DEFINING BEST PRACTICE IN FLOODPLAIN MANAGEMENT

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Abstract

With the upcoming release of the national best practice manual, "Managing the floodplain: a guide to best practice in flood risk management in Australia" (McLuckie, 2013) an attempt to define best practice in floodplain management around the country has been undertaken. While aspirational best practice is important to ensure the best outcome for the community. Within Australia, each state has its own floodplain management structure, for good reasons. As part of the review best practice has been defined for the following aspects of floodplain management: Mapping, Planning, Floodplain Management Measures, Risk, Evacuation and Warning and Strategic Management. The aim of this paper is to encourage full integrated floodplain management which considers a full range of risk and provide a simple chart for benchmarking best practice.

Introduction

With the upcoming release of the national best practice guideline to floodplain management ("Managing the floodplain: a guide to best practice in flood risk management in Australia" (McLuckie, 2013)) an attempt has been made to produce simple chart to determine what aspects of practice in a location confirm to best practice and how crucial are the aspects that have not been pursued. The first step in developing a simple chart or tool is to first understand the term best practice and how it applies to floodplain management. The second step is to examine aspects of floodplain management and to what extent they have been pursued.

The term "Best Practice"

The term best practice is not new to floodplain management as it was previously used in SCARM report 73, *Floodplain Management in Australia: best practice principles and guidelines* (CSIRO 2000). The term has been used in many diverse areas including health, education, business management and environmental management and has been subject to some criticism. Much of the criticism has revolved around the implied meaning that there is only one best practice and it is always the best approach or solution and that all other approaches are therefore poor practice. In the new guide to best practice in flood risk management in Australia this issue is clearly addressed. According to McLuckie (2013),

> *Best practice promotes understanding flood behaviour so that the flood risk to the community can be understood, effectively communicated and, where practical and justifiable, mitigated. It facilitates informed decisions on the management of this risk, and economic investment in development and infrastructure on the floodplain.*

The guideline (McLuckie, 2013) also clearly states that a sophisticated or consistent understanding of flood behaviour is not required across all areas of Australia. The

approach adopted in any location will depend on size and needs of the community, and the nature of the flood risk. The adopted approach can vary within a catchment with simpler approaches appropriate in less populated rural areas.

It is also recognised in floodplain management that effort should be focused were it is most needed, whether it is managing risk to existing development or future development.

The term best practice is referring to the principles and framework that need to be followed to produce appropriate outcomes for a location.

Measures

Floodplain management is complex because it involves the interaction of the natural environment, built environment and human behaviour. This makes measuring success difficult as only when interaction of all three components is considered can a fully functional floodplain management plan be produced. It is only in recent times that the human component has been properly considered. Floodplain management measures can provide communities with a false sense security and can exacerbate the evacuation problem.

Six key measures were identified that could be easily assessed to measure what extent the best practice process had been used. These measures are listed below:

- *Mapping* – the reliability and types of spatial information produced,
- *Risk* – to what extent flood risk has been quantified,
- *Planning* – the extent to which flood risk was incorporated into planning,
- *Floodplain Management Measures* – types and way floodplain management measures were produced,
- *Warning and Evacuation* – the extent to which warning and evacuation measures had been incorporated into the floodplain management process,
- *Strategic management* – how strategically floodplain management was being carried out.

Other important measures that where considered include the degree of community involvement and the communities understanding of flood risk. This type of measure is hard to quantify and can easily go backwards.

Mapping

Mapping is the spatial presentation of flood information and is a core output of a flood study. It is often the first thing people outside the sphere of floodplain management think about after a flood but is actually a starting point for floodplain management and not a solution.

Mapping can take many forms from very simple flood maps based on surrogate information such as soils to complex maps that convey information about the extent and probability of flooding and can even include the hydraulic characteristics of floods including velocity and depth. Velocity is used to define flood function. Complex maps can only be produced using computer modelling and where these models are calibrated and validated there is considerable confidence in the results.

Mapping based on surrogates

Where real flood data is limited or not available it is possible to produce maps based on flood surrogates such as soil. This type of map conveys no information about the probability of flooding and only provides an indicative Boolean extent based on the surrogate. The indicative Boolean extent could be considered as probably flood prone, flooded one side and probably not on the other. A further consideration is that surrogates such as soil are themselves spatially mapped from relatively course data. This mapping can be done by hand, guided by other variables such as surface slope, air photos and vegetation or by using complex surface gridding techniques that use a range of covariates. Ironically attempts to map flood extent directly from other variables for insurance and other purposes have failed. It is hard to see what benefit a transitional surrogate variable provides other than being already mapped. This type of mapping is challenging given the extreme variability in flood flows in Australia. It is also not possible to account for changes to the environment that affect flooding such as something as simple as a levee or as complex as land clearing. This type of map allows rapid assessment of broad areas but often provides a false sense of reliability.

Use of historical floods

Mapping based on historical flood marks and air photos has long been used in Australia. The historical flood extent for many NSW rivers was mapped in the 1980's and has proved particular reliable in Western NSW rivers. The major limitations with this style of mapping have been where irrigation is carried out, as laser levelling, irrigation delivery channels or even roads, bridges and railways have changed flood behaviour. These works tend to block flow paths raising levels elsewhere. One issue is that the probability of events often changes along a river.

Modelling of design floods

Where modelling has been carried out, spatially mapped design flood levels can be generated, this allows assignment of probability to flood extents and can lead to a detailed consideration of flood risk. Modelling allows hydraulic behaviour to be assessed and changes to the floodplain to be considered. Unless a model is based on good survey, calibrated and validated to observed events, there will still be considerable uncertainty about the mapping and ie. about the probability.

Mapping beyond extent and depth

Modelling allows the mapping of flood characteristics that are important to floodplain management including:

- Velocity,
- Hazard (depth x velocity),
- Function (flood way, flood storage), and
- Evacuation classification.

Ranking of maps

The Queensland Commission of Inquiry (referred to herein The Commission) also produced a hierarchy of mapping that can be used as a guide to best practice (Queensland Floods Commission of Inquiry, March 2012).

The Commission has ranked (note reverse order) the flood maps in order of appropriateness for use in land planning (Queensland Floods Commission of Inquiry, March 2012):

1. Flood maps which depict both the likelihood of flooding and the characteristics of flooding.
2. Flood maps which depict a number of different levels of flood likelihood, for example probable maximum flood, 1 per cent (Q100) and 5 per cent (Q20) and 0.2 per cent (Q500).
3. Q100 maps – flood maps which depict the 1 percent Annual Exceedance Probability alone.
4. Historical flood maps.
5. Queensland Reconstruction Authority interim floodplain maps.
6. Mapping using topography.

Using the above ranking and expanding upon it a proposed best practice hierarchy for measuring mapping is set out below:

1. Nil
2. Based upon soils only
3. Based on historic floods only
4. Mapping single flood extent based on probability
5. Mapping series of probabilities with consequences
6. Mapping hazard and floodways
7. Mapping evacuation zones and low flood islands to life, evacuation

Planning

Flooding is only one input into the planning process, but is often the most contentious. This arises from a desire to reduce flood risk to a single line or single set of controls when flood risk spans a continuum from nearly no risk to extreme risk. The most common approach is to draw a single line based on probability at the 1% AEP without a consideration of risk. Best practice involves careful consideration of all risk factors and how they will impact on people and the built environment.

This can be used to produce a best practice hierarchy for land use planning controls:

1. None,
2. Single planning level without mapping,
3. Planning level based only on historic events,
4. Planning level based upon historic or single event considering probability,
5. Flood Planning Precincts,
6. Flood Planning Precincts considering Emergency Management.

Risk

Risk is defined as:

> " 'The chance of something happening that will have an impact on objectives' (ISO 13000:2009). It is measured in terms of consequences and likelihood. Risk is based upon the consideration of the consequences of the full range of flood behaviour on communities and their social settings, and the natural and built environment" (McLuckie, 2013)

This can be used to produce a best practice hierarchy for risk:

1. No assessment of risk,
2. Probability only for one event,
3. Probability for a range of events,
4. Consequence and Probability for a limited number of events,
5. Full Understanding of Probability and consequence up to PMF, and
6. Full acceptance of residual risk and consideration in management.

Floodplain management measures

Often a flooded community focuses on structural mitigation works to reduce flood risk without a detailed assessment of all measures and without developing a detailed floodplain management plan. Good floodplain management is built round a full consideration of flood risk and will usually involve a mixture of structural and non-structural works with a full consideration of the residual risk. Residual risk needs to be communicated to the public, be tolerable and must involve input from emergency services.

This can be used to produce a best practice hierarchy for mitigation measures:

1. No mitigation works in place but risk significant,
2. Only structural floodplain management works (dams, basins and levees) based upon a design flood with no consideration of larger events,
3. Management measures consist of non-structural and structural works, and
4. Full Integrated floodplain management plan considering the full range of risk.

Emergency management and warning

Until recently warning and evacuation has often been treated as an afterthought in floodplain management with combat agencies left to deal with the residual risk. Best practice in floodplain management must consider evacuation risk and the role of the emergency services in dealing with residual risk.

In recent years there have been big advances in quality of the flood warnings and predictions provided by the BoM. Reliable rainfall forecasts allow emergency services to start planning and mobilize resources earlier. Ensemble forecasts will allow planning for a range of possible outcomes. There has also been significant advances in the planning process used by emergency services. These agencies have moved from a pure response role to active planning.

Historically most of the flood response planning was based upon previous local flood experience with much of this knowledge being formalized in flood intelligence systems. The major short coming in this approach was that larger events or different types of events could behave very different to those that have been previously observed. Flood

modelling and evacuation modelling tools can now supplement flood planning in a significant way.

Emergency services are now providing input into the land use planning phase to modify high risk development and expecting flood studies to properly categorise high risk areas such as low flood islands.

Best practice floodplain management must consider evacuation and warning from the beginning and the floodplain management profession needs to actively debate how the dividends from advances in warning and evacuation should be spent. It is possible that these advances will be used to justify putting more people at risk instead of lowering evacuation risk the same way structural works can create a false sense of security.

This can be used to produce a best practice hierarchy for evacuation and warning:

1. None,
2. General warning only,
3. Specific Warning only,
4. Specific Warning with General advice on consequences from mapping of areas at high risk, and
5. Specific Warning with Detailed Emergency Management Planning based on understanding of evacuation zones and low flood islands.

Strategic flood risk management

Much of the flood risk management in Australia has been reactionary with little time for a strategic approach. Serious legacy issues that demand immediate attention make it difficult for floodplain managers to find the time to take a strategic approach across a Local Government Area. Some well-resourced Council's are taking a strategic approach to floodplain management.

A proposed best practice hierarchy for measuring strategic management is set out below:

1. None
2. Anecdotal historic flood knowledge on individual catchments
3. Flood studies in some known problem areas
4. Floodplain management plans in some known problem areas and main new growth areas
5. Flood information bought together to inform decision making across catchments
6. Strategic understanding of risk and its management across the entire service area to identify knowledge and management gaps and prioritise studies and works

Effect of mapping on other best practice measures

A good understanding of flood behaviour is vital to good floodplain management and affects the quality of other measures. This understanding can generally be assessed by the quality of the mapping. The table below sets out how mapping limits the other measures.

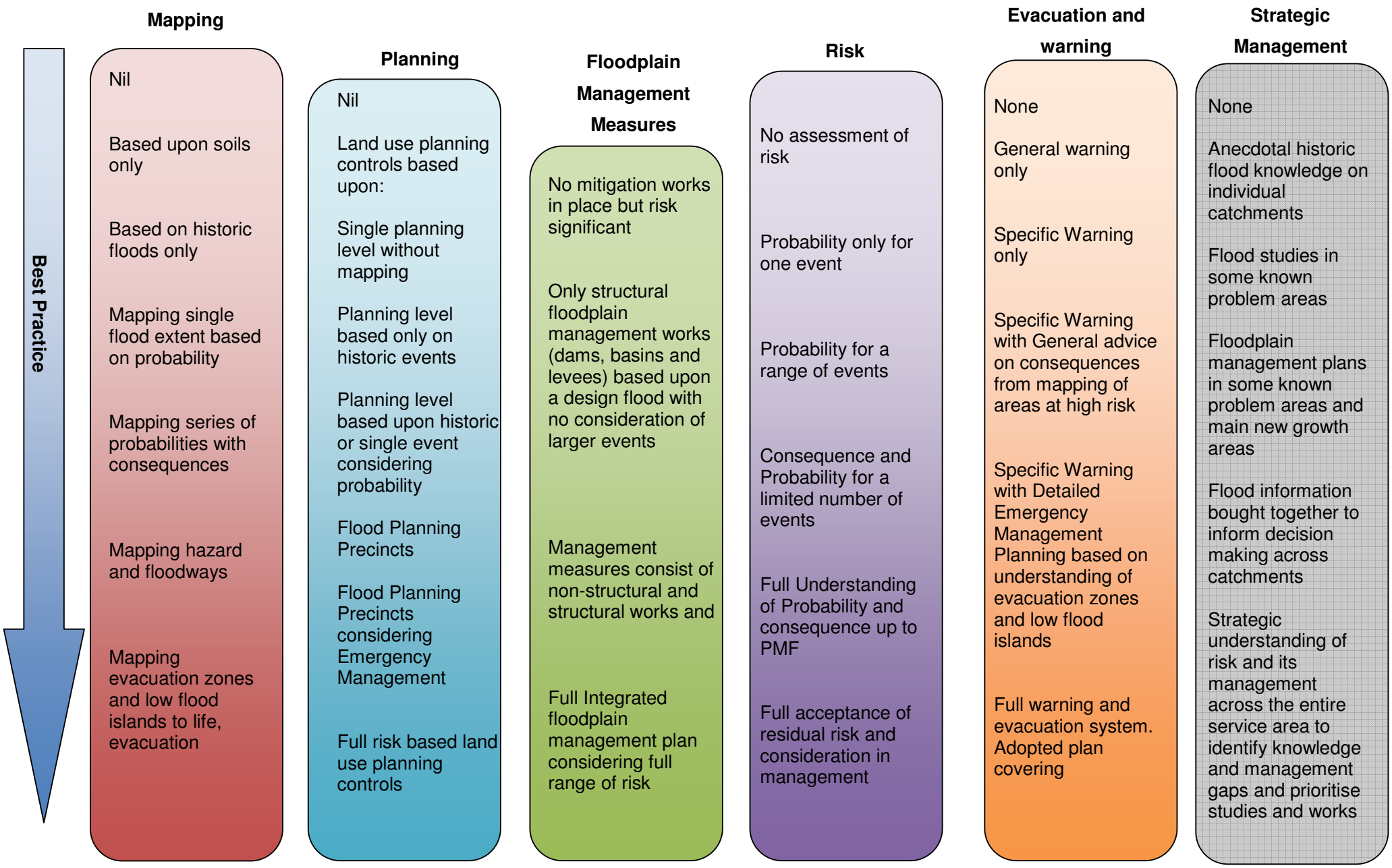
Table 1. Mapping's limits on other Measures

Mapping	Planning	Floodplain Management Measure	Risk	Evacuation and Warning	Strategic Management
Based upon soils only	Very limited	Nil	Nil	Nil	Nil
Based on historic floods only	Limited	Very limited	Implied	Very Limited	Nil
Mapping single flood extent based on probability	Limited	Limited	Very Limited	Very Limited	Nil
Mapping series of probabilities with consequences	Basic Planning precincts	Proper assessment of structural works	Yes	Limited	Limited
Mapping hazard and floodways	Planning precincts	Mix of structural and no structural works	Yes	Limited	Good
Mapping evacuation zones and low flood islands to life, evacuation	Planning Precincts that consider risk profile	Fully Integrated	Yes	Yes	Detailed

Figure 1 below summarises how best practice can be assessed. By drawing together these six categories a best practice assessment chart can be produced. A floodplain manager could use this type of chart to benchmark their practice and to assess whether there are benefits from improving certain aspects of their floodplain management practice.

Conclusion

This paper sets out a simple chart that can be used to benchmark and compare best practice. The chart presented in this paper represents a first pass at the complex task and could benefit from input.


Best Practice
Mapping
Nil
Based upon soils only
Based on historic floods only
Mapping single flood extent based on probability
Mapping series of probabilities with consequences
Mapping hazard and floodways
Mapping evacuation zones and low flood islands to life, evacuation
Planning
Nil
Land use planning controls based upon:
Single planning level without mapping
Planning level based only on historic events
Planning level based upon historic or single event considering probability
Flood Planning Precincts
Flood Planning Precincts considering Emergency Management
Full risk based land use planning controls
Floodplain Management Measures
No mitigation works in place but risk significant
Only structural floodplain management works (dams, basins and levees) based upon a design flood with no consideration of larger events
Management measures consist of non-structural and structural works and
Full Integrated floodplain management plan considering full range of risk
Risk
No assessment of risk
Probability only for one event
Probability for a range of events
Consequence and Probability for a limited number of events
Full Understanding of Probability and consequence up to PMF
Full acceptance of residual risk and consideration in management
Evacuation and warning
None
General warning only
Specific Warning only
Specific Warning with General advice on consequences from mapping of areas at high risk
Specific Warning with Detailed Emergency Management Planning based on understanding of evacuation zones and low flood islands
Full warning and evacuation system. Adopted plan covering
Strategic Management
None
Anecdotal historic flood knowledge on individual catchments
Flood studies in some known problem areas
Floodplain management plans in some known problem areas and main new growth areas
Flood information bought together to inform decision making across catchments
Strategic understanding of risk and its management across the entire service area to identify knowledge and management gaps and prioritise studies and works

References

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