PWS Workshop on Warnings of Real-Time Hazards by using Nowcasting Technology

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Theme 1(b): Nowcasting Systems Overview – Forecast Demonstration Projects (FDPs)
Sub-theme - Applying the Social Science

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Introduction

Nowcasting technologies are being developed and applied within the Meteorological community to support the delivery of early warnings so that exposed and vulnerable communities have the maximum opportunity to prepare for hazard impacts and make informed decisions about effective defensive action responses.

The nowcasting system developers are applying cutting-edge, state-of-the-science processes to produce a suite of decision support products that can really only be considered '*successful*' when they have been applied to support community decision making that ultimately results in minimizing loss - particularly loss of life, in hazard impacted communities.

This paper, together with the workshop presentation will provide a societal perspective to the discussion of the use and values of nowcasting technologies for warnings of real-time hazards. Much of the following discussion will focus on:-

- The importance of the end-to-end concept building into Nowcasting Forecast Demonstration Projects;
- Understanding end-users needs and capacities;
- Lessons learned from WWRP FDP'S – particularly the Sydney 2000 Olympics and the planning for Beijing 2008 Olympics;
- Considering nowcasting applications in a developing country context

Background

The primary aim of providing warnings ahead of hazard impact is to empower individuals and communities to respond appropriately to the hazard threat in order to reduce the risk of death, injury, property loss and damage. Each member of the community at risk should be aware, at the very least, of what is happening; what it means to them; and what they can do about it. In principal, this is true at all levels of society – from national policy makers right down to the individual household - and across all time scales – from the very long term to the immediate.

NMHS'S have long recognized that warnings are more than a simple statement about impending hazardous hydro-meteorological or oceanographic conditions. Rather, warnings are a *process* that is, in the truest sense, *end-to-end-to-end*. The hazard conditions must be detected, forecast and monitored. A warning message must then be produced, detailing current dynamics of the hazard event and it's predicted future development and movement. This science is a core business of NMHS's. The warning message must then be transmitted, through the various formal and informal communication networks to all appropriate levels of the hazard threatened community. Again, this is core business for NMHS's. Once received, the information contained in the warnings message must be both understood and believed, this is contingent on the appropriate use of language and an informed, hazard-educated and receptive community that trusts the source of the warnings message. This is achieved primarily through multi-agency public education campaigns to which the NMHS's contribute. Stakeholders and residents receiving the warnings will usually seek to confirm the messages so it is important that the same information be available from all sources, and that it is consistent with community experience and 'world-views'. Risk will then be personalized, that is, people will determine what the *risk* is to them and then, given that they have the capacity and appropriate available resources, informed decisions about effective defensive actions may then be made.

The warnings process is only successful when effective loss minimizing action has been taken.

NMHS's have an important role in all parts of the warnings process, either as the lead agency or in partnership with emergency management and other stakeholders.

Understanding community capacity

Nowcasting technologies offer an opportunity to provide the community with **warnings** for severe weather events with short lead times. These warnings may be technically perfect but if they do not reach the target community – either physically or because the message is not understood or could not be appropriately acted upon – they are all but useless.

It is of primary importance that those within the weather services that are responsible for developing and delivering nowcast products understand the needs, wants, and, most importantly, the capacities of their target communities.

Nowcasting technologies provide decision support tools for forecasters to apply to the delivery of warnings services. Personal observations over several years lead me to the conclusion that system developers – the world-class, specialist scientists - have a good understanding of the strengths and capacities of the forecasters and, that the forecasters have a good understanding of their user-community needs – but, that neither system developers nor forecasters have a good understanding of the user-community *capacity*. This is where the social scientists can support the physical scientists and practitioners and contribute to the total warnings process.

Social scientists can employ a range of methodologies to qualitatively and quantitatively evaluate and understand community capacity in terms of (for example): understanding and valuing the warnings messages; community perception of risk; community use and application of weather information; effective risk communication; efficient communication networks (particularly the informal networks; disaster mitigation policy frameworks; community demographics and societal networks; and, community 'wants'. Providing this information to system developers and forecasters supports the production of 'useful, user-friendly products that are accepted and appreciated by the community and increases community confidence in the weather services.

<u>Lessons learned from Case Studies WWRP FDP S2000; WWRP FDP B08</u>

WWRP FDP S2000

The Nowcasting Forecast Demonstration Project associated with the Sydney 2000 Olympics aimed to *"To demonstrate how operationally tested state-of-the-art nowcast systems can provide an improved nowcast service."* The primary goal was to *"To demonstrate the capability of modern forecast systems and to <u>quantify</u> the associated benefits in the delivery of a real-time nowcast service"*. It is now required that Forecast Demonstration Projects include a Societal and economic impacts assessment. Therefore, a project was developed to *"….determine and measure the uses, benefits and value of enhanced short-term weather forecasts, warning systems and information to the operations of the S2000 Olympics and a range of other selected users".*

A range of survey processes and methodologies were used to answer two primary research questions.

1. " How was the improved nowcast information used to produce 'better' forecasts?" This research focused on the enhanced information provided by WWRP FDP to the Australian Bureau of Meteorology Olympic forecasters.
2. "How were the improved nowcasts assessed, used and acted upon by the end-users?" Research here focused on the Bureau of Meteorology forecasts that were produced with the benefit of the improved weather data

A series of secondary research questions investigated:

- What lessons could be learned from the S2000 Olympics that could be transferred to similar public large scale events;

- Any quantifiable change between Atlanta 1996 Olympics and S2000 Olympics;
- What the critical meteorological thresholds for various events / situations were; and .
- How decisions are made in response to specific hazardous weather events.

Also investigated was the notion of 'Forecast Quality' which involved an evaluation of the perception of both producers and users of forecasts as to what inputs and qualities make a **"good forecast"** and what inputs and qualities contribute to a **"bad forecast"**

The 'end-users' included: the Olympic Forecasters; the Sydney Organizing Committee for the Olympic Games (including venue and events managers); Air Services Australia; Air Traffic Control; various National and International Airlines; New South Wales State Emergency Services; Bridgeclimb (tourist venture)and the Sydney general public.

Of the range of investigation techniques employed the most common were interactive face-to-face interviews and a series of questionnaire based surveys. These were designed to: investigate how users accessed weather information; understand users needs and expectations of warnings information; determine current use of and access to weather products; identify type of weather information essential to operations and activities; understand decision making processes within each 'user' organisation; understand information flow in each organisation; investigate how users respond to warnings messages; and identify any real or potential economic impacts of decisions made based on weather forecast information.

The process was iterative and throughout the various stages of the project products were developed and disseminated in response to users identified needs and capacities. Some examples of this include the production of a storm track graphic and meteogram that indicated past, present and forecast future track and storm intensity. This product specifically supported emergency services response activities – particularly with regard to the efficient deployment of their volunteer workforce. Bridgeclimb, on the other hand required, and received, a graphic and meteogram that more clearly defined the beginning and end of thunderstorm activity over the Sydney Harbour Bridge area to support decision making that would ensure the safe evacuation of climbers on the Bridge with the minimum possible disruption to climb schedules and minimise economic impacts.

These are just two examples of products and services were able to be tailored to suit the users identified needs and capacities.

On completion of the WWRP S2000 FDP Societal Impacts project Keenan (Bureau of Meteorology, Australia Research Centre) *concluded "The impacts study established a greater awareness to end-user requirements, raising the* *level of communication and feedback associated with the provision of Bureau of Meteorology weather services. This applied to both forecasters and end users."* He further noted that "*The usage and understanding of information presented to end users is ultimately as important as the nowcasting process itself and clearly needs to be incorporated in any evaluation process"*

WWRP FDP B08
Following on from the Sydney 2000 FDP, the B08 FDP has also included a societal impacts component in the project. The stated aims of this project are to: evaluate the social and economic values of the state-of-the-art nowcasting techniques used in B08 FDP; help BMB and CMA to develop a user-oriented weather service for the Beijing 2008 Olympics and other users; and to identify the new opportunities in research, technology and application for other WWRP international projects.

Initial community and stakeholder surveys have been completed to gain an understanding of who the users are; what they want/need; and their current capacities for obtaining and utilising nowcast warnings information. Examples of some very interesting early results indicate that (among other things) users:

- Currently consider weather information is presented in a very simplistic form
- Would prefer to receive more graphical products
- Heatwave information is important to the majority of users
- Access information primarily via television – very limited use of the internet
- Are very concerned about traffic related weather information
- Consider air quality and outdoor summer temperature information important
- Consider timeliness of forecasts to be more important than accuracy

This feedback from the user community provides solid baseline information that can guide the developers and producers of Beijing Olympics nowcast warnings products.

<u>Using Nowcasting technology for warnings of real-time hazards - Developing world context</u>

Developing countries provide particular challenges for the developers of nowcasting technologies and the forecasters that produce and communicate warnings messages. To successfully deliver warnings in the context of an end-to-end warnings process, and to ensure that increasingly vulnerable populations have the maximum opportunity to make informed decisions in response to severe weather event, it is essential that the <u>needs and capacities</u> of the range of threatened communities are well understood. Some of the particularly challenging societal and community constraints that face NMHS' s throughout the developing world may include poor physical infrastructure; lack of resources; shortages of skilled officers; unreliable utilities (eg power supplies); failing formal communication networks; language difficulty; unknown levels of literacy and education in some communities; frail societal infrastructure, and, the list could go on – as we are all aware. In contrast to this however, there may be identifiable, although less visible community strengths that greatly increase community capacity, such as efficient informal communication networks and strong cohesive societal infrastructure.

This was found to be powerfully true in the small Solomon Islands communities in Tikopia and Anuta in late December 2002 when their islands were pounded by Severe Category 5 Cyclone Zoe. For almost three days winds and storm surge decimated the physical environment, destroyed most of the food producing gardens, washed away fishing canoes and damaged village dwellings. For many weeks prior to this the islands were known to have been without two-way radio communications and had very little other opportunity for contact with the outside world. It was feared that these communities had not be able to receive the warnings that were being issued by the Solomon Islands weather service and that villagers would be totally unprepared and without access to help. In fact, one islander had heard the warnings on a personal, battery-operated short wave radio and had sent runners to advise others in the community. This demonstrates a strong and efficient informal communication network. The community was severely impacted but there was no loss of life and, remarkably, due to the very high levels of social capital and the strong cohesive social and community fabric, the community is now rebuilding and recovering well.

Identifying and understanding this community capacity is essential if appropriate warnings and response support processes are to be developed and delivered. In this instance the data and information was discovered, by a well trained multi-agency team visiting the impacted area as soon as possible. Post impact assessments provide an opportunity for systematic collection and analysis of data in support of understanding how communities received, responded to warnings and consequent impacts. With this information NMHS's can better understand community capacity and needs and shape their services accordingly.

Conclusion

Nowcasting technologies provide the meteorological community with the opportunity to develop and apply products and services to support the delivery of early warnings so that exposed and vulnerable communities have the maximum opportunity to prepare for hazard impacts and make informed decisions about effective defensive action responses. These nowcasts can add value to the suite of services NMHS's deliver regularly and reliably to their various communities.

If the scientific community 'collectively' (physical and social) works together to support the development of nowcast systems products and services can be 'matched' with identified, understood community strengths, capacities and needs. Thus ensuring that the warnings process is truly end-to-end-to end.