The Floodwise Initiative

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Abstract: Brisbane has significant flooding from two sources (River Flooding and Creek flooding) and disruptive flooding from a further two sources (Overland flow and Storm Surge). Significant work has been carried out to mitigate the damage from all sources. There are essential differences between each type. River flooding is from the Brisbane River. Flood mitigation is provided by two Dams in the top half of the Catchment. The Bureau of Meteorology provides 24-hour forecasts of river levels and the Brisbane City Council has developed a process to advise its citizen's of the details of the disaster. Creek flooding can occur anywhere along the 640km of creeks of various sizes. These creeks respond within 12 hours of heavy rain with the smaller creeks able to rise by 4m in less than an hour and within 3 hours of heavy rain. Overland Flow occurs when the piped Stormwater system cannot cope with the rain event. Storm Surge provides a similar problem as little can be done to avoid inundation. Damage mitigation in these latter flood sources is through planning controls. For all sources, except the River, flooding occurs without warning. Brisbane City Council is meeting this challenge in a unique way through Floodwise. It has developed a plan to utilise its telemetry network to improve their reaction time to flooding. Every five minutes, every day the telemetry network is examined, summarised and the results displayed on the web. This interface provides information in a simple, meaningful way, allowing both internal and external users to respond appropriately to these events and minimise flood impacts. Automatic SMS messages and emails react to a variety of pre-defined triggers alerting mangers and community leaders to impending events. This paper discusses the various systems and the advantages it delivers to BCC departments and external government organisations.

Keywords: Flood Preparedness, Flood Responsiveness, Web Based, SMS and Email Alerts

1. INTRODUCTION

In 1969 and throughout the 1970's and 1980's Brisbane experienced regular flooding. This began an era of significant expenditure on flood investigations and flood mitigation works. The main focus was on preparedness (through understanding) and on management (through town planning controls and structural alteration of the creeks and River). This endeavour did not happen overnight and it has taken many years of dedicated work to provide a basis for the last phase of Defence.

A large flood occurred in the Brisbane River in 1974. This flood dramatically showed that much more could have been done to assist the flood-affected community. River flooding is relatively rare with only one occurrence in the 20th century. No reliance can therefore be placed on people's memory to help assist during another such event.

On the afternoon of 9th March 2001, a flash flood occurred in Brisbane that caught both the community and Brisbane City Council (BCC) off guard. The intense storm lasted only three hours but many creeks rose up to four metres in 1.5 hours. Major flash flooding occurred on a number of creeks. Roads were cut and peak hour traffic chaos ensued. Radar images showed little movement, making it impossible to predict how long the storm would last. Constructing a situation report was also impossible as the report was out of date before it was finished. It was following the storm, when reports of house flooding came in, that the full extent of the event was realised.

External to BCC, reports have been developed indicating that, due to global warming, storms will become more violent. The reports also hint that for Brisbane at least, flash floods could increase while general rainfall (yearly totals) declines. With this in mind, an action plan was developed to improve BCC's responsiveness to flash flooding.

Over thirty creeks pass through the city, with a combined length of around 240 kilometres. These creeks can flood within one to ten hours following heavy rainfall (depending on the catchment size). There are pockets of residential development, built prior to development controls, where a one in five year event can cause flood damage. Many road creek crossings are cut in a two-year event. BCC's call centre is inundated with requests for assistance when flash floods occur.

BCC currently has 40 water level telemetry gauges and 60 telemetry rainfall gauges. The network was initially installed to assist calibration of computer models used in flood studies, which set development control levels and recommend flood corridor requirements. It was also hoped that the telemetry data/ computer models could be used for flash flood forecasting. Telemetry data was collected on non-networked computers, with the data only available to limited BCC staff, who prepared reports to assist in planning for future events. The focus was on improving the infrastructure (enlarging stormwater pipes, removing thick vegetation that caused flood constrictions and assisting maintenance programs).

The forecasting function of the telemetry network for creek flooding has never been achieved. However major advancements are occurring with the release of a new system that directly assists different groups to minimise their flood damage.

2. SYSTEM REQUIREMENTS

-River Flooding

The Bureau of Meteorology carries out flood forecasting for the Brisbane River. That role exists as it did in 1974. Although their predictions were quite accurate and gave 24 to 30 hours warning of the peak at the river gauge, it did little to help with community confusion during the event. The main reason was that the community was unable to relate the level at the gauge to the level at their property. A new system has been developed to provide an interpolation service through the BCC call centre to provide ground level (highest and lowest property levels) and the predicted depths at the Enquirer's property. Further enhancements to provide isolation information is also planned. With the significant forecast times this should enable the community to move valuable belongings and minimise their loss.

-Creek Flooding and Overland flow

A large number of processes are instigated when heavy rain and associated flooding occurs. Appropriate access to and distribution of information about a current event is crucial to ensuring the most effective response. A web-based system with automatic alerts could provide this service.

Workshops were conducted with potential BCC users to determine their needs and provide a basis for various web pages. The results of the workshops indicated that the system had to:

- manipulate data so the information was presented in an easily understood manner;
- update information rapidly due to the nature of flash floods (every five minutes, every day was the standard adopted);
- be fully automated and cope with computer network outages; and
- alert users via SMS and/or email when a situation has occurred or is about to occur.

The main focus of the system would be to provide users with information to allow them to take appropriate action to minimise or mitigate the damaging effects of flash flooding. This is similar to the river flood premise though the time frame for action is significantly shorter.

The new system is named FloodWise. It is a modular system that can easily be expanded to adapt to new and/or changing requirements. Significant enhancements have occurred since the system was first developed.

Though it is used successfully within Council its ultimate future is to also include the Community. Coupled with the technical requirements is the need for education of the public to ensure appropriate understanding and actions. This awareness campaign is the BCC's BE FLOODWISE campaign.

3. FLOODWISE SYSTEM OVERVIEW

Hydrometric data collected on the Bureau of Meteorology's (BoM) Enviromon program is extracted and converted into operational information and stored on a database. A graphical web interface (Figure 1) provides this information in a simple and meaningful way.

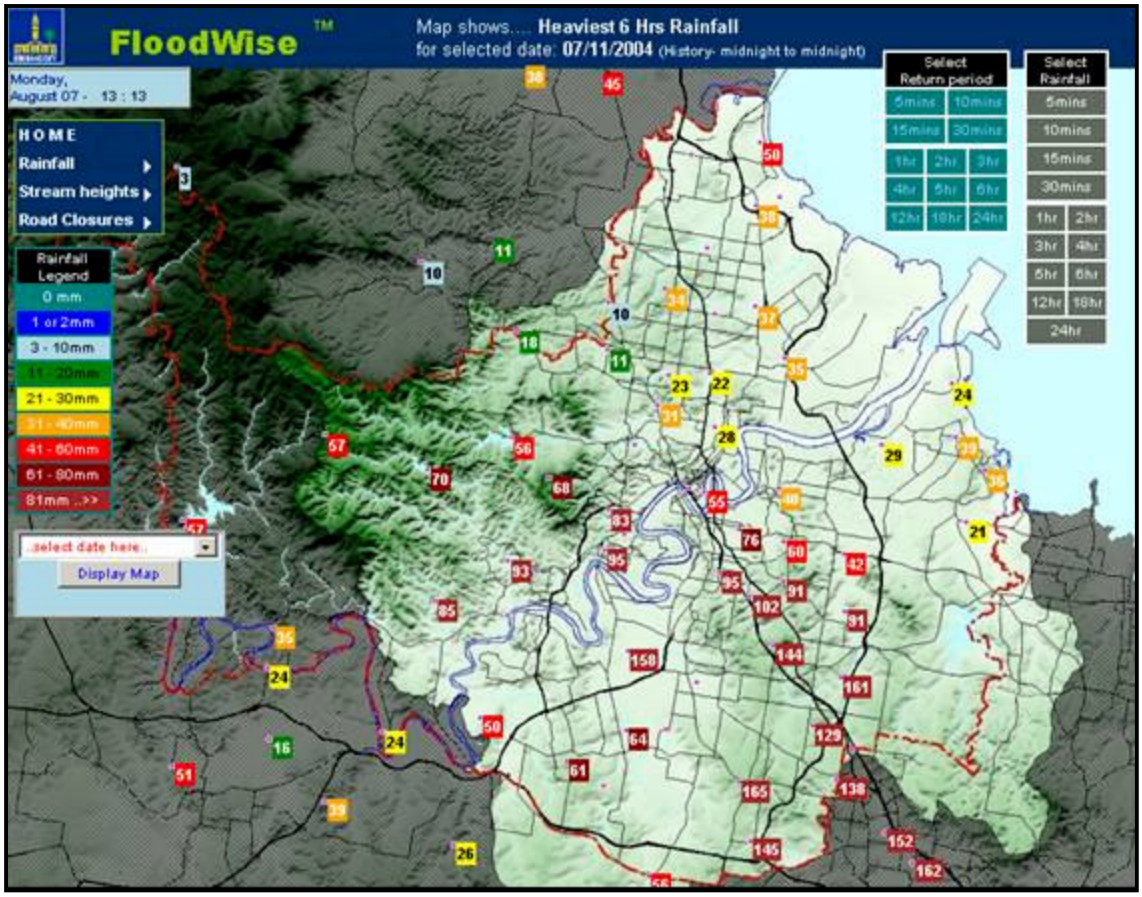

Figure 1: FloodWise Graphical Web Interface

3.1 Rainfall

Rainfall gauges, indicating rainfall over a selected period, are displayed on a map. Floating over the gauge activates a dropdown menu showing the rainfall return period for various durations or the rainfall in the last 0.5, 1, 2, 3, 6, 12 and 24 hours.. The background colour of the gauge varies depending on the amount of rainfall, making it easy to get a picture of the distribution of heavy rain. Double clicking the gauge shows the hyetograph over the last 24 hours.

Full colour rainfall contour maps (Figure 2) are also available. They are coloured such that an reddens as the threat of flood increases: the deeper the red the worse the problem.

3.2 Stream Height

Stream height gauges, indicating water level, are displayed on a map. The background colour of the gauge relates to the minor, moderate, major levels used in BoM warnings. Double clicking the gauge produces a stage hydrograph that can also show the level of a nearby significant structure (eg. spillway or bridge deck).

3.3 Flooded Roads

Symbols on a map show the location of roads being monitored. These roads are associated with telemetered stream gauges. Symbols are colour coded (black – gauge not functioning,

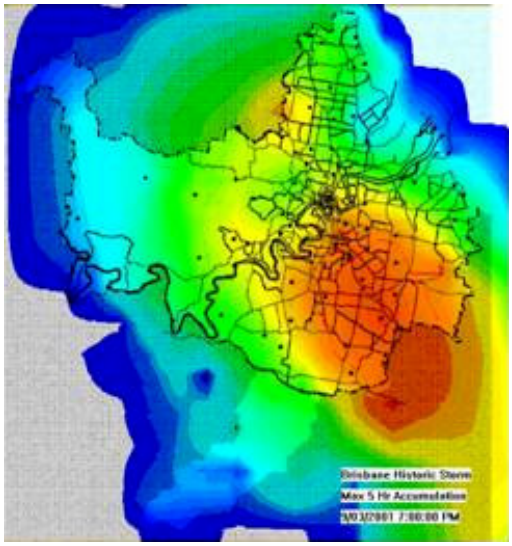

Figure 2: Full Colour Rainfall Contour Map area

green – road open, yellow – road will flood in next 30 minutes and red – road flooded). Floating over the symbol produces an inset

"street directory style" map showing the location of the crossing and surrounding roads.

3.4 Flooded Areas

Similar to flooded roads except when the symbol is clicked a full screen "street directory style" map (Figure 3), shaded to depict the current flood inundation of the area, is displayed.

When forecasting is added, it will also toggle between current and maximum for the event. The amount of inundation is linked to the associated gauge.

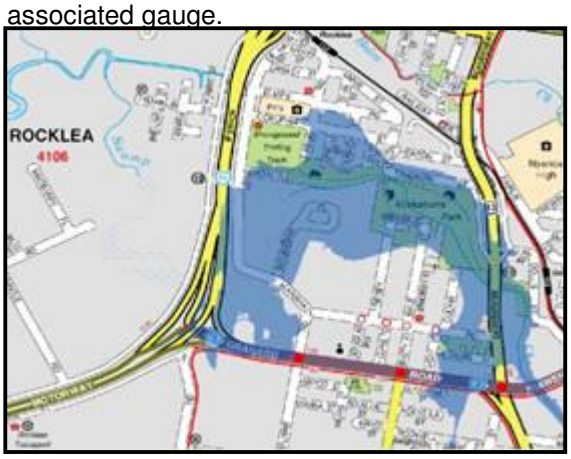

Figure 3: Flooded Area Map

3.5 SMS/ Email Alerts

Alerts can be set up on any of the collected and processed data. Examples of these alerts are discussed in Section 4.0.

In addition, tide tables are stored and checked to provide a three day warning if a predicted high tide is above a trigger level (king tides may cause inundation of low lying lands and roads).

BoM now has a single point of contact and emails their warnings to one address within BCC. The messages are automatically converted to SMS messages and forwarded to relevant BCC staff. The message is also forwarded as an email. Different messages can go to different people. This greatly simplifies BoM's task, as they no longer need to maintain a complex distribution list. Users can also stop the messages while on holidays.

4. CURRENT USES

Many different groups within BCC use flood information. Some external groups involved in emergency management also have access. These groups and their requirements follow.

4.1 City Design (BCC)

City Design use flood and rainfall information to investigate a current flood (if it is a major flood), determining if any flood mitigation options are necessary or possible to reduce future flood impacts. They use historic data for calibration of creek and river models used in flood studies. Rainfall mapping and hyetographs are used as background data for environmental monitoring. Historic and current data is used for creek, stormwater and drainage investigations to assess pipe sizes, scour and maintenance. Estimates of rainfall return period give an important indication of the severity of an event.
City Design's Project Management group use current information to make "on the spot" strategic decisions on projects affected by heavy rain or flash floods to minimise impacts on delivery dates. Construction Management use historic rainfall hyetographs to determine if contractor's wet day claims are valid.

4.2 Brisbane Water (BCC)

Brisbane Water provides water supply and sewerage. They own three dams (Enoggera, Gold and Lake Manchester) for which they are responsible for dam safety. They treat and distribute water from state owned dams and are responsible for the collection and treatment of Brisbane's sewage.

Detailed rainfall data is used in conjunction with sewer gauging which in turn is used in modelling the sewer network. They use current data for investigation and treatment of wet weather sewer overflows. Dam monitoring is now automatic with FloodWise able to send SMS and/or email alerts when pre-defined triggers are reached.

Water Supply Operations also take advantage of the easy to access information as Floodwise provides a 10 hour warning when flows containing high levels of farm fertilisers are entering the water supply (requiring different treatment to normal supply).

4.3 Urban Management (BCC)

Urban Management, whose role is to provide strategic and policy direction, uses information from FloodWise to advise the Lord Mayor on aspects of flooding events. They combine flood measurements with event consequences to assess desired changes.

4.4 LAS (Local Asset Services) (BCC)

The LAS group responds to drainage system failure during an event. They clear pipe/ culvert blockages and minimise the local flood damage that occurs. FloodWise helps them direct their limited resources, allowing them to respond to obvious blockages first and not to an area experiencing a rainfall event in excess of design capacity.

LAS is also responsible for barricading flooded roads. Fifty flooded road sites across the city are now linked to telemetered flood gauges. FloodWise uses the relationship between the road level and the critical gauge height to provide a half hour warning when the crossing is likely to be flooded.

4.5 SES (State Emergency Service)

SES uses rainfall contour maps to determine which parts of the city are under threat from flash flooding.

4.6 Call Centre (BCC)

The Call Centre increases operational staff numbers in response to events like flooding. They use rainfall contour maps to ensure they only call staff from areas not affected by the flooding event. During the 2001 event, many staff were called from affected areas. They were unable to get through the traffic chaos and there was a significant reduction in the capacity of the Call Centre.

4.7 Traffic Control Centre

Traffic Control uses both the flooded road and rainfall pages for traffic control operations.

4.8 Brisbane Transport (BCC)

Brisbane Transport have expressed interest in using the flooded roads map to assist with bus operations during periods of heavy rain. They also use the rainfall contour map to determine where timetables may be disrupted.

5. FUTURE USES

5.1 Forecast Rainfall

BoM is making advances in the science of forecasting rainfall. In Brisbane, flash flooding is generally caused by thunderstorms that can readily change direction and intensity. Rainfall prediction is difficult and may only be in the order of an hour, although this timeframe can be significant. It is proposed to work with BoM and incorporate rainfall forecasts into operational processes that can realise a considerable flood responsiveness benefit.

5.2 Forecast Flooding

FloodWise provides an excellent platform to display the results of modelling that uses current (and forecast) rainfall to calculate creek flow. Provided the system is automatic, the current alerting system can deliver a forecast derived from the model, in a timely manner.

5.3 Community Involvement

In line with BCC's strategy to provide integrated, timely and consistent flood management information and advice to the community, this "Be Floodwise" campaign's aim is to provide the community with education and information to help them to reduce potential flood damage. Discussions and workshops will introduce aspects of FloodWise, which will allow affected communities to respond more effectively to flash flood events.

5.4 Business Involvement

Business can benefit by incorporating the available information into business continuity planning for rainfall or flood events.

6. CONCLUSION

A similar flood to the March 2001 event occurred in November 2004. It occurred on a Sunday. This time alert messages went out and sufficient officers were available to deal with the event. While the community did not have access to the system and did suffer some flood damage, BCC was in a much better position to assess and assist.

Prior to FloodWise, there was pressure to reduce the size of the telemetry network; there is now pressure to increase the network. The benefits of the data is not just in the hands of a few hydrologic experts, many users are realising tangible benefits. Users are not limited to BCC staff. They include communities at risk of flash flooding, providing them with tools to reduce their own flood damage. The travelling public will also benefit as the system of warnings of dangerous locations via radio improves and/or flashing lights are incorporated at dangerous flooded roads.

Traditional uses of telemetry data will always remain but new uses will ensure the long term future and improvement of the hydrometric telemetry network. .