PREPARING BALLINA SHIRE COUNCIL'S FLOODPLAIN RISK MANAGEMENT PLAN – THE CHALLENGES

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Abstract

Ballina is a town of 18,000 people at the mouth of the Richmond River in NSW. In 1997 Council completed a 1D model flood study which identified the nature and extent of its flood problem. The flooding problem is complex due to interaction of the Richmond River, local catchment and ocean events. The study also considered the impact of "anticipated" development in the area. High flow areas and their connectivity with adjacent river and creeks were designated. To address adverse flood impacts due to cumulative development Council commenced an approach where the cumulative impact of development should not exceed 50mm in the 100 year ARI flood. External use of the model by others prevented a consistent approach.

2D modelling of the Ballina floodplain since 2007 introduced some transition issues with new and extensive data. Also the cumulative impact approach became difficult to manage due to development pressures and this included the construction of the Ballina Bypass, a state government project. The 2D modelling also included the potential implications of climate change on flooding behaviour in Ballina.

Council is now finalising a floodplain risk management study and plan for its entire shire. The management study considered a range of measures from flood modification, property modification to response modification. For Ballina, planning and development controls still provide the best mechanism for adaptive management of the adverse flood risk in a changing climate.

This paper highlights the issues and problems Council encountered in the preparation of a well conceived Floodplain Risk Management Plan. The challenges ahead are clear. Future flood damage costs are bound to increase and future floodplain development should therefore not exacerbate it and give consideration to evacuation capability. Community engagement with respect to climate change and flooding will be significant, given no major flooding and evacuation in the last few decades.

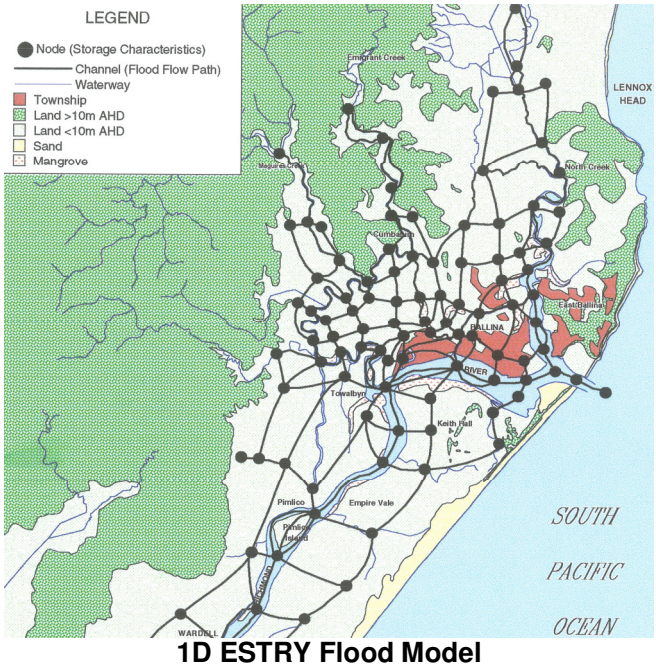
Introduction

This paper will present the roll-out of the Ballina Floodplain Risk Management Plan, which is now in draft form and has taken some 15 years since the first 1D flood model. The aim of this paper is to present a snapshot of the history and to present some practical outcomes regarding the process. The following table sets out the project's timeline.

YEAR	1995 – 1997	2000 – 2008	2005 – 2008	2009 – 2013
PROJECT	Floodplain Management Study – 1D model	Wardell & Cabbage Tree Island • Flood Study – 2D model • Floodplain Risk Management Study	Ballina Flood Study Update – 2D model	Ballina Floodplain Risk Management Study & Plan
OUTCOMES	• 100 year ARI flood level map • Revised flood policy and DCP • Scenario modelling and flood mitigation (floodways)	• Flood risk precinct mapping • Flood mitigation options • Revised flood policy and DCP (building control)	• 100 year ARI flood level map (plus other ARIs) • Sea Level Rise • Revised flood policy and DCP • Scenario modelling and flood mitigation schemes	• Sea Level Rise (2050 and 2100) • Flood risk precinct mapping • Revised flood policy and DCP • Flood mitigation schemes • Emergency management

1997 Floodplain Management Study - 1D flood modelling

In 1997 Ballina Shire Council (Council) completed a 1D (ESTRY) flood model of the lower Richmond River floodplain. The model extended from Ballina (the mouth of the Richmond River) to upstream past Wardell and Cabbage Tree Island, some 20kms. This was the first time that computer based modelling was used to determine flood levels. Prior to this it is understood that historical flood records of the 1950s, 1970s and 1980s was used to determine minimum fill height for building pads, which was the extent of Council's flood policy at the time. New IFD data was also prepared by the Bureau of Meteorology (BOM) based on an additional 20 years of rainfall data held at the Tropical Fruit Research Station at Alstonville.



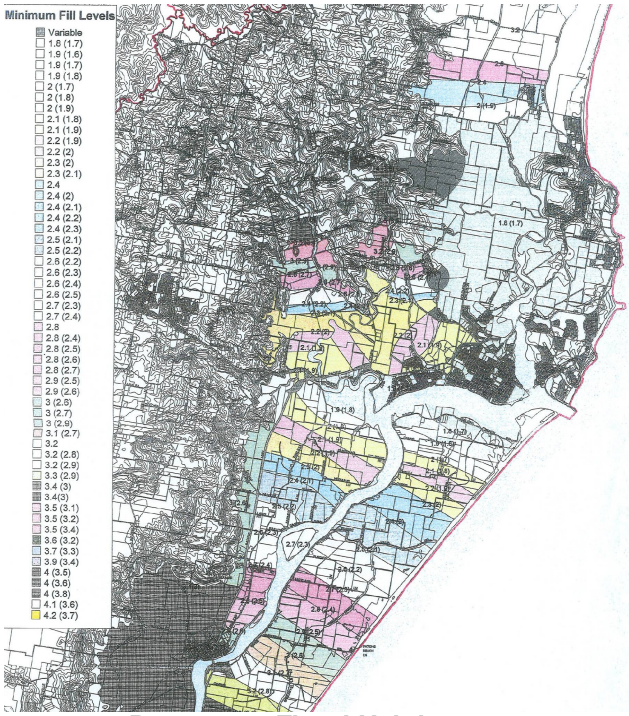
1D ESTRY Flood Model

The use of the 1D flood model introduced some new approaches:

- The use of the predicted 100 year flood height for minimum fill height
- The combination of three different flood sources, being Richmond River flooding, local catchment flooding and ocean storm surge
- The consideration of "future development" on the floodplain, being Council and NSW Government infrastructure as well as private development

The 100 year flood/fill height

The completion of the 1D flood model allowed for the presentation of new predicted 100 year flood heights. These heights were represented by way of contour plans (interpolated from node outputs) across the floodplain. Due to limited terrain survey the 100 year flood mapping represented flood levels only and not the extent of flood prone land.



1D 100 year Flood Heights map

Council's flood policy, being part of the Development Control Plan, was updated and the most difficult issue was dealing with the need for higher fill pads. The urban area around Ballina was "lifted" less than 200mm however the largest impact was experienced with rural areas south of Ballina where fill pads for dwellings were raised in excess of 1.0 metre. It is not surprising that significant negative feedback occurred regarding the introduction of computer flood modelling. The previous filling requirement south of Ballina was based on 1954 Richmond River flooding observations.

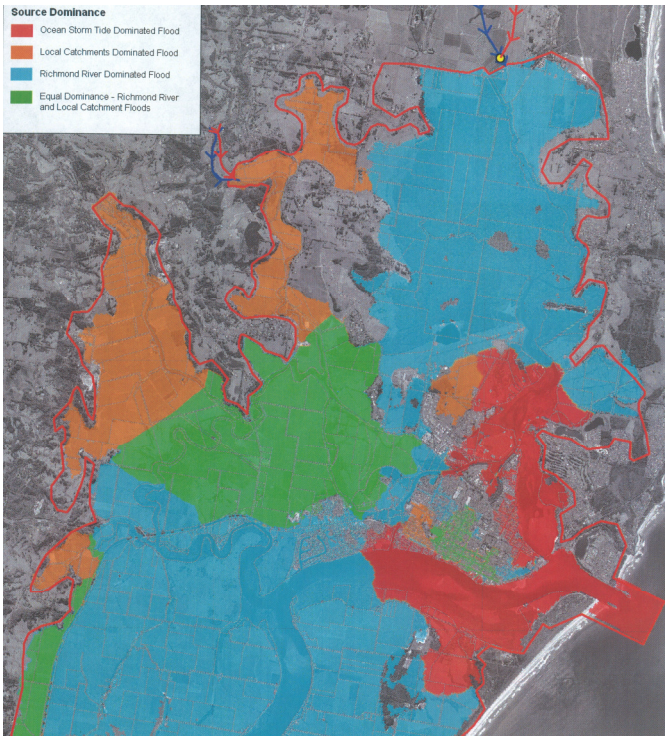
The creep in fill heights for flood protection purposes has continued with flood model development and climate change, and is discussed later in this paper.

Flood sources

The introduction of flood modelling at Ballina highlighted the influence of different flood sources.

- Richmond River flooding
- Local catchment flooding
- Ocean storm surge

The single 100 year flood map described above has been derived from mapping the results of the three flood sources, and taking the maximum envelope of the three overlaying flood profiles. At Ballina township the ocean storm surge event produces greatest flood levels and conversely further upstream the Richmond River event produces maximum flood levels.

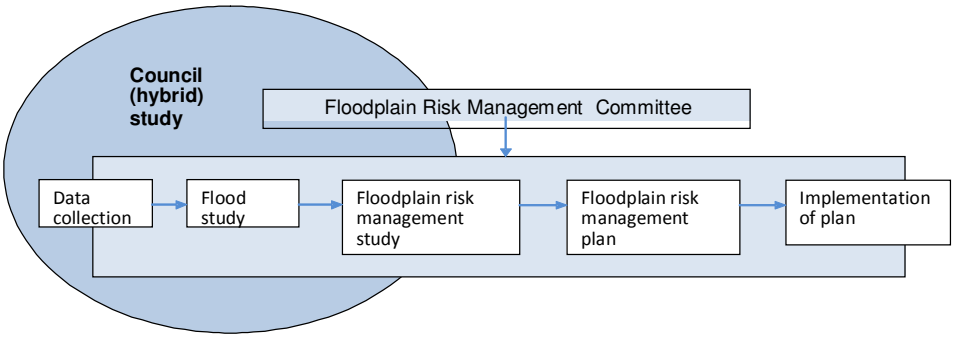


Dominance of flood sources

Future development and scenario modelling

During the development of the 1D flood model the town planning team at Council became particularly interested in assessing future urban and industrial development sites, and in part this was also due to interested landholders looking for rezoning opportunities. Furthermore regional and local growth plans were being updated. The base case flood model developed into scenario modelling where urban filling was shown to work or not work. The land filling scenarios identified flood mitigation measures (usually floodways and flowpaths) such that cumulative flood impacts across the floodplain would be limited to 50mm flood height increase. The technical merits of this quantum may be argued, however at the time the 50mm figure provided a baseline for assessment.

The NSW Government's Floodplain Development Manual process of completing a flood study and followed by a management study was short-circuited, and a hybrid study was produced due to "development pressures". Feedback from the industry showed this to be a unique process at the time.



Given the development of the flood model it was also felt that the knowledge base should be available for better community outcomes and the model was allowed to be used by third parties (landowners/developers). However there was inconsistent use of the flood model with respect to what was represented as the terrain model, and hence the assessment of developments for cumulative impact was lost. On the other hand the model was useful for example to show speculative developers that filling of a site at West Ballina could only proceed on 30% of the area. The use of the 1D flood model for this purpose was challenged, and Council undertook an independent peer review process to verify the integrity of the model and its application.

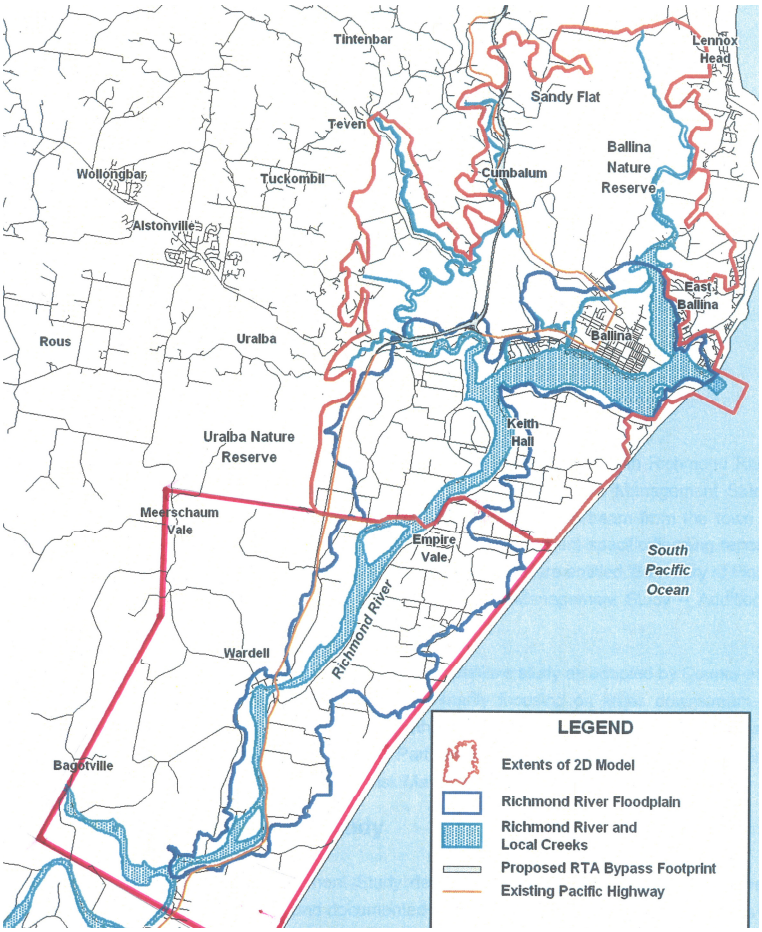
Outcomes of 1D modelling

The completion of 1D modelling and a hybrid flood study/management study provided Council with:

- A forecast 100 year flood map, which represented a new minimum fill map
- A revised Development Control Plan and Flood Policy
- Early flood mitigation schemes highlighting floodway and flow corridors

Introduction of 2D modelling at Wardell and Cabbage Tree Island

The next stage of implementing floodplain management processes occurred with the preparation of a floodplain risk management study and floodplain risk management plan for the upstream communities of Wardell village, Cabbage Tree Island and rural surrounds (1,800 population).



2D Model : Wardell (south) and Ballina (north)

The funding model required a tendering process, and a new consulting team and a new flood model (RMA2) was adopted. From a modelling perspective there was difficulty with embedding a new 2D (RMA2) model within a 1D (ESTRY) model and dealing with two consulting teams. However from a floodplain management study perspective the process of introducing flood hazard zones, undertaking flood mitigation assessments and engaging the small community of Wardell can be viewed as successful. Unfortunately the community of Cabbage Tree Island was unable to be suitably engaged during the process of the study largely due to Local Aboriginal Land Council issues, for example, the appointment of administrators. However, with the outcomes of the study and liaison with SES, grant funding for raising sections of Back Channel Road for improved flood evacuation was achieved.

The engagement of the community at Wardell introduced a revision to the current Flood Policy and DCP as it applied to Wardell. The compulsory filling of building pads for flood protection was applied across the Shire. The Wardell community promoted a change to building controls to not have filling compulsory, and to allow under storey flooding of engineered non-habitable spaces. This in part was stimulated by a village values study and heritage study. This policy change was limited to low hazard areas as some residential areas upstream of the Wardell highway bridge were high hazard and remained as fill only options.

Council has been active in assessing flood information as and when it developed and Council's policy for Wardell was changed following the public exhibition of the floodplain risk management study.

Outcomes of Wardell and Cabbage Tree Island 2D modelling

The completion of 2D modelling and a floodplain risk management study provided Council with:

- Flood hazard mapping
- A revised Development Control Plan and Flood Policy at Wardell
- Raising of low sections of Back Channel Road for improved evacuation of Cabbage Tree Island

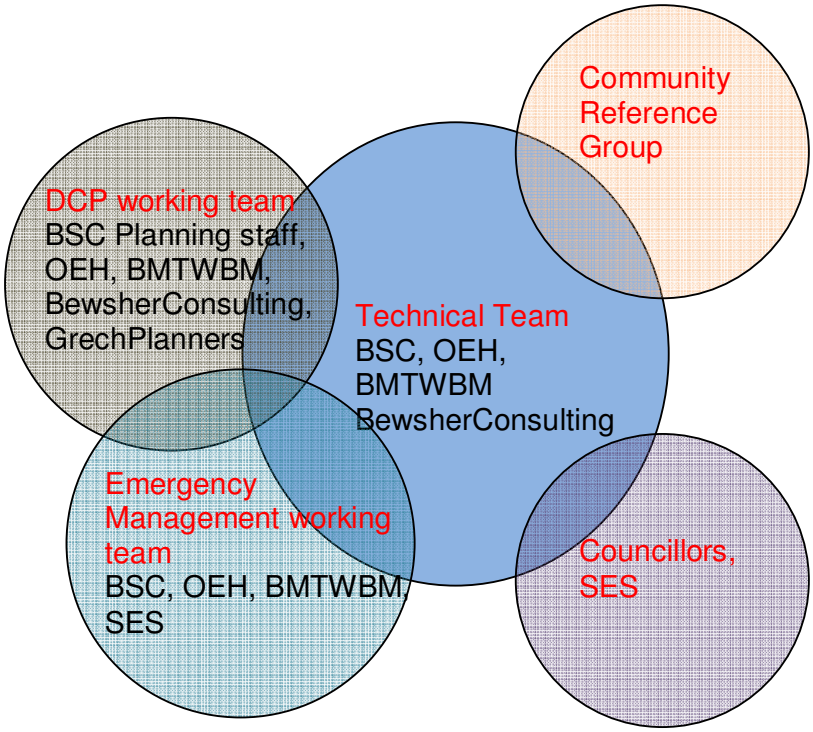
The Ballina Flood Study Update, Floodplain Risk Management Study and Plan process – 2D flood modelling

During 2005 the process to complete the floodplain management study and floodplain management plan for Ballina commenced.

The process comprised of two separate consulting engagements:

- 2005 "Ballina flood study update" being to convert the 1D flood model to include 2D(TUFLOW)
- 2009 "Ballina Floodplain Risk Management Study and Floodplain Risk Management Plan" following the guidelines in the NSW Government Floodplain Development Manual

The framework for consultation within Council with the consulting team and with elected Councillors and the community is shown below:



At the time of writing, the above process has reached the stage where a draft Floodplain Risk Management Plan is nearing completion along with an accompanying draft Development Control Plan for floodplain management encompassing some new outcomes from the study and plan.

The following sections of this paper will deal with some specific issues and areas of interest regarding the above process since 2005. This will include:

- Community engagement
- Converting 1D to 2D
- Continuing to deal with development and the Ballina Bypass – Integrated Model
- Sea Level Rise
- Development Control
- Emergency Response and community education

Community engagement

A framework for community consultation has been in place across the Council organisation since the early 2000s. This comprises the establishment (and disestablishment) of Community Reference Groups (CRG) for specific projects, as and when required. For each CRG there are Terms of Reference established, which generally describes the consultative role of the CRG and the feedback process managed by the project team.

At the commencement of the flood study update (1D to 2D) in 2005 an advertisement calling for CRG membership had little response. A more targeted invitation was undertaken later in 2005 when flood model calibration was evolving. The invitation canvassed active community groups, Chambers of Commerce, real estate representatives, local consulting organisations and landowners who responded to the initial invitation round. Membership of the CRG was not restricted, and initially comprised up to 20 representatives being rural landowners, local consulting representatives and the local environment society.

A valuable outcome of the CRG process during the early stages of the project occurred with the reporting of the calibration of the 2D flood model. Rural landowners were able to verify the computer based flood model with their recollection of flood events they experienced in the 1970's and 1980's. This has been a 'legacy' of the project whereby the 2D flood model has largely withstood criticism due to support from respected long term landowners.

However, as the project developed and outcomes with respect to 'new' 100 year flood heights presented, and the strategy for dealing with developments emerged in the form of an integrated model, there was drop-off in interest from the consulting representatives. Consequently the CRG remained largely rural landowners who were rightly interested in limiting development on the floodplain, and preserving waterways and investigating choked waterways. This has reflected in the outcome of the study which proposes some waterway investigations.

The next stage of community engagement will include the public exhibition of the plan and DCP and the promotion of emergency response. A significant community education campaign is envisaged given the community has not experienced major flooding for many decades.

Converting 1D to 2D

The conversion of the 1D model to 2D model (1D/2D embedded with initial 40m grid) required new aerial laser survey and river bathymetry. Although the re-modelling process also included a community broadcast for fresh flood archive data, a small but

localised storm and flood event in mid-2005 allowed for a “more recent” calibration event to be considered.

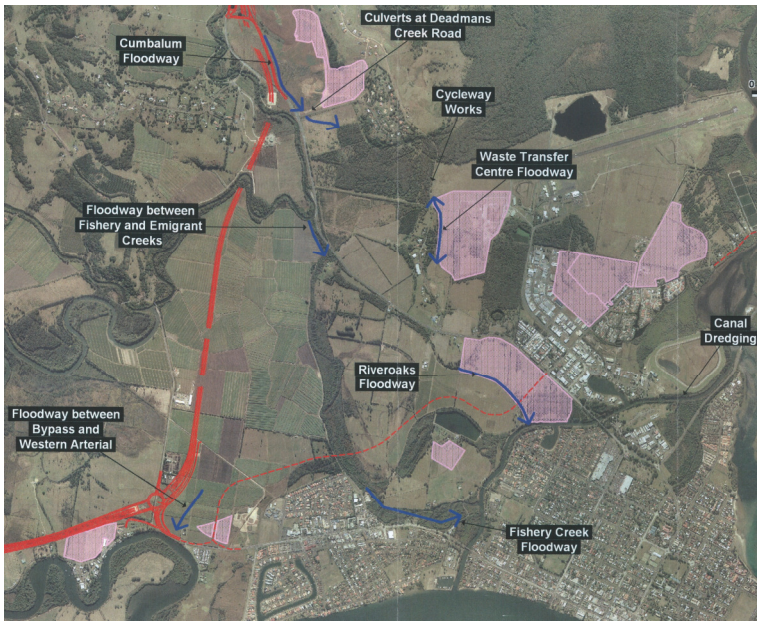
The new 100 year 2D flood mapping varied from the 1D flood mapping. This was anticipated due to the extent of additional data and more accurate estimations. Some parts of the floodplain (south of Ballina) showed reduced 100 year flood heights as a result of the conversion. It was determined that where the 2D flood heights fell below the old 1D flood heights then the old flood heights would remain. It was recognised that Sea Level Rise (SLR) calculations would shortly need to be embedded into the process given the forecast reporting timeline of the Intergovernmental Panel on Climate Change (IPCC). It was considered reasonable that flood heights should not be lowered and then possibly be increased. This required appropriate single source mapping to be made available for the purposes of Council use for flood planning policy and control.

Continuing to deal with development and the Ballina Bypass – Integrated Model

Similar to the development of the 1D flood model, the 2D flood model also replicated future planning scenarios and anticipated development due to the ongoing interest and pressure for urban and business/industrial growth. The 2D model included:

- Council planned public infrastructure such as future road improvements (West Ballina corridor and Lennox Head corridor), wastewater treatment plant upgrade and waste facility upgrade.
- Currently zoned developments or approved developments (particularly since the 1D model)
- Known development proposals (not zoned or approved)
- Ballina bypass project

The future development scenarios included mitigation measures as previously adopted.



Future development scenarios and mitigation measures

Floodway improvements

The 2D model was successful in identifying floodway deficiencies. For example the 1D model supported the Ferngrove development north of Ballina on the basis that the open buffer surrounding the Ballina waste water treatment plant remained for flood conveyance. The 2D model identified the need for a formed floodway. Similarly the Ballina Heights Estate received staged planning approval which included filling near to the existing Pacific Highway. The 2D model identified the need for a flood corridor up to 100m wide (which later also prompted the investigation and relocation of the estate's access road.) Both of these outcomes arising from the 2D modelling were able to be negotiated and implemented.

Richmond River dredging

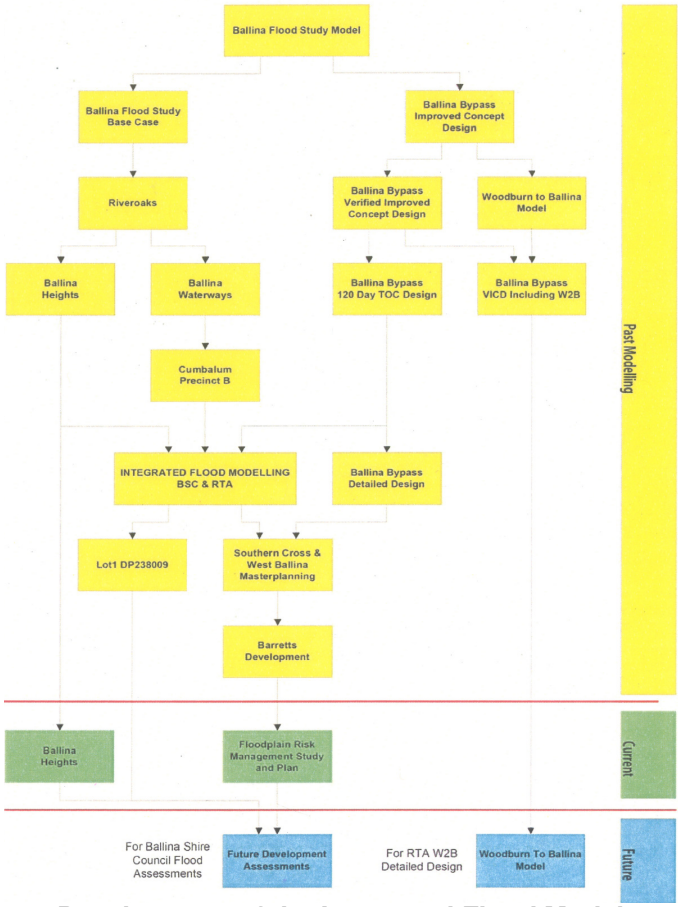
CRG and Councillor inquiries about the benefits of dredging the Richmond River and improving flood relief were able to be investigated. This showed a worsening of flood height predictions in and around Ballina due to the influence of the ocean storm surge event at Ballina.

Dredging assessment deepening Richmond River and North Creek

Management of the flood model

The 2D flood model was again considered for use by third parties. However strict protocols were established for its use. A fee for service system is established to recover costs. The request for flood modelling is made through Council and in turn the consulting team BMT WBM would update the flood model and ensure the assessment of impacts would be reported on a cumulative basis, and against the 50mm cumulative measure. Modelling of new developments would consider mitigation measures such as floodways where necessary to limit cumulative impacts, reorientation or downsizing and report accordingly.

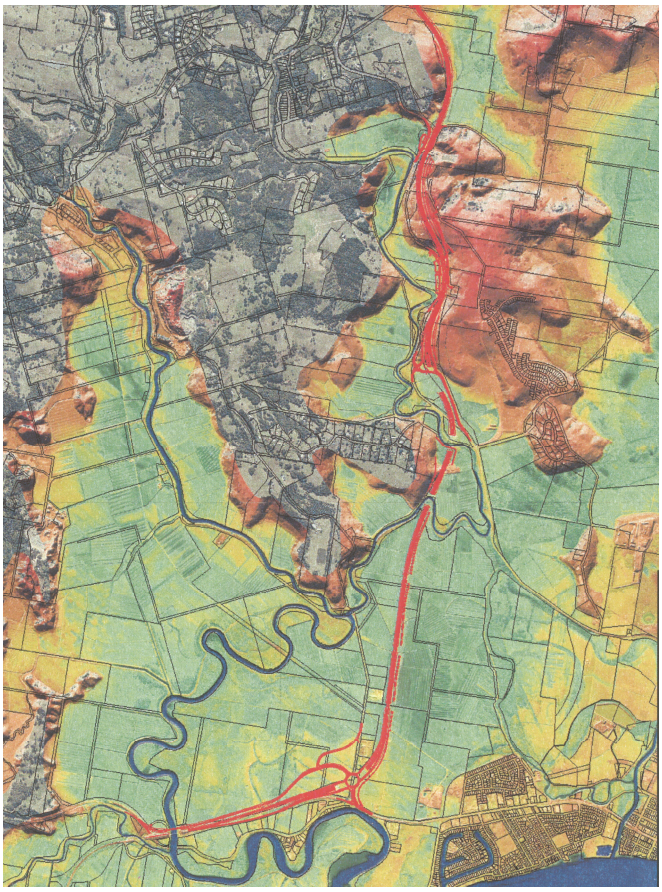
This dynamic approach to the use of the flood model led to the term Integrated Flood Model to describe the current stage of model development. Certain pinch points on the floodplain have been identified where the 50mm cumulative impact has been exceeded and in part this is due to State projects such as the Ballina bypass.



Development of the Integrated Flood Model

Ballina bypass project

The Ballina bypass project comprises a 12km highway bypass of Ballina to the west and north of Ballina. The project was built between 2006 and 2010 with a cost in excess of $600M.



Ballina Bypass

The state government planning approval for the project was issued circa 2000, and included conditions of consent dealing with limiting bypass flood impacts to 50mm. The flood impacts were assessed by the State with the bypass being a standalone project within the floodplain as it was at 2000. This approval did not recognise Council's existing approved development within the floodplain, let alone the proactive approach taken by Council in modelling future development scenarios. The flood impacts of the bypass project led to increased flood impacts over and above Council's 50mm cumulative benchmark. Overall this is viewed as an unsatisfactory arrangement where one arm of state government does not recognise the requirements of another. An outcome of the stalemate was that Council contributed to cost sharing for enlarging the bypass's Emigrant Creek overflow culverts.

Sea Level Rise

Sea Level Rise (SLR) was initially considered by the project team during the 2005 Flood Study Update. Based on existing IPCC publications and using a 50 year planning window an allowance of 0.2m ocean rise was adopted.

It was anticipated that the NSW State Government would take a position on SLR following the 2007 IPCC round of reporting. Accordingly the brief for the floodplain risk management study and plan included a requirement to reconsider the implications of SLR. In late 2009 the 0.4m and 0.9m benchmarks for years 2050 and 2100 were established. Although the benchmarks are now withdrawn by the current state government, Council has maintained the benchmarks with its own policy.

The floodplain risk management process has been addressing the implications of SLR for both flood immunity purposes and for future tidal inundation.

Flood immunity has traditionally been achieved with filling, and there has been significant creep over time with incremental increases to fill heights. There are practical issues associated with small blocks and high fill and vehicle and person access, notwithstanding the use of fill resource. The current fill height appears to be reaching practical limits in tight situations. Accordingly there is argument not to fill, and allow flooding of engineered sub floors.

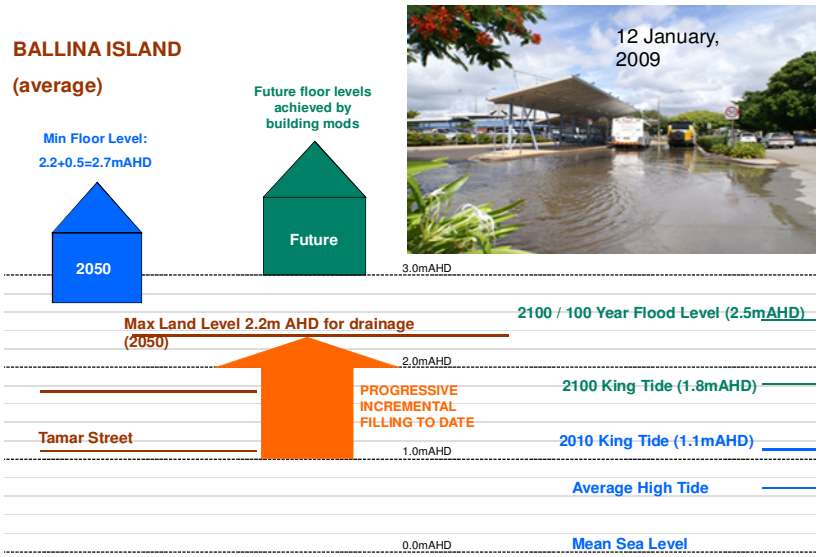
Old low area of Ballina and current fill policy (2008)

Year	Ballina Island (AHD)	Based on
Pre 1997	1.64	Historical flood levels
1997	1.8	1D flood model
2008	2.0–2.2	2D flood model
2010	2.0–2.2 and 2.5-2.7 (2100)	2D and SLR
2012	2.1–2.4 (2050) and 2.5-2.7 (2100)	SLR

Tidal inundation has also become part of the assessment because “Ballina Island” is characterised by old low lying areas with ground levels less than 1.5mAHD in parts. Localised overland flooding as well as drainage backflow occurs now during king tide events. The 2D modelling of king tide events for 2100 shows that tide levels of up to 1.8m AHD will surround Ballina Island and low lying land.

The approach taken with the floodplain management study recommend:

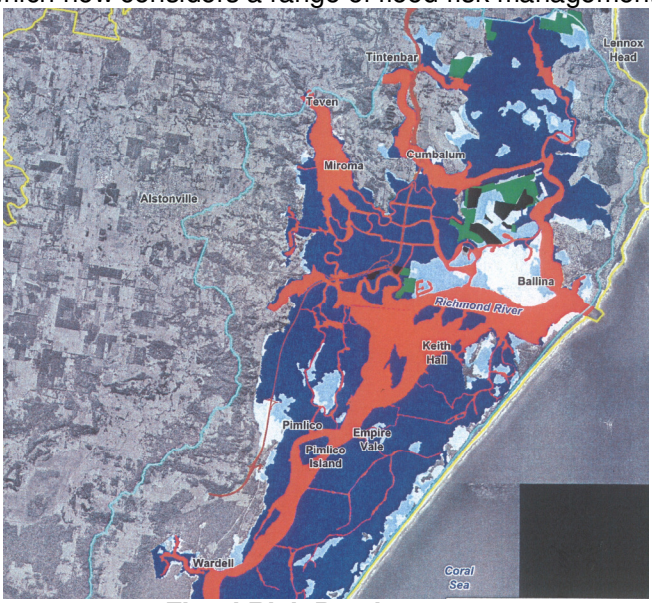
- For infill development the continuation of the fill policy to 2050 levels for the purposes of protection of private property from tidal inundation due to SLR. This allows for some freeboard regarding the 0.9m SLR projection.
- For infill development the continuation of the fill policy to 2050 levels for the purposes of protection of private property from 100 year flood events. This offers an average protection during the projected SLR period.
- For greenfield development the continuation of the fill policy to 2100 levels for the purposes of protection of private property from 100 year flood events. This covers the full SLR projection.



The floodplain management study has secured a short to medium term approach to dealing with flood risk and SLR for private development which is not too dissimilar to the current approach. The challenge ahead lies with the assessment of public infrastructure and adaptive measures dealing with SLR. This is likely to require the further development of the 2D flood model to include for stormwater networks and to consider a range of mitigation and adaptive measures for SLR alone.

Development Control

A challenging aspect of the project has been to provide a better alignment with existing and proposed planning outcomes. A shift to the preparation of flood risk precinct maps was viewed as providing a clearer direction regarding desirable and non-desirable development. It can be derived from previous sections of this paper that flood modelling was a key element to meeting flood planning objectives. The proposed flood risk precinct approach and associated flood planning controls has set a new standard within the shire which now considers a range of flood risk management objectives.



Flood Risk Precinct map

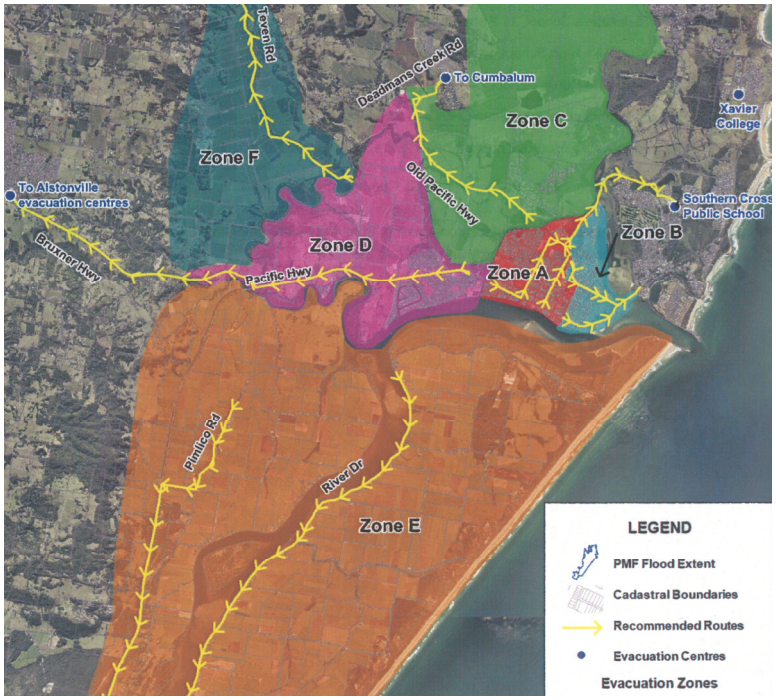
The flood risk map shows significant areas of rural land as extreme flood risk or high risk. This impacts significantly on the rural landowner and farmer. The DCP allows for re-development of existing rural farms and for development where building entitlements exist. Larger greenfield sites which may have previously been proposed as developments are now potentially viewed as not desirable according to the risk mapping. If proponents are inclined to proceed with development then rigorous assessment is demanded.

The above documentation has been on public exhibition during 2012 and the immediate feedback has been regarding the complexity of the documentation. The DCP is currently under review and will be resubmitted for public exhibition with the draft floodplain risk management plan.

Emergency Response and community education

Response to flood events and emergency management was critically assessed for Ballina for the first time as part of the floodplain risk management study. The work of SES "The Application of Timelines to Evacuation Planning" (Opper, 2004) formed part of the assessment. Of the three flood sources which affect Ballina only the Richmond River and the ocean storm surge event allow near sufficient time for an evacuation process. Evacuation for a local catchment flood event is not possible.

For evacuation to be effective mass communication is required and door knocking will not be able to be resourced with the time available. Also the method of evacuation needs to be strategically staged to optimise the limited escape route capacity. (The population of Ballina and West Ballina for evacuation planning is near 11,000 persons). These two requirements don't offer a comfortable outcome.



Evacuation routes and zones

The study identifies the need for improved flood warning, flood education and dissemination of information and a further assessment of evacuation routes to determine opportunities for improving evacuation.

The most challenging aspect of emergency management from this study is the need to engage, communicate and educate the community with respect to flood susceptibility and emergency response. There is a new and growing community which has not experienced any recent flood events, having had the last round of major flooding occur some 30 to 60 years ago.

Conclusion

The flood modelling process at Ballina commenced in 1997 with a 1D model being used to establish flood planning levels but quickly moved to management study issues such as modelling of development scenarios and identifying flood mitigation measures (floodways). Significant interaction with the development industry occurred. Further progression with 2D modelling was inefficient by taking two separate consultancies for two parts of the floodplain. Changes to state government funding programs would now allow a better whole of catchment staged approach.

The completion of the Floodplain Risk Management Study has seen the development of flood risk precinct maps which will provide an additional context to development on the Richmond River floodplain at Ballina. Previous studies have focussed on outputs such as flood planning levels without strong commitment to dealing with the appropriateness of development within the floodplain.

A disappointing aspect of the project has been the outcome dealing with the state significant project, the Ballina Bypass. Timing was an issue with both Council and bypass projects running parallel flood studies at the same time. However, it is considered short sighted for state government planning approval to be issued to the state government road authority without recognition of the pro-active floodplain management work of local government, (working under guidance of another state government office).

The consideration of sea level rise and flood planning together has led to the short to medium term solution to continue to fill to provide property protection of low lying land in and around Ballina. Sea level rise assessment by itself, without flood impacts, requires the existing low level land to be raised. This is due to the absence of other adaptive responses yet to be assessed for protection of works or for public safety due to sea level rise. This assessment forms part of the recommendation of the Study.

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