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Abstract

Executive Summary

This chapter will contain a summary of the NAP containing the key priorities to be communicated.

Framework for the NAP

Essential functions of the NAP process:

The adaptation movement is taking a turn at the juncture of public awareness on the impacts of climate change and disaster risks, towards the formulation and implementation of National Adaptation Plans (NAPs), strategies, legislation and projects. The heterogeneity of the NAPs, due to the context-specific nature of adaptation suggests that different approaches are conditional on the available resources, intrinsic values, needs and perceptions within societies¹. At the outset, adaptation planning and implementation, which are at the core of the NAP process are intended to be dynamic and iterative. The NAP is envisioned to have a harmonizing influence over adaptation strategies, plans and actions at different levels of government and across multiple sectors. According to the IPCC, the most auspicious adaptation options are ones that offer development benefits in the short term and reduce vulnerabilities in the long term. What is more, linkages between climate change adaptation, disaster risk management and development need to be clear to foster co-benefits against societal objectives. Equally, coordination of relevant stakeholders and integrated cross-sectoral approaches are integral to the NAP process, which could pose a significant challenge for Least Developed Countries (LDCs) and Small Island Developing States (SIDS).

On account of this, the Comoros, which holds its place among SIDs has constructed a roadmap for the NAP that will guide the consideration of climate risks and opportunities within medium and long-term plans at national and island levels and across all relevant sectors². The NAP roadmap is split into three workstreams which comprise: (I) enhancing coordination mechanisms and steering the NAP process, (II) implementing the NAP process, and (III) reporting, monitoring, review and outreach. The creation of national and island level steering committees would further enhance the coordination of the NAP, support institutional and technical capacity building, improve data collection and analysis, increase knowledge and information sharing, and strengthen monitoring and evaluation processes.

Integral to the NAP was the Conference of the Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC), which agreed that improved adaptation actions should:

- Be undertaken in accordance with the Convention
- Follow a country-driven, gender-sensitive, participatory and fully transparent approach, taking into consideration vulnerable groups, communities and ecosystems
- Be based on and guided by the best available science and, as appropriate, traditional and indigenous knowledge, and by gender-sensitive approaches, with a view to integrate adaptation into relevant social, economic and environmental policies and actions, where appropriate
- Not be prescriptive, nor result in the duplication of efforts undertaken in-country, but rather facilitate country-owned, country-driven action

Recommended actions to promote the alignment of adaptation with national planning processes and ensure effective implementation of the NAP, include the following: (I) enhance public sensitization activities such as public information and education on climate risks; (II) streamline capacity building of media and civil society associations to improve the same; and (III) develop and maintain database systems to support the collection of climate data and socioeconomic statistical information. Improved surveyance of socio-economic benefits will reinforce public sensitization to climate risks and opportunities, and increase the local, national and island level ownership of adaptation actions.

The NAP as the umbrella programme for adaptatio

The NAP aspires to coalesce all adaptation activities through the implementation of a coherent and coordinated approach. Practically, it would enhance institutional and technical capacity building, improve monitoring and evaluation of development projects and support the mobilization of climate finance.

In 2014, the Comoros jointly initiated its National Adaptation Plan (NAP) process, led by the Ministry of Production, Environment, Energy, Industry and Handicraft (MPEEIA) and the General Commission for Planning (CGP). In the process to formulate its NAP, the Comoros established a political and strategic framework to ensure sustainable development, taking into consideration the impacts of climate change and the natural environment.

The Comoros' Strategic Framework includes the following actions and plans:

- The National Environmental Policy (NEP)
- The Strategic Document for Rapid Growth and Poverty Reduction (DSCR)
- The National Adaptation Programme of Action (NAPA)
- 2011-2016 Strategic Planning Framework on Natural Environment, Climate Change and Disaster Risk Reduction
- The Accelerated Growth and Sustainable Development Strategy (SCA2D)

The role of civil society and local entities in shaping adaptation policy:

According to the NAPA and the second National Communication, the most climate vulnerable sectors in the Comoros consist of: agriculture, water resources, health, trade, energy, forestry and fisheries. Other vulnerable sectors include coastal systems, soils, biodiversity, infrastructure, land and tourism. The National Adaptation Plan Global Support Programme (NAP-GSP) recalls the implementation of several initiatives in the Comoros that have contributed to knowledge and capacity building on the impacts of climate change including pathways to adaptation. The literature suggests that in the Comoros, civil society could take on a larger function in the implementation of development initiatives as traditional social structures hold prominence and a majority of municipalities have, at a minimum, some variant of social or cultural associations that are operational. In fact, youth movements such as the Ngo'shawo (Movement of Conscious Youth of Comoros), which is a well-positioned actor focuses on youth engagement and local implementation of development activities. The Comorian Consumer Federation (FCC) and the Union Chambers of Commerce, Industry and Agriculture (UCCIA) are examples of entities that increase the agency and collective bargaining power of local organizations by advocating on their behalf to influence policy at the national level³. In the same way, international development actors target initiatives that are centered on local capacity development and ensure grassroots bodies participate in the development and monitoring of projects.

While the NAP offers numerous entry points that ensure co-benefits among development objectives, challenges in the overall process include:

- Addressing technical and human resources capacity constraints in key institutions
- Strengthening coordination mechanisms and a regulatory framework for climate change
- Increasing coordination among donors, and federal and island authorities
- Developing adequate information systems
- Improving knowledge and understanding of civil society
- Effectively mainstreaming environmental issues at island level
- Increasing data in all sectors and improving dissemination of information

Benefits of vertical integration and coordinated planning:

While renewed political stability and social peace in the Comoros has created an enabling environment, favorable to good governance in the execution of public affairs, the autonomy of the islands could impede coordination efforts at the national level. Political will ought to be demonstrated across all levels of government to ensure the vertical integration of climate change adaptation (CCA) into new and existing development planning processes and strategies, within all relevant sectors. Veritably, such a political standing would ensure that development gains are secured and that climate change adaptation efforts are not fragmented across the islands. Under different conditions, incoherent approaches to development and adaptation planning would surely stifle progress as it pertains to poverty reduction and improvements to food security.

Climate change adaptation priorities identified in the Comoros' INDC

The impacts of climate change in the Comoros are widely observed and clearly undermine development efforts that have been implemented by the government in the last decade. Owing to its socio-economic vulnerability and fragility, the Comoros exhibits limited adaptive capacity. Its Intended Nationally Determined Contribution (INDC) is predicated on the Accelerated Growth and Sustainable Development Strategy (SCA2D) and numerous climate change management programs with the ultimate objective to contribute to poverty reduction, sustainable development and provide adequate climate change solutions.

The development of adaptation actions is based on strategies and sectoral plans affecting areas related to agriculture, energy, waste and Forests, Land Use, Land Use Change and Forestry (LULUCF), with many land-related climate change mitigation options that have co-benefits for climate change adaptation. While the government of the Comoros aims to employ a mixed portfolio of measures, the challenges of ensuring sustainable development across the islands are compounded given the barriers and limits to adaptation. The government further recognizes the impact of climate change on the most vulnerable, chiefly rural communities and poor farmers who too often lack the capacity to shield themselves against the harmful impacts of climate change.

The INDC highlights four critical areas of climate change adaptation that aim to: (I) apply strict regulations to restore degraded areas; (II) promote intensive agriculture; (III) increase the participation of women and local communities in decision-making on matters of environmental protection; and (IV) build the resilience of populations in the face of climate and disaster risks. The Comoros proposes to

integrate these adaptation measures into sectoral policies, as well as support capacity building and resource mobilization efforts.

The INDC reinforces the country's intention to remain a carbon sink and contribute towards global decarbonization efforts. The Comoros with its status as a fragile country and one undergoing reconstruction and reform, has secured sustainable development gains and made progress in its adaptation efforts in the past two decades, yet results are fragmented and difficult to measure. A few of the adaptation constraints and challenges the Comoros faces include: (I) the lack of financial resources that accentuates its dependence on international support and favors a project approach against a conflation of adaptation and domestic and local development; (II) the limited capacity of responsible institutions to coordinate adaptation; (III) the lack of human, technical, and financial resources; (IV) the lack of clarity of mandates to ensure the management and protection of the natural environment; (V) the lack of an adequate regulatory framework and coordination mechanism among actors; (VI) a focus on response measures to emergency situations rather than prevention; (VII) the lack of baseline data; and (VIII) the unmet technology transfer needs for adaptation.

Existing Initiatives and Projects on Climate Change Adaptation:

Major climate change adaptation projects as indicated in the INDC, VNR and other relevant documents, include:

Table 1 Existing Initiatives and Projects on Climate Change Adaptation

ACCLIMATE	Aimed at improving the understanding of climate change in the Indian ocean region, identifying vulnerabilities to climate change impacts, and drafting a regional adaptation strategy to reduce vulnerabilities in the Comoros, Madagascar, Mauritius and Reunion Island.
Enhancing Adaptive Capacity and Resilience to Climate Change in the Agriculture Sector in Comoros (CRCCA)	Aims to strengthen the capacities of vulnerable communities to cope with the additional risks posed by climate change as well as the variability on agro-sylvo-pastoral systems through training and dissemination of information. The CRCCA's water component is funded to the tune of 2.2 million dollars by the LDC Fund from 2014 to 2021.
Adapting Water Resource Management in Comoros to Increase Capacities to Cope with Climate Change (ACCE)	Focused on increasing climate resilience of drinking and irrigation water supplies on all islands. The ACCE was a \$ 5.14 million project funded by the GEF LDC Fund and supported by UNDP-UNEP, for the period 2011 to 2016.
Support to the Union of the Comoros for Strengthening Resilience to Climate Change (AMCCA)	Seeks to improve consideration of climate change in strategies, projects as well as planning, coordination and monitoring mechanisms by national and local actors.
Joint Adaptation Program on Water	Proposes to reduce the impacts of climate change on daily life and on water resources using information from 5 pilot sites.
Building Climate Resilience through Rehabilitated Watersheds, Forests and Adaptive Livelihoods	Focused on coastal zones, particularly building resilience through rehabilitation of basin slopes, forests and livelihood diversification in the Comoros.
Strengthening Comoros Resilience against Climate Change and Variability related Disaster	Seeks to strengthen the adaptive capacity of the Comorian population to manage the current disaster risks and to reduce vulnerability to climate change.

ACCLIMATE	Aimed at improving the understanding of climate change in the Indian ocean region, identifying vulnerabilities to climate change impacts, and drafting a regional adaptation strategy to reduce vulnerabilities in the Comoros, Madagascar, Mauritius and Reunion Island.
Mainstreaming Disaster Risk Reduction into Policies to Reduce Poverty in the Union of Comoros	Aimed at mainstreaming disaster risk prevention and management into national policies. Focused on building institutional, systemic and individual capacities to prevent, manage and reduce natural and climate-related disaster risks.
Sustainable Human Development Programme	Intends to reduce poverty by promoting better management of natural resources to increase agricultural production.
The ER2C project	Ensures a supply of climate-resilient water, funded to the tune of 60.8 million dollars by UNDP-GCF from 2019 to 2027.
Projet d'alimentation en eau potable et d'assainissement (PAEPA)	Constitutes a water adduction program, specifically on drinking water and sanitation, funded at \$ 8 million by the African Development Bank (AfDB)
GECEAU	Aimed at establishing a sustainable and accessible public drinking water service in a pilot area on Grande Comore, based on a 5-million-euro fund by l'Agence Française de Développement (AFD) from 2012 to 2018.
ProgEau	Focused on strengthening water sector governance and enhancing climate resilience of the country's infrastructures and water resource management, funded up to 6.5 million euros by AFD.
AEP Domoni	Aimed at enhancing the drinking water supply for the city of Domoni on the island of Anjouan, funded up to 6 million euros by AFD.
AEP Sima	Enabled the construction of a drinking water network for six villages and offered consumers a continuous supply of water. In addition to the infrastructure, the project also set up a community management model in Sima for the distribution of water to consumers. This was a 4.2-million-euro project funded by AFD, for the period 2010-2015.
HYDROMET	Aimed at strengthening meteorological, hydrological and climatic services; improving observation systems, climate modeling and forecasting; implementing early warning systems that respond to user needs; and developing risk management in key sectors such as agriculture and fishing.
ANCAR II	Proposes to build capacity to ensure the coordinated and decentralized multisectoral management of the environment. Aims to achieve the objectives of the Rio conventions (based on three conventions on biological diversity, climate change and desertification).
The Germination Project	Supports the expansion of the agricultural sector development model promoted by the NGO Dahari on the three islands of the Comoros and provides assistance to the municipalities of Anjouan on territorial development.

Lessons from Comoros' NAPA process:

The NAPA provides a solid foundation for examining and communicating national adaptation plans, priorities and needs within the context of sustainable development and the fight against poverty. It strives to increase the effectiveness of the country's development goals by focusing on thematic areas of interest in support of short- and medium-term climate change adaptation options. By curating a list of national adaptation initiatives and projects that reflect the crux of domestic political structures, socioeconomic conditions, cultural values and development challenges and opportunities, the Comoros seeks to strengthen its capacity to ward off the harmful effects of climate change.

The NAPA is rooted in four clustered priority areas, which comprise:

- An overall view of the geographic, environmental and socio-economic context of the Comoros
- An analysis of the observed and predicted vulnerability due to climate change and climate variability; the influence of climate change and climate variability on the biophysical processes and the key sectors; and the identification of the most vulnerable groups or zones;
- NAPA's objective; the implementation strategy including its links with development programmes and multilateral agreements on the environment
- A survey of adaptation options; the conditions for systematic integration of adaptation into development planning; and a methodology for ranking and prioritizing adaptation options

In the process to formulate the NAPA, consultations that focused attention on vulnerable groups gave emphasis to the main concerns of each island. A multi- criteria analysis, consisting of a cost-benefit analysis was used to prioritize key systems. Within the four priority areas, each of the islands cited the agriculture and water sectors as the most important to the population. Priorities at island level were reiterated at the national level. The distinction among the priorities rested on their ascribed order of importance. Priorities articulated by the population, such as poverty reduction and improvements to food security were given a higher ranking.

Key adaptation options identified through the NAPA include: introduction of fish-aggregating devices, reconstruction of watersheds, restoration of soils, development of drought-resistant seeds, fodder production, fish conservation under ice and early warning systems, among others. While, these options respond to the most climate vulnerable sectors in the Comoros, which is critical to ensuring poverty reduction and improving food security, there are additional opportunities for alignment of adaption to national development policies that take into consideration a wider range of climate risks and address not only the current needs but the future vulnerabilities of Comorians. According to the IPCC, there is a propensity to underestimate the complexity of adaptation planning as a social process, which could inflate the capacity of adaptation planning to achieve the intended result⁴.

While the NAPA is the first juncture for LDC national adaptation responses, the NAP is projected to increase the scope and influence of adaptation measures, by systematically linking development and adaptation agendas, policies, knowledge and risks into the medium- and long-term. Continued monitoring, evaluation and reporting derived from the NAPA process is vital to support the Comoros' transition from a project-based effort to a more consolidated approach. Moreover, it is important to incorporate local knowledge and experience to support the formulation and integration of adaptation responses into multidimensional and multiscale approaches. This is based on the ability of traditional knowledge to increase adaptive capacity at the community level.

Coherence with the national development context, SDGs, SFDRR and other relevant frameworks:

National Development Framework

i. Accelerated Growth and Sustainable Development Strategy (SCA2D)

The SCA2D is a national repository of interventions by the State and its development partners. Its objectives are to: (I) create an enabling environment that ensures structural transformation of the economy with a view to achieve strong, sustainable and inclusive economic growth; (II) improve the quality of life of the population and provide equitable access to basic social services; (III) ensure the sustainable exploitation of natural resources, while taking into account climate change; and (IV) strengthen good governance, build resilience, and promote the rule of law and social cohesion. The

current version of the strategy captures the vision of the government to “make the Comoros an emerging country by 2030, respectful of human rights, gender and promoting the rule of law”. As it concerns the natural environment, the government seeks to establish an effective sector management system capable of meeting the needs of the population on water and sanitation and climate change adaptation. The strategy emphasizes the integration of climate change into national policies and strategies including those on ecotourism, coastal and marine systems. Adaptation actions would be carried out benefitting the most vulnerable in the water and agriculture sectors, particularly in urban, peri-urban and rural expanses. These adaptation actions constitute: (I) organization of information, training and communication campaigns; (II) promotion and effective implementation of environmental legislation and regulation; and (III) capacity building of the National Agency for Civil Aviation and Meteorology (ANACM), civil protection and the General Directorate of the Environment. By the same degree, enhancing agricultural policies that are geared towards modernization, and sustainably harnessing the natural and geopolitical potentials of the Comoros would contribute to the strategic goals of SCA2D.

ii. 2011-2016 Strategic Planning Framework on Natural Environment, Climate Change and Disaster Risk Reduction (CSP 2011-2016)

A cohort of local and national planning authorities, and development partners including the UNDP on behalf of the UN System, collaborated with the Comoros in the process to develop and adopt the CSP 2011-2016. The strategic programming framework is structured around 3 thematic pillars within the milieu of sustainable development. This multidimensional and multi-year programmatic framework is primarily split into strategic parts followed by programmatic components and operational outcomes. The methodological approach adopted fosters effective national coordination and multisectoral coherence. As a direct result, the framework does not give room to fragmented sectoral approaches that intersperse internal human and budgetary resources across the national development landscape. The framework tackles issues related to climate change, specifically the degradation of the natural environment as well as disaster risk reduction. It focuses on several key areas that aim to: (I) improve the resilience of ecosystems and capacities to adapt to climate change at all levels; (II) contain the risks of pollution and insalubrity and to diversify the means of livelihood; (III) promote the effective implementation of innovative policies that deal with climate change and the loss of biological diversity, land degradation and integrated management of coastal areas; (IV) ensure the sustainable exploitation of natural resources and the promotion of the ecosystem services; (V) develop systemic and institutional capacities for coordination and multisectoral management of the environment; and (VI) support the prevention and management of disaster and climate risks. While the framework includes actionable points organized by thematic pillars and a monitoring and evaluation framework, it lacks a budget and implementation plan.

iii. Poverty Reduction and Growth Strategy Paper (PRGSP) 2010-2014

The PRGSP proposed to shape the country's development priorities from 2010-2014, while highlighting the socioeconomic conditions of the Comoros and its medium- term macroeconomic outlook. The PRGSP presented outcomes of household survey findings taking into consideration peoples' living conditions, along with varying dimensions of poverty and inequality, and provided an assessment of key socioeconomic sectors. The PRGS now serves as the reference document for the Comoros on socioeconomic development. On the basis of the evaluation of the PRGSP, economic activity in the Comoros has advanced auspiciously in spite of its complex international standing, marred by the public debt crisis. Aptly, the Comoros reached the completion point of the Heavily Indebted Poor Country Initiative and benefited from a debt cancellation of US\$176 million (Stocktaking Report for the NAP Process in the Comoros, n.d.). Irrespective of the fair state of the environment, there is much to do in order to reverse the effects of environmental degradation. A point of import is the sustainable management of natural resources that contributes to subsistence for the majority of vulnerable people. Building up natural capital requires the implementation of

specific measures devised to increase the number of protected areas and ensure the restoration of soils and the reconstitution of vegetable cover. It is generally recommended that such initiatives remain cost efficient, technologically sound and accessible by those most in need. This would equip subsistence farmers with alternative resources to sustainably manage natural resources and build their adaptive capacity. The PRGSP evaluation brings to view, the conspicuously weak capacity to manage projects and the rigidity of the Technical and Financial Partners (TFP) disbursement procedures. National absorption is also a challenge. Other priorities include, amending the mandate to ensure that the relevant bodies involved execute their roles effectively apropos of planning, implementation, monitoring and evaluation of development projects.

iv. National Environmental Policy (1993) and the Framework Law (1994)

The Comoros adopted a political framework that led to the development and adoption of the National Environment Policy (NEP), the Environmental Action Plan, in addition to the national strategy and action plan for the conservation and sustainable management of biodiversity. In October 1994, a legislative and regulatory framework was established with the adoption and promulgation of decree No 94/100/PR of the Framework Law on the Environment. The Framework Law presides over sustainable development, biological diversity, protection of the terrestrial and marine environment and protected areas. Whereas, the NEP was formed and adopted in 1993 by decree No. 93-214 / PR, centered on the "Analysis of the State of the Environment in the Comoros" document. Markedly, climate change has not been referenced which impels an amendment of the regulations to ensure its inclusion. According to the NAP-GSP, a series of documents have been adopted to implement the National Environmental Policy, these comprise: 'The National Strategy on Biodiversity (2010)', 'National GEF Strategy (2007)', and the 'Strategy for Coastal Areas Integrated Management (2010)' and its action plans.

v. Second National Communication on Climate Change

The conception of the second National Communication on Climate Change was predicated on national data from different sectors and thematic areas of relevance, including regional and global normative documents. It publicizes the need to place climate change at the center of the fight to eradicate poverty, among other priorities. It also spotlights the importance of strengthening adaptation efforts to maintain, at the very least, minimum standards of living for vulnerable people. As it happens, capacity building and implementation of adaptation measures will lead to increased costs that ought to be subsidized through international support. The second National Communication suggests that implementation, in principle, be grounded in a participatory approach with varying climate change related technical institutions and departments. Studies on vulnerability and adaptation to climate change carried out in the second National Communication covers four sectors, namely: health, agriculture and livestock, coastal areas and forestry/biodiversity. In the Comoros, national development plans and sectoral strategies do not sufficiently integrate climate change considerations. Government authorities have little understanding of the importance of climate change so as to strategically back initiatives, which results in a relatively low degree of prioritization of adaptation actions. Equally, funding requirements fall short and dedicated budget lines for climate change activities are uncommon. The quantity of climate change specialists is further limited and few training opportunities exist to upskill. Other constraints are demonstrated by: (I) the lack of a climate change adaptation strategy; (II) lack of coordination of the three post-Rio conventions; and (III) inadequate financial resources needed to implement environmental strategies and adaptation actions.

vi. The 2030 Agenda and its Sustainable Development Goals (SDGs)

The government has streamlined actions on sustainable development by aligning its policies, strategies and programs to the SDGs to ensure inclusive growth. In an effort to address the economic

and social challenges, and meet both domestic and global commitments, the Comoros has committed to extensive structural reforms, at all levels. This coincides with the Comoros 2030 vision to transition to an emerging economy. Therefore, it follows that the SCA2D's alignment with the 2030 Agenda would complement the country's 2030 aspiration. In 2019, the Comoros adopted a development plan for 2030 entitled Plan Comores Émergent (PCE), which has become a reference document for national planning and promotes the joint implementation of the 2030 Agenda and the African Union's Agenda 2063. The PCE proposes a set of measures: (I) promoting the prevention and management of disaster risks; (II) developing emergency response plans (nationally and in the Indian Ocean); (III) establishing an early warning system for natural hazards; and (IV) improving the security and protection of ecosystems.

All in all, 68 SDG targets with affiliated indicators were prioritized, reflecting key concerns and national constraints. Concrete outcomes have also been achieved, specifically on climate-related priority targets: (I) SDG target 13.1: Strengthen resilience and adaptive capacity to climate related hazards and natural disasters in all countries; (II) SDG target 13.2: Integrate climate change measures into national policies, strategies and planning; and (III) SDG target 13.3: Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. By the same token, progress has been achieved on SDG 14 with the adoption of a blue economy strategy that promotes economic and social development, and supports marine conservation and coastal biodiversity. Actions to promote sustainable management of terrestrial ecosystems between 2015 and 2020 have ensured the achievement of SDG targets 15.2, 15.4 and 15.9.

vii. Sendai Framework for Disaster Risk Reduction (SFDRR)

The Hyogo Framework for Action (HFA) was the initial global blueprint for disaster risk reduction efforts between 2005 and 2015. In post-HFA era, the Comoros' was aligned to the Aqaba declaration on disaster risk reduction in cities, the Arusha Declaration and the Mauritius Declaration. The evaluation on the implementation of the HFA, specifically on priorities to ensure strong policies and a solid institutional framework for disaster risk reduction indicated minor progress. On the readiness of contingency plans and disaster preparedness plans, some progress was observed though it was devoid of the political will required. Following the 2nd and 3rd Global Platform for Disaster Risk Reduction, the Comoros implemented a series of interventions involving: (I) revisions of the law on national land use planning; (II) launch of an institutional civil protection mechanism; (III) preparation of local emergency plans at the island level to build local resilience; (IV) establishment of a national platform for disaster risk reduction; (V) integration of disaster risk management in financial laws; and (VI) adoption of a national contingency plan. All things considered, the paucity of literature on- and references to the Sendai Framework for Disaster Risk Reduction within the national documents, policies and plans suggests a lack of alignment but admittedly an opportunity to integrate the seven Sendai targets and four priorities for action to prevent new and reduce existing disaster risks.

iii. UNFCCC | Kyoto Protocol | Paris Agreement

In the face of climate change, the Comorian government plans to achieve strong, inclusive and equitable economic growth without the damaging effects to the natural environment. In advance of the UN climate conference in Paris which subsequently launched the Paris Agreement, the Comoros submitted its climate action plan to the UNFCCC. The Comoros, which demonstrated its firm commitment to tackling climate change, ratified the Kyoto Protocol on April 2008. In due course, on April 2016 it signed the Paris Agreement, which was later ratified in November of the same year - conveying its continued commitment to dealing with climate change and all its impacts. The Comoros initial National Communication to the UNFCCC called attention to its climate vulnerability and flagged the country's most exposed sectors. Indeed, the NAP would further enrich adaptation communications submitted to the UNFCCC in response to Article 7 of the Paris Agreement. Pursuant

to submissions of the NAP, National Communication and the INDC to the UNFCCC, the Comoros could put forward, as appropriate, other communications or documents to that reflect its priorities, plans and support needs.

Approach and Methodologies

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National Context

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Vision, Goals and Objectives of the NAP

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Climate Change Adaptation Assessment

Figure 1 Map of the Union of the Comoros



Source: (Union of Comoros: National Marine Ecosystem Diagnostic Analysis (MEDA). Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project., n.d.)

Current Climate (Baseline)

The Union of the Comoros, an archipelago in the Indian Ocean, is characterized by an evolution of microclimates that is impacted by its topological relief. The country's weather is influenced by south and south-east trade winds from the months of April to November, which carry a relatively cool and dry tropical current between the months of May and October. The hot and rainy season descends in the months of December to March, when the north-west monsoon prevails. The warmest period is from November to April. The hot season is marked by humidity and frequent storms due to the tropical depressions near the archipelago or by the passage of the intertropical convergence front. The coastal zone exhibits an average temperature of 27oC, with a maximum temperature variation between 31oC and 35oC and a minimum of about 23oC. The cool, dry period known as the rainy season, has minimal humidity, comparatively lower temperatures and presence of winds or sea breezes. In low altitudes the minimum average temperature ranges between 18 oC and 19oC. Annual rainfall ranges between 1000mm and 5000mm depending on the region and is influenced by the altitude and exposure to strong winds. The Western regions of the Comoros, for instance in Grand-Comoro, the highest annual rainfall recorded is above 4000mm at the elevation of the Karthala forest due to exposure to monsoons and a higher topological relief. Whereas, the islands of Mohéli and Anjouan exhibit the highest range of annual rainfall between 2500mm and 4000mm.

Exposure to Climate Impacts and Risks

The Comoros NAPA suggests that current and future climate change impacts are expected to undermine development gains, especially in the fight to eradicate poverty and ensure socioeconomic security. Against a weak economic system, the income opportunities and prospects that ensure alternative livelihoods in response to climate change are very limited. Climate change presents a unique challenge to the Comoros, which has to deal with the impacts and risks of climate change. The challenges that countries face, particularly Small Island Developing States (SIDS), is magnified due to their small geographic territory, isolation and exposure. What is more, development gains are threatened due to slow onset events such as sea level rise and other natural hazards including storm-surges. The country has a largely maritime tropical weather, marked by rainfall variability, early onset and prolonged droughts, and warming- evident by a 1oC rise in the average temperature. The trade winds and monsoon winds that can reach speeds of 100km/s in Moroni, at times exhibit a cyclonic nature, and the variance between the warmest and coolest average temperature is in the order of 4oC.

Emerging Climate Trends

Given the 1960 to 1989 period, a steady reduction in rainfall was observed between 1960 and 1975. In 1976, the rainfall pattern surged, followed by strong fluctuations for the remaining period. The intense rainfall peaks that were observed in 1976 could be attributed to El Niño, which has been increasing in frequency and intensity in East Africa region in the last half century. According to the NAPA, these trends are predicted to continue into the future. What is more, the frequency of cyclones and storms is predicted to intensify with increasing unpredictability. In the Comoros, 23 cyclones were reported between 1911 and 1961, 13 cyclones between 1967 and 1986 and in 2004 numerous losses in human lives and damages were reported as a result of forceful cyclones in the South West region of the Indian Ocean.

As a result of irregular rainfall patterns, the Comoros has experienced shortened periods of the rainy season from 6 months to 3 months, with a shift to the dry season and the persistence of drought. The variation in rainfall is also expected to alter the temporal and spatial distribution of available water resources important for agricultural production. It therefore follows that these trends cause long-term modifications in the vegetation cover and livestock availability.

For the last thirty years, the warming of the Comoros has exhibited through the rise in the minimum and maximum temperatures. The 1961 to 2008 period depicted a 15% decrease in cold days and nights, and a 20% increase in hot days and nights across the country. Furthermore, warming in the order of 1oC was observed over the 1961 to 2008 period with a variation of +/- 0.2oC per decade.

Future Climate Scenarios: Projected Future Climate

Although the Comoros is a carbon sink of Greenhouse Gases (GHGs) and only contributes minimally to emissions (2.3 teq CO₂/hab/yr), it is still threatened by the impacts of climate change. The predicted impacts that the country faces include a decrease in agriculture and fishery production, loss of biodiversity, displacement of over 10% of the population that reside in coastal areas, contamination of groundwater sources due to saltwater intrusion and a rise in the incidence of malaria cases⁶.

According to the IPCC, climate change scenarios for SIDS in the Indian Ocean for the 2040-2069 period indicate an increase in the annual average rainfall in the order of 3.1% (+/- 0.45%) with a decrease in the annual average rainfall during the dry season by a range of about -2.6% to -1.8 %. With respect to annual average temperatures, IPCC scenarios for the islands of the South West part of the Indian Ocean indicate an increase of 2.10oC in the 2040-2069 period. Furthermore, sea level rise is predicted to reach 0.20m by 2050. Considering a 1.5oC rise in the average ocean temperature, coral whitening would cause the damage or even death of coral reefs and lead to the reduction of marine flora and fauna, including reef fish. This would have a direct impact on deep sea fishery resources due to declining fish populations and could lead to the loss of income for those working in the fishery sector.

Tourism services would be adversely affected due to damage or destruction to coral reefs. According to the NAPA, the economic valuation of tourist services with respect to coral reefs under the jurisdiction Mohéli Marine Park is USD \$3.5 million, representing 1.3% of GDP⁷. Ultimately, the impacts of emerging climate trends are numerous. The Comoros is expected to endure intensified soil erosion, hotter summers, frequent droughts particularly north of the islands and accelerated sea level rise, which would have adverse impacts on tourism, port facilities and human settlements⁸.

The Second National Communication describes the climate scenarios for the Comoros grounded on IPCC projections for future (2025, 2050 and 2100) temperature and rainfall based on the 1961-2000 reference period. The predictive results are obtained by using the MAGICC/SCENGEN software that explores future climate change and its uncertainties. The Special Report on Emission Scenarios has four sets of scenarios called "families": A1, A2, B1 and B2. The A1 scenario depicts a future of very rapid economic growth and global population that peaks mid-century and declines thereafter, given the rapid introduction of new and efficient technologies. The A2 scenario describes a very heterogeneous world, with continuously increasing global population and fragmented economic growth and technological change. The B1 scenario, similar to A1 describes global population peaking mid-century and declining thereafter, with an emphasis on environmental sustainability.

According to the Second National Communication, the warming of temperature scenarios in the Comoros, projected for the 100-year horizon between 2000 and 2100 is grounded on the following assumptions:

- a. Scenario B (low pathway): increase of 1.27oC on average (probable range: 0.16oC to 2.9oC)

- b. Scenario A1B (intermediate pathway): increase of 1.40oC on average (range probable: 0.16oC to 2.70oC)
- c. Scenario A2 (high pathway): increase of 1.46oC on average (probable range: 0.16oC to 3.22oC)

By 2025, the evolution of average temperatures will lead to monthly temperature increases, the highest of which will be observed from the months of January to April and November to December. This will translate to a rise in average temperatures between 0.61 and 0.78oC, and a decrease in average rainfall by 14% for the month of October.

By 2050, rainfall is predicted to marginally increase for the months of December to April, and decrease for the remainder of the year. At the national level, this will result in an increase in average temperature between 1.26oC and 1.47oC.

By 2100, warming of temperatures will intensify with a variation in average temperatures of about 1.99oC to 2.35oC. The temperature rise will be marked in the north of the islands. Thermal variation also indicates a near doubling in temperature from 2050 to 2100. Rainfall predictions suggest a significant reduction between the months of August and November.

Based on these climate scenarios, Scenario B1 shows warming of temperatures of 0.16oC in 2000 to 2.29oC in 2100, suggesting a temperature rise of 2.13oC over the course of the century. Whereas, scenario A2 predicts a more pronounced warming of temperatures of 3.06oC.

ASSESSMENT OF KEY SYSTEMS

Agriculture

The Comoros' economy is highly reliant on the agriculture sector and gives way to 66.9% of jobs for women and 51.2% of jobs for men. The primary sector employs 70% to 80% of the active population and contributes to 98% of export revenues given a limited range of cash crops. The Comoros exports crop commodities such as vanilla, cloves and ylang-ylang, which comprise 90% of the country's total exports. At present, the Comorian export market is underdeveloped and vulnerable to world market fluctuations. Given that agriculture production is mainly for domestic consumption, only 30% of total production is allocated for commercial purposes. The country's dependency on the import of food products is however increasing; currently the country imports almost 95% of its rice for consumption. Food crop production includes bananas, tomatoes, coconuts, corn, beans, cassava, yam, taro, sweet potatoes and other tubercles. What is more, agriculture in the Comoros only covers 40% of the food needs of the population and follows a strictly pluvial practice, one that is largely focused on subsistence but not sufficiently mechanized. Chemical fertilizers are used sparingly, if at all, and the agricultural sector benefits rather minimally from investments.

Priority Area: Development of Crop Commodities

Agriculture represents 90% of the total land area in Anjouan, 77% of Mohéli and 61% of Grande Comore based on four farming systems, which include open field food crop production, traditional agroforestry, cultivation in natural forests and monoculture farming. Agriculture in the Comoros is influenced by both endogenous and exogenous constraints such as population growth that has surpassed growth in agricultural production as well as changes in local diets with a proclivity towards imported food products. The supply chain for export crop commodities comprise vanilla, ylang-ylang and cloves. Despite its low productivity, vanilla holds the highest value in terms of exports, comprising 43% of export production. However, vanilla production has fallen from 200 tonnes in the 1990s to 50 tonnes in 2009.

Figure 2 ylang-ylang flower (Cananga Odorata) and basket of cloves (Anjouan, Comoros)



image



image

Source: Gettyimages and Marco Casiraghi

The Comoros is one of the leading producers of ylang-ylang, meeting an estimated 70% of global demand, however, production of the essential oil has been in long term decline over the past 30 years. Ylang-ylang oil is a key ingredient in many fine fragrances. The *Cananga Odorata* crop is produced by smallholder farmers in Anjouan and Mohéli, subsequent to which, the flowers are distilled by small distillers. Ylang-ylang oil is used in many high-end perfumeries, which makes it all the more attractive for export production. In consideration of the export-oriented agriculture, a few limitations need to be address that involve low-tech farming practices using rudimentary equipment for power-intensive operations such as plowing, threshing and harvesting activities. Low mechanization together with variable technical capacities among farmers result in lower quality crop production. Ultimately, a priority for the Comoros will be to revive ylang-ylang production and improve vanilla and clove exports by enhancing the technical and operational capacity of domestic producers in line with international quality standards. Notwithstanding, climate change impacts such as temperature and rainfall variability, sea level rise and probable salt water intrusion in coastal areas,

could affect ylang-ylang plantations, which could lead to the loss of income for producers and affect export revenues.

Vulnerability of the Agriculture Sector

The impacts of climate change and climate variability on the biophysical process of natural ecosystems generates potential harms to the agriculture sector. It causes the delay of fruit maturation as a consequence of prolonged droughts and high temperatures. What is more, the reproduction cycle of plant and crop parasites and disease agents such as coconut aleurodidae (*Aleurotrachelus atratus*) coincide with the crop production cycle. New parasites continue to emerge and parasites that were previously regulated are re-emerging and at times in their most virulent forms, causing the destruction of crops. This decrease in agricultural productivity leads to the loss of income, livelihoods and intensifies issues of food insecurity. When coupled with extensive agriculture, high costs to access food and dependence on food imports, this renders a large segment of the population vulnerable.

As detailed in the Second National Communication, the key socioeconomic impacts on agriculture include: (I) prolonged droughts and water shortages, (II) degradation of cultivable land, (III) decrease in the production of specific cultivars, (IV) increased food insecurity, (V) lower agricultural income, and (VI) increased unemployment and precarious work, particularly among young people.

Exposure to Climate Impacts and Risks

The agriculture sector in the Comoros bears threats due to climate change impacts such as thermal stresses to the environment including the warming of temperature in extremes, including the prevalence of crop diseases caused by parasitic and disease agents, and changes in rainfall patterns and rainfall intensity. Heavy rains, a pronounced dry season and high temperatures accelerate the degree soil erosion, land degradation and desertification, with adverse effects to the integrity of agricultural lands. According to the NAPA, a total of 65 335 acres of agricultural lands, which represents 57.5% of the total agriculture area, are degraded. Moreover, the North West and South East regions, which comprise eroded coast zones 1.5km to 3km long, pose flood risks from sea level rise and experience more water shortages than all other agricultural regions in the Comoros. The country is further exposed to strong cyclones and their subsequent destruction of crops, triggering a reduction in crop yields and causing disruption to food security. Climate impacts and subsequent risks to livestock involve plant and cattle diseases (e.g., Newcastle disease and smallpox) that lead to livestock death, degradation of grazing pastures and health impediments to existing cattle such as growth retardation, reduction in milk production and sensitivity to diseases.

[Projected Impact on the Agriculture Sector:]

In the Comoros, changes in rainfall will cause the reduction of river flows and waterfalls that will lead to reduced water availability required for agriculture. To date, the country has experienced a decrease in rainfall by about 0.5mm per annum. Disruptions to the agro-climatic zones triggers a drier climate that causes changes to local water resources. All in all, marginal variations in temperature and precipitation are causing major shifts in the water flow, particularly in Ndzuani and Mwali. The drop in local agricultural production will affect livelihoods and diminish purchasing power of consumers, whereas a surge in the global demand of major crops will cause a 25% to 150% increase in the price of rice, wheat and maize by 2060.

Adaptation Options

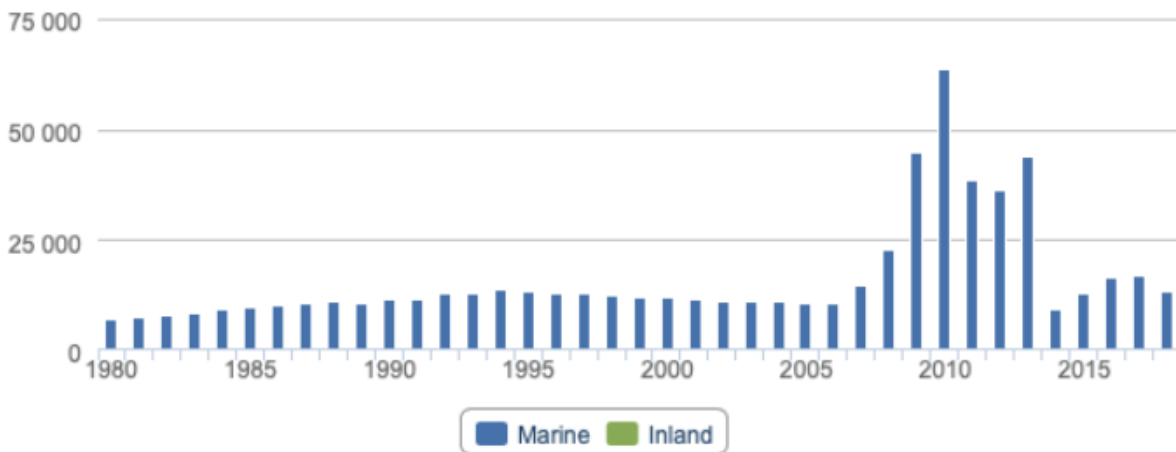
- Examination into and enhancement of cultural practices to reduce the impacts of water and thermal stress

- Surveying and development of crop varieties resistant to water and thermal stress, to ensure food security
- Offering technical advice and extension services to producers on production techniques to generate high quality yields
- Development and adoption of heat-resistant cultivars
- Enhancement of farming practices that reduce pests and crop/plant diseases
- Floodproofing' measures (such as elevation of living spaces)
- Adoption of climate smart agricultural techniques
- Promotion of agroforestry
- Grouping of farmers into cooperatives and pooling of equipment and resources
- Improvement to land-use planning
- Marketing of new soil protection techniques
- Provision of improved access to microcredits to procure farming equipment and machinery
- Establishment of agricultural insurance schemes or risk transfer mechanisms to protect against loss of or damage to crops or livestock
- Development of an integrated pest management program
- Relaunching of national research and extension programs

Fisheries

Despite a 12-mile territorial sea and 200-mile exclusive zone, fisheries in the Comoros are largely small-scale and harness around 10 000 tonnes of fish production annually¹⁰. The fishery sector is among the key sectors in the Comoros and plays a critical role in the economy. In many ways it supports job creation and income generation for a large segment of the society and contributes significantly to improving food security. The Second National Communication estimates that the fishery sector provides 8,500 direct jobs for fisherman and an additional 24,000 indirect jobs in shipyards, marketing and equipment stores¹¹. The Comoros lacks an offshore industrial fishery and the industrial fisheries that exist are those exploited by distant fishing nations. In fact, between the 2007 and 2012 period, an estimated 22 000 tonnes of fish resources per annum were caught by fishing vessels flagged in the Comoros harvesting fish in the Economic Exclusion Zone (EEZ)¹². What is more, inland fishing is acutely rare due to the dearth of rivers, water courses and lakes and semi-industrial fishing and aquaculture are non-existent. The totality of fishery products is marketed locally or consumed fresh. The processing of fish is minimal and limited to salt cured fish and fish smoking as preservation methods.

Figure 3 Capture production by inland and marine waters of the Union of the Comoros (tonnes)



image

Sources: FAO FishStat

Traditional fishing in the Comoros accounts for 40% of the dietary need in terms of animal proteins, comprising an estimated per capita consumption of 25.2 kg in 2011. The Comorian people exhibit a preference of reef fish to pelagic fish. The offshore pelagic potential amounts to 20 000 tonnes, yet only 30% of pelagic fish have been sustainably exploited. Fish resources in the Comoros consist of offshore and coastal pelagic species, demersal species and reef species. The demersal resources of the continental plateau, which covers 900km², are estimated to be 450 to 1 350 tonnes per annum, while coastal pelagic resources amount to 900 to 2 700 tonnes per annum.

Artisanal fishing takes place by means of small fiber glass motorized boats ranging from 6.3m to 7.1m in length. As of 2012, there were a total of 5 800 boats across the Comorian islands, of which 30% comprised motorized fishing boats. Traditional fishing is described by the use of non-motorized wooden outrigger boats (canoes) and account for 70% of the vessels surveyed. The national production of fish has increased from 6 000 tonnes in 1985 to 16 200 tonnes in 2004, which has contributed to the abandonment of fresh fish imports and has amply added foreign currency to the domestic revenue base. National fishing catches are distributed across the 3 islands of the Comoros, 60.8% from Grande Comore (Ngazidja), 29.6% from Anjouan (Ndzouani) and 9.6% from Mohéli (Mwali), 60% of which constitute two main species, namely the skipjack tuna and yellowfin tuna.

Figure 4 Wooden boats in the old harbor of Moroni, Grande Comore, Comoros



image

Sources: Gettyimages

Priority Area: Fish Conservation and Preservation

Means of preservation extend the storage life of fish without substantially altering its natural state. Losses of catch due to climate impacts such as high temperatures in the absence of means of preservation to reduce post-harvest losses in fisheries, leads to a decrease in fisherman's income. Therefore, proper on-board handling of fish, for example ensuring fish are chilled and that good hygiene conditions prevail to avoid cross contamination, as well as ensuring the physical integrity of fish to avoid bruising and damage to fish flesh and accelerated spoilage is a priority for the Comoros. Moreover, the conservation of fisheries is critical to the ecological balance of the marine system, the social well-being of the population and the economic growth potential of the country. In the Comoros, fishing during cyclonic periods and heavy rains leads to limited catch and a chronic deficit of fish in the market, especially for poorer populations. Construction of conservation facilities for fish as well as selective fishing gear that avoids the capture, retention, and subsequent discarding of immature fish and unwanted species is increasingly important for the country's ecological sustainability.

Vulnerability of the Fishery Sector

Sea level rise and shifts in coastal hydrodynamic processes could impact coastal areas by causing flooding and saltwater intrusion, while warming of temperatures could threaten the health and integrity of coral reefs across the islands. Limited income and social protection mechanisms make it further challenging for fishermen to invest in small-infrastructures or facilities such as cold storages or ice machines to help preserve fishery resources and reduce post-harvest losses. Due to constraints in establishing means of preservation that extend the storage life of fish, 'fish conservation under ice' is among the main adaptation priorities described in the NAPA. This would not only benefit fisherman but the entirety of local actors across the fish supply chain, including fishmongers and local suppliers.

Exposure to Climate Impacts and Risks

The worsening of climatic conditions, specifically the frequency and intensity of storms, cyclones and other extreme weather events render fishery activities unmanageable and often result in the loss of fisherman's income and pose adverse impacts on tourism services. Whitening of coral reefs has historically been an issue for the Comoros. In particular in 1997, a rise in sea temperatures in the range of 1 oC to 1.5oC relative to average temperatures of 26 oC to 28 oC caused the whitening and death of approximately 60% of coral reefs across the islands. The destruction of coral reefs also promotes the acceleration of coastal erosion and the contraction in in the number of reef fish, including juvenile fish populations.

Adaptation Options

- Fish Concentration Mechanisms, which will facilitate an increase in catches, in order to better value the contribution in time worked
- Investment in small-infrastructures and facilities for fishing communities e.g., cold storage, ice-machine and landing sites, with proper management systems to ensure their sustainable use
- Construction of conservation facilities for fish
- Means for reducing post-harvest losses in fisheries
- Means of preservation that will extend the storage life without substantially altering the nature of the raw material
- Selective fishing gear that avoids the capture, retention, and subsequent discarding of immature fish and unwanted species
- Proper on-board handling of fish, for example ensuring fish are chilled and good hygiene conditions prevail to avoid cross contamination

Water Resources

Climate variability has led to the decline in rainfall in the country, which has severely impacted the quality and quantity of freshwater. High temperatures have further accelerated evapotranspiration, which has contributed to the reduction in the supply of groundwater reservoirs. Surface water in Anjouan and Mohéli are mainly supplied through river water and wells, whereas water resources in Grande Comore are primarily supplied through coastal aquifers. In the Comoros, as is the case in a number of LDCs, the reduction of water resources influences the availability of potable water. At present, the quantity of potable water is insufficient to meet the population's needs. The coverage of the population with access to drinking water comprises 30% of the population of Grande-Comore, 15% of Anjouan and 80% of Mohéli. Rainfall fluctuations, seasonal disturbances and prolonged droughts are some of the determinants of persistent water shortages, which create issues in the implementation of basic domestic activities such as food preparation, maintenance of hygienic conditions and waste treatment. Furthermore, the agriculture and livestock sectors are highly dependent on the availability, accessibility and quality of freshwater sources. Banana trees for instance, are often hacked and used to water cattle, however this practice results in undernutrition and produces high susceptibility to parasitic diseases such as theileriosis. Cases of theileriosis in cattle have led to the deaths of 20% of bovines in Grand-Comoro between 2002 and 2003.

Priority Area: Extend water supply and improve water quality

Improving the water supply by strengthening water distribution networks and enhancing water quality are identified as strategic priorities in response to the vulnerabilities of the water resources sector. Such vulnerabilities include poor water management, low supply of potable water and inadequate coastal and flood protection measures. As local communities play an integral role in sharing local and indigenous knowledge on water resource management with a focus on sustainability, their participation is vital to the success of adaptation projects and programs. Indeed, the construction of barrages and dams to collect and store rainwater and the regulation of river water based on existing hydrographic networks across the three islands underpinned by an inclusive stakeholder approach, will be critical. Ultimately, the establishment of sound watershed management is expected to support the sustainable distribution of water resources, help visualize current land use and the varying degrees of degradation, and support the development of future scenarios against which plans can be made to protect and improve the quality of water and other natural resources.

Vulnerability of the Water Resources Sector

The environment radiates a natural fragility and holds a limited availability of critical resources such as freshwater. There is great variability in rainfall across the Comorian islands. The profile of Grande Comore soils exhibit high permeability. The lack of surface water also puts downward pressure on groundwater systems required to collect and store rainwater. Water tanks are often left uncovered and are poorly maintained. Contamination of groundwater aquifers due to exposed water tanks and saltwater encroachment along the coastal zone increase the prevalence of malaria and other vector-borne and waterborne diseases. Coastal waters are typically brackish as a result of saltwater intrusion. Conversely, Mohéli and Anjouan are originally endowed with quasi hydrophobic soils and a dense hydrographic network. However, river and stream flows have declined considerably over the last two decades. Previously, there were over 40 rivers to supply the islands' population with water. Today, fewer than 20 rivers remain and during warmer months, surface water evaporates, increasing incidences of siltation. On the island of Grande-Comore, the freshwater supply stems from basalt tanks which requires maintenance that often falls short¹³.

Exposure to Climate Impacts and Risks

Climate change impacts on the water resources sector have been demonstrated in myriad ways. In recent years, the groundwater has been depleted in the dry season. In Grande-Comore sea level rise has led way to saline intrusion of coastal aquifers, which has altered the quality of freshwater with damaging effects for crop irrigation and groundwater supplies. A survey in the 1980s revealed that after the excavating of 44 exploration wells in the coastal zone, only 24 wells demonstrated salinity under 3g/l. Follow up evaluations undertaken in 1997 disclosed that over half of the surveyed wells were not functional and an estimated 31% displayed issues related to pumping and sewage facilities.

Decreased precipitation has narrowed the hydrographic network and disrupted the fragile balance between freshwater and saltwater resources. The encroachment of seawater is particularly harmful to coastal communities that depend on the freshwater for household activities and farming practices. The risk of contamination of freshwater is high, owing to high soil porosity and an upsurge in the concentration of sodium chloride as a result of seawater intrusion¹⁴. The loss of freshwater vegetation could indirectly impact the dietary composition of affected populations.

Based on a bacteriological analysis conducted in Anjouan to test microbiological parameters of freshwater, 60% of the collected water was shown to be contaminated. Contaminated water is also a known cause of hepatitis A and typhoid fever, which are both transmitted through ingestion of contaminated food and water, and have plagued the island for many years, causing adverse health effects and even death.

Adaptation Options

- Increase in water supply by strengthening water distribution networks and infrastructure
- Reconstruction of basin slopes
- Promotion of small hydraulic installations and protection of hydrological units
- Involvement of local communities in planning and sustainable management of water resources
- Construction of artificial lakes, barrages and dams to store rain and river water
- Construction of reservoirs of drinking water and preservation of water quality
- Introduction of monitoring policies of resources and use of appropriate tools (techniques and juridical), for the control rivers and forests
- Examination of current and future availability and demand of water resources
- Preparation of a comprehensive assessment of the available hydrological potential, including groundwater resources
- Assessment of biophysical features, such as climate, geology, topography, soils, water quality and quantity in terms of infiltration rates and runoff, natural vegetation, fauna
- Assessment of socioeconomic conditions, and livelihoods analysis e.g., major resource user groups, farming systems, actual land uses, local institutions and service providers, and relevant policies and laws
- Watershed/ River basin mapping and zoning to visualize current land uses, the degree of degradation, etc., and to develop future scenarios
- Action research for joint problem analysis, the identification of solutions, and immediate field-testing and validation of improved practices in each area
- Establishment of watershed/ river basin management committees; preparation of watershed management/ river basin management plans
- Implementation of prioritized activities; monitoring and documentation of processes, results and impacts; and capacity building for all stakeholder

Energy

According to the literature, a well-defined energy policy for the Comoros does not yet exist, however, a strategy for the diversification of energy sources is under development. A mere 25% of Comorian households are connected to the power grid. The high cost of accessing electric power is sighted as the main barrier for poorer households. The electricity supply is described as erratic in major towns and is essentially nonexistent in rural areas. As such, the government and people of the Comoros are determined to pursue GHG emission reduction targets and transition to renewable energy sources.

The energy supply in the country is dominated by fuelwood (78%) as a result of biomass exploitation in domestic activities and for its part in powering operations in ylang-ylang distilleries. Imported petroleum products constitute 20% for their use in electricity and transport, while butane gas (2%) represents a small amount of the energy supplied. There is a strain on already depleted fuelwood

resources and limits in terms of alternative sources of energy. In regards to biomass, alternative plants such as oilseed plants (i.e., coconut, sesame, peanut and *Jatropha Curcas*) are being explored with the view to generate bioenergy.

Despite its hydroelectric potential, the islands of the Comoros have an estimated 1 MW of installed hydroelectric capacity¹⁶ and further studies are required to assess the country's full hydropower potential. The country is deficient in oil and gas reserves and it also exhibits a low potential to harness wind power. Whereas, geothermal energy satisfies the country's ability to meet the population's energy demands. According to a UNEP country brief, the geothermal reservoir on Grande Comore based on a rift system linked to active volcanos (namely the Karthala and La Grille), could be potentially tapped. Solar energy also demonstrates great potential for expansion as the islands experience an average of 500 wh/m² equivalent to 8hrs/day of sunshine¹⁷. What is more, numerous solar installations exist at both domestic and commercial levels and even hotels are shifting to solar energy to reduce their carbon footprint and contribute to a green economy.

Priority Area: Biomass (Exploration into fuelwood alternatives) The energy sector in the Comoros is characterized by numerous constraints, power supply in major towns is erratic and essentially non-existent in rural areas, for example sources of lighting in rural expanses are limited to small paraffin lamp with wicks. As a priority adaptation option among renewable energies, biomass operates as a renewable and sustainable source of energy. Biomass fuels includes those derived from wood, charcoal, scrap lumber, forest debris, and certain varieties of waste residues. By sustainably exploiting wood and charcoal alternatives, such as oilseed plants (i.e., coconut, sesame, peanut and *Jatropha Curcas*), biomass could offer relatively cleaner fuels that could be used for cooking and heating in homes, and as a fuel alternative (e.g., ethanol) in transportation and power generation. Biomass power plants that use biomass-derived waste to generate electricity, could in the long run contribute to carbon neutral electricity by supporting the transition away from traditional fossil fuel usage towards an alternative energy source, which produces relatively less GHG emissions from wood waste or other organic residuals. This in turn advances adaptation and mitigation efforts by offering an accessible, cost efficient, renewable energy source that improves air quality in the process.

Vulnerability of the Energy Sector

The Comoros lacks a clear and sustainable energy policy at the national level. Policy reforms enacted in the 1990s in favor of fossil fuels that encouraged the use of oil in lieu of fuelwood, influenced the level of emissions for that period. Specifically, biomass emissions amounted to 242 728 tonnes of CO₂ in 2002 against 328 000 tonnes in 1994. Higher emissions were accounted for during that period due to the retrogression towards fossil fuels. In addition to the adverse environmental impacts of fossil fuel usage, imported petroleum and hydrocarbons incur high costs. In 2009, the Voidjou power plant in Grande-Comore was impacted by catastrophic disaster. The total installed power capacity fell from 18MW and currently stands at 12 MW, however only 5MW is available. The capacity factor of power plants in Anjouan and Mohéli similarly represent under 50% of the installed capacity. The power grid is faulty which generates losses of 40% of the total electricity production. These factors among others, are relevant to the fact that 75% of Comorian households are not connected to the power grid. Hydropower energy production falls during the dry season when water resources diminish. Lack of funding is also a significant factor in the Comoros' inability to fully pursue the development of hydroelectric power. While biomass is a preferred renewable energy source for its waste reduction capacity, versatility and accessibility, biomass from wood does not burn entirely clean and contributes to massive deforestation when not properly managed. Forest clearing, particularly in rural areas are common due to the need of firewood and timber. This presents an opportunity for the sustainable land use management.

Exposure to Climate Impacts and Risks

In consideration of the two main primary energy sources, namely biomass and hydrocarbons, the exposure to climate impacts and risks should be carefully assessed. First, the extensive use of biomass has put a strain on already depleted fuelwood resources and if not adequately and sustainably managed could intensify current levels of deforestation. In effect, emissions emanating from the energy sector increases with population growth and the energy needs of the transport and industrial sectors. The very high costs of electric energy and oil have already resulted in the extensive felling of trees for firewood to meet household consumption. Land degradation, landslides and soil erosion could further impair an already fragile natural system. As rainfall fluctuations become more pronounced, this could directly impact biomass production. The irregular supply of groundwater, especially the depletion of freshwater reservoirs in the drier periods, increases the vulnerability of natural and human systems. Therefore, improved water harvesting techniques and infrastructure (e.g., dams and pits) and functional irrigation systems are critical to ensure water resource efficiency. Climate change further impacts the reproduction cycles, distribution, and intensity of pests and diseases.

The Comoros' disaster risk profile indicates that the greatest flood hazard associated with tropical cyclones occurs on Anjouan and Mohéli, while storm surges are greatest along the southern and eastern coasts of the Comoros¹⁸. Such extreme weather events could impact the productivity of biomass feedstocks. Further to this, the greatest absolute risk of loss from earthquakes is Grande Comore. Although infrequent, inquiries should be made as part of a study on the potential effects of earthquake and volcano (specifically, the Karthala and La Grille) interactions on geothermal energy production in the Comoros.

Adaptation Options

- Developing the capacity of the energy sector in the Comoros and implementing cost reductions related to energy consumption by households
- Promoting the use of appropriate renewable energy-based lamps
- Improving energy efficiency, particularly that of biomass
- Soil and nutrient management to ensure richness of biomass feedstocks
- Investing in conservation measures against deforestation, and promoting massive afforestation and reforestation in and around river basins
- Ensuring irrigation efficiency, stress-resistant crop varieties, and improved land management
- Improved flood protection mechanisms and expansion of rainwater harvesting and water storage to enhance feedstock productivity
- Development of robust biomass power plants
- Use of multi-hazard early warning systems for rainfall and temperature extremes to support emergency harvesting in advance of extreme weather events
- Ensuring resilient ecosystems through implementation of targeted biodiversity policy measures
- Behavioral adaptation measures that educate local communities on various forms of renewable energies and the need to retire/phase out fossil fuels

- Promotion of agroforestry techniques to enhance soil fertility, soil moisture and increase soil organic matter

Biodiversity

The Comoros is an archipelago, which covers a total surface area of 2236km², comprising four volcanic islands situated along 225km of a submarine shelf. It is marked by its volcanic landscape, small size and insularity. The Exclusive Economic Zone (EEZ) is approximately 160 000km², with 900km² of continental shelf and 427km of coastline¹⁹. In the Comoros, there are an estimated 2000 plant species such as the Khaya, the Comorensis, the Ocotea and the Tambourissa leptophylla on the islands of Grande Comore, Anjouan and Mohéli. The country boasts 50 species of coral that cover 60% of the coast of Grande Comore, 80% of Anjouan and almost 100% of Mohéli. Mammal species include the Livingstone's fruit bat, the Mongoose lemur and the Comoro rousette. Endemic bird species comprise the Karthala white- eyes, the blue pigeon and the Karthala scops owl, among others. While endemic reptile species include the Comoro Flapnose Chameleon and the Comoro Clawless Gecko.

Figure 5 Moya beach on the island of Anjouan



image

Sources: Gettyimages

The islands of the Comoros have an extremely narrow continental shelf of volcanic origin and subsequent poor development of coral reefs. Still, the coastal and marine ecosystem on Grande Comore is rich and diverse including coral reefs, mangroves, seagrass beds, tri-colored beaches, lava flows, and islets. Coral reefs are home to key species such as the hawksbill turtle as well as mollusks, sea cucumbers and reef fish, essential for ensuring food security and coastal livelihoods. Seaweed beds are recognized for their high productivity and abundance of fauna, they also serve as habitat for the green turtle (*Chelonia Mydas*) and the dugong (*Dugong Dugon*). Islets are vital for seabirds and home to turtle nesting sites where marine turtles lay their eggs. Coral reef systems are characterized as diverse, complex and among the most productive of the marine systems. Coral reefs serve as green infrastructure based on their natural coastal protection mechanisms, absorbing between 70%

to 90% of wave energy. Coastal areas of the islands are rich in biodiversity and home to endemic species including ecosystems with significant ecological value. Further to this, Lake Dizan Boudouni covers a surface area of 30 acres in the southern part of the island of Mohéli and is highlighted for its biodiversity of flora and fauna of great scientific interest.

Figure 6 (left) Green sea turtle (Chelonia Mydas) in Mayotte and (right) a green Hawksbill turtle in Mayotte



image

Sources: Gettyimages

Priority Area: Protection of biodiversity and coastal ecosystem

The Comoros is characterized as a biodiversity hotspot with high endemic species and key threats. Yet the potential of the biodiversity is not well understood, which leads to weak environmental protection as well as the misuse and mismanagement of natural resources and natural habitats. The Comoros harbors the most important eggs-laying site for marine turtles in the Indian Ocean and the 10th in the world²⁰. It therefore follows that a key priority area for the Comoros is the protection of marine turtles and their natural habitat along the coastal zone. Climate impacts such as sea level rise and saltwater intrusion exacerbate coastal erosion, which when coupled with the exploitation of beach aggregates, results in the diminution in the number of sea turtles. The disappearance of sea turtles is predicted to have an adverse effect on major economic activities related to the tourism sector, upon which it depends. The income generated from trading beach aggregates (inert granular materials such as sand, gravel, or crushed stone) support the livelihoods of coastal inhabitants. However, the extraction of aggregates in coastal zones has physical and environmental implications for the erosion of the coastal land. In the absence of coastal management policies and practices, tourists that are drawn to observing nesting sea turtles in their natural habitats will likely look to other tourism destinations where protection and conservation are prioritized.

Vulnerability of the Biodiversity Sector

The natural environment in the Comoros is described as fragile. The area classified as a “hotspot zone” is highly endemic yet exposed to threats. Anthropogenic effects such as the mismanagement of natural resources leads to poor protection and subsequent exploitation of natural resources. For example, population growth and increasing poverty combined with deforestation stemming from unsustainable agricultural practices could threaten the country’s national biodiversity heritage. Auspiciously, the adoption of the National Environmental Policy of 1993 has to some degree created an enabling environment for the protection of biodiversity and the promotion of environmentally

sustainable agricultural production. With respect to fresh waterbodies, the Grande Comore lacks permanent river systems. The soils are composed of porous basaltic base of limited use. In effect, fragile soils are vulnerable to erosion, including gully erosion, and tectonic instability. The low pluviometry, particularly in the eastern parts of the islands contributes to degraded soils and coastal erosion. Additionally, the lack of monitoring mechanisms and available data on open sea marine resources intensifies vulnerabilities of the marine system. Pollution as a result of marine gasoil from fishing vessels, and overfishing of species affect the integrity of seagrass beds, while sea turtles are contemporaneously threatened by beach degradation, attenuation of seagrass beds and unsustainable poaching practices. Coastal and marine species, specifically immature fish and unwanted species, are also occasionally captured, retained, and subsequently discarded. To boot, there has been a steady exploitation of local demersal resources.

Exposure to Climate Impacts and Risks The influence of climate on the biophysical process in the Comoros has been widely observed. For instance, rainfall fluctuates at varying altitudes and at different levels of wind exposure. There are changes in average climatic conditions and seasonal discrepancies, with impacts to the hydrologic cycle, causing rivers to dehydrate. Increases in flood risk, decreases in groundwater level and acceleration of soil erosion are also evident. With respect to the oceanographic system, very strong currents have been observed at the western region of the island of Anjouan.

The impacts of climate change are predicted to reduce agriculture and fishery production, cause the loss of biodiversity, and contaminate freshwater resources, including aquifers along the coast due to seawater encroachment and increases in the prevalence of infectious diseases such as typhoid and malaria. Saltwater intrusion often also produces brackish water along the coast. Such impacts are expected to drive the displacement of over 10% of coastal inhabitants.

Anthropogenic effects of development such as overfishing and unsustainable fishing practices that involve the use of dynamite or poisonous substances, pollution such as waste dumping and soil runoff, together with the exploitation of coral and beach aggregates continue to threaten natural systems. Coral reef systems are at risk of destruction. It is estimated that by 2030, 60% of all coral reefs will be impacted by anthropogenic activities such as pollution as well as ocean acidification, as a consequence of the absorption of CO₂. The phenomenon of climate-induced coral bleaching due to sudden changes in ocean temperature remains a risk. By 2050, bleaching of corals in the Comoros will result in a 90% mortality rate of coral reefs in the Comoros. Comparably, nearly all species of mangroves are predicted to disappear by 2050 due to global temperature rise. While sea level rise is expected to destroy all the remaining mangroves that would have survived global warming.

Adaptation Options

- Conservation and sustainable management of biodiversity, including wildlife in protected areas and forests
- Reforestation and rehabilitation of degraded and desolate lands while conserving natural biodiversity
- Cataloguing of national forest and marine genetic resources to assess climate resilience
- Promotion of best practices in forest, coastal and marine genetic resource management, specifically in the areas of conservation, exploration, testing, breeding and sustainable use
- Promotion of biodiversity conservation and sustainable management of natural resources
- Enacting laws and policies on the prohibition of extraction and trading of beach aggregates

- Monitoring and evaluation of coastal management practices
- Investing in well-designed coastal protections such as dikes, levees and groins to reduce expected damages and enhance cost efficiency
- Protection of the coastline through 'soft' protection measures such as beach nourishment and wetland restoration
- Enforcement of coastal zoning regulations that prohibit construction in flood areas
- Measurement of beach dynamics for modelling future climate scenarios such as sea level rise and storm surges
- Control of land-based and ocean-based activities to reduce pollution and lower sedimentation, especially in coastal and marine areas

Tourism

The Comoros tourism sector, although in an embryonic stage of development displays strong potential for expansion. Tourism in the Comoros is described as offering a rich biologically diverse ecosystem, with natural resources of great global and scientific interest. The tourism sector is globally acknowledged as a climate-sensitive economic sector. Both demand and supply side stakeholders are directly impacted by climate variability and extreme weather events including secondary effects on a broad range of natural resources that are critical for the tourism sector. Prior to 1989, tourism was predominantly driven by business activities, missions and visits by the Comorian diaspora. However, since the opening of hotel Galawa in 1989, tourism in the Comoros has taken a shift towards leisure. Although, since 2000 the number of incoming tourists has plummeted, from 27 474 tourists in 1998 to 18 900 tourists in 2003. Compared to other island destinations in Africa such as Mauritius and the Seychelles, the hotel occupancy rate in the Comoros is exponentially lower. What is more, quality of standard and comfort is not consistently upheld. Despite the 600 personnel employed in hospitality services, a majority of hotel establishments are in fact managed by nonprofessionals and poorly trained hotel staff. Under current conditions, the Comoros tourism industry is confronted by a number of challenges that will influence its long-term development and success, among these include climate change and sustainability, human resources, and productivity and competitiveness²³.

Priority Area: Ecotourism

Promotion of the Mohéli marine park would help develop ecotourism in the archipelago, providing effective economic incentives to support conservation and improve the bio-cultural diversity and protect the natural and cultural heritage of the country. The marine park would serve as a marine protected area to safeguard a section of the ocean by imposing limits on human activity. In regards to the economic value of tourist services such as the coral reefs, the Mohéli Marine Park is an estimated 1.2 billion Comorian Francs equivalent to USD \$3.5 million. Further to the promotion of the marine park, national tourist services in the Comoros need to be improved. Currently, there are insufficient tourist services and hotel accommodation capacity is limited. Improvements in terms of basic hotel infrastructure, education and training of hotel personnel and tourism-related workers, and enhancements with respect to public information on tourism information resources is required.

Vulnerability of the Tourism Sector

The tourism sector in the Comoros is underexploited and according to the Second National Communication, tourism and hospitality services are inadequate and accommodation capacities are quite limited. For instance, there are less than 500 beds with an annual occupancy rate of under 40%. Education and skills development are also critical for tourism destination countries and a persistent

challenge in LDCs. In order to meet tourism growth, the Comoros will need to focus on service quality standards both physically via hospitality and accommodation services, and virtually by means of expedient tourism information resources websites.

Sand mining of beaches accelerates coastal erosion and is expected to negatively affect the future development of tourism. The national economy and the livelihoods of coastal communities is largely provisional on the tourism and fishery sectors. The disappearance of sea turtles is also predicted to have an adverse effect on major economic activities related to the tourism sector.

Exposure to Climate Impacts and Risks The Comoros is expected to endure intensified soil erosion, hotter summers, frequent droughts particularly north of the islands and accelerated sea level rise, which would have adverse impacts on tourism, port facilities and human settlements²⁴. These climate trends are predicted to cause changes to the country's vegetation cover, with consequences to the subsistence of certain plant and animal species and cause the destruction of natural habitats. According to the literature, several beaches namely those in Itsandra, Mitsamihouli, Maloudja, Chomoni and those belonging to the islands of Nioumachoua, Moya, Ouani and Mirontsi are expected to disappear due to sea level rise. Based on economic projections, the loss of tourism revenue associated with the disappearance of beaches is estimated to reach the current value 40 billion Comorian Francs by 2050²⁵.

Floods and cyclones are expected to cause major damage to dwellings, property and critical infrastructure, as well as affect inhabitants and destroy crops. Damages to hotels and tourist centers, including roads, airport facilities and water and sewage systems could directly undermine the tourism sector. In the absence of coastal management policies and practices, tourists that are drawn to observing nesting sea turtles in their natural habitats will likely look to other tourism destinations where protection and conservation measures are prioritized. Coral bleaching and the subsequent destruction of coral reefs as a result of climate change will not only impact the livelihoods of coastal communities and put pressure on food security, but also destabilize an economy that is highly dependent on the growth of the tourism sector.

Adaptation Options - Sustainable development and promotion of the Mohéli marine park

- Preparation of a climate change risk assessment for the tourism industry
- Creation of risk maps (e.g., for floods, landslides and coastal erosion) for planning tourism development projects
- Monitoring of eroded coastal zones (e.g., beaches)
- Ensure principles of public-private cooperation in the tourism sector
- Training of National Agencies in monitoring climate change effects on coastal resources, natural systems beneficial to tourism and natural attractions (beaches, reefs)
- Conducting environmental audits and retrofit programs for hotels and marinas to add climate change component
- Ensuring new infrastructure incorporates a hazard-resistant designs and retrofitting existing buildings and coastal structures
- Using an integrated approach to tourism development across a wide spread of government ministries and integrating green agenda policies into tourism and non- tourism policies

- Education and training focused on developing customer-service skills for local front-line staff to deliver high quality tourism services to visitors²⁷
- Well-targeted tourism policies to promote innovation (e.g., human resources, knowledge, R&D, information technology), the development of new business models, and a dynamic culture of enterprise²⁸

Disaster Risk Management

Disaster risk reduction is still a nascent area of work in the Comoros. According to the NAPA, disaster risk management and coordination mechanisms are still under development and en route to being operationalized. In the country, disaster risks are closely associated with climate change risks and impacts. A segment of Comoros' INDC that focuses on risk management includes priorities such as capacity building of Geographic Information Systems (GIS), development of risk assessments, awareness raising to improve the understanding of disaster risks, and preparation of civil society on disaster risk management. According to the 2020 human development indicators for the Comoros, a mere 29.2% of Comoros' population reside in urban areas²⁹. Analysis indicates that on average, the Comoros has around USD \$5.7 million in combined direct losses from earthquakes, floods and tropical cyclones every year³⁰. Tropical cyclones pose the most significant risk of the three hazards, producing an estimated 64% of the average loss per annum. Cyclones such as the one that took place in 1950, claimed 524 lives on the island of Grande Comore and equivalent losses were recorded on the other islands. Beyond this, seven severe cyclones and storm surges occurred between 1986 and 1999 in the Comoros.

Priority Area: Building the capacities of GIS, EWS and disaster risk assessments

In order to be successful, climate change adaptation and disaster risk reduction strategies require public interest, leadership, and acceptance³¹. The IPCC suggests that based on the knowledge of disaster risk research and findings, the condition for understanding climate risks and extreme events involves knowledge of different key elements. These include, understanding the exposure within its spatial and temporal dimensions, recognizing drivers of vulnerability, and ways in which climate change influences hazards. Key for the Comoros will be the development of technical capacities and measures that include Geographic Information System (GIS), Early Warning Systems (EWS), disaster risk assessments and risk communication between decisionmakers and local inhabitants. Risk communication failures experienced in other countries suggest that trust in official institutions responsible for early warning and disaster management in the Comoros is vital for reducing disaster risks. Moreover, it is important to engage different stakeholders to process the existing or impending challenges and identify respective solutions.

Vulnerability of the Disaster Risk Management System

There are numerous disaster risks in the country, which involve volcanic eruptions in Grande Comore, as well as tropical cyclones, floods and to a lesser extent, tsunamis. Eruptions of the Karthala volcano on Grand Comore have, on three occasions, resulted in the evacuation of many towns situated on the slopes of the mountain. Other disasters on Grande Comore based on anthropogenic hazards include the Voidjou power plant disaster in September 2009, characterized as one of the worst disasters of its time. In general, the Comoros' status as an LDC and SIDS renders it highly vulnerable to climate change impacts and extreme weather. According to literature, the Comoros displays a vulnerability rate of 82.1% based on the 2011 Human Development Report, which indicates the country's high level of exposure to numerous natural risks and threats.

The increase in intensity and frequency of extreme weather and slow onset events such as floods and droughts, exacerbate vulnerability to infectious diseases, trigger disasters and destruction of natural

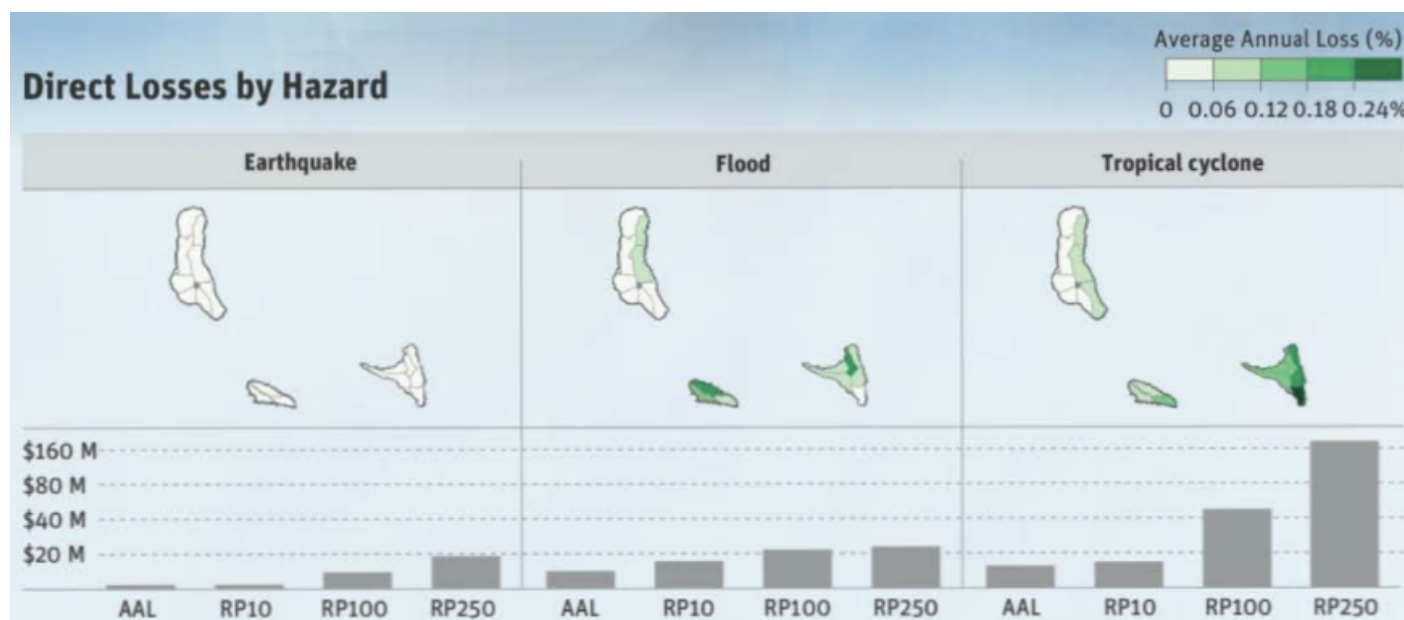
resources, and perpetuate socioeconomic problems associated with daily life. Forced migration and displacement due to extreme weather would be difficult to control. Weather-related disasters in the Comoros deprive households of secure dwellings, and cause the destruction of pastures and meadows which disrupt farmers' means of agricultural production and subsistence. Loss of productivity in sectors such as commerce, energy and transport, together with secondary effects in all other economic sectors limit future investments and put downward pressure on consumption, ultimately lowering GDP. Increased vulnerability in the absence of social protection mechanisms suggests insufficient means and opportunities to recover from climate and disaster related shocks. The combination of the status of socioeconomic development in the country, coupled with climate sensitive resources such as water, forests and soils, and the level of development of critical infrastructure, is too precarious to reasonably offset the effects of climate change and climate variability.

Exposure to Climate Impacts and Risks

Earthquakes, floods and tropical cyclones comprise the three most common hazards in the Comoros. Other natural hazards include landslides, wind, storm surges, excessive rainfall and earthquakes. Anjouan incurs the highest economic losses of the three islands, amounting to 80% of the average annual losses from all three hazards across the archipelago. The greatest wind hazard is in the northeast and southeast of Anjouan. The greatest flood hazard due to tropical cyclones is in Anjouan and Mohéli. While the greatest storm hazard runs along the southern and eastern coasts of the Comoros. The residential sector is generally the hardest hit and experiences 80% of the combined losses, followed by 11% of losses in the public sector and 6% in the commercial sector³². Direct losses total USD \$5.7 million from earthquakes, floods and tropical cyclones every year. The losses of human lives are linked to the resurgence of infectious diseases. Climate risk associated with seasonal drought is expected to lead to 34% loss of human life, while cyclonic events are predicted to cause a 24% loss in human life³³.

Further to this, the 100-year return period loss from earthquakes, floods and cyclones totals over \$48 million which is equivalent to about 8% of the Comoros' GDP in 2014. The assessed total replacement value in 2015 for all residential, industrial and public buildings and other infrastructure was reported to be nearly USD \$2.6 billion. The island of Grande Comore exhibits the largest concentration of replacement value. With respect to occupancy type, the residential sector reports above 66% of the total replacement value³⁴.

Figure 7 Direct losses by Hazard



Adaptation Options

- Setting-up of a multi-hazard early warning systems and surveillance systems
- Establishing coastal protection measures (dikes, embankments, sea walls and surge barriers)
- Provision of access to climate- and disaster-related information (both emergency information and training programmes),
- Provision of economic resources including financial means such as micro-credit and resilience insurance
- Provision of different tools, methodologies, and sources of knowledge (e.g., expert/scientific knowledge, local or indigenous knowledge) that allow capturing new hazards, risk, and vulnerability profiles, as well as risk perceptions
- Ensuring adequate risk communication to reach different audiences to make risk comprehensible, exploring ways to understand audience values, anticipating the audience's response to the communication, and improving awareness and decision making
- Integration of climate and disaster risk policies and considerations into sector policies and management plans
- Creation of a database and a Geographic Information System (GIS) to better anticipate, respond to and manage disaster risks
- Strengthening of national security systems and response to affected individuals or communities in case of a disaster
- Establishment of a National Committee for Risk and Disaster Management
- Establishment of a General Directorate of Civil Security (DGSC) within the Ministry

Waste and Sanitation

The anarchic development of urban centers marked by informal housing and spontaneous districts has increased risks of pollution in the country. There are no sustainable waste management solutions in the Comoros, which is a significant cause for concern as open burning of household waste is common and largely uncontrolled. The Second National Communication highlights that inadequate waste management and cleaning systems increase the prevalence of infectious diseases such as malaria and typhoid, and present potential risk of contamination of groundwater reservoirs and damage to coral reef systems. The deterioration of coral reefs results from exposure of the reefs to unsustainable fishing practices such as the use of dynamite, uncontrolled anchoring of ships, treading at low tide, waste dumping and soil runoff³⁵. Anthropogenic hazards coupled with climate variability, magnifies the effects of coral bleaching, which is caused by the precipitous warming of ocean temperatures. In the Comoros, waste is scattered along the coastal zone and in the vicinity of townships and metropolitan areas. The lack of a drainage and waste management system also signals that wastewater flows directly into the ocean. Water distribution infrastructure needs to be

adequately developed and managed, water tanks need to be covered to reduce the risk of vector-borne diseases, and the treatment and disposal of municipal, industrial and other solid waste should be prioritized.

Priority Area: Improve urban waste management system

Population growth, expressly in urban areas, and the lack of waste management causes the indiscriminate dumping of household waste in close proximity to coastal areas and the ocean, with harmful effect on the marine system. In the absence of proper waste management system and sanitation systems, public health issues arise as wastewater and solid waste discharges generate the spread of communicable diseases. In addition, improper disposal of waste directly contributes to air pollution. Whereas the urban waste management system consists of a number of septic tanks to dispose of sewage in towns, in rural expanses households rely on pit latrines. In consideration of the fact that a large concentration of solid waste emanates from large cities, as a priority, the focus will be upon improving the urban waste management system.

Vulnerability of the Waste Sector

The aggregate amount of urban solid waste disposed in landfill sites is estimated at 28.37 Gg per year³⁶. In effect, the low levels of emissions of solid waste in landfills is explained by lack of adequate waste collection and disposal methods in the country. Municipal solid waste and wastewater form main sources of GHG emissions in the waste sector. The methods used for the disposal of solid waste are linked to aerobic decomposition, which produces low levels of emissions. Still, in the Comoros, a mere 2% of the population predominantly situated in urban areas use toilets with a flush mechanism. Based on a study highlighted in the Second National Communication, findings suggest that there is a lack of substantial disparities between urban and rural expanses, as over 79% of the population continue to use traditional latrines for waste treatment and disposal. In Grande Comore, 60% of the population is dependent on uncovered water containers and 40% of the population is reliant on coastal aquifers. Challenges in terms of access to clean water still persist. Deterioration in the quality of potable water as a result of contamination from products of weathering and erosion, human and animal excrement, and other hazardous waste and chemicals, and other issues such as chronic problems with water supply, as well as high costs to access water all contribute to the vulnerabilities of the waste sector.

Exposure to Climate Impacts and Risks In the Comoros, pollution from waste, which is diversified and large in quantity, is principally concentrated in large cities along the coast. Due to high reliance on imports, most of the waste that is identified consists of mainly imported and non-biodegradable products such as plastic, glass and metal³⁷. When waste is incorrectly disposed, blocked drainage systems and stream flows can generate flood disasters. Major risks of pollution are further aggravated in the open sea by large oil tankers. Whereas, illegal waste dumping can trigger the spread of infectious diseases and vermin, as well as increase the risk of contamination of groundwater reservoirs and coral degradation³⁸. Waste incineration is also a contributor to GHG emissions for its role in the release of dioxins and furans into the atmosphere. Improper treatment and disposal of wastes that go unchecked result in contamination of waterbodies, which cause biodiversity loss due to chemicals and harmful toxins that destroy terrestrial or marine fauna and flora. In the absence of solid waste management, waste such as sewage sludge, special waste and leachate can pollute waterbodies with irreparable harm.

Adaptation Options

- Development or transfer of appropriate technologies and systems for wastewater treatment
- WASH awareness campaigns and education on proper waste disposal and hygiene practices to ensure behavioral change

- Source separating solid wastes for composting, recycling, anaerobic digestion or special disposal
- Improving coordination with municipalities at all district levels in the collection and verification of data on solid waste and relevant reporting procedures
- Ensuring political will and commitment to improving solid waste management, supported by a strong regulatory environment
- Ensuring the necessary infrastructure is in place to support sustainable waste management
- Creation of outlets for buying of recyclable wastes in every community including job creation or entrepreneurial development schemes

Infrastructure

A majority of infrastructure in the Comoros is constructed proximate to the ocean with most of the structures situated less than 6 meters above sea level. This intensifies existing levels of vulnerability given the manner in which infrastructure is designed and constructed, and the lack of rules and standards to ensure protection against climate risks. For example, traditional houses constructed of cob and straw exhibit poor resilience against extreme weather. In fact, losses from coastal infrastructure are assessed at USD \$400 million. Trends indicate that current and future impacts of climate change are likely to undermine decades long progress to reduce poverty. The Comoros is further subject to pressures of potential landslides, collapse of embankments, and flooding, which inundate lands, cause damage to critical infrastructure such as roads, hospitals and schools and destroy dwellings of inhabitants, especially those located in Anjouan and Mohéli.

Priority Area: Critical infrastructure protection due to sea level rise

Extreme weather is damaging to infrastructure as evidenced by disaster-related damage and loss indicators⁴⁰. In the Comoros, as is the case in many LDCs, persistent gaps in quality data undermine climate change projections preventing optimum decisions from being made on infrastructure reliability and safety. Storm surges, flooding and saltwater intrusion have in the past caused damage to infrastructure located along the coast in the villages of Mirontsi and Pomoni in Anjouan. According to the NAPA, an oil station was partially destroyed, while a primary school in the village of Itsamia in Mohéli was inundated. Health care centers are generally under threat from the risk of weather-related events, as are 20% of marine turtle breeding sites. Several villages in Mohéli remain at risk, while a number of districts have been destroyed, triggering the displacement of local inhabitants. Saltwater intrusion and sea level rise impact villages. In the village of Bangoi-Kouni, sea level rise reported in March 2006 caused the inundation of two districts comprising of 20 houses once a levy was compromised by tidal waves. Protection of critical infrastructure due to sea level rise should therefore be prioritized to address some of the pressing effects of climate change.

Vulnerability of the Infrastructure Sector

Most of the infrastructure in the Comoros is constructed in close proximity to the ocean, situated at less than 6 meters above sea level. Basic infrastructure consisting of ports, airports, diesel electric stations, petroleum depots, major roads, monuments, canal dykes and embankments, will likely be impacted by climate change and extreme weather due to its proximity to the ocean. Sea level rise is projected to affect the north and northeast regions of the country, namely in M'Boinkou and Hamahamet, and Bambao ya Mboini in the central region, and Mbachilé in the south. Concern over the impacts of extreme weather events on the population in the Comoros is mounting, due to risk factors such as population growth, urbanization, poverty and climate variability. The weakening of the

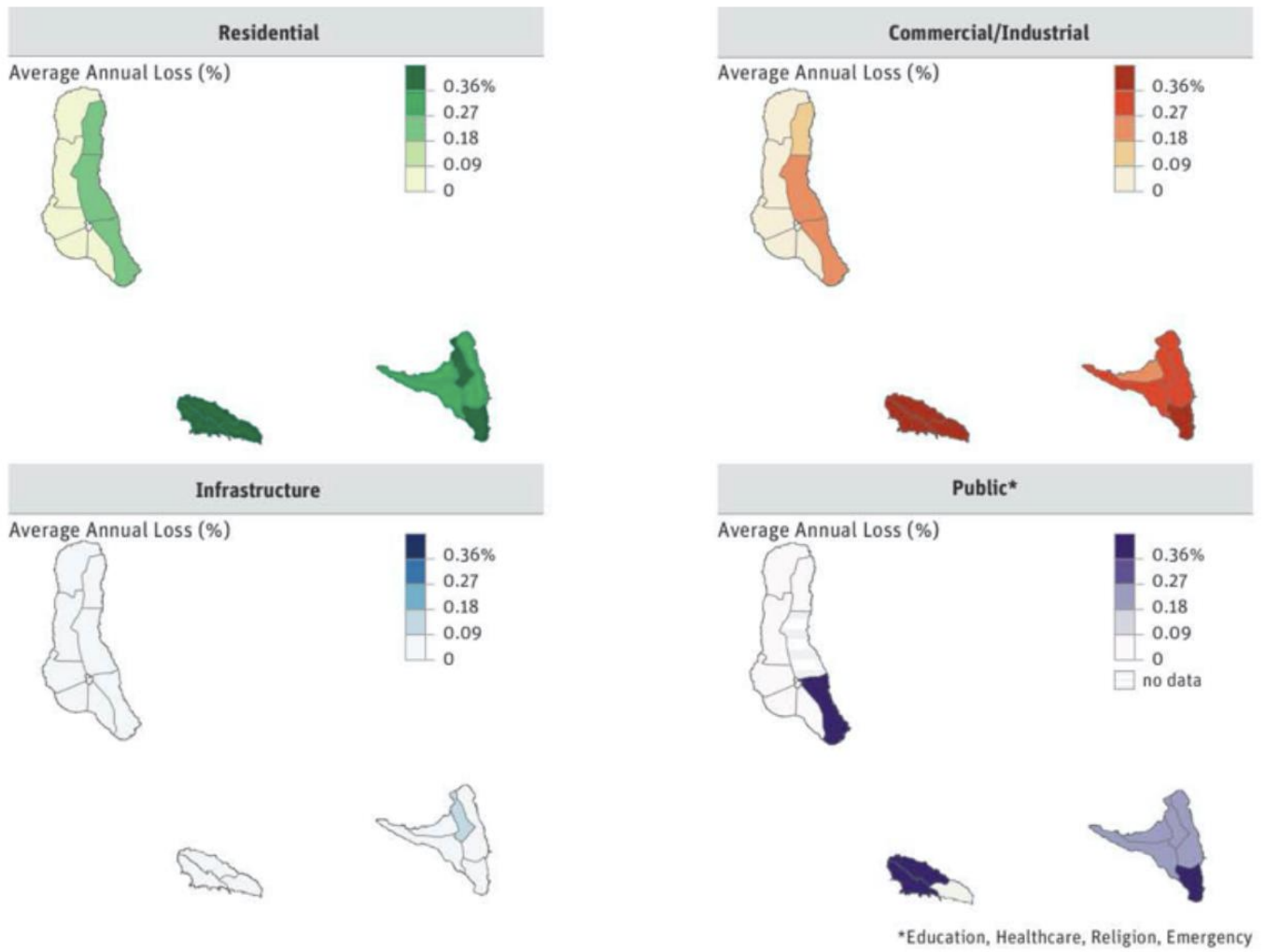
infrastructure base must therefore be rapidly addressed considering its role in sustaining essential socioeconomic activities. Auspiciously, the deficiencies of infrastructure-based industrial plants spotlight not only gaps but potential opportunities for growth. Actions to lower the exposure to disasters are critical through sound disaster risk management plans with the integration of relevant adaptation actions such as proper land use planning, planned response based on multi-hazard early warning systems, and good infrastructure engineering design⁴¹. Crucial to the Comoros' disaster management strategy is the development of a Multiple Hazard Mapping composite and a Vulnerability Risk Assessment, which will assist in the prioritization of communities at-risk and the identification of key hazards, critical infrastructure and expected risks.

Exposure to Climate Impacts and Risks

The Comoros continues to experience a shortened rainy season combined with intense and irregular rainfall patterns. The IPCC predicts that the frequency of heavy rainfalls will increase in the 21st century. The Comoros is among the countries that has experienced heavy rainfalls associated with tropical cyclones with continued warming, and increases in heavy rainfall occurring despite shortened rainy seasons. The acceleration of deforestation and degradation also prompts river floods, which gives way to risks of landslides and rock falls. On the islands of Anjouan and Mohéli, rock falls are common and often block or destroy roads and bridges. The floods damage public infrastructure such as hospitals, schools and sport fields. As a result of climate change, the NAPA projects that a majority of big cities and townships, including roads, ports, tourist infrastructure, power plants and historic monuments, close to the ocean will disappear. The direct economic loss is estimated at 170 billion Comorian Francs (current value) equivalent to USD \$486 million, by 2050.

The estimated total replacement value for all residential, commercial, industrial and public infrastructure for 2015 is assessed at almost USD \$2.6 billion⁴². With respect to occupancy type, the residential sector contributed to more than 66% of the total replacement value. Approximately 87% of direct losses from flooding stem from the residential sector and 5% from the commercial sector. Annual emergency costs, according to the Comoros' Disaster Risk Profile are, on average, in excess of \$460,000. All in all, floods and cyclones cause major damage to residential structures including personal property and the lack of proper drainage systems and adequate water distribution infrastructure, increases the impacts of floods and worsens issues of waste and sanitation.

Figure 8 Direct Losses by Building Type for all Hazards



image

Sources: *Disaster Risk Profile Comoros. (2016). GFDRR.*
https://www.preventionweb.net/files/52379_comoros.pdf

Adaptation Options

- Enforcement of building codes and standards
- Reducing premature deterioration of existing and new infrastructure (e.g., improved maintenance of structures from weathering)⁴³
- Coordination of community pre-disaster and post-disaster management planning
- Incorporation of disaster resilient construction and climate change adaptation topics in curriculum for engineering and planning professions
- Prioritization and development of adaptation solutions such as retrofit technologies for the most critical zones and existing infrastructure types
- Incorporation of infrastructure adaptation into the planning, maintenance and replacement cycle of existing infrastructure
- Relocation of the most at-risk structures and where necessary, the most at-risk communities

- Demolition and replacement of unsafe structures or abandonment of high-risk locations⁴⁴

Health

The country has realized significant gains in the 30 years since independence. Its health coverage is considered to be solid and provides access to good health care facilities. In fact, 60% of the population is in close proximity to health posts. In the Comoros, the health effects of climate change include increased respiratory and cardiovascular disease, early death associated with extreme weather events and increase in the prevalence of waterborne, foodborne and vector-borne diseases, including threats to mental health. Climate change is predicted to cause direct harm to human health by increasing particular matter in the air in certain locations including smog that may diminish lung function. In the Comoros, climate variability and warming of temperatures increase the prevalence of vector-borne diseases such as malaria, chikungunya, dengue, cholera and diarrhoeal diseases as well as acute respiratory infections. According to the WHO, diarrhoeal disease is the second highest cause of death in children under five years old. Whereas, malaria in the country is the leading reason for medical visits at 30%. In 2002, from a pool of 7 157 recorded deaths, 20% were attributed to malaria. Climate change is a major factor in the distribution of malaria, in combination with socioeconomic conditions, pest control and access to healthcare. Given year-long trends, the incidence of malaria in the Comoros increased from 33% in 2000 to 34.6% in 2004, including in areas of altitude, due to temperature rise.

Priority Area: Infectious diseases: Vector-borne diseases (malaria)

The epidemiological situation in the Comoros continues to be dominated by malaria, despite its decreasing trend. Owing to climate variability, malaria could reach areas that have as of yet been spared. Climate is one of the drivers that influence the distribution of vector-borne diseases. The effects of climate variability on the geographical distribution and incidence of vector-borne diseases is observable in tropical areas such as the Comoros. Infectious disease transmission is sensitive to local, minor variations in climate as well as alterations of the landscape, human behavior and the diversity of animal hosts⁴⁵. Still, much is unknown about the interactions of weather-related variables and incidences of vector-borne pathogens. What is required in the Comoros in order to accelerate the end of malaria is enhanced vector surveillance and human disease tracking to address issues with vector-borne pathogens.

Vulnerability of the Health Sector

The prevalence of malaria in the Comoros is higher in rural areas (32.6%) than in urban expanses (25%)⁴⁶. From a health perspective, much progress still needs to be made to reduce the socioeconomic disparities between the islands, rural and urban areas and sexes⁴⁷. Based on 2015 statistics, the WHO reported that just 35.8% of the population use improved sanitation facilities, of which 48.3% comprise the urban population and 30.9% the rural population⁴⁸. Further to this, 90.1% of the population has access to clean potable water, 89.1% of whom live in rural areas and 92.6% in urban areas. The under-five mortality rate per 1000 live births is 73.5%⁴⁹.

Although the United Nations specialized agencies allocate significant funds to support the development of the health sector in the Comoros, the fraction of technical and financial support from WHO is declining. Challenges in regards to the national health system range from poor management and utilization of the health workforce, to financing gaps of universal health coverage, and capacity gaps to prepare for and manage epidemics and disaster risks. What is more, the country continues to experience increases in health costs.

Epidemiological surveillance could help monitor oceanographic changes, including measures to decrease risks of food poisoning, as numerous cases of food poisoning through consumption of

marine fauna have been observed in the Comoros. Overall, the population suffers from low awareness of health risks, high costs of health services, and limited medical personnel such as doctors, medical technicians and other types of health workers.

Exposure to Climate Impacts and Risks

Climate variability causes recurrent dehydration among children and vulnerable groups including sick and old individuals. Eye diseases such as photokeratitis, acute retinopathy and cataract constitute diseases influenced by temperature and climate conditions. Global warming that intensifies with the weakening of the ozone layer, strengthens ultraviolet rays that consequently lead to eye diseases and skin cancers. Such is the case in the Comoros, where cataract is the leading cause of blindness. The amount of people requiring operative treatment for cataracts has risen, along with those who are partially sighted and individuals that are presently awaiting to be operated. The NAPA estimates that 540 individuals turn blind annually.

The increase in temperature, in addition to prolonged heatwaves could lead to expansion of geographical ranges of malaria prone areas. Such shifts can change disease incidence contingent on vector-host interaction, host immunity, and pathogen evolution⁵⁰. The incidence of cardiovascular diseases is also influenced by heatwaves, however, improved forecasting and heat-related early warning systems can drastically prevent deaths and reduce the vulnerability of Comorians, particularly children, old people and poor individuals, to heat-related health effects. The rise in the prevalence of waterborne pathogens such as bacteria, viruses, and parasites, and cyanobacterial blooms in the water could be aggravated by increased runoff, and discharges from sources of pollution⁵¹. Such are the risks associated with rising temperatures and frequency of weather-related events such as tropical cyclones and storm surges. The Initial National Communication points towards the probable increase in the incidence of cyclones, storms and flooding that could cause the destruction of 17 health centers and 35 nursing stations in the country.

Adaptation Options

- Integration of human health into all climate-change adaptation and disaster risk reduction policies
- Ensuring the resilience of the health sector within broader disaster risk reduction strategies, including surveillance, monitoring and assessment
- Designing of policies that support adaptation actions in geographical areas that are particularly vulnerable to health-related hazards as a result of climate change
- Modelling of future climate change to better understand expected climate vulnerabilities to water quality conditions
- Enhancing vector surveillance and human disease tracking to address issues with vector-borne pathogens
- Advocating for cleaner energy systems and promoting the safe use of fuelwood for domestic activities to cut the burden of household air and ambient air pollution
- Advocating for and disseminating information on the threats that climate change presents to human health, and opportunities to promote health and behavioral change
- Capacity building of health decision-makers to improve understanding and ensure integration of climate change risks into health planning

- Integration of meteorological data and climate information into national health plans and programs to support the development of a climate-informed health-based early warning system

National Adaptation Priorities

XXXX XXXX

Implementation Strategy for the NAP

XXX

Alignment with the GCF Country Programme

XXX

Mobilization of other Sources of Finance

XXX

Monitoring and evaluation of adaptation actions and process

XXX

Reporting

XXX

Further development of the programme to support future NAPs

XXX

Annex I: NAP Outputs

XXX

Annex 2: Country Profile

XXXX

Annex 3: Data and information system to support the NAP

XXX

References
