IS THE BEST AVAILABLE INFORMATION FIT FOR PURPOSE?

Mark Babister[1] Monique Retallick[1] Erin Askew[1] Isabelle Testoni[1] Duncan McLuckie[2]
[1] WMAwater
[2] NSW Office of Environment & Heritage

Abstract

Flood risk management is not simply about developing flood maps or putting up flood mitigation works. It involves an integrated range of measures across prevention, preparedness, response and recovery and decisions on how to most effectively and efficiently use the scarce resource available to manage the flood risk to the community.

The modelling approaches used to understand and manage flood risk vary with the complexity of the flood situation, the scale of the risk to the community and the end uses of the commissioning agency. This may or may not include the reasonable information needs of the broad range of end users who may use this information in fulfilling their role in managing this risk. The additional work in fulfilling these needs may, in some cases, be able to be undertaken with little additional cost or effort.

This paper aims to identify the:

- key end users of information and their general information needs and how these may vary depending upon the flood situation and considering the degree of exposure of the community to risk.
- The modelling approaches generally used considering the complexity of the flood behaviour and the scale of the community at risk and the outputs generally derived from these approaches.

It will examine how these factors interact to look at the fitness for purpose of these approaches in meeting reasonable end user needs and to identify gaps in the capability of approaches.

Introduction

This paper relates to a project being undertaken for the National Flood Risk Advisory Group, as Stage 1 of a project for the development of practical specifications on mapping and modelling outputs and outcomes for flood risk management (WMAwater, 2014).

Stage 1 provides a framework for:

- Selecting a flood modelling approach based on end user needs,
- Understanding the limitations of a selected flood modelling approach in satisfying end user needs, and
- The development of technical specifications in Stage 2.

The approach put forward in this project is the reverse of the typical approach to flood modelling studies where the modelling tool is chosen based on an immediate need often without consideration of other potential future users of the outputs and outcomes. In this approach end users and their needs are first identified to inform the selection of the appropriate modelling approach and associated tools.

By initially considering the scope of end user needs appropriate to the flood situation being investigated, the best suited modelling approach can be specified. This provides critical advice to prospective consultants so that they can recommend an approach and methodology to satisfy the range of needs in the most cost effective and efficient manner.

The approach overcomes a common limitation of studies, which is to engage work to satisfy only the immediate end user needs, often the commissioning agency. The ability to expand a selected approach to meet the needs of other legitimate and identifiable end users may be complex, costly or impractical. Significant rework may be required which could have been avoided if a different approach had been identified prior to the work commencing, and these needs were recognised, identified and considered.

This guidance, along with work in Stage 2 on technical specifications, aims to enable those commissioning and undertaking studies to make informed decisions on the approach, type of modelling and the outputs and outcomes that will be derived from the study. It also enables them to understand the limitations of approaches and associated outputs in providing effective information to inform decisions on the management of flood risk and investment in the floodplain.

The needs of end users were compared to the different flood modelling outputs that various typical approaches generate, in order to determine output gaps. The study considers the relative importance of these gaps and indicate the reasonable possibility of filling these gaps using the general methodologies of typical studies and enhancing these methodologies with additional work or post processing. The project then considers whether it would be more logical and cost effective to change the modelling approach to provide the additional information.

Flooding in Australia is extremely variable and situational dependent, and while this report aims to provide information for end users in all situations, decisions should be made as most appropriate to the particular circumstance. End user needs can also vary across Australia with varying flood situations and local and state government requirements. It is prudent to confirm the specific needs of end users and approving authorities.

End Users

The study has identified the following primary end users; this list is of course not exhaustive:

- Those involved in emergency management,
- Land use planners (strategic planning and planning controls),
- High level decision makers,
- Insurers,
- The community,
- Flood risk manager, i.e. those involved in the management and mitigation of flood impacts and infrastructure providers,
- Those involved in flood prediction and forecasting.

Flood information is typically used to inform decisions on investing in the floodplain, managing flood risk through prevention, preparedness, response and recovery activities, to price insurance, and to inform and educate the community on flood risk and response to floods. Much of the information that is required to consider these issues relates to the peak of flood events, however there are a number of situations where consideration of other aspects of flood behaviour, such as the rate at which the flood level rises during an event, are warranted.

The needs of each of the user groups vary greatly. The end users of flood information have been broken down into two general groups:

- Users with needs generally independent of the flooding situation, and
- Users with needs that often vary depending on the flooding situation.

The main distinction between the two groups relates to the need to consider emergency response.

Emergency response often relies upon evacuation of the community to flood free land; where the community can be supported, during and in the aftermath of a flood event. These aspects are fundamental to planning for response, and enacting a response to floods.

There are a range of secondary end users. These secondary end users would rarely commission a flood study, but make better informed decisions when modelling results are available. This group includes natural resource manager, water cycle managers, developers, some infrastructure designers, GIS users, and other flood consultants.

Emergency response can also be a key consideration in land use planning, and particularly strategic planning; where the difficulty of evacuation may influence a decision to develop an area, the way in which an area may be developed, or the infrastructure needed to support development of an area. Such decisions rely upon knowledge of any difficulty with flood evacuation (as identified through methodologies such as the use of flood emergency response classifications for communities), the logistics of the situation, and how flood characteristics change with time during an event at key locations. For example, for an area which is cut off by floodwaters and then completely inundated (that is, a low flood island), the key logistical constraints may be the time at which the evacuation route is cut and the ability to safely evacuate the area before that time. It may be the point at which an emergency situation turns from response to rescue. This may occur well before the peak of the flood event. In addition, the critical evacuation time may be the result of a shorter duration flood than that giving the peak flood level, as a key event, such as loss of evacuation access, may be reached earlier in a flood event with less time to react.

The end user needs for consideration of emergency response vary greatly with the type of flood situation the community is exposed to, and how rapidly floods will rise at the location, in addition to the size of the community. Therefore the information needs required to understand and consider this in emergency response and land use planning will vary depending on whether it is a large rural catchment, where the warning time is in the order of a day to months, whether there is scattered residential development or a major town located on the river or an urban area subject to flash flooding with little warning. Information needs have therefore been subdivided into the following categories:

- Rural catchment with scattered development,
- Large rural catchment with town (where there is plenty of warning),
- Small rural catchment with township (where there is little warning),
- Large urban catchments, and
- Small urban catchments (overland flow).

These situations may not cover every flood circumstance in Australia but aim to give an overview of the needs of end users in these general situations.

Planning has been subdivided into strategic planning and planning controls. Strategic planning focuses on making broad area land use planning decisions aimed at identifying where, from a flood risk perspective, development may and may not be viable. This considers adverse impacts on flood behaviour, the degree and manageability of flood hazard, the difficulty of emergency response, and the type of development and development conditions appropriate in different areas where development is considered viable. In the case of strategic planning, flooding is just one constraint, however it is one where a poor decision on location may be very expensive or impractical to mitigate afterwards, with associated ramifications for the community. Planning controls are applied to new or existing development after a strategic decision has been made about the land use.

High level decision makers includes elected officials (local councillors, state and federal politicians), judges, government working groups, who are not experts in flooding but are often the final arbitrators on development on flood prone land and have an important role in communicating decisions and flood advice to the community. This group requires high level information and an understanding of the uncertainty associated with flood information. In cases where the decision can be seen as controversial they may also need to access more detailed information.

Insurers include insurance companies and underwriters who need good information on flood risk across a range of flood probabilities in order to provide insurance products for the community. The degree of information needed by insurance companies depends on the magnitude and diversity of the risk. As well as wanting to understand the risk at a particular property the insurance companies want to understand how an event will affect their portfolio risk. A major event can affect one catchment or a series of adjoining catchments. Where an insurance company has broad exposure in a catchment their information needs become very similar to a floodplain manager. It is also important to understand that insurance premiums tend to be more conservative where good flooding information is not available due to the additional uncertainty.

Community needs can vary greatly depending on the community and what they deem is essential information. This has been generalised for the purpose of this project as there are a number of key end user needs that are always relevant to the community.

Flood risk managers need reliable flood information across a range of probabilities to be able to understand flood behaviour, be able to assess risk and the effectiveness of options for risk treatment, and inform the development of mitigation works and management measures. In addition flood risk managers require flood information to be able to make recommendations on management and give advice to other end users. Similar to those who manage emergency response, those who manage flood risk require flood information beyond just peak flood results. Those responsible for managing flood risk associated with infrastructure design would need to consider for example, available time before inundation occurs and the route is cut and increased inundation times on existing infrastructure.

Flood prediction and forecasting professionals require access to reliable information on how either rainfall transfers to a flow or how a flood of a particular size moves through the catchment. This knowledge is needed before an event so that relationships are understood and relevant tools can be developed so predictions can be derived to inform flood warnings to the community and emergency service organisations during a flood. Assessment of this nature is often required as the event is occurring and often more simple representations of the system provide quick, reliable and efficient estimations. These simple representations can be developed from more complex calibrated models. Issues arise for flood prediction professionals when applying the most sophisticated and up to date modelling as model simulation can be difficult to start and run times can be long. These end users tend towards simple hydrologic models with hydraulic attributes such as flow relationships and one dimensional hydraulic (1D) models, which have been validated against a more complex model which was in turn calibrated and validated against historical events.

Outputs

Types of outputs

End users require a range of different outputs that include simple point information at key locations through to detailed spatial information over a wider study area. This information can be a snap shot in time, the peak, maximum values or a complete time series for an event. While some outputs come directly from a model such as peak flood level, depth or velocity, other outputs require a secondary level of calculation (post processing) or interpolation or extrapolation (generally requiring engineering judgement). Examples of these outputs include flood hazard (product of velocity times depth), velocity vectors, flood function, levels at which properties are inundated or roads are cut and flood emergency response classifications.

End users may require outputs for a single design or historic event or for a range of events. The assessment of a single event does not consider the range of flood risk present. Most circumstances require consideration of a range of flood events where the impacts or consequences vary between events. For example, a location that is protected from flooding from a river by a ring levee, would not be subject to flood risk from the river up to the levee design height. However the consequences of the levee being overtopped could be significant and would not be appropriately identified unless a range of probabilities are considered. Community understanding of flood risk is dependent on good quality mapping (Meyer et al, 2012).

End users may also require the ability to assess the impact of a development or the impact or benefit of a floodplain mitigation measure or management option. This requires the model to be able to assess change in flood level or flood behaviour, examples include how a levee may impact flood levels over the wider floodplain or how the loss of floodplain storage as part of filling for a development, may change flow behaviour.

Outputs to meet end user requirements

Table 1 and 2 summarise the outputs required by each end user group. End user needs have been ranked according to relevance to function of the end user:

1. Passing Interest
2. Nice to have
3. Important
4. Critical to function

The final rankings were workshopped with a group representing primary end users. Emergency management has been separated from other end users as the needs of the end user will vary depending on location and flood situation.

Models

End user needs are a significant factor governing the choice of model to be applied as part of a flood study; there are a range of other factors that can also influence the final decision, including data availability. Model choice should consider any future potential uses and end users of the model that are envisaged at the time of project initiation. Where possible the model should be readily extendable to meet other end user needs.

In order to effectively compare end user needs in different situations and using different models for this report an assumption about the underlining availability of data has been made. It has been assumed that all data appropriate to the situation is readily available and of high quality although this is often not the case. In reality the data quality will vary wildly and poor quality inputs would affect the reliability of some models.

All available information should be accessible during tender either remotely or in person to assist in the determination of the best modelling tool and to improve costing.

Recent advances in the collection of topographic information such as ALS/LiDAR, has meant that wide scale ground level information can be collected with reasonable accuracy in a quick and cost effective way. The availability of this type of data allows spatial mapping of flood related information across the wider study area.

Table 1: Emergency Management - End User Needs Dependent of Flooding Situation

	Emergency Management				
Basic Model Outputs	Rural catchment with scattered development	Large rural catchment with town Plenty of warning	Small rural catchment with township Little warning	Large urban catchments	Small urban catchments (overland flow)
Flood Information at a Point Location (eg. Flood level or depth) [(1)]	3	3	3	3	3
Historical Flood Information (eg. Recorded flood levels) [(1)]	4	4	4	3	3
Flood Levels [(1)]	4	4	4	4	4
Flood Profiles (ie. Flood levels along a river) [(1)]	4	4	3	3	3
Flood Depths	3	4	4	4	4
Flood Velocities	2	3	3	3	3
Spatial Flood Extents	4	4	4	4	4
More Complex Outputs					
Flood Planning Levels	2	2	3	3	3
Spatial Flood Information for a Range of Events	3	3	3	3	3
Flood Hazard [(1)]	4	4	4	4	4
Flood Function	3	4	4	4	4
Assessment of impacts of changes in the floodplain due to development, filling, or infrastructure crossing the floodplain on flood behaviour	2	3	3	3	3
Flood Information for Future Conditions (Climate Change/Land use change) in the Catchment	2	2	3	3	3
Mapping Depicting Percent Chance of Flooding on an Annualised Basis	3	4	3	4	3
Gauge Height/Elevations at which Structures are Overtopped [(1)]	4	4	4	4	4
Timing of Structures Overtopped including Levees and Bridges [(1)]	3	4	3	4	4
Gauge Information (Relating timing) [(1)]	4	4	4	4	3
Inundation Timing of Properties/Access Roads [(1)]	4	4	3	4	3
Levels/AEP at which Critical Access Roads are Affected[(1)]	3	4	3	4	3
Levels/AEP at which Properties are Affected	4	4	4	4	4
Levels/AEP at which Critical Municipal Structures (including pump stations, power sub-stations, water and wastewater treatment facilities, hospitals, schools, airports, and fire and police stations) are affected [(1)]	3	4	3	4	3
Assessment of Change in Flood Behaviour or Levels as a Result of Mitigation Works	3	4	3	4	4
Link between gauge height and inundation precinct [(1)]	2	4	3	4	2
Assessment of worst case flood outcomes such as levee failure [(1)]	3	4	4	4	3

(1) From an emergency management perspective these types of outputs are normally considered to fall under the category of flood intelligence.

Table 2: End User Needs Independent of Flooding Situation

	End User Group						
Basic Model Outputs	Strategic Planning	Planning Controls	High level decision makers	Insurers	Community	Flood Risk Manager	Flood Prediction
Flood Information at a Point Location (eg. Flood Level or Depth)	2	3	3	4	3	4	4
Historical Flood Information (eg. Recorded flood levels)	4	3	3	3	4	4	4
Flood Levels	3	3	3	3	3	4	4
Flood Profiles (eg. Flood levels along a river)	1	1	3	3	3	4	3
Flood Depths	3	3	3	4	3	4	3
Flood Velocities	3	3	2	3	1	4	3
Spatial Flood Extent	4	4	4	4	4	4	3
More Complex Outputs							
Flood Planning Levels	4	4	3	3	3	4	1
Spatial Flood Information for a Range of Events	4	3	3	4	3	4	3
Flood Hazard	3	3	2	3	3	4	2
Flood Function	4	3	2	2	3	4	3
Assessment of impacts of changes in the floodplain due to development, filling, or infrastructure crossing the floodplain on flood behaviour	3	4	3	4	3	4	4
Flood Information for Future Conditions (Climate Change/Land Use Changes) in the catchment	3	3	3	3	3	4	3
Mapping Depicting Percent Chance of Flooding on an Annualised Basis	3	3	2	3	1	4	4
Gauge Height/Elevations at which Structures are Overtopped	1	2	3	3	2	4	3
Timing of Structures Overtopped including Levees and Bridges	2	2	3	3	3	4	3
Gauge Information (Related timing)	2	2	3	3	3	4	4
Inundation Timing of Properties/Access Roads	2	2	3	3	3	4	4
Levels/AEP at which Critical Access Roads are affected	4	3	4	3	3	4	4
Levels/AEP at which Properties are Affected	4	2	3	3	2	3	4
Levels/AEP at which Critical Municipal Structures (including pump stations, power sub-stations, water and wastewater treatment facilities, hospitals, schools, airports, and fire and police stations) are Affected	4	4	3	3	3	4	1
Assessment of Change in Flood Behaviour or Levels as a Result of Mitigation Works	4	3	3	4	3	4	3
Link between gauge height and inundation precinct	3	3	2	2	3	3	4
Assessment of worst case flood outcomes such as levee failure	3	3	3	3	3	4	4

Description of models

This study breaks modelling approaches down into the following different groups:

- Simplistic based on hydrologic and hydraulic theory,
- Simplistic based on other spatial methods – Pseudo two dimensional, this involves no hydrologic or hydraulic modelling,
- Historical events,
- Flood Frequency Analysis (FFA),
- One dimensional (1D) hydraulic model – steady state,
- One dimensional (1D) hydraulic model – unsteady state,
- Two dimensional (2D) hydraulic model - Basic,
- Two dimensional (2D) hydraulic model - Advanced.

These groups were selected to cover the range of different approaches being undertaken in flood risk management in Australia. More details on the model types can be found in WMAwater (2014). Table 3 discusses the limitations and data requirements of each method with a relative cost assigned to each model (however exact costs vary according to the scale and complexity of what is being modelled).

The most advanced model is not necessarily the best for the end user needs for example it may take too long to run, when a simple 1D model was suitable for purpose. Long run times may make calibration and validation prohibitive.

Ability of models to meet end user needs

Table 4 relates end user needs to model outputs. While not all end users need certain information (for example, flood profiles) it might be of use to other interested parties and be able to be extracted from the adopted model with limited increase in costs. The most complex model is not always necessary to provide the outputs required as they may be able to be produced reliably from a simpler model.

Reliability and accuracy in modelling has a huge impact on the final result of a study and the ability of the outputs to meet end user needs and therefore be fit for purpose. As such, it should be noted that the model chosen should address the reliability and accuracy to the needs of the end users.

The purpose of relating end user needs to modelling outputs as outlined in Table 4 is to give a guide of what types of approaches may be appropriate to produce certain outputs. Some modelling approaches can be extended or added to (through add-ons or post processing) to meet additional end user needs. This can often be costly and result in a poorer or less reliable product and can be time consuming. Therefore it is preferable to identify and consider needs up front so that these can feed into the selection of the methodology and costed into project delivery.

Table 5 attempts to simplify this further by providing some guidance on the appropriateness of different modelling techniques to suit the needs of different end users. This table does not account for all the particular needs of specific end user groups nor the variation in the needs of specific end user groups (better considered through Table 4). Nor does it replace critical thinking of the unique problem at hand which can influence both the approach appropriate to the situation and the end user needs requirements, as evidenced in Table 2. In addition, it might not be appropriate to follow Table 5 in complex situations, where the complexity of the flooding may dominate model selection.

Table 3: Outputs and Limitations of Modelling Techniques

Model	Data requirements	Spatial outputs		Temporal outputs		Assessing Changes in Flood Behaviour	Limitations	Relative Cost
		Type	Reliability	Type	Confidence			
Simplistic – Hydrologic/ Hydraulic	• Coordinates • catchment size	Point data (rational)	Low	Only Peak	Low	Not suitable	• Steady state assumption (peak flow)	0.25
Pseudo 2D	• Coordinates • Surrogate information such as soil mapping	Map (GIS)	Low	Not related to hydraulic attribute	Low	Not suitable	• No hydraulics • Not as accurate in Australia • False sense of accuracy	0.5
Historic	• Historical flood record	Map	Medium	Only Peak	Medium	Not suitable	• Probability can be unknown	0.5
FFA	• Historical flood record	Point Data	High	Only Peak	High	Not suitable	• Not suitable on its own in most situations	0.75
1D – Steady state	• Cross sections • Hydrology • Gauged (some form of calibration) • Catchment topography information	Cross-sections (extent possible with add-on)	Medium	Only Peak	Medium	Some options	• Often steady state assumption can have large impacts on result • Limited reliable applicability	1
1D – Unsteady State	• Cross sections • Hydrology • Gauged (some form of calibration) • Catchment topography information	Cross-sections (extent possible with add-on)	Medium	Complete hydrograph	Medium	Some options	• Time consuming to build • Requires more interpolation of interpretation of results • Relatively easy to modify	1.5-2
2D Basic	• DEM • Hydrology • Gauged (some form of calibration) • Catchment landuse	v, d, h etc. spatially gridded	High	Complete hydrograph	High	Suitable	• Can give false sense of accuracy • Inaccurate input data can have larger impact on result if not checked properly	1.5-2
2D Advanced	• DEM • Hydrology • Gauged (some form of calibration) • Catchment landuse	v, d, h etc. spatially gridded option of range of spatial	High	Complete hydrograph at various locations	High	Suitable	• Inaccurate input data can have larger impact on result if not checked properly • Time consuming to build and modify • Relatively slow run time	2-3

Table 4: Model Appropriateness to End User Output Needs

	Modelling Technique						
Basic Model Outputs	Simplistic	Pseudo 2D	1D - steady state	1D – unsteady state	1D with add-on mapping	2D Basic (5)	2D Advanced
Flood Information at a Point Location (eg. Flood Level or Depth)	Yes	No	Yes (4)	Yes (4)	Yes (4)	Yes	Yes
Historical Flood Information (eg. Recorded flood levels)	No	No	Yes	Yes	Yes	Yes	Yes
Flood Levels	Yes (1)	No	Yes (2)	Yes	Yes (1)	Yes	Yes
Flood Profiles (eg. Flood levels along a river)	No	No	Approx.	Approx.	Approx.	Yes	Yes
Flood Depths	No	No	Yes	Yes	Yes (1)	Yes	Yes
Flood Velocities	No	No	Yes	Yes	Yes (1)	Yes	Yes
Spatial Flood Extent	No	Yes (1)	No	No	Yes (1)	Yes	Yes
More Complex Outputs							
Flood Planning Levels	No	No	Yes (1)	Yes (3)	Yes (1)(3)	Yes	Yes
Spatial Flood Information for a Range of Events	No	No	No	No	Yes (1)	Yes	Yes
Flood Hazard	No	No	Broad Brush	Broad Brush	Approx.	Yes	Yes
Flood Function	No	No	Broad Brush	Broad Brush	Approx.	Yes	Yes
Assessment of impacts of changes in the floodplain due to development, filling, or infrastructure crossing the floodplain on flood behaviour	No	No	Yes (6)	Yes	Yes(6)	Yes	Yes
Flood Information for Future Conditions (Climate Change/Land Use Changes	No	No	Yes(1)	Yes(1)	Yes (1)	Yes	Yes
Mapping Depicting Percent Chance of Flooding on an Annualised Basis	No	No	No	No	Approx.	Yes	Yes
Gauge Height/Elevations at which Structures are Overtopped	No	No	Yes (4)	Yes (4)	Yes (4)	Yes	Yes
Timing of Structures Overtopped including Levees and Bridges	No	No	No	Approx. (4)	No/Approx. (4)	Yes	Yes
Gauge Information (Related timing)	No	No	No	Approx. (4)	No/Approx. (4)	Yes	Yes
Inundation Timing of Properties/Access Roads	No	No	No	Approx. (4)	No/Approx. (4)	Yes	Yes
Levels/AEP at which Critical Access Roads are affected	No	No	Approx. (4)	Approx. (4)	Approx. (4)	Yes	Yes
Levels/AEP at which Properties are Affected	No	No	Approx. (4)	Approx. (4)	Approx. (4)	Yes	Yes
Levels/AEP at which Critical Municipal Structures (including pump stations, power sub-stations, water and wastewater treatment facilities, hospitals, schools, airports, and fire and police stations) are Affected	No	No	Approx. (4)	Approx. (4)	Approx. (4)	Yes	Yes
Assessment of Change in Flood Behaviour or Levels as a Result of Works	No	No	Some	Some	Some	Yes	Yes
Link between gauge height and inundation precinct	No	No	Approx.	Yes	Yes	Yes	Yes
Assessment of worst case flood outcomes such as levee failure	No	No	No	Approx.	Yes	Yes	Yes

(1) – Reliability issues
(2) – Peak only
(3) – With appropriate schematisation
(4) – Depends of Cross Sections
(5) – Reliability increased with detail and analysis
(6) *– Limited Ability*

Note: 1D modelling with add on mapping can be either steady or unsteady state

Table 5: Model Appropriateness to general End User Requirements

End User	Modelling Technique						
	Simplistic	Pseudo 2D	1D - steady state	1D – unsteady	1D add-on mapping	2D Basic	2D Advanced
Emergency Management	Few	Few	Some	Some	Some	✓	✓
Strategic Planning	x	x	Some	Some	✓!	✓	✓
Planning Controls	x	x	Some	✓ (1)(2)	✓	✓ (1)	✓
High Level Decision Makers	Few	Few	Some (2)	Some (2)	✓	✓	✓
Insurers	Few	x	Some (2)	Some (2)	Some (3)	Some (1)	✓
Community	Few	Few	✓ (1)	✓ (1)	✓ (1)	✓	✓
Flood Risk Manager	x	x	Some (1) (2)	Some (1)(2)	Some (1)	✓ (1)	✓
Flood Prediction	Few (4)	x	✓	✓	✓	✓	✓(4

x – Not Fit for Purpose
✓– Suitable
(1) – Some Aspects Broad Brush
(2) – with Mapping preferred
(3) – Depends on Schematisation
(4) – Point information only
(5) – Not fit for end use but can provided basis

Conclusions

This project aims to provide the linkage between the end users and the modelling approaches that are appropriate to their needs. It identifies what model outputs are typically required by each end user groups. Identifying the needs of all end users is one of the most important steps in the flood modelling process as this directly informs the appropriateness of the modelling technique. This can influence both the specification of projects and the availability of suitable information to enable end users to effectively fulfil their role in flood risk management. This can in turn influence the ability of the community to be more resilient to flooding.

References

Australian Emergency Management Institute (2014) *Australian Emergency Management Handbook 7: Managing the Floodplain Best Practice in Flood Risk Management in Australia*.

V. Meyer, C. Kuhlicke, J. Luther, S. Fuchs, S. Priest, W. Dorner, K. Serrhini, J. Pardoe, S. McCarthy, J. Seidel, G. Palka, H. Unnerstall, C. Viavattene, and S. Scheuer, 2012, Recommendations for the user-specific enhancement of flood maps In *Natural Hazards and Earth Systems Sciences*, 12, 1701–1716, 2012

WMAwater, 2014, *Development Of Practical Specifications For Mapping And Modelling Outcomes And Outputs Stage 1 – Comparing Model Capability And Using End User Needs To Guide Model Selection*, For NFRAG