(9/5/2006)

Benefits, challenges and issues of multi-hazard (e.g. hydro-meteorological) approach for the development of warnings

Submitted by Hydrology and Water Resources Department of WMO

1. Introduction

1.1 Frequency of the Hazard, Risk Management Concepts, Emergency Response, Institutional Framework, Multidisciplinary Work and other issues are some of the benefits and challenges for developing a multi hazard warning system.

1.2 In addition to the example included in section 2, some general ideas could be discussed. In same cases some of the issues mentioned above could be at the same time a threat and an opportunity. For a very low frequency hazard it is not easy to establish an Early Warning System (EWS). This is a threat but if an EWS combines this hazard with another hazard or with more hazards, then there is an opportunity. In some cases the EWS for a hazards has nothing or almost nothing in common with other hazards from the point of view of its prediction. In some other cases there are common aspects (see section 2 bellow).

1.3 With respect to response mechanisms, to which an early warning system should be linked, it is clear that adding to an existing EWS another hazard will not imply to start a completely new mechanism. In relation to risk management, it is also obvious that an early warning system will serve the real need and be more efficient if is linked to risk management. For making this link it is a must that vulnerability studies and assessments are carried out. Many aspects of vulnerability studies are the same for different hazards and therefore considering a multi-hazard approach could prevent duplication of studies.

1.4 One important challenge that has been detected only few time ago is the fact that the in depth knowledge on the forecasting part of an EWS for a specific hazard could be forgotten or not taken properly into account when many hazards are considered (other documents presented to the symposium could be taken as example). The following example expands the concepts presented above and includes some further considerations.

2. An example on Integration of tsunami warning system in the existing tropical cyclone and storm surge warning system – The Indian Ocean

2.1 Form the theoretical point of view, the movement of water in the Indian Ocean responds to the continuity and momentum equations. To develop a mathematical model of this water body, these equations have to be taken into account. During a tropical cyclone event, the surface of the water will be affected by forces produced by the air (air pressure and wind stress). These forces will induce the water movement and a storm surge will be generated. In the case of a tsunami produced by and earthquake (there could be other origins, but will not be addressed in this document), the movement of the bottom of the ocean will induce the movement of the water body. Any numerical scheme that takes into account these equations could be used if appropriate for simulating both phenomena. Only the boundary conditions would be different. In the extremely extraordinary event of the combination of a tropical cyclone and an earthquake, this system would not collapse.

2.2 In addition to the governing equations of the water movement, a mathematical model would also need information on the bathymetry of the ocean (related to the boundary conditions). In this case, for both events: tropical cyclone and earthquake, the information needed is exactly the same. This implies another advantage for combining the two early warning systems.

2.3 With respect to the calibration and verification of the model, it is obvious that as storm surges are more frequent, they will provide more sources of information for this process and therefore this process would be based more in tropical cyclone data for the benefit of the prediction of tsunamis.

2.4 There are most probably more advantages from a practical point of view in combining a tsunami warning systems and a storm surges warning system than from the above-mentioned theoretical one. The affected zone is the same and therefore the target group to which the warning should be issued is the same. All the arrangement on the procedures to issue the warning would be the same especially on the communication aspect or dissemination of the warnings. The sustainability of the warning systems is linked to the frequency of the events for which the warnings are issued. Low frequencies could imply that the system is not well maintained, both from the point of view of facilities required and the training of the affected personnel. A combination of both events would obviously increase the frequency of the use of the warning system.

2.5 This practical advantage will also be present in the case of warnings issued based on empirical methodologies (difficult to develop for low frequency events) that may not imply the simulation of the movement of the concerned water body based on the physical laws (continuity and momentum equations).

2.6 Another aspect of importance is the response to the warning, which could also benefit from the combination of the systems.

2.7 The existing Tropical Cyclone and Storm Surge Early Warning System could serve as a basis for the development of the Tsunami Early Warning System. At present the System includes the following institutions: India Meteorological Department, Department of Meteorology (Maldives), Pakistan Meteorological Department, and Department of Meteorology (Sri Lanka). There is a telecommunication system in place that could be expended to include the information needed for issuing warnings on Tsunamis. The personnel in charge of the operation of the system could expand their activities without many difficulties. Some of the facilities with the necessary improvements could also serve the double purpose of predicting Storm Surges and Tsunamis. The link with the meteorological forecasting (Tropical Cyclones) already exists and the link with the earthquake information could be added.

2.8 Coastal tide gauge measurements for the Storm Surge Warning System can be used also for the Tsunami Early Warning System: However, it should be noted here that tide gauge data are essentially indirect and interpretation can be difficult because of the complex tsunami transformations induced by interaction with continental shelf, coastline and harbour features. It is also known that tide gauges may not survive the impact of a tsunami and if in case it survives, the data are not immediately reported until after the tsunami had struck a coastal community. For direct, deep ocean measurements of tsunamis, a bottom pressure recorder with an acoustic link to a surface buoy equipped with a satellite telecommunication capability would be needed. The Storm Surge Warning System at present does not include a bottom pressure recorder in its component. It does however have surface buoys and satellite telecommunication capability.

2.9 Many aspects produced by the flooding caused by storm surges and tsunamis would be similar, as for example how to react and respond after the warning. In relation to this issue, as the probabilities of flooding produced by Tsunamis associated with flooding produced by other phenomena is much lower than in the case of Storm Surges, because of the fact that Tropical Cyclones are also associated with heavy rains, the expansion of this part of the system would be quite simple. The geographical coverage may be different, but in principle this wouldn’t be a real problem.