TUFCFLOW – An Introduction

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Overview

- TUFLOW Background & Recent Milestones
- TUFLOW Model Types and Applications
TUFLOW

- Stands for Two-Dimensional Unsteady Flow
- Also, solves full one-dimensional equations
- Solves the “Shallow” Water Equations (SWE) for modelling “long waves”, ie.
  - Tides, Storm Surges, Tsunamis
  - Floods (Rivers and Urban)
TUFLOW Solves ALL SWE Physical Processes

How Velocity changes over time

- Inertia Term
- Gravity

Coriolis Force

Atmospheric Pressure

Viscosity (Turbulence)

External Forces (Wind, Waves, …)

\[
\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} = c_f u + g \frac{\partial h}{\partial y} + g v \sqrt{u^2 + v^2} \frac{\sqrt{u^2 + v^2}}{C^2 H} - \frac{1}{\rho} \frac{\partial p}{\partial y} = F_y
\]
Inertia

- Very important where velocity
  - Speeds up or slows down
  - Changes direction
- Essential at structures and bends
Viscosity
Sub-Grid Scale Turbulence

- Important where bed resistance term not dominant and/or rapid changes in velocity gradient
  - Low Manning’s n values and/or deep water
  - Flow constrictions
- Smagorinsky formula preferred (varies coefficient based on velocity gradient)
- Many 2D schemes omit this term
- Never have to artificially increase viscosity for stability
Milestones

- 1989/1990 TUFLOW Developed and first applied
- 1991–2000 Applied to high profile 2D flood studies
- 2001 TUFLOW made commercially available
- 2004 Selected for London SS Inundation Study
- 2006 SMS and XP-2D interfaces released
- 2009 Most used 2D flood modeling software in UK
- Today used in over 15 countries and more than 400 organizations
2D Data Input Types
Background Imagery

- Needed as a background for developing the 2D model
  - Aerial Photos
  - Topo Maps
- Need to be geo-referenced
2D Data Input Types

DTM

- Ground or bathymetric elevations from DTM
- TUFLOW allows inputs from any number of DTMs
2D Data Input Types

2D Domain Extent

- 2D Domain
- Outer Extent (Rotated Rectangle)
- Used to create 2D cells
2D Data Input Types
Active/Inactive Areas

- Can use polygons to activate or deactivate areas
- Reduces output file sizes
- Reduces run-time
2D Data Input Types
Land-use (Materials)

- Polygons of Land-use Categories (Materials)
- Each material
  - Manning’s $n$ (Fixed or Depth Varying)
  - Rainfall infiltration losses
2D Data Input Types

**Boundaries**

- Flow vs Time
  - Side Inflow
  - Area Inflow
- Water Level
  - vs Time
  - vs Discharge
- Direct Rainfall
- Flow vs h
- Z vs Time
2D Data Input Types
Geometry Modifications

- Embankments (Levees, Roads, Railways)
- Landfill
- Excavations
- Land-use
2D Data Input Types
Flow Constrictions

- Modify 2D cells
  - Soffit/Obvert
  - Adjust cell-side flow widths
  - Additional energy losses (eg. from piers)
- Side wall friction (box culverts)
- Bridges
- Box Culverts
- Floating Decks
2D Data Output Types

- Water Levels (h)
- Velocities (V)
- Depths (d)
- Unit Flow (q)
- Several Hazard Categories (Zx)
- Energy (E)
- Froude No. (F)
- Flow Regime (R)
- Mass Error (MB1)
- and more...
Urban Areas – Buildings and Fences
Modelling Fences!

- Able to raise element sides
- Element sides wet and dry
- Layered parameters
  - eg. vary blockage and losses with height
- Collapse element sides
- Switch between u/s and d/s controlled weir flow
Collapsible Fences Animation
Modelling Blockages!?
2D Layered Adjustments

- Blockage = 0%
  - FLC = 0

- Blockage = 50%
  - FLC = 0.5

- Blockage = 100%
  - FLC = 0.8

- Blockage = 5%
  - Form Loss Coeff = 0.1
Detailed Urban Models
Detailed Urban Models

- 1,600 pipes / culverts
- 900 pits (drains)
- 600 manholes
- 1.8 million wet cells at peak
Flood Impact Assessments

CBD Levee Option
TUFLOW AD Module
TUFLOW MOR Module
GIS Based
Creating Models: GIS / Text Editor / Excel
Results: GIS / SMS / WaterRI DE / Excel
SMS TUFLOW GUI
TUFLOW Manual

- 550 pages
- Hyperlinked
  - Easy to navigate
- Very detailed
- Messages and Tutorial Wikis
TUFLOW Forum

- Post and reply to topics
- Receive emails of TUFLOW updates and announcements
- ~700 members
- www.tuflow.com/forum
TUFLOW In Summary

- Successfully applied to:
  - Estuaries / Coastal Waters / Storm Surges
  - Major Rivers
  - Broad-scale models (River/Streams 1D; Floodplain 2D)
  - Urban Flooding (Overland 2D; Pipe Network 1D)
- GIS Based / SMS Interface
- Pre-dominant 2D Flood Modelling Software in Australia and the UK