

# FROM RIVER TO RESIDENT: Findings on flood warning effectiveness and response

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## ***Abstract***

Social research following floods provides emergency organisations with insights into community perceptions and attitudes and how they influence responses to flood warnings. Using both quantitative (survey) and qualitative (focus groups) methods, an understanding of community awareness, attitudes and behaviours can be developed and used to improve flood warnings and community education. In Australia two organisations are responsible for flood warnings, the federal Bureau of Meteorology and each state's State Emergency Service. The warnings that they construct and issue must contain correct, clear and relevant information for the flood affected communities. They must also be delivered through multiple, appropriate communication pathways so they reach the largest number of people possible and in a timely manner to allow for preparation and evacuation. Community education plays a major role in how people interpret and respond to flood warnings, as ultimately the attitudes and knowledge of flood affected communities will determine the effectiveness of the warning messages.

Key Words: Social Research, Flood response, Flood warning, Evacuation

## ***Background***

### **Roles and Responsibilities**

There are two main organisations that play a part in flood warning in Australia, the Australian Government's Bureau of Meteorology (BOM) and each State Government's State Emergency Service (SES).

The Bureau of Meteorology monitors catchment and river conditions through rainfall and stream gauges and uses this information and computer models to forecast downstream river levels. It issues flood warnings and releases them to the SES and other local and state government organisations that have a role in flood response. It publishes the warning on its website.

The SES is the lead agency for flood emergencies and co-ordinates and conducts response, evacuation, rescue and resupply. It is made up mostly of volunteers, with more than 10,000 volunteers located throughout New South Wales (NSW) and 5,000 throughout Victoria.

The role of the SES varies from state to state. While in most states it is the lead combat agency for floods, in NSW it has expanded its role over the last 20 years to include flood emergency planning and community education. The Victoria SES is looking to expand its role into these areas too.

The difference in SES roles in both states also extends to their role in flood warning. In Victoria the BOM issues the flood warning to the media (radio, television, newspapers). These warnings generally are limited to an expected gauge height at a specified time in the future. The Victoria SES may issue a separate general advice of what to do in the event of a flood.

In NSW however, the BOM does not issue warnings directly to the media. Rather the SES issues flood warnings to the media based on the warnings received from the BOM but with additional information about the specific impacts of the forecast flood levels and advice on how to respond. This may include issuing evacuation notices to properties that are likely to be flooded. These notices will not only be issued through the media but are also generally supplemented by door knocking homes and businesses that need to evacuate.

## **Risks and Reviews**

The need to conduct social research into warnings, evacuation and preparedness of flood affected communities was first realised in the 1990's in the Hawkesbury-Nepean catchment, in Western Sydney. It became apparent that due to the topography, flood levels could rise up to 25m above normal river levels. Most homes are not much more than 15m above normal river levels and some older homes only 10m. To make matters worse, most evacuation routes are cut when the river has risen between 6m and 13m. In the more extreme events more than 60,000 people would be seriously threatened with catastrophic consequences for the area.

Also, many regional towns and cities in Australia are protected by levees. One such town is Grafton, on the mid-north coast of NSW, which has a population of 15,000, many of whom are at risk of being flooded. The levees protect the town from a 5% flood. In 2001 BOM issued forecasts of a major flood that would overtop the levees and flood most of the town.

The SES ordered more than 9,000 people to evacuate. Less than 2,000 evacuated and about 1,000 went down to the river to watch the levee being over topped. Fortunately, the river rose 10cm less than forecast and the levee was 10cm higher than the Council records showed so the town did not flood. In 2009, again heavy rain prompted the SES to issue an evacuation order to residents based on BOM forecasts. This time out of 9,000 people, less than 200 evacuated. The town once again did not flood but it exposed the question of why people didn't evacuate and indicates serious implications for the future response to subsequent flood warnings and evacuation orders.

Molino Stewart has conducted several social research projects over the past 5 years in various regions of NSW and Victoria for the SES. Questions dealt with the respondents' awareness of and preparedness for the flood risk, respondents' sources of information for flood and evacuation warnings, understanding of the warnings, responses to these warnings and satisfaction with the warning service. Research methods have included postal, telephone and web surveys, face-to-face interviews and focus groups. While the sample sizes and limitations of the surveys mean that they are not statistically conclusive, the consistency of results across regions and over time are sufficiently indicative ways in which flood warnings can be improved.

These studies help to evaluate warning and evacuation performance during severe weather events and gauge community attitudes and behaviours in response to these

warnings and evacuation orders. These kinds of studies are extremely important to the SES as it gives the organisation a better understanding of warning and public information management and how it can design and target community education programs and continuously improve the flood warning service. The SES recognises the need to review the appropriateness, effectiveness and efficiency of warning systems and public information which will allow it to better meet the needs of communities in the future.

## ***Types of Warning Messages***

The BOM's Flood Warning Service provides different types of warnings that depend on the type of flooding and the flood risk. The range of warning information, which may vary between States and areas within a State, includes:

**Flood Watch:** An Alert, Watch or Advice of possible flooding, if flood producing rain is expected to happen in the near future. The general weather forecasts can also refer to flood producing rain. About 75% of Flood Watches escalate to a Flood Warning.

**Flood Warning:** A Generalised Flood Warning that flooding is occurring or is expected to occur in a particular region. No information on the severity of flooding or the particular location of the flooding is provided. These types of warnings are issued for areas where no specialised warnings systems have been installed. As part of its Severe Weather Warning Service, the Bureau also provides warnings for severe storm situations that may cause flash flooding.

**Minor, Moderate and Major Flood Warnings:** Warnings of 'Minor', 'Moderate' or 'Major' flooding in areas where the Bureau has installed specialised warning systems. In these areas, the flood warning message will identify the river valley, the locations expected to be flooded, the likely severity of the flooding and when it is likely to occur.

- *Minor flooding:* Causes inconvenience. Low-lying areas next to watercourses are inundated which may require the removal of stock and equipment. Minor roads may be closed and low-level bridges submerged.
- *Moderate flooding:* In addition to the above, the evacuation of some houses may be required. Main traffic routes may be covered. The area of inundation is substantial in rural areas requiring the removal of stock.
- *Major flooding:* In addition to the above, extensive rural areas and/or urban areas are inundated. Properties and towns are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from flood affected areas may be required.

**Specific height predictions:** Predictions of the expected height of a river at a town or other important locations along a river, and the time that this height is expected to be reached. This type of warning is normally the most useful in that it allows local emergency authorities and people in the flood threatened area to more precisely determine the area and likely depth of the flooding. This type of warning can only be provided where there are specialised flood warning systems and where flood forecasting models have been developed.

- *Observed River Height:* Depth of water (in metres) at a river height measuring gauge located along the river. In most cases, a zero reading is the lowest water level that is reached during dry conditions. In many tidal areas, as well

as a few inland areas, river levels are expressed in metres above mean sea level or Australian Height Datum (AHD) instead.

- *Peak River Height:* Highest river height (in metres) observed during a flood event at the specified site on the river.
- *Predicted River Height:* Height (in metres) to which the river is predicted to rise at the river gauge referred to in the warning. The actual depth of flood water will vary across the floodplain. Knowledge of past flood events, as well as estimates of flood levels from flood studies, are used by the SES, local Councils and landowners to determine which areas are likely to be flooded from the predicted river height. The accuracy of this prediction will depend on a number of factors, including the type of flood forecasting model and its input data. Predicted river heights are subject to forecasting error and are regularly updated as more information becomes available.
- *River Height Bulletins:* A summary of observed river heights (metres) at selected locations and specified times within river basins. These bulletins are not available in all States.

**Flood Bulletins:** These are issued by the SES to communities and contain the information from BOM with additional information about the likely impacts of the flooding.

### ***Key Findings: River to Resident***

Warning messages are created and distributed through a step by step process. Weather information and data conditions are relayed to BOM from stream gauges and rainfall measurements. Using this information, catchment details and weather predictions, BOM analyses the risk and issues a warning through its Flood Warning Service. The warnings are available on the BOM websites for the public to see. The warning is also issued to the SES to further relay to affected communities.

The SES has the task of distributing the warnings to communities and other emergency response agencies who may not have previously seen it. There are several important aspects to this process. Firstly, the warning must contain the correct information about the flood event, it must also be delivered in a timely fashion to communities so they have time to respond and prepare and it must be delivered through communication channels that reach the majority of the population.

Communities and the SES, working with other agencies such as the local Council, Police, Fire Units and aid/emergency agencies then respond to the flood threat as well as seek more information on the warning and any updates that may come through.

### **Data Collection**

The source of the warning originates from rainfall predictions, rainfall gauges and river gauges. Results from the surveys point to a repeated problem in gathering data for warnings – the failure of instream gauges. High river flows and intense run-off from upstream catchment often damage or remove gauges. Gauges also occasionally malfunction and there are some catchments that lack an appropriate number of gauges to correctly deduce stream behaviour. When a gauge malfunctions or is washed away, the reading posted on the BOM website is recorded as a blank, instead of an estimate from the past readings or other local gauge readings. This means in times of peak flood, gauge readings are often misleading or unavailable for use by agencies or the community. Community surveys have consistently pointed to

the lack of information in regards to correct gauge readings for a reason why warnings are not often heeded or their severity is misunderstood by communities.

In the Macalister River in Gippsland, Victoria in 2007 flooding was so severe in the remote upstream part of the river the banks were completely stripped of soil and vegetation and the stream gauge destroyed. A nearby rain gauge was giving such high readings that it was assumed it was malfunctioning. The result was that no estimate of downstream flood levels could be made until nearly 12 hours later when the water flowed into Lake Glenmaggie, a water supply dam on the river.

In 2009, on the Macleay River at Kempsey, NSW, failure of key upstream gauges led to an apparent drop in river levels recorded, despite the actual river continuing to rise. Up to four metre discrepancies were seen in river heights, the worst being a prediction of 7m when the height was closer to 11m. This would have undoubtedly had a serious impact on the BOM's ability to predict the future peak levels and a reduction in the time to produce a warning.

An increased gauging density would improve the quality of BOM forecasts and the accuracy of warnings but it must be acknowledged that a device that is placed by a river has a risk of being damaged by a flood and the bigger the flood, the greater the risk it will be damaged. This means that the worse the flood gets and the more critical it becomes that BOM must issue an accurate and timely forecast, the higher the chance that the data collection devices will be damaged and the forecast accuracy will diminish.

A major response seen in almost every study conducted is the desire by communities to move away from one point of data based on gauges to multiple sources of information that include observations by members of the community to reduce the margin from error when technology fails. The main suggestion from communities is to set up a network of volunteers who can manually read gauges upstream and use qualitative information from community members. While this may mean that the supplementary or backup flood data is less accurate, it will also be a more reliable means of obtaining the data. As noted in the studies, there is also a prevalent desire for the community to participate more actively in the flood warning process, particularly those with previous experience and knowledge. In fact, some community members say that they take more notice of information provided by community members upstream than official warning information from agencies.

**Key lesson:** Involving the community in data collection may increase the credibility of the warnings with the community.

## **Flood Impacts**

In all states of Australia the BOM's responsibility in floods is to forecast river levels as accurately as possible. While a forecast river level is useful, it is meaningless unless people understand what that level means in terms of flood extent and impacts.

In NSW the SES takes this information and compares it to data it has on its flood intelligence database which records the impacts of particularly flood levels recorded from previous floods or derived from flood models. It uses this information to add value to the BOM forecasts and issue warnings which contain information about what areas will flood, what roads will be cut and whether levees are likely to overtop.

In Victoria, the SES is not in possession of such information and is reliant on water supply authorities and catchment management authorities, who may have modelling information, to advise of the potential impacts during a flood. Agency interviews following the June 2007 Gippsland floods suggest that this lack of knowledge by the SES may have impacted significantly on the timeliness of warnings in some locations.

An example of this was seen in the town of Newry in June 2007. The water supply authority, Southern Rural Water, knew that a 60,000 ML/day outflow from Lake Glenmaggie on the Macalister River was sufficient to flood the town. It notified the BOM, SES, police and community flood wardens downstream that outflows would exceed this level at daybreak and that flooding would be worse than the 1971 flood. The problem here was that none of these other agencies or community members knew that such an outflow would flood the town nor were any of the people involved around in 1971. Therefore the first residents knew that the town would be flooded was when water began entering homes. People were airlifted off rooftops by helicopter as the water rose to a peak flow of 148,000 ML/day.

Had the SES and BOM understood the significance of that outflow they could have targeted their warnings and response around that critical level.

But even in NSW where better information is available to the SES, it is not always well understood that because each flood behaves differently, critical levels may vary from flood to flood. For example, in the town of Lismore the official river gauge is downstream of the junction of two rivers but the overflow spillway on the town's levee is upstream of the junction on one of the rivers. The flood model which was used to design the levee was used by the SES to relate gauge height to overtopping but that model used design flood events. The 2005 flood in Lismore came mostly down the Wilson River which meant that there was a 0.5m slope on the river between the spillway and the gauge. The SES was forecasting that the levee was a long way from overtopping and no evacuation preparations were made, when in reality it was very close to overtopping. Fortunately it did not overtop.

**Key lesson:** It is critical that response agencies know the range of possible impacts related to key gauge heights and understand that each flood will behave differently.

## **Warning Dissemination**

### *Timeliness*

The timing of a warning is critical to allow people to have enough time to prepare their homes or businesses for a flood and evacuate if necessary. From the surveys conducted, it was interesting to note that residents said they took an average of five hours to prepare to evacuate while businesses said they took more than twice as long. This compares to the one hour which the SES currently allows for in its flood evacuation planning models.

The amount of warning available varies depending on catchment characteristics but generally is between 6 hours and 24 hours. Problems occur when warnings are not transmitted quickly enough from BOM to the SES and then from the SES to the community.

**Key Lesson:** Don't let adding specific detailed information to warning messages significantly delay the dissemination of warnings.

### *Communication Mediums*

From all the surveys conducted, overall, radio is the most effective means of disseminating flood warnings, and most trusted source of information, particularly for those in rural areas and during power outages. Warnings can be broadcast instantly and often they provide the most detailed and frequent coverage of any source.

More than 50% of people in Gippsland said they were alerted to the flooding through radio broadcasts. However, this indicates that there is still a significant proportion of the population who often don't hear the warnings by this means. This is particularly the case if people are at work at the time the warning is broadcast. In Maitland, 36% of respondents were unaware that they would flood and the majority of people cited being at work and not having access to a radio as the main reason. This is exacerbated if it is a flash flood warning because the time between the warning and the flooding is often less than an average work shift. Radio therefore cannot be relied upon alone to reach the total population at risk and communities have regularly expressed a desire for more diverse and direct forms of flood warning communication, particularly where warning times are short and flash flooding is a risk.

In Gippsland more than 70% of people said they would like to hear the flood warnings on the radio and about the same percentage said they would also like to receive the message face to face. About 40% said they would like to be warned by telephone. It was also found that the internet is increasingly being used for flood information and despite some areas having limited access to the internet, websites such as BOM, SES and local Council are an important source that could contain and distribute all the information that a community could need.

It should be noted that it is not uncommon for electricity networks to be down during floods as was the case in the Hunter Valley in 2007. Telephone networks can also be down and even if they are not many modern telephones cannot operate if the electricity network is down. Warning systems which rely heavily upon functioning electricity and telephone systems have a high risk of failure, particularly in the more extreme events.

From the community surveys, there was also a request for more personal communication between the emergency agencies and the community. Surveys suggest that up to as much as 18% of residents solely receive their flood warning messages from family, friends or neighbours. In Gippsland about half the people passed the flood warning they heard on to others. Similar results were found in Maitland and Newcastle with 50% and 47% respectively stating they had warned family, friends and neighbours. It has been suggested that the SES investigate the use of community networks for personal dissemination of warning messages throughout the at-risk communities because these networks already exist and are being used by the community but could perhaps be made more efficient and effective.

Community meetings and doorknocking, as used in the Gippsland Lakes communities, were seen to be effective ways of making sure warning messages and information was communicated thoroughly. These however, need resources and ample time but with good flood plans it should be possible to implement them efficiently. Using doorknocking to notify people of the need to evacuate appears to be an effective adjunct to broadcasting the notification on the radio. Not only does this ensure that most people are aware of the need to evacuate but it may have been a

factor in the high percentage of people that did evacuate in the 2007 Gippsland floods.

A survey was conducted in 2008 in Grafton outside of a period of flooding. There 68% of respondents identified that the main way to convince residents to evacuate was an SES or Police Officer knocking on the door. Also 44% identified they would evacuate after a telephone call from the SES or Council. These trends were also repeated when surveying businesses.

The NSW SES strives to work out all of its evacuation plans around doorknocking as the most reliable, but not the only, means of informing people of the need to evacuate. It has also been noted that it would be useful to have literature to give to people during doorknocking and community meetings which gives them a record of what was said or elaborates upon the advice given verbally.

It is not only residents and businesses who need to receive warnings; organisations such as traffic authorities, aid agencies and the Police have stated through agency interviews that they would like more advance warnings and to hear them more often. In the town of Maclean, a town outside of Grafton, the local aid and emergency agency, The Salvation Army, worked for 32 hours without relief after they responded to the flood warning in May 2009. It did not receive any warning directly from the SES or local Council despite being heavily involved in the response to flood events. It was also not updated on road information and when highways were reopened after floodwaters.

**Key Lesson:** Many different communication mediums are needed to reach everyone and personal forms of communication are likely to be more effective.

## **Warning Message Content**

An appropriately constructed warning message should contain information about why there is a hazard, what locations are at risk, who the warning applies to and the recommended actions to take. The message should use clear consistent language so it can be understood by all members of the community.

### *Localities*

From the studies conducted it can be seen that the most significant barrier to people thinking that flood warnings apply to them is not hearing their locality specifically mentioned in the warning. This is particularly problematic when there are warnings for flash flooding because not only is it difficult to predict which localities might experience it but often the people in those locations are not aware that they could flood and may disregard the warning in any case.

Residents have consistently stated that the warning should include information regarding suburbs, or specific localities rather than broad regions. The communities have identified this as the greatest improvement that can be made to flood warnings. Many Gippsland community members expressed that they were unprepared for an impending flood when warnings interchangeably used terms such as "Gippsland region", "Gippsland towns" and "Gippsland rivers". It seems that if there is ambiguity about location, most people choose to believe that the warning does not apply to them, particularly if they are lacking in previous flood experience.



Incorrect terminology and locations is also a problem that leads to confusion in regards to warnings. A flood warning issued by BOM in June 2009, inexplicably called the river at Lismore “Richmond River at Lismore”, despite the fact that it is the Wilson River and it remained being called that until the final flood warning two days after the first was issued.

The studies also show that there can be a significant difference in understanding across different parts of the same region. A review of the effectiveness of warnings in Lismore and Byron Shire in 2005 showed that a severe weather warning issued for the North Coast was heard by 56% of Byron Shire respondents and 71% of Lismore respondents. Of those who heard the warning, 67% of residents in Byron Shire thought it applied to them compared to 91% of Lismore residents.

Less than 40% of respondents in Gippsland in 2006 said they heard the Flood Watches and less than 60% of these thought it applied to them. In other words, less than a quarter of the population were reached by the Flood Watches.

A more worrying statistic is the response to evacuation notifications. While 61% of Lismore respondents heard the notification and 80% believed it applied to them, just 2% of Byron Shire respondents said they heard it and no-one believed it applied to them. The main reason stated by Byron Shire residents as to why they didn't respond was the fact that specific localities were not mentioned and many residents didn't believe they could flood.

Other potential reasons for these results could include the fact that Lismore has experienced a greater number of floods since the late 1980's and has had extensive community education programs in place.

**Key Lesson:** Be as specific as possible when referring to places which will be impacted.

### *Terminology*

Another critical part of an effective warning is the use of consistent terminology. Generally from across all the survey results, Minor, Moderate and Major flood warnings for rivers appear to be well understood by riverine communities, but less so by areas that do not flood regularly. Severe Weather Warnings and Flash Flooding are terms that are less well understood by communities. Flood Watch is the term that is most poorly understood but where it has been explained in community education activities it appears to be much better understood.

Results from Lismore and Gippsland showed that flood watches were not well understood with only about 20% and 30% of respondents, respectively, knowing what they meant but in Maitland where ongoing community education had been in place, up to 90% of those surveyed were able to provide a sufficient answer as to what Flood Watch meant, with many respondents using words such as, 'beware', 'listen', 'caution' and 'be alert' to describe Flood Watch.

**Key Lesson:** Consistent, plain language terminology with commonly understood meanings should be used.

### *Comparisons with Previous Events*

A flood warning for Gippsland Lakes was issued on the morning of June 28th 2007. Height data for Gippsland Lakes was not included in the BOM flood warnings but

instead contained information on flood heights comparative to June 1998 flood levels as well as comparative tide levels. The restricted nature of this information meant it wasn't immediately clear to all residents what it meant, particularly new residents who had moved to the area since the 1998 flood. Similarly comparisons with the 1971 event at Newry proved to be particularly unhelpful as previously discussed.

**Key Lesson:** Comparisons with previous events can be helpful but should not be the sole information about flood magnitudes.

### *Media Interpretation*

The role of broadcast media in warning dissemination must not be underestimated. Problems arise with the quality of warnings to the public when the media lacks the knowledge and understanding of how their reports are being interpreted amongst the community. Incorrect or over dramatised reports can significantly under play or over play the actual risk to residents and over time can lead to flood prone communities becoming sceptical of media reports and their role in flood warning.

From the studies it was noticed that there was a tendency for television coverage to pay little attention to forecasts and current warnings but instead to report on recent damages or dramatic rescues. This is particularly evident in larger media outlets with state wide coverage and it often means current warning information is left out of television news bulletins.

In Kempsey in 2009, there were reports from residents that stories were being over-dramatised and that TV stations were using footage of previous, more serious flood events which falsified the current situation. They also included measurements that indicated the levee was overtopping which it was not. False reporting causes confusion and misinformation and can invoke unnecessary panic.

On the other hand, mixed messages and the wrong flood terminology can under-report the threat to audiences. For example, during the Gippsland floods in 2007, numerous media reports and warnings were not progressive in time with media reports interchangeably using the more general, preliminary warning terms such as "flash flood warning", "flood warnings in Gippsland" and "severe weather warnings", despite official "major flood warnings" being already issued by BOM for specific rivers and localities.

Radio and television interviews with BOM and SES personnel provide an opportunity to add value to warning messages by explaining what the different terms mean, what locations will be affected, what people need to do and where they can get further information. Giving selected regional SES officers basic media training assists in creating early and regular media interviews to communicate key warnings and response messages.

The BOM and SES has a memorandum of understanding with the national broadcaster ABC radio that its local radio stations will broadcast regular, up-to-date warnings throughout floods.

**Key Lesson:** Proactively engage with the media to ensure correct and important information is being broadcast.

## Resident Response

### *Verification and further information*

Across all the studies a significant number of residents seek to verify the initial warnings after they are heard. Three quarters of Gippsland residents stated they did not act on the warnings until they had found more information. Nearly 80% monitored the flooding by observation of river and lake levels while more than 60% listened to the radio for updates. About 13% used the BOM website.

Generally, most people seek further information about flood warnings on the radio. The internet is also being used by a small but significant number of people for verifying, clarifying or even updating flood warning information. While the BOM website is the logical place to look for the flood warning information, others go to news websites, SES websites or even their local council website. Road and traffic authority websites are also regularly used to check for updates on road closures. Community networks also figure prominently as information sources more popular than the Bureau or SES as information sources for confirmation of warnings.

One problem that is brought up consistently by flood affected residents is the level of service available from the SES's flood information telephone number which is operated from a central system at State Headquarters. Residents across all the studies have indicated strongly that they are extremely unhappy when their calls and requests for further information are not answered locally, but by a communications centre with staff unfamiliar with the region. Many residents reported receiving wrong information on catchments, towns, evacuation routes and the status of the evacuation order.

**Key Lesson:** Flood warning information needs to be consistent and up to date across all mediums so that when people seek message verification it is confirmed rather than contradicted.

### *Preparation*

Respondents generally took actions to reduce or prevent loss of or damage to property and possessions. Lifting possessions to higher levels appears to be an intuitive response to flooding which is not strongly influenced by community education.

Other actions however, such as shutting off power and gas and placing valuables in a waterproof container were less common but more likely to occur where there was ample warning time and/or previous community education. Interestingly, these were prominent in the actions that people said they would do differently next time along with responding sooner.

**Key Lesson:** Community education and warnings need to list all actions that should be taken.

### *Evacuation*

Of concern in many of these studies is the small percentage of people who said they evacuated when ordered to. In Gippsland less than half the people who heard the warning chose to evacuate, likewise with the majority of respondents in both Byron Shire and Lismore. In Grafton, despite previous studies indicating that up to 44% of

people said that they would evacuate if told to do so, less than 200 out of a town of 9,000 evacuated in May 2009, indicating a percentage of 2.2%. Businesses were found to be far more likely to evacuate than residents.

An exception to this was the communities surveyed in Maitland where up to 75% of residents said that they evacuated after being told to do so. The reasons for this may be related to the infrequency of floods in Maitland, as well as the extensive community education that had taken place previously. In the other study areas the reasons people gave for not evacuating varied and many gave more than one reason. Amongst the most common reasons were:

**Not believing the flood warnings.** Consistently mentioned throughout the Grafton and Lismore studies was the fact that many residents did not believe that the flood warnings issued were accurate. They believed the figures from gauges were wrong and that evacuation orders were overly dramatic. This feeling was particularly prevalent in residents who had lived in the region for a long time. This meant that the majority of residents ignored reports and orders which stems from the past few flood events that have seen many people ordered to evacuate and the flood inundation not eventuate.

The BOM and SES acknowledge that they err on the side of caution with their warnings and evacuation orders. However, residents say they have lost confidence in warnings with survey results suggesting that with every false alarm, there are less people who follow evacuation orders and become complacent so the consequences of a future extreme event could be catastrophic. A small but significant trend across all the resident's responses is the large number of people that said they would not change their response to a flood warning next time, should a similar flood occur again although some businesses and residents said they might delay preparations and evacuation next time.

**Not understanding the personal risks.** Despite the risks to personal safety, most residents mainly see flooding as a threat to property and possessions. Generally, the majority of residents surveyed across all regions do not evacuate unless the water is directly threatening their property despite advanced warnings. Residents who chose not to evacuate cite reasons such as staying to protect their property or because they were convinced their property would not flood.

In Grafton of the 927 residents surveyed 6 months before the flood, 63% said they would evacuate if they were 'told that a flood was going to go over the top of the levee' and they 'were advised to evacuate'. 33% would not evacuate. It appears that safety concerns and the need to comply with authorities such as the SES are the main reasons to evacuate. It is interesting to note that of those who wouldn't evacuate, only 12% stated that they could not be convinced to evacuate. However, as seen from the 2009 study, the number that followed the evacuation order was actually closer to 2%.

In Maitland, where 75% of the population evacuated, the post-flood survey revealed that about 10% of people said that they would only ever evacuate if they were forced to.

Studies before the floods also showed that there was a higher correlation with age and the number of storeys and unwillingness to evacuate. A greater proportion of respondents 60 years or over and residents with two storey homes said they would not evacuate. Another correlation found within business was the length of time a business had been in the location and those that are business owners. Those

businesses that had existed at the location '1 to 10 years' had a greater proportion that would not evacuate. There was also a higher proportion of business owners that would not evacuate compared to business managers and employees.

**Key Lesson:** Emergency management agencies need to back up evacuation orders with credible evidence and stress the potential consequences of failing to leave.

## ***Community Education***

Flood warning outcomes are only as good as community preparedness and response which is strongly influenced by community education. When developing community education strategies it needs to be recognised that the research is showing that personal safety is a poor motivator for people to take action in floods. People seem to feel at more risk personally if they have received no warning of the flooding therefore the better the warnings provided the less likely personal safety will be a motivator to action. Appropriate responses however, appear to increase where education has taken place. This includes seeking more information from appropriate sources, better protecting property and possessions and evacuating when instructed to do so.

However, there are often vast differences in the level of education within each region with a trend that those residents in high risk areas know what to do and make preparations early while those in other locations such as the urban town centres are often unaware because they flood less frequently. Preceding community flood education appears also to be strong influence on a community's willingness to evacuate.

Although the type of flooding and agency warnings and responses were different in the various locations, there are some noticeable differences in the survey results which warrant commenting on. Where extensive community education had taken place in Maitland, in the Hunter Valley, the community was more likely to:

- hear the warning and think that it applied to them;
- understand the difference between a Flood Watch and a Flood Warning;
- more likely to contact the SES for further information; and
- more likely to evacuate,

than in Newcastle or Gippsland where little education had taken place.

Implementation of the FloodSmart education program before a second flood within the Gippsland region in late 2007 appears to have improved preparedness in communities, evidenced by an increase in the number of people developing flood emergency plans although experiences five months earlier would have also contributed to better responses.

Community education to boost the response of warnings needs to target;

- the real risks of flooding because there is poor understanding of this amongst communities which have not flooded;
- the meaning of different flood warning terminology, particularly Flood Watch and Flash Flooding because these were poorly understood and people did not realise they were getting an early warning;
- additional actions people can take to protect possessions beyond lifting items as few seemed to take many actions other than this;

- the dangers of flood waters because it appears that 80% of people travelled through floodwaters and for half of them those floodwaters would have been high hazard floodwaters; and
- the benefits of timely evacuation because many appear to have not done so until it was too late or too dangerous.

## ***Conclusions***

It is important to understand that despite the best efforts of emergency and warning organisations, warning failures will arise through failures in both technology and failures by people.

Technological failures can be backed up by using people. While this can result in a loss of precision or time, it is better than no warning at all. Examples can include using community members to provide observations in catchments and on rivers as one of the inputs to the forecasting process. The community can also play a vital role in establishing effective communication networks for the dissemination of warnings through doorknocking and telephone trees to reduce the reliance on broadcast mediums. Involving communities in this way also increases the credibility of messages.

Possible failures by people can only be mitigated against by providing education to reduce the risks. This education needs to occur at several points in the warning system.

The education and training of staff and volunteers in emergency service organisations can ensure accurate, timely and easily comprehended messages are being disseminated to the right people by the right means.

The education of media to ensure warning messages are being communicated accurately will also improve the effectiveness of flood warnings.

Education of the community is a vital tool to ensure the seriousness of warnings are understood and preparation and response is improved.

To maximise their effectiveness, the warning messages themselves need to be specific about the threat, the locations which are threatened and actions which people should take. These messages need to be consistently presented across all mediums if they are to be believed by the majority of people.

Even with all of these measures in place, the research suggests that there will always be a proportion of the population, perhaps as high as 10%, who will never be convinced that they need to evacuate.

The use of community surveys before and after floods provide will continue to provide useful insights into how flood warnings can be improved.