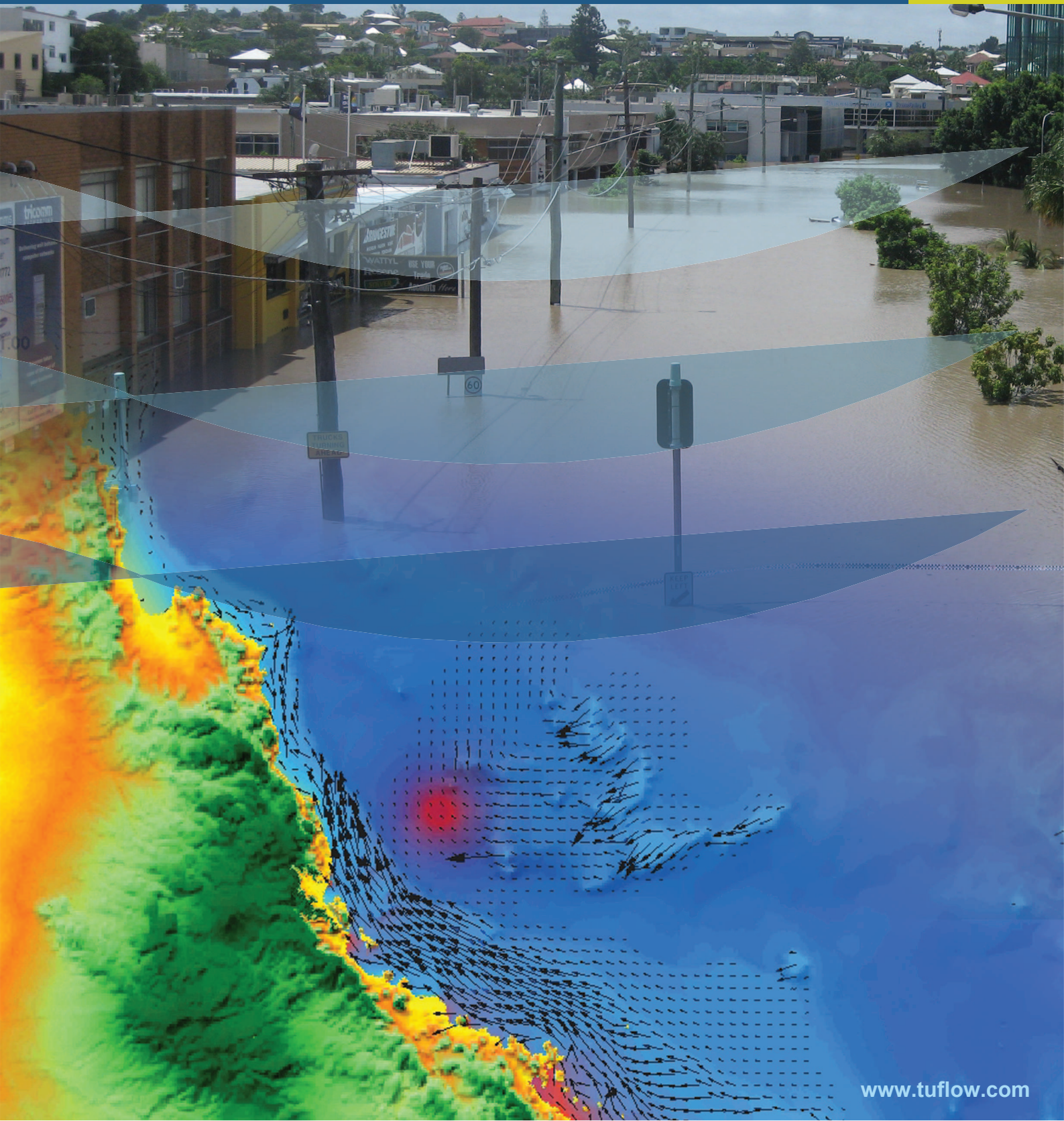
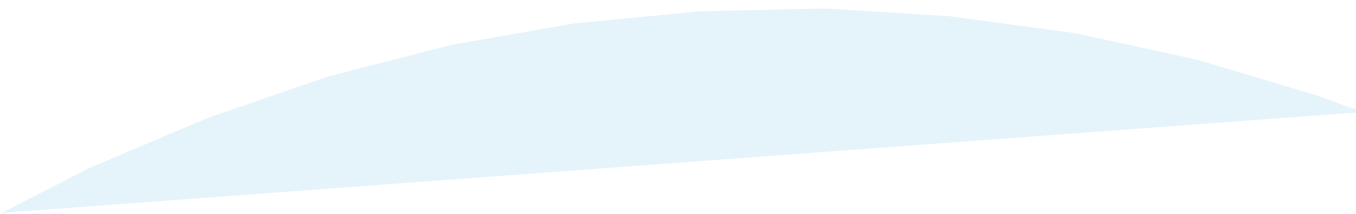


# TUFLOW

## Flood & Coastal Simulation Software



# Flood and Coastal Simulation Software





“

# Powerful, affordable numerical engines for flood and coastal modelling

”



## Contents

- 4 Our approach
- 5 Numerical engines
- 6 TUFLOW
- 9 TUFLOW AD
- 9 miTools
- 10 TUFLOW FV
- 12 Capabilities at a Glance

TUFLOW is a suite of numerical engines primarily for application to urban waterways, floodplains, estuaries and coastlines.

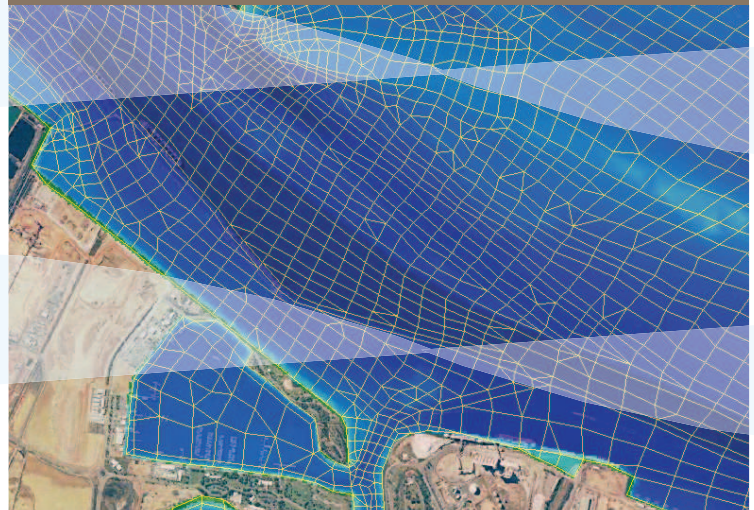
Our approach to software is grounded on two philosophies:

1

We develop numerical engines through collaborative efforts with universities and research organisations to ensure they are scientifically of a high standard and are thoroughly benchmarked.

2

We design software for the rigorous demands of consulting. This makes TUFLOW products useful, efficient, flexible and suited to the workplace.





At the core of TUFLOW products are two numerical engines:

1

### TUFLOW

Our flagship 1D network and 2D grid based software for simulating flood and tidal flow. TUFLOW's leading 1D/2D dynamic linking capabilities, robustness, established performance and wide ranging functionality, arguably make it *the world's most powerful 1D/2D hydrodynamic computational engine*.

2

### TUFLOW FV

Our new 2D / 3D flexible mesh (finite volume) numerical model that simulates hydrodynamic, sediment transport and water quality processes in oceans, coastal waters, estuaries and rivers. A *powerful engine proven at all scales*.

From here, we offer a range of additional modules and interfaces to suit most applications and study requirements.

Applicability at a glance:

Applicability						
Hydrology	Urban drainage and stormwater	Floodplains and rivers	Estuaries	River entrances	Coastal and nearshore	Offshore
TUFLOW	>	>	>	>	>	
<	<	<	<	<	<	TUFLOW FV



## TUFLOW

# A proven and reliable solution

Floods, storms and coastal surges cause extensive damage, stress, loss of life-and-limb and disruption. To understand and manage these risks requires software that accurately models inundation of rivers, urban areas and coastal floodplains.

TUFLOW meets this challenge effectively, reliably and within an economical cost structure. TUFLOW is the most powerful and affordable software for modelling:

- Flooding in major rivers
- Complex overland and piped urban flows
- Storm tide inundation of coastal plains
- Estuarine and coastal tidal hydraulics



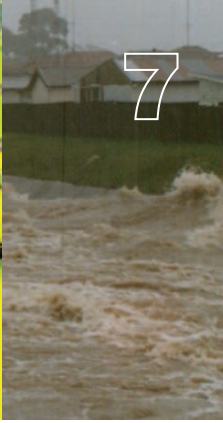
## Ahead of the pack

TUFLOW is a fully featured modelling platform that has been continuously enhanced, based on users' needs, since the 1990s.

Key Features are:

- Layered data approach - no data duplication
- Layers independent of 2D cell size and orientation
- Modify data easily for "what-if" scenarios
- Powerful topography modification tools
- Hydraulic structures in 1D and 2D
- Supercritical, weir and subcritical flow switching in 1D and 2D
- The best 1D/2D linking available
- Boundaries and 1D/2D links at any orientation and location
- Vary the 2D cell size and orientation using the multiple 2D domains module
- Easily manage events and scenarios
- Fast and reliable for real-world models
- Extensive range of outputs
- Advanced flood risk management analyses
- Extensive QA and mass balance outputs
- Comprehensively detailed manual
- Seamless integration with GIS platforms and third party graphical user interfaces
- 32 and 64-bit; single and double precision; regular releases
- Customise TUFLOW – create your own USER\_DEFINED.dll
- TUFLOW Tutorial/Demo models
- Active online TUFLOW Forum and Wiki





## Background

TUFLOW originated from a joint R&D project between WBM Pty Ltd and The University of Queensland to develop a 2D modelling system with dynamic links to a 1D system. TUFLOW stood for Two-dimensional Unsteady FLOW, but includes a highly developed 1D solution.

The project was successful and the software was widely applied by WBM within the Australian industry through the 1990s. Since 1997 there have been considerable enhancements to the software, especially for urban flood and pipe network modelling, and seamless integration with GIS platforms.

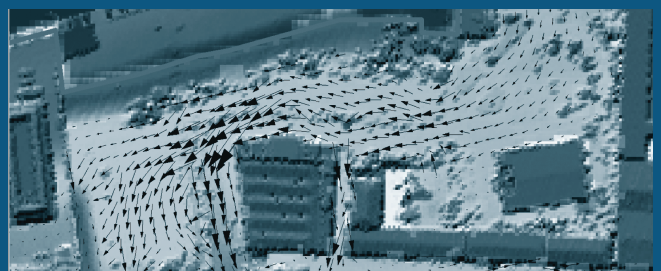


## Solution Schemes

TUFLOW's 2D solution is an enhancement of the Stelling finite difference, alternating direction implicit (ADI) scheme that implicitly solves the full 2D free surface shallow water flow equations over a regular grid. The 1D scheme is a finite difference, second-order, Runge-Kutta solution.

The 2D scheme has been improved to handle upstream controlled flow regimes (eg. supercritical and weir flow), bridge decks, box culverts, robust wetting and drying, and other key features.

The 1D solution includes detailed representation of rivers, floodplains, a range of structures, pipe networks, gully traps and manholes.



# TUFLOW

## Dynamic Linking

## Links to other software

- 

- 

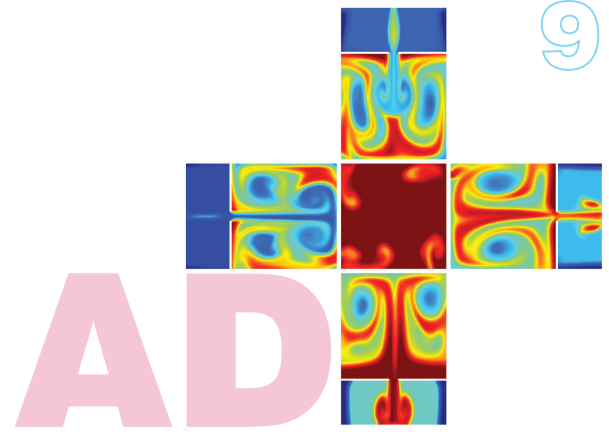
## Results/ Presentation

TUFLOW uses published formats to produce map, time-series and text based outputs of over 20 different data types including water level, velocity, depths, unit flow, energy, and customised flood hazard categories. 1D and 2D map and time-series output are combined and viewable via GIS, SMS, WaterRIDE and XP-2D software.

Modellers can readily:

- Display DEMs, aerial photography and other GIS layers in the background
- Create computer animations showing changes over time
- Interactively select and graph time-series output
- Produce high quality maps for reports and public displays
- Post process output using free utilities or by writing their own





## TUFLOW AD

TUFLOW AD (Advection Dispersion) is a module for simulating depth-averaged, 1D and 2D constituent fate and transport. Both dissolved and particulate constituents can be simulated, as can water temperature via a spatially variable atmospheric heat exchange.

It is applicable to:

- Mixing in inland waterways
- Fate of plumes
- Flushing assessments

The TUFLOW AD 2D advection solution algorithm is based on the third order ULTIMATE QUICKEST method. It solves the full two-dimensional, depth averaged, constituent conservation equation, including sink terms such as settling (for particulate species) and decay. The continuity equation is used to ensure conservation of mass.

Specific simulation features include:

- Support for all water level and flow boundaries
- Constituent decay for dissolved matter
- Constituent settling for particulate matter
- Water temperature and full atmospheric exchange
- Simultaneous handling of multiple constituents
- Automatic time sub-stepping to enforce stability of the scheme in terms of advective (CFL) and diffusive (Peclet) constraints
- Automatic computational stencil expansion using a 9<sup>th</sup> order scheme to maintain sharp constituent gradients where detected and reduce numerical diffusion
- Simple 1D components (full linked 1D solution under development)
- Linkages with third party water quality models

## miTools

miTools are a suite of utilities embedded within MapInfo to assist in setting up and reviewing TUFLOW models.

miTools have been developed specifically to improve the efficiency of setting up and reviewing TUFLOW models, as well as improving the day to day ease of using MapInfo Professional. The suite of utilities enables 'automation' of many of the common repetitive tasks, saving valuable time and therefore money.

The utilities also allow the efficient creation and visualisation of key TUFLOW model inputs/outputs within the MapInfo environment. Other tools provide data checking and quality assurance functionality, thus helping to minimise modelling errors.

miTools includes many new utilities and significant enhancements to earlier utilities. There are new TUFLOW utility interfaces, batch processing of cross-sections from DEMs, as well as TUFLOW layer styles.



# TUFLOW FV

TUFLOW FV is a 2D / 3D flexible mesh (finite volume) numerical model that simulates hydrodynamic, sediment transport and water quality processes in oceans, coastal waters, estuaries and rivers.

## Flexible Mesh

TUFLOW FV uses a flexible mesh, consisting of triangular and quadrilateral elements of different size and shape. Compared to a fixed grid approach, this has significant benefits for applications of complex geometry, or sharply varying flow and concentration gradients.

*The flexible mesh gives the modeller more scope to design a model domain that best suits the problem to be solved.*

## Interface

We use a range of 3rd party user interfaces that best suit our needs and are chosen according to usefulness and value for money.

To apply TUFLOW FV we recommend the SMS interface, developed by Aquaveo ([www.aquaveo.com](http://www.aquaveo.com)). This product is, in our view, the best pre and post processing tool available for flexible mesh modelling.

## Solution Scheme

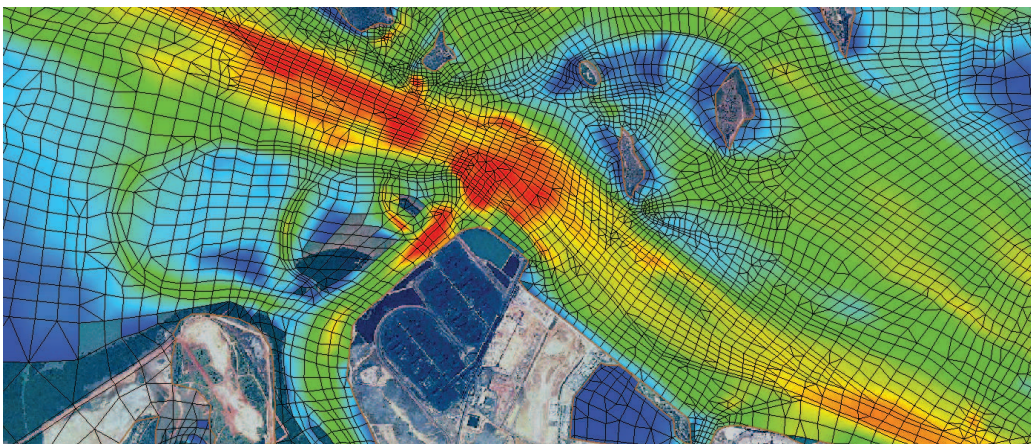
The finite volume numerical scheme solves the conservative integral form of the non linear shallow water equations (NLSWE). The scheme can also simulate advection and dispersion of multiple scalar constituents. The equations can be solved in 2D (vertically averaged) and 3D, and both 1st and 2nd order solution schemes are available. The solution scheme is explicit and uses a varying Courant dependent timestep.

## Speed

TUFLOW FV code is optimised and parallelised for multi-processor machines, using the OpenMP implementation of shared memory parallelism. It's as fast, or faster, than any other comparable model on the market today.







## Capabilities

Core applications are coastal and estuarine studies, tides and wave driven currents, cyclones and storm surge, flushing, dredge plumes and sediment transport. It is also suitable for flooding, river morphology and deepwater / ocean currents. A water quality module is currently under development.

## History

BMT WBM have been using flexible mesh models since the early 1990s and quickly recognised and utilised the benefits of the flexible mesh approach for complex coastal and estuarine modelling studies.

In 2006 we identified the need for a better tool than was currently available in the marketplace. Development of TUFLOW FV commenced and it is now the core modelling tool for coastal and estuarine projects.

## Specific Features

### *Flexible controls / interfacing:*

- TUFLOW FV inputs are controlled via a macro style text-file interface. This allows the user to flexibly and efficiently control model configuration, boundary condition specification and output requirements.

### *Open boundaries:*

- Fully open (non-reflective)
- Specified water level
- Specified discharge

### *Miscellaneous forcing:*

- Global cell inflows and outflows (e.g. rainfall, evaporation)
- Cell inflows/outflows (e.g. pollutant source/sinks)
- Wind stress
- Atmospheric pressure
- Wave radiation stress
- Holland parametric cyclone wind and pressure model
- Various gridded forcing (e.g. spatially and temporally varying wind, wave, etc)

### *Additional Modules:*

- 2D and 3D base models
- Advection Dispersion (with heat exchange)
- Cohesive and non cohesive sediment transport module (with morphological update)

## Capabilities at a Glance:



core capability,  
feature used frequently



able to do within product,  
feature used less frequently



in-house application / beta testing stage /  
under development

Capabilities			
Category	Feature / Capability	TUFLOW	TUFLOW FV
General	Grid (including nesting)		
	Mesh (triangular and quadrilateral)		
	1D / 2D Links		
	2D		
	3D		
Hydrodynamic (HD)	Structures		
	Pipe networks and urban drainage		
	Precipitation input		
	Wind field input		
	Wave field input		
	Links to global ocean circulation		
Advection Dispersion (AD)	Plumes and pollutants		
	Decay coefficients		
Sediment Transport (ST)	Mud transport		
	Sand transport		
	Sediment plumes		
	Morphological Update (Rivers)		
	Morphological Update (Coastal)		
Water Quality and Ecology (WQ)	Water Quality processes		
Other	Emergency flood response and evacuation		
Interfaces	GIS Environments (eg. MapInfo, ArcGIS)		
	ISIS-TUFLOW <a href="http://www.halcrow.com/isis/isis-tuflow.asp">http://www.halcrow.com/isis/isis-tuflow.asp</a>		
	SMS <a href="http://www.aquaveo.com/sms">http://www.aquaveo.com/sms</a>		
	XP Software <a href="http://www.xpsoftware.com/products/xp2d-module">http://www.xpsoftware.com/products/xp2d-module</a>		

www.tuflow.com

# TUFLOW



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