Bureau of Meteorology's 50th year of riding the flood of change to provide flood warning services for New South Wales

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Abstract

April 2012 marks the 50th anniversary of the Bureau of Meteorology's involvement in quantitative flood forecasting for Australia, which began in the lower Macleay Valley in New South Wales (NSW). The Bureau's flood warning role had its origin in the early 1900s when warnings were based upon weather forecasts and dissemination of rain and river level observations. Over time, local organisations in some areas also provided limited flood forecasting based on upstream river levels. Following the devastating floods of 1949 and the 1950s the Commonwealth Government decided that a more sophisticated hydro-meteorologically based flood warning service was necessary. Such a service was established by the Bureau of Meteorology in the early 1960s.

This paper will track the evolution of flood warning services for NSW with improved numerical weather prediction models, field data collection and dissemination, weather radars, hydrological research and next generation flood forecasting systems.

Introduction

Following a series of disastrous floods in NSW during 1949, 1950, 1954, 1955 and 1956 the Commonwealth Government directed the Bureau of Meteorology to develop a national hydro-meteorologically based flood warning service to cover flood prone areas affected by riverine flooding. In NSW the first system was developed for the Macleay River for which the first quantitative flood forecasts were issued in April 1962 (McKay 2002).

The vision to incorporate meteorologically based rainfall predictions into hydrological forecasting was ahead of its time given the technology available for weather forecasting in the early 1960s. As well, even though the Macleay valley flood warning system was underpinned by automatic rainfall and river level data transmitted by an advanced radio telemetry network, other services developed in the first 30 years relied heavily on manually read data.

This reliance on manually read data, particularly rainfall, severely limited the quality of services that could be provided, particularly for the smaller NSW catchments. Some notable events where these limitations were noticeably apparent included the major 1986 Georges River flood and the 1991 Inverell flood.

The Committee of Inquiry into the Bureau of Meteorology (CIBM) held during the 1970s recommended that state government should take over the flood warning role. State governments were reluctant to assume this responsibility and there was a hiatus in the advancement of flood warning networks, particularly the automation of rain networks, until this matter was resolved in the late 1980s leading to the formation of the NSW Flood Warning Consultative Committee (FWCC) in 1989.

The formation of the FWCC and restructure of the NSW SES in 1989/90 heralded a new era in the advancement of flood warning services in NSW that are discussed in this paper.

Flood Warning Service Development

Below is the timeline of some key events in the development of flood warning services in NSW over the past 50 years.

2020

NextGen flood forecasting system

175 forecast locations, 1500 gauges

2012 – 50th anniversary of NSW flood warning services

2010/11- Record 1598 flood watches & warnings issued

2010

2010 - NextGen weather forecasting & warning services

2007 - Water Division formed within the Bureau

2002 - Flood Watch introduced to replace CFA

2000

2001 - NSW rain & river data put on www.bom.gov.au

1998 - Rain forecasts used quantitatively for modelling the flood prediction for Bathurst in the Aug. flood that prompted early evacuation

1990

1990 - NSW SES reformed. Nyngan flood.

1989 - NSW FWCC formed

113 forecast locations, 500 gauges

1987 - New flood warning arrangements. Bureau to issue flood warnings. Defines data network responsibilities of other govt. agencies

1980

1976 - CIBM recommends state govt. to assume responsibility for flood warnings

1974 – Then record 792 flood warnings issued 1973/74

1970

Confidential Flood Advices (CFA) issued to agencies ahead of flood producing rain

1 forecast location, 4 auto gauges

1962 - First Bureau flood warning issued in April

1960

Bureau instructed to develop flood warning services

1956 - Major floods most parts of NSW

Local flood forecasts based on "rule of thumb" methods

1955 - Record floods Hunter, central & north west NSW NSW SES formed

1954 - Record floods Richmond & Tweed Valleys

1950

1950 - Major flooding at Kempsey, Hunter & north coast

1949 - Major floods Kempsey, Hunter & NSW mid-north coast

Over the past 50 years major improvements to flood warning services provided by the Bureau have occurred as the result of advancements in the following key areas:

- Rain and river data – since the formation of the FWCC in 1989 there has been considerable growth and automation of the rain and river gauging network which underpins the service. Data from numerous agencies are published in near real time on www.bom.gov.au . The 9am "web maps" now include data from over 2,000 sensors including 1,500 rain and river gauges that now comprise the real time flood warning network and is refreshed every hour with the latest information on hand. Data from the Bureau's 113 automatic weather stations and manual reporting observation stations are also published in this product. The Bureau has also provided $80 million over the past 5 years to fund a national hydrometric upgrade program as part of its water information role. This investment has led to significantly improvements in the reliability and availability of field data.
- Forecast rain – from vision in the 1960s to reality. Forecast rain from computer weather models has become increasingly reliable, particularly since the mid 1990s with the growth in computing power. Forecast rain has been used successfully in Flood Watches and Warnings in NSW to help the SES and flood affected community to be better prepared for major floods. In NSW the accuracy of Flood Watches has improved from 20% to over 70% since 1984. The evolution of the Flood Watch product is discussed in the next section
- Hydrological modelling – used to convert recorded and predicted rainfall values to river level forecasts. Forecasting techniques have advance from "rule of thumb" correlations to basic lumped hydrological rainfall runoff models through to complex models, such as URBS, that can better simulate catchment behaviour. Flood warning accuracy, measured by the number of river level forecasts within 0.3 metres of actual, has improved by over 50% since 1984.
- Scope of services – improved data networks and modelling has allowed the Bureau to provide flood warning services to 55% more NSW locations than in 1984. This has included extending the services to the lower reaches of tidal rivers, lakes as well as some smaller catchments with riverine flood problems. The smallest catchment presently covered by a flood warning service in NSW is Coffs Creek, which can flood several hundred properties as well as parts of the Coffs Harbour CBD.
- Weather radar coverage – from no weather watch radars to coverage of NSW by 12 radars, including 4 located close to the NSW border. Five of these are now high resolution Doppler radars which when linked to rain gauge data allow the production of rainfall intensity fields across their area of coverage. This rain field product is presently available for the Sydney (Terry Hills) and Brisbane (Marburg) radars that cover the NSW central and far north coast respectively.
- Flood warning services on www.bom.gov.au – all Bureau warnings are available on its internet site within a few minutes of being issued from the regional forecasting and warning centres. The role of the internet is discussed further under WWW of Flood Warning.

Flood Watch

Flood Watches aim to provide early identification of the potential for flooding. They are typically issued 24 to 48 hours ahead of flood producing rainfall. This gives the SES and the affected community additional time to plan and prepare for a heightened risk of flooding.

The precursor to the Flood Watch was the Confidential Flood Advice (CFA) that was issued by the Bureau to the SES and various water agencies ahead of flood producing rainfall. It first began in 1970's and was a much maligned product that was more often criticised for missing likely flood events than providing early warning. Figure 1 shows that in 1984 the accuracy was lower than the detection.

The accuracy of the flood watch has greatly improved in recent years (Figure 1). Currently, around 70% of flood watches correctly identify flooding (accuracy) and more importantly around 90% of floods are preceded by a flood watch (detection). This reflects the continued improvement in the meteorological forecasting models as well as the methods and experience of the hydrological forecasters in managing the inherent uncertainties forecast rainfall and catchment conditions to identify flood potential.

In 2002 the CFA was renamed as Flood Watch and was to the public. It is now a key product in the flood warning service provided by the Bureau in NSW.

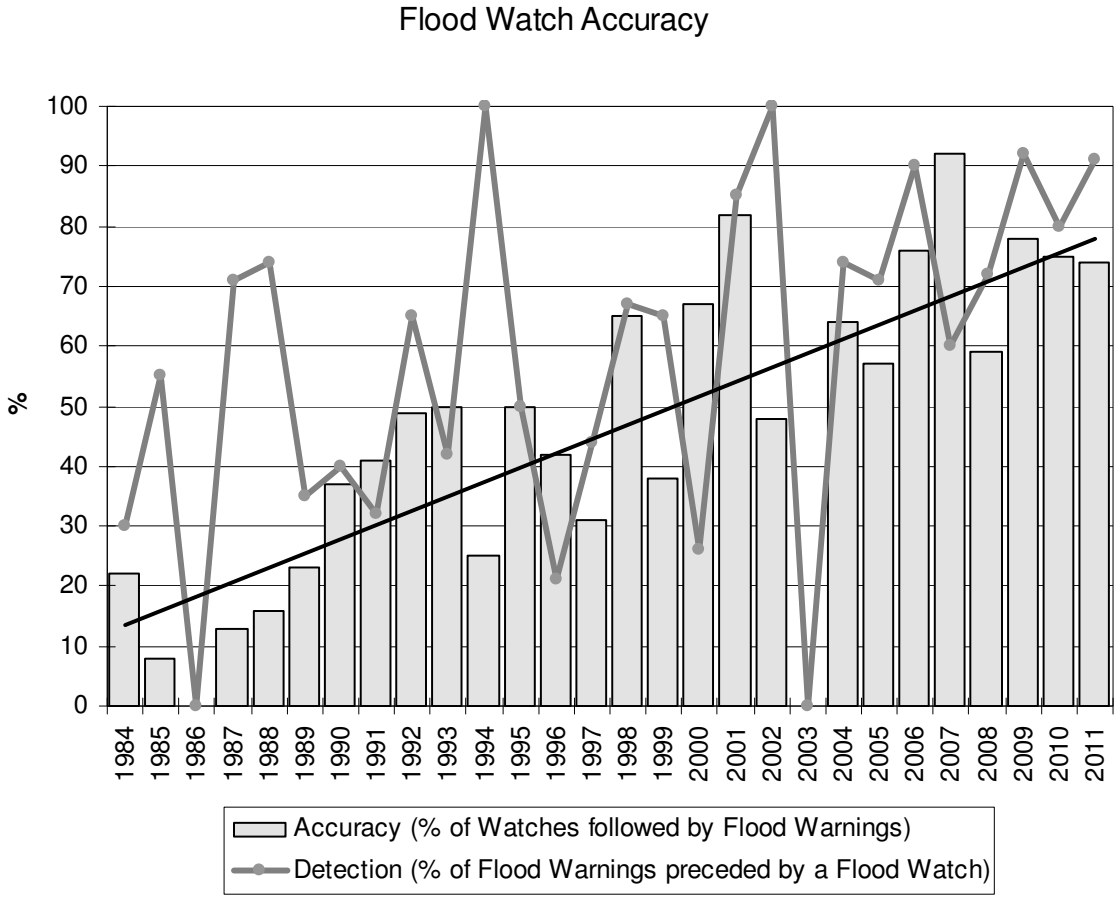

Figure 1: Flood Watch Accuracy

WWW of Flood Warning

In 2001 there was wide spread flooding across NSW. These floods provide a pointed reminder as to the high expectations of the community. Feedback from post-flood public meetings showed that many people were dissatisfied with the dissemination of real time rain and river level information (McKay 2001).

To improve the flood warning service it was clear that there was a greater need for technology to be used for more than just improving the way data is collected but needs to be fully utilised for dissemination, visualisation and communication of flood warnings. (Robinson & McKay, 2003).

The internet today is a ubiquitous part of our lives but 2000 it was only beginning to be considered useful as channel for delivering flood warning information. It is only since 1996 that the Bureau has had flood warnings available on its web site. Following the 2001 floods there was considerable effort was made to develop information products to support the communication of the flood warning message (www.bom.gov.au/hydro/flood/nsw). This site remains the key source for near real time rainfall and river information during floods. It provides:

(i) Latest warnings issued by the Bureau.

(ii) Tables for hourly, 3-hourly and 24 hourly rainfall data collected by all major agencies in NSW.

(iii) Tables and plots of water levels.

(iv) Map views showing rainfall and river level information. Figure 2 shows an example of the river conditions map.

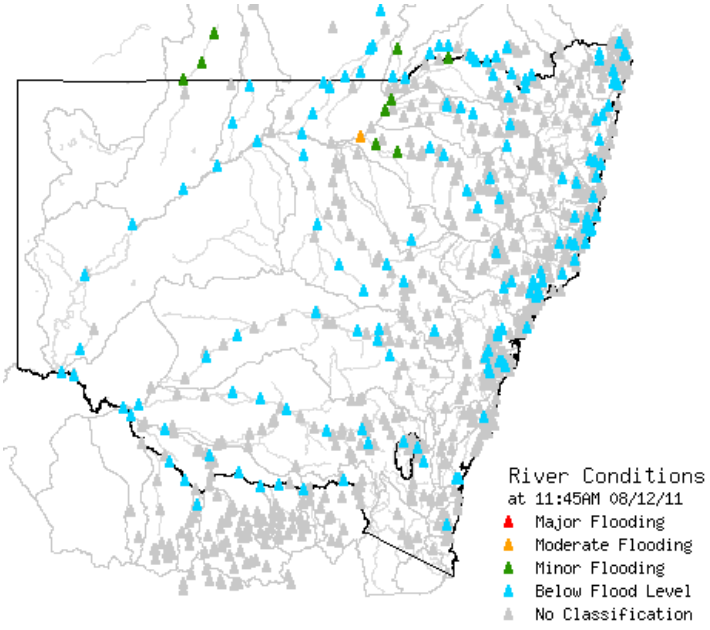

Figure 2: Rainfall and River Conditions from *www.bom.gov.au/hydro/flood/nsw*

The next challenge for the Bureau is in the utilisation of the next generation of internet communication channels (Facebook, Twitter and other social media), and in better integrating its forecasts with observations to ensure that flood threats are clearly communicated and understood.

2012 and Beyond

A record of 1534 flood warnings was issued in 2010/11. The Bureau was able to provide record levels of accuracy and timeliness. This enabled the NSW State Emergency Service and the NSW community to effectively and efficiently respond to floods in NSW.

The Bureau is well aware that the community expectations of flood warning systems continue to increase and the level of service must continue to improve to just maintain the current level of community satisfaction.

It took thirty years (1960-1990) for the modern institutional arrangements for flood warning in NSW to be established. The 1990s were a period of tremendous growth and automation of the flood warning network. The 2000s represented a greater focus on how to communicate the flood warning message and in the early identification of flood producing weather systems through better use of rainfall forecasts. Meteorological forecasts of rain are now routinely used in Flood Watches and Warnings that help the SES and community be better prepared and respond to major floods.

For 2012 and beyond the key challenge will be to continue to improve the flood warning service to meet the ever rising community expectations. The Bureau must deliver a world class forecasting service for the NSW and Australian Community. The Bureau needs to fully realise the benefits from the integration of real-time data collection and the modern hydrological and meteorological forecasting techniques. To meet this challenge the Bureau has commenced a major upgrade to its hydrological forecasting systems. This system will provide hydrological forecasters with access to state of the art hydrological forecasting models, meteorological forecasts, observed and historical data. This new system will provide the necessary information for the Bureau to develop a new generation of hydrological forecasting products and services to ensure that the flood warning message is clearly communicated and understood by the community.

Conclusion

The clarification of roles and responsibilities and the joint funding of automated flood warning networks through the FWCC lead to major improvements in the scope, accuracy and timeliness of the Bureau's flood warning services for NSW. Improved meteorological forecasts of rain are now routinely used in Flood Watches and Warnings that help the SES and community be better prepared for major floods. The expansion of the real time data network combined with more sophisticated hydrological models has led to a 50% improvement in flood forecasting accuracy since 1984. The upgrade to the Bureaus flood forecasting system should help maintain this trajectory of continuing improvement to flood warning services provided to NSW.

References

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