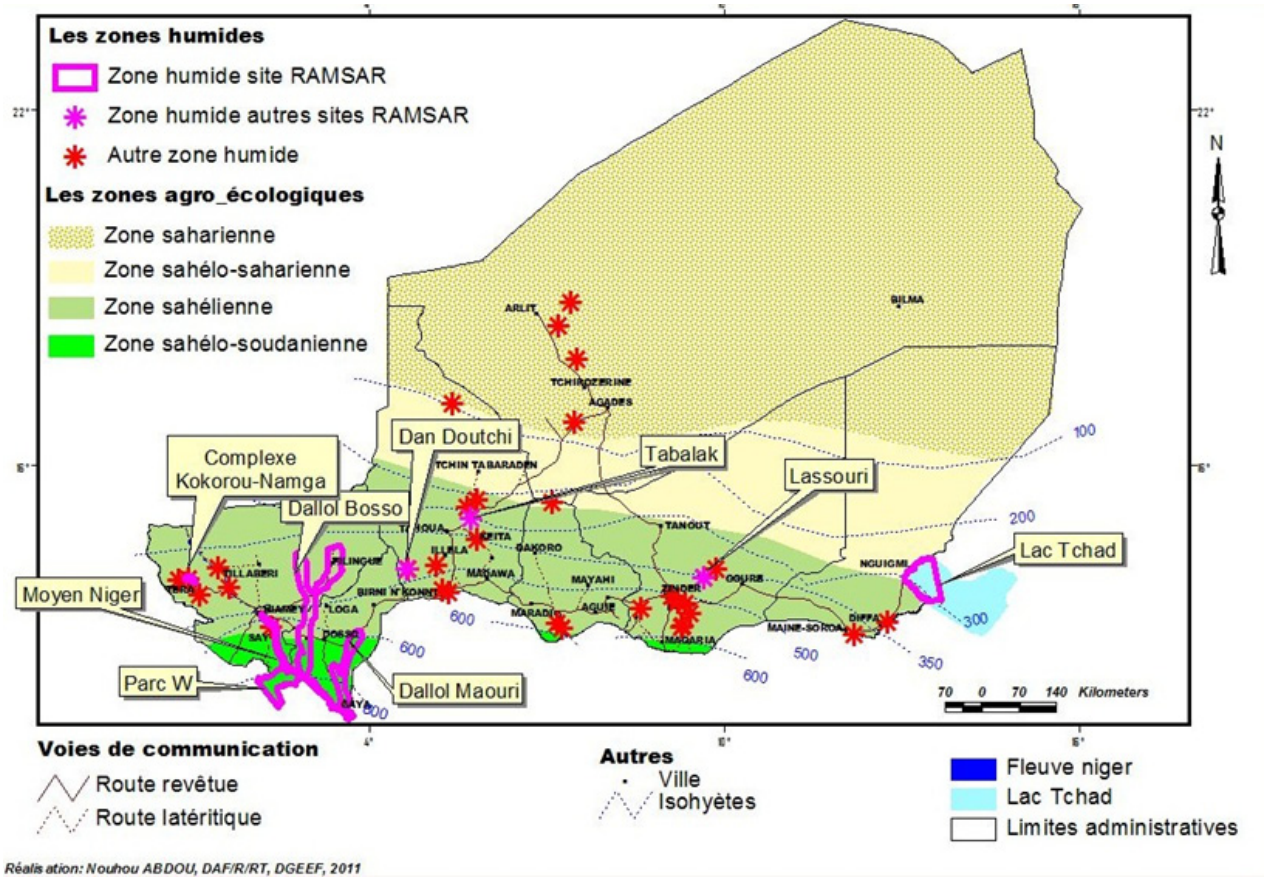

Figure 4. Map of wetlands in Niger

Translation of the legend from French to English

Les zones humides	Wetlands
Zone humide site RAMSAR	Ramsar wetland
Zone humide autres sites RAMSAR	Other Ramsar wetland
Autre zone humide	Other wetland
Les zones agro_écologique	Agroecological zones
Zone saharienne	Sahara zone
Zone sahélo-saharienne	Sahara-Sahel zone
Zone sahélienne	Sahel zone
Zone sahélo-soudanienne	Sahel-Sudan zone
Voies de communication	Communication routes
Route revêtue	Surfaced road
Route latéritique	Dirt road
Autres	Others
Ville	City
Isohyètes	Contour lines
Fleuve niger	Niger River
Lac Tchad	Lake Chad
Limites administrative	Administrative boundaries

The degradation and retreat of wetlands are hindering Niger's development. This degradation has a number of causes: environmental pressures (e.g. silting caused by droughts and overexploitation of resources by humans, limited and poorly distributed rainfall, bank erosion, the gradual disappearance of certain species, and soil degradation) and human pressures (natural resource exploitation methods remain largely traditional and are not consistent with sustainable exploitation, unregulated fishing, uncontrolled land-clearing bush fires, excessive forest clearance, and overuse of chemical fertilizers and pesticides) (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009). Furthermore, one of the major issues facing wetlands is a severe institutional deficit, such as the lack of detailed wetland management plans (as required by the Ramsar Convention), with the exception of four wetlands (Dallol Bosso, Parc du W, Moyen Niger I and Namga-Kokorou), where the existing plans are not always applied (apart from in Parc du W) (see table 3). Action to introduce measures aimed at conservation and wise use of wetlands, or to identify and remove measures that discourage conservation, therefore remains extremely limited. For this reason, a national wetlands policy was developed to strengthen the institutional framework.

Priorities/inclusion in national policies

The 'National Wetlands Policy' of 2009 was developed to solve this institutional deficit. It sets out strategic priorities and guiding principles for wetland-related actions and details how the policy itself will be implemented. It also reflects the environmental and antidesertification strategies outlined in the PRS and SDR, both in general terms and in relation to wetlands in particular (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009: 8). The 'National Wetlands Policy' is in line with key national-level strategies such as the PRS and SDR, and it has the following general objective: "to improve the living conditions of the country's poor populations and to reduce the number of people living in poverty from 66 percent to less than 50 percent by 2015" (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009: 41) (unofficial translation).

Its aim is to encourage the "conservation, enhancement and sustainable management of wetland ecosystems and their biodiversity" (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009: 42). The policy is designed to reconcile the need to exploit the resources contained in these areas with the need to ensure that they are sustainable, in order to protect these areas and secure the country's future development (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009: 52). It is based on seven key objectives, listed below. Despite these, the national wetlands policy remains vague, and a detailed action plan is required to put these objectives into practice.

Objectives of the National Wetlands Policy (draft version) (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009):

1. To help to maintain and/or improve the functions and values of wetlands.
2. To enhance understanding of the values of wetlands among actors.
3. To help to improve knowledge on wetlands and create a wetlands knowledge bank.
4. To encourage the addition of new sites to the Ramsar List and to draw up suitable management plans.
5. To build wetland-management capacities.
6. To promote scientific research on wetlands.
7. To harmonize wetland-related legislation.

Key messages: Development profile

- Niger is one of the world's poorest countries. It has one of the highest population growth rates in the world, which exerts constant pressure on its natural resources. Its key national priority is to alleviate poverty and food insecurity.
- The economy is largely dependent on agropastoral activities and mining. Only 12 percent of the country's land is suitable for agriculture, which depends largely on irregular and unevenly distributed rainfall.
- The population currently uses just 1 percent of its water resources, with most water supply coming from groundwater. Easily accessible water resources are becoming depleted.
- Niger's wetlands are important sources of water and irrigable land, making them critical in efforts to increase agricultural and pastoral production and resolve the country's chronic food insecurity.

CLIMATE PROFILE

Niger has a particularly dry, continental climate, with significant temporal and spatial variations, two distinct seasons, and high temperatures (DNPGCA, 2007; Sanda et al., 2011). There are four distinct climate zones, from south to north (see figure 5 and table 4).

Niger has a single wet season, from June to September, with thundery downpours, high humidity and an average temperature of 33° C. The dry season is much longer, running from October to the end of May, and can be divided into three separate seasons: a dry season from October to mid-November, with average humidity and an average temperature of 35° C; a cold dry season from late November to late February, with cold nights during which the temperature sometimes falls below 10° C; and a very hot dry season from March to late May, with hot winds, maximum temperatures of 46° C in the shade and temperatures rarely falling below 25° C at night (UNDP, 2011).

Annual average temperatures range from 27° C to 29° C, and precipitation varies from 0 mm to 800 mm per year in the country's different climate zones (see table 4) (DNPGCA, 2007). Potential evaporation is about three metres per year[14] (DNPGCA, 2007). During the dry season, the average temperature varies from 18.0° C to 31.1° C, and in the wet season, from 28.0° C to 31.7° C (Sanda et al., 2011).

Niger's climate is affected by two alternating air masses. The first is hot, dry, tropical air from the northeast (the Harmattan), which comes from the Sahara. The second is maritime, moist equatorial air from the southwest (the Monsoon, from the South Atlantic High) (CNEDD, 2003). These two air masses converge in the Intertropical Convergence Zone. This convergence zone causes Niger's two distinct seasons at ground level (CC/SAP, 2011b).

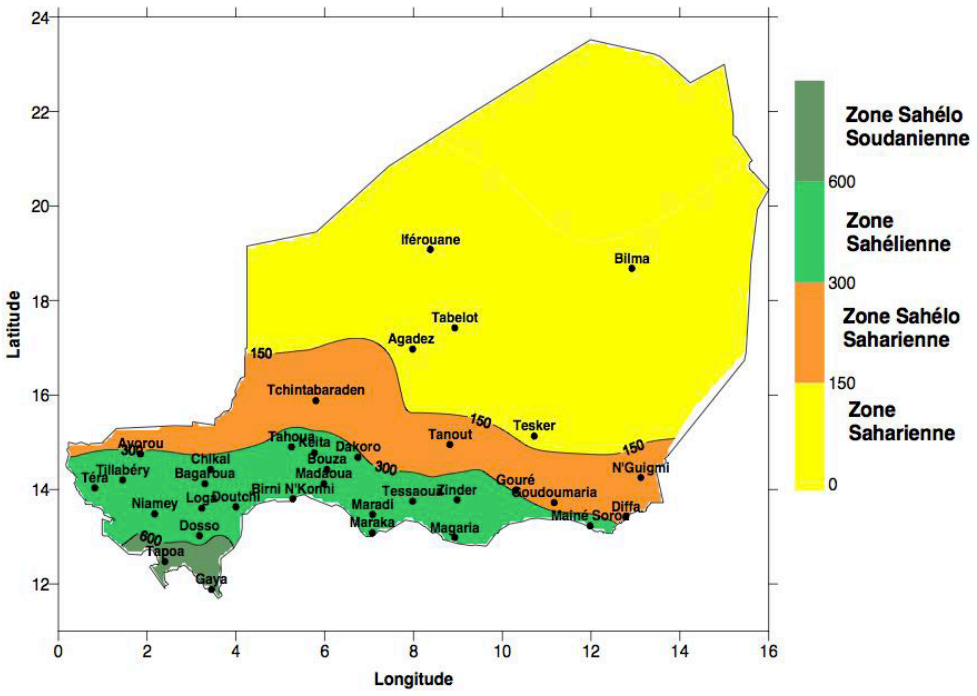

Figure 5. Distribution of Niger's four main climate zones according to average precipitation levels (isohyets) (reprinted with permission from CNEDD, 2009)

[14] Evaporation levels across the Sahel stand at approximately 7 mm to 12mm per day, resulting in annual evaporation of two to three metres. This means that if a pond is less than two metres deep, it may disappear from evaporation alone.

TABLE 4. NIGER'S FOUR CLIMATE ZONES (CC/SAP, N.D.; CNEDD, 2009; UNDP, 2011)

CLIMATE ZONE	PERCENTAGE OF TOTAL COUNTRY SURFACE AREA	PRECIPITATION
Sahel-Sudan	1%	600 mm to 800 mm per year (area suitable for agriculture and pastoral activity)
Sahel	Approx. 10%	350 mm to 600 mm per year (ideal for livestock farming)
Sahel-Sahara	Approx. 12%	150 mm to 350 mm per year
Sahara	Approx. 77%	0 mm to less than 150 mm per year (no crop-growing possible, except for a few regions, such as the *koris* in the centre of the country and the Kaouar and Djado oases in the northeast)

Table 5 compiles major climate hazards recorded in Niger since 1903 and their human impacts (CRED, 2012). Between 1900 and 2011, droughts affected and killed more people than any other type of disaster, followed by floods (CRED, 2012). In 2010, drought affected almost 7.9 million people (CRED, 2012). The Zinder and Maradi regions are affected by floods more often than droughts. These two regions straddle two climate zones, the Sahel and the Sahel-Sahara, but are mostly in the Sahel, which receives the second-highest level of precipitation (an average of 350 mm to 600mm per year). This may explain the regular floods that occur in these regions. Very limited information about the economic damage of each of these events is available.

TABLE 5. REPORTED CLIMATE HAZARDS IN NIGER FOR THE PERIOD 1900–2011

	NUMBER OF EVENTS	TOTAL KILLED	TOTAL AFFECTED	DAMAGE (000 US$)
Drought	13	85,000	23,655,058	-
Flood	17	149	745,822	11,200
Storm	1	4	1,253	-
Total	**31**	**85,153**	**24,402,133**	**11,200**

Data source: CRED, 2012

Drought is the most common extreme climate phenomenon in Niger. It can occur in any of the country's agroecological zones, extend over vast areas and last for a substantial time (CNEDD, 2006). Figure 6 shows those areas most susceptible to drought. Some of the country's regions, such as Tillabéri, Maradi, Zinder and Diffa (from west to east), are susceptible to recurring droughts (UNDP and BCPR, 2010). The northern areas of these regions are located in the Sahel-Sahara zone, which, as noted previously, receives only 150 mm to 350mm of rainfall per year.

Droughts have a significant impact on agropastoral production, which is highly dependent on spatially and temporally variable precipitation. The 1984 droughts, for example, primarily resulted in the loss of 1.6 million cattle (3.0 million cattle in 1980 and only 1.4 million in 1984), 0.5 million sheep (3 million in 1980 and 2.5 million in 1984) and 5.7 million goats (7 million in 1980 and 1.3 million in 1984) (Brouwer, 2009). Droughts also result in the loss of large areas of forest (CNEDD, 2006), increase the risk of bush fires and cause water reserves to dry out. Niger loses around 27 billion m^3 of water per year, which in turn reduces fish stocks (CNEDD, 2006). The 1984 drought, for example, caused fisheries production to fall from 5,000 tonnes in 1978 to just 1,100 tonnes in 1985 (Brouwer, 2009).

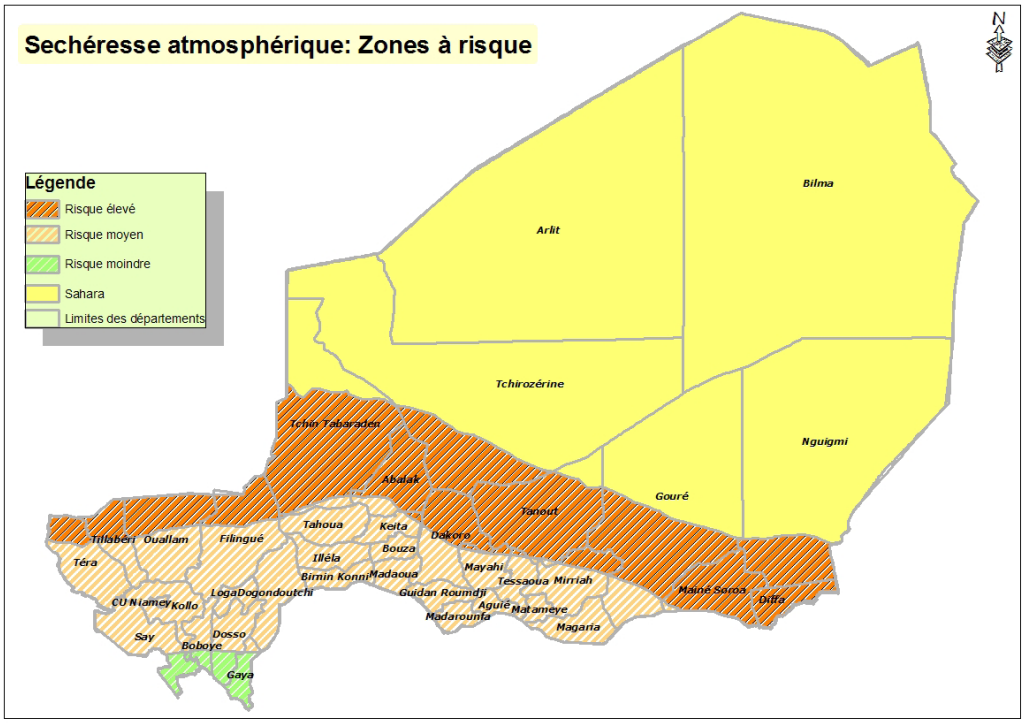

Figure 6. Map of areas at risk of atmospheric drought (reprinted with permission from CC/SAP, n.d.)

Translation of the legend from French to English

Légende	Key
Risque élevé	High risk
Risque moyen	Medium risk
Risk moindre	Low risk
Limites des départements	Department boundaries

The Sahel (and especially Niger) experiences three main types of flood, all of which are linked to precipitation (CC/SAP, 2011a):

1. Flash floods, which occur when heavy rain falls in a very short time.
2. River floods (rivers and *koris*), river-flow levels caused by intense and/or sustained rainfall in upstream watersheds, followed by significant run-off into the main watershed network. Examples include floods caused by the Niger River, the Komadougou Yobe River and uncontrolled discharge from the Jibya Dam on the Goulbi de Maradi River.
3. Floods caused by rising groundwater, the result of rising water from a shallow aquifer following exceptionally heavy rainfall. This type of flood occurs in the Dallol Bosso area in Boboye.

Flood risk is highest in the country's urban centres, such as Niamey, Tillabéri and Dosso, which are located in the valleys of active rivers, such as the Niger River (DNPGCA, 2011; CC/SAP, 2011a). As mentioned previously, the southern part of the Maradi, Zinder and Diffa departments, which are located in the Sahel climate zone, are more susceptible to floods (see figure 7). Despite low rainfall levels and the almost complete lack of rivers and waterways in the north, the Aïr and Azawak *koris* (in the Aïr Mountains, in the northern section of the map, within the Sahara climate zone) can also cause catastrophic floods due to the lack of protective structures and unregulated occupation of the floodplains. One such example is the city of Agadez, as shown in figure 7 (CC/SAP, 2011a).

Heavy rainfall is often accompanied by violent winds, which erode the soil and farmland and cause silting in rivers such as the Niger River (CC/SAP, n.d., CNEDD, 2006). In 1998, estimates are that flooding destroyed more than 9,000 ha of farmland and rice fields, killed almost 8,000 cattle, affected more than 40,000 people and submerged 4,000 homes (UNDP and BCPR, 2010). Floods also cause certain plant species to die early, resulting in poor fodder crop development and subsequently impacting agricultural production. Flooding also damages infrastructure (CNEDD, 2006).

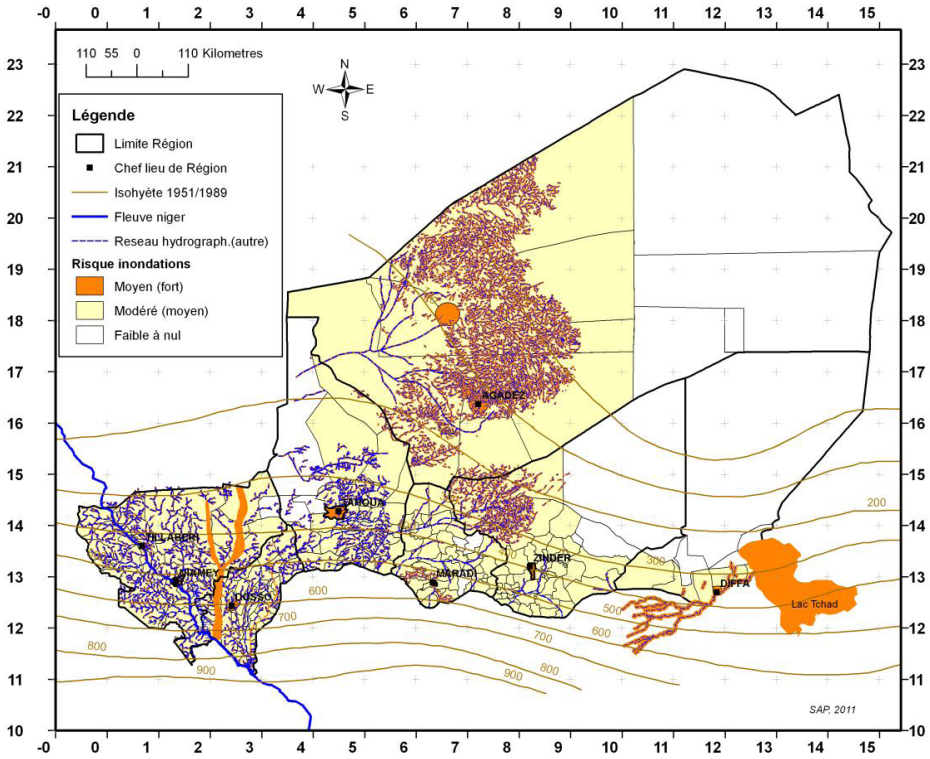

Figure 7. Flood risk areas (reprinted with permission from CC/SAP, 2011a)

Translation of the legend from French to English

Légende	Key
Limite Région	Regional boundary
Chef lieu de region	Regional capital
Isohyète 1951/1989	Contour line 1951/1989
Fleuve niger	Niger River
Réseau hydrograph. (autre)	Drainage network (other)
Risque inondations	Flood risk
Moyen (fort)	Medium (high)
Modéré (moyen)	Moderate (average)
Faible à nul	Low to zero

Niger is affected by a number of other climate hazards, including sandstorms, violent winds and heat waves. However, currently almost no information or data are available about the geographical distribution, frequency and impact of these events. Violent winds erode sandy soils, reduce agricultural production, damage infrastructure and can cause health problems (CNEDD, 2006). Combined with heavy rainfall, violent winds are a major cause of silting in rivers. Heat waves also cause severe health problems, such as epidemics of meningitis and measles and aggravation of cardiovascular diseases (CNEDD, 2006).

OBSERVABLE CHANGES IN CLIMATE

Climate conditions in Niger are highly variable over both space and time. Following a recent climate data analysis conducted as part of the AAP, Sanda et al. (2011) calculated the average annual values of a range of different climate measurements (precipitation, maximum and minimum temperatures, humidity, wind speed and potential evapotranspiration) using daily data recorded between 1961 and 2010 at the nine synoptic weather stations available for the study (Agadez, Birni N'Konni, Gaya, Mainé Soroa, Maradi, Niamey, Tahoua, Tillabéri and Zinder).

Sanda et al.'s analysis reveals a fall in average annual precipitation levels since 1970 at the Maradi, Niamey, Tahoua and Tillabéri stations, but no significant change at the other stations between 1961 and 2009. All the weather stations also indicate a slight increase in rainfall since 1990, but with one or two dry years at regular intervals. Temperatures exhibit an upward trend at all stations, with both minimum and maximum average temperatures increasing. This increase is relatively small at the Niamey and Tahoua stations. Average humidity values remained relatively stable. The results of the wind speed and annual evapotranspiration analyses were not reliable enough to draw any conclusions.

As with previous analyses (the NAPA and the 'Second National Communication' (SNC)), the results of this study cannot be used to draw conclusions about climate variability from year to year, as it deals solely with averages across the year. Furthermore, due to the limited number of synoptic stations used and their geographical distribution, it has not yet been possible to create annual average temperature maps for Niger.

PROJECTED CLIMATE TRENDS

Two major studies, conducted as part of the SNC (CNEDD, 2009) and the African Adaptation Programme (Sanda et al., 2011) feature climate forecasts for Niger. Their results are presented below. The two studies do not use the same models and do not cover the same geographical area and time period, so it is not possible to compare their results directly. There is consensus between the studies, however, on certain aspects of the forecast: an increase in temperature and uncertainty over precipitation forecasts.

Niger's SNC used a number of different models for the three Intergovernmental Panel on Climate Change scenarios (A2, B1 and B2). Data regionalization and disaggregation techniques were used to produce specific forecasts for Niger.[15] All the models predict an increase in average maximum annual temperatures from 2020 to 2049 compared with the reference period (1961 to 1990) (CNEDD, 2009). The predicted increase ranges from 2.3° C under scenario B2 to 2.6° C under scenario A2 (CNEDD, 2009). These are annual values, with the potential for more significant seasonal variations. For example, the forecast temperature increases are less significant during the wet season (June to September). Figure 8 outlines predicted average annual temperatures for 2020 to 2049 compared with the reference period (CNEDD, 2009).

A climate forecast study conducted as part of the AAP (hereafter called simply the AAP study) was based on two climate scenarios: dry and wet. The data came from nine synoptic weather stations in Niger. The forecasts are therefore specific to each of these stations (Sanda et al., 2011). The results show that the average annual temperature is likely to increase by 0.5° C in Tahoua under the dry scenario, and by more than 2° C in Maradi and Agadez under the wet scenario, by 2050 (Sanda et al., 2011).

[15] Commonly known as 'statistical downscaling.'

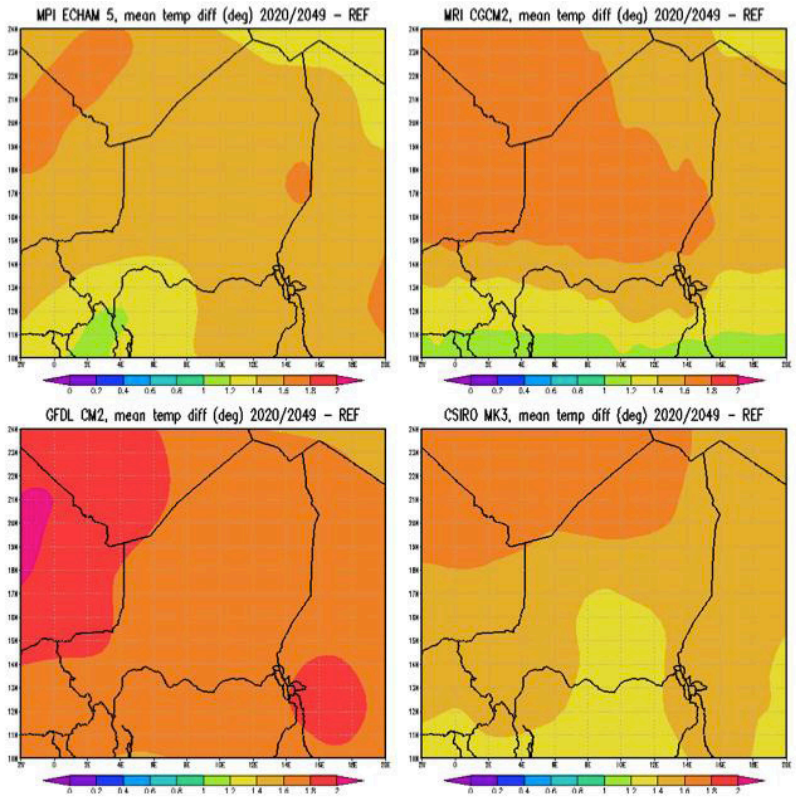

Figure 8. Relative variations in average annual temperatures (reprinted with permission from CNEDD, 2009)

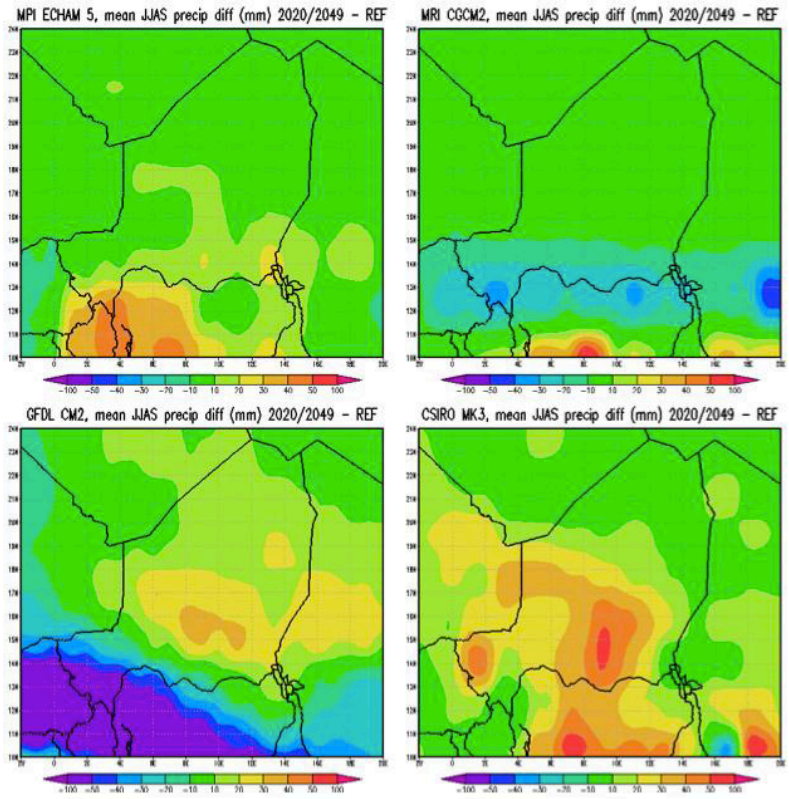

Figure 9. Relative variations in JJAS precipitation in Niger (reprinted with permission from CNEDD, 2009)

According to the models used for the SNC, precipitation is projected to increase slightly by 2020–2049 (CNEDD, 2009). Two of the four models, however, predict increased precipitation, while the other two predict a decrease (CNEDD, 2009). Figure 9 outlines predicted average annual precipitation levels for June, July, August and September (JJAS) for the period from 2020 to 2049, compared with the reference period (CNEDD, 2009). According to the wet scenario used in the AAP study, average annual precipitation levels will increase compared with the reference period, from less than 10 percent in Niamey to almost 90 percent in Agadez. The dry scenario, meanwhile, predicts a precipitation increase of 25 percent in Agadez, and a slight reduction of 10 percent in other areas, including Niamey and Tillabéri (Sanda et al., 2011). Average annual precipitation levels from 2020 to 2039 are predicted to be 8 percent higher than from 1980 to 1999 (Sanda et al., 2011). The forecasts suggest that episodes of heavy precipitation and drought will become more frequent, although there is some uncertainty over the areas and time periods concerned (CNEDD, 2009). Major uncertainty also remains over precipitation forecasts in general, as demonstrated by the SNC and AAP results.

The most significant and direct impacts of climate change will be rising temperatures and diminishing water resources. The climate models predict that flow levels in the Niger River will decrease due to the impact of future climate change. This could exacerbate the fall in river levels observed in recent years. The models also predict that floods will increase in size and frequency, particularly in the south. Evaporation will also increase, caused by rising temperatures, reducing available water resources even in those areas where precipitation is predicted to rise (CNEDD, 2009). Significant uncertainty remains over the impact on groundwater.

Other than rising temperatures, the most important impact of climate change may be increased spatial and temporal climate variability (with variability already high). Indirect future impacts could include accelerated soil degradation, a fall in agricultural and pastoral production levels, and a chronic lack of food supplies (CNEDD, 2009). A World Bank study predicts that by 2050, agricultural production in Niger will fall by more than 30 percent as a result of climate change. This would make Niger the most severely affected country in Sub-Saharan Africa (IFAD, 2012).

STATUS OF NATIONAL CLIMATE AND HAZARD INFORMATION

According to our literature review, significant discrepancies remain between different climate models and observed variables. In this respect, all climate forecasts contain a substantial element of uncertainty. Information about climate change in Niger remains limited due to a severe lack of climate data (CNEDD, 2009). Niger also lacks an economic assessment of the future impacts of climate change, past natural disasters and the economic value of the goods and services wetlands provide. This is due primarily to a considerable lack of data concerning these phenomena in general and wetlands in particular. For example, even though the country has 59 weather stations, only nine of these appear to have sufficient, continuous data records to allow conclusions about future precipitation and temperature levels (Sanda et al., 2011).

Key messages: Climate profile

- Niger has a particularly dry climate, with significant spatial and temporal variations in precipitation and temperature. The country experiences a four-month wet season and an eight-month dry season.
- The two main climate hazards that affect Niger are droughts and floods. Since the early 1970s, declining precipitation has been observed in some areas, while increasing temperatures have been observed countrywide.
- Temperatures are projected to increase, and uncertainty remains over whether precipitation levels will increase or decrease.
- Climate-related data is lacking in general, due to poor synoptic weather station coverage and limited institutional climate data collection, storage and dissemination.

CLIMATE IMPACTS AND RISKS

This section summarizes the results of a climate risk assessment conducted by Nazoumou et al. (2012) at La Mare de Tabalak as part of this study, using hydrological modelling and field surveys. This section is also based on the outcomes of a national workshop held in October 2011 and attended by 50 representatives of the village of Tabalak, the commune and department of Abalak, the Tahoua region, and various government ministries, research institutions and national NGOs (Karami and Danguiwa, 2011). The area covered by the climate risk study encompasses the pond's entire watershed, not just the body of water itself (as suggested in the Ramsar definition of 'wetland'). This is to ensure that all hydrological, biophysical and socio-economic processes that influence the body of water and wetland are included. 'Climate risks' are defined as the likelihood that the interaction between climate hazards and vulnerability conditions will have a negative impact on the pond, its resources and the local population.

La Mare de Tabalak (also known as the 'Water Valley' in Tamajeck) is about 50 km northeast of the city of Tahoua and 600 km from Niamey, at an average altitude of 395 m (figure 3). The pond's watershed includes at least 60 villages, mostly within the rural commune of Tabalak in the Abalak department (Tahoua region). The watershed also covers five other communes,[16] and this sharing of the wetland among six communes is one of the features that makes managing this wetland challenging. In the early 1970s, local populations began to settle around the pond, coinciding with the laying of an asphalt surface on the road between Tahoua and Agadez, and formed the village of Tabalak (LUCOP, 2009). The future of the village, as with many other surrounding villages, is therefore inextricably linked to the future of the pond. In 2001, when the last census was conducted (INS, 2001), the pond's watershed had a population of just under 42,000, spread across 60 different villages, with an average population density of 30 people per km^2 and an estimated population growth rate of 2.7 percent.

This natural freshwater pond became permanent in the 1950s following the rupture of the Kori d'Igaba Dam (Koroney, 1988; Greigert, 1966). Before 1950 the area was a vast, wooded swampland, which would dry out two or three months after the wet season (Koroney, 1988). In 1986 the pond had a surface area of almost 1,000 ha and was approximately 10 km long and between 100 m and 1 km wide. Its average depth was 2 m, but was up to 6 m in some areas (STUDI, 2001). The pond fills during the wet season (June to September) with surface run-off from a vast watershed covering an area of around 142,000 ha and drained by five *koris*. At the end of the wet season, in September, the pond is a single, thread-shaped reservoir. By the end of the dry season in April or May, it has divided into three separate reservoirs due to evaporation and silting. The basin comprises a series of plateaus, inland valleys and sand dunes (Département d'Abalak, 2004b).

The area has a climate favourable to agriculture (rain-fed and out-of-season), which remains the main economic activity of the basin. Rain-fed crops are grown on dune fields during the wet season, with each farmer cultivating around 6 ha. Millet, sorghum and black-eyed peas are the region's primary food crops. Yields are poor and often unpredictable due to poor soil quality and irregular rainfall (rainfall is insufficient in one of every three years). Yields have also stagnated since the 2000s, a trend that reflects a general fall in agricultural production across the country. In 2009, an estimated 40,500 ha of rain-fed crops grew in the basin, representing an increase of 57 percent from 1975 to 2009, in spite of adverse climate conditions (LUCOP, 2009).

'Out-of-season' crops are normally grown during the dry season (in February/March) in floodlands or on irrigated farmland, in inland valleys, and on the bed of the pond itself. Each farmer tends to cultivate less than one hectare. Land is irrigated using water taken directly from the pond, using concrete wells and catch basins or channels. Crops include onions, sweet potatoes, zucchinis, tomatoes, apples, cauliflower, lettuce, cassava, peanuts, black-eyed pea, capsicum, wheat, garlic, eggplants and peppers. As rainfall is so unpredictable, market gardening is the safest and most common form of agriculture. It is, however, highly labour-intensive because of its reliance on rudimentary techniques. Unlike rain-fed cropland, the area of irrigated farmland diminished by 12 percent between 1975 and 2009 (LUCOP, 2009), with 6,756 ha in the basin in 2009. Local actors confirmed this during the consultation process.

[16] Commune of Akouboune (Abalak department); commune of Kalfou (Tahoua department); and communes of Keita, Ibohamane and Azeye (Keita department).

Figure 10. Millet cultivation at La Mare de Tabalak. Photo: Yahaya Nazoumou

The Tahoua region owns 20.6 percent of Niger's livestock and is the largest livestock region of the country after Zinder (MDA and MRA, 2007). Livestock farming is the second-most-common economic activity in the La Mare de Tabalak watershed. The basin is home to a high number and wide variety of livestock (cattle, sheep, goats, camels, horses and donkeys). It was a migratory herding point before the formation of the pond. It is now a focal point for migratory herders, and it is also an important source of income for the indigenous population (from calf penning and fattening). Fishing has become a more common practice, with support from external parties and the local population. As well as providing a food source for the local population, fishing also generates income both for those who work in the sector and for the commune (through taxation) and the government (through fishing permits). The area also attracts many fishermen from across the region and even from abroad. The fish may even be sold abroad (such as to Nigeria) (Département d'Abalak, 2004b).

Figure 11. Houses (top left and right) and livestock rearing (centre) at La Mare de Tabalak. Photo: Yahaya Nazoumou

This area has a Sahel-Sahara climate, with a long dry season, lasting eight months, from October to May (with almost half of total annual evaporation occurring between March and May), and a short wet season of around four months, from June to September. An analysis of climate data for the period from 1961 to 2011, recorded at the Tahoua synoptic weather station (around 50 km from La Mare de Tabalak), was conducted as part of the AAP (Sanda et al., 2011). Temperature trends show an increase in minimum temperatures of 0.6° C. No clear rise in maximum temperatures was observed, however, in the 50-year period. The records show regular temperature spikes, pointing to the frequent occurrence of extreme events. Average temperatures in Tahoua vary from 15° C to 41° C. There was no clear increase or fall in rainfall levels between 1961 and 2011, but the records do indicate significant variation in annual totals (successive wet and dry periods). Average precipitation in Tahoua is 380 mm/year.

CURRENT CLIMATE HAZARDS AND VARIABILITY

According to members of the local population, "the level of the pond has changed." They associate droughts (*hamada*) with a lack of rain (*fari*), or with irregular rainfall throughout the seasons. Droughts are cyclical, generally occurring every 10 years or so. When the *koris* fail to supply enough water, the pond is unable to fill completely. This can sometimes cause it to dry out. According to the local population, the pond dried out completely in 1996, 2004, 2008 and 2011. In living memory, the area has received insufficient rainfall around one year in three. According to local actors, these droughts are the most significant threat to their livelihoods, as they affect almost every available income source. The participants stated that the pond has been more severely affected by droughts in the last few years than in the previous 10, 20 or even 30 years.

Local farmers find it increasingly difficult to organize agropastoral activities, due to a shift in the seasons from the traditional calendar. The local communities, especially women, are noticing a change in the quantity, frequency, intensity and duration of rainfall during the wet season (generally from June to August). They note that the wet season is becoming shorter, with less regular and less intense rainfall than 20 to 30 years ago ("The wet season starts late and ends early"; "We used to irrigate once a week, now we have to do it every other day.") The harvest (*kaka*) season generally falls between September and December. Traditional harvest celebrations (*sharo*) are no longer held as the harvests have become less abundant. Opinions differ on the issue of temperature changes in the cold season (*dari*, January to February) and the hot season (rani, March to May). However, local residents generally admit that increases or falls in temperature are now less perceptible due to improvements in living conditions (types of housing, fridges, better clothing, fans, air conditioning, etc.)

Floods (*hambalia ruwa*) are associated with rapid, sudden filling of the pond, followed by overflow onto farmland, residential areas and infrastructure (e.g. the main road). An event may be considered a flood if the water level rises to the level of the nearest residential areas. Only one major flood has occurred in living memory, in 1986, when homes collapsed (and the affected residents were moved to higher ground) and traffic was affected on the Tahoua to Agadez road.

Low rainfall levels and frequent droughts have had a major impact on the pond and its local population. Those questioned during local consultations revealed that the droughts have reduced the maximum water levels of the pond and groundwater sources (drawn from wells in irrigated farmland areas). Some even suggested that these droughts are causing the pond to dry out earlier than before at the end of the dry season (May), due to evaporation, infiltration and overexploitation for crop-growing and livestock farming ("Since November, we've been able to cross the pond on foot. In the past, it didn't start drying out until November!"). They remembered how the pond almost dried out completely in 1996 and 2004. The pond has dried out more frequently in recent years; a fact the local population sees as a threat to the pond's existence and a major concern for all population groups.

In collective memory, these droughts are associated with recurring food crises, particularly in 1973–1974 (the so-called *sagagi* famine), 1984 (the *timmoussou* famine), 1994 (the *chawaatou* famine) and 2004 (the *mairaga* famine). Droughts therefore coincide with a general fall in the ecosystem's productivity and all socio-economic activities that depend upon it (agriculture, livestock farming, fishing and handicrafts) and a subsequent rise in poverty and food insecurity. During water shortages, many animals gather around the pond, resulting in overexploitation of water resources and acting as a potential source of conflict. This situation also increases the risk of disease transmission and epidemics, both for livestock and humans.

Before a permanent pond formed, production activities in the area had never come to a complete standstill. The pond's regular drying out, however, causes a fall in activity across the watershed. The local population observed that frequent rainfall shortages result in a fall in agricultural production due to lack of water for irrigation and loss of farmland. While droughts are becoming more frequent and more intense, people also fear that the use of groundwater for irrigation—drawn from individual wells—could no longer be viable due to a drop in the water table due to insufficient replenishment. These regular water shortages also lead to a fall in livestock numbers due to a lack of grazing land and drinking water. This lack of water resources is already said to be causing a fall in fish production, due to degradation of the aquatic environment (shrinking of the pond, more rapid increases in water temperature through heating, eutrophication, etc.). Local residents and actors have already seen around five fish species disappear altogether, along with bank erosion and pond silting. Some local actors suggest that variations in water quantity and quality may already be having an impact on migrating birds. The handicrafts sector is also affected, as a lack of water leads indirectly to a reduction in raw material availability (leather, hide, wood, etc.). Floods can also contribute to falling agricultural production, with crops rotting when fields and channels are submerged under flood water for a sustained period, and farmland being lost when the pond expands past its normal level.

Successive droughts have accelerated pond degradation. Effects have included silting, degradation of vegetation, wind erosion (silting-up), degradation of grazing lands and infestation of the pond by invasive plant species. At the same time, factors not related to climate—primarily associated with changes in land use—have exacerbated the negative impacts of climate hazards on the pond's watershed.

The local communities have a somewhat more positive view of floods, probably because they occur less frequently and are less intense (especially in recent years). Floods are mainly seen as an opportunity to increase production and fishing. The additional water resources floods bring, boosting irrigation, fishing and livestock farming and delivering nutrients to farmland that becomes accessible once the waters recede, currently outweigh the negative effects.

The occasional floods damage infrastructure. In the past, the impact of flooding on homes and other infrastructure was relatively minor. Over the last few decades, however, construction of infrastructure around the edge of the pond during prolonged dry periods has been uncontrolled, increasing the risk posed by flooding.

FUTURE CLIMATE IMPACTS AND RISKS

Climate change impact studies were conducted as part of the AAP (Sanda et al., 2011). These impact studies included climate forecast data for the period from 2011 to 2050. According to the results, the average temperature in the Tahoua region will rise by 0.5° C to 1° C by 2050. Under the wet scenario, precipitation will increase by 8 percent in Tahoua compared with the reference period (1961 to 1990). Under the dry scenario, a 2 percent increase is forecast. These forecasts do not, however, reveal a significant change in precipitation (detailed charts are available from the author at jkarami@iisd.org). Also, climate variability under these projections is significantly reduced. Further analysis of the existing climate and climate change projections would validate the scenarios used.

According to the local community and actors, the risk of the pond drying out is now higher than before, due to extended and more frequent dry periods (perhaps every three years), a rise in the average temperature of the pond, and evaporation. The communities also anticipate a greater risk of flooding and, therefore, greater loss of habitat (due to population growth in at-risk areas) and more intense and frequent violent winds and sandstorms. They also believe soil degradation will continue to increase surface run-off and soil erosion. Their greatest fear is that the pond will disappear altogether due to a range of different factors, including the climate. If nothing is done to limit these negative impacts, the local population fears the onset of widespread poverty. They also point to the likelihood of greater conflict between users of the pond. The workshop report contains more details about local actors' perceptions of future climate hazard risks (Karami and Danguiwa, 2011).

Figure 12 shows changes to the water level in the pond, calculated on a daily basis using the SWAT model and based on projected climate data for the two extreme climate change scenarios (dry and wet). The graph shows a seasonal cycle of rapid filling during the wet season (due to high flow levels), followed by slower emptying during the dry season. Under this scenario, the risk of early drying-out is likely to persist. However, the level of the pond and volumes of water drawn from it have not been properly monitored over time. It is therefore difficult to identify a 'fill threshold' below which the pond is likely to dry out completely, or a 'flood threshold.' The graph shows 22 years of past observed climate data, and 38 years of projections based on the results of the AAP study (Sanda et al., 2011a).

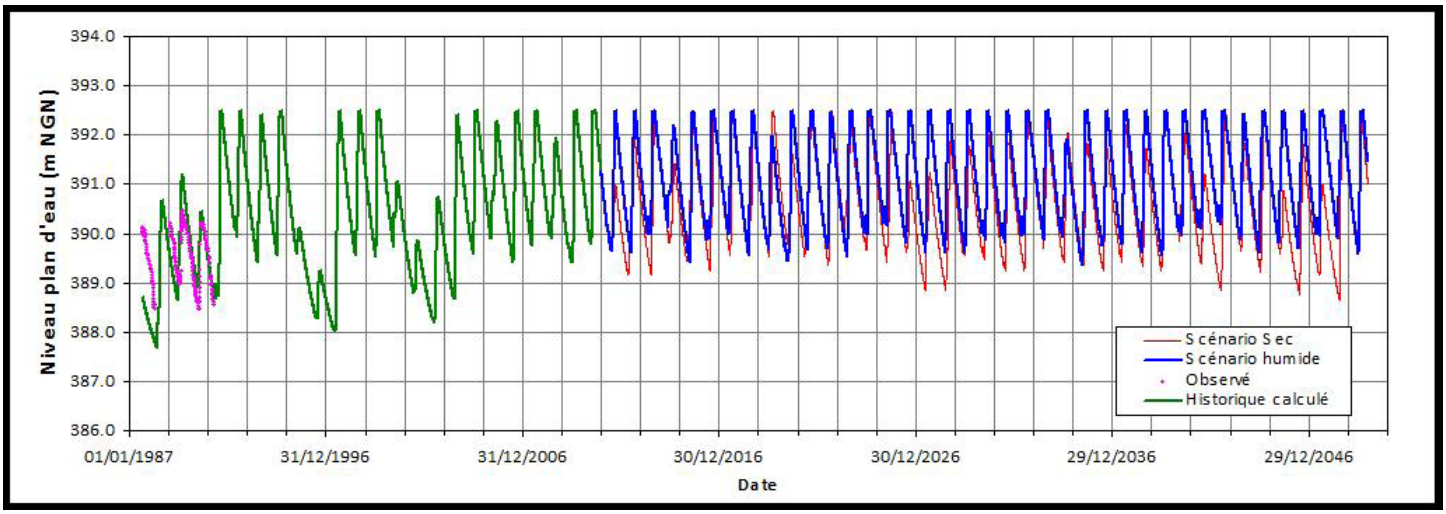

Figure 12. Future changes to La Mare de Tabalak: scenario based on the SWAT model

Translation of the legend from French to English

Niveau du plan d'eau (m NGN)	Water level (m NGN)
Scénario Sec	Dry scenario
Scénario humide	Wet scenario
Observé	Observed
Historique calculé	Historical (calculated)

The highly variable pond level shown in past data is consistent with historical rainfall records in Tahoua, which indicate long dry periods with a negative Standardized Precipitation Index from 1970 to 1990, 1995 to 1997 and 2000 to 2004 (see figure 12). Similar results were obtained using a water-balance model for the pond, covering the same simulation period (Adamou, 2011). The model indicated two especially dry years (1996 and 2008), characterized by an unusually low water level in the pond. The local communities confirmed that the pond had dried out in these years. The model did not, however, reproduce the drying-out that the communities had observed in 2004. Nevertheless, it does indicate a series of dry years ending two years earlier, between 1989 and 2002.

The historical records of Tabalak (see table 6) do not allow for accurate determination of pond elevations at which drought conditions can be determined. With the absence of threshold benchmark elevations, a pond height of 389 m above sea level was selected as an indicator of a dry year, because levels below 389 m are only periodically observed. Similarly, maximum elevations of 391 m and 392 m above sea level were selected as benchmarks of annual pond refilling. Further study would be required to determine the impact of these elevations for agriculture and fishing.

TABLE 6. NUMBER OF YEARS IN WHICH THE POND WATER LEVEL EXCEEDS CERTAIN THRESHOLDS

	TOTAL NUMBER OF YEARS	NUMBER OF YEARS IN WHICH THE WATER LEVEL FALLS BELOW 389 M	NUMBER OF YEARS IN WHICH THE WATER LEVEL DOES NOT REACH 391 M	NUMBER OF YEARS IN WHICH THE WATER LEVEL DOES NOT REACH 392 M
Modelled historical	22	9 (41%)	10 (45%)	6 (27%)
Dry scenario	38	5 (13%)	17 (45%)	3 (8%)
Wet scenario	38	0	2 (5%)	

The data indicate that in the observed period, the level of the pond did not exceed 391 m in 45 percent of years. In the projected period, the pond does not exceed this 391 m threshold in 45 percent of years under the dry scenario and 5 percent of years under the wet scenario. According to the results of the model, the water level of the pond is likely to vary less in the future, due to the climate change scenarios being less variable than historical records. However, further analysis is required to authenticate the climate scenarios used. The reduction in the water level of the pond in itself could also have negative impacts on some livelihoods that rely on crop production in the bed of the pond.

The gradual silting of the pond is a major concern for the local population. The pond is becoming shallower and extending over a larger area, reducing the amount of irrigated farmland available. To some extent, this process is part of the natural life cycle of ponds in general. However, changes to the pond calculated using the SWAT model do not account for gradual silting of the pond with sediment eroded from the watershed itself and the banks of the *koris*. In fact, no data are available on sediment transport in the Tabalak area. However, based on the average suspended sediment concentration (15 g/L) measured in the neighbouring Keita Valley basin (STUDI, 2001), the volume of the pond is estimated to be shrinking by around 1 percent per year. This means that by 2050, the pond will have lost 28 percent to 33 percent of its total volume, according to the extreme dry and wet scenarios respectively. However, sediment transport is highly variable from one year to the next and from one rainfall event to the next. This means that, depending on events and the condition of the surface (soil), an exceptional year may see high levels of sediment transport that could, in turn, significantly alter the configuration of the pond. As the pond has no natural downstream outlet, there is limited scope for natural dredging during major floods.

Without intervention, the pond may continue to silt up, expanding its surface area and swallowing up some of the surrounding land (residential areas and farmland). The expanding surface area of the pond is likely to result in higher levels of evaporation, as well as greater infiltration. In turn, the surrounding crop fields, major road and residential areas are likely to be flooded more regularly due to the pond's reduced water-storage capacity. Silting could therefore threaten the future of all production systems in the area (agricultural, pastoral and fishing).

In conclusion, although the SWAT model predicts that the water level in the pond is likely vary less in the future, there is a real threat to the existence of the pond itself and to the socio-economic activities of the local population, from increased water demand (due to rapid population growth in the basin and potential 'environmental refugees' from other regions affected by climate hazards) and unregulated use of water resources combined with natural resource degradation and gradual silting. The exact role of climate as a contributing factor to the silting process is yet to be determined.

VULNERABILITY OF THE POND AND LOCAL RESIDENTS TO CLIMATE RISKS

"When the pond will disappear, the village will disappear."
—resident of the commune of Tabalak

We have assessed the pond's vulnerability to climate risks in three steps: exposure and sensitivity to climate risks, existing capacities and resources, and current local responses.

Exposure and sensitivity to climate risks

Factors that make the pond and its inhabitants more vulnerable to the negative effects of climate risks include the exposure of the area and its inhabitants to climate risks; livelihoods that are heavily reliant on the condition of the pond; overexploitation of the ecosystem by an ever-growing number of users; a lack of integrated natural resource management throughout the basin; damage to the ecosystem from silting and invasive plant species; poverty, especially among women; and the security situation and conflict-prone nature of the area. Most of these vulnerability factors were documented between 2004 and 2006 in two development programmes (the Community Action Programme (PAC) and the Tillabéri and Tahoua Poverty Alleviation Programme (LUCOP), and in the '2010–2014 Tabalak Commune Development Plan' (Conseil Municipal de Tabalak, 2010). These trends were confirmed in the field survey conducted as part of this study.

High exposure to climate risks. Due to its location on the border of the Sahel and the Sahara and its closed water system, which is entirely dependent on rainfall, La Mare de Tabalak is a highly fragile ecosystem. The pond fills quickly during the wet season and empties more slowly during the dry season. It could therefore disappear as abruptly as it appeared around 50 years ago. The 'Local Development Plan' for the area (Département d'Abalak, 2004b) states: "The pond is located at the very limit of the rain-fed crop area; in this sense it is a 'frontier' zone, where the relationship between humans and the environment is especially complex" (unofficial translation). The area's climate is especially harsh and, as with the rest of the country, the local population depends heavily on rain-fed agriculture. The 'Multi-Risk Contingency Plan' (CC/SAP, 2011b) identifies Tahoua as one of the country's regions worst affected by severe food insecurity (23.6 percent), with a 'medium' flood risk.

Ten years ago, the population of the pond's watershed was just under 40,000. Most of its inhabitants depended on rain-fed and irrigated crops, livestock farming, and fishing for their livelihoods (INS, 2001). The high population growth rate around the pond is combined with intense competition for resources, both within the indigenous population and with outsiders. This pressure varies from season to season and follows changes in economic activity. It is also dependent on the surrounding socio-economic and environmental conditions. For example, during the dry season (and especially in May and June), livestock farmers from across the region bring their animals to the pond to drink. The commune alone is home to some 28,402 livestock, with annual water demand of 362,835 m^3 (Conseil Municipal de Tabalak, 2010). Fishing also attracts a large number of fishermen each year from the local area, across Niger and abroad. The number of local fishermen has risen from 5 in 1984 to 214 in 2010 (Service Communal de l'Environnement et des Eaux et Forêts, 2011).

An ecosystem overexploited by a varied and growing number of users. According to local communities and actors, degradation of the entire ecosystem is advanced. Plant coverage and plant biodiversity are on the decline. The woody plants on which the local population depend for their energy and food needs are gradually disappearing, and the local population now faces regular food shortages. In 2003 and 2004, a diagnosis of the state of La Mare de Tabalak (Département d'Abalak, 2004a) compared field observations with aerial photos of the area from 1955 to 1965 and 1984. The study found that degradation of plant coverage had already begun when the area was sparsely populated during periods of multiple droughts and low precipitation.

As already indicated, the local population has also noticed a reduction in animal biodiversity, particularly in terms of fish stocks, with some fish species having disappeared altogether. The field observations conducted as part of this study confirmed the findings of the 2004 assessment (Département d'Abalak, 2004a): that the watershed is degrading rapidly. Examples of this degradation include the silting or deepening of some *koris*, the appearance of new *koris*, water erosion caused by high sand content and bank erosion, and the development of ravines. According to the local population, farmland is degrading, soil quality is becoming poorer and more polluted due to frequent droughts and deforestation, and land degradation is already affecting the quantity and quality of water in the pond. They point to the emergence of new diseases such as schistosomiasis, which are associated with increased water pollution.

No integrated natural resource management. The local population recognizes that the pond is severely degraded and links this to a fall in agricultural, fishing and handicraft production. Degradation of the environment around the pond is exacerbated by poor natural resource management regulation in the watershed. Six communes created under the decentralization process are reliant on the pond for their development. Two of these communes have prepared commune development plans (PDCs, in French). No coordinated management of resources across the basin exists at present, despite a number of initiatives led by communities and community action programmes and supported by the Nigerian-German Programme to Fight against Poverty. In 2004 the community action programme began to prepare an intercommunity integrated resource management plan. But this development programme has not yet been implemented, due to differing opinions on a number of questions—including migratory herding—and lack of funding. The lack of regulation extends to other areas, including the use of unregulated seeds from Nigeria, household waste management and commercial activities. All these activities are responsible for polluting local water resources. Tighter regulations govern fish stocks (e.g. regulations concerning fishing bans, net mesh sizes and fishing gear), but these are often ignored by fishermen, despite the fact that the pond is monitored by local officers and community cooperatives.

Damage to the ecosystem through silting and invasive plant species. The greatest concern among local communities and actors is the gradual, continual silting of the pond, which threatens the future of both the pond itself and all socio-economic activity in the region. This process also gradually reduces water availability, as more water evaporates from the pond during the dry season. Furthermore, invasive plant species (such as *tsékia, sisoubouba, shalla* and *tifa*) are becoming more widespread. This is a relatively

recent phenomenon that seems to have started some 15 to 20 years ago but was relatively rare until around 10 years ago. This invasion of both the pond and the land by plants is yet another hazard facing the communities, and fisherman in particular. For example, once *typha* has taken root, it places pressure on the fish population. It also tends to resist herbicides. The local population associates the gradual silting of the pond with water and wind erosion. In general, however, they do not appear to have established clear links between silting or invasive plants and climate risks. They have several theories to explain the invasion of the pond by aquatic plants, the most common of which is that they have been carried there by migrating birds. International studies have shown that climate change can both directly and indirectly increase the incidence of invasive plant species by enabling them to take root and spread. Invasive plants can also exacerbate the harmful effects of climate change on ecosystems (Burgiel and Muir, 2010).

Poverty, especially among women. Between 2005 and 2007–2008, poverty increased in the Tahoua region, and in 2008, the region was the fourth-poorest in Niger, after Tillabéri, Dosso and Maradi (INS and PNUD, 2009). No centrally held, detailed, specific socio-economic data exist for the populations of the villages within the watershed. The 'Local Development Plan' (Département d'Abalak, 2004b) states that the literacy rate within the pond basin is extremely high (over 95 percent), especially among women. Both men and women often carry out several activities at once. The men mainly grow irrigated crops (mostly onions), herd livestock, grow rain-fed crops, fish and trade. The women, meanwhile, tend to grow market garden crops, fatten livestock and grow rain-fed crops (in decreasing order of importance). The results of the household surveys conducted as part of this study show that women earn, on average, one-twentieth the income of men,[17] primarily because they also perform many unpaid, family-related tasks. Furthermore, women of all groups have much more limited access to resources. The men own the land and are responsible for fishing. The women often work on marginal land and are involved only in selling the fish (fish trading and frying). The local population recognizes that women (of all groups) and children are more vulnerable to the harmful effects of climate risks, as they have fewer options to fall back on during crises.

A complex and sensitive environment. The farming system within the watershed is highly complex. Activities are organized in such a way that many different ethnic and user groups interact (farmers, livestock farmers, fishermen and traders; sedentary and nomadic users; and local residents and visiting users). Although some of the local population has settled around the pond, nomadic groups continue to travel to the area during the dry season, intensifying the pressure on the pond during this long season. This pressure on the environment heightens competition between users. While the local population and actors talk of strong social cohesion and a lack of conflict among farmers, there remains a significant, if latent, risk of conflict. Furthermore, increasingly frequent conflicts began being reported back in 2006 (Watakane et al. 2006). This potential for conflict affects all pond users. Farmers use thorny plants, for example, to mark the boundaries of their fields and protect crops from damage by animal herds. This is already creating problems for fishermen, however, as these thorny plants are washed into the pond during floods, making fishing difficult. Conflicts also occur between farmers and livestock herders, with farmers encroaching onto traditional herding routes. As well as these 'horizontal' conflicts among different users of the pond, there are also potential 'vertical' conflicts between upstream and downstream users. Upstream projects (such as dams), for example, can have serious negative repercussions and can even move risks (e.g. flooding) downstream. Regional conflict is ongoing between the Tuaregs and the Government, and this conflict affects the area's development.

Existing capacities and resources

Despite the numerous challenges outlined above, La Mare de Tabalak boasts significant potential, which could help limit the negative effects of climate risks. These include its human and economic potential, a varied institutional landscape, the availability of donors to support the local population, the emergence of a new generation of female leaders, and awareness among the local population that the environment is degraded but that this can be reversed.

Human potential: a diverse, cosmopolitan environment. The major ethnic groups living at La Mare de Tabalak are Hausas, Tuaregs and Fulas. The Hausas were the first to arrive, seeking fertile farmland to grow crops. They were followed by the Tuaregs in the 1970s and 1980s (drought years), who were attracted by water and grazing lands for what remained of their cattle, as well as the availability of farmland. The Fulas were moved into the area by the Government after losing their entire herd following the 1983 droughts. Each group has brought its own knowledge and expertise. The coexistence of these groups is not, therefore, simply a potential source of conflict, but also of enrichment. For example, in order to adapt to recurring droughts, all ethnic groups now carry out livelihood activities traditionally reserved for just one or two groups.

[17] The annual incomes of the eight male heads of household questioned ranged from US$3,291 to US$14,981. By comparison, the annual incomes of the eight women questioned (either heads of household or juniors) ranged from US$197 to US$748.

Economic potential (heavily reliant on the condition of the pond). As outlined previously, the household survey conducted in 2011 showed that income levels in Tabalak (especially among men) are high: an indicator of a strong economy. The local authority (Mairie de Tabalak) also receives additional income by issuing fishing licences and imposing other taxes on fishermens' groups. In general, the local population has seen a major improvement in living conditions and an increase in income. This income is mainly earned through use of the pond's resources (including grazing lands for livestock) and is boosted by the favourable location of the village, which is ideally situated for trade, on a major road. Despite this, the economy remains heavily reliant on the pond and, therefore, vulnerable to climate hazards. When the 'Local Development Plan'[18] was prepared in 2004 (a drought year), agriculture had become a subsistence activity. The plan (Département d'Abalak, 2004b, 18) states: "we have been unable to meet our food needs for the last 10 years or so; there are no financial reserves and fallowing is becoming increasingly rare" (unofficial translation).

Figure 13. Local fish market at Tabalak. Photo: Lawali Malam Karami.

A varied institutional landscape—a key driver of development. Tabalak and the surrounding area benefit from a range of different organizations and associations, which play a central role in the area's socio-economic development. The local populations (especially women) are very familiar with the institutions of their commune. The commune of Tabalak was created in 2004 as part of the country's decentralization process. This new, local administration has helped close the gap between government and the population and has played an important role in conflict resolution. Structures known as Commune Land Committees have been set up to deal with land shortage issues and are operating effectively. The local government is also involved in steering and preparing programmes and projects via the 'Commune Development Plan' (PDC in French). As well as the local government, many other organizations support development in the area, including the local technical departments (agriculture, water and forests, fishing), which play a very important advisory role despite being poorly funded, and unions and federations of local and communal socio-professional organizations. The local radio station and the Islamic Association also play an important role in social life.

[18] With the recent creation of 'communes' through decentralization, the 'Local Development Plan' has been replaced by the 'Commune Development Plan' (PDC in French).

Support from development programmes and projects. Due to the number of droughts and famines the area has suffered, La Mare de Tabalak has been a regular target of development projects. Interventions in the area reflect Niger's national priorities: food self-sufficiency, poverty alleviation and protection of the environment (particularly combating desertification and soil degradation). The pond and its inhabitants first came to the attention of development partners in the late 1960s, when UNICEF introduced the first fish to the pond. Since then, the area has seen numerous external interventions, which have supported sustainable development. The projects and programmes have focused on supporting decentralization, livestock farming and food security, infrastructure development such as the construction of the Kéhéhé agricultural water system (dam) to create an area of irrigated farmland, and protection and restoration of the watershed environment.

A new generation of female leaders. Despite the fact that poverty is significantly higher among women than men, women are a dynamic group and play an active role in the region's socio-economic life (and in the implementation of development projects, as proven by their active participation in this study). Women seem to be the main beneficiaries of development programmes and projects. They now tend to have better access to land, through the efforts of development projects (e.g. the purchase of market gardening land for female use only). In general terms, the local women are entrepreneurs and actively seek to improve their own living conditions. With external support, they have formed women's groups and associations for a wide range of activities, including self-financing, microcredit, cattle and sheep fattening, and fish-trading, while continuing to carry out most (if not all) household tasks. Over time, these groups have transformed into self-help structures. By playing an active role in community life, women create a more dynamic local economy and prove their importance in alleviating rural poverty.

Awareness among the local population that the environment is degraded. The local consultations reveal that the population is aware that the economic boom in the area is not irreversible, and that it relies heavily on wise management of the pond and its watershed. A number of NGO-run development projects and programmes have helped raise awareness of this. Most of the population is concerned about the future ("If the pond disappears, the village will disappear"), particularly due to the increased frequency of droughts and to degradation of the environment.

Responses to climate risks and hazards

While some famines (such as in 1973–1974) are associated with death (*sagagi*), especially among men, the local population is far from powerless in its responses to a range of different hazards, including climate hazards. The field surveys and consultations reveal that the local communities and regional actors have developed a range of responses to such hazards (with the support of development projects and technical departments). Table 7 contains a detailed list of all existing responses and capacities, as documented during the consultation process. The sustainable strategies used at present primarily involve diversifying livelihoods, developing small-scale irrigation and performing environmental protection and restoration activities.

Diversifying livelihoods. While livestock farming and rain-fed crop-growing are the area's two traditional activities, the local communities have diversified into irrigated crop-growing, market gardening and fishing. According to the 2005–2007 Agriculture and Livestock Census (MDA and MRA, 2007), the trend for households to combine both livestock farming and agriculture—instead of specializing in one of these sectors—is reflected at the national level. This diversification undoubtedly helps households adapt more effectively to hazards (including climate hazards). Herding small ruminants (goats and sheep) is a useful way to supplement often unstable income from rain-fed agriculture. Alongside these agrosilvopastoral activities are other revenue-generating activities such as handicrafts and petty trading.

Developing small-scale irrigation. The development of small-scale irrigation (with donor support) means that farmers are now less dependent on rain-fed crops, which in turn are heavily reliant on an uncertain climate. Various projects and programmes have been initiated, such as the Export and Agro-Sylvo-Pastoral Market Development Project, delivering a range of support, including the development of groundwater boreholes. The introduction of modern agricultural techniques, and the shallow water table, mean that farmers irrigate their fields by pumping water from boreholes. As well as sinking individual wells, farmers have developed small-scale irrigation by constructing boreholes and catch basins to access groundwater. By using groundwater for irrigation, the water in the pond is reserved for livestock when required. Women are not capable of digging wells and boreholes, however, and only men with high incomes are able to afford motorized pumps.

Figure 14 .Fishermen with livestock in the background at La Mare de Tabalak. Photo: Yahaya Nazoumou.

Protecting and restoring the environment. The area has also seen the introduction of a range of different environmental protection and restoration activities, again with the support of development programmes and projects, which have had a major focus on this issue in the last 20 years. Protection measures have included planting small trees (mesquites) in the village and surrounding area, restoring a number of *koris*, and building a downstream channel to carry water from the pond in the event of a flood. From a strategic viewpoint, some interventions (e.g. the Nigerian-German Programme to Fight Against Poverty) are also intended to make the PDCs 'greener.'

Current responses to silting involve biological and mechanical intervention on the *koris* and watershed. Several water system projects (including dams, dune stabilization, etc.) have been conducted in the watershed (see the Integrated Keita Project and the Special Programme of the President of the Republic of Niger). The local communities recognize that some activities, such as planting trees around the pond, could be funded from local resources. Other measures to protect the watershed from erosion, however, require substantial resources that go beyond the capabilities of the local village communities. Examples include constructing anti-erosion systems, planting trees, stabilizing dunes and sinking boreholes. Such activities require the ongoing support of the government and NGOs.

Responses of last resort. In the event of a severe food crisis (famine), households turn to short-term solutions—often of last resort—in response to climate hazards. The local population has already experienced several famines associated with recurring droughts. During times of food shortage, households turn to 'crisis' foods such as tree leaves and wild fruits (e.g. the leaves of *Leptadenia hastate*, and wild fonio[19] or *intay*). The poorest sometimes resort to selling leaves and wild fruits for income. Unfortunately, according to the local community these plants are disappearing. Those in greatest need often receive some assistance from other village members through food-sharing.

Most of the responses of last resort are not sustainable. The most common practices include selling livestock to reduce herd sizes, dependence on food aid, deepening the pond, exodus to urban centres or neighbouring countries, and dependence on money sent by migrants. Tahoua has the highest exodus rate in the country, and most migrants are heads of household and young people. This situation places pressure on households, and especially on women, who are increasingly forced to take on the duties of head

[19] A West African herbaceous plant.

of household. Those consulted stated that the income generated through migrant work is extremely important. However, the mass return of migrants from Libya and Côte d'Ivoire since February 2011 demonstrates how this income stream is heavily dependent on socio-economic and political events in the region. The reduction or disappearance of these income streams can leave households in debt and much more vulnerable (Webrelief, 2011).

Some responses are the same across all social groups, while others are only accessible to certain groups (e.g. exodus and individual well-sinking are primarily male solutions, while market gardening is primarily a female solution). Some strategies are not financially viable for the communities and require continuous, coordinated, basin-wide external support (e.g. sinking individual wells, deepening the pond, building new infrastructure on the dunes).

TABLE 7. MAIN RESPONSES TO DROUGHTS AND FLOODS IN THE POND WATERSHED

CURRENT RESPONSES	CLIMATE HAZARDS	SCALE	SUSTAINABILITY
AGRICULTURE			
• Developing small-scale irrigation by sinking individual wells, constructing boreholes and catch basins to access groundwater, and extracting water using motorized pumps.	Droughts	National Regional Local	Not financially sustainable. External support is needed to construct these relatively expensive systems.
• Promoting out-of-season crops.	Droughts	National	Sustainable.
• Using improved, drought-resistant, short-cycle seed varieties.	Droughts	Regional	Sustainable, but must be accompanied by research and outreach work.
FISHING			
• Diversifying into new activities (e.g. petty trading).	Floods Droughts		Sustainable.
• Regulating fishing (introduction of a fishing ban period).	Droughts	Local	Sustainable, but problems enforcing the regulations.
• Moving fishermen to other water points (ponds).	Droughts		Not sustainable.
• Introducing new fish (the men travel to Nigeria to acquire new fish stocks for the pond).	Droughts		Sustainable if the fish species are adapted to the new conditions.
• Keeping breeding animals in wells.	Droughts	Local	Sustainable.
• Cutting back invasive plants.	Droughts	National	Unknown.
• Raising awareness to stop the local population from growing market garden crops in the pond.	Droughts	Regional	Sustainable.
LIVESTOCK FARMING			
• Creating cereal banks and livestock food banks (Banques d'Aliment Bétail – BAB)—wheat, bran, peanut and cotton seed stocks—with the support of NGOs, donors and the government.	All	National Regional	Sustainable with external support.
• Supplying agricultural residues and purchasing bran and wheat.	Droughts	Local	Depends; requires good storage methods.
• Moving to more favourable areas in search of grazing lands (to the north for wintering and to the south in the cold season).	All	Local	Not sustainable, and often a source of conflict.
• Migratory herding to Benin, Nigeria and Chad, and exodus during the difficult season.	All	Local	Sustainable; this is a traditional activity.
• Selling livestock to meet the food needs of a smaller herd.	All	Local	Not sustainable.
HANDICRAFTS			
• Mobilizing women's groups to raise funds and secure loans from credit unions.	All	Local	Sustainable if loan amounts are small.
• Selling handicraft products in Niamey through social/ family networks.	All	Local	Sustainable.

TABLE 7 CONTINUED

CURRENT RESPONSES	CLIMATE HAZARDS	SCALE	SUSTAINABILITY
LAND DEVELOPMENT/LAND MANAGEMENT			
• Using biological and mechanical means (cloning and sowing) to stabilize the dunes and prevent siltation • Protecting the watershed by developing anti-erosion systems (regional and national). • Carrying out remedial work on the *koris*. • Planting new trees around the pond ('food for work' or 'cash for work').	All	National	Sustainable but unaffordable for the local population, even if they have the technical expertise.
HEALTH			
• Building public latrines and showers.	Floods	Regional?	
INFRASTRUCTURE			
• Moving homes and infrastructure onto the dunes.	Floods	Regional	Sustainable, and accessible to both men and women.
• Building new/future homes on the dunes.	Floods	Local	Sustainable, but only accessible to those with sufficient resources.
• Using the Kéhéhé canal to drain away excess water.	Floods	Regional	Not sustainable, as it requires proper maintenance of the canal and understanding from downstream populations.*
INTERSECTORAL			
• Turning to 'crisis' or 'famine' foods.	All	Local	Sustainable, but according to the local population, some of these 'crisis' foods are disappearing.
Rural exodus, of men and young people in particular, to the Maghreb and other neighbouring countries (Côte d'Ivoire, Benin, Togo, etc.) and relying on funds sent back by migrant workers.	All	Local	Not sustainable. This creates tensions within households, with women having to take on more responsibilities and losing income as a result (at least initially). Funds are not always sent back consistently.
Food-sharing.	All	Local	Sustainable
Turning to food aid (cassava flour, biscuits, oil, etc.).	All	National (government and partners)	Not sustainable, as this solution depends on the international economic situation. The aid does not always reach the neediest.
Deepening the pond.	Droughts Floods	Local	Not sustainable.

** The inhabitants of Kéhéhé fear that their fields will be flooded.*

Key messages: Climate risks

- La Mare de Tabalak has an important ecological and socio-economic role at local, regional and even international levels. The pond and its inhabitants are highly vulnerable to recurring droughts, which reduce water levels or even cause the pond to dry out. This leads to falling production from all agrosilvopastoral activities and, in turn, recurring food crises (famines).
- Although floods damage infrastructure, the local population associates them with an abundant water supply that enables them to increase production and fishing levels. The negative impacts of climate hazards are exacerbated by a number of other factors, such as environmental degradation, population growth, siltation and invasive plant species, poor management of the basin, local and regional insecurity, and poverty.
- The water level in the pond is likely to become less variable in the future, but further climate analysis is required to validate this conclusion. Despite these challenges, the pond has a number of assets that help the local inhabitants respond to stress. But many of these responses are insufficient for coping with recurring droughts, with local inhabitants often turning to strategies that are unsustainable, reinforcing degradation and vulnerability.

INSTITUTIONS AND POLICIES FOR CLIMATE RISK MANAGEMENT

As in most countries, climate risk management policy currently focuses on two key areas: disaster risk management and climate change adaptation. The following sections describe the main institutions and government policies in each of these areas and examine the extent to which climate risks are incorporated into the country's main national and sector-specific policies. The analysis is based on an examination of existing documentation and national-level consultations.

DISASTER RISK MANAGEMENT

Niger has the **Early Warning System** (EWS), responsible for disaster risk management. It was created in 1989 and is managed by the Prime Minister's office. EWS was originally set up to manage food insecurity. However, since the **Food Crisis Unit** took over the management of food crises, the role of the EWS has been revised to cover a wider range of risks, including disaster risk management (Food Crisis Prevention Network, 2011). The **Disaster Risk Management and Prevention Unit** was set up in early 2012 to ensure that EWS covers disaster risk management effectively.

EWS has four key objectives (Ousseini, 2010):

1. To collect and analyse data relating to food, health, nutrition and socio-economic factors.
2. To collect information about the ability of specific populations to adapt.
3. To recommend other measures to support disaster victims.
4. To analyse the impact of food crisis alleviation actions.

Other national disaster risk management systems include:

- The **National Food Crisis Prevention and Management System (DNPGCA in French)**, launched in 1997, which involves "the government and its key donors and partners" (DNPGCA, 2007) (unofficial translation). This is the country's only coordination, collaboration and joint management framework for food crisis and rehabilitation management and prevention. EWS is one of several institutions involved in this national system.
- The **National Natural Disaster Risk Management Platform**, introduced as part of the Hyogo Framework for Action in 2005, with the support of UNDP (Ousseini, 2010). The Early Warning System Coordination Unit acts as the permanent secretariat of the National Natural Disaster Risk Managment Platform. It is chaired by the director of the Prime Minister's office (CC/SAP, n.d.).
- The food and nutritional security section of the '**National Contingency Plan**,' created in 2008, which exists to "limit the impact of food and nutritional crises on the population" (Ousseini, 2010) (unofficial translation).
- A **flood warning and monitoring technical committee**, introduced in August 2010.
- A '**National Multi-Risk Contingency Plan**,' and **regional multi-risk contingency plans** for Tahoua, Agadez, Diffa and Tillabéri, prepared in 2011 by DNPGCA and the General Directorate for Civil Defence to address "food crisis, flood and population-movement risks" (DNPGCA, 2011) (unofficial translation).

Niger has not developed a specific disaster risk management policy. Although food security has long been a priority, climate risk management is much more recent. Since 2008 the country has had a 'National Disaster Risk Management and Prevention Strategy' and a 'National Natural Disaster Risk Management and Prevention Plan,' developed as part of the National Natural Disaster Risk Management Platform (CC/SAP, n.d.).

CLIMATE CHANGE

In 1996 Niger created the **National Environment Council for Sustainable Development** (CNEDD in French) as the key national environment and sustainable development policy coordination and monitoring body, in accordance with the agreements made at the Rio de Janeiro Summit in 1992 (CNEDD, 2011a). The Council is managed by the Prime Minister's office.

The '**National Environment Plan for Sustainable Development'** was officially adopted in 2000 to "investigate new development options, improve the food security situation, find a solution to the domestic energy crisis, improve sanitation conditions and promote economic development among the population" (CNEDD, 2011a) (unofficial translation).

The Executive Secretariat of the CNEDD (SE/CNEDD) is supported by seven national technical committees to "design and implement priority programmes of the national environment and sustainable development policy, and to monitor and assess these programmes" (CNEDD, 2011a) (unofficial translation). The **National Technical Committee on Climate Change and Variability**, created in 1997, supports the SE/CNEDD in implementing the **Climate Change and Variability Programme** (Bako Safi, 2010). The SE/CNEDD also set up an **Adaptation Unit**, involving a range of different actors from civil society and government ministries, in 2011.[20]

In accordance with the United Nations Framework Convention on Climate Change, CNEDD has prepared a collection of key documents concerning climate change. These include the **national communications in 2000 and 2009** and the 'N**ational Adaptation Programme of Action' (NAPA)**, to adapt the harmful effects of climate change, in 2005.

RECOGNITION OF CLIMATE RISK MANAGEMENT IN KEY POLICY DOCUMENTS

The Government has made significant efforts to incorporate climate risk considerations into its policy planning. The NAPA identified agriculture, livestock farming and forestry, water resources, and wetlands as most vulnerable to climate risks. The wetlands sector encompasses all the other sectors in this list, as it provides the environments and resources needed for these activities. The extent to which climate change and variability issues are incorporated into national agrosilvopastoral activity and water resource policies is therefore crucial in determining how effectively the wetlands sector will be able to adapt to climate change. The country's main wetland-related policies (including those concerning La Mare de Tabalak), and other key national policies, are detailed below according to the extent to which climate risks are incorporated into each policy.

Climate risks fully incorporated:

- **'Accelerated Development and Poverty Reduction Strategy (ADPRS) 2008–2012'** (Secrétariat Permanent de la SRP, 2007a): Climate hazards are identified as a key obstacle to achievement of the ADPRS objectives and, as such, to the country's development and poverty alleviation efforts. The strategy aims to make Niger less vulnerable to exogenous shocks such as climate disasters and to limit the economy's reliance on adverse climate conditions. It binds the Government to specific climate change measures, such as improving weather and climate data collection, processing and archiving, improving climate observation and weather monitoring networks, and making weather and climate products available to users.
- **'Rural Development Strategy' (SDR in French)** (Secrétariat Permanent de la SRP, 2007b): Climate risks are mentioned as one of the factors affecting the vulnerability of farmers. The SDR also focuses on crisis and natural disaster prevention and management in order to make the population less vulnerable to these events.

Climate risks partially incorporated:

- **The 'National Wetlands Policy'** (draft version) (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009): Not yet final. It contains only one direct reference to climate change and extreme climate phenomena, as one of the 11 guiding principles of the national wetland and watershed protection and restoration policy. The purpose of this policy is to increase the resilience of wetlands to climate risks and extreme climate phenomena and to reduce the impact of floods and droughts. Although the policy does not mention climate change specifically, the document does set out a range of different actions, such as restoring and protecting wetlands, to indirectly minimize the negative impacts of climate risks on wetlands.

[20] At the time of writing, the terms of reference were pending approval. So far, the members have met to approve a range of different studies on climate change and to ensure that the findings are followed up on.

Climate risks hardly incorporated (or not at all):

- **Rural Code** (Code Rural) (1993): Does not mention climate risks associated with climate change or variability.
- **Pastoral Code** (Code Pastoral) (1993, revised in 2010): Does not mention climate risks associated with climate change or variability.
- **Water Code** (Code de l'Eau) (1992, revised in 2010): Does not mention climate risks associated with climate change or variability.
- **'Niger Water Resource Management and Use Master Plan'** (1999): Makes no reference to climate change or variability.
- **'National Strategy for Irrigation Development and Water Harvesting'** (2003): Incorporates climate variability to some extent, with an objective of breaking the reliance of agrosilvopastoral production on climate uncertainty and delivering sustainable social and economic development in the country regardless of climate variations.
- **'Tabalak Commune Development Plan 2010–2014'** (PDC in French) (2010): Makes no reference to climate change or variability.

Climate change and variability remain insufficiently incorporated into Niger's sectoral and national development policies (CNEDD, 2009; Adaptation Partnership, 2011). However, as the ADPRS is the country's key strategy, guiding other social and economic policies, it is promising to note that climate change and variability are fully incorporated into this strategy, ensuring that other policies are on the right track. Furthermore, Niger is currently developing a National Climate Change Policy (CNEDD, 2011b), and there is a general desire to incorporate climate risks into disaster prevention policies. Work is currently underway to incorporate climate change and climate risks into EWS (Sanda et al., 2011).

CLIMATE RISK MANAGEMENT ACTIVITIES

Niger has extensive experience adapting to climate change. As part of the United Nations Framework on Climate Change, Niger presented its 'First National Communication' in 2000, its NAPA in 2006 and its 'Second National Communication' in 2009, and is currently preparing its 'Third National Communication.' Niger has a number of national programmes to build national capacities and incorporate climate change and/or climate risks into:

- Development planning, such as the Pilot Programme for Climate Resilience and the African Adaptation Programme (AAP).
- Sustainable natural resource management, such as the Community-Based Adaptation Programme.
- Food security issues, such as the '3N' initiative ("*les Nigériens Nourrissent les Nigériens*": Nigeriens Feeding Nigeriens).
- Socio-political conflict and disaster prevention and management, such as the Crisis Prevention and Management Capacity-Building Programme.

These national programmes are relatively recent or have not yet been implemented, so it is not yet possible to draw any conclusions about effective implementation or the extent to which synergies have developed among projects. A review of past and current climate change adaptation projects in Niger (CNEDD, 2010) concluded that coordination and knowledge-sharing was lacking among actors at all levels, and so was consistency among different projects. The review also noted that no national result-dissemination system exists. Climate risks have only recently been incorporated at the national level. Most local development projects have focused on natural resource management, which can indirectly minimize the negative impact of climate risks. In accordance with the country's decentralization process, almost all projects and studies involve participatory processes and focus on reducing vulnerability and increasing the resilience of communities (such as the Community-Based Adaptation Programme, the NAPA and the Crisis Prevention and Management Capacity-Building Programme).

ASSESSMENT OF CLIMATE RISK MANAGEMENT CAPACITY

This assessment of national climate risk management capacities is based on a short literature review and national-level consultations, using the 'National Adaptive Capacity Framework' developed by the World Resources Institute (World Resources Institute, 2009). The framework identifies a series of national functions that countries must perform in order to adapt to climate change: assessment, prioritization, coordination, information management and climate risk reduction.

Assessment. A number of climate change vulnerability and adaptation assessment studies have been carried out, from the national to the commune level. The major studies in this area were conducted as part of the national communications and the NAPA (Sanda et al., 2011; UNDP, 2011). Most of these studies have adopted a participatory approach (e.g. the NAPA). However, most remain specific to one sector, mostly rural agriculture. As yet, no integrated climate change and variability impact study has been carried out for these sectors. Several studies have focused on disaster risk factors (UNDP, 2007; DNPGCA, 2007) and a number of ongoing studies are assessing the economic impacts of climate change (the AAP and 'Third National Communication'). EWS has recently commissioned a number of studies on flood risks and urban risks. Very few studies, however, focus on the most vulnerable groups or incorporate gender issues (UNDP and BCPR, 2010). National-level climate risk assessment capacities are therefore improving, but Niger does not have sufficient national-level experts in this field for implementation and monitoring. Furthermore, none of the country's key climate change or disaster management documents provide a clear, accurate definition of the term 'climate risk' in relation to other environmental or disaster risks. The food and nutritional security section of the 'National Contingency Plan' (DNPGCA, 2007) is the only document that defines this type of risk. However, the definition is overly simplistic and focuses almost exclusively on the physical event, only briefly mentioning the importance of other factors such as socio-political conflicts (DNPGCA, 2007).

Prioritization. Climate change documents, such as the NAPA, SN/PACVC and national communications, identify a number of adaptive measures. Generally speaking, these are vague in terms of implementation and time scales, with the possible exception of the NAPA, which identifies the sectors, communities and areas most vulnerable to climate change and variability and sets out 14 priority adaptation options,[21] with transparent selection criteria (CNEDD, 2006). The SNC includes the adaptive measures listed in the NAPA. With the 'Third National Communication,' Niger is expected to publicize recommendations on how to prioritize potential adaptive measures, thereby improving prioritization capacities (UNDP, 2011).

Coordination. Climate risk management is the responsibility of the Prime Minister's office, demonstrating its cross-sectional nature and importance. However, it is jointly managed by CNEDD and EWS. Initiatives to incorporate disaster management with climate risk management have only appeared recently. For example, a climate change study was recently conducted as part of the AAP, in collaboration with EWS. This study looked at both climate adaptation and disaster risk management.

Nationally, several current and/or potential coordination and information-sharing platforms exist in this field, such as the SDR Programme Steering Committee, the National Natural Disaster Risk Management Platform and the Adaptation Unit. The effectiveness of these platforms has yet to be assessed, however, and some (such as the Adaptation Unit) are new. More work therefore needs to be done to improve 'horizontal' coordination between EWS and CNEDD and, in general, among those ministries whose mandate covers climate risks at the national level. A climate change policy (currently under development) will help ensure that climate change is incorporated into policies, strategies and planning processes. The Government already plans to incorporate climate change considerations into the health, water resource and transport sectors.

'Vertical' coordination between central and regional structures is also a major problem. Although Niger has implemented a decentralization process, coordination between climate change management bodies and programmes remains difficult due to a lack of expertise, technical and institutional capacities and, most importantly, funding (UNDP and BCPR, 2010). Nevertheless, progress is being made in this area. As mentioned previously, the EWS developed a number of Regional Multi-Risk Contingency Plans in 2011 to

[21] These are: (1) Introducing fodder crop species in pastoral areas; (2) creating livestock food banks; (3) restoring basins for crop irrigation; (4) diversifying and intensifying crop irrigation; (5) promoting peri-urban market gardening and livestock farming; (6) promoting income-generating activities and developing mutual benefit societies; (7) water control; (8) producing and disseminating meteorological data; (9) creating food banks; (10) contributing to the fight against climate-related diseases, (11) improving erosion control, water harvesting, and conservation measures for agricultural, forestry and pastoral purposes; (12) disseminating animal and crop species that are most adapted to climatic conditions; (13) promoting riversides and restoring silted-up ponds; (14) building material, technical and organizational capacities of rural producers.

build institutional capacities regionally and coordination and implementation capacities nationally. Another example is the revision of the national PDC preparation guide (Ministère du Plan, de l'Aménagement du Territoire et du Développement Communautaire, 2011), which now covers a series of new concerns, including climate change, and is the only reference document for commune development planning. This new dimension is currently being incorporated into around 38 PDCs. The CNEDD aims to ensure that it is incorporated into all 266 PDCs by 2016. To achieve this, the SE/CNEDD is currently preparing a methodology for incorporating climate change into sectoral and local planning (Bokonon-Ganta, 2012). One proposal is to use a participatory analysis grid to assess climate change risks and responses. Although climate risks are not yet fully incorporated into Niger's development policies, strategies and programmes (see section 5.2) (CNEDD, 2009), several initiatives are ongoing, at all levels, to remedy this problem by building upon revisions to national and local reference frameworks and incorporating climate change adaptation (revision of the SDR, revision of the national PDC preparation guide).

Information management. The ADPRS binds the Government to improving weather and climate data collection, processing and archiving, and to making these data available to users (Secrétariat Permanent de la SRP, 2007a). However, significant progress is still required in implementation. The SNC (CNEDD, 2009) identified a number of shortcomings in terms of information management, especially in relation to data collection, archiving and processing (UNDP, 2011). The SNC specifically mentions the lack of a structured and accessible national database or coherent observation network; inconsistencies in data and information documentation and archiving methods due to the high number of different data-holding structures; the lack of a coherent, specific and effective model for assessing vulnerability and adaptation across all sectors; the lack of a national climate change research centre; and a shortage of funding to resolve these shortcomings. In terms of climate data, Niger has a severe shortage of weather stations, a lack of surveillance systems and continuous data (an essential requirement for climate forecasting), and a lack of disaggregated climate forecast data (both in terms of past observations and future predictions). Furthermore, existing information needs to be made more accessible and disseminated widely. In fact, this process is generally put off until the final stages of a project and, through a lack of funding, is often only partially completed, if not abandoned entirely (UNDP, 2011). There is no national visual representation of past and present temperature and precipitation distributions, other than the two NAPA representations (CNEDD, 2006), which are based on the annual standardized precipitation index. Information on the websites of the relevant government entities is difficult to access. Nevertheless, initiatives are underway, such as the Climate Forecasting and Information Development Project, implemented as part of the Pilot Programme for Climate Resilience, explicitly to improve climate information dissemination and sharing and to incorporate this information across all key sectors.

Key messages: Institutions and policies

- Although food security has long been a priority in Niger, climate risk management has only recently become an area of interest nationally.
- Climate risk management is the responsibility of the Prime Minister's office. It is managed by two key institutions: CNEDD and EWS, responsible for climate change and disaster risk management, respectively.
- Climate risk has already been incorporated into the country's key national development strategies (ADPRS, SDR), and will start to be incorporated into sectoral and subnational polices, programs and projects.
- A number of programmes are also currently underway, several of which address the issue of adaptation to climate change in key sectors. These will help build the country's capacities in this area. However, progress is hindered by a lack of capacity, poor coordination and inadequate information management.

RECOMMENDATIONS FOR CLIMATE RISK MANAGEMENT

Promoting the sustainable development of wetlands such as La Mare de Tabalak in the context of climate risks requires consideration of a range of factors, including population growth, gender inequality, natural resource degradation and other factors, regionally and nationally, with compromises among all actors. Mitigating and adapting to climate risks is essential if the country is to meet its development goals.

PRIORITY ACTIONS

Most of the management options were identified at a participatory scenario development workshop held with the communities of the commune of Tabalak, representatives of the Tahoua technical departments, representatives of various ministries, and national civil society members. The participants identified a number of long-term (2030) development objectives for La Mare de Tabalak, then identified climate risks that could prevent achievement of these and discussed short-, medium- and long-term climate risk management options (see Karami and Danguiwa, 2011).

Most local actors agreed that the future of La Mare de Tabalak needs to be secured by 2030, by improving governance of the pond through joint resource management by the communes within the watershed; introducing a regular, continuous system to monitor environmental and socio-economic conditions; consolidating and accelerating environmental restoration and protection; and building capacity to support development, implementation and monitoring of these actions.

Joint natural resource management across the watershed (intercommunal cooperation). Coordinated action to protect the pond and promote diverse revenue-generating activities is imperative. This applies not only to the pond itself, but also upstream and downstream, as well as at the source—the entire watershed. Collaboration among communes is essential, especially to ensure completion of more cumbersome priority actions, such as stabilizing dunes and replenishing fish stocks. Niger is already promoting decentralized resource management, and its legislative and regulatory framework favours decentralized and intercommunal cooperation, although the decentralized entities lack funding (Salifou, 2008). Niger has also already recognized the approach of integrated water resource management (Ministère de l'Hydraulique et de l'Environnement, 2005).

The need to create an intercommunal cooperation framework *across the entire pond watershed* has not yet been recognized, but has already received support locally from the communities and development programmes. Between 2004 and 2006, Tabalak created a coordinated resource management committee and management plan, but these have never been implemented, due to lack of funding and political will.

Successful implementation of a joint resource management plan requires a number of preconditions. First, *all* rural actors must be aware that their environment (and hence their rights) is degraded. Mechanisms that already exist at regional and communal levels to facilitate joint resource management include the regional land development plans and the commune land committees, which help people identify local resources and actors and the user rights associated with these resources. This is a new and untested approach in Niger, so those involved could learn from recent, similar intercommunal cooperation initiatives such as the UNDP/Global Environment Facility COGERAT project ('co-management of natural resources in the Aïr and Ténéré natural reserves and adjacent areas') in the Agadez region, which runs from 2006 to 2012.

Create a regular/continuous system to monitor and survey environmental and socio-economic conditions. The pond and its basin require regular monitoring, with regular collection of environmental and socio-economic data. This will provide a better understanding of the impact of climate risks and other key factors, how these factors interact, and the consequences of these interactions (such as the link between siltation or invasive plants and climate change).

As part of its membership in the Ramsar Convention, Niger collects certain information about wetlands, largely concerning biodiversity, but monitoring remains irregular. Ideally, data collection should cover the entire watershed. Government funding is needed to deliver regular, universal information and data monitoring. In order to secure the long-term future of the system, local communities and actors must be involved in both data collection and (where possible) data analysis. The monitoring system must encourage interaction between scientific and local knowledge. Different structures (agriculture, water systems, environment, livestock farming and agricultural engineering) must work together at all levels to facilitate information collection and access and to avoid duplication.

Due to the pond's importance and the fact that the ecosystem has been under development and monitoring for longer than other wetlands, La Mare de Tabalak should become one of the long-term ecological surveillance observatories used by the National Ecology and Environment Monitoring Centre. With the agreement of CNEDD and relevant government ministries, Centre can support the ecological and socio-economic data collection process, including assisting with the search for funding.

It is important to expand data collection and analysis not only to environmental information but also to socio-economic information and to disaggregate data according to different categories (e.g., gender, age, ethnic groups). For example, regular monitoring should support interventions addressing the increasing risk of conflicts due to climate and non-climate factors.

Consolidate and accelerate environmental restoration and protection. Action to restore and protect the pond and its watershed can help slow evaporation, extend the lifespan of the pond, and curb wind erosion, water erosion and silting. The government and development partners have already implemented a number of actions, with the local communities seemingly satisfied with the results. At basin level, however, these responses are not enough to significantly reduce the effects of climate risks on the pond. The government and development partners must continue to accelerate environmental restoration and protection work at the basin level while ensuring that the beneficiaries of these actions take responsibility and ownership. For these actions to be sustainable, the beneficiaries must be involved before the work begins. Any attempt to accelerate such actions depends on the engagement of local authorities and grass-roots community organizations (groups, unions, federations). The government and development partners must also give the communes themselves greater responsibility to manage consolidation activities.

Support livelihood diversification. Climate change is likely to put increasing stress on natural resources within Niger, and sectors like agriculture and livestock are likely to be strained. The communities depending on La Mare de Tabalak have already learned to diversify their livelihoods to minimize the risk of hazards (including from climate). Interventions aimed at mitigating the impacts of climate risks on the livelihoods of communities should continue to be prepared and implemented through administrative agencies and other in-country partners to ensure livelihood diversification and continued access to, and benefits from, natural resources.

Build the capacities of actors at all levels. Building capacities of all actors at all levels is essential, so that they are able to support the development, implementation and monitoring of the actions recommended above. For example, local authorities and community organizations need support and training in the use of water-efficient irrigation techniques and drought-resistant species of fish, plants, trees, cattle, etc. Outreach and training campaigns are needed in a number of areas, including environmental protection (including hygiene and sanitation), women's participation, and joint resource management.

Sustainable wetland management in the face of climate risks requires the cooperation of both government ministries and local authorities. Building their capacities, raising awareness about the issues and improving their understanding of the role and importance of wetlands is essential. They will then be better placed to understand the nature of climate risks and identify responses. Local elected representatives need to be made aware of the Ramsar Convention. Communities must also be made aware of the importance of data collection and measuring instruments. The field survey, for example, revealed that the local populations in Tabalak have abandoned water-level markers built around the pond, probably due to a lack of knowledge, since the local inhabitants seem to have used these markers for other purposes (such as making shoes). Increasing the level of advice and support that users of the pond receive should also promote dialogue between scientists and local experts.

GOVERNANCE

This study makes the following recommendations: consolidate climate risk management capacities and actions; promote synergies in climate risk management; continue to support livelihood diversification; finalize and adopt the national wetlands policy and develop synergies between this policy and the strategic planning documents currently under development; implement the Ramsar Convention and broaden the scope of wetland management plans to cover the entire watershed; and promote gender equality.

Consolidate climate risk management capacities and actions. The most visible impacts of climate variability and change in Niger are likely to take the form of increasing temperatures and shifting rainfall patterns. The previous section highlighted that several climate change initiatives are underway to improve the country's capacity to manage climate risks. The country needs to continue its efforts to formulate risk reduction and adaptation programmes and mainstream climate risks into existing initiatives, particularly to:

- Effectively monitor climate and weather patterns regularly and in real time, analyse precipitation and temperature data, disseminate information related to climatic risks and impacts, and set up hydrometeorological stations to improve climate data.
- Validate and improve climate change projections.
- Carry out climate risk mapping of regions within Niger to better assess the impacts of climate hazards and extreme weather events, including mapping areas especially vulnerable to floods and droughts.
- Conduct more detailed regional climate risk assessments in order to develop and implement comprehensive climate risk management interventions that are specific and adapted to the local context.
- Develop an early warning system for addressing drought and flood risk management harmonized with the climate and weather monitoring system.
- Improve human capacities to manage climate risks. A strategy to increase skilled human resources should be based on a detailed capacity assessment. Initiatives to build capacity of weather monitoring agencies and their staff should enable them to analyse, interpret and disseminate weather and climate information. English language training for technical staff should be supported so personnel have improved access to international information and to support cross-regional collaboration.
- Create a common directory for all climate risk management structures, and a centralized climate risk information database (climate variability and climate change) to improve information sharing between the various institutions involved in climate risk management. This directory will only be effective if it is regularly updated and made accessible online.

Promote synergies in climate risk management. Climate risk management as a cross-cutting topic requires integrated solutions and calls for increased synergies among different sectors, actors and levels.

- **Synergies among sectors/fields.** Work must continue to strengthen synergies between national disaster risk reduction and climate change adaptation in order to avoid duplication. The SDR Programme Steering Committee (Comité de Pilotage des Programmes de la SDR) is expected to provide an interministerial collaboration platform to improve coordination in the cross-sectional field of climate change.
- **Synergies among actors.** Government, NGOs, universities and research institutions should continue to strengthen their collaborative efforts to address climate risk. For example, more synergies should be established between the CNEDD, the EWS and the universities so that students can be involved in climate risk initiatives to build their capacity as well as staff capacities within those institutions.
- **Synergies among levels.** Effective climate risk management requires strengthening coordination between central and regional structures. In the context of decentralization, various initiatives are underway, but the country needs to ensure that capacities are strengthened at all levels, that those initiatives lead to concrete and sustained implementation, and that impacts are monitored.

Finalize and adopt the national wetlands policy and develop synergies between it and strategic planning documents. Internationally, progress towards mainstreaming climate risks into wetland management is underway, and the Ramsar Convention is starting to better account for climate change issues. For example, it has developed a methodology to assess wetlands' vulnerability to climate change (see Gitay et al., 2011). Nationally too, climate risks must be included explicitly in wetland management policies and strategies. The draft version of the wetlands policy (Ministère de l'Environnement et de la Lutte Contre la Désertification, 2009) does not address climate risks directly, though the actions it proposes help minimize the negative impacts of climate hazards (e.g. remedial work on the *koris*, combating wind and water erosion, etc.). The National Ramsar Committee needs to review the policy to ensure climate risks are included explicitly. Similarly, wetland management plans need to address climate risks as specifically as possible. It is also important to develop synergies between the 'National Wetlands Policy' and the strategic planning documents currently under development. Wetlands are not addressed at all in certain key public policies. Given the important role wetlands play in alleviating poverty and delivering food security, and especially against a background of growing uncertainty, it is important that the revised SDR address wetlands directly.

Implement the Ramsar Convention and broaden the scope of wetland management plans to cover the entire watershed. The Ramsar Convention requires that a management plan be implemented six years after a site has been listed. Of the 12 Ramsar sites in Niger, however, only four have finalized management plans or have plans under development. La Mare de Tabalak was listed in September 2005. As yet, no development plan exists for the site. Of the four management plans developed to date, only two have been (partially) implemented. Wetland management plan development and implementation are hindered by a lack of funding and programming problems. Inclusion of wetland management plans in the PDCs and SDR regional action plans may help ensure they are developed and implemented more effectively. Wetland management plans must also adopt a broader definition of 'wetlands' than that used by the Ramsar Convention.

Incorporate gender issues into climate risk initiatives. Improving gender equality by ensuring that men and women have the same opportunities and rights, and recognizing their different interests, needs and responsibilities may help alleviate poverty and improve the resilience of households and communities to climate hazards. Currently a number of initiatives are underway to address this issue. Many local projects now incorporate gender issues. The Ministry for Women and Children developed a national gender policy in 2008. Plans exist to conduct research and deliver training on incorporating gender issues into the revised SDR. The national PDC preparation guide (Ministère du Plan, de l'Aménagement du Territoire et du Développement Communautaire, 2011) also includes new concerns such as gender and equality. The next step is to monitor how these initiatives are implemented, and their impact. Efforts must continue to incorporate gender issues into all national and local climate change policies, in terms of both risk and vulnerability assessment and the decision-making and planning process at all levels. Practical gender equality objectives include equal participation and representation by all groups (men, women, young people, minorities and marginalized groups) in the decision-making process, pond management and local development policies; inclusion of women's groups in regeneration activities such as reforestation; inclusion of gender issues in the pond's integrated development action plan and in its implementation; and development of specific revenue-generating activities for women's groups.

FURTHER RESEARCH

This study opens several possible avenues of research to improve our understanding of La Mare de Tabalak:

- **Gender analysis.** Women are often more vulnerable to climate risks than men, and it would appear their role is being redefined. It is therefore important to consider gender issues so that effective responses incorporating gender equality can be developed and supported. An additional study could focus on gender issues, and on solutions that take them into account.
- **Survey of the pond's bathymetry curve.** Calibration of the SWAT model used in this study could be improved by collecting new pond water level and quality data. A new survey of the pond's bathymetry curve is required (the only survey was conducted in 2000). This will provide a more accurate assessment of the rate at which the basin is filling with sediment. The extent to which climate risks affect silting and expansion of the pond (and the way in which silting can exacerbate the negative impacts of climate risks) has not yet been clearly established.
- **Socio-economic scenarios**. By using the SWAT model and collecting more field data, it may be possible to test a range of different socio-economic scenarios (population increase, change of land use), to understand how these factors affect the pond when combined with climate factors.
- **Impact of reservoir infrastructure on sediment transport to the pond.** Since 1994 more than 10 artificial reservoirs have been constructed in the Kori d'Igaba basin for irrigation, with a total capacity of 4 million m^3. As the Kori d'Igaba is the number-one source of sediment transported to the pond (around 70 percent), it may be necessary to conduct a study to assess the impact of these infrastructures on sediment transport from the *kori* to the pond.

This study also opens several possible avenues of research for other wetlands in Niger:

- **Replication in similar wetlands**. This study uses a number of tools (CVCA, CRiSTAL, SWAT) that can be accessed by different partners, although some training is required in their use. It could therefore be replicated in other, similar wetlands in Niger and across the region.
- **Validation of climate projections**. Climate forecast research in Niger must continue, and the results of the climate forecast study conducted as part of the AAP must be validated (Sanda et al., 2011).

- **Economic assessment of the goods and services of the country's wetlands.** This study should also assess how climate risks could influence these goods and services. The results could be used to support decision-making and raise awareness of the importance of these areas and the urgency with which action is required. The technical departments could be assigned to collect data.

Key messages: Climate risk management

- Key stakeholders have identified four priority climate risk management options for wetland management: improving governance of the pond through joint resource management by the communes within the watershed; improving monitoring of environmental and socio-economic conditions within the watershed; consolidating and accelerating environmental restoration and protection; and capacity development.
- Further research is needed on more detailed climate risk assessments focusing on gender related issues; validation and further analysis of the climate projections for the country; and economic assessment of the goods and services of the country's wetlands. The current study could also be replicated in other, similar wetlands in Niger and across the region.
- A strong governance framework will include consolidating climate risk management capacities and actions at all levels; promoting synergies in climate risk management; finalizing and adopting the national wetlands policy and developing synergies between it and the strategic planning documents under development; implementing the Ramsar Convention and broadening the scope of wetland management plans at the watershed level; and promoting gender equality.

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