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REFINEMENT OF PROCEDURES FOR DETERMINING FLOODWAY EXTENT

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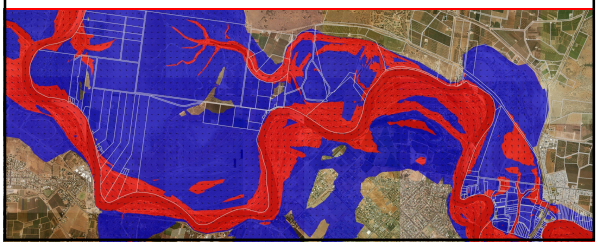

TOPICS TO BE COVERED

- What is a Floodway?
- Previous Consideration of the Issue
- Aims of this Paper
- Case Studies
  - Case Study 1 – Hastings River, Port Macquarie
  - Case Study 2 – Browns Creek, South Nowra
  - Case Study 3 – Main Drain 'J', Griffith
- Preferred Approach for Floodway Delineation
- Conclusions
- Future Directions / Considerations

WHAT IS A FLOODWAY?

- Those areas of a floodplain where a significant discharge of water occurs during a flood
- Areas of high flow conveyance that can often be identified by high flow velocity
- Areas that are often aligned with naturally defined channels
- Areas that if only partially blocked, would cause a significant redistribution of flood flow <u>or</u> a significant increase in upstream flood level

PREVIOUS CONSIDERATION OF THE ISSUE

- 1986 Floodplain Development Manual suggested floodways could be defined by:
  - determining the extent of encroachment that will cause a maximum change in water surface elevation of no more than 100 mm;
  - determining areas where the velocity / depth product is greater than 1; and/or
  - by the extent of the 20 year recurrence flood.

PREVIOUS CONSIDERATION OF THE ISSUE

- Howells et al (2004)
  - Floodways could be a function of velocity-depth product <u>and</u> velocity
  - Rigorous testing required to confirm a correlation
  - In absence of rigorous testing, no "one size fits all" approach for all types of floodplains
- Rigby (2007)
  - No known and universally accepted modelling procedure for determination of floodway boundaries
  - Need for a procedure to avoid:
    - varying interpretations by different practitioners
    - different outcomes for similar types of floodplains

PREVIOUS CONSIDERATION OF THE ISSUE

- 2007 Floodplain Risk Management Guideline on Floodway Definition
  - 1986 Manual approach inappropriate
  - No definitive method for defining floodway limits in models
  - Iterative Assessment Approach

Where to from here for Practitioners and Flood Management Committees?

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PREVIOUS CONSIDERATION OF THE ISSUE

- Thomas et al (2010)
  - Despite advancements in modelling tools and data-sets that define the floodplain, the assessment of floodways remains the domain of experienced practitioners
  - Recommended an Iterative approach that considers:
    - Section-averaged velocities at the peak and rising limb of the flood
    - Velocity-Depth (VxD) product
    - Floodplain topographic and Geomorphic features
    - Hydraulic Controls
    - The results of hydraulic analysis and / or flood modelling including blockage analysis or encroachment modelling
  - Approach tested and applied for one-dimensional creek system in Western Sydney

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PREVIOUS CONSIDERATION OF THE ISSUE

- Thomas et al (2010) Continued…

FUTURE DIRECTION

- Uniform methodology could be developed but would require further investigation
- The methodology would involve an iterative assessment, the steps of which require further investigation

Where to from here for Practitioners and Flood Management Committees?

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WHAT HAS HAPPENED SINCE THEN

- To build upon the 2010 paper by Thomas et al, by
  - testing the practicality of applying the suggested iterative procedure:
    - Case Study 1 – Hastings River, Port Macquarie
    - Case Study 2 – Browns Creek, South Nowra
    - Case Study 3 – Main Drain 'J', Griffith
  - reviewing and refining the steps outlined in the iterative procedure

OVERALL GOAL:

Develop a Uniform Approach for the Determination of Floodway Extents

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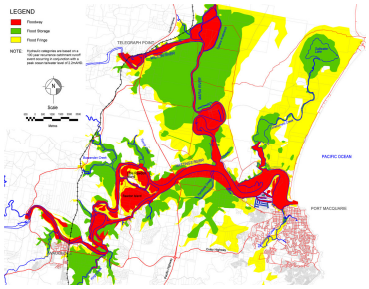
CASE STUDY 1

HASTINGS RIVER



Application of the iterative procedure to determine floodway corridors along the Hastings River

An initial application.

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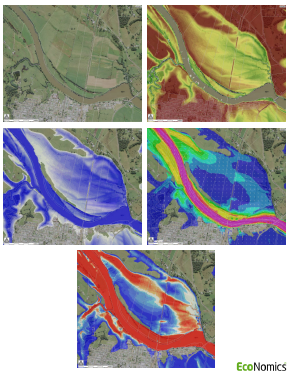
Determining a Preliminary Floodway Extent

Based on consideration of the full range of available data:

- **Aerial Photography**
- **Topo Survey (*DTM from LiDAR*)**
- **Flood Modelling Results**
  - **Depth Mapping**
  - **Velocity Mapping**
  - **Velocity – Depth Mapping (V x D)**



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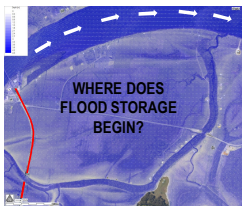
- Consideration of all of the available inputs sufficient to determine an initial estimate for most of the floodplain

  ==> Velocity-Depth product found to be most indicative of floodway extent

  IN THIS CASE!!

- Difficulty determining boundary between floodway and flood storage in areas where flow is two-dimensional and little variation in velocity / V*D

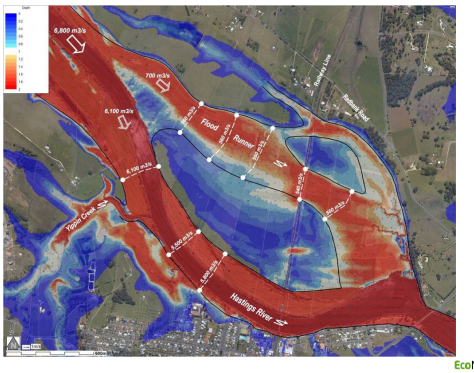


How to approach without undertaking timely and expensive flood modelling?

- Re-assessment of difficult locations based by considering distribution of flow

  ==> Greater Emphasis on CONVEYANCE

- Process:
  - Use of waterRIDE's Flow Extraction Tool
  - Where initial floodway extent determined with confidence, flows were extracted to determine the total flow conveyed within the floodway corridor
  - Application to numerous locations throughout floodplain established a correlation between the range of floodway indicators and the extent of the floodplain required to convey approximately 80% of total flows
  - Problem locations re-visited in order to determine extent of corridor required to convey 80% of flows

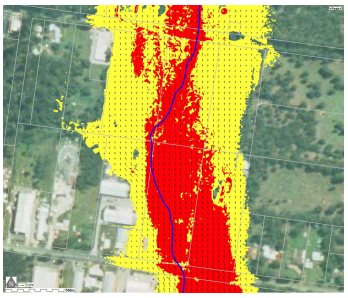


CONCLUSIONS:

- Iterative procedure generally sufficient to determine initial estimate of floodway corridor
- Difficulty experienced in locations where floodwater movement is highly two-dimensional and where large expanses of uniform velocities and depths
- Consideration of flow distribution incorporated as an additional step to the Iterative Procedure
- Extent of floodplain required to convey 80% of flows found to be indicative of the floodway corridor
- Blockage testing used to confirm floodway extent

CASE STUDY 2

BROWNS CREEK (South Nowra)



80% Flow Criteria…….

Is it indicative of the floodway corridor?

A Test Application

DETERMINATION OF PRELIMINARY FLOODWAY CORRIDOR BASED ON APPLICATION OF TWO METHODOLOGIES

- **METHOD #1**

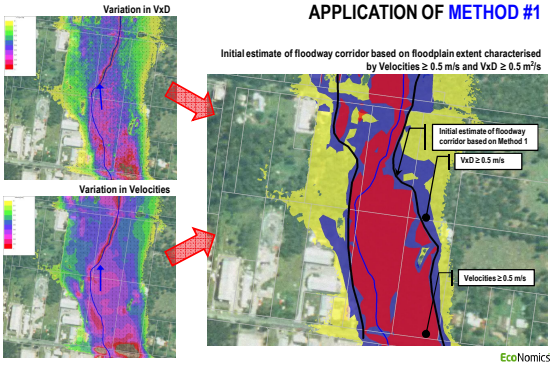
  Determination of a preliminary floodway corridor based on analyses of velocities and velocity depth product

  Initial estimate of floodway corridor considered to be characterised by:
  - Velocity-Depth product ≥ 0.5 m^2/s
  - Section averaged velocity ≥ 0.5 m/s

- **METHOD #2**

  Determination of a preliminary floodway corridor based on mapping of the 80% flow corridor

APPLICATION OF METHOD #1



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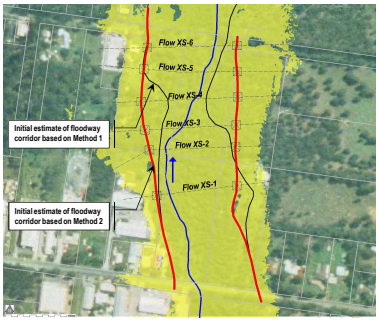
APPLICATION OF METHOD #2



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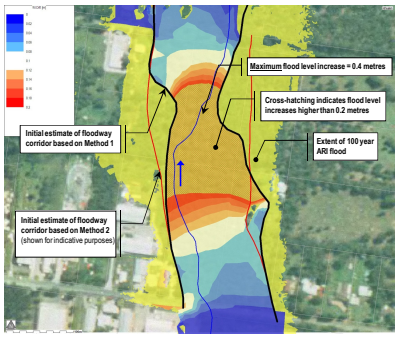
ENCROACHMENT TESTING OF METHOD #1



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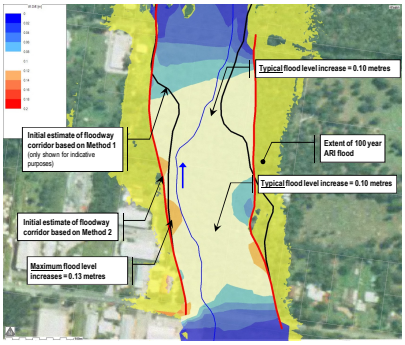
ENCROACHMENT TESTING OF METHOD #2



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CONCLUSIONS:

- Both Method #1 and Method #2 were found to be suitable for determining an initial estimate of the floodway extent
- Although both methodologies gave similar extents along the upstream limits of the test reach, some significant differences occurred further downstream
- Encroachment testing for both floodway corridors developed using Method 1 and Method 2 showed results that support placing greater reliance on Method #2.

  ==> Because flood level increases were generally around 100 mm.
- In Summary → **80% flow criterion provides reliable representation of the floodway corridor**

  → **BUT it is recommended it by applied as a step in the Iterative Procedure and not in isolation**

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APPLICATION OF THE REVISED ITERATIVE PROCEDURE

- **As part of the revised Iterative Procedure the following were considered:**

❑Location of flood storages that are readily identifiable from aerial photography.

❑Location and potential impact of hydraulic controls and geomorphic features that could influence flood characteristics.

❑Secondary drainage channels, which drain to Main Drain 'J'.

❑Variation in peak flow velocity.

❑Distribution of flow across the floodplain ~ 80% flow criteria.

❑What happens in events rarer than the 100 year ARI flood?

❑Testing of the floodway corridor using selective encroachment and/or blockage investigations.

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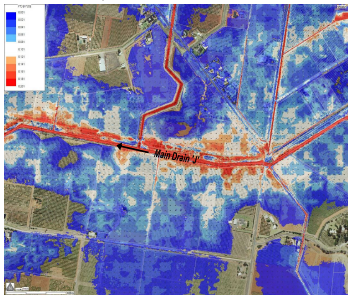
CASE STUDY 3

MAIN DRAIN 'J', GRIFFITH



Application of a revised version of the iterative procedure

==> Including 80% flow criterion

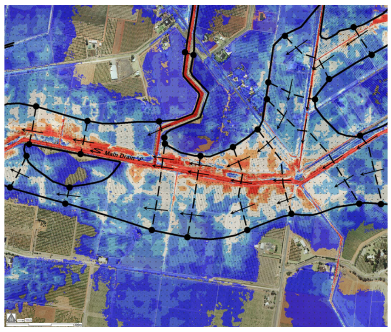
IMPORTANCE OF FLOODPLAIN TYPE

- **Main Drain 'J ==> Very flat floodplain WITH low gradient channel slope :**
  - Velocities less than 0.8 m/s within channel
  - Velocities less than 0.2 m/s along overbank areas
  - Velocity-Depth product less than 0.3 m^2/s in overbank areas
- **Very flat terrain**

  ==> difficult to identify flood storage areas
- **Limited variation in flow velocity across overbank areas**

  ==> difficult to identify floodway extent

CONSIDERATION OF FLOW DISTRIBUTION AND THE VARIATION IN VxD MOST SUITABLE



80% flow criteria found to be suitable for much of the floodplain

Some difficulty due to slow moving floodwaters – difficult to discern flowpaths and areas of concentrated flow

The variation in VxD found to be most indicative of flow paths.

A VxD of 0.1 m^2/s was generally found to be indicative of the floodway corridor.

OUTCOMES FROM CASE STUDY #3

- Application of the Iterative Procedure difficult due to very flat floodplain and low gradient channel slopes → Slow moving floodwaters, Velocities < 0.2 m/s
  → Low Velocity-Depth product, VxD < 0.3 m^2/s
- Assessment of topography and aerial photography difficult to determine any locations of obvious flood storages
- Limited variation in Velocities in overbank areas resulted in difficulty determining local flow paths and areas of concentrated flow
  - Consideration of the distribution of floodwaters found to be an important step in the Iterative Procedure
  - Determination of the extent of floodplain predicted to convey 80% of the peak flow found to be a reliable indication of the floodway corridor
  - Velocity-Depth values of 0.1 m^2/s found to be generally representative of the floodway corridor

PREFERRED APPROACH

- Revised Iterative Approach involves considering:
- section averaged velocity in the planning level flood at both the peak and on the rising limb of the hydrograph
- variation in velocity-depth product for the planning level flood
- topographic and geomorphic features
- hydraulic controls
- distribution of floodwaters

  ==> extent of floodplain predicted to convey 80% of the total flow
- the results of hydraulic analysis and / or flood modelling that incorporates a blockage scenario

CONCLUSIONS

- Iterative Procedure (2010) suitable for floodway delineation for most floodplains
- Assessment of the flow distribution found to be an effective step for the determination of floodway extents. Can be applied:
  - as a stand-alone step at problem locations, or
  - as a step in the iterative procedure

Suggested that the iterative procedure (2010) be revised to include 80% flow criterion

- Application of the Revised Iterative Procedure particularly useful for low gradient systems such as commonly found in Western NSW
- Flow Extraction Tool within waterRIDE ideal for obtaining flow data and carrying out analysis
- Revised Iterative Procedure reduces the additional modelling and cost associated with encroachment testing approaches to identifying and confirming floodway extent

ACKNOWLEDGEMENTS

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