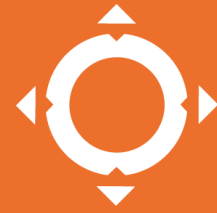


REPORT



Global
Risk
Modelling
Alliance

GRMA Programme in Madagascar Inception Report

February 2023



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List of Acronyms


AAL	Annual Average Loss
ADRIFI	Africa Disaster Risk Financing or Programme De Financement De La Gestion des Risques Et des Catastrophes En Afrique
AFD	Agence Française de Développement
AFM-R	ARC River Flood Model
ARC	African Risk Capacity
ARV	African RiskView
BMZ	Federal Ministry of Economic Cooperation and Development
BNGRC	Bureau National de Gestion des Risques et des Catastrophes (The National Office for Risk and Disaster Management)
CAT DDO	Catastrophe Draw Down Option
CDRFI	Climate and Disaster Risk Finance and Insurance
CDRM	Climate and disaster risk management
CERC	Contingency Emergency Response Components
CMAP	Climate Macroeconomic Assessment Program
CNGRC	Conseil National de Gestion des Risques et des Catastrophes (National Council for Risk and Disaster Management)
CPGU	Cellule de Prévention et d'appui à la Gestion des Urgences (Prevention and Support Unit for Emergency Management)
CPP	V20 Climate Prosperity Plan
CRA	Climate Risk Assessment
CRIC	Comité de Réflexion des Intervenants aux Catastrophes
CVF	Climate Vulnerable Forum
DEM	Digital Elevation Model
DGM	General Directorate of Meteorology
DRM	Disaster Risk Management
DRR	Disaster risk reduction
EOC	Emergency Operations Centre
EWS	Early Warning System
FEWS NET	Famine Early Warning Systems Network
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GRMA	Global Risk Modelling Alliance Programme
IDF	Insurance Development Forum
IASA	<i>International Institute for Applied Systems Analysis</i>
IMF	International Monetary Fund
IRM	World Bank's Immediate Response Mechanism
ISF	InsuResilience Solutions Fund
KfW	Kreditanstalt für Wiederaufbau (German Development Bank)
LiDAR	Light Detection and Ranging
NAP	National Adaptation Plan
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organisation
PNGRC	National Policy on DRM
PPCR	Pilot Program for Climate Resilience
RIMES	Regional Integrated Multi-Hazard Early Warning System
SAF/FJKM	Sampanasa Fampanandrosoana established by the Church of Jesus Christ in Madagascar
SFGRC	La stratégie de financement de la gestion des risques et des catastrophes de Madagascar
SNGRC	National Strategy on DRM
SWIO-RAFI	Southwest Indian Ocean Risk and Financing Initiative
TA	Technical Assistance
TCe	ARC's Tropical Cyclone Explorer
TWG	Technical Working Group
UNDP	United Nations Development Program
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children's Fund
V20	The Vulnerable Twenty Group of Ministers of Finance of the Climate Vulnerable Forum
WASH	Water, Sanitation and Hygiene
WBG	World Bank Group
WFP / PAM	World Food Programme / Programme Alimentaire Mondial
WHH	Welthungerhilfe
WRSI	Water Requirement Satisfaction Index

1. Context

This report describes the origin of GRMA support to Madagascar, outlines the activities and outcomes of the country workshop, and makes the initial proposal for GRMA programme activities in Madagascar.

1.1. The Global Risk Modelling Alliance

The Global Risk Modelling Alliance (GRMA) results from a strategic agreement between the V20 Group of Ministers of Finance and the cross-sector Insurance Development Forum (IDF). Its purpose is to strengthen climate and disaster risk insight, support strategic decision-making and help unlock risk finance for public good. Working side by side with officials and local experts in ministries and their agencies, it offers open risk management tools, technical assistance (TA) and funding for open models and data. Funded by the German government and supported by the international insurance industry, the GRMA offers countries open data, technology, and practical learning through co-development of risk management strategies and applied risk finance projects. It aims to strengthen local capacities in risk understanding and support the establishment of open-source risk modelling platforms. The GRMA programme is a significant contribution to the Vision 2025 of the InsuResilience Global Partnership, which aims to catalyse financial protection for 500 million vulnerable people by 2025.



The GRMA is a public-private technical assistance programme to address persistent challenges of risk understanding in the most climate vulnerable countries. The GRMA programme will assist countries in building, sharing, and developing local capability in climate and disaster risk understanding, using open modelling principles and private sector knowledge to increase access to risk finance. The GRMA programme comprises three key elements:

1. An open-source risk modelling platform and open data standards to promote accessibility, choice, and sharing across departments and sectors.
2. A model and data component providing a funded mechanism to fill critical gaps with data and models produced as digital public goods, with a particular emphasis on co-developing these with local knowledge and information.
3. The GRMA technical assistance team, which provides human interaction and connects private sector experience to development needs.

Furthermore, the GRMA has been selected as a key resource for the Global Shield Initiative, particularly during initial in-country climate risk assessments and subsequent capacity building. The GS, launched at COP27, is an initiative launched by the G7 in partnership with the Vulnerable Twenty Group (V20) of Finance Ministers for pre-arranged financial support designed to be deployed during climate disasters. It aims to increase protection for poor and vulnerable people by substantially enhancing pre-arranged finance, insurance and social protection mechanisms against disasters which will help to minimise losses and damages exacerbated by climate change, in an efficient manner.

The GRMA is also an integral component of V20 Climate Prosperity Plans, now being rolled out in a number of Climate Vulnerable Forum (CVF) member states.

The objectives of the GRMA program include:

1. Strengthen long-term local capacities in risk understanding.
2. Co-develop clear (sub-)national risk priorities for application of risk analytics to disaster risk reduction, adaptation and CDRFI, as well as own (sub-) national climate and disaster risk management strategies.
3. Develop capacity on modelling techniques and data acquisition to enable sustainable access to open risk modelling data and tools through practical learning / experience.

1.2. Madagascar Request for GRMA support

The government of Madagascar submitted an expression of interest in GRMA support with letters from the Cellule de Prévention et d'appui à la Gestion des Urgences (CPGU; Prevention and Support Unit for Emergency Management) on 6th January 2023 and le Ministre de L'Economie et des Finances (The Ministry of Economy and Finance) on 8 February 2023 (see Annex 1).

After initial discussions with the Malagasy delegation at COP 27 in Sharm El Sheikh, Egypt, in November 2022, support was requested to build capacity in risk modelling and to be able to access new risk transfer mechanisms.

A country workshop was held on February 22nd and 23rd in Antananarivo, Madagascar, to define the potential GRMA support in greater detail, and in collaboration with representatives of the Malagasy government.

In preparation for the workshop, CPGU identified current relevant activities, which are elaborated on in *Institutional arrangements in disaster and climate risk*, and gaps in risk modelling in Madagascar. Bilateral meetings with various stakeholders were arranged on 20 and 21 February 2023 with the aim to better understand these gaps to inform the workshop and co-define GRMA support. The following points were highlighted in the meetings:

1. A lack of specific data on risks, in time and space, to be addressed with good quality and more granular risk data to help with targeted disaster risk response and planning of appropriate prevention measures.
2. An absence of risk modelling methodology and a lack of materials and tools to host the software for modelling, which may be addressed by developing locally adjusted models for requested hazards.
3. Lack of technical experience on risk modelling, which could be addressed by helping better understand projected climate impacts and costs/benefits of adaptation and risk-transfer solutions. This can guide, incentivise, and accelerate public and private sector investments for a climate-resilient transformation.
4. Lack of experience and sharing with other countries.

1.3. Madagascar context

The island nation of Madagascar is situated in the southwestern Indian Ocean, off the southeastern coast of the African continent. The population of Madagascar was 28.9 million (World Bank Data Catalog), with over 80% of people living in poverty (2012, World Bank Data Catalog). GDP in 2021 was USD 14.47 billion in an agricultural-based economy where subsistence farming is the primary activity (64% of the population are employed in the agricultural sector).

Madagascar is one of the countries most vulnerable to climate change in the world. The country is exposed to various climatic hazards and geological phenomena, such as tropical cyclones, floods, drought, landslides, earthquakes, and coastal erosion. The effects and impacts of these hazards often compromise the achieved progress and are a significant brake on sustainable development.

I. Climate conditions and risk

The location and topography of Madagascar results in distinct regional climates within the country and influences the distribution of climate hazards. In the south-west the climate is arid to semi-arid, while the eastern coastline facing the Indian Ocean has a tropical climate. The central highlands, including where the capital Antananarivo is located, have moderate temperatures. A single rainy season occurs in Madagascar during November to April; highest annual rainfall occurs on the east coast, and the lowest annual rainfall totals in the southwest.

Climate change is expected to increase air temperatures over Madagascar with substantial increase the annual number of very hot days, especially in the west (GIZ, no date¹). Sea level is expected to rise by 22cm by 2050, compared to 2000 levels. While annual rainfall is expected to decrease, there is indication of a slight increase in the number of days with heavy precipitation events (GIZ, no date). There is less agreement on magnitude of change in precipitation between models than for temperature projections, which means greater uncertainty in projections. More details on climate projections for Madagascar are presented in Climate Risk Profile: Madagascar (GIZ, no date).

A review of historical disaster data, available for the period 1968-2022 in the EM-DAT catalogue (EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be), shows 97 disaster events were recorded. Sixty-six (68%) were listed as storms, 11% flood, 10% drought, 8% epidemic and 2% insect infestation. Storms contributed 94% of total monetary damages, 56% of deaths, and 97% of the population was made homeless. Owing to the wide effect of droughts, storms were responsible for 48% of the people affected by the 97 disasters, with drought being responsible for 38%.

There is no clear trend in population affected by storms over time in the EM-DAT data, with the population affected by individual storm events around or below 0.5 million, except in 2000 and 2004 (1 million) and in 1972 (2.5 million). However, total damages (adjusted for inflation) in individual events appear to have decreased. In 2004 a tropical cyclone caused USD 390 million in damage, but the five events with higher estimated damage (adjusted) all occurred between 1977-

¹ GIZ. No date. Climate Risk Profile: Madagascar. 12p.

1986. Four droughts have each affected over 1 million people – in 1981, 2016, 2017 and 2020. In 2010 a locust infestation affected 2.3 million people.

In 2016, GFDRR² in collaboration with Verisk (then AIR Worldwide) conducted a risk assessment in the context of the regional Southwest Indian Ocean Risk and Financing Initiative (SWIO-RAFI) study. A disaster risk profile was produced for Madagascar using a catastrophe model and combining global and regional data with available local information. The study estimated that on average Madagascar could suffer direct losses of USD 100 million annually due to the combined effects of tropical cyclone, flood, and earthquake. USD 85 million is due to tropical cyclone and USD 13 million due to floods. Droughts were not considered in this risk assessment. The estimated 1-in-10-year loss (an event with a 10% chance of occurring in a given year) was almost USD 200 million and the 1-in-100-year cyclone (1% annual probability) USD 810 million – with most impacts in the eastern and northern areas. In contrast, there is a 1% annual probability of direct flood loss exceeding USD 120 million. It is worth noting, that this analysis is based on the current climate not considering the effects of climate change over the next decades.

In 2020, CPGU published a new risk atlas “Atlas des risques climatiques de Madagascar”, which presented the distribution of hazard and risk from cyclones, floods, coastal erosion and coastal flooding, and drought. The risk atlas synthesises information from earlier studies to inform local and national authorities, planners, donors, and civil society. The risk atlas includes presentation of georeferenced digital data in the open-source mapping software QGIS. Other notable sources of climate risk information are provided by USAID (2016³,2018⁴) and GFDRR (2011⁵).

II. Institutional arrangements in disaster and climate risk

The Malagasy Minister of Economy and Finance is a member of The Vulnerable Twenty (V20) Group of Ministers of Finance of the Climate Vulnerable Forum, which is a dedicated cooperation initiative of economies systemically vulnerable to climate change.

The Malagasy Government has an established governmental / institutional structure to improve the financial, physical, and social resilience to climate risk. Following the third World Conference on Disaster Risk Reduction (DRR) in Sendai in March 2015, the Government with the support of partners, updated its National Policy and Strategy on Disaster Risk Management so that these framework documents can be adapted to the Sendai Framework and to the national context. Law No. 2015-031 relating to the National Policy on DRM (PNGRC) was declared on February 12, 2016,

² SWIO-RAFI (2016) - Initiative de financement et d'évaluation des risques dans le sud-ouest de l'océan Indien (SWIO-RAFI, Southwest Indian Ocean Risk Assessment and Financing Initiative), Air Worldwide, financement Banque mondiale.

³ USAID (2016) – Profil du risque de changement climatique à Madagascar - Fiche documentaire. Task Order No. AID-OAA-I-1400013 'Climate Change Adaptation, Thought Leadership and Assessments' (ATLAS). 5 p. (accessible sur le site : https://www.climatelinks.org/sites/default/files/asset/document/2016_USAID_Climate%20Risk%20Profile_Madagascar_FR.pdf)

⁴ USAID (2018) - Profil de risque climatique, RISQUES CLIMATIQUES DANS LES ZONES URBAINES ET EN VOIE D'URBANISATION MADAGASCAR – Projet Atlas, mars 2018. (accessible ici : https://www.climatelinks.org/sites/default/files/asset/document/180404_USAID-ATLAS_Climate-Risks-in-Urban-and-Urbanizing-Geographies-Madagascar_French.pdf)

⁵ Banque mondiale, GFDRR (2011) - Climate Risk and Adaptation Country Profile - Vulnerability, Risk Reduction, and Adaptation to Climate Change/Madagascar. 15 p. (accessible sur le site : <https://www-gfdr.org/sites/default/files/publication/climate-change-country-profile-2011-madagascar.pdf>).

and the National Strategy on DRM (SNGRC) was adopted by the Council of Government on September 13, 2016.

The SNGRC aims to make DRM/DRR a pillar of sustainable development. Axis 4 of this National Strategy specifically urges the practice of knowledge and information management for the benefit of DRM/DRR. Indeed, improving the understanding of disaster risks through modelling is necessary in order to have a reliable and relevant risk profile for the effectiveness of actions in the area of GRC.

For the PNGRC to be effective throughout the country, the decree governing its application was drawn up and adopted by the Council of Government in October 2019. The text sets out the organization, functioning and attributions of the two entities working directly in DRM, namely the CPGU (Cellule de Prévention et d'appui à la Gestion des Urgences) and the BNGRC (Bureau National de Gestion des Risques et des Catastrophes). This organisation has been adopted to complete the decree implementing the law on the National Policy on DRM and to strengthen the legal and regulatory framework of the mechanisms to be implemented.

The structure of DRM in Madagascar is based on two levels. The strategic level is made up of:

- (i) the National Council for DRM, which is the structure for consultation and decision-making at the national level,
- (ii) the CPGU – the permanent strategic body on DRM that supports the Prime Minister and the National Council for DRM, and
- (iii) the National Platform for DRR which serves as a space for exchange and sharing of good practices and lessons learned on DRR between all stakeholders (NGOs, projects/programs, private sector, United Nations System).

The Operational level is made up of:

- (i) the BNGRC which is the central operational structure on DRM, and
- (ii) the CRIC (Comité de Réflexion des Intervenants aux Catastrophes) which supports the BNGRC in the implementation of its activities, especially in times of emergency and brings together humanitarian actors from NGOs, private sector, and the United Nations System.

2. Bilateral meetings, Antananarivo, 20-21 February 2023

Preceding the country workshop the GRMA team held bilateral meetings with the following entities, with the aim to introduce the GRMA program and understand the roles and objectives of key institutions. The following sections summarise the content and outcomes of the meetings, with potential requests to GRMA underlined.

2.1. CPGU, 20 February 2023

This meeting included an introduction to GRMA, to the national institutional DRM framework of Madagascar, and workshop logistical discussions due to CPGU's role as co-convenor of the country workshop and contact point for the GRMA support request.

The meeting highlighted key areas of potential GRMA support including centralising data in a platform for DRR, noting that the existing Geonode data repository (resiliencemada.gov.mg) is active but that World Bank funding is coming to an end. While the data catalogue exists, there is a lack of sector level data to support decisions. There is also a lack of risk analysis method and capacity – good models/software to understand risk in Madagascar are required. Having said that, the ARC Technical Working Group (TWG) are involved in customising ARV (editing vulnerabilities, coping capacities) and this TWG involves technical people from multiple ministries, though participation changes with the changing TWG mandate. The TWG has hands-on experience in monitoring drought and cyclone exposure and the ARC mechanism is well-developed at CPGU to mobilise insurance.

CPGU staff pointed to the existing risk profiles of SWIO-RAFI, World Bank 2020, and USAID, and highlighted the draft DRFI strategy to be finalised by end of March (see relevant section for more detail on this).

2.2. INSTAT, Institut National de la Statistique, 20 February 2023

INSTAT staff highlighted the lack of good data primarily as a challenge in managing risk. Data is held on population, society, households, health, economy, and enterprises / businesses. There are data gaps in environmental and climate data and no data on vulnerability to climate, with the current definition of vulnerability related to socio-economic factors. INSTAT staff expressed interest in having a model to identify the population most vulnerable to climate impacts, tailored to the Madagascar context, in particular improvements in tropical cyclone modelling.

There was interest in GRMA's capabilities to work with INSTAT to help customise satellite data to their needs. INSTAT are involved in estimating drought impacts in southern Madagascar, providing information on the population to inform the response; they work in this with Ministry of Agriculture, WFP etc and provide data into ARV modelling. There is hands-on experience in INSTAT of working with CPGU and ARC/ARV. INSTAT confirmed the latest census data is from 2018.

INSTAT mentioned an approach to collate damage to households, infrastructure including roads, and population, which has been used since 2015 and is done with BNGRC. A suggestion for GRMA

support is to organise a small-scale survey of households with BNGRC, to understand exposure better and demonstrate approaches for mapping exposure data.

2.3. Geographic and Hydrographical National Institute, 20 February 2023

This is the public institute in charge of mapping for Madagascar. They hold lots of potentially useful data for GRMA projects, including digital hydrography layers, levelling data, scanned cartographic maps, and by the end of 2023, LiDAR elevation data for c. 65% of the country / 76 urban centres (derived DEM: 4m horizontal resolution, and vertical resolution on the order of centimetres). Aerial photographs (c.20cm resolution) are used to extract roads and buildings, but this is using a manual process, using Maxar data (available for public entities via sharing agreement with IFTM). LiDAR access would be costed in order to recover development costs. Land use classification uses Sentinel-2 data at 10m resolution. The French government is responsible for marine hydrography.

Concern was expressed over the ownership and quality of developed data – and what should be considered the official source. It is also important for GRMA to understand where data can be hosted and accessed. On ResilienceMada / Mahantsagy Geonode-Madagascar, everybody can enter data, and a data policy is needed to ensure quality and define official data – no national data infrastructure exists yet and no data policy exists. Support was requested for hardware and software for automated extraction of data from satellite imagery.

2.4. BNGRC, 21 February 2023

BNGRC highlighted their operational mandate and hosted the GRMA team at their emergency operations centre (EOC). BNGRC communicated that risk models are already being used, but they are receptive to new models and research. The staff responsible for Information Services and Data Management highlighted the Madagascar Climate Risk Atlas has including static maps and historical data, while ARV provides dynamic maps customised to Madagascar with local data included. A lack of sector data was highlighted again, while some geospatial data layers exist for floods and census information. BNGRC was interested in knowing which models we could share; there is a need for financial impact / financial risks modelling.

2.5. Directorate General for Meteorology, Ministère du Transport et de la Météorologie, 21 February 2023

DGM focusses on forecasting and warnings within the five steps of the UNDRR framework. There is understanding that Met Agencies are one part of what needs to be multisector projects, and there have been a lot in recent years in Madagascar. There are similarities Madagascar in context to other African countries. The big challenge is in how people read climate information and how to transform technical information to decision-makers and the public. DGM wants to understand who wants what information to make decisions. And sought clarification of who would use the proposed models and for what purpose.

DGM highlighted a World Bank project in January 2023 which asked what sector interventions are used to address flood and drought risk in Madagascar. During the week workshop each sector defined gaps, a budget and launched a 5-year project to address those risks. GMRA expressed a

need to understand that project and funding, so we can be complementary, for example identifying risks to inform that project.

DGM expressed a need to improve meteorological information as the basis for all interventions: improving the quality of observations, forecasting models and communication, and the number of tools and qualified people. For example, Madagascar weather stations comprise 30 climate stations exists, 26 automatic/manual synoptic stations, and 10 hydrological stations, but no atmospheric, marine, or agrometeorological stations. A map of stations is available in the DGM database where an openly available web interface provides readings entered automatically, and calibrated satellite information.

2.6. Ministry of Environment and Sustainable Development, Ministère de l'Environnement et du Développement Durable, 21 February 2023

This ministry is responsible for Madagascar's Nationally Determined Contributions (NDCs) and National Adaptation Plan (NAP). The Ministry representatives sought clarification of whether GRMA is doing modelling, or recommending what data is needed for risk management. Data exists in the responsible organisations, but tools needed for Benefit-Cost Analysis. In the National Program of Adaptation, a model for assessment [of interventions?] exists and priority use is in WASH, DRR and fishing. A request was made around tools to estimate how much funding each sector needs. GRMA notes this may already be being addressed by the World Bank project identified by DGM.

In the DRR platform in Madagascar, for communicating between sectors, Ministry of Environment is looking at biodiversity and forestry (mandated to manage natural resources) but need data and a to be used to sustain the programs. The importance of working with the DRR platform and CPGU was highlighted. They are interested to understand how they can use quantitative data as best as possible.

2.7. Ministry of Economy and Finance, Ministère de l'Economie et des Finances, 21 February 2023

The Ministry of Economy and Finance is leading initiatives to face climate change, under the Minister's membership of the V20. There are lots of similar initiative to GRMA being presented, but the challenge of bringing something new is that technicians don't know how to use it. There is a need to improve the impact of investments – to put in place strategies and manuals, to identify the priorities for investment, especially for climate change. The Ministry is working with IMF and World Bank on these elements.

CPGU already have a model; the most important thing is building competency and transfer of knowledge in handling disasters. There is a question of how to support the public aid department – Ministry holds the bank accounts for interventions so can Ministry support the structure of the platform to ensure all funded projects consider infrastructure resilience.

There is a possibility to support Madagascar to elaborate the Climate Prosperity Plan (CPP). The V20 Secretariat is helping, and if specific analysis is needed GRMA offered to assist. This includes, amongst others, the analysis of fiscal and macroeconomic impact (and model) of catastrophic

events , which is based on a research cooperation between Frankfurt School, hosting the GRMA, and the International Institute for Applied System Analysis (IIASA).

3. Country workshop, Antananarivo, 22-23 February 2023

The objective of the workshop was to engage key officials and subject matter experts in Madagascar, and to develop the work programme of support requested within the expression of interest submitted to the InsuResilience Solutions Fund Management by Madagascar's Cellule de Prévention et d'appui à la Gestion des Urgences (CPGU) on 6th January 2023. See Annex 2-4 for participant list, invitation letter and agenda.

The proposed outcomes of this workshop were:

1. A proposal for the project scope including a draft roadmap will be developed for the GRMA project. This will be co-developed with key stakeholders to meet the stated needs of the request for GRMA support.
2. Key stakeholders in Madagascar will gain understanding of the scope of the request for support, the GRMA Program and proposed project for Madagascar. Those stakeholders will have the opportunity to contribute to defining the GRMA project through their existing and aligned activities.
3. The GRMA team will gain an improved understanding of existing risk information, technical capacity, and analytical activities in Madagascar. This will support co-development of the project plan, including identifying the roles of project partners.

In addition to the Ministries and departments with whom we held bilateral meetings, the workshop was also attended by: Ministère de l'Education nationale, Ministère des Travaux Publics, Ministère de l'Aménagement du Territoire et des Services Fonciers, Ministère de la Santé Publique, Ministère de l'Eau, de l'Assainissement et de l'Hygiène, Ministère de l'Agriculture et de l'Elevage, Secrétariat d'Etat en Charge des Nouvelles Villes et de l'Habitat, Centre de Fusion des Informations Maritimes – CFIM, Fonds d'intervention pour le Développement, Office National pour la Nutrition, Institut et Observatoire de Géophysique d'Antananarivo, Agence Routière, Office Nationale de l'Environnement, Commune Urbaine d'Antananarivo, the German Embassy, UNDP, UNICEF, WFP (PAM), FEWS NET, START NETWORK, SAF/FJKM, World Bank, ARC, GIZ, KfW, WHH, and Medair. BNGRC were unable to attend due to their disaster relief activities following landfall of Cyclone Freddy on 19 February 2023.

Day 1 comprised a presentation of the GRMA program and the value of risk analytics, and the political framework for disaster risk management in Madagascar. A stocktake on risk understanding was presented by multiple stakeholders and included an overview of available risk profiles, DRFI solutions being used and the status of climate change information. The GRMA team ran an activity in the final session to share the contributions of as many participants as possible, to *understand what participants need to achieve in their role planning, managing, or responding to disaster/climate impacts* and to *understand what kind of information, data or tools are missing, preventing participants from achieving these needs*. The activities followed a '1-2-4-all' user-centred design process to elicit individuals' ideas, and to use small group discussion to consolidate and develop those ideas before sharing with the whole workshop. Participants' contributions were captured by the GRMA team and analysed to inform day 2.

Day 2 featured an overview of academic activities in climate and disaster risk, followed but an overview of CDRFI activities of international partners (GIZ, Start Network, FEWSNET, World Bank, WFP, ARC, Map Platform CARE, and KfW). A discussion followed with all participants proposing their priorities for GRMA support based on institutional requirements and future capacity needs. The outcomes of this session are captured in Table 1. After lunch a subset of the participants, involving CPGU, Ministry of Economy and Finance, Ministry of Education, and the country's Chief Climate Negotiator met to discuss the topics proposed during the workshop and to prioritise next steps.

3.1. Outcomes of the workshop

The overall outcome of the workshop was that there are many and varied requests for GRMA support in Madagascar. These coalesce around:

1. Estimating financial impacts of disasters and prioritising climate adaptation strategies,
2. Developing and centralising relevant data for risk assessment, and
3. Ensuring effective transfer of knowledge, including opportunities to learn from other countries.

The workshop discussions did not result in a defined GRMA project workplan, rather CPGU requested that GRMA propose some possible activities for Madagascar within the scope/range of activities identified with participants, and that CPGU circulate those proposals to relevant Ministries to take a decision on which to proceed with. Those proposals (see *Possible GRMA activities*) are based on the following sections, which describe 1) *Ongoing CRA and CDRFI activities in Madagascar* based on literature review, bilateral meeting and presentations of government and international development partner activities; and 2) Insights from participant discussions.

The workshop brought together participants from many international agencies and Ministries of the Malagasy government. The outcomes of the interactive activities and discussions aimed to elicit participants' perceived needs and priorities in risk understanding and management. The findings of those discussions are presented here, and more information is presented in Annex 5.

The first activity aimed to understand what participants need to achieve in their role planning, managing, or responding to disaster/climate impacts and to understand what kind of information, data or tools are missing, preventing participants from achieving these needs. The information was analysed by the GRMA at the end of day 1 and used to reflect and frame further discussion on day 2.

The 2nd activity involved asking the participants to describe existing capacities in assessing the potential impact of disasters and in designing risk financing solutions – and finally what GRMA support they would seek to close any capacity gaps. This activity showed that any need for institutional capacity building should relate to data access and encouraging open data policies / centralisation of data. Technical assistance should focus on estimating impacts including economic loss and assisting sectors to assess risk for planning purposes rather than event impact

estimates for response. There should also be strong support for autonomous and centralized, or at least locally led update of data and technical capability to access and use interoperable data. Knowledge transfer between countries and to multiple sectors would be of benefit, as well as involving university academics.

The outcomes of the participant discussions reflect the following priorities:

- Improving access to sectoral data is paramount. This may involve developing sector-specific data and also contributing to centralising data hosting and sharing. Sectors which featured most commonly in participants' responses to the activities were infrastructure and education.
- There are many requests to elaborate estimation of disaster and climate impacts, in particular economic losses. This applies to asset level impacts for sectoral planning (especially in education and infrastructure), and to macro-economic modelling for fiscal planning by Ministry of Economy and Finance. There is a focus currently on using historical losses and estimating impact on impending events, rather than long-term frequency and severity. It was notable that agriculture was not highlighted as a priority.
- There is no strong priority towards one hazard, which is taken to mean the requests for support should apply across the main hazards of cyclone, flood, and drought, but that we should also communicate use of data for other relevant hazards.
- Capacity building on applying data and models is requested, and specifically to include knowledge between countries and with academia.

3.2. Ongoing CRA and CDRFI activities in Madagascar

The workshop and bilateral meetings allowed GRMA to consolidate, confirm and deepen, knowledge developed from earlier literature review, and provided an opportunity to take stock of the ongoing or planned climate risk assessment (CRA) and CDRFI activities of the Malagasy government and development partners active in Madagascar. This stocktake is particularly critical for defining the GRMA program in Madagascar, and in the context of the Global Shield, which aims to address and improve the fragmented state of the current global CDRFI architecture. Under this umbrella, the GRMA aims to ensure that there is synergy between complementary activities and avoid duplication of work.

This section summarises recent reviews and recommendations, strategies, and technical tools available. The proposed GRMA program will seek not only to fill gaps in data, models, and technical capacity but to also identify pathways to support ongoing initiatives and recommendations made by other institutions and projects.

I. IMF Climate Macro Economic Assessment, 2022

In November 2020, the International Monetary Fund (IMF) published a technical assistance report for Madagascar, under the IMF Climate Macroeconomic Assessment Program (CMAP)⁶. The report summarised the situation around climate policies and strategies in Madagascar and was useful to identify some of the areas that GRMA support might be valuable to the Malagasy government. Key points from the IMF CMAP are included below, with a note on the possible contribution of GRMA; these were defined before the bilateral meetings and country workshop.

1. Key climate policies and strategies are in place and linked to development goals and the government's National Determined Contributions (NDC), which are being updated. Climate change is not mainstreamed into sectoral strategies, and while some sectors have standalone documents on climate change there is limited understanding of climate change impacts at sector level.
2. Land use and building regulations promote resilience to climate risk but there is a lack of capacity to implement these.
3. In the National DRM strategy there has been progress, but gaps remain:
 - a. Disaster risk assessment could be integrated into budget process to provision for fiscal risks.
 - b. Fiscal mechanisms are in place for shocks, but domestic resources remain small. Scale up social protection systems by expanding beneficiary register to include vulnerable non-beneficiaries: "While the government has recently improved risk transfer through external contingent financing and sovereign insurance instruments, domestic insurance could be further developed to increase financial resilience of the population. Finalizing the Disaster Risk Financing and Insurance (DRFI) strategy would provide centralized guidance on disaster risk assessments and available instruments in a risk layering framework." *GRMA support to develop risk modelling insights including the impact of domestic insurance and cover of vulnerable populations could inform development of domestic insurance markets.*
 - c. Under the National Adaptation Plan (NAP): investment and non-fiscal measures are proposed for key sectors, but not sufficient to fulfil adaptation needs. Proposed measures could reduce disaster risk and bring economic and environmental benefits. However, no prioritisation framework exists, and investments are selected through fragmented external financing. *GRMA support to develop modelling of climate adaptation strategies could support prioritisation of investment under the NAP.*
 - d. Public Financial Management and Public Investment Management efforts could increase their focus on climate. Climate change concerns could be mainstreamed in comprehensive sectoral strategies. Infrastructure maintenance strategies need to be developed, building on efforts made in the road sector. *GRMA support to understand risk to the infrastructure sector might be of value.*
 - e. There is a priority to increase transparency on macroeconomic and fiscal information related to climate, as a basis for planning/managing public resources. In ongoing reform of budget classification, create capability for identifying and tracking spending on adaptation and mitigation. The IMF CMAP states: "*Quantifying the impact of climate and climate change on growth and fiscal aggregates is critical to designing an*

⁶ IMF, Republic of Madagascar Technical Assistance Report – Climate Macroeconomic Assessment Program, IMF Country Report No. 22/342.

appropriate and sustainable policy response. Madagascar's macroeconomic and fiscal projections do not factor in climate and climate change risks, even though the country is being consistently and increasingly hit by natural disasters. Policy responses are typically reactive and constrained by the availability of ex-post concessional financing." And that "disasters should no longer be treated as downside risks but as components of the country's baseline projections. Even though predicting the frequency and impact of future disasters is a challenging task, a quantification and projection of economic impacts based on historical experience and research-based assumptions would capture some of the risks and build the case for a quick policy response." This provides a clear pathway of impact for GRMA support to build capacity on quantification and projection of economic impacts (including macroeconomic and fiscal effects of climate risks through established insurance modelling and climate adaptation modelling solutions.

Key recommendations of the IMF CMAP include:

- for DRM:
 - Include disaster risk assessment in annual fiscal statements (short term timeframe)
 - Finalize and publish a DRFI strategy short term timeframe)
- For adaptation:
 - Enhance the National Adaptation Plan (NAP) by providing more data on climate change impacts and exploring financial resources (short to medium term)
 - Continue with a sectoral approach to identify, assess, and prioritize adaptation measures, including by fully reflecting adaptation aspects in cost-benefit analysis (short to medium term)

To achieve the above recommendations, there is a clear need for greater internal expertise on disaster risk assessment and assessment of adaptation options (not limited to event impact modelling in ARV or TCe) within the Malagasy government. The GRMA program contribution of private and public sector expertise provides clear value in assisting the Malagasy government to develop this expertise to be able to fulfil these recommendations.

II. Provisional DRFI Strategy

In December 2022, 'Oriental Consultants Global Co., Ltd' delivered to CPGU a provisional version DRFI strategy, *La stratégie de financement de la gestion des risques et des catastrophes de Madagascar* (SFGRC), under the *Africa Disaster Risk Financing or Programme De Financement De La Gestion des Risques Et des Catastrophes En Afrique* (ADRIFI) project. The objective of the strategy is to strengthen the financing capacity for all cycles of disaster risk management to improve disaster resilience and make development sustainable. Recommendations actions are grouped under five priorities:

1. AXIS-1: Promotion and implementation of adequate financing mechanisms for multi-hazard risk reduction and climate change adaptation.
2. AXIS-2: Development of a mechanism for disbursing CRM funding under better conditions.
3. AXIS-3: Improving multi-hazard governance for multi-sectoral resilience to rebuild better.

4. AXIS-4: Identify appropriate funding needs at all levels, including community and gender, to community level and gender, to reduce multi-hazard risks and vulnerability factors over the long term.
5. AXIS-5: Strengthening the mechanism of involvement and support for financing directed towards decentralised territorial authorities and technical services to strengthen local resilience.

Recommend actions where GRMA may support the Malagasy government include to integrate private sector contribution into overall funding strategy and to consider new funding mechanisms and promote ex ante funding, under Axis 1. Under Axis 3, strengthen coordination and centralisation of data and information on DRM funding and strengthen institutional governance for better synergy of DRM activities and funding. And under Axis 4, identify vulnerable populations and their CRM needs and establish a mechanism to prioritise vulnerable groups for funding. See Annex 7 for full list of actions under each Axis.

III. Pilot Program for Climate Resilience (PPCR)

As well as working with BRGM to develop the Madagascar Climate Risk Atlas referred to above, this program is developing Climate change scenarios for Madagascar. The CPGU has engaged the Regional Integrated Multi-Hazard Early Warning System (RIMES) to prepare, with the General Directorate of Meteorology (DGM), information on observed climate trends and new climate change scenarios for Madagascar at the national and regional levels.

IV. V20 Climate Prosperity Plan (CPP)

The Ministry of Economy and Finance is looking to start the CPP⁷ process with the assistance of the V20 Secretariat. The CPP is explained in Figure 1. Areas of potential GRMA support are: providing climate change scenarios and impacts analysis, including macroeconomic and fiscal impacts; Identification of priority risk reduction investments; and identification of risk transfer options.

⁷ <https://www.v-20.org/climate-prosperity-plans>



Figure 1 Climate Prosperity Plans explainer (source: www.v-20.org/climate-prosperity-plans)

V. African Risk Capacity

In 2014 The Malagasy government signed a Memorandum of Understanding with African Risk Capacity Ltd, to reinforce the capacity of government, DRR experts, and NGOs in Madagascar, in the use of drought risk profiling and development of operational plans to manage drought risk⁸. Since 2015, CPGU has been the host agency for a capacity building program conducted with ARC and coordinator of the Technical Working Group (TWG) of Madagascar. Capacity building activities focus on develop the drought risk profile to quantify drought risks to be transferred, to use the Africa Risk View (ARV) monitoring software and to establish operational plans.

Today Madagascar is a member of ARC, and the Ministry of Economy and Finance participates in ARC sovereign parametric insurance product to cover drought and tropical cyclone losses. Madagascar's ARC drought insurance purchased in 2019 provided coverage to \$2.5 million and has an annual insurance premium of around \$0.5 million financed through by ADRiFi through to 2022, with Madagascar paying full premium in 2023. Madagascar received \$2.1 million pay-out in July 2020 in response to extreme drought in the south. Madagascar was the first ARC member to purchase tropical cyclone parametric insurance, in 2020, and paid an annual premium of \$2 million fully financed through ADRiFi for the 2021-22 cyclone season. The government received a \$10.7 million pay-out in March 2022 in response to TC Batsirai.

The ARV (Africa Risk View, www.arc.int/africa-riskview) drought software combines rainfall data, Water Requirement Satisfaction Index (WRSI) with population vulnerability data to establish the drought risk profile and to monitor the evolution of drought in the south of Madagascar. ARC's Tropical Cyclone Explorer (TCe) software allows users to track and model the impact of cyclones, including to estimate economic loss and population affected by a landfalling cyclone. These products are both designed for monitoring the risk profile of the current drought season or arriving cyclone, and do not provide full probabilistic modelling for the assessment of risk to quantify Annual Average Loss (AAL) and return period losses. The tropical cyclone model covers the impact

⁸ Andriamanalinarivo, R.R., Faly, A.F., and Randriamanalina, J.H. *Madagascar, a country resilient to the effects of hazards and protected from damage for sustainable development*. No Date. https://www.preventionweb.net/files/66376_f346finalrandriamanalinamadagascarr.pdf

of wind and storm surge, but not cyclone-induced flood. The ARC River Flood Model (AFM-R) and ARC's index-based river flood insurance product are currently in development. It will provide daily information on flood extent across Africa, with a focus on large-scale river flooding, using microwave data that can detect standing water in flooded areas in near real-time. It will produce estimates of river flooding impact on countries and their vulnerable populations.

VI. Other ex-ante and ex-post financing

A review of Madagascar's economy by the International Monetary Fund⁹, summarises various DRFI solution already in place in Madagascar. Madagascar was one of the first African countries to take up a World Bank Catastrophe Draw Down Option (Cat DDO). A Cat DDO is a contingent credit line triggered after the declaration of a state of emergency due to a disaster. They provide immediate liquidity, acting as 'bridge financing' while funds from other sources are mobilised¹⁰. Access to a Cat DDO is dependent on implementing a disaster risk management program monitored by the World Bank. The country limit for IDA clients (which includes Madagascar is \$250 million. The 2019 DPO was financed by the World Bank (\$50 million) and Agence Française de Développement (AFD) (€25 million). Amounts of \$15 million and €3 million were disbursed in response to the 2020 floods.

Madagascar mobilized \$13 million of funding through the World Bank's Immediate Response Mechanism (IRM) after cyclone Enawo in 2017 to address food security and other emergency response. A Contingency Emergency Response Components (CERC) disbursement of \$12 million was activated in 2021 in response to the drought in Southern Madagascar. During the COVID-19 pandemic several CERCs were activated, with total funding of \$123mn for government's Multisectoral Emergency Plan.

Madagascar also receives funding via IMF emergency funding, the World Bank Crisis Response Window, and AfDB humanitarian aid.

VII. Risk data management

CPGU manages an open data portal called Mahatsangy Geonode-Madagascar, available at resiliencemada.gov.mg. The data portal holds 97 geospatial data layers (last checked 8 March 2023), 12 maps and a link to OpenStreetMap. The data include historical cyclone tracks, risk maps from the Madagascar Climate Risk Atlas, 90m SRTM digital elevation data, population distribution, and administrative boundaries (see Figure 2 for a screenshot indicating data types). There are over 20 users responsible for data on the portal, indicating a community of contributors already exists. Moreover, the metadata for the submitted layers appears to be well curated, suggesting a reliable and well-maintained resource.

⁹ IMF Climate Macroeconomic Assessment Program, Nov 2022

¹⁰ <https://pubdocs.worldbank.org/en/563361507314948638/product-note-cat-ddo-ida-english-2018.pdf>

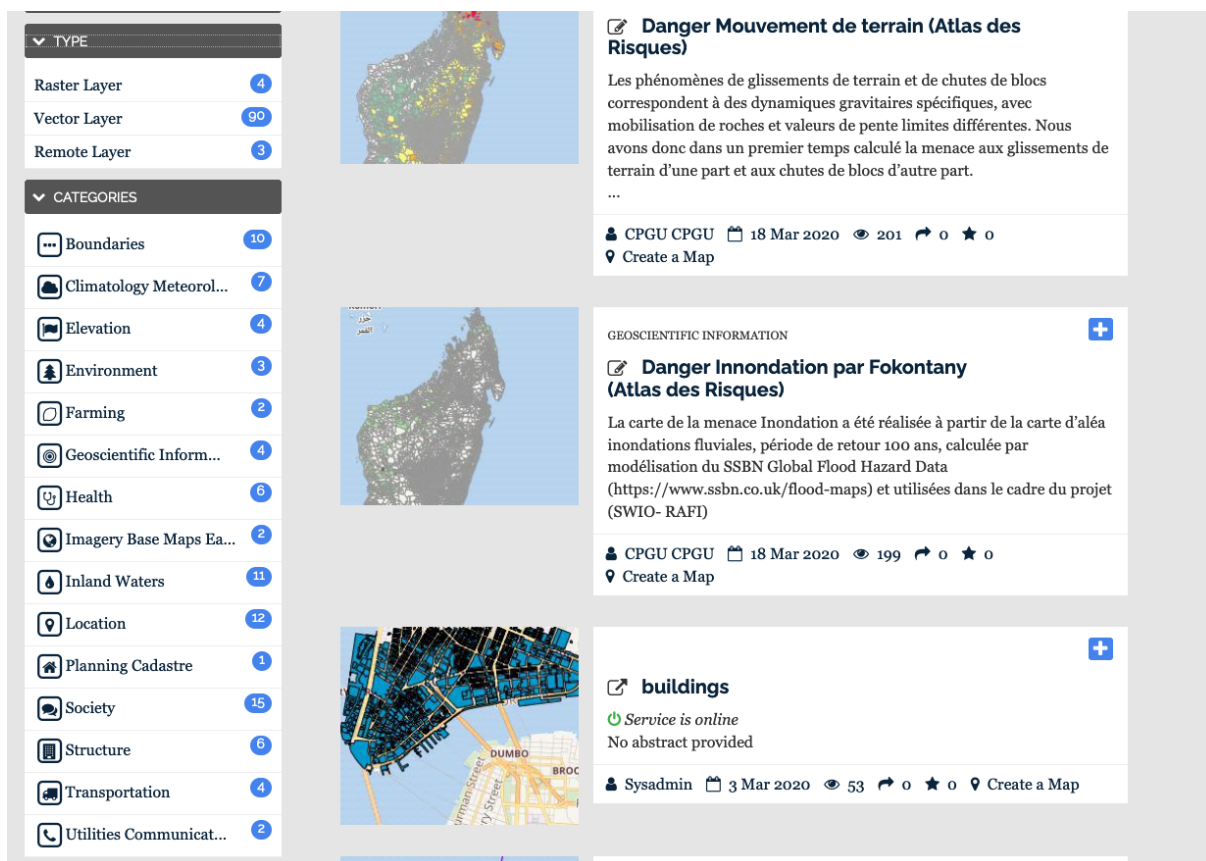


Figure 2 Example of layers held on the Mahatsangy Geonode-Madagascar open data platform

3.3. Synthesis of ongoing activities

Table 1 presents a summary of ongoing activities, the sector of application and synergies with GRMA, to identify areas of potential support.

Table 1 Summary of ongoing CRA and CDRFI activities in Madagascar

	Target sectors and provinces	CRA activities	CDRFI activities	GRMA synergies
ARC	<ul style="list-style-type: none"> • South MDG 	<ul style="list-style-type: none"> • Impact estimation of upcoming / current disasters • Capacity building via CPGU and Technical Working Group 	<ul style="list-style-type: none"> • ARC TC and DR insurance cover purchased by MDG • Flood cover to be available soon 	<ul style="list-style-type: none"> • Capacity building activities – can GRMA build on current capacity and networks • Technical input to ARC models – improve exposure through GRMA project
WBG	<ul style="list-style-type: none"> • National • Min. of Ec. & Fin. • DGM 	<ul style="list-style-type: none"> • Workshop with DGM - sector interventions to address flood and drought risk 	<ul style="list-style-type: none"> • National Contingency Fund • Catastrophe Draw Down Option (Cat DDO) 	<ul style="list-style-type: none"> • Working with Min. of Ec. & Fin.
WFP	<ul style="list-style-type: none"> • Multiple 	<ul style="list-style-type: none"> • Presented slide on tools in use 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • Providing tools for climate risk analytics
GIZ	<ul style="list-style-type: none"> • South MDG • Agriculture 	<ul style="list-style-type: none"> • Assessing climate impacts on groundnut production 	<ul style="list-style-type: none"> • Preparing agriculture index insurance 	<ul style="list-style-type: none"> • Working on index insurance
START Network	<ul style="list-style-type: none"> • Humanitarian 	<ul style="list-style-type: none"> • Locally led action with multiple NGOs • FOREWARN 	<ul style="list-style-type: none"> • START Fund and START Ready 	<ul style="list-style-type: none"> • Provide improved exposure / analytics
UNDP	<ul style="list-style-type: none"> • National 	<ul style="list-style-type: none"> • Country diagnostics commissioned by Milliman for UNDP 	<ul style="list-style-type: none"> • TBD 	<ul style="list-style-type: none"> • Country Diagnostics / risk profiling may involve analytics
FEWSNET	<ul style="list-style-type: none"> • Humanitarian response • Partner of DGM 	<ul style="list-style-type: none"> • Principal provider of Drought Early Warning System 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Operate a Famine EWS learning network and open analytics system
UNDRR	<ul style="list-style-type: none"> • National 	<ul style="list-style-type: none"> • Collating disaster/climate-related data in the RiX system 	<ul style="list-style-type: none"> • None 	<ul style="list-style-type: none"> • Collation of existing data (UNDRR have done global data, not in-country collation yet)
Map Platform CARE	<ul style="list-style-type: none"> • National • Civil society, universities, private sector, government 	<ul style="list-style-type: none"> • Building understanding in risk financing as part of DRM, as well as gender equality and human rights 	<ul style="list-style-type: none"> • Building understanding in CDRFI as part of DRM. Consortium: OSC, BMZ, MCII 	<ul style="list-style-type: none"> • Existing capacity building activities and networks – GRMA to leverage those?

3.4. Insights from participant discussions

The workshop brought together participants from many international agencies and Ministries of the Malagasy government. The outcomes of the interactive activities and discussions aimed to elicit participants' perceived needs and priorities in risk understanding and management. The findings of those discussions are presented here, and more information is presented in Annex 5.

The first activity aimed to understand what participants need to achieve in their role planning, managing, or responding to disaster/climate impacts and to understand what kind of information, data or tools are missing, preventing participants from achieving these needs. The information was analysed by the GRMA at the end of day 1 and used to reflect and frame further discussion on day 2.

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- There is no strong priority towards one hazard, which is taken to mean the requests for support should apply across the main hazards of cyclone, flood, and drought, but that we should also communicate use of data for other relevant hazards.
- Capacity building on applying data and models is requested, and specifically to include knowledge between countries and with academia.

4. Possible GRMA activities

Based on the findings and discussion at the workshop, GRMA proposes below, a selection of projects that could be achieved within the 12-18 months and available budget. The options presented are:

1. Modelling the macro-economic impacts of shocks
2. Simulating cyclone-induced flood hazard
3. Mapping asset information for risk assessment
4. Assess multi-hazard risk to schools.

Not all of these options can be taken up, but we anticipate that a maximum of two options may be executed in addition to 'Modelling the macro-economic impacts of shocks'. Some options are mutually beneficial, and benefits are noted in the sections below.

The Malagasy Government is also invited to propose additional options or amend the options below. Any new or amended options will then be considered by GRMA.

1: Modelling the macro-economic impacts of shocks

The macro-economic model would be developed in order to improve the assessment of optimal climate risk transfer solutions. The model would be capable of simulating the impact of disasters and disaster risk management (DRM) policies on economic growth and assess needs for fiscal stability. The macro-economic model would estimate appropriate disaster fiscal policies composed of multiple DRM measures: mitigation/adaptation investments and risk financing solutions such as reserves, lines of credit and insurance contracts, which meet the sovereign debt sustainability as well as the expected level of economic growth. Outputs of this model could assist the V20 Climate Prosperity Plan process.

The developed model would be an improvement of the CATSIM model, and the simulation program is going to be coded. The input data has already been collected and parameters of functions have been calibrated. The model will be developed into the following versions in a step-by-step manner. The input requirements for the model would include, but are not limited to, national account and international financial market conditions (published by international organizations), climate hazard projections, climate damage functions, and the costs of multiple adaptation options.

Capacity building benefit: Government officials, academics and private sector staff would participate in training to understand the principles, simulation approaches and data used in the assessment. The model used is open-source and the training would enable participants to use the macro-economic model themselves and train others to support future institutional decision-making and research.

Link with other options: This analysis would make use of information developed in Option 3 (flood hazard modelling).

2: Mapping asset information for risk assessment

There was an expressed need for sector level data, including exposure (asset) information. GRMA could provide technical support to learn how to combine remote sensing information (satellite

data) with ground surveys to develop exposure datasets which describe the distribution and characteristics of assets. This project could be focussed on one or more sectors in selected areas of Madagascar, to include rural and urban areas. A pilot project would enable GRMA to support CPGU, INSTAT and others to collect asset data specifically designed to support risk assessment. This data would contain the structural and non-structural characteristics, and replacement costs required to estimate asset vulnerability, and when combined with hazard information, estimate risk (economic losses).

There are several examples of this approach being taken to empower officials and communities to develop data and keep information up to date. These include the community mapping focussed OpenDRI project, which has operated in Madagascar previously, and community of volunteer mappers from OpenStreetMap Madagascar. Under the World-Bank funded PCRAFI project, the regional entity SPC has been implementing a train-the-trainer approach to equip in-country officials in several Pacific Island countries with the tools and knowledge to collect asset data to a defined data standard suitable for risk assessment. The Global Earthquake Model has pioneered tools and processes for the collection of asset data, and augments on-the-ground data collection with satellite imagery to map buildings.

Capacity building benefit: The aim would be to demonstrate the methodology and explore ways to continue and scale up the project beyond the GRMA project. This project would enable local experts to gradually update and refine the modelled exposure data provided by the 2011 SWIO-RAFI project to give an updated view of asset distribution. The pilot project would provide practical training in using off-the-shelf asset survey tools and satellite data to develop asset information over large areas.

Link with other options: This project would link to Option 3, because we would look to include the detailed exposure data within the risk assessment, at least for the selected pilot project area. If this project is not selected, we would deliver the theoretical background to developing exposure datasets using earth observation and ground-based surveys during other trainings but would not conduct the field-based training and data sampling in ground surveys.

3: Simulating cyclone-induced flood risk analysis

There is an absence of up-to-date probabilistic hazard information to estimate long-term average flood losses (flood risk) in Madagascar. We would propose to focus on estimating pluvial (surface water) and fluvial (river) flood hazard due to intense rainfall, including cyclone-induced rainfall. A selection of climate scenarios would be included to estimate risk under future climate conditions. To better understand Average Annual Loss and potential impacts of extreme events, probabilistic flood hazard analysis is proposed. National-scale flood maps would be produced to show maximum expected flood intensity for each of several return period events and for selected climate scenarios. An assessment of climate adaptation (flood management) options would be undertaken to assess their costs and benefits and to inform prioritising potential adaptation investments.

This exercise would improve the detail provided in existing global flood hazard maps by using LiDAR elevation data available to the government. This exercise would augment the existing ARC capability to estimate in near-real time event flood impacts of impending or ongoing events. The

latter enable triggering of insurance products and planning of response, but a better understanding of flood risk would support risk-informed decision-making for climate adaptation and CDRFI and the V20 Climate Prosperity Plan process.

Capacity building benefit: Training and co-development of flood hazard information using open-source databases and tools would develop local experts' (including government staff, academics, and the private sector) understanding of probabilistic hazard assessment. This could enable development of other hazard information and updating hazard information over time, to ultimately contribute to greater expertise in risk assessment.

Link with other options: This analysis would be complementary to Option 1 (macro-economic modelling) because it would provide estimated AAL and extreme flood event losses into the macro-economic analysis. This analysis would be complementary to Option 4 (assessing risk to schools) because it would provide the level of detailed hazard data required for a sector-level assessment of flood risk.

4: Assess multi-hazard risk to schools

There was an expressed need to better understand potential impact of disasters on Madagascar's schools, in order to prepare for and reduce disruption to education and inform development of multiple-use community shelters (schools being used for cyclone shelter currently). Using existing and new hazard maps, GRMA could support the Malagasy government to learn and run sector-focussed risk analysis to identify:

- which schools are at greatest risk of damage from cyclones and floods,
- the monetary losses associated with damage to educational buildings,
- understand the potential for disruption to key road networks which can cause disruption to schooling, and
- to estimate the potential benefits and costs of retrofitting school buildings to reduce damage.

Capacity building benefit: In the analysis and training, open-source tools would be used, and the learning associated with running this sector analysis would enable the participants of training to assess risk and impacts on other sectors or asset types.

Link with other options: This analysis would make use of flood hazard information developed under Option 3. If Option 3 was not taken up, the learning on risk assessment could take place but the analysis would look to make use of lower resolution global hazard information which would result in less reliable estimates of risk.

5. Next steps

In the final 'closed' session of the workshop, it was agreed with CPGU that GRMA would provide several possible projects in which GRMA would provide technical support on the expressed needs of the workshop participants. The project suggestions are outlined above in Possible GRMA activities.

The next steps are for CPGU to share these possible projects with other Ministries of the Malagasy government, and to agree which proposals they would like to prioritise. At that point, GRMA and CPGU can define a workplan and agree which projects can be supported in the available time and budget for GRMA technical support. Once that is agreed, CPGU can begin to complete the formal application for GRMA support following the application process and templates available at grma.global/join-the-alliance/.

ANNEXES

See Annexes file.

Annex 1: Letters of Interest to GRMA

Annex 2: Participant list

Annex 3: Invitation letter

Annex 4: Concept Note and agenda

Annex 5: Description and results of workshop discussions activities

Annex 6: Workshop group discussion questions and responses – activity 2

Annex 7: Actions proposed under the DRFI strategy

Annex 8: Selected workshop photographs