Mapping of Floodways and Floodplain Development Zones Using 2D Models

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Overview

Different Approaches to zoning flood prone land

Approaches to delineating zones
  1D representation
  2D representation

Simple example for deriving Floodplain Development Zones

Tweed River, NSW, example
Zoning Flood Liable Land

For floodplain managers to make informed decisions, flood liable land needs to be zoned according to:
- risk to life and limb
- potential damage to property and infrastructure
- importance for conveying and storing (attenuating) flood waters

Future developments can then be confined to zones with:
- low risk of flooding
- ease of evacuation during an extreme flood
- low hydraulic importance to minimise flood impacts

**Flood Hazard Extent**

- **Distribution of Land Uses to Minimise Consequences**
  - Critical community needs e.g. hospitals
  - Elevated medium density and commercial
  - Open space and agriculture

- **Modify Building Design and Community Response to Minimise Consequences**
  - Environmentally friendly buildings
  - Car parking

**Extent of Floodplain**
NSW State Government, Australia

Floodway
- High conveyance (carries majority of the flow)
- High values of velocity and depth

Flood Storage
- High depths, low velocities
- Stores significant volumes of water
- Attenuates flood wave

Flood Fringe
- Shallow depths and/or low velocities
- Minor importance hydraulically

USA FEMA

Regulatory Floodways

“A Regulatory Floodway means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height [nominally 1 foot]. Communities must regulate development in these floodways to ensure that there are no increases in upstream flood elevations.”
UK Environment Agency (EA)

Zone 3: The 100 year fluvial event or 200 year tidal event
Zone 2: The 1,000 year event extent
Zone 1: The remainder (ie. > 1,000 year event)

Zone 3b: The “Functional Floodplain”
(usually initially derived using the 20 year flood extent)
Zone 3a: Remainder

There is some correlation with the NSW approach where “Functional Floodplain” (Zone 3b) would be similar to combining the Floodway and Flood Storage Zones. Zone 3a would be the Flood Fringe.

Future Urban Development

Where on the floodplain (if anywhere) can we fill for future urban growth?
Whilst minimising the flood risk AND the flood impacts.
Mapping Floodplain Development Zones

1D Modeling

Reduce conveyance of cross-sections so as to comply with the impact acceptability criteria.

2D Modeling

2D models don’t use cross-sections, therefore, conveyance is not readily quantified (especially in complex 2D flow patterns).

Use Velocity times Depth (VxD) to help identify:
- Floodplain Development Zones, and
- Floodway, Flood Storage and Flood Fringe Zones.

VxD is an excellent measure of hydraulic importance, and for mapping flood hazard categories (the higher the VxD value the greater the hydraulic importance and flood hazard).

VxD also known as Unit Flow or “q” and has units of m²/s or ft²/s.
Simple 2D Model

- Flood Depths
- Velocities
- Water Level Contours
- Development Sites

Impact Acceptability Criteria
- < 5cm rise at existing buildings
- < 10cm on other properties
- < 15cm increase in-bank

VxD Mapping

VxD Shades
- Green  < 0.1 m²/s
- Yellow 0.1 to 0.3
- Blue 0.3 to 0.5
- Orange 0.5 to 1.0
- Red  > 1.0 m²/s
Impact Assessments

Impact of Filling Entire Sites
- Green < 5cm increase in peak level
- Yellow 5 to 10cm
- Orange 10 to 15cm
- Red > 15cm

Unacceptable

Impact Assessments

Impact of Filling Areas where VxD is less than 0.4
Impact Assessments

Impact of Filling Areas where VxD is less than 0.5

Possible Solution

Left Bank Site
VxD < 0.4 and Boundary Adjustment

Right Bank Site
VxD < 0.5

Floodplain Development Zones
Revised VxD Mapping

Waterway between sites is now nearly entirely floodway

Nearly all VxD > 0.5 m²/s

Tweed River, NSW
Impacts from Filling Entire Development Areas

Process has been automated in TUFLOW so that the user simply assigns a max VxD value to one or more regions in a GIS layer.

Impacts from Filling VxD < 0.3

Process has been automated in TUFLOW so that the user simply assigns a max VxD value to one or more regions in a GIS layer.
Conclusions

VxD excellent parameter for helping define
Floodway, Flood Storage and Flood Fringe Zones
   Ideally suited to 2D modelling

Strategic Planning needs to consider
   Long term cumulative effects of development
   Define impact acceptability criteria
   Focus on developing where VxD is small (< 0.3 to 0.5m²/s)
   Optimal solution – minimise flood impacts and maximise development area

Need to consider other criteria
   Evacuation – exclude areas that become isolated
   Land-use changes (seasonal and perennial)