Total flood warning systems

Mary Barry, CEO Victoria SES, reports on the findings of a recent review of the role of VICSES in flood warning in Victoria.

Abstract

As the control agency for flood response in Victoria VICSES commissioned Molino Stewart consultants to review its current and future role in Flood Warning across Victoria. This paper provides an overview of the key findings and recommendations on how to ensure Victoria has a robust flood warning system across the State.

Warning systems components

In 1995, recognising the importance of flood warnings, Emergency Management Australia (EMA) developed a set of guidelines for flood warning system development and implementation in Australia. These guidelines (updated in 1999) provide a national reference for best practice and are based around the integrating concept of a "total flood warning system" (TFWS). The purpose and goal of TFWS are:

Purpose

- to enable and persuade people and organisations to take action to increase safety and reduce the costs of flooding.

Goal

- to generate appropriate responses from the people and organisations at risk, and from the agencies with responsibilities during flood times (EMA, 1999, p.2).

TFWS have six integrated parts:

- **Prediction** - Detecting changes in the environment that lead to flooding, and predicting river levels during the flood.
- **Interpretation** - Identifying in advance the impacts of the predicted flood levels on communities at risk.
- **Message Construction** - Devising the content of the message which will warn people of impending flooding.
- **Communication** - Disseminating warning information in a timely fashion to people and organisations likely to be affected by the flood.
- **Response** - Generating appropriate and timely actions from the threatened community and from the agencies involved.
- **Review** - Examining the various aspects of the system with a view to improving its performance (EMA, 1999, p.7).

Total flood warning system in Victoria

In October 2005, the Victorian Flood Warning Consultative Committee (VFWCC) released a report titled A Review of Flood Warning System Development Priorities Within Victoria. This report found that there are many organisations participating in floodplain management and flood warnings including:

- The Bureau of Meteorology,
- The Department of Sustainability and Environment,
- Catchment Management Authorities,
- Water Supply Authorities,
- Victoria State Emergency Service (VICSES),
- Local Councils and others.

However, with a few exceptions, the roles and responsibilities of each organisation are not well defined, which can result in important tasks being poorly done or omitted. The report concluded that a "continuation of the current lack of clarity on this matter will prevent the full realisation of the benefits that can stem from Victoria's existing flood warning systems." (VFWCC, 2005, p iii).

The report states that the task of educating the Victorian community about flood risk, and maintaining and updating this knowledge, is not the clear responsibility of any stakeholder. It is loosely spread across VICSES, Local Government and Catchment Management Authorities (CMA), none of whom regard it as core business (VFWCC, 2005, p.16, 37, 64).

As a result, flood warning systems maintenance and operation within Victoria lacks a clear "champion" or leader—which is essential to drive the on-going processes given that roles and responsibilities are not always clear cut. (VFWCC, 2005, p (iii), p 6, 16).

Given that VICSES is the control agency for flood response in Victoria and has a clear legislated role for aspects of emergency management planning and preparedness, VICSES declared that with access to appropriate resources and funding it was prepared to:

- Be the "champion" for flood warning systems maintenance and operation in Victoria: and;
- Take a lead role in community education and awareness.

The VFWCC report made 22 recommendations that were sorted into 10 themes of action by the State Flood Policy Committee. VICSES identified two of these themes for action:

- Flood awareness responsibility and roles; and
- Sustainability of flood warning systems

With the support of the VICSES Flood Project Board (comprising representation from all flood stakeholders in Victoria), VICSES engaged Molino Stewart consultants to:

- Determine the roles and responsibilities for VICSES in relation to flood warning systems
- Assess the sustainability of flood warning systems in Victoria including gaps
- Determine the roles and responsibilities for VICSES in flood awareness and education
- Determine the resourcing for flood education and warning systems and the steps required to meet responsibilities for VICSES.

Key findings from Molino Stewart report: Review of SES role in flood warning

EMA's total flood warning systems (EMA Guide 5, 1999, pg. 8) depicted above (Figure 1) includes the concept of consultation and review with agencies and the community at all points within the system, stating that:

> *"credible well communicated warning messages will best be able to generate appropriate community behaviour when they are preceded by soundly-based public consultation and education programs."*
> *(EMS Guide 5, p. 11)*

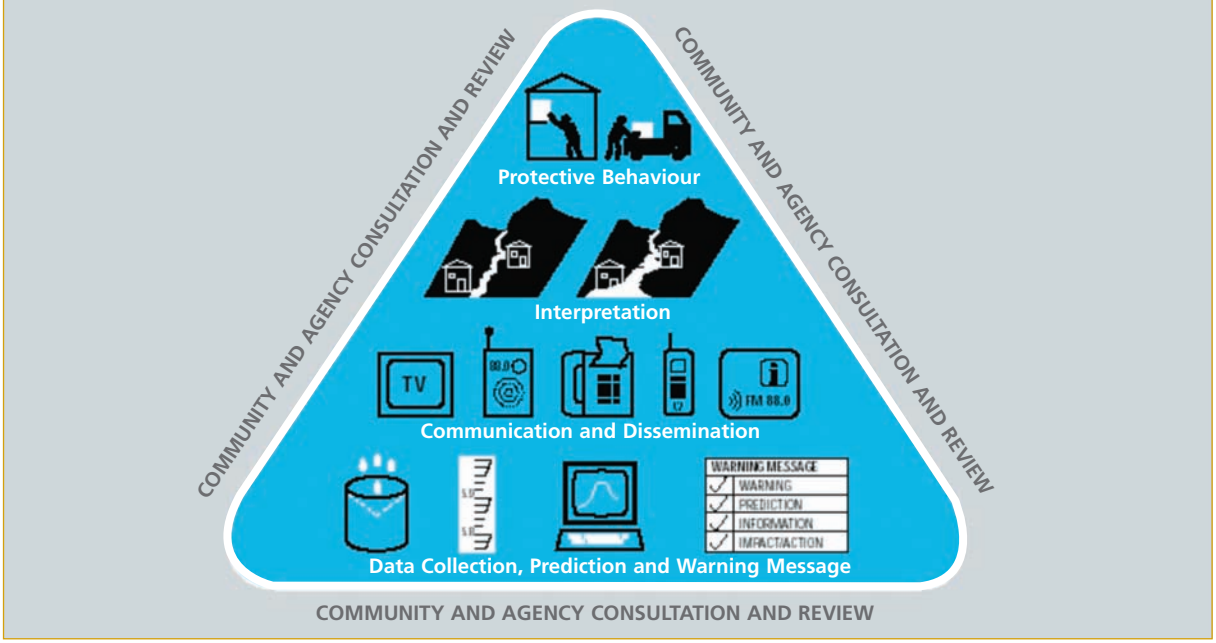
This means that when flood warning messages are disseminated, business, organisations and individuals should respond in a premeditated way based on preceding flood education and awareness programs.

This premeditation or preparation for action could be as comprehensive as a documented flood response or action plan, or as simple as a mental check list.

In either case, unless some thought is given to appropriate actions beforehand, there is a high risk that the response actions taken by organisations and individuals will not be appropriate when a warning is issued.

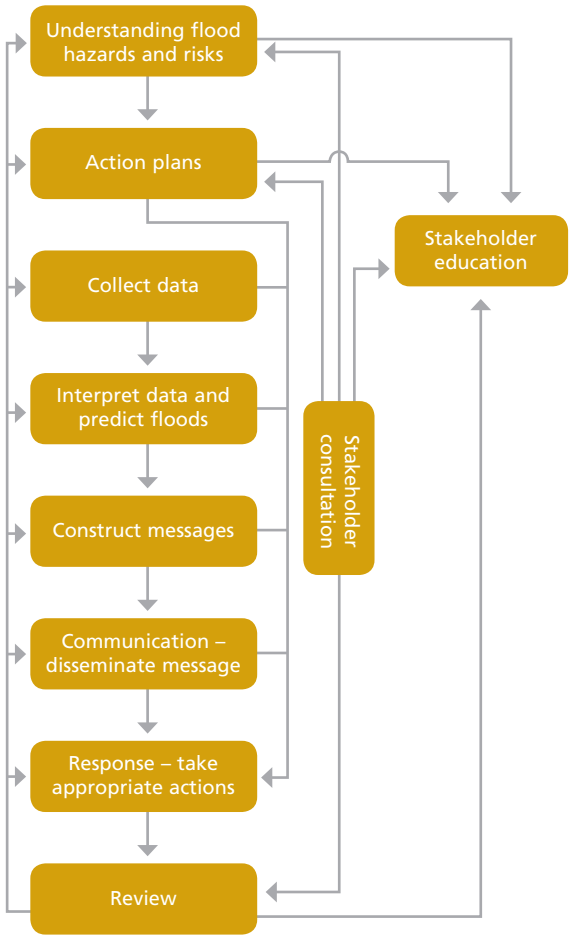
Molino Stewart argue that flood response planning should actually drive flood warning system design. They argue that to enable people to take appropriate actions they need to be given useful information in a timely manner via reliable communication channels.

Figure 1: The main elements of a flood warning system



Total Flood Warning Systems – EMA.

Figure 2: Interrelationships between flood warning components.



To be able to provide this information in a meaningful way, the flood warning system design along with flood response planning, must be based on an understanding of flood behaviour, hazards and risks.

Molino Stewart has therefore put forward the following diagram (Figure 2) that attempts to show the inter-relationship between:

- Flood warning system components,
- Stakeholder consultation,
- Stakeholder education,
- Flood studies and flood response plans.

In the following diagram Molino Stewart have added three preceding steps to EMA's six-step TFWS:

- Understanding the Flood Risk
- Action plans
- Data Collection

They argue that for Victoria to have a robust flood warning system these first three steps must already be in place.

Without the information, action plans, data and crucial flood intelligence generated by these three steps, VICSES and other flood stakeholders will find it extremely difficult to ensure there is an effective flood warning system and flood response plans across the State.

Findings on the status of the above three steps

1. Understanding the flood risk

Understanding flood behaviour, hazards and risks in particular localities is vital for VICSES to carry out its role as the control agency for flood as it provides vital information about:

- What areas will flood;
- When they will flood;
- What and who will be directly affected;
- The danger the flood poses to people and property;
- What and who will be indirectly affected through loss of access, utilities and services;
- What resources are needed to manage the direct and indirect impacts of flooding;
- How much time is available to warn and respond; and
- When and where flood warning messages need to be issued and what information they need to contain.

This understanding can be used to:

- Improve flood response plans;
- Improve warning systems;
- Train those affected by flooding; and
- Issue more useful flood warning messages.

Both the Bureau of Meteorology and Melbourne Water have indicated that they can provide targeted flood warning information, including predicted peak heights at gauge locations and the expected timing of the height.

However, for community safety and operational reasons, it would be useful for VICSES and other stakeholders to have access to height information at various points before the peak height is reached.

This will be critical for determining when:

- Key road and pedestrian routes will be cut;
- Levees will be overtopped;
- Infrastructure will be shut down; and
- Homes and businesses will be flooded.

Flood warnings could advise the time at which these situations are likely to occur, in addition to the timing of expected peaks.

Current information sources

Information about flood risks comes from two sources:

- Historical flood data; and
- Flood modelling.

Historical flood data

- Some historical data relating to flood heights and extents has been collected as part of flood modelling exercises by Catchment Management Authority (CMA) following a flood.
- Some VICSES local units observe flood behaviour during a flood which is then relayed to the operations controller; however, this is often not recorded.
- Although over 250 flood studies have been completed throughout Victoria, these studies have been undertaken over a period that has seen many changes in industry practice, modelling techniques and computing capabilities. Therefore, these studies vary in both scope and accuracy—for some only hard copy maps of flood extents exist, while others are computer based and can be reproduced to manipulate outputs.

Flood modelling and mapping

- In the greater Melbourne metropolitan area, local councils are responsible for drainage in catchments less than 60 hectares. Melbourne Water is responsible for drainage in larger catchments.
- Melbourne Water undertakes flood modelling and mapping for its catchments including overland flow modelling. It is considering extending the flood modelling and mapping to include the smaller catchments for which it is not responsible so that it has a more complete picture of flooding.
- Some Metropolitan councils have completed their own flood mapping.

Outside metropolitan area

- Outside the metropolitan area, Catchment Management Authorities (CMAs) have developed regional floodplain management plans which set priorities for flood modelling and mapping.
- Much of the available flood mapping data was produced before the CMAs were formed (1988).
- More recent studies which are dependent on the availability of local, state and federal funding are commissioned by either the CMA, local councils or both.
- There are also areas with known flood risks but where no flood modelling or mapping has been completed.

There is no legislative requirement for these studies to be undertaken or for them to be done by any particular organisation.

Shortcomings of existing processes

Focus on 1 in 100 levels

In many locations across Victoria the flood modelling and mapping has only extended to the 100 year Annual Recurrence Interval (ARI) flood, because town planning constraints are only applied at this level.

This can be particularly problematic for VICSES flood response where a flood exceeds the 100 year ARI event.

- There could be a quantum leap in the number of buildings experiencing overfloor flooding if most buildings are built just above this level due to planning constraints. Yet there may be little or no information on the extent of flooding and impacts which can occur above this level.
- Critical access routes, infrastructure or older residential and commercial developments could be flooded at levels lower than the 100 year event, but the studies don't always provide a clear indication of at what levels this occurs.

From an emergency planning point of view, simply knowing historical or modelled flood levels and the impacts at those levels is usually not sufficient information. Other information that is critical for emergency planning includes:

- Flood depth and velocity, which are critical for determining flood hazard;
- Rate of rise, which determines how much time is available for evacuation, response or rescue; and
- Critical changes in flood behaviour such as those that occur when levees fail or are overtopped.

While all stakeholders agree that more flood modelling and mapping would be useful, CMA's advise they are unable to do so due to funding constraints. As a result, CMAs are focused on trying to map the 1 in 100 flood extents in as many areas as possible.

Lack of other Data

As well as flood data from historical records and flood studies, there is often a shortage of other useful information available to VICSES such as:

- Ground and floor flood levels within new developments;

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Accessing flood height information is critical for understanding when levees will be overtopped.

- Where and when roads will close due to flooding and how regional road networks should operate in these situations;
- The location, impact and condition of levees;
- The risks of flooding to VICSES and other emergency service resources; and
- The indirect impacts of flooding from both an operational and social point of view.

2. Action plans

Current situation

- All councils are required by law to prepare a municipal emergency management plan (MEMP), which is audited by VICSES every three years.
- The preparation of a Flood Sub-Plan is not a mandatory part of the MEMP, even where there is a credible risk of floods.
- As the response agency, VICSES must have its own plans for responding to floods.

Shortcomings of existing processes

VICSES

- The quality of VICSES flood response plans is variable, mainly due to the variability of available information.
- Plans tend to focus on VICSES response to floods rather than strategic response and co-ordination with other organisations.
- Historically VICSES has a 'response and combat' culture rather than a planning culture; current planning revolves around assisting councils with MEMPs.
- As floods often cover a larger area than an LGA there may be the need for catchment-wide flood response, plans which do not currently exist in Victoria.

Councils

- Quality of MEMPs varies across the state.
- Where flooding is recognised as a significant hazard the way in which it is dealt with in the MEMP can vary from a few lines about how the council would manage the issue, to a comprehensive flood sub plan.
- The knowledge and time available for emergency management varies across the State, with EM accounting for no more than 10% of the Municipal Emergency Resource Officer's (MERO) time in some councils.

Proposed improvements

VICSES plans

- VICSES flood response plans could be improved by ensuring that there are local as well as regional and state plans available depending on the level of flooding.

- Catchment-wide flood response plans could be prepared where required.
- Local plans could focus on VICSES operations and rely on MEMPs for wider community, inter-organisational and strategic issues.

To do this VICSES requires better information on flooding and its impacts, and more planning officers to develop, implement and maintain these plans.

MEMP flood subplans

- MEMPs should have flood subplans where flooding is a significant hazard.
- Guidance should be provided to Councils in preparing flood subplans.
- A template, or table of contents or list of issues should be prepared by VICSES for use throughout the state.
- The council MERO needs to have the time, resources and expertise required to work in partnership with VICSES to develop these plans.

3. Flood data collection

In Victoria there is no legislated responsibility for collecting flood data. Without reliable data on rainfall and runoff it is not possible to provide accurate and timely predictions of flooding.

Current situation

There are several different types of data collection systems operating throughout Victoria, however, a lack of clear responsibility for the funding, installation and maintenance of the systems is a common issue.

Bureau of Meteorology (BoM)

The BoM has weather radar and rainfall gauges, but also collects data from rainfall and stream gauges owned by others including:

- Department of Sustainability and Environment (DSE),
- water supply authorities,
- local councils and
- privately owned gauges.
- In the greater Melbourne metropolitan area, Melbourne Water installs, owns, maintains and collects the data from all rainfall and stream gauges. The Bureau of Meteorology has access to all of Melbourne Water's data for display on its website, but Melbourne Water does the flood predictions.
- During and after a flood the CMAs generally take responsibility for collecting data on flood extents.
- Water Authorities also provide information about outflows from reservoirs.

Regional systems

In regional Victoria there are generally two kinds of data collection systems:

- newer systems, which are managed and maintained by the CMAs with funding from a range of sources depending on who uses the data, and;
- older systems, which are more than 10 or 15 years old and usually have more primitive technology and no formal funding arrangements.

There are also a number of flood data collection systems that are owned and funded by Councils.

One of the shortcomings of both the newer and older systems is that it is only practical and affordable to have gauges at a few locations in a catchment and along a stream. The variable spatial distribution of rainfall means that it is possible for intense rainfall in one part of a catchment, or flow from a particular tributary to be missed, meaning flood forecasts may be inaccurate. The greater the density of data collection the less likely this is to occur.

Flash floods and overland flows

Most of the flood warning systems in Victoria are for riverine floods with more than six hours warning time. It is more difficult to provide flood warning for shorter, steeper riverine catchments or where flooding is caused by overland flows.

There are some flash flood warning systems installed across the state, but these tend to advise of intense rainfall in the catchment and a risk of flooding as there is generally insufficient time for streamflow measurement and flood modelling. Some of these systems also bypass the Bureau of Meteorology and send the data directly to the local Council or even directly to residents. Melbourne Water is soon to introduce Doppler Radar, which will in time provide improved quantitative rainfall estimates.

Proposed improvements

- Several locations throughout the state require a network of rainfall and stream gauges to collect data as part of a total flood warning system.
- In other places there is the need to supplement existing gauges to provide more accurate and timely data.
- While in other locations there is the need to replace obsolete or ageing gauges.

The newer systems being installed generally require a total annual contribution of about $30,000 - two thirds for system maintenance and the remainder for future capital replacement costs. The availability of funds will be difficult to resolve while there is no agreement on who is responsible for creating and maintaining data collection networks.

According to Molino Stewart, "Without adequate data appropriate flood warning cannot begin".

Conclusion

The findings from the Molino Stewart report confirm to VICSES that Victoria does indeed need a flood warning "champion". A champion will not just drive the development, implementation and sustainability of a TFWS, but will raise awareness of the importance of appropriate resources for relevant agencies. Recognising the appropriateness of resources will help the organisation to carry out critical tasks such as flood modelling, mapping and data collection. These tasks are necessary pre-requisites to having an effective TFWS.

Without access to this information VICSES will not be able to develop and implement appropriate flood response plans or effective flood education and awareness programs, which when combined, help to reduce the damage and impact of flooding on communities, business and critical infrastructure.

The last 12 months has seen a vast increase in storm and flood activity in Victoria, NSW and Queensland. With COAG, CSIRO and others predicting an increase in more extreme weather events, and large scale single events with more severe cyclones, storms and floods, it will be crucial for all Victorian flood stakeholders to work together over the next 12 months to ensure the impacts of flooding are understood and acknowledged by government, VICSES, the media and the community.

Key Recommendations

1. VICSES to become a central repository of existing flood data

   To be able to perform its legislated responsibilities appropriately VICSES needs access to flood information and intelligence. The report recommends that in partnership with CMAs, Melbourne Water and Councils, VICSES should collect, collate and catalogue all existing data about historical and modelled flood extents in Victoria.

2. Flood studies

   VICSES should be involved in all future steering committees that develop flood study briefs, ensuring that they include outputs that will assist with operational functions.

3. Request and record flood intelligence

   VICSES should seek to have MOUs with Melbourne Water, CMAs, councils, Vic Roads and utility organisations so that it is notified by field staff of observed flood levels and impacts as a flood unfolds.

4. VICSES field staff

   VICSES field staff and volunteers should report key observations of flood behaviour and impacts as the flood unfolds.

5. For the above initiatives to be implemented VICSES would need additional professional staff with appropriate skill sets in flood modelling and intelligence recording

   This does not mean having hydrologists or flood modellers on staff, but rather providing planners with appropriate training in the fundamentals of flood modelling.

References

Council of Australian Governments (COAG), 2001, - a paper prepared for COAG - *Economic Costs of Natural Disasters in Australia Report 103*. Bureau of Transport Economics Commonwealth of Australia

Emergency Management Australia, 1999, Australian Emergency Manuals Series Part 111, Emergency Management Practice volume 3 Guidelines, *Guide 5 Flood Warning second edition*, Commonwealth of Australia

Molino Stewart Pty Ltd (NSW)
(1) *Review of SES Role in Food Warning*, 2007
(2) *Roles and Responsibilities for VICSES in Flood Education 2007*, Victoria, VICSES Website: www.ses.vic.gov.au

VFWCC – Victorian Flood Warning Consultative Committee, 2005 Flood Warning Service Development Plan for Victoria , *Review of flood Warning System Development Priorities within Victoria*, Main Report; Commonwealth of Australia, AusInfo, Canberra ACT

About the author

Following its re-establishment as a Statutory Authority, **Mary Barry** was appointed inaugural CEO of the Victoria State Emergency Service (VICSES) in January 2006. VICSES is the control agency for response to flood, earthquakes, storms, tsunamis and their affects across Victoria. It is also the largest road rescue service in Australia with 101 accredited road rescue units.

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