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Risk Communications for Coastal Inundation Forecasting to the Community

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Coastal inundation associated with tropical and extra tropical cyclones has a long history of causing death and destruction along our coastlines—and the threat has never been greater. It is imperative that the ever-increasing coastal public understands cyclone risk, particularly related to coastal inundation and storm surge. The potential for massive loss of life due to coastal inundation persists but there is very limited knowledge to generate information on coastal inundation due to cyclone. It provides a call to action for the national hydro-met services research and operations program to develop and implement new coastal inundation mitigation strategies. WMO, the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the WMO Commission for Hydrology (CHy) have initiated the Coastal Inundation Forecasting Demonstration Project (CIFDP) and successfully implementing in many countries (i.e., Bangladesh, Fiji, Indonesia, China, etc.). Its purpose is to address the challenges faced by coastal communities to enhance their safety and to support sustainable development, through the improvement of coastal inundation forecasting and warning systems at the regional scale. Risk communication of coastal inundation is new and required to understand the community perceptions and preferences two categories of stakeholders: providers or experts (forecasters, broadcast meteorologists, and emergency managers) and users (public).

A schematic diagram for the overall forecast system of coastal inundation is shown in Figure 1. As can be seen here, information obtained from (a) responsible national / regional agency(ies), such as the Regional Specialized Meteorological Centre (RSMC), is used as the basis for these forecasts, including: 1) Regional atmospheric models (providing winds, pressures, and precipitation), 2) Inputs from large-scale ocean circulation and wind-wave models (providing information on large scale sea surface height anomalies and on waves generated outside the region) 3) A coastal inundation model (using information from wind wave and wind stress, tidal and large scale- anomaly), and 4) Hydrodrologic models to handle inflow into the coastal domain from rivers and streams when local rainfall is a dominant contributor to coastal flooding. All of these dynamic models must be set upon a digital terrain model that includes bathymetric and topographic information at an appropriate accuracy and resolution. The goal of this system of models is to be able to provide accurate forecasts of inundation from hazardous meteorological forcing in different areas around the world, including storm surges produced by direct wind and wave forcing, wave set-up from large swell events, and inundation from high river/stream flows interacting with sea-level variations in coastal areas.

Communication of storm coastal inundation is closely tied to how such forecasts are generated and the accuracy of the scientific data they are based on. For tropical cyclone forecasts issued by Meteorological office has lots of uncertainty. To generate coastal inundation information requires an integration of cyclone model, storm surge model, wave model and hydrodynamic or river modeling. It is obvious that linking number of model the level of uncertainty will be very high. At the same time cyclone changes its path very frequently and the model need to have capacity to generation information in short interval so that forecast information could be reach to the people living at the last kilometers of the coasts. While cyclone track forecasting continues to improve, the average track error for the Bay of Bengal still more than 200 km for 72 hrs. forecasts. From the analysis of track error forecasts of 2013 it was found that ECMWF-IFS have the best performance in 2013 at each lead time. NCEPGFS was very nearly to ECMWF-IFS. It is gratifying, most global models' track error were under 100km at 24h lead time level, and all the global models' track error were under 200km at 48h lead time level (Table 1).

Communicating risk in a convincing manner is a complex process studied by numerous disciplines and fields for more than 30 years with the findings successfully applied in many areas such as climate change and health issues. There is scarce evidence, however, that the weather enterprise has utilized risk communication knowledge in a systemic way. Significant research efforts have focused on understanding how people make evacuation decisions including the important effects of past experience. Research shows that before deciding to take a disruptive and often expensive action such as evacuation, people must understand the forecast, believe it applies to them and, most important, feel that they and/or their loved ones are at risk. However, common practice has been to prepare and release forecast messages without adequately understanding how they are received, understood, and interpreted.

Risk message effectiveness depends on the development of arguments based on knowledge of the targeted communities, particularly those at high risk. Even though emergency managers and officials bear more direct responsibility for citizen response, forecasters, at a minimum, need to test how their forecast messages are received and interpreted within the context of targeted communities and, in risky situations, the extent to which they evoke cognitive and emotional responses that promote protective action.

	24 hr	48 hr	72 hr	96 hr	120 hr
ECMWF-IFS	72.7	118.0	175.9	251.8	422.0
NCEP-GFS	72.4	129.8	202.8	300.2	437.7
UKMO-MetUM	86.8	152.0	214.8	309.9	528.0
JMA-GSM	93.0	170.0	248.8		
KMA-GDAPS	107.8	188.0	262.9	667.1	1125.1
CMA-T639	102.3	197.1	306.0	442.6	525.8
CMA-T213	112.0	196.4	296.5	410.2	563.3

Table 1: Performance of track forecast.

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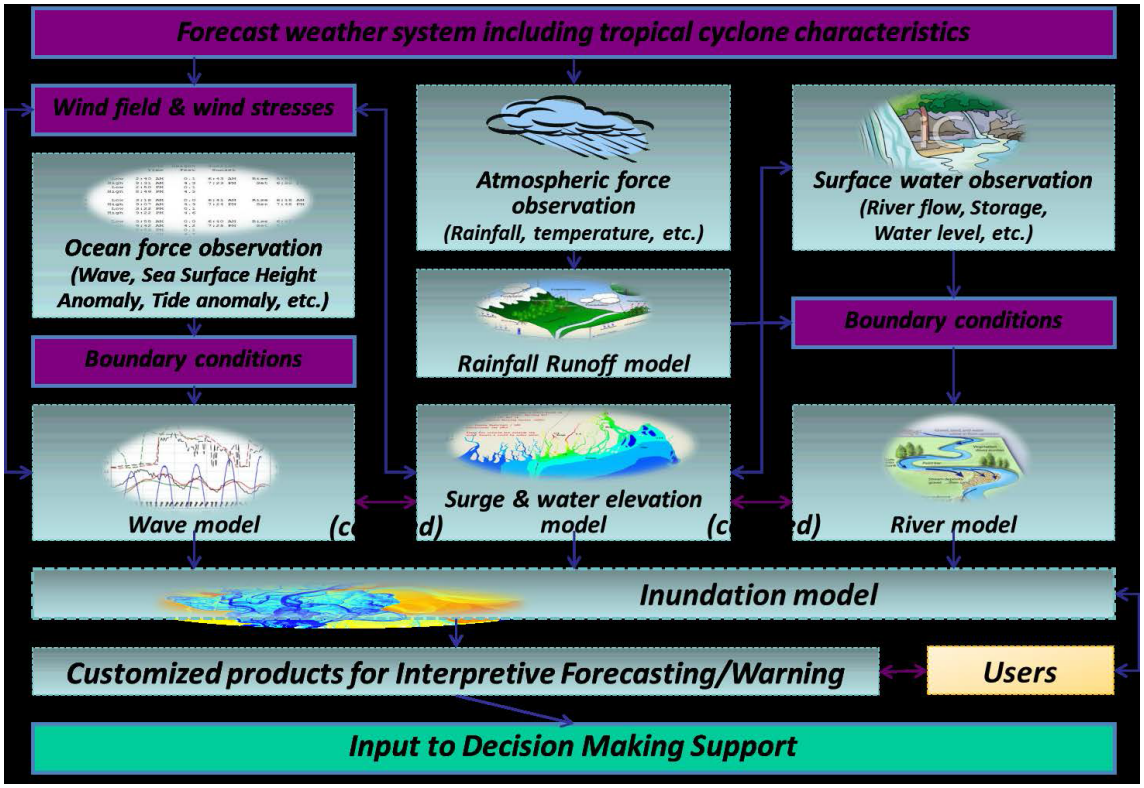

Figure 1: Conceptual diagram of forecast systems recommended for application within the CIFDP effort.

For any new forecasts product (i.e. coastal inundation), there will be lack of communication to receive the warning to the affected people, interpret or internalize the information for decision-making and response. As mentioned Fakhruddin, early warning systems alone do not prevent hazards turning into disasters. Early action is essential in order to mitigate potential damage early warning and early action together can save thousands of lives and livelihoods; reduce vulnerability and strengthen resilience. Nevertheless without lead-time to react an early warning is almost ineffective. For taking a good decision, the capacity of generation of coastal inundation forecasts with sufficient lead-time with an acceptable degree is essential. Therefore a breakdown in any one of these elements of early warning can cause warning messages to fail to reach and motivate their intended recipients. It's clear that early warning is not helpful unless its reach to the people who need to act. To response to the early warning the information need to understand and internalized by the people. Thus an interpretation and translation of the science information is essential. People do not immediately respond to early warnings because people worldwide first "search" for additional information to "confirm" that they are really at risk. This searching happens despite the technology used to give warnings. Searching is a social phenomenon. It involves talking things over with others and seeking to hear the same warning multiple times from different sources. Warned people turn to friends, relatives, and strangers to determine if they agree that risk is present and if protective actions are warranted. This process, constructing new perceptions of risk out of existing perceptions of safety adds time before protective actions are taken- it is fundamental to all human beings worldwide, and it is difficult to change. Early public warnings work best when they are under mandate from a government that is trusted as they can facilitate the process and speed it along. Ignoring these basic human warning elements may continue to cost lives. The new system needs to incorporate all these users' needs to enables peoples to visualize the possible scenarios with probabilities of risk to reduce their vulnerabilities.