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| WORLD METEOROLOGICAL ORGANIZATION  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  STAKEHOLDERS WORKSHOP TO IMPLEMENT  A PILOT PROJECT ON IMPACT-BASED FORECASTING AND RISK-BASED WARNINGS  NAY PYI TAW, MYANMAR, 28-30 September 2015 |  | WDS-PWS/SHW-IBFRBW-PP/Doc.2  ORIGINAL: ENGLISH |

GUIDANCE ON DELIVERING AN IMPACT-BASED WARNING SERVICE

***Purpose of the document***

This guidance is intended for those countries seeking to move towards an impact-based warning service as recommended in WMO Guidelines on Impact-based forecast and warning services:

<http://library.wmo.int/opac/index.php?lvl=notice_display&id=17257>

It proposes a workshop plan that ensures those attending the workshop understand the value of introducing an impact-based warning service in their country, and in particular how it can add significant value to their sectors and area of responsibility. The guidance document also presents an approach that should motivate and empower participants to deliver a pilot project on impact-based forecast and warning services.

***Overall workshop plan***

The following generic steps are required to deliver a successful workshop. These are:

1. Stimulating the need for action
2. Engaging the decision makers
3. Creating an in-country hazard matrix
4. Developing impact and mitigating advice matrices; building blocks of an impact-based warning service
5. Running a Workshop
6. Standard Operating Procedure and developing a communication plan
7. Post implementation evaluation (Piloting and refining the plan)
8. Holding exercises to review and refine practices and maintain relationships

The remainder of this guide will look at each of these steps

***Stimulating the need for action***

Stimulating the need for action and attracting the required decision makers may be the hardest part of integrating an impact-based warning service into disaster risk reduction management. This will require evidence of recent hydrometeorological events that have had negative impact on people, the economy or reputation of the country. It may also illustrate the failure of the underlying warning process involving communications, leadership and clarity of roles.

Evidence should show the trigger event and the resulting impacts noting the time, place and duration of the trigger event as well as the time, place and duration of the resulting impacts. Both direct impacts such as lives lost and property damage and indirect impacts such as performance of harvests or occurrence of disease should be captured. If there has been a study of how the national infrastructure or the population will become more sensitive to hazards, such as due to greater urbanisation, then this should also be included. The outcome should be awareness that the cost of taking no action is more than the cost of taking action.

Ideally this evidence should be presented to the national body or political lead with responsibility for disaster risk reduction to gain buy-in to establishing an impact-based national warning service.

***In presenting this evidence it is important to recognise that although models will assist in objectively assessing impact this is not a prerequisite to initiate a service.***

Impact based warnings are given a colour depending on a combination of both the likelihood of the event happening and the impact the conditions may have. With or without the support of impact models the impacts are first discussed with partners who deal with the aftermath of disasters and users to better understand the ‘what if’ and to explore the possible impacts associated with a hazard. The outcome of the discussion is to subjectively assess the impacts taking account of the timing, location, duration, intensity, antecedent conditions (e.g. catchments), seasons, vulnerability and exposure of the area at risk.

Responsibility for planning, delivering and following up on a workshop should be assigned to a lead agency. Lead agency will often be assigned to the organisation making the case for integrating an impact-based warning service which usually will be the NHMS.

In summary, the following is recommended as actions in preparation for a workshop:

* Bibliography of existing risk mapping information or if non-existent consider possibility of commissioning a study to capture dispersed knowledge on locations that are prone to hydro-meteorological hazards, such as flood; from climate and historical media or academic reports.
* Collation of existing vulnerability and exposure information to create real-time or climate based impact mapping
* Feedback and experience of the existing and potential user community on the utility of existing service whether or not this is already impact-based or threshold-based or some other form of warnings, what works and what doesn’t. Things to consider include:
  + The role of the media and its association during high impact events, such as in educating the public, disseminating and emphasizing public messaging
  + An understanding and appreciation of the effectiveness of an evacuation order / or mitigation actions instigated by government, local authorities and people
  + The role, if any, of community resilience volunteers, community leaders or community groups

***Engaging the decision makers***

An impact-based warning service involves many players including:

* Civil Protection
* Emergency response e.g. fire, police, ambulance
* Transport: e.g. Highways, Coastguard, Rail, Aviation
* Telecommunications
* Local and national Government
* Government departments such as education, health, Social Welfare
* Media
* Utility companies (water, power)
* Some infrastructure operators (private and public)
* General Public – a representative who can inform what and how to communicate to the public as part of the overall process

A national body or political lead supporting the integration of an impact-based warning service offers a door through which the lead agency can build a rapport. Rapport is essential to the successful engagement of decision makers and relevant experts and an appropriate amount of time and effort should be spent by senior figures in the lead agency to ensure this is gained. This may require many bi-lateral conversations with the range of decision makers. It is this ground work that will bear fruit later.

***Creating an in-country hazard matrix***

Dealing with these commonly occurring events requires an all-hazards approach to better coordinate emergency preparedness and response efforts. All-hazards planning must include the potential for subsequent or secondary emergencies following a primary natural disaster. Natural hazardous process of all types can have primary, secondary, and tertiary effects and in the case of hydrometeorological related hazards are largely sourced by the natural variability associated with equatorial atmospheric waves, tropical cyclones and tropical convection.

Hazards are categorized according to the stages in which they appear following the event itself and whether they are directly attributed to the hazard source, or in-directly through a combination of other hazards. The category is therefore primary, secondary and tertiary all of which are defined below

***Primary Hazard Phenomena***occur as a result of the process itself. For example ground shaking during an earthquake. These lead to Primary Hazard Impacts, such as building collapse and utility pipeline rupture.

***Secondary Hazard Phenomena*** occur only because primary Phenomena has caused them. For example, soil liquefaction as a result of earthquake ground shaking, drought as a result of prolonged periods of hot weather or pest infestation as a result of prolonged or seasonal rainfall. Secondary impacts may include infrastructure damage (flood impacted bridges and potholes following a cold spell), lack of irrigation for crops, and reduced crop harvests induced by pest swarms.

***Tertiary Hazard Phenomena*** occur as a result of Primary and Secondary Phenomena. Often these exhibit long term effects. These include things like loss of habitat caused by a flood, permanent changes in the position of river channel caused by flood, crop failure caused by a pest infestation, induced by prolonged or seasonal rainfall etc. Impacts associated with tertiary hazards are often harder to quantify and have significant duration. Examples include, food chain disruption and loss of species due to habitat reduction, increased long term probabilities of flooding associated with geometry and course alterations and famine.

| **Source** | **Primary** | **Secondary** | **Tertiary** |
| --- | --- | --- | --- |
| Tropical Cyclones | Strong winds (gales)  Storm surge  Lightning  Heavy rainfall  Tornados | River and coastal flooding  Land instability  Surface water flooding | Disease  Flooding |
| Monsoons | Strong winds  (gales)  Heavy Rainfall  Thunderstorms | River and coastal flooding  Surface water flooding  Land instability | Disease  Flooding |
| Convective rainstorms | Strong winds  Tornados  Lightning  Heavy rainfall | River flooding  Land instability  Surface water flooding | Health |
| Prolonged period of hot weather | Heat | Thunderstorms (and their associated hazard phenomena)  Drought  Dust/smog/haze | Land instability  Health  Algae  Famine |
| Prolonged period of dry weather | Reduced rainfall | Dust/smog/haze/fog  Reduced ground water flow  Water quality  Drought | Health  Famine  Disease  Subsidence |
| Excessive cold with frost | Cold  Frost | Wind chill |  |



*Figure showing the complex relationship during a hurricane / typhoon between the weather source / phenomena, its downstream primary & secondary hazards and then how these are translated to the impacts and resulting response strategies. Courtesy, Baode Chen.*

The workshop should focus on specific climatological and hydrometeorological hazards. For example, a tropical cyclone directly induces heavy rain, wind and storm surge which then drives downstream hazards such as rainfall induced landslides, inland and coastal and inundation. These primary and secondary hazards then results in long term tertiary hazard impacts to society, infrastructure and the environment, such as health and famine. By developing an in-country hazard matrix it is advised that no attempt should be made to account for interdependency or concurrency to formulate an all hazard impact or risk as illustrated in the matrix

However, the basic foundation to better understanding the whole end to end process from hazards sources to their combined impacts requires a step by step understanding of each specific hazard in turn. This is a fundamental building block for any future multi-hazard impact based service. If one cannot predict the onset, track, intensity of say, a tropical cyclone then forecasting the subsequent flood inundation associated with a storm surge will be misleading at best, and worse could put people in harm’s way as they make incorrect life threatening mitigation decisions based on poor advice

***Developing impact and mitigating advice matrices***

The decision makers together with regional and national experts from a range of supporting disciplines including; hydrology, geology and meteorology and non-governmental organisations such as UN agencies and humanitarian agencies will between them have the expertise to develop the matrices critical in the development of an impact and mitigating matrices required for an impact based warning service.

To assess the level of impact we take into account the hazard matrix and for each hazard determine the impacts. These should be presented on a coloured impact matrix depending on the likelihood and impact – an example is shown below for flood.



In order to assess the impact we should take into account the following:

***Likelihood:*** This could be the likelihood of a worst case severe impact scenario or based on a most probable, but either way the resulting colour should be similar e.g. a very low likelihood of a worst case severe event would result in a yellow warning which is comparable to a medium likelihood of a most probable minor impact. Ideally the likelihood score should be derived from an ensemble system or an approximation of the probability of occurrence defined by:

* Very low < 20%
* Low 20-40%
* Medium 40-60%
* High 60% or greater

These four likelihood levels map onto the four rows on the impact matrix.

**Impacts matrix**

An impacts matrix is developed for each sector and for each hazard. This should be achieved by working with partners and holding sector specific breakout sessions. An example is shown below which has been developed in the UK for flooding and the public.

| **Impacts Matrix for the public** | | | |
| --- | --- | --- | --- |
| **Minimal impacts** | **Minor Impacts** | **Significant impacts** | **Severe impacts** |
| * Generally no impact expected * Isolated and minor flooding of low lying land and roads * Isolated instances of spray/wave overtopping on coastal promenades * Little or no disruption to travel although wet road surfaces could lead to difficult conditions | * Localised flooding of land and roads * Localised flooding could affect individual properties * Individual properties in coastal locations affected by spray and/or wave overtopping * Localised disruption to key sites identified in flood plans (e.g. rail and utilities) * Local disruption to travel – longer journey times | * Flooding affecting properties and parts of communities * Damage to buildings/infrastructure is possible * Possible danger to life due to fast flowing/deep water/wave and storm surge overtopping/wave inundation * Disruption to key sites identified in flood plans (e.g. rail, utilities and hospitals) * Disruption to travel is expected. A number of roads are likely to be closed | * Widespread flooding affecting significant numbers of properties and whole communities * Collapse of buildings/infrastructure is likely * Danger to life due to fast flowing water/ deep water/ wave, storm surge overtopping and wave inundation, * Widespread disruption or loss of infrastructure identified in flood plans * Large scale evacuation of properties may be required * Severe disruption to travel. Risk of motorists becoming stranded. |

**Mitigating advice matrix – public advice key**

The next stage is for each sector to develop and implement a bespoke mitigating advice matrix describing the actions required to reduce the impact. An example is shown below which has been developed in the UK for flood.

|  |  |  |  |
| --- | --- | --- | --- |
| **Mitigating advice matrix – public** | | | |
| **Very low** | **Low** | **Medium** | **High** |
| **No action required**   * Keep an eye on the weather and flood forecasts | **Flooding possible – BE AWARE**   * Remain alert and ensure you access the latest weather forecast for up to date information * Be aware of conditions and drive accordingly * Check weather and flood warnings | **Flooding is expected**  **BE PREPARED**   * Remain vigilant * Consider re-scheduling your journey. Don’t drive or walk through flood water * Think about preparing for flooding and take precautions where possible * Check flood warnings | **Significant risk to life**  **TAKE ACTION**   * Remain extra vigilant and ensure you access the latest weather and flood forecasts * Avoid all non-essential travel to postpone journeys if at all possible * Follow advice given by authorities under all circumstances, and be prepared for extraordinary measures |

***Running a Workshop***

With such a diverse group with a vested interest there will be a lot of information sharing and discussion between the multiple parties to reach an agreed approach and commitment to deliver. To achieve this with clarity and speed requires dedicated time for relationship building, networking, knowledge sharing, enquiry, learning, idea development and problem solving amongst all parties. An effective and efficient way to provide such creative time is a workshop.

Trust created by activities between disasters helps to speed decision making during a disaster and so better protect lives and livelihoods.

Assuming that a workshop is run this would normally be organised and delivered by the lead agency but with support and help from others in the stake holder group and possibly WMO.

When planning a workshop the following topics should be considered for inclusion:

* Introduction to Disaster Management and how NMHS fits in
* Introduction to impact-based warnings; introduce the concept of relating a colour warning to a specific action – Be aware, Be prepared, Take action
* Capturing resilience issues and impact information
* Gathering information/mapping impacts
* Identifying what the stakeholders need from the NMHS
* How to use warnings – both within the NMHS and by stakeholders
* How impact based warnings can facilitate response strategies
* Learning from each other – stakeholder networking opportunity and sharing best practice.
* Impact based services beyond warnings e.g. for social or economic applications such as hydroelectric generation
* Developing Standard Operating Procedures between NMHS, partner agencies and stakeholders leading up to and during a high impact event to enable sharing of information, effective decision making and issuing joined up warnings and communications.
* Developing a communication strategy for the launch of revised warning system.

These could be organised into a 3 day workshop along the following lines:

| **Stakeholders Workshop** | **Notes** |
| --- | --- |
| **DAY 1: Introduction** |  |
| General Introductions, health, safety and house rules |  |
| Getting to know the Participants (groupings - short introductions, objectives, course expectations) |  |
| **WORKSHOP** |  |
| Overview of how Hydrometeorology hazards affect the country and their Impacts | Delivered by NMHS |
| Create a bespoke in-country hazard matrix which describes sources, primary, secondary and tertiary hazards |  |
| **Break** |  |
| Overview of existing warning services and Disaster Risk Reduction and Management in country | Civil Protection rep |
| Introduction to impact- based warning services (lessons learnt and the importance of partnerships) | WMO rep |
| **Afternoon** |  |
| How impact- based warnings can facilitate response strategies  Learning from each other – stakeholder networking opportunity and sharing best practice knowledge on locations that are prone to hydrometeorological hazards, such as flood; climate and historical reports, which would assist with risk mapping. |  |
| Introduction to technologies and modelling that in time could provide objective risk – impact assessments | GIS / Science rep |
| Regrouping |  |
| **DAY 2: Impact and advice matrices** |  |
| Recap on the previous day |  |
| Developing an impact matrix for a range of hazards and tailored to each sector – breakout sessions |  |
| **Break** |  |
| Review and discuss |  |
| **Afternoon** |  |
| Developing a mitigating advice matrix for a each sector – breakout sessions |  |
| Review and discuss |  |
| **Break** |  |
| Importance of partnerships in developing an impact based warning service |  |
| Regrouping |  |
| **DAY 3: Testing, communications and implementation** |  |
| Recap on the previous day |  |
| Exercises using historical events or simulated scenarios to test each impact matrix and the resulting warning colour |  |
| Creating and agreeing Standard Operating Procedures during times of severe weather and related hydrometeorological events |  |
| Developing a communication plan, |  |
| Post implementation evaluation and Next steps |  |
| Closing Session |  |
| **DAY 4 & 5 (*optional*): Technical** |  |
| Recap on the previous day |  |
| Recap from day 1 on the need to develop modelling and technical capabilities as a vehicle to provide objective impact-based predictions |  |
| Discuss how an innovative, integrated hydro-meteorological model system could be developed that addresses the movement of water through the soils, rivers and aquifers to the estuary, including tidal effects. See figure |  |
| Explore the relationship between specific hazards and impacts which were developed during Days 1 to 3. This would be further refined using the more advanced vulnerability database. |  |
| Review the role of GIS to enable users to better understand and visualise the relationship between multiple hazards, vulnerabilities and impacts |  |
| Develop an operational implementation to deliver an impact-based forecast and warnings service. A proposed GIS multi-hazard system would be tested, evaluated and revised as feasible. Once this is complete, the new system could replace, or complement the subjective process |  |
| Closing Session |  |

***Standard Operating Procedure (SOP)***

A standard Operating Procedure sets out an agreed process by which the NMHS and the contributing partners share information and expertise in real time. This exchange of information aids in better decision making through assigning an impact score and warning colour during high impact weather. The impact matrix is a key component of the decision making process.

The SOP should define:

* The purpose of the process
* Participating members and their roles and responsibilities
* Information shared
* Mechanism to share and discuss e.g. face to face, email, Teleconference, Video Conferencing
* Timing and duration

***Developing a Communication Plan***

This communications plan aims to support and promote the range of impact based products and services provided.

**Communications objectives:**

* To position NMHS as the definitive source of relevant hydrometeorological (or geophysical as well if that is in the mandate of the NMHS) hazard information to a range of customers and stakeholders and the authoritative voice for weather.
* To promote and increase the use of weather forecasts and impact based warnings in decision making
* To promote the value of the impact based warning service
* To help customers and stakeholders, especially new users, understand the impact matrix

**Key Messages/Unique Selling Point of the NMHS:**

* NMHS is the trusted and only source of meteorological (and hydrological, if applicable) advice and impact based warnings in country
* NMHS will listen to and work with the response community to develop new and existing impact based services which help improve response to future emergencies.
* NMHS will help stakeholders to plan, prepare and respond to the impacts of severe weather backed up by our science and the 24/7 resilience

**Target Audience:**

* **Users:** Government, emergency responders, volunteer organisations
* **Partners**:
* **Stakeholders and influencers:** Government ministers and officials, Government departments, Regional and local government
* **Funders**:

\*The public are not included in this plan as there is a separate Public Communications plan.

***Post implementation evaluation (piloting and refining the plan)***

There can be no prescribed plan as each country and its stakeholders are different. An important consideration for everyone’s implementation plan is the need to develop a pilot to test the relevance and value of an impact based warning service.

The following should inform a post implementation evaluation:

* Feedback from target audience.
* Review meetings for large campaigns and events.
* Email evaluation for smaller activities.
* Web analytics and trends – monitoring the flow of traffic to the relevant pages of the website following each campaign
* Media analysis - review volume of articles/blogs the news story is mentioned in, also review message penetration and tone (positive/negative/neutral).
* Measure activity in social media – which messages had the furthest reach? Analyse tone (positive/negative/neutral)
* NMHS staff to report back on any activities they’ve undertaken to promote impact based services/products.
* Number of people signing up to activities around the products and services
* Measure the Open and Click- through rates from any direct mail campaigns sent

***Holding exercises***

Events triggering the need for action cannot be predicated with any particular frequency or regularity and they may come spaced well apart. The longer the gap between events the more people forget what to do or key staff change will lead to losing hard achieved rapport. To maintain the good work, relationships, and trust in each other’s ability to act according to the agreed plan requires regular exercises on an annual cycle or more frequently. Establishing the means to undertake such exercises should be a feature of the plan that emerges from the workshop.

***Examples:*** For each example assign an impact score and associated colour.

***Example A: Typhoon is forecast to make landfall.***

**3 Day Forecast.** A developing, potentially severe typhoon is predicted to make landfall. There is a 40% probability that it will come onshore in a region that is highly populated. Forecasters are predicting a 5-7m storm surge, hurricane force winds and a 30% probability for rainfall to peak 250mm in a catchment susceptible to flash flood.

**2 Day Forecast.** The likelihood for the typhoon to make landfall has increased to 60%, though the probability of exceeding 240mm has decreased to 10%. The mean rainfall predicted to be 100mm in one of the more flashy catchments. No change to wind and storm surge potential.

**1 Day Forecast.** Strike probabilities are forecast to be 80%, storm surge closer to the high end of the ensemble spread at 7m though predicted wind not changed in strength. Rainfall is now higher as the typhoon is predicted to slow down as it makes landfall. There is a 70% probability of 100mm and 30% for totals to exceed 300mm.

***Example B: Thunderstorms expected to develop this afternoon.***

**6 hour Forecast.** Forecast is for a severe thunderstorm to form over the city. It is currently dry, sunny and hot and forecasters are relying on a sea breeze convergence to trigger storm development. Chance of a storm is rated 30%, but could lead to 50mm in one hour rain-rates and severe lightning if a storm does materialise.

**3 hour Forecast.** The likelihood has increased to 40% as a sea breeze has developed and there are first signs of cumulus towers. Probability of exceeding 50mm in one hour has increased to 20%. Concerns expressed by partners as onset could coincide with the evening rush hour.

**1 hour Forecast.** Storm is now fully developed with slow moving lines of storms cells repeatedly forming and running over the same city area. Rain gauge observed 25mm in one hour and forecasters consider the probability of 50mm falling in one hour rising through the next 3 hours, from 20% to 40%. Lightning frequency is likely to increase and it will be late evening before storm activity subsides.

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