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Flood Risk

A paper examining the importance of building community resilience

WHITE PAPER:

FLOOD RISK

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ABSTRACT

"IDEALLY SOCIETY WOULD LIKE TO BE FREE OF THE RISK OF FLOODING, BUT THIS IS NEITHER PRACTICALLY NOR ECONOMICALLY FEASIBLE. WHAT CONSTITUTES AN ACCEPTABLE LEVEL OF FLOOD RISK HOWEVER IS A VEXED QUESTION. THE IMMEDIATE RISK IS BORNE BY THE COMMUNITY, WHICH MUST HAVE A SIGNIFICANT INPUT INTO DEFINING THE ACCEPTABLE LEVEL. TO THIS END, PUBLIC CONSULTATION AND RISK COMMUNICATION IS VERY IMPORTANT" (SCARM, 2000).

RECENT ADVANCES IN TECHNOLOGY MAKE THE CREATION AND DISSEMINATION OF FLOOD RISK INFORMATION VERY ACCESSIBLE AND ACHIEVABLE FOR EVEN MODEST SIZED AGENCIES. MANY OF THE DATASETS MAY ALREADY EXIST IN A FORMAT THAT IS SUITABLE FOR USE IN FLOOD RELATED LOCATION INTELLIGENCE, CAN BE COMBINED WITH FLOOD MODEL RESULTS AND SUPPLEMENTED BY ANY ADDITIONAL INFORMATION THAT MAY ADD VALUE TO THE PROCESS - SUCH AS LIDAR. A TRAINED ANALYST CAN PRODUCE RESULTS IN A RAPID MANNER THAT FORM A VALUABLE FOUNDATION FOR DECISION SUPPORT ON HOW TO BEST BUILD AND SUSTAIN COMMUNITY RESILIENCE FOR FUTURE FLOOD EVENTS.

SECTION ONE

COLLECTIVE CHALLENGES

Building community resilience through Location Intelligence

In 2009, the Council of Australian Governments (COAG) agreed to establish a whole-of-nation resilience-based approach to disaster management. It recognised that a nationally coordinated effort is essential to enhance Australia's resilience to disasters – being the capacity to quickly recover from disaster (COAG, 2009).

Despite less than 10% of the Australian community historically being exposed to flood risk, it accounts for close to one third of total natural hazard damage and is the most expensive natural hazard in Australia (Jones, 2008).

Scientific modelling suggests that climate change trends will likely result in greater frequency and severity of extreme weather events like flooding. This increases the uncertainty about future flood risks and then challenges existing flood risk mapping, where available, to accommodate these changing trends.

In the past, standard emergency management planning emphasised the documentation of roles, responsibilities and procedures. Building on existing emergency planning arrangements, there is a need to focus more on action-based resilience planning to strengthen local capacity and capability.

Prevention, preparedness, response and recovery

Australian emergency management is built on the concept of prevention, preparedness, response and recovery (PPRR). All elements are equally important in helping build community resilience towards disasters. A disaster resilient community considers many factors including:

- Land use planning and building controls to limit dwellings to predicted natural hazards
- Attempting to relocate flood damaged dwellings above the 1/100 ARI flood line and enforcing different building materials (such as plastic cladding instead of timber cladding) when located in flood plains (Thomas M, 2011)
- Flood altering mitigation investments like levees
- Access to information and education programs so the community can understand the hazard risk and how it relates to them
- Current, robust emergency plans maintained by local authorities and emergency service organisations
- Access to appropriate insurance cover for home and contents.

Australia is not inexperienced in terms of floods, or inundations, with 77 floods recorded in the past 35 years of the 20th century. However, the flood events of early 2011 in both Queensland and Victoria have brought home the level of devastation to people and property of this kind of natural disaster (OQCS, 2011).

The 2011 floods have also provided the impetus, or continuation, of efforts by Australian Governments at all levels to examine approaches to reduce the risk of floods to life and property. Traditional approaches to flood risk are being reviewed in light of changing environmental factors, population factors, community acceptance and technology.

Responsibilities and responses

On the front line of flood defence are Local Government Authorities, Water Authorities and Catchment Management Authorities. Tasked with executing flood surface modelling and flood risk mitigation plans, each faces a daunting task in light of significant population growth, evolving land uses across the country and changes in climatic patterns. There is much an authority can do to establish comprehensive intelligence and

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mitigation plans. Indeed, the opportunity for better governance is enhanced through the effective use of the technologies available today.

It is the responsibility of Local Government and/or Water Management Agencies to perform a variety of duties to build and retain community resilience to flood risk. Activities relating to mitigation and preparation include:

- Development of comprehensive local disaster management planning strategies
- Creating and maintaining a community awareness and education program
- Modelling risk and assessing the potential impact of disaster.

The reviews that came out of the 2011 floods in Victoria and Queensland highlight that despite significant progress being made by national flood resilience programs and enhanced inter-agency collaboration there is still significant room for improvement. Some key findings from the interim Victorian report include (Comrie N 2011):

- A lack of flood studies and an acknowledged lack of municipal flood plans
- Lack of availability, timeliness and accuracy of road closure information
- Incident control apparently ignoring, discounting or not using local Council knowledge
- Difficulties in information exchange, data collection and availability.

Flood surface models are an essential element to predict heights of waterways, spread of floodwater inundation and to calculate which assets and properties may be impacted. These types of exercises, undertaken prior to a flood happening, greatly assist authorities to fine-tune response procedures and responsibilities of different organisations. The ultimate result is improved community disaster resilience.

The standard used for detailed flood modelling is for a 1 in 100 year flood event. Interestingly, in Victoria alone major regional flooding occurs somewhere across the state once every 10-20 years (Comrie N, 2011). Viewed in isolation the results from detailed flood modelling scenarios can often seem complex and difficult to apply to various emergency mitigation and planning activities. Whilst flood models alone are helpful to understand the extent of inundation and the intensity of flow, the value increases significantly when this data can be readily integrated with a range of emergency planning and town planning processes.

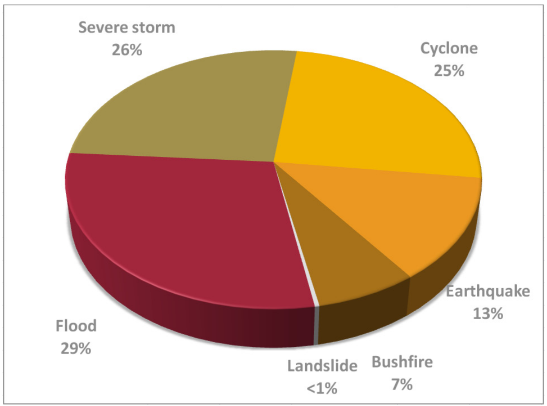
FINANCIAL CONSEQUENCES AND INSURANCE IMPLICATIONS

The term flood can mean different things to different parties. To avoid confusion the definition for flood adopted in this paper is the same endorsed by the Australian Government, November 2011.

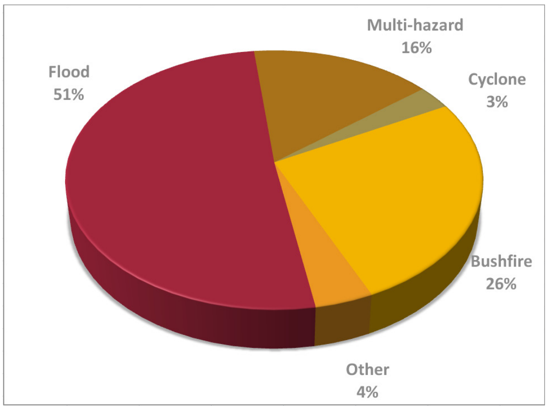
Flood means the covering of normally dry land by water that has escaped or been released from the normal confines of:

a. any lake, or any river, creek or other natural watercourse, whether or not altered or modified; or

b. any reservoir, canal, or dam (Commonwealth, 2011). With so much destruction caused by floods in recent years, there is a heightened level of pressure on the Government and the Insurance Industry to better protect those communities in high risk flood zones. How to most effectively minimise the physical, financial and emotional impact on those at risk ultimately defines the best plan for the future.



Graph 1 from the National Disaster Management Plan shows annualised cost of disasters in Australia by hazard type. The period of review is 1967 – 1999 (Jones, 2008).



Graph 2 from the National Disaster Management Plan, total government expenditure on disasters by hazard, 2003-04 to 2006-2007 (Jones, 2008).

The recent 2011 floods that affected 70 percent of Queensland are likely to be the most costly natural disaster in Australian history, which on the 25th August 2011 was estimated to be at $2.45 billion (Hon Mc Clelland, 2011), (ICA, 2011).

For those householders that have adequate flood insurance, history has shown that if flood water levels rise above the height of the floor of a dwelling then the estimated damage bill could be 40%-50% of the sum insured for the home and 90%+ of the sum insured for the contents in and around that home (Middelmann, 2010).

Insuring with more certainty

However, not all insurance companies in Australia offer flood cover and not all homes are insurable. There is also inconsistency regarding how flood cover is offered and the kinds of flood events covered. This can result in reduced community resilience against the risk of flood and potentially significant financial and emotional hardship.

"We need to ensure individuals and communities at risk of extreme weather events are aware of the risks but are able to obtain suitable protection against those risks, both in terms of having access to insurance and

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benefiting from appropriate mitigation strategies," said Bill Shorten, Assistant Treasurer, Australian Government on the 4th March 2011 (Hon Shorten, 2011).

The National Disasters Insurance Review

The Australian Government this year implemented the National Disasters Insurance Review. The aim is to examine ways of ensuring individuals and communities at risk of extreme weather events are aware of the risks and are able to obtain suitable protection against those risks, including access to appropriate insurance. The terms of reference include (NDIR, 2010):

- Individuals and communities affected by flood and other natural disasters are able to recover and rebuild as quickly as possible.
- People are able to choose where they live in an informed way.
- Individuals and communities at risk of future flooding or other extreme weather events are aware of the risks and are able to obtain suitable protection against those risks, both in terms of having access to insurance and benefiting from appropriate mitigation strategies.

Although the findings of the review are still to be ratified, it is acknowledged the primary obstacle to achieving greater market availability of flood insurance cover for the majority of households in Australia is the ability for insurers to understand the risk of flood and price it accordingly.

"Flood damage is a persistent risk to only seven per cent of properties in Australia, and is in many cases, the result of poor government mitigation, failed land use planning and ineffective building codes," said Mr Rob Whelan, Chief Executive of the Insurance Council of Australia (ICA, 2011).

To help resolve this and pave the way for greater availability of insurance cover in Australia the Local Government and Flood Management Authorities can play a pivotal role by implementing the following risk identification and reduction measures (Sullivan, 2008):

- Providing better flood mapping over all regions of the country at risk of any prominent flood event – riverine or flash flood.
- Providing better flood mitigation and management practices that accommodate the potential for more intense flash floods and more frequent flooding events.

"We strongly encourage the development of a single national standard for flood mapping in this country to support better risk mitigation efforts, risk pricing, risk exposure management and risk transfer mechanisms. Stakeholders should contribute to the cost of these maps, depending on use," said Melinda Howes, IAA Chief Executive (Howes, 2011).

Greater investment in the management and communication of flood risk mapping and mitigation would directly help improve the resilience of at-risk communities. Such initiatives would promote greater awareness of the risk and necessary associated emergency plans. Furthermore, they have the potential to help ensure appropriate insurance cover is available to facilitate the recovery process after a flood event.

MODELLING AND LOCATION INTELLIGENCE OPTIONS

Various applications of flood models integrated with Location Intelligence technology can help rapidly generate valuable insights and support decisions. This is not an exhaustive list of applications. However, it does represent best practice being undertaken by some of the more progressive Local Government and Flood Planning Agencies across Australia.

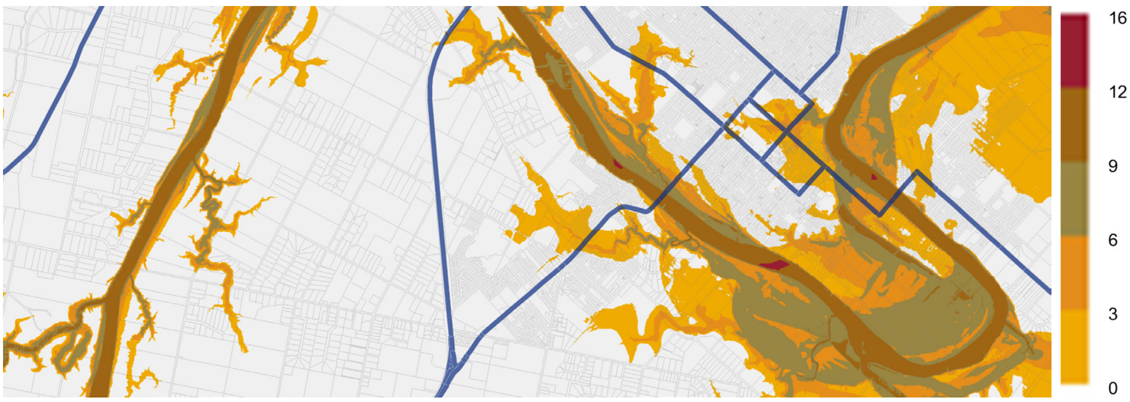
Interactive, accessible flood risk mapping

The use of Location Intelligence, at its most fundamental, is in establishing a single point of the truth for all relevant information around community infrastructure and flood risk. Flood models, often depicted as surfaces, can be placed over relevant spatial information in a GIS (Geographic Information System). This can include land parcels, roads of significance, evacuation routes, drainage networks, critical infrastructure, evacuation centres and demographic statistics. Having all of this information in one planning environment is powerful and lends itself to robust risk analysis, mitigation and response planning.

Flood risk visualisation

Combining modelled flood surfaces with a digital elevation model (DEM) is one immediate way to help better understand the community's exposure to flood risk and intuitively visualise it. With the availability of LiDAR data a DEM can be easily computed. This is invaluable for understanding the elevation of land across the modelled area. It is an effective way of determining which properties are exposed to different flood event scenarios. In combination with dwelling flood height data, a planner can also differentiate the potential extent of flood risk including which roads are inundated, all properties inundated and specifically, which dwellings are inundated above floor level. This promotes pre-emptive needs analysis and action before an incident occurs and can also highlight where existing emergency plans are compromised in a flood event. Specifically focusing on road inundation is important to understand which parts of the community may get isolated, and whether any evacuation routes or evacuation centres will be impacted.

Most flood modelling projects look at different events. Besides the '1 in 100 year' flood it is important to also understand the '1 in 50 year', '1 in 20 year', '1 in 10 year' and also '1 in 5 year' flood events. By comparing each it is possible to determine which parts of the community are regularly affected and/or severely affected.



Rapidly build a perspective of inundation area and depth of flood waters through built up areas and across evacuation routes.

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KEY INSIGHTS

LIDAR - WORLD BEST PRACTICE IN EARTH SURFACE MEASUREMENT

LiDAR has fast become the standard in earth surface measurement. Using airborne laser scanners, the data can be collected quickly, accurately, and at a very dense rate. The result is a high fidelity representation of the earth surface and its various features. This is the best source of data possible for the creation of modern, robust flood surface models.

A LiDAR (Light Detection And Ranging) system is fitted to a vehicle, usually a plane, and rapidly transmits laser pulses that reflect off the terrain and other features such as vegetation and infrastructure. The return pulses are converted into electrical impulses and collected digitally.

The resulting LiDAR data is a very dense network, known as a 'point cloud' of XYZ coordinates that define the ground and also the features on the ground.

LiDAR point clouds offer a superior foundation for the creation of high fidelity digital terrain models and flood models. However, they are very large datasets. This is why LiDAR processing is usually performed by specialists, who create derivatives like surface levels, contours and vegetation profiles.

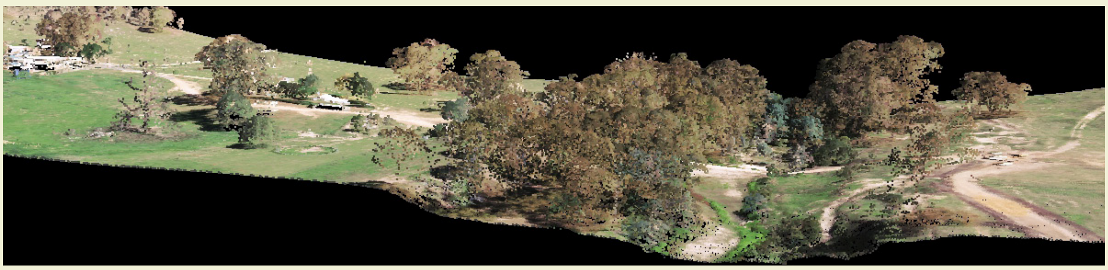
A specialist organisation in high definition LiDAR capture and analysis is Terranean Mapping Technologies. Recent project examples of the extensive analysis only possible through the use of LiDAR technology include:

1. Governments remapping most of the populated Australian coast including all large urban areas.
2. A 1 million sq km survey of the Murray Darling Basin - the data was used to derive a range of environmental variables including vegetation density and stream channel shape. This work was completed within twelve months and would have been impossible using traditional field-based geomorphology.
3. The detailed mapping of 10,000 sq km in the Surat Basin in Queensland for a coal seam gas company. This data was used to design infrastructure and map vegetation.

High Definition LiDAR has radically improved the cost -efficiencies of capturing mapping data. For the same costs users are now receiving more accurate data in shorter time frames, over larger areas.

Some organisations may wish to perform additional, ad-hoc modelling with the LiDAR LAS files. This has historically demanded significant investment in expertise and computational power, beyond the reach for most organisations. However, recent advances in desktop-based software are making such analytical intelligence more accessible and affordable.

"Companies such as Pitney Bowes have reacted quickly to this requirement and have built robust, powerful software tools capable of reading and processing these voluminous sources of information. Organisations can have more analytical autonomy, giving them much more scope to perform extensive scenario planning, which is very powerful in the hands of emergency planners," says Wal Mayr, Director, Terranean Mapping Technologies.



High fidelity terrain modelling with imagery draped.

Web mapping

When a flood disaster occurs and authorities are in response mode, it is imperative that everyone has ready access to up to date information. Increasingly, interactive web mapping is chosen as the preferred option to collect and communicate this information. Location is at the centre of critical information around a flood. So it makes sense that emergency response personnel can see the known extent of the flood in relation to modelled extents, along with the locations of critical infrastructure, road closures and active evacuation centres.

Understanding limitations in accuracy

Every flood event is unique. Any flood event modelled is based on a large number of assumptions. Often, these are based on historical events. But, things can still change, so any use of flood models should consider them to be indicators and not exact decision-making benchmarks. For example, if a heavy rainfall event occurs at a different location to what was modelled, then this can impact on the volume of water falling on the relevant catchments and the time it takes for the water levels to reach the predicted height. Thus, the time available for warnings and evacuation procedures can be affected. Another example is the direction of a storm. If the storm is travelling downstream towards a township the combined effect of rainfall runoff gathering as a single, significant mass will create a more devastating flood event, compared to a scenario where the same amount of rain fell, but the storm travelled upstream away from the township. In this situation the water has more time to discharge more evenly.

In a real time situation, flood surfaces can be generated dynamically to track the potential impacts of a flood event based on assumed river gauge levels. Although not as precise as flood surface models, the use of quick surfaces around a creek or drain gauge gives valuable insight into what the impacts can be.

Identifying and scoring risk

Modelled flood surfaces are the best way to determine at-risk segments of the community. Different flood scenarios show the changes to those at risk. With this information a Council can begin to compare risk at a catchment level and consider various capital works to mitigate flood damage. The investments necessary can be substantial. As an example, Mornington Peninsula Shire has budgeted $30 million over a 10 year period to improve the resilience of their community to the risk of flood (Mornington, 2011). Much of this will be invested in combined flood management and drainage capital works to lessen the impact of certain flood events. A Council can consider the installation of more storm water drainage networks, drainage upgrades, retarding basins, the clearing and widening of natural drainage networks or a combination of these and other infrastructure changes. It is clear to see that the role a Local Government Authority or Water Authority plays in flood risk mitigation is significant.

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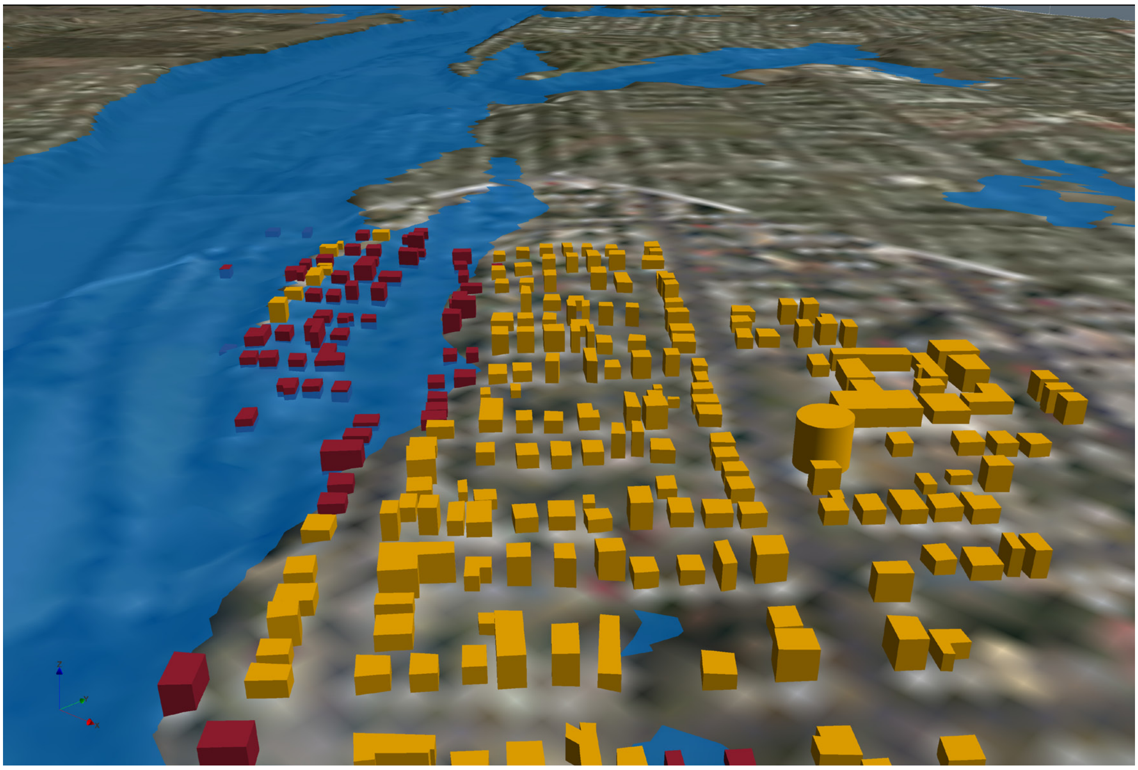
For authorities responsible for investing in flood mitigation infrastructure, it can be a challenge to prioritise where capital works are needed the most. To assist with this, study catchment and sub-catchment areas need to be identified and each needs to be risk assessed individually. There are a variety of factors that can go into scoring the risk of flood for a catchment. These include the number of dwellings inundated above flood level, impacts on community safety and infrastructure. Although flooding is a way of life for parts of Australia, there is some flood risk that can be deemed too extreme or too frequent to be acceptable. In effect, authorities need to determine what 'intolerable flood risk' is within their jurisdiction and plan mitigation investments to reduce or remove this level of risk.

Using Location Intelligence an authority can determine how many dwellings are predicted to be inundated in a variety of modelled flood events. Once the impact can be determined, capital works projects can be considered and flood risk models recomputed with the new infrastructure factored in.



3 Dimensional viewing gives a powerful perspective of various flood scenarios and their impact.

NEW DIMENSIONS IN MODELLING AND SCENARIO PLANNING

Traditional standard practice

Flood risk assessment has followed a familiar path for over 30 years. Using historical data and 100 year Average Recurrence Interval (ARI) flood levels, Local and State Governments have been assessing risk to human life and property as part of their planning duties. While each responsible authority may follow very similar processes, a lack of nationwide co-ordination can contribute to inconsistencies that hamper their efforts.

"Key variables in risk assessment as set by Government define a hazard in terms of the velocity and depth of floodwaters. These guidelines vary between Councils and State Government but tend to be broadly similar across Australia. Efforts are underway by the National Flood Risk Advisory Group for a national set of guidelines for flood risk management and the responsibility of Government and the community in the effective management of flood risk for local communities" (NFRAG 2008).

Additionally, the Australian Building Codes Board currently has a 2010-11 work program for the development of a technical standard for housing and other low rise residential buildings in flood prone areas (Australian Building Codes Branch, 2011).

"All councils have embedded flood risk elements into their planning procedures, leveraging guidelines for velocity and depth in mapping models to determine safe and unsafe areas for development. At best we hold 30 to 40 years of flood data and assessments on the 100 year ARI flood event but it's the impact of bigger flood events – the 150 or 200 year flood event, that can show a sudden jump in risk profile and alter the assessment. This more extreme analysis of hazards helps to focus attention to those flood prone areas where the risk, particularly to people, is so severe that it becomes prudent for the council to adopt a higher ARI for that area" (Dr Mark Jempson, National Flood Practice Lead, BMT WBM).

New dimensions in modelling

Increasing sophistication of technology and data has made risk assessment via modelling the impact of flood easier and more reliable. It also enables fast reassessment and decision-making in times of flood or high rainfall periods for emergency services, using scenario planning to guide warnings and evacuations.

Modelling floods is a complex task with numerous interdependencies. Historically, performing this has taken extreme computing power to make thousands of calculations simultaneously. Enhanced computing capabilities coupled with sophisticated modelling software and highly accurate geographic data sources has seen the rise of two dimensional (2D) flood models that deliver significantly better results.

Traditionally, one dimensional (1D) hydraulic models were used to model water flow in well-structured drainage channels, like rivers, creeks and stormwater drains in urban areas. But, this kind of analysis is inadequate to model the flow of rainfall runoff across flood plains, street networks, overbank flows and urban landscapes during a flood event.

2D models emerged about 10 years ago to address this concern. Although relatively more complex, costly and time consuming these models do offer a robust representation of the flow of floodwaters outside structured drainage networks. The availability of high quality ground surface data such as LiDAR (Light Detection And Ranging) and advances in desktop computing power have also made this modelling more accessible; to the point where it is now expected in overland flow flood modelling across Australia.

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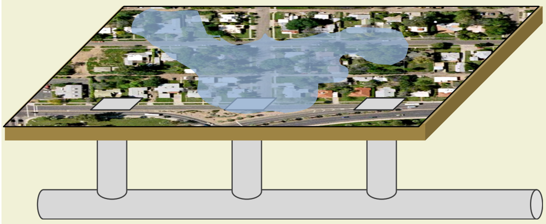
KEY INSIGHTS CONTINUED

Combining strengths and mapping interdependencies

By combining 1D and 2D modelling an extensive representation of drainage dynamics of overland flow and drainage networks can be formed without exponential processing time. In reality, urban environments will experience a combination of water dynamics – overland flow and structured drainage network flow. These systems are interdependent. It is now possible to combine the computational nimbleness of 1D to model constant discharge dynamics of structured drainage networks whilst also factoring in a complex web of overland flow, watershed, roughness and water velocity parameters. The result is robust and defensible flood risk modelling - essential for flood mitigation and flood planning activities to build community resilience to flood risk (Haestad 2003).



1D/2D hydrographic and hydraulic modelling can simulate the interdependent dynamics of structured drainage networks like stormwater pipes with overland flow dynamics of rainfall runoff across an urban environment.

Focusing purely on the property cost of floods, the Federal Government sought to reduce the cost to taxpayers by encouraging authorities to use 2D and 1D/2D mapping and modelling more intensively. Part of this encouragement is in the form of disaster risk mitigation funding from Federal and State Governments that share the costs involved with better planning via mapping between Local Authorities, State and Federal Governments.

This effectively reduces the Local Authority cost to just a third. This funding is still available today for relevant projects.

Models of real-world experience

“There are some great examples of best practice in specific areas in the country. Hopefully the NFRAG (National Flood Risk Advisory Group) will help to bring these to the fore and encourage similar best practice across all councils and water authorities in Australia while building the connections for a coordinated and consistent management structure”, says Dr Mark Jempson, National Flood Practice Lead, BMT WBM.

Flood analysis outputs are a natural source of content for Location Intelligence technology (the application of GIS technology and spatial data). With these models authorities can develop hazard maps, depth maps, flood height contours as well as flood extent polygons. The resultant maps and models allow engineers to quickly and effectively communicate outcomes and likely scenarios.

“A 2D model that is based on high quality terrain data and is well set up will reliably reproduce real life flooding patterns. I will often ask stakeholders and communities in the flood prone areas to review model output such as flood animations and GIS produced mapping“, says Dr Jempson. “In my experience the stakeholders and community groups have always being impressed with how close the computer model is to real life, and they subsequently have high levels of confidence in the study outcomes.”

REAL WORLD PLANNING AND IMPLEMENTATION

This helps an authority optimise investments to reduce the impact of a larger flood event into a smaller event. For example, scarce investments can be best aligned to change the impact of a '1 in 50 year' flood event into a lesser '1 in 5 year' flood event. This process, which essentially determines the investment required to reduce intolerable flood risk, requires intensive, repetitive use of advanced flood modelling technology or consulting expertise.

Dwelling floor levels

It is important to note that to determine whether a dwelling will be inundated by floodwaters the height of the floor is needed for all dwellings in and around flood risk zones. There are several ways to determine this height, but the most reliable way is through field survey.

Measure the risk of flood as number of dwellings that would be flooded above floor level in a flood event, then formulate capital works to reduce the amount of dwellings inundated to a tolerable amount.

Asset maintenance

A subtle, yet critical consideration for Council and Water Authorities is effective asset maintenance programs for drainage networks. Flood modelling, as mentioned earlier, needs to take into consideration a large number of assumptions. One of those assumptions is the effective capacity of the storm water drainage network. So, it is vital that any asset maintenance work planned for the drainage network considers keeping the network clear and at capacity if related to a region susceptible to flooding.

Risk mitigation through town planning

A key risk mitigation practice exercised by Local Authorities is land use planning and the establishment of building codes. Areas that are susceptible to flood can and should be regulated with development limitations and/or building code regulations to ensure that the number of dwellings at risk does not increase as development advances. Enforcing specific building codes for dwellings in a flood risk zone can also offer pragmatic solutions to reduce potential damage.

Evacuation planning

A key part of any risk management strategy around flood is evacuation planning. Evacuation planning, including the selection of evacuation centres, can be significantly improved by effectively using Location Intelligence in concert with demographic profiles, critical infrastructure layers and flood risk modelling. When considering the location and number of evacuation centres, naturally there is a need to consider all disaster scenarios, but the focus here is flood risk.

Evacuation planning is supported in Australia with extensive guidelines from organisations such as Emergency Management Australia. However, what is not as clearly prescribed in the guidelines is how best to determine appropriate sites as emergency shelters.

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There is a range of constraints to consider around the facility's capacity to shelter a high number of people in safety. Responsible agencies would benefit significantly from using Location Intelligence in the site selection process.

Evacuation centre selection

For residential areas in Australia, evacuation planning is an important inclusion in risk management plans designed to increase community resilience to flood events. There are many variables to consider when determining viable evacuation centres. To begin with, the sites should be accessible and easily recognisable within the community. Other logical constraints include holding capacity, availability of essential facilities and safety. There are other equally important criteria that rely on the use of Location Intelligence to effectively determine:

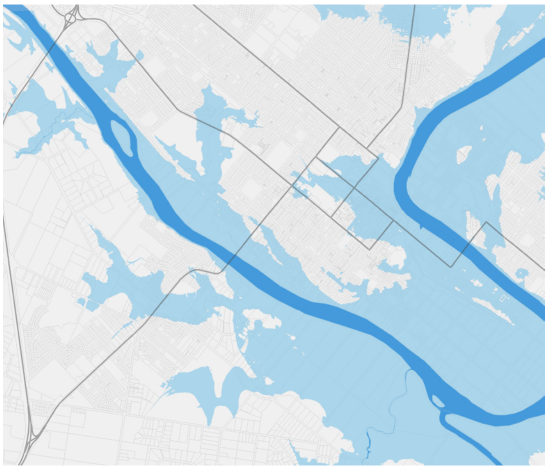
- Accessibility of site and access roads in a flood event
- Estimated population size and compilation of the surrounding area
- Geographic catchment around the site
- Facilities capable of housing special-needs groups around the site.

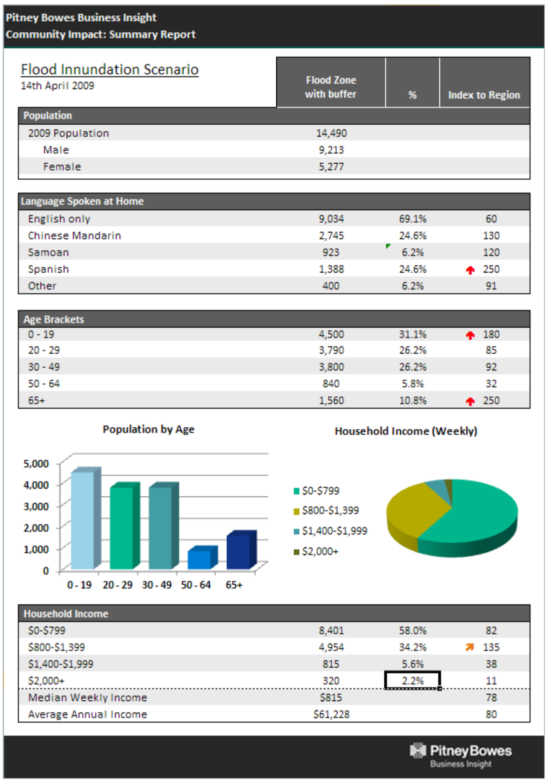
Accessibility in a flood event

Before a site can be considered, it is important to determine whether it will be affected by a 2, 5, 10, 20, 50 or 100 year flood scenario. Just as important are the access routes to and around the site. If the primary routes are cut to the site, and road works to mitigate the issue are not viable, then the site is not suitable.

Demographic considerations

One determinant of the number of sites to select is the density of the population needing refuge. Just as various flood events can be modelled and analysed using Location Intelligence, so too can the impacted demographics of the inundated areas. Following is a scenario where a flood surface is being used to determine





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Community Impact: Summary Report

Flood Innundation Scenario
14th April 2009

	Flood Zone with buffer	%	Index to Region
Population			
2009 Population	14,490		
Male	9,213		
Female	5,277		
Language Spoken at Home			
English only	9,034	69.1%	60
Chinese Mandarin	2,745	24.6%	130
Samoan	923	6.2%	120
Spanish	1,388	24.6%	250
Other	400	6.2%	91
Age Brackets			
0 - 19	4,500	31.1%	180
20 - 29	3,790	26.2%	85
30 - 49	3,800	26.2%	92
50 - 64	840	5.8%	32
65+	1,560	10.8%	250

Household Income			
$0-$799	8,401	58.0%	82
$800-$1,399	4,954	34.2%	135
$1,400-$1,999	815	5.6%	38
$2,000+	320	2.2%	11
Median Weekly Income	$815		78
Average Annual Income	$61,228		80

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Effectively report on community profiles affected by a flood scenario, necessary for appropriate response planning.

a demographic study area. From this process key demographic variables can be identified such as:

- Total population in inundation area, or portion of inundation area
- Mix of gender and age group
- Prevalence of primary foreign language used at home.

These are all essential statistics to help select an appropriate site for an evacuation centre, and also ensure that appropriate facilities (such as the provision of interpreters) can be established at the centre.

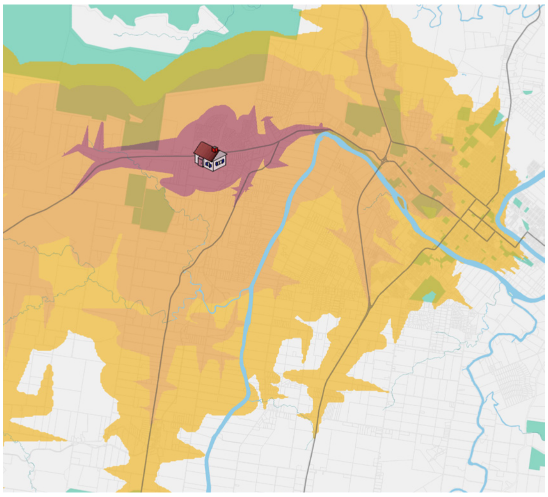
Catchment definition and transportation

Another important aspect to site selection is the time it takes for evacuees to get to the evacuation centre. Naturally, when public transport options to the site are not readily available it needs to be as close as possible to at-risk communities. An easy way to determine this is through dynamic drivetime catchment analysis. Locations can be assessed against specific travel times to determine the likely time needed to reach the centre.

Special-needs groups

An emergency plan must take into consideration special-needs groups. Factors such as communication, culture and mobility can cause challenges when catering for people with disabilities, people from non English-speaking backgrounds, children and the elderly.

In addition to demographic analysis to determine community profiles of those at risk, another important spatial theme that needs to be analysed is the Socio-Economic Indexes for Areas (SEIFA). SEIFA was developed by the Australian Bureau of Statistics specifically for those interested in assessing the welfare of Australian communities. It is also a strong indicator of special -needs groups and can be directly overlaid spatially with the flood surface models and potential evacuation sites. This helps add depth to the assumptions made about an at-risk community, and its ability to seek independent refuge options.



Determine the catchment potential for an evacuation centre. Here we see catchments for five, ten and thirteen minute drive times.

Other special-needs groups are often concentrated at specific venues.

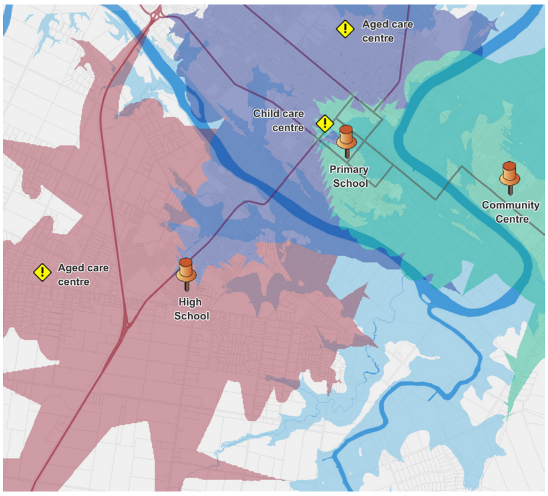
Examples of these include:

- Hospitals
- Nursing homes
- Schools
- Tourist destinations.

It is important these concentrations of special-needs groups are considered in the spatial analysis. Incorporating this information into site analysis helps score a site by the number of these facilities in the catchment and the representative populations that need to be considered in capacity calculations.

Flood Risk

A paper examining the importance of building community resilience



Overlay viable catchment centres, drive time catchment boundaries, special needs facilities and key access routes.

The Emergency Alert System

An outcome of the tragic bushfire events in Victoria in 2009 was the creation of a National Emergency Warning System called Emergency Alert. This facility, created by the Australian Federal Government, is designed to provide advance warning to at-risk members of the community through landline and mobile phone messages. Those contacted are determined to be in an at-risk zone based on the service address of the landline and/or mobile phone.

The Australian Government released on the 1st September 2011, an announcement on the findings of an assessment of the effectiveness of the Emergency Alert System. Overall the results suggested the system was working well and those in receipt of a warning message found it invaluable.

However, a key finding from the review suggested community preparedness was the weakest part of the warning system. Attorney-General, Robert McClelland commented, "While it is important that we develop strong emergency warning systems we also need to ensure our communities are ready, willing and able to deal with natural disasters when they occur."

"Of particular concern is the need [to] make families having recently arrived in Australia, international students and young people generally more aware of [Emergency Alert] EA, and the need for such groups to have plans in place to react appropriately to a warning message" (AG, 2011).

Operationally the emergency response operators draw a polygon on a map to delineate the at-risk zone. This structure is then used to extract limited community contact details that are then used to issue communications to home phones and mobile phones. Although the definition of that polygon is ultimately determined by the operator of the day, having access to reliable flood surface models can provide essential reference information to consider at response time.

The message for Local Government is that more work is required to ensure their communities are well informed on the risk of flood and the disaster plans in place that prescribe community notification systems. The determination of special-needs groups used for evacuation centre site selection can also help make community awareness programs more targeted and effective.

The same considerations used above to determine the location of an emergency evaluation centre network are also appropriate when determining the locations of other forms of shelter, including assembly areas and temporary accommodation. These same selection criteria need to be applied to establish more than one viable evacuation centre in each region.

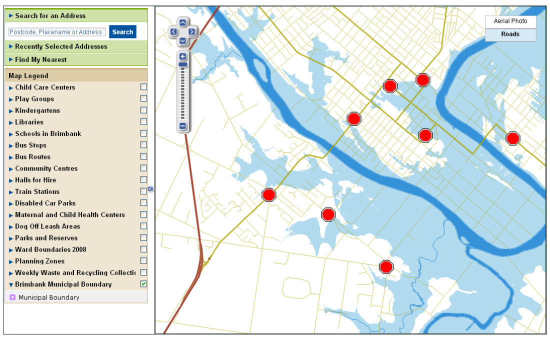
Recovery

Once the immediate threat of flood has passed the emergency management plan will move into a recovery phase. This phase is focused around the restoration of Government services, repairing damage and allowing citizens to return to their homes and places of work. For a significant flood event this phase could last many months or perhaps years. As the floodwaters subside there will be an influx of emergency services and utilities companies working to restore damaged assets and infrastructure. Efforts at this point need to be planned and first coordinated to ensure that the highest priority items are addressed in order of need. This planning is aided by a clear understanding of the assets that have been impacted. This is something that is delivered by using the output from the flood model process overlaid with critical infrastructure. An important part of the recovery phase is capturing exact flood heights, which can then be recorded and used as historical information to fine-tune future flood modelling activities.

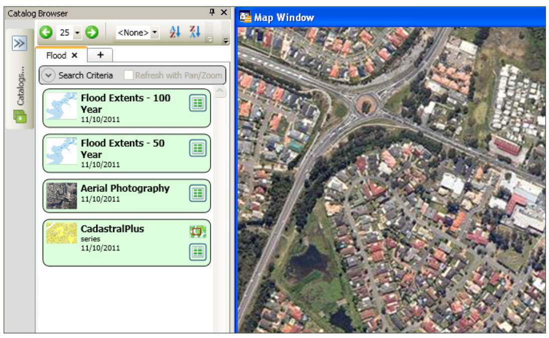
An important element of this process is the supply of up to date information to the community. By using web based mapping to communicate changes to road services and service availability, information can be distributed immediately in a consistent and intuitive fashion.

Collaboration

As the awareness of the existence and value of flood model results increases within an organisation there is a corresponding increase in demand for access to the data. This presents challenges for data custodians. An organisation may choose to provide various levels of access to different users. For example, one group of users may need access to the raw datasets for use in a variety of different applications. Others may require access to generalised versions of the data. Whoever the users are, they need to be clearly informed about any relevant caveats or limitations relevant to applying the results of the model. This information that describes the dataset is called “metadata” and although it is easy to overlook, it is a valuable tool in implementing a structured data management process. Platforms exist that allow users to search across catalogues of published metadata to identify the relevant dataset, the dataset owner and physical or logical location of the dataset. This can all happen seamlessly for the end-user who may be operating in a desktop or web GIS application. Once identified, the platform will facilitate ease of download to the local application.



Empower your community with up to the minute information on emergency response and recovery activities.



Effectively catalogue essential planning information – reduce duplication – ensure consistent resilience planning.

Flood Risk

A paper examining the importance of building community resilience

SECTION FIVE

System compatibility and communication consistency

Disaster scenarios are not a frequent occurrence. The best way to ensure everyone knows what to do when it really counts is to make sure they are relying on technology, procedures and skills they are familiar with and use regularly. That is why it is important to use the same Location Intelligence technology in an emergency response as that used in day-to-day operations. For Local Government, this will ensure the staff required to operate the system will be experienced with the technology and better able to perform in times of high stress. Furthermore, the system can effectively scale to support any disaster coordination activities more readily when already deployed across the organisation. It also means that community members, familiar with information resources normally used to service general enquiries can also access disaster response related information without confusion.

Even today, many Local Government Authorities and Emergency Response Agencies do not use Location Intelligence to coordinate their disaster planning, response and recovery activities. Along with the issues that are caused by having insufficient and inconsistent information available on demand, there are also substantial costs created from paper trail record keeping and post-event digital re-entry.

FURTHER TOPOGRAPHICAL AND HYDROLOGICAL SURFACE ANALYSIS

When exploring the investment in detailed flood modelling and digital elevation modelling there is also the opportunity to create several new derivative datasets that can add significant value to an organisation's operational efficiencies.

Contours design

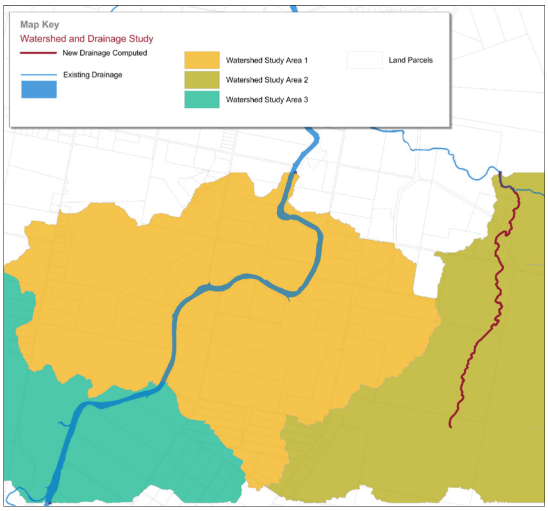
Contour maps are a traditional way of depicting elevation levels and changes in elevation levels for a region on a two dimensional map. Even though analysts using Location Intelligence have ready access to powerful 3D visualisation and analysis, it still pays to have a relatively current contour map layer as part of the solution. Contours are easily shared with large, disparate groups of mapping users and are still a staple inclusion in hard copy map production – essential for a variety of field workforce and power-outage scenarios. Contours are also an essential inclusion on any flood planning map.

Generate high fidelity contours automatically from detailed field data like Lidar.

These days LiDAR is an ideal source of data to create contours. The spatial precision of the contours is determined by the fidelity of the processed LiDAR data. A GIS can be used to rapidly generate contours at a nominated contour interval, in a relatively simple and quick process. The resulting data can then be readily shared across an Enterprise GIS, including a public facing web mapping interface.

Defining catchments and watercourses

A drainage catchment zone is essentially the area that captures rainfall and channels it to a specific point. Catchments are a prime determinant of flooding and are factored into flood models. This data is often also supplied with flood analysis by flood consultants. It can be quite valuable to have catchment layers incorporated into the Location Intelligence solution. Even if catchment zones have been provided, there is still often a call for the ability to created revised drainage catchment boundaries. Especially important when considering the impacts of new capital works programs, road development, erosion control, or flood mitigation measures. With the availability of LiDAR technology, field survey or existing high fidelity DEM catchments can be readily generated by a GIS analyst.

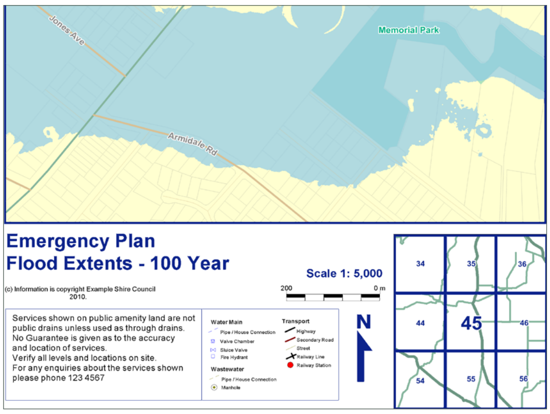


Define water catchments and calculate water courses to better understand the hydrographic dynamics across your region.

As well as defining drainage catchments, it is also possible to define watercourses as a geometrical network. Again, this information may also exist from other sources, such as State Government data archives. But, often this data can be quite old and based on a rough scale, like 1:50,000. With the availability of LiDAR or a derived DEM, an authority can actually create a high fidelity, hierarchical drainage network. This helps further validate the natural drainage network currently being referred to for flood planning or as a better replacement.

Map series production

Critical planning and response intelligence stored in a GIS should also be made available in hard copy to response teams. A simple, yet effective way of producing printed maps is as a map series sequence – much like a street directory. Streets, critical infrastructure and landmarks can be referenced in a look-up index. The rich, layered intelligence can be formatted on to a specified template and then large numbers of maps can be printed automatically.



Rapidly produce hardcopy maps for field crew with automated map production facilities.

Flood Risk

IN CONCLUSION

INTEGRATING EFFICIENCIES AND BUILDING COMMUNITY RESILIENCE

With initiatives such as Government 2.0 and intuitive web mapping technologies readily available, authorities can quite easily share likely flood scenarios with their community to enhance awareness and build resilience. However the trade-off with sharing is the potential for panic. Councils are still exploring where on the sharing-panic continuum they are comfortable and what legal consequences may result.

There is a case that can be made, that to build community resilience to flood risk there is a need to change attitudes in all tiers of Government from 'need to know' to 'need to share'. Providing information and warnings is important but educating people how to act on this knowledge is equally crucial.

Political leaders, Governments, and the private sector all need to create improved emergency management and advisory roles, and focus on integrated and coordinated disaster resilience. In turn, informed communities and households need to take more responsibility for their own safety and act on information available before, during and after a disaster (COAG, 2009).

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