Draft Early Warning System Needs Assessment and Investment Plan for the Pacific Islands - Samoa

1. Key Findings and Recommendations

Finding 1: Communicating warning information to the public in a form that results in an effective response remains a challenge for the Samoa Meteorological Service.

> **Recommendation 1a:** Review, revise and extend the current multi hazard early warning system taking into consideration good practices as recommended by the World Meteorological Organization (WMO).
>
> **Recommendation 1b:** Introduce an impact forecast and warning system for all natural hazards, which would evolve the focus from information about the hazard to information about the impact of the hazard. This would help the public more readily understand what actions to take to reduce the risk to lives and livelihoods

Finding 2: More formal and extensive partnerships are needed to share critical data.

> **Recommendation 2:** Review and extend existing legislation to ensure that the appropriate regulatory framework for sharing of critical data to support impact forecasts and warnings are in place.

Finding 3: New ways of working are required to provide relevant warning information directly to the public.

> **Recommendation 3:** Provide training to staff of Samoa Meteorological Service, the National Disaster Management Office and other agencies to increase skills in warning services and communication.

Finding 4: Nowcasting, drought monitoring, flash flood guidance, flood warnings need to be strengthened.

> **Recommendation 4:** The current suite of forecast services could be enhanced through the introduction of nowcasting, drought monitoring, flash flood guidance, geo-hazard and flood warnings. This would require strengthening observing systems and forecasting tools.

Finding 5: The National Emergency Operations Center (NEOC) not adequately equipped to support emergency operations.

> **Recommendation 5**: The NEOC needs to be expanded and upgraded to manage all emergency operations functions.

Finding 6: Continuity of operations is at risk.

> **Recommendation 6:** If the expansion and upgrading of NEOC is supported, the changes should include the provision of backup systems support for all operational functions of Samoa Meteorological Service and its partners.

Finding 7: Community preparedness needs to be strengthened.

Recommendation 7: Community preparedness for activities need to be extended beyond the 41 villages currently involved to reach all communities at risk from meteorological and geophysical hazards.

2. EWS in the Pacific

Pacific Island Countries (PICs) are among the most vulnerable nations in the world due to the combined impact of meteorological and geophysical hazards. Flash floods, river floods, high winds, storm surges, earthquakes, volcanic eruptions and tsunamis frequently affect people and property. Droughts are also common and climate change is contributing to sea level rise and an overall increase in the risk of extreme weather events. In the absence of adequate response, these hazards result in disasters that affect PICs' entire economic, human, and physical environment and impact their long-term development.

The effectiveness of early warning systems designed to reduce exposure to hazards depends on people's capacity to understand and respond to a given situation. This remains a challenge in most countries and is a high priority in PICs, where early action is essential to save lives and to protect livelihoods and property.

A common approach to multi-hazard early warning systems (MHEWSs) has been advocated by National Meteorological Services (NMSs), which are primarily responsible for forecasts and warnings of weather, climate and geo-hazards. MHEWS inform the people of the potential impacts of impending natural hazards, the risks on their lives and livelihoods, and the action they should take. To be effective, this approach entails multi-stakeholder cooperation and coordination between and among national science, disaster risk management agencies, and other relevant stakeholders. It also needs to be combined with actions to make communities more disaster resilient so that they can respond more effectively to natural hazards.[1] In addition, translating technical warning information into impacts is important to ensure that people take early action to minimize their exposure to extreme events.

Impact forecast and warning services depend on forecasts of hazards and a comprehensive understanding of vulnerability and exposure, which in turn depend on data sharing and cooperation among multiple government agencies and civil society. Therefore, it is important to ensure that institutional capacity is increased, monitoring and forecasting systems are strengthened, and service delivery to the public and economic sectors is enhanced.

Working with multiple PICs within a regional framework will allow the introduction of good practices in MHEWSs, introduce impact forecast and warning services, and streamline warning and response coordination.

PICs work closely with each other and with regional organizations, such as: the WMO Regional Specialized Meteorological Centers (RSMCs); the Pacific Tsunami Warning Center (PTWC), which provide operational guidance; and with regional entities such as the Secretariat of the Pacific Community (SPC) and the Secretariat of the Pacific

[1] "Concept Paper on International Network for Multi-Hazard Early Warning Systems (IN-MHEWS)". Jointly proposed by WMO, WHO, UNDP, UNESCO-IOC, UNESCAP, UNISDR, UNOOSA/UN-SPIDER, IFRC, ITU, GFZ, GIZ. Published on 24 Feb 2016. Available from: https://www.wmo.int/pages/prog/drr/events/2016-EAG-MHEWS/documents/2016.02.24-Doc10-IN-MHEWSConceptPaperDRAFT.pdf

Regional Environment Programme (SPREP), which provide capacity building and training. Improving the capabilities of the regional operational centers is also recognized as a high priority by NMSs since they provide the regional guidance essential for accurate and timely national forecasts and warnings.

The expected outcomes of a regional framework for PICs include a common, easy to understand multi hazard warning system; greater understanding of the impact of hazards by people at risk and therefore more effective response enabling communities to "self-rescue" mitigating potential disasters; and greater cooperation among PICs to improve the accuracy and timeliness of forecasts and warnings.

3. Country Assessment

Background

The World Bank team conducted several meetings with the staff of the Meteorological Division (the Samoa Meteorological Service) and Water Resources Division (the National Hydrological Service or NHS) of the Ministry of Natural Resources and Environment (MNRE) of Samoa. The team also met with the Assistant Chief Executive of Disaster Management Office (DMO) of the Ministry of Natural Resources and Environment.

The aim of this assessment is to validate the gaps, which have been identified in the capacity of these agencies and other stakeholders to minimize the adverse impacts of meteorological, hydrological and geophysical hazards (hereafter, natural hazards), which can result in disasters that affect their entire economic, human, and physical environment and impact the long-term development agenda of Samoa.

The Samoa Meteorological Service (SMS) which along with its principal counterparts (such as the Water Resources Division) is responsible for hydrological services. The SMS is responsible for meteorological and seismological forecasts and warnings. Its role includes providing a variety of services in support of national needs, including water resources management, transport safety, food security, protection of life and property, safeguarding the environment, contributing to national security and sustainable development and promoting capacity building. The SMS is the designated authority for the issuance of weather and tsunami warnings to the public. It has the capacity and ability to issue warnings and currently does so through many communication channels (radio stations, TV, social media, etc.).

It is a well-organized department within the MNRE, which fulfills its mandate to provide weather services, climate services and warnings of natural hazards. It has received, and continues to receive, extensive donor support from various sources to strengthen its observing networks and improve its access to decision support tools. The forecast office has also been recently refurbished and is equipped with modern forecaster workstations.

The Seismological department of SMS is responsible for the Tsunamis, Earthquakes and Volcanic events warning dissemination is also fully functional. Organized in a 24/7 shift, they have access to sufficient local and regional data to provide timely warning to the designated disaster risk reduction (DRR) stakeholders. However, several priority gaps were identified and need to be addressed in order to integrate properly this department into the national end-to-end multi-hazards system.

The DMO is responsible for the NEOC and for managing emergency operations. This function is currently carried out within relatively limited facilities located in a comparatively "safe" area of Apia that can assure continuity of operations for all operational entities involved in warning and response. Improving these facilities is a priority for DMO. DMO is currently responsible for triggering the new siren alerting system for evacuation.

Multi Hazard Impact Forecast, Warning and Response System

Samoa is similar to many countries that face multiple threats from natural hazards and the consequential cascading threats, such as contamination of water supplies, disruption of connections between communities, loss of electrical power, disease outbreaks and so forth. Samoan society needs to be well informed about the actions to take to minimize the risk of loss of live, livelihoods and property. The recognized approach, which Samoa is following, is based on the MHEWS concept as explained in Chapter 2. This system does not, however, explicitly consider meteorological, hydrological and seismological impacts. Therefore, it is often difficult for those at risk, and those responsible for public safety and economic security, to know exactly what actions to take for a given hazard. This requires the extension of existing forecast and warning services to include specific information about impacts. This can be achieved by developing an end-to-end multi-hazard impact forecast, warning and response system, which considers the combined threats posed by all potential hazards with an understanding of the vulnerability of people and assets and their specific exposure.

Such a multi-hazard approach implicitly requires good meteorological, hydrological and seismological forecasts as well as cooperation among many stakeholders, some of whom are expected to supply critical data to underpin the impact warning service as well as issuing warnings within their area of responsibility. For example, the ministry responsible for schools may be tasked with issuing specific directives to protect the lives of children; the highways agency may provide warnings to avoid potential loss of life and property on damaged roads and bridges; and yet another agency may be responsible for electricity supply and provide warnings about the risk of electrical hazards associated with damaged power lines. These examples highlight the need for a high level of cooperation among government agencies and civil society in general to provide timely and meaningful advice to affected communities.

Gaps and Recommendations

While many aspects of such of end-to-end impact forecast, warning and response system are in place, there are many gaps that need to be addressed. These include:

Impact Forecast and Warning System

Ensuring people take appropriate life-saving steps requires forecasts and warnings that are easily understood and actionable. Historically, all National Meteorological and Hydrological Services (NMHSs) have featured forecasting of the weather, hydrology, climate and seismic events as central to their mission, and many also issue warnings in the case where hazardous weather, hydrological, climate and seismic events are expected. Usually, in the case of both weather forecasts and warnings, the focus is on what the weather will ***be***. However, there is a need to evolve from a weather-based to an impact-based paradigm, consistent with the WMO Guidelines on Impact Forecast and Warning Services as described in Annex 1. In other words, the focus should evolve to what the weather will ***do***.

The same paradigm shift would also apply to hydrological, climate and seismic forecasts and warnings within this program.

In many regions of the world, forecasts and hazard warnings have become very reliable, but this has not necessary resulted in more lives saved. Understanding the impact of weather, for example, is much more critical than understanding the weather. In Samoa, while there is a high degree of skill in meteorological forecasts and warnings, translating these forecasts and warnings into impacts is relatively limited. A critical component of any effective warning system is the ability to understand the warning and take effective action. This requires greater emphasis on understanding vulnerability and exposure of everyone and providing individuals with the means to take effective action to reduce their own exposure. In Samoa, it is well-recognized by government agencies that impact forecasts and warning are needed. Additional capacity is needed to capture sufficient information on vulnerability and exposure and to build the impact forecast and warning system into the MHEWS. In effect, this requires creating an Impact Forecast Multi Hazard Early Warning System (I-MHEWS) that facilitates effective communication of impacts and enables an informed response. The same system would help emergency services target their response to those most at risk. It would also be used to monitor changes in impact risks as the hazard evolves and exposure is reduced, for example, through adequate sheltering.

Partnerships for Data Sharing

A system that focuses on impacts requires significantly more information than is routinely available to meteorologists and hydrologists. Partnerships among agencies should, wherever possible, be formalized so that critical data are always available. Therefore, it is recommended that existing legal frameworks be reviewed with the aim of revising existing regulations and institutional arrangements to facilitate the exchange of data and information among agencies required for a fully operational multi-hazard impact forecast, warning and response system. Such a framework is usually implemented through a set of bilateral agreements among the stakeholders.

Since vulnerability to natural hazards is the primary source of risk, it is recommended that the responsibility to host the I-MHEWS is designated to the Meteorological Department of MNRE, working in close cooperation with the DMO, and with the active participation of all stakeholders responsible for providing data and those responsible for issuing sector specific warnings. The new system would build on the existing MHEWS, which should conform to the standards set by WMO. A formal partnership among all stakeholders is a desired outcome of this activity to ensure ongoing, operational cooperation. A review of legal arrangements will take place in October-November 2014 by the Government of Samoa. It could be an opportunity to review institutional arrangements between divisions to support early warning and response at that time.

Identifying All Relevant Hazards

The impact forecast, warning and response system needs to consider all contingencies and therefore needs to include all likely hazards, both natural and as a consequence of human actions, such as congestion on highways due to an

evacuation or breakdown in communication due local customs and behaviors. Discussions between all national stakeholders will be instrumental in identifying the hazards and vulnerabilities that need to be quantified and included in such a system.

Monitoring and Forecasting Hazards

In addition to the introduction of new capabilities, the Samoa Meteorological Service and the Water Resources Department need to strengthen their capacity to monitor and forecast droughts and floods. Potential capacity-building activities include: the introduction of a Drought Monitoring and Advisory Service; the provision of modernized flash flood guidance (i.e., via nowcasting, which combines limited area models with data assimilated from radar); and the forecasting of storm surges responsible for coastal flooding. Improving each of these services requires further investment in the hydro-meteorological observation networks, including more real-time automated weather and hydrological stations. Increased understanding of coastal inundation needs to take into account state of the art tsunami modeling and storm surge modeling. The latter is a relatively new initiative of WMO. Besides droughts and floods, the seismic network also requires strengthening by adding up to five additional broadband sensors (integrated on the current existing stations or new stations) and securing spare parts for the maintenance of those stations (until the Ministry is able to secure this as part of their annual budget). Volcanic hazards, including forecasting volcanic ash also needs to be considered.

Facilities

While the Weather forecast Operation Center (OC) is brand new, the Seismological Operation Centre will require some investments to accommodate its expansion (e.g. via refurbishment, addition of new workstations, and increase in office space). The facilities of the current National Emergency Operations Center (NEOC) are also limited. While the NEOC currently occupies a strategic site in close proximity to both the Fire and Emergency Services and the Samoa Red Cross Society, it is housed in a small temporary building that has limited space to coordinate emergency operations. The Government has made available the land on which the NEOC currently sits and has approved proposals to expand the current floor area.

A fully operational NEOC should have the capacity to monitor an evolving situation in real-time so that civil protection can be used to maximum effect. The NEOC should have the capacity to accommodate operational meteorologists and other hazard specialists during major events. Ideally, the NEOC would be the hub for all emergency communication and dispatch, regardless of the scale of the event, to help ensure timely response by those impacted. A review of emergency response procedures is currently underway by the Government of Samoa.

Training

New ways of working require appropriate levels of training. Training should be available to all of the participating agencies to improve their understanding of warning services and their ability to develop the appropriate communication tools to convey actionable warning information. Training is

required to increase skills in the development of applications, management of ICT systems, technical support, and effective communication of scientific information to end-users. As introducing impact forecast and warning would require extensive training, twinning arrangements with the institutions leading the development of these skills could be beneficial.

Visualization Tools

Investment is needed in common visualization tools, such as real-time maps of forecast impact risks based on a common color-coded system, consistently generated for all hazards and impacts. Such a system is currently available through donor support (e.g., FMI), but would require additional investment to make this the public interface of the I-MHEWS. This system would consist of a warning dissemination system able to communicate hazard impact warnings with DRR stakeholders, media, communities and individuals through new technology platforms (e.g. mobile phone application, web platform). This system would also consist of a two-way communication system to give the opportunities to exchange efficiently timely warnings and receive feedback from communities on the current threat for better Disaster Risk Management from the NEOC. This system could potentially leverage the high mobile phone penetration rate in Samoa.[2] In order to reach all of the population, however, all other methods of communication should be used and each strengthened to ensure consistency in messages across all platforms (e.g., local radio, TV, mobile communication, internet, social media, public signs). Public sirens should be used for the purpose of evacuation regardless of the cause. There is no need to differentiate between different hazards, but simply to require a specific action (evacuation to public shelters) in response to the alert.

Continuity of Operations

Continuity of operations in the face of disasters is currently weak. The current natural hazards forecast and warning system is operated at the Meteorology Department, located at the end of Mulinu'u Road in Apia, which is basically at sea level. This should continue. Under normal circumstances this is an ideal working environment. It is located close to the MNRE's headquarters, which is home to many other agencies including water and disaster management, and therefore can facilitate necessary interactions among partners. However, to ensure continuity of operations within Samoa, critical infrastructure should be mirrored at another site given the risk of inundation from to storm surges or tsunamis. Ideally, this would be housed within the NEOC, whose design should be made resilient to all hazards. Forecast operations and support for the I-MHEWS should be temporarily transferred as needed from the Meteorology Department to the NEOC accompanied by the relocation of staff responsible for supporting disaster management in advance of high impact events. Similarly, the seismic operations center would be able to relocate to the NEOC. In addition, to provide data security, the NEOC should also house a backup data archive of all critical information (ultimately this should include all government data records). It could

[2] According to a World Bank report, approximately 165,500 people gained access to a mobile phone from 2002 to 2010—some 90 percent of the population. Reference: "Samoa's Connected", World Bank Group, Published 4 April 2013. Available from: https://www.worldbank.org/en/results/2013/04/04/samoa-connected

be managed between the Meteorological Department and the NEOC through a redundant and secured Data Center, and linked by a dedicated fiber connection.

Regional Integration

The proposed I-MHEWS should be integrated into regional organizations. For instance, it could be an operational component of the existing WMO regional institutions and systems, such as the Regional Specialized Meteorological Center Nadi, Regional Specialized Meteorological Center Wellington, WMO Severe Weather Forecasting Demonstration Project or SWFDP, and the WMO Coastal Inundation Forecasting Demonstration Program.

The Seismological Division, which is already integrated into the Oceania Regional Seismic Network (ORSNET), should have stronger links with other seismological networks in the region, such as the Pacific Tsunami Warning Center (PTWC). It is also important to include NMS into the regional Volcanic Ash Advisory Center Network as well.

Although each of these relationships is governed by international conventions (e.g., WMO), specific details on data sharing, continuity of operations, communications, etc. tends to be ad hoc. MOUs are recommended to formalize some of these regional relationships to assure continuity of operations.

Community Preparedness and Response

Community preparedness and response needs to be strengthened. The Community Disaster and Climate Risk Management Programme guides the approach used by Government and organizations working with communities. The program harmonizes collective efforts of support by various partners to reduce duplication, maximizes resources made available for community implementation, and ensures consistency in the terminology used with communities.

Community preparedness and response activities have begun in 41 villages through the support of the Pilot Program for Climate Resilience (PPCR) and the Adaptation Fund (AF). Tsunami modeling by New Zealand's GNS Science has been used in a number of communities to identify safe evacuation routes and sites for which Standard Operating Procedures have been developed and tested during drills. Tsunami evacuation maps and signs are also being installed in each of these communities. There is still a need to extend this work to others as well as ensuring that all hazards are taken into consideration.

In addition, a task team consisting of the Disaster Management Office, Samoa Red Cross, Ministry of Works, Transport and Infrastructure (MWTI) Building Division, Fire and Emergency Services, and Ministry of Education has developed guidelines to assist village mayors in selecting evacuation shelters for their respective communities. The team is in the process of evaluating these shelters in regard to location, building design & layout, structure, amenities & services, settlement, and current use. Recommendations for retrofitting are drawn up by the team and submitted to the agency responsible of the facility. The majority of these are school buildings, which are the responsibility of the Ministry of Education. Other facilities used by communities include church and community halls. As of August 2014, 10 community facilities have been assessed with an additional 10 to be done later in the year.

4. Proposed Investment

Based on the above assessment, the proposed investment consists of two components focused on early warning & preparedness and community resilience. The needs assessment identified several areas requiring investment to strengthen the interpretation and communication of warning information and to improve the capacity of more communities to respond effectively to warnings.

Component 1: Early Warning, Preparedness and Resilience

The objective of this component is to increase the resilience of each participating country and the region as a whole to natural hazards such as cyclones, flooding, volcanic eruptions, tsunamis and earthquakes. This component has two sub-components: (i) Early Warning and Preparedness, and (ii) Resilient Investments, each with a number of tasks involving regional cooperation among PICs.

Sub-Component 1.1: Early Warning and Preparedness

This sub-component will improve the quality of forecasting and warning services by providing i) a stronger institutional and regulatory framework; ii) modernizing the observation and forecasting infrastructure; and iii) enhancing the services SMS delivers to the public and to its partners.

A. Institutional and regulatory strengthening, capacity building and implementation support

This task aims to strengthen the legal and regulatory framework of SMS and its partners to exchange data and information critical for the implementation of impact forecast and warning services as an integral part of a MHEWS.

Experience elsewhere suggests that an operational partnership between stakeholders would be needed that may go beyond current institutional arrangements. It will also be necessary to build capacity with the SMS and among stakeholders to ensure the operability of the future systems, and to support project design and implementation. The task will facilitate increased participation and/or operational partnerships with the WMO Severe Weather Forecasting Demonstration Project, the WMO Coastal Inundation Forecasting Demonstration, the PTWC, the WMO Regional Specialized Meteorological Centers in Nadi and Wellington, and other regional bodies that can assist with training and capacity building.

This task comprises three parts:

A.1) Institutional strengthening and development of a legal and regulatory framework, which includes (1.1) Institutional development and strategic planning, review and revision of legal and regulatory frameworks for SMS, NDO, Water Resources and other key partners' operations including the revision and/or development of standard operating procedures (SOPs); and (1.2) twinning support to enable SMS to work closely and sustainably with more advanced National Meteorological and Hydrological Services (NMHSs) and the WMO.

A.2) Capacity Building and Training, which includes (2.1) developing and implementing a capacity building and training program consisting of (a) SMS personnel training and retraining; professional orientation for senior staff, and study tours; and (b) training in WMO Regional Training

Centers, WMO RSMCs, PTWC and other regional entities as needed; and (2.2) implementing training activities (workshops, round tables, etc.) for major users of warning services (e.g., disaster management, agriculture, water resources, energy, health, surface transportation and civil aviation).

A.3) Systems design and integration, component management and monitoring, which includes (3.1) detailed design of the updated MHEWS systems, support for procurement and support for implementation (Systems Integrator Consultant); and (3.2) project management, monitoring, reporting and evaluation of all Tasks under Subcomponent 1.1.

B. Modernization of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems

This task aims to expand the observational networks to improve SMS and Water Resources Division observational networks in: nowcasting, coastal forecasting, seismic monitoring, drought monitoring and hydrological modeling. It also aims to upgrade communication systems and data management, provide redundancy of the forecasting platforms in a more secure NEOC, and support the reconstruction and refurbishment of facilities.

This task comprises four parts:

B.1) Technical modernization of the observation networks, which includes (1.1) expansion, rehabilitation and technical re-equipment of the hydrological network including the field communications network; (1.2) expansion of the surface meteorological observation network; and (1.3) expansion of the seismic observation network including GPS. The modernized observation networks must be capable of being fully integrated with any existing observing systems.

B.2) Upgrade of data management, communication, and IT systems, which includes: (2.1) communication and computer equipment to improve network communications within Samoa and through the WMO Information System (WIS); (2.2) data management systems capable of fully integrating all sources of data including existing and future national observing networks, and forecast products, and with backup capability within the NEOC; and (2.3) back up operational forecasting platform available to SMS meteorologists and seismologists with NEOC.

B.3) Improvement of Nowcasting, coastal forecasting, seismic monitoring, drought monitoring and hydrological modeling, which includes: (3.1) the development of platforms for nowcasting, drought monitoring, coastal inundation forecasting and hydrological forecasting consisting of software, computers, visualization tools for each platform with appropriate back up at the NEOC; (3.2) Enhanced of the MHEWS including computers, software and visualization tools for computation of impact forecasts and warnings including backup at the NEOC; and (3.3) computers, software, furniture, generators for the Seismic Operations Center with back up at the NEOC.

B.4) Reconstruction and refurbishment of facilities, which includes: (4.1) NEOC; and (4.2) SMS Seismic Operations Center. Mirroring critical operational functions of the SMS in a refurbished and fully equipped NEOC will strengthen continuity of operations in the event that the facilities of the SMS become nonfunctional during an emergency.

C. Enhancement of the Service Delivery System

This task aims to improve service delivery by enhancing SMS's existing MHEWS functions to include impact forecast and warnings to include meteorological, hydrological and seismological impacts, as well as actionable information to at-risk communities and emergency service providers. Effective Standard Operating Procedures (SOPs), as described in Annex 2, will be a critical element of the MHEWS.

This task comprises two parts:

C.1) Expansion of the MHEWS services to sectors, which includes (i) developing, improving and operationalizing new information services, such as drought advisory services and nowcasts; (ii) improving the means of delivering services to communities and individuals including the development of new mobile applications; and (iii) providing feedback from users on the quality of services through public and sector specific surveys.

C.2) Support of MHEWS including impact forecasts and warnings, which includes: (i) developing SOPs, warning protocols and signals agreed with all stakeholders (ii) Operational training and drills with government stakeholders and communities; (iii) Vulnerability assessments for each identified hazard and for the entire country; and (iv) introducing and pilot testing (jointly with DRM agency) of impact forecasting techniques and warnings.

Sub-Component 1.2: Resilient Investments

This sub-component will identify priority investments in physical resilience and public asset retrofitting with a view to supporting community preparedness and response efforts.

The approach adopted by Samoa in its Community Disaster and Climate Resilience Programme advocates "self-help" which can further strengthen the social structures within each community. Communities with the support of organizations such as the Adventist Development and Relief Agency (ADRA) and Samoa Red Cross Society and government agencies, develop and implement village disaster preparedness and response plans. The tasks include:

A. Training for community-based organizations and national agencies working with communities to apply Community Disaster and Climate Resilience Program's methodology

B. Support to develop and test for each community evacuation plans and procedures that identify suitable shelters and safe evacuation routes. Evacuation procedures will need to be congruent with warnings issued from the warning center.

C. Retrofitting of public facilities, in particular schools, identified as community evacuation centers to ensure that they conform to the national building code and meet the requirements of an emergency shelter.

Regionally-Supported Activities

Several of the tasks mentioned above depend on regional cooperation and would provide a common warning platform for all participating PICs. These include the following:

Activity	
A1.2	"Twinning" operational support from WMO (SWFDP, FFG, Impact Forecasting, MHEWS)
A2.1	Developing and implementing capacity building training program
A3.1	Detailed design of the MHEWS systems, procurement and implementation support (Systems Integrator Consultant)
C1.1	Development, improvement and operationalization of production of basic and specialized information products
C2.1	Development of SOPs, warning protocols and signals agreed with all stakeholders
C2.3	Vulnerability assessments for each identified hazard

5. Cost Estimates

The estimated cost Component 1 of the proposed investment for Samoa is:

Activity	Cost (US $)	???
Subcomponent 1.1 – A. Institutional and Regulatory Strengthening, capacity building and implementation support	2.8M	
Subcomponent 1.1 – B. Modernization of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems	4.75M	
Subcomponent 1.1 – C. Enhancement of the Service Delivery System	2.4M	
Subcomponent 1.2 – Resilient Investments	2.5M	
TOTAL	12.45M	

6. References

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Annex 1 – WMO Guidelines on Multi-hazard Impact-based Forecast and Warning Services (2015)

Annex 2 - Concept of a Multi-Hazard Early Warning System (MHEWS) including Impact Forecast and Warning Services for Samoa

The current Multihazard Early Warning System (MHEWS) in Samoa should be updated and extended in line with best international practices (Tang et al. 2012) to provide warnings of the *impact* of hydrometeorological hazards and geophysical hazards. The risk of the cascading impact of natural hazards highlights the importance of developing a system that can increase the capability of decision-makers, emergency services and ordinary people to take effective actions that reduce the risk of disaster. The MHEWS focuses on managing the potential cascade of disasters stemming from an initial hydrometeorological or geophysical hazard, the primary, secondary and sometimes tertiary impacts require well-ordered coordination and cooperation to support those vulnerable and exposed to the hazards (Rogers and Tsirkunov 2013).

Extensive, operational multi-agency coordination is required for a multiphase response to reduce the impact of natural hazards based on Standard Operating Procedures (SOPs). For hydrometeorological hazards, good practice indicates that these SOPs should be based on the following:

1. Early monitoring, objective weather forecasting and impact forecasting. Monitoring, hydrometeorological and geophysical hazard forecasts and warning services are the responsibility of the Samoa Meteorological Service (SMS) and Water Resources Division of the Ministry of Natural Resources and Environment using all available data, model guidance, etc. Impact forecasts and warnings would be based on these hazard forecasts combined with exposure and vulnerability information, which would need to be acquired in coordination with the Disaster Management Office (Davidson and Wong 2005).

2. Early briefing to decision-makers, special users, and agencies well in advance of public warnings. These briefing would include both information on the hydrometeorological hazard (the so-called "objective forecast"), the potential impact of the hazard and likelihood of occurrence. This would trigger the appropriate response from these stakeholders to reduce the adverse impacts of the event.

3. Early Warnings for the public would be prepared, which would include the normal hydrometeorological warning as well as impact warnings. The latter would include specific instructions about actions to be taken. The latter would evolve from impact-based warnings to impact warnings as skills evolve (see Annex 1 for WMO Guidelines on Impact Forecast and Warning Services for more details on this aspect).

4. Early dissemination of the warnings to all those who need to take action using all available means of communication appropriate to the situation and location of people.

5. Early handling of the situation by emergency services and those responsible for the safety of people and livelihoods.

The MHEWS should have two components: one focuses on management of the system: the other on the technical aspects. The management component includes a multi-agency coordination mechanism consisting of all government organizations, and a social community protection system, which includes the appropriate basic social units within communities. The technical component is based on six platforms or systems. These include:

1. Monitoring and Detection Platform – This consists of network of observations, operating by various divisions of MNRE, as well as access to a various regional and global

products available through WMO Regional Specialized Meteorological Centers (RSMCs) and the Pacific Tsunami Warning Center, for example.

2. Forecasting and Warning Platform – The Forecasting and Warning Platform utilizes the data from the monitoring and detection platform, combined with numerical weather prediction and other guidance from the RSMCs, which enables the SMS forecasters to prepare objective weather forecasts, alerts and warnings and to prepare flood alerts and warnings and based on these forecasts and guidance. The next steps are to prepare hazard impact forecasts, alerts and warnings based on the likely impact of the event. This would be the primary responsibility of SMS forecasters, working in close cooperation with the Decision-making Support Platform.

3. Decision-making Support Platform – The decision-making support platform would be the means by which the objective forecast (e.g., the weather forecast) is combined with information on vulnerability and exposure. For example, the meteorologist responsible for weather forecast would provide appropriate information about the likelihood of occurrence of a hazard, while the impact forecaster/advisor or disaster risk management specialist (hereafter the Public Weather Service Advisor)[3] would be responsible for identifying the potential impact on the population and livelihoods. It is anticipated that this would be an iterative process with the meteorologist and Public Weather Service Advisor updating each other on the evolving situation as the hazard evolves or as the exposure of people changes, or both.

4. Warning Information Dissemination Platform – The Warning Information Dissemination Platform would be the primary means through which alerts and warnings are disseminated to stakeholders, specialized users and the public. It must ensure that messages are consistent, actionable, disseminated through multiple channels, communicated quickly, and received effectively. The dissemination system could use color-coded symbols, which would be consistent across all agencies responsible for providing warnings. The means of dissemination would include radio, television, mobile short messages, telephone landlines, etc. In the case of limited impact, warning communication should be targeted as closely as possible to those identified as at risk.

5. Database Platform – The Database Platform consists of historical and real-time data supplied by all the agencies and sectors at risk. It is important that this database is maintained to ensure the currency of vulnerability and exposure information.

6. Multi-Agency Support Platform – The Multi-Agency Support Platform supports the development and updating of SOPs for all agencies involved whether providers of information and services or users of information and services. The aim is to facilitate efficient cooperation across all government emergency managers. Early briefing prepares departments and agencies ahead of the joint response mechanisms and before warnings are issued to the public. This platform should also be responsible for ensuring that all stakeholders understand and heed warnings.

The MHEWS should be dynamic; that is, it should be designed to evolve with changing circumstances and needs.

[3] This post could be a meteorologist or disaster management specialist with the specific task of providing advice about hazard impacts. In some countries the title Public Weather Service Advisor is used. In small services the responsibility may remain with the meteorologist/forecaster or equivalent.

Annex 3: Detection, Monitoring, Analysis, Forecast and Warning of Natural Hazards

Event	Forecast Parameters	Scale	Impacts	National responsibilities	Regional Support	Global Support	Regional/ National Strengths	Regional/ National Weaknesses
Small scale convection	Rainfall intensity / amount Wind velocity	Local, confined to individual islands or smaller (10-100 km^2)	Localized flooding /flashfloods causing damage to property and loss of life, injury	*NMHSs / DRM* National Weather forecasts and Warnings; Impact Forecasts and Warnings, Early response, Evacuation / Shelter / etc.	*WMO RSMCs with responsibility for severe weather* Interpretation and downscaling of global NWP; Guidance to national meteorologists and hydrologists	*WMO Global Centers* Global multi-model NWP outputs supplied to *RSMCs with responsibility for severe weather*	Forecasting skill exists within NMHS WMO RSMC Wellington supports Severe Weather Forecasting Demonstration Project (SWFDP)	No capacity to observe small- scale intense rain. No capacity to nowcast Requires radar for detection (to be supplied by JICA) No impact forecast and warning at national level
Large scale convection (supercells)	Rainfall intensity / amount Wind velocity	Multiple islands, affects several countries simultaneously (1,000 - 10,000 km^2)	Extensive flooding / flash floods causing damage to property and loss of life/ injury. Wind damage to structures and power-lines with potential loss of life or injury	*NMHSs / DRM* National Weather forecasts and Warnings; Impact Forecasts and Warnings, Early response, Evacuation / Shelter / etc.	*WMO RSMCs with responsibility for severe weather* Interpretation and downscaling of global NWP; Regional scale NWP; Guidance to national meteorologists and hydrologists;	*WMO Global Centers* Global multi-model NWP outputs supplied to *RSMCs with responsibility for severe weather*	Forecasting skill exists within NMHS WMO RSMC Wellington supports Severe Weather Forecasting Demonstration Project (SWFDP)	No impact forecast and warning at national level
Tropical Cyclones	Rainfall intensity / amount Wind velocity Storm surge (wind- driven, sea water inundation)	Medium scale, affects countries in path (1,000 km^2)	Extensive flooding / flash floods causing damage to property and loss of life/ injury. Wind damage to structures and power-lines with potential loss of life or injury	*NMHSs / DRM* National Weather forecasts and Warnings; Storm surge forecasts; Impact Forecasts and Warnings, Early response, Evacuation / Shelter / etc.	*WMO RSMCs with responsibility for Tropical Cyclones* Interpretation and downscaling of global NWP; Regional scale NWP; Storm surge modeling;	*WMO Global Centers* Global multi-model NWP products supplied to *RSMCs with responsibility for Tropical Cyclones*	Forecasting skill exists within NMHS RSMC Nadi provides support for TC forecasts and warnings	No regional NWP No impact forecast and warning at national level

					Guidance to national meteorologists and hydrologists;			
Drought	Rainfall, temperature	(1,000 – 10,000 km^2)	Extensive crop failures and freshwater scarcity	*NMHSs, Agricultural Advisory Services* Climate outlook forums	*Regional Climate Centers* Downscaling climate data; Climate Outlook Forums	*WMO Global Centers* responsible for season and longer scale prediction		No drought monitoring service No regional climate center
Tsunami	Shallow water wave	Up to basin wide (100 – 10,000 km^2)	Extensive coastal flooding causing damage to property, loss of life and injury	*NMHSs / DRM / others* Impact Forecasts and Warnings, Early response, Evacuation / Shelter / etc.	*Tsunami Warning Centers* Warning guidance issued to national authorities	N/A	Geo-hazard monitoring and forecasting	Pacific Typhoon Warning Center no longer providing warnings to Samoa (As of Oct 2014) No impact forecast and warning at national level
Volcano	Volcanic ash	Local/regional; potential threat to larger scales due to air travel (10 – 10,000 km^2)	Damage to structures, loss of life and injuries, disruption to air traffic	*NMHSs / DRM* Early warning Early response, Evacuation / Shelter / etc.	*WMO RSMCs with responsibility for aviation safety* Downscaling of global NWP; Regional NWP; Volcanic ash advisories	*WMO Global Centers with specialized responsibility for volcanic ash advisories* Global NWP products supplied to *RSMCs*		No volcanic ash forecasts and warnings at national level
Earthquake	none	Local (1 – 1,000 km^2)	Damage to structures, loss of life and injuries	*Agencies responsible for Geo-hazards / DRM* Early response & recovery	Regional monitoring	Global monitoring	National seismic monitoring	Insufficient sites