Innovation in public and private engagement (PPE) – multi-hazards early warning system and disaster risk reduction

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Background

This paper describes good practices in public and private engagement for disaster risk reduction, focussing on early warning systems in the Pacific and the Caribbean regions, which have been developed though engagement of both public and private sectors.

Natural hazards[1], both climatic/hydro-meteorological and geological/geomorphic, continue to claim thousands upon thousands of lives and wreak irreparable damage upon homes, businesses and critical infrastructure. If not managed well and mitigated to the maximum extent possible, they leave impoverished people and deteriorated economies in their destructive wake. The complexity of the problem requires an all-inclusive solution. Thus, in 2015, a global effort by numerous organizations and experts culminated in a set of frameworks driving economic development: the 2030 Agenda for Sustainable Development with its 17 Sustainable Development Goals (SDGs); the Paris Agreement on Climate Change; and the Sendai Framework for Disaster Risk Reduction. These frameworks call for multi-stakeholder (intra- and cross-sectoral engagements of stakeholders at all scales) and a holistic (end-to-end, multi-hazard) approach to disaster risk management.

The year 2015 is indeed a watershed moment for this new era of development, called risk-informed sustainable development. It was recognized that we are all in this together, and that we all have a shared obligation to meet the 2030 targets. The 2020 pandemic is an aching reminder of the urgent and strong need to work together for the benefit of all of us.

Multi-stakeholder engagement for disaster risk reduction

The above-mentioned frameworks reflect the collective responsibility of governments, communities, and the private sector to prevent and reduce disaster risks. SDG 17 ("strengthen the means of implementation and revitalize the global partnership for sustainable development") specifically recognizes the importance of multi-stakeholder partnerships for achievement of the targets.

[1] Natural hazards can be classified as climatic/hydro-meteorological (floods, storms, drought, hurricane, and others) and geological/geomorphic hazards (earthquakes, slope movements, erosion, volcanic activity, and others).

In this context, the World Meteorological Organization (WMO) has developed its multi-stakeholder workstream branded "public-private engagement" (PPE). This paper here have used the definition of PPE as given in the WMO Policy Framework on PPE (2018): PPE is engagement by National Meteorological and Hydrological Services (NMHSs) and/or other public agents with the private sector in various modes in the production and delivery of weather, climate, hydrological, and related environmental information and services while respecting the public interest and the mandates of NMHSs and keeping in mind budgetary constraints.

To leverage PPE for early warning and disaster risk reduction, key aspects of the hydromet value chain shall be understood: *maturity* (how mature is the hydromet value chain and its each element); *sector balance* (to what extent do the public, private, and academic sectors contribute to the hydromet value chain); and *policy framework* which shapes the hydromet value chain (World Bank, 2019). Figure 1 provides a hypothetical example, showing the relative contribution from the public, private, and academic sectors to each element of the advanced value chain in NZ; it can be seen that both the public and private sectors contribute substantially while the academic contribution is notable in most elements.

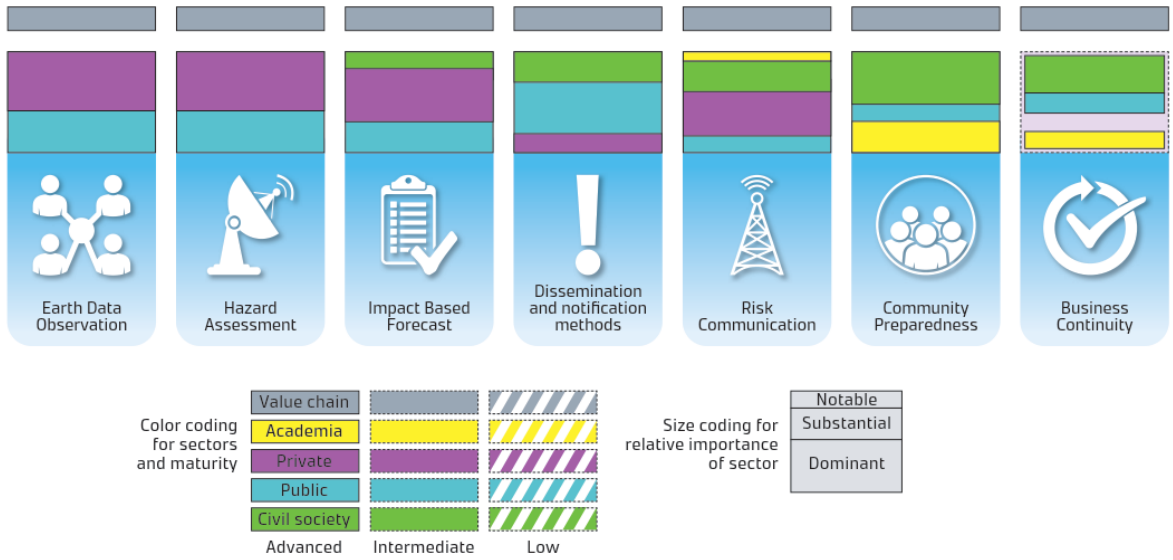

Figure 1. Hypothetical example of PPE in hydromet value chain in New Zealand (based on World Bank, 2019 framework)

Historically, the public sector has led funding and development of the infrastructure across the whole hydromet value chain. Observation networks, observation data management, and large numerical weather prediction systems have been run as public services. The private sector actors, especially businesses working in weather-dependent sectors (such as agriculture, tourism, aviation, and transport) have been consumers of hydromet services.

However, private and academic sectors are now playing increasingly important roles, significantly contributing to the warning systems and overall disaster risk reduction. They both play an important role in innovation and capacity building. They participate in development of technologies for data acquisition and data processing, as

well as for information dissemination. During the last two sessions of the WMO's ruling Congress (17th session in 2015 and 18th session in 2019), it was acknowledged that the private sector has evolving capabilities for and an increasing role in the "weather enterprise" (i.e., hydromet services value chain). Private sector is becoming more competitive in elements traditionally dominated by the public sector.

End-to-end, multi-hazard approach to disaster risk reduction

It has long been recognized that if societies could have advanced information on hazard warning, the adverse effects of hazards on humans and their activities could be minimized. Early warning systems (EWSs) are thus key tools in disaster risk reduction.

For an effective EWS, it is critical to have accurate information rapidly disseminated, informing individuals and organizations exposed to hazards to take action so that they can avoid or reduce their risk and prepare an effective response. The engagement of various public and private sector stakeholders is at the core of effective EWS.

As climate change and natural hazards have increased over the years, there has been a need to understand the new challenges that are faced and how EWSs can help. Tonkin + Taylor in New Zealand together with WMO, International Science Council (ISC) and Integrated Research in Disaster Risk (IRDR) has developed a method for assessment of EWSs, following the 10 essential elements as outlined in the figure below. For the system to be effective, these 10 elements need to be coordinated across many agencies from national to community levels. Each element plays an important role, and all are considered equal in strength in order to provide an effective and robust EWS. Failure in one component or a lack of coordination across them leads to failure of the whole system.

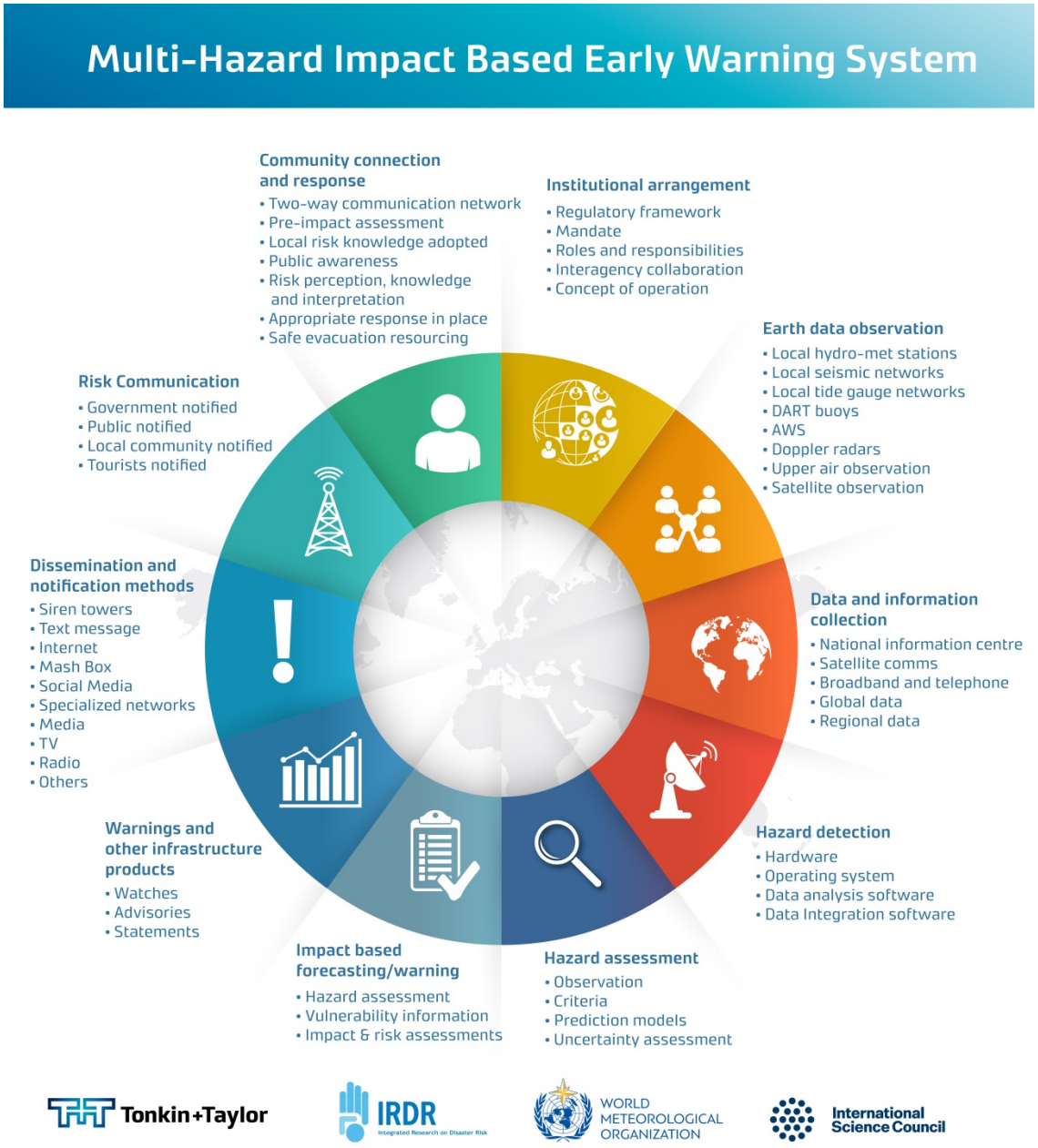

Figure 2: End-to-end-impact-based EWS

EWS is a holistic process involving everyone (public, private and academic) through various stages of implementation. The end-to-end EWS helps us to think about how we can achieve a reliable and effective system by facilitating partnerships between sectors and stakeholders, especially given limitations in terms of finance, equipment, technical capability and manpower. The roles and responsibilities of public- and private-sector stakeholders within the EWS must be reflected throughout the regulatory frameworks, and planning, budgetary, coordination and operational mechanisms.

Good practices in public and private engagement for disaster risk reduction

Tonkin + Taylor, Met Service New Zealand, Met Ocean New Zealand, NIWA, and other institutions in New Zealand have established several good practices and innovations for the design and implementation of a multi-hazard, impact-based EWS. This paper describes some of those good practices utilised in EWSs in the Pacific and the Caribbean, which have been developed though engagement with public and private sectors. These good practices are in the area of funding of public services, capacity building, development support, and technology for EWS.

Canterbury geotechnical database

The Canterbury Geotechnical Database was established by Tonkin + Taylor in 2012 as an online 'one stop shop' and authoritative data warehouse to help rebuild the greater Christchurch area following the 2010 and 2011 Canterbury earthquake sequence. As a private sector business, Tonkin + Taylor's involvement in this project started through the contract with the Earthquake Commission (public sector) to assess land damage in residential areas. This has led to the collection of massive amounts of land damage information and geotechnical data. The data sharing model in Canterbury has enabled a significant dataset to be developed to the benefit of both private and public sectors and has been a success factor in the recovery of the greater Christchurch region.

Natural hazard rapid response and damage mapping

Kaikōura earthquake viewer

Tonkin + Taylor assisted local and central government in New Zealand in the response to the Kaikōura Earthquake which struck at midnight, on 13 November 2016. Within 18 hours of the earthquake, Tonkin + Taylor carried out initial ground-based and aerial land damage surveys, uploaded the data into a central online viewer available for all response agencies, and provided an initial report to the Earthquake Commission, Prime Minister and the National Crisis Management Centre, while the Prime Minister was still in the bunker below the parliament building. Through professional relationship with the Linked Open Data for Global Disaster Risk Reduction and the Integrated Research on Disaster Risk Group, Tonkin + Taylor obtained satellite imagery from the Chinese government to understand the extent of the earthquakes' effects across the region. Resultant interactive maps, geo-coded photos and damage reports allowed first responders to effectively triage their efforts. Users were able to provide their photos and observations to update the viewer, resulting in constantly evolving datasets offering improved accuracy, and subsequently, the best possible outcomes for all involved. The ability of the private sector to rapidly deploy response teams and provide critical damage information was essential in providing decision makers with an understanding of the damage, allowing immediate response and timely rescue efforts.

Pacific tropical cyclone response

Tonkin + Taylor assisted local National Disaster Management Offices throughout the Pacific in responding to a number of natural disasters, including Tropical Cyclone Winston which impacted Fiji, Tropical Cyclone Gita which impacted Tonga, and the Sulawesi Tsunami and Earthquake in Indonesia. Through relationships with organisations such as the China Group on Earth Observations, Tonkin + Taylor rapidly captured and mapped

damage information. This helped both governments and non-governmental organisations (NGOs) to understand the distribution of damage and needs, to effectively triage and prioritise disaster response to worst impacted areas within 24-48 hours. Typically, without this kind of external support, this can take local agencies weeks to obtain, hampering response and recovery efforts. Utilising tools and techniques on offer through the private sector can greatly enhance the ability to respond and therefore recover from significant disasters such as these.

Tsunami warning mass notification system, Fiji

Potentially life-threatening delays were experienced on 4 January 2017 in Fiji, when a local earthquake required that a tsunami warning be issued. At the time, the existing warning system was reliant upon specialist input and the public sector was under-capacitated, with insufficient funds to upgrade observation equipment. The study undertaken by Tonkin + Taylor found that these issues could be alleviated through strategic partnerships. A key recommendation was for the government to work with the Red Cross and mobile service operators to improve the level of communication through the use of mesh extenders. Mobile service operator networks may be used as a secondary link to activate sirens and to monitor instruments and tsunami EWSs. Another recommendation was to form a partnership between mobile service operators and the United Nations' International Telecommunications Union (ITU), launching a cooperation agreement to allow all ITU countries to make use of universal message broadcasters for emergency communications. It was noted that engagement of various sectors can also help upskill and educate those sectors on important features of EWS. (Tonkin + Taylor International Ltd, 2017).

Coastal Inundation forecasting demonstration project, Fiji

The Coastal Inundation Forecasting Demonstration Project was jointly coordinated by the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology and the WMO's Commission for Hydrology. It has developed and implemented a multi-hazard EWS that promotes an integrated approach to forecasting, monitoring and warning for coastal flooding, no matter what the source, river or ocean. The project's approach was innovative and unique in that, for the first time, it brought together the hydrological, oceanographic and meteorological communities to develop an enhanced capability for effective coastal warnings that are accessible to, understood and actionable by communities at risk. This was an example of where the engagement of both public and private (in this case academic) sectors was vital in ensuring consistency in the skills and knowledge used to carry out forecasting, monitoring and warnings (Tonkin + Taylor International Ltd, 2019).

Coordination and standardization services of EWS, Dominica

The Government of the Commonwealth of Dominica developed a National Resilience Development Strategy, which has emphasised the need for strengthening EWSs for multiple hazards. This study found issues in relation to how the information was obtained and disseminated, as well as a gap between the government and the scientific community. An investigation post Hurricane Maria in 2017 found that communication failures were impacted on by the hurricane. Therefore, mobile and television service providers were recommended to disseminate notifications of alerts, alarms and guidance to population at risk. The study also found that the Red Cross together with other partners such as the Caribbean Disaster Emergency Management Agency

(CDEMA), the Caribbean Institute for Meteorology and Hydrology (CIMH), the United States Agency for International Development (USAID), the United Nations Development Programme (UNDP) and other NGOs are working at the community level to enhance the prevention, mitigation and response capacities at both the institutional and community level, based on mutual learning and collaboration between countries and regional institutions working in disaster risk reduction across the Caribbean. A recommendation was therefore made that the government forecasters focus on building relationships with the NGOs already working in the area. This helps build trust, which in turn builds a greater community connection and response (Tonkin + Taylor International Ltd, 2020).

Web app development

World Food Programme, Pacific Prepositioned Stock

Following Tonkin + Taylor's rapid disaster mapping of Fiji in the aftermath of Cyclone Winston, it became apparent that aid efforts were hampered by logistical problems associated with getting emergency supplies to affected communities quickly and efficiently. To deal with this barrier, Tonkin + Taylor supported the UN World Food Programme initiative to develop a bespoke web-based software platform that identifies the location and quantities of prepositioned stock for disaster readiness in the Pacific. The solution is tailored towards aid agencies and NGOs to help them manage and update their stock that is held across various warehouses. Fundamentally, the system provides an inventory of stock in all locations, identifying which items are available where, from sanitation kits to tarpaulins and water purification tablets. It promotes collaboration between different agencies to eliminate duplication of items or gaps and allows effective re-stocking of supplies as appropriate. It gives agencies a big-picture view and allows them to effectively prepare for disaster. As or when a disaster happens, agencies see where specific supplies are available in order to source and deliver them quickly and efficiently to those affected. The system has been implemented in the Pacific and is likely to be deployed further afield.

Conclusions and recommendations

It is widely acknowledged, by all stakeholders, that private-sector and academic stakeholders are playing an important role, helping to push the frontiers of knowledge and technology, and developing innovative solutions that deliver more reliable forecasting and more efficient warning services.

This paper looks at the good practices that have explored PPE seeking to strengthen the provision of EWS. Not surprisingly, literature review and these experiences show that partnerships between public, private, and academic stakeholders in disaster risk reduction can be challenging but are worth the effort. In other words, an attempt to design a balanced PPE model that builds on an awareness of capabilities of each sector and stakeholder and a shared commitment to strengthening global resilience, is worthwhile. Better EWSs and improved hydrological services can contribute to reduced cost of hazard events and strengthen resilience. Experience in the Pacific shows that USD 1 investment in EWS gives a return of USD 6 in socio-economic benefits; in Asia, from USD 1 invested, a return of USD 40.85 in socio-economic benefits may be realized over a 10-year period (Fakhruddin & Schick, 2019). The willingness to pay (invest in) improved EWS in developing countries such as Bangladesh was estimated at USD5.57 per year (Fakhruddin, et al, 2020).

Key lessons from the experience in the Pacific and Caribbean regions, that may form the recommendations for strengthening PPE for disaster risk reduction are:

- Good understanding of the benefits of reinforcing EWS by all stakeholders may serve as an incentive in investing and improving technologies.
- Developing an open and structured dialogue between all stakeholders to promote trust between them and to clarify their roles and responsibilities is very important.
- Economic assessment and scenario modelling are efficient tools for decision making in respect of investment and technology improvement for preparedness and actions during response.
- Economic assessment of EWS may help in quantifying pre-impact assessment to demonstrate to policy makers the economic benefit of disaster risk reduction.
- Cross-sectoral engagement can be vital for ensuring consistency in the skills and knowledge to carry out forecasting, monitoring and warnings.
- By collaboration and cooperation from local, national and global authorities, increased capabilities and capacities of the National and Hydrological services may lead to cost-effective disaster risk reduction.
- To strengthen capacity for disaster risk reduction, it is crucial to involve the private sector as a major actor across the whole value chain. The private sector can contribute enormously to disaster risk reduction by developing business continuity plans, innovating technology for EWS, and providing and sharing technical knowledge, skills, and resources in the field of disaster preparedness.

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Bapon Fakhruddin, PhD – Technical Director- DRR and Climate Resilience

Dr Fakhruddin is an expert climate change risk assessor with 18 years' global experience in working on disaster risk and climate resilience projects. This experience is a major advantage in climate change adaptation and mitigation strategy development. His key areas of expertise are climate and multi-hazard risk assessment, disaster preparedness, early warning and emergency response and coastal community resilience. He has designed climate change and disaster response projects more than 25 countries in Asia and the Pacific.

During his career, Dr Fakhruddin helped to design major international multi-hazard early warning systems for floods, cyclone and tsunami to save life and property damage. His most high profile

work has been developing multi-hazard warning systems including a tsunami warning system for Indian Ocean countries following the deadliest one in history - the 2004 Boxing Day Tsunami.

Dr Fakhruddin is currently work as a mentor and supervisor for postgraduate study in disaster risk management in University of Auckland (UoA). He is a Science Committee Member of IRDR of ICSU/UNISDR, Co-Chair for the Disaster Loss DATA and Risk Interpretation and Applications (RIA) Working Group of IRDR of ICSU/UNISDR. He is also Co-Chair CODATA task group Linked Open Data for Global Disaster Risk Research (LODGD) and PSG member of the Coastal Inundation Forecasting Demonstration Project (CIFDP) and Open Panel of Commission for Hydrology Experts (OPACHE) of WMO. Recently Dr Fakhruddin appointed by the Government of New Zealand to develop national climate change risk assessment framework.

Capabilities: climate and hydrological risk assessment, design and implementation of hazard early warning system and emergency communication, climate change adaptation, training and capacity building and integrated water resources management

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