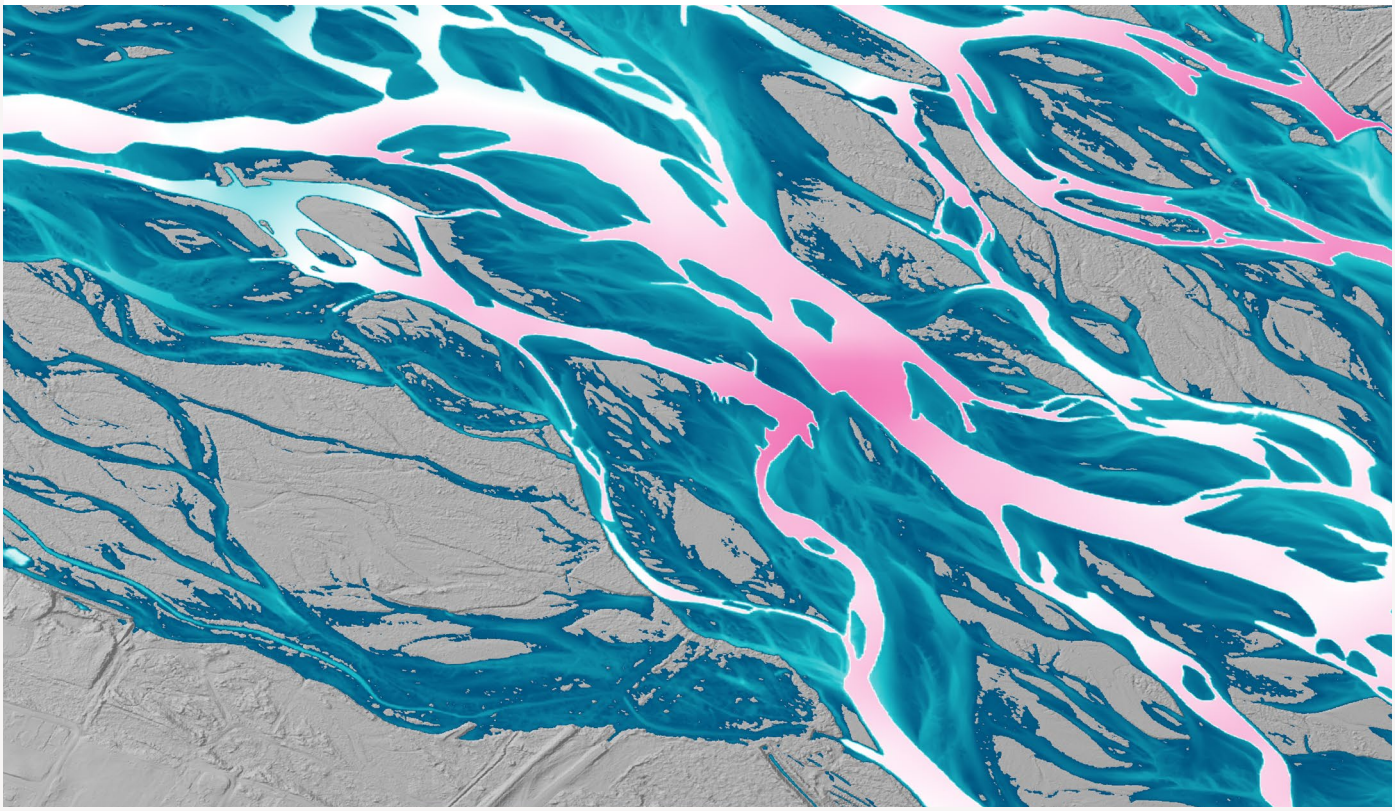
Agenda

TUFLOW United Kingdom / Europe User Conference

Bristol Zoo

21st - 22nd September 2021



Hosted by EdenvaleYoung BMT

Welcome

Welcome to the 2021 UK/Europe **TUFLOW** Conference. The world has changed significantly since the last conference in April 2018. We have seen climate change rise to the forefront of international policies as well as the Covid-19 pandemic both of which have wide reaching implications for the way that we work and live.

For these reasons, we have put together an exciting line up of presentations, workshops and round table discussions on the theme of a 'Change in a Changing World' focusing on the changing climate, the changing nature of flood risk management and the continued enhancements to **TUFLOW** to accurately analyse these changes.

We'll start the conference on the growing emphasis on climate change and how this effects our work with flood risk management.

I would love to be there in person but Covid won't allow that, so I'll present a live presentation beamed from Australia showing the industry leading enhancements to TUFLOW's hydraulic modelling capabilities in 2020 and under development for 2021.

Other presentation sessions over the two days focus on new and exciting applications of **TUFLOW**'s functionality in terms of whole of catchment modelling, coastal hydraulics and environmental modelling. A wide range of **TUFLOW** applications within in UK/Europe are scheduled from city-wide flood decision support systems modelling to simulating sea-lice to improve aquaculture operations.

In parallel with the presentations are a series of **TUFLOW** modelling workshops and round-table discussions covering: new developments, GIS tools, and for those who wish to improve their utilisation of **TUFLOW**, a workshop on python scripting to improve your workflow efficiency may appeal.

It's an exciting time to be **TUFLOW** modelling, and myself and the UK sales and support team look forward to sharing our recent developments with you.

Thank you for attending and enjoy the conference.

Bill Syme
TUFLOW Manager, **BMT**

Duncan Kitts
TUFLOW UK/Europe Lead, BMT

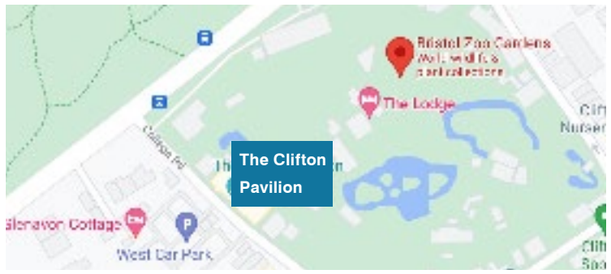
John Young
Director,
Edenvale Young

TUFLOW User Conference 2021 - Agenda

Venue Map

Getting here:
The Conference will take place at:

The Clifton Pavilion,
Bristol Zoo Gardens,
College Road,
BS8 3HH



The First Bus number 8 runs between Temple Meads Station, the city centre and the Zoo. Alight at the main entrance and walk around the corner to College Road.

If you do decide to travel by car - we have a small number of spaces allocated for delegates, please email Colette.linehan@edenvaleyoung.com to book your space.
Parking is provided in the West Car Park opposite the entrance to the venue.

If you prefer to avoid the morning rush hour, then The Wessex Bristol 505 Park & Ride service runs from Long Ashton Park and Ride.

Opening times and more information is available from http://travelwest.info/park-ride/bristol/505-long-ashton-southmead-hospital.

For further travel information visit TravelWest journey planner.

**The sessions blocked in green below are in the Garden Suite and all other plenary sessions and presentations are in the Clifon Pavillion Lecture theatre and also streamed online for virtual attendance*

Day 1 21st September

TUFLOW User Conference Programme

Time	Session
08:30 - 09:30	**REGISTRATION AND REFRESHMENTS**
09:30 - 09:40	**Conference Welcome and introductions** Duncan Kitts
09:40 - 10:10	**Welcome to the future: living and working in a climate-changed world** Duncan Faulkner-JBA Consulting
10:10 - 10:40	**Keeping our eyes on the prize** Will McBain-Arup
10:40 - 11:10	**REFRESHMENTS AND NETWORKING** Coffee with Bill Syme
11:10 - 11:45	**Changing nature of hydraulic modelling** Bill Syme-TUFLOW
11:45 - 12:30	**Climate change debate** David Balmforth (chair) Clive Onions, Will McBain, Duncan Faulkner, Gerald Morgan
12:30 - 13:30	**LUNCH**
13:30 - 13:50	**Uncertainty in design flood estimation and climate change** Thomas Kjeldsen-University of Bath
13:50 - 14:10	**Modelling natural flood risk management in both the urban and rural environment** Chris Whitlow-Edenvale Young
14:10 - 14:30	**Machine learning for real-time decision support in Bangkok** Sharla McGavock and Quy Vu-Mott MacDonald
14:30 - 14:40	**QUESTIONS AND ANSWERS**
14:40 - 15:10	**The many benefits of sub grid sampling** Duncan Kitts-TUFLOW
15:10 - 15:40	**Developing a TUFLOW FV model to support oil spill assessments in the Irish Sea** Rohan King-BMT
15:40 - 15:45	**QUESTIONS AND ANSWERS**
15:45 - 16:00	**REFRESHMENTS AND NETWORKING**
16:00- 16:20	**TUFLOW HPC – enabling continuous simulation of asset failure scenarios in development of asset maintenance strategies** Simon Jepps-Thomas Mackay
16:20- 16:40	**Making the case for change (Quadtree case study)** David Hughes-Waterco
16:40- 16:45	**QUESTIONS AND ANSWERS**
16:40- 16:50	**Wrap-up** John Young

Garden Suite sessions

Python scripting – improve your workflow efficiency
Ellis Symons-TUFLOW

New TUFLOW input/output file formats
Ellis Symons-TUFLOW

QGIS TUFLOW viewer and other tools
Ellis Symons-TUFLOW

GIS Mesher
Duncan Kitts-TUFLOW
Rusty Jones-Rising Water Software

TUFLOW User Conference 2021 - Agenda

Day 2 22nd September

TUFLOW User Conference Programme

Time	Session
08:30 - 09:20	**REGISTRATION AND REFRESHMENTS**
09:20 - 09:30	**Conference Welcome and Introductions** John Young - Edenvale Young
09:30 - 10:00	**Hydraulic, morphological and habitat modelling of a restored, dynamic, gravel bed river using TUFLOW FV** Eric Gillies - CBEC Eco Engineering
10:00 - 10:30	**Modelling sea lice infestation with TUFLOW FV** Mat Roberts and Dannny Kennedy - BMT
10:30 - 10:40	**QUESTIONS AND ANSWERS**
10:40 - 11:10	**REFRESHMENTS AND NETWORKING**
11:10 - 11:30	**What's new in TUFLOW FV** Mitchell Smith - TUFLOW
11:30 - 11:50	**TUFLOW FV water quality** Mitchell Smith - TUFLOW
11:50 - 12:10	**Environment Agency updated flood modelling guidance** Antoine Lebrun-Environment Agency Kevin Haseldine-JBA Consulting
12:10 - 12:40	**How sure are you? Quantifying uncertainty for scheme design** Adam Parkes - Jacobs
12:40 - 13:00	**QUESTIONS AND ANSWERS**
13:00 - 14:00	**LUNCH**
14:00 - 14:20	**Direct rainfall modelling: applications to headwater catchments using TUFLOW HPC. Limitations and benefits.** Chris Cameron-Hann-Aegaea
14:20 - 14:40	**Modelling land use change from forestry to peat, an approach for setting antecedent conditions for direct rainfall modelling** Brett Park-Wallingford HydroSolutions
14:40 - 14:50	**QUESTIONS AND ANSWERS**
14:50- 15:00	**REFRESHMENTS AND NETWORKING**
15:00- 15:30	**Into the future. What we have planned for 2021 and beyond.** Duncan Kitts-TUFLOW
15:30- 16:00	**Final Q&A Session,** Duncan Kitts and Ellis Symons-TUFLOW

Garden Suite sessions

Modelling for fish pass design
John Young and Peter Aylett - Edenvale Young

Representation of afforestation and peatland in direct rainfall models
Gerald Morgan – Edenvale Young

Is direct rainfall modelling accurate?
Duncan Kitts - TUFLOW

What would you like to see in TUFLOW?
Peter Aylett-Edenvale Young
Ellis Symons-TUFLOW

TUFLOW User Conference 2021 - Agenda

Abstracts - Day 1

Climate Change Keynote
Welcome to the future: living and working in a climate-changed world

Duncan Faulkner[1]
[1]JBA, Skipton, UK

Once upon a time, climate change was something that we expected to impact our future. Now we are living in that future. How does it compare with our expectations?

I will present results from a new trend analysis of flood flow data from UK rivers, asking whether trends are more likely on some catchment types and how we can know if the trends are caused by climate change. I will compare estimates of design flows for 2020 with those derived using pre-1990 data. How do the differences compare with the climate change uplifts we have been applying in the UK? Are the latest uplifts fit for purpose?

To close, some thoughts on whether Tesco offers a suitable slogan when it comes to climate change mitigation.

Keeping our eyes on the prize

Will McBain[1]
[1]Arup, Leeds, UK

As the impacts of climate change start to bite, client organisations are asking a great many questions of modellers that lie well beyond the realms of "how high do I need to build my flood defences?" There is a hunger for answers to questions about future hazard characterisation, natural flood management, long term morphological change, habitat evolution, carbon sequestration potential, design exceedance, residual risk…the list goes on. But we are effectively on a war footing tackling the environmental crisis. There has never been a greater need for us to deploy our available skills and resources wisely to make sure we're asking the right questions about the right problems. And this means keeping our eyes on the prize. My talk will elaborate on what we might usefully consider that prize to be. I hope to stimulate some thinking over the course of the conference about the crucial role of the modeller in formulating solutions that decarbonise infrastructure and improve the long-term resilience of both society and the environment.

Changing nature of hydraulic modelling

Bill Syme[1]
[1]TUFLOW, Brisbane, Australia

Whilst the equations that govern the physics of fluid flow have not changed, how our industry goes about applying those equations for hydraulic modelling is in a flux of change.

Firstly, the advancements in computational hardware have allowed us to increasingly break down or discretise the real world at finer and finer resolutions. This has brought great change and greater accuracy just like high resolution monitors have enhanced our visual experience of watching a movie at home.

Secondly, the other less clear change is how we go about solving the equations. For the flood modelling industry, we've seen progression from using the highly simplified 1D equations to the more realistic 2D equations, with often a combination of 1D and 2D being optimal. Whilst this was inevitable with the advancement of computers, what is not so transparent is how the 2D equations are solved.

Behind the easily produced and highly visual flood mapping images, there is a multitude of different approaches to solving the hydraulic equations, especially for the more complex 2D form. Many of these approaches, unbeknown to practitioners and decision makers, are often not fit-for-purpose.

However, for coastal and estuarine hydraulic modelling the proliferation or use of inappropriate 2D and 3D solvers is much less of an issue as accurate representation of the physics is paramount. The low friction, deep water environment requires good representation of inertia and turbulence, and therefore the solvers mostly used for coastal and estuarine hydraulics tend to be of high quality and accuracy.

When solving the equations for flood flows, where the flow is benign (i.e. slow moving), the more complex physical terms (e.g. inertia and turbulence) are often inconsequential, especially where the ground or surface over which the water is moving is rough and the bed resistance term (e.g. Manning's equation) dominates. In these situations, nearly all hydraulic solvers can produce a reasonable representation of flooding given accurate input data.

Where flood flows are not benign (i.e. fast moving; forced to change speed or direction; or over smooth surfaces), the accuracy of 2D solvers varies greatly. This is for two primary reasons:

- The numerical order of the solver's mathematics. For example, where the hydraulics are not benign, a 1st order scheme will be numerically diffusive generating a compounding error resulting in inaccurate results compared with a 2nd order scheme.
- The omission or poor representation of key physical terms such as inertia and turbulence.

A third reason exists that is related to model resolution, in particular the ability to utilise terrain and surface roughness data sub-cell. Whilst model resolution issues can be resolved by reducing the cell size smaller and smaller, this is rarely practical due to increased simulation times. The recent advent of sub-grid sampling (SGS) by some 2D solvers has greatly assisted with resolving this constraint.

The future of the flood hydraulic modelling industry is dependent on the industry using 2D solvers that are accurate under all flood conditions, not just when the flows are benign. The presentation backgrounds the evolution of hydraulic modelling and highlights current day innovations that are changing the flood modelling industry for the better.

Uncertainty in design flood estimation and climate change

Thomas Kjeldsen[1]
[1]University of Bath, Bath, UK.

The impact of past and future change in flood characteristics is of major importance for design flood estimation. In particular, the existence of change will potentially invalidate parts of existing methods and calls for new tools to support flood management. This talk will present the outcome of ongoing investigations into detection, attribution and implications for design flood estimation of trend and change in UK flood data. A new regional non-stationary statistical model based on the FEH pooling-group concept is presented. The new model is shown to provide more credible and robust estimates of design floods under change than possible using the corresponding single site analysis.

Modelling Natual Flood Risk Management in both the Urban and Rural environment

Chris Whitlow[1]
[1] Edenvale Young, Bristol, UK.

This talk focusses on the potential role of Natural Flood Risk Management (NFM) interventions to reduce flood risk in four catchments in Greater London, namely the Salmons Brook, Pymmes Brook, Edgware Brook (Harrow Headwater) and the Rise Park Stream. The project was undertaken jointly with Thames21 with significant input from staff from the London Borough of Enfield.

Four new direct rainfall models were developed and calibrated to available hydrometric data or flood extent data. The NFM measures considered were different amounts of woodland planting, river restoration, multiple rural SUDS measures, multiple leaky dams and constructed wetlands.

The hydraulic modelling results showed the relatively high level of effectiveness in terms of flood peak reduction over a range of return periods of extensive woodland planting in the upper reaches of the catchments as well as rural SUDS and constructed wetlands.

Machine learning for real-time decision support in Bangkok

Sharla McGavock[1] **and Quy Vu**[1]
[1] Mott Macdonald, Singapore.

Mott MacDonald has delivered a pilot Flood Management Decision Support System (DSS) in Bangkok as part of the FCDO Global Future Cities Programme. The DSS, delivered in Moata Smart Water, provide a central, easily accessible and visual single source of truth to enable better informed operational and maintenance decisions before and during severe rainfall events. Rainfall observations from existing radars in Bangkok were improved using rain gauge and Vertically Profiling Radar data, facilitating automatic quick generation of accurate near real-time rainfall maps and operational Nowcasting.

A real-time surface water flood forecasting system was developed by applying machine learning to a TUFLOW-ESTRY hydraulic model and using rainfall Nowcasts as an input. These observations and predictions are integrated in the DSS, with a spatial interface and dashboard for interrogation. Alarms provide early warnings to Bangkok Metropolitan Administration (BMA) to inform operational response, improving BMA's ability to prepare for and respond to surface water flooding.

This presentation will provide an overview of the project including the radar improvements, hydraulic modelling and machine learning undertaken to deliver real-time flood forecasts.

TUFLOW User Conference 2021 - Agenda

Abstracts - Day 1

The many benefits of sub-grid sampling

Duncan Kitts[1]
[1]TUFLOW, Leeds, UK

Sub-Grid Sampling is an exciting new addition to the TUFLOW functionality. It provides the ability to represent all available topographic data within a digital terrain model regardless of the model cell size.

This representation of the sub-grid level topography has numerous benefits from the modelling of open channels to the simulation of whole catchments and really opens up the possibilities for hydraulic modelling across all scales and for a range of applications.

A number of applications will be presented to show the benefit of sub-grid sampling in terms of eliminating sensitivity to mesh orientation as well as significantly reducing the sensitivity of results to mesh size.

These benefits will be described for a number of applications including:

- The full representation of high-resolution bathymetry data, making modelling of open channels, something traditionally undertaken in 1D, easier and more accurate than ever.
- The improved representation of urban flow paths and buildings which are a key receptor and form the basis for quantifying flood risk management.
- Excellent mesh size results independency, improving the simulation and calibration of direct rainfall models in terms of model results as well as run speeds.

These benefits making allow more consistent results across a range of mesh sizes, really opening up the possibilities of faster model calibration, long term continuous modelling, increased modelling of mitigation options and uncertainty run ensembles.

Developing a TUFLOW FV model to support oil spill assessments in the Irish Sea

Rohan King[1],
[1]BMT, London, UK

As part of a financial responsibility assessment of oil spills within the Irish Sea and Liverpool Bay, a TUFLOW FV model was built to provide hindcast hydrodynamic inputs into an oil spill modelling assessment. Due to the complex coastline, strong tidal currents and shallow bathymetry in the region, a higher resolution hydrodynamic model was developed within TUFLOW FV instead of the commonly used global ocean-circulation models. This presentation discusses the TUFLOW FV model development and validation undertaken to reproduce the tidal current magnitudes, and the influence of density-driven effects and nearshore bathymetry on the hydrodynamics in the Irish Sea.

Python scripting – improve your workflow

Ellis Symons[1]
[1]TUFLOW, Leeds, UK

Python is one of the most popular programming languages currently available. It's free, there's plenty of free online training material, and a lot of key software such as QGIS, ArcGIS, Mapinfo, and cloud compute providers offer Python Application Programming Interfaces (APIs). This makes Python perfect for use in combination with TUFLOW and it's open input/output file formats. This presentation talks about how Python can be incorporated into your TUFLOW workflow to improve efficiency and quality control, as well as the new resources TUFLOW is producing for new and experienced Python programmers alike.

New TUFLOW input/output file formats

Ellis Symons[1]
[1]TUFLOW, Leeds, UK

TUFLOW use of open GIS formats such as MapInfo Interchange Format (MIF) files and ESRI Shape files has allowed easy and rapid development of hydraulic models from commonly used GIS mapping formats. In the last few years there have been developments of additional file formats which are increasingly being used as the go to format for mapping and Digital Elevation Model (DEM) data sources. TUFLOW 2021 introduces direct reading/writing of popular open format vector and raster GIS data: GeoPackage and GeoTiff. This presentation discusses the development and testing of these formats, how TUFLOW interacts with them and the available options, and looks at the exciting potential that the database format, GeoPackage, offers to TUFLOW modellers in terms of speed, interoperability, versioning, and file management.

TUFLOW HPC – enabling continuous simulation of asset failure scenarios in development of asset maintenance strategies with the Yorkshire Internal Drainage Boards

Simon Jepps[1]
[1]Thomas Mackay, Leeds, UK

Internal Drainage Board (IDB) assets often sit within a network of infrastructure ranging from landowner maintained, field level land drainage to large scale fluvial or tidal flood management structures. These assets may provide a flood risk management function and benefit, however, if they were to fail or be removed, areas of land which currently benefit from their operation may also become inundated with water for long periods of time even under non-flood conditions. TUFLOW HPC has enabled these potential impacts to be simulated and assessed at the IDB scale, through the application of long-term continuous simulation and scenario modelling across a range of durations. This approach is used to inform the development of asset maintenance strategies within these IDBs.

Making the case for change (Quadtree case study)

David Hughes[1]
[1]Waterco, Ruthin, UK

Waterco have been successfully utilising TUFLOW Quadtree for the last 12 months on a number of projects. Quadtree has helped our modelling team support a larger range of schemes, improved model resolution and run times and led to an overall improvement in the teams work life balance. Today's short presentation will look at how the use of Quadtree has realised these (and other) benefits. We will touch on a recent project case study to provide some real world numbers / observations and discuss what went well (what could be improved) and hopefully provide support for others who are looking to present a business case for change.

QGIS TUFLOW Viewer and Other Tools

Ellis Symons[1]
[1]TUFLOW, Leeds, UK

The availability of QGIS and the development of the QGIS TUFLOW plugin has provided TUFLOW with a graphical interface to build, run and analyse results for 1D, 2D and coupled models. The QGIS TUFLOW Plugin is a very popular tool with over 50,000 downloads and a 5-star rating in the plugin repository. Along with tools such as the asc_to_asc.exe utility, it has become a part of most TUFLOW modellers workflow. Learn about the latest and future development within TUFLOW Viewer, the QGIS Plugin, as well the utilities and add-ins to other software including some exciting developments particularly relevant to UK users.

GIS Mesher Introduction

Duncan Kitts[1] **and Rusty Jones**[2]
[1]TUFLOW Leeds, UK
[2]Rising Water Software, USA

TUFLOW FV solves the non-linear shallow water equations on a flexible mesh which has a number of advantages particularly for environmental modelling. Unstructured or flexible mesh geometries can be created using any suitable mesh generation software and this presentation will provide an overview of the GIS Mesher software which generates a mesh comprising a combination of quadrilateral and triangular mesh elements for TUFLOW FV using standard GIS applications and a workflow familiar to TUFLOW modellers. The integrated GIS approach allows meshes to be generated quickly and easily from existing GIS lines, polygons and nodes as well as common raster formats. An advanced solution guided meshing approach provides an automated workflow to iteratively improve generated meshes based on hydraulic outputs and user-defined thresholds which is particularly suited for complex hydrodynamics. The presentation will provide an overview of the GIS Mesher, from the generation of a simple mesh, real world examples and an interface for running TUFLOW FV models.

TUFLOW User Conference 2021 - Agenda

Abstracts - Day 2

Hydraulic, morphological and habitat modelling of a restored, dynamic, gravel bed river using TUFLOW FV

Eric Gillies[1]
[1]CBEC Eco Engineering, Inverness, UK.

We present the geomorphic and hydraulic evolution of two restored gravel bed rivers in the Scottish Highlands, using both annual bathymetric 2D survey data and sediment sampling, and compare to TUFLOW FV hydraulic and morphodynamic/sediment models. Both morphodynamic models are shown to reliably predict a growth in hydromorphic complexity, accurate thalweg evolution, sediment sorting and formation of gravel bars seen at both sites, including avulsions from the main channel into new wetland areas of the floodplain. We use tracking of individual sediment size classes in TUFLOW FV, together with hydraulic variables (depth, velocity and Froude), to infer Atlantic salmon spawning habitat growth in the restored reaches during the winter season; and we use particle tracking of turbulent, invertebrate drift to infer that the spawning habitat is closely located to good salmon fry habitat in the spring and summer seasons. The presentation highlights the utility of TUFLOW morphodynamic modelling in reducing risk while restoring dynamic gravel river environments, and also demonstrates that it can be combined with additional post-processing to infer improvements to aquatic habitat, the end-goal of most river restoration.

Modelling sea lice infestation with TUFLOW FV

Mat Roberts[1]
Danny Kennedy[2]
[1]BMT, London, UK
[2]BMT, Aberdeen, UK

Sea lice infestation is a major issue facing salmon aquaculture in Scotland, which contributes £1.8 billion annually to the Scottish economy. Without treatment, sea lice cause physical damage and stress in fish, and adversely affects growth and performance. Traditional chemical treatment methods are costly and may impact the marine environment. With plans to double aquaculture production by 2030, the industry needs innovative solutions for environmentally sustainable and effective lice management.

To help businesses reduce the commercial risks, while seeking to reach SEPA's 'beyond compliance' vision of sustainability, BMT is supporting research and development into evidence-based approaches on effective lice treatment. We have developed a predictive marine modelling tool, using TUFLOW FV that integrates hydrodynamic, particle tracking, water quality and aquatic ecosystem software to aid planning and operational decisions.

In partnership with Scottish Sea Farms, Marine Scotland Science, Aquatera and SEPA, the particle tracking module in TUFLOW FV has been enhanced to incorporate sea lice maturation and motility response to environmental triggers as well as mortality from bath treatment. This tool can be used to target effective lice treatment practices and minimise environmental impact while reducing treatment costs and production losses, ensuring seafood security for years to come through sustainable farming practices.

What's new in TUFLOW FV?

Mitchell Smith[1]
[1]TUFLOW, Brisbane, Australia

The flexible mesh solver, TUFLOW FV, is TUFLOW's flagship 1D/2D/3D hydrodynamic and environmental modelling engine and our software of choice when undertaking 3D hydrodynamics, sediment transport, water quality and particle tracking modelling in fluvial, lacustrine, estuarine and coastal environments.

Although used extensively since the mid-2000s, the period 2018-2021 has seen significant investment focused on synchronising TUFLOW FV's workflows with TUFLOW. This process aims at 'cherry picking' the best features from both engines/modules thereby integrating products to provide a seamless and feature rich experience for our users. GIS integration is one major upgrade that has significantly enhanced model build efficiencies and results analysis for TUFLOW FV. It is now possible to build TUFLOW FV models entirely within a GIS platform and analyse 2D and 3D results. Additionally, a series of GIS, Python and MATLAB tools are now available to support project workflows. One such tool, released in 2021, is a GIS plugin (and supporting tutorial) for the interactive graphical development of SWAN spectral wave model inputs and control files that can subsequently be used as input boundary conditions for one or two-way TUFLOW FV coupling.

Our sediment transport module has been refined and enhanced to ensure intuitive modelling of cohesive and non-cohesive sediments in a range of environments. The world-leading Aquatic Ecosystem Dynamics water quality library has now been integrated into TUFLOW FV as the TUFLOW water quality module and an application programming interface developed to allow integration of TUFLOW FV with any other third-party water quality engine.

Both sediment transport and water quality constituents can be coupled with Lagrangian particle tracking to allow simulation of advanced environmental processes such as animal migration driven dynamically (rather than preset) by ambient environmental conditions.

All this functionality is now compatible with GPU compute to allow the modelling of the extended simulation periods associated with resolving long term sediment transport and water quality processes. Current development priorities include offering domain decomposition, distributed-GPU compute and automated cloud compute in the near future, all of which will further add to TUFLOW FV's power and suitability for advanced environmental simulation.

Water quality in TUFLOW FV

Mitchell Smith[1]
[1]TUFLOW, Brisbane, Australia

The last 18-24 months has seen a rapid growth in the appreciation of water quality within the UK. 2021 saw the designation of the first river bathing water site in Ilkley, West Yorkshire, and concepts such as 'nutrient neutrality' have risen to the fore during the planning process. High profile media campaigns by the Rivers Trust and the Guardian newspaper, now mean that regulators are increasingly looking to consider water quality as part of future strategic planning.

With the above in mind, 2021 will see the release of TUFLOW's first supported water quality module. Water Quality modelling has long been achievable using TUFLOW either through the use of simplified tracers or coupling with the Advanced Ecosystem Dynamics library from the University of Western Australia but the latest developments now allow advanced water quality simulations with the simple to use TUFLOW formats that are familiar to users. With technological improvements in computational hardware, the long running simulations that are required for water quality analyses can now be taken with relative ease. This session will provide a preview of the module, and demonstrate some of the capabilities that make water quality modelling with TUFLOW FV accessible and efficient

Environment Agency updated flood modelling standards

Antoine Lebrun[1]
Kevin Haseldine[2]
[1] Environment Agency, Warrington, UK
[2] JBA Consulting, Skipton, UK.

The Environment Agency must produce evidence of flood risk. It is must also advise others how to produce evidence of flood risk. This evidence supports decision-making for

- development and planning
- flood alleviation scheme proposals
- flood incident management
- emergency planning

Flood risk management decisions are based on various sources of information, but hydraulic models are particularly important. These are computer-based mathematical models of flood risk.

Construction of models requires skill and careful consideration. Models must put thorough quality assurance (QA) procedures to make sure they produce high quality and reliable outputs. The Environment Agency must establish "how good is good enough?" for fluvial and integrated, non-real-time, hydraulic modelling. This also helps the Environment Agency to advise on future model developments. The river modelling guidance provides a record of best practice techniques in the fields of hydrological analysis and hydraulic modelling. It uses existing literature and industry knowledge.

TUFLOW User Conference 2021 - Agenda

Abstracts - Day 2

How sure are you? Quantifying uncertainty for scheme design

Adam Parkes[1]
[1]Jacobs, Warrington, UK

Hydraulic models are an essential tool when developing flood management schemes, informing many key aspects of design. No matter how much work is undertaken, however many simulations run, there will always remain inherent uncertainties in results, and understanding this uncertainty is important to ensure flood defences perform as needed during a flood, giving confidence to operators and the community.

New UK guidance on quantifying residual uncertainty in modelling has been in force for the last year, this talk will provide an overview of the updated methods, using case studies to demonstrate how the guidance can be applied, its impact on scheme design and appraisal, areas of potential improvement and the challenges this presents to the industry.

Modelling for fish pass design

John Young[1]
Peter Aylett[1]
[1]Edenvale Young, Bristol, UK.

In the past three years Edenvale Young has seen a significant increase in the number of environmental projects including river restoration and fish pass design. This has involved hydraulic modelling, civil engineering design and site support during construction. John and peter will discuss a range of fish pass projects including the challenges, opportunities and modelling for a number of projects including Holland Wood Weir on the River Darwen and and Skerton weir on the River Lune.

Representation of afforestation and peatland in direct rainfall models

Gerald Morgan[1]
[1] Edenvale Young, Bristol, UK.

Afforestation and moorland restoration schemes are becoming more and more common across the country, but the accurate representation of these schemes in models continues to vary widely. In this workshop, Gerald will present the key hydrological effects of these restoration schemes, with an overview of the evidence for how these schemes affect flood risk. This will then be followed by a wider discussion with the workshop participants on how our modelling techniques could be improved

Is direct rainfall modelling accurate?

Duncan Kitts[1]
[1] TUFLOW, Leeds, UK

Direct rainfall modelling has been widely used for surface water applications particularly in urban areas for over a decade. The rise of integrated modelling approaches and whole catchment modelling now mean direct rainfall is increasingly applied in areas more commonly represented by 'rural' hydrological approaches such as FEH and ReFH/ReFH2. There is much debate about the appropriateness of direct rainfall approaches and how well they can be applied to UK catchments.

This workshop session will discuss the application of direct rainfall modelling and the barriers to its widespread acceptance. Comparisons of direct rainfall outputs against observed flow records as well as predictions obtained from other hydrological techniques will be presented. The benefit of sub-grid sampling to direct rainfall modelling applications will be shown as well as the introduction of upcoming TUFLOW functionality which provides a representation of sub-surface routing of infiltrated volumes.

Direct rainfall modelling: applications to headwater catchments using TUFLOW HPC. Limitations and benefits

Chris Cameron-Hann[1]
[1]Aegaea, London, UK

Direct Rainfall Modelling gets a hard time from the EA and is not recommended for anywhere except Urban areas. However, there are areas of the country and areas in lots of catchments where a fluvial approach is itself perhaps less justified and a calibrated sensible direct rainfall model could be more accurate and beneficial depending on the problem you are tackling. Here we present the difference between a fluvial and pluvial approach, some of the methods we undertook to try and validate it, then look at some of the interesting benefits that TUFLOW can bring.

Modelling land use change from forestry to peat, an approach for setting antecedent conditions for direct rainfall modelling

Brett Park[1]
[1] Wallingford Hydro-Solutions, Cardiff, UK.

This project required a catchment scale pluvial model, using the latest industry standards and methodologies to model;

- Net rainfall falling onto the catchment, accounting for infiltration across the variable soil types and land uses (Modelled in ReFH2)
- Overland flow across the catchment (Modelled in TUFLOW HPC)
- Baseflow recharge (Modelled in ReFH2) into the main river channel (Modelled in ESTRY)

This catchment scale model was then used to inform flood risk under different scenarios;

- Understanding the present day (baseline) flood risk.
- Understanding the benefits of installing Natural Water Retention Measures across the catchment.
- Understanding the impacts of restoring 'Lost Peat' in the headwaters of the catchment, where there has been commercial coniferous forestry since the 1950's. This has dramatically changed the landscape, where the uplands of the South Wales valleys were once blanket peat bogs. This scenario required the modelling of changing land use with the hydrological model CERF, which was used to identify the change in antecedent conditions as a result of the Peat Restoration. This enabled us to identify changes in net runoff and baseflow and hence identify potential impacts on flood risk through the TUFLOW model.

What would *you* like to see in TUFLOW?

Peter Aylett[1]
Ellie Symons[2]
[1] Edenvale Young, Bristol, UK.
[2] TUFLOW, Leeds, UK

This workshop session will provide attendees the opportunity to feedback on current TUFLOW functionality and contribute their suggestions for future areas of development for the TUFLOW suite of products and associated tools. If you have a key issue which you think could be represented within TUFLOW or if there is a repetitive pre- or post-processing task which you undertake during your hydraulic modelling, put forward your ideas and discuss with industry experts and other attendees to assist development of TUFLOW and ensure it continues to be the tool of choice for flood and hydraulic modellers.

Into the future. What TUFLOW have planned for 2021 and beyond.

Duncan Kitts[1]
[1] TUFLOW, Leeds, UK

The 2020 release of TUFLOW saw some significant new features such as Quadtree and Sub-Grid Sampling, both functionality that provide significant benefits to hydraulic modelling outputs and will change the way that we undertake hydraulic modelling for years to come.

However, the developments do not stop there, the TUFLOW team have been working extremely hard on the next generation of TUFLOW tools and functionality, with R and D, development, testing and benchmarking to make TUFLOW the most accurate, stable and quickest hydraulic solver available.

The continued developments will open the possibilities of modelling and seek to provide our users with the tools to further enhance flood risk modelling outputs but also allow modelling for novel purposes and will be introduced within this presentation. Upcoming developments build upon the success of the 2020 TUFLOW release by pushing the boundaries of Quadtree through the support of multi-GPU functionality, allowing bigger and more efficient models to be generated than ever before; development of new approaches to allow Digital Terrain Model resolution flood map output from simulations utilising sub-grid sampling; and automatic checks to ensure that sub-grid terrain features which are likely to impact the hydrodynamics are correctly represented by the modeller.

New functionality will provide benefits to direct rainfall modelling through the representation of sub-surface routing through interflow and groundwater flow meaning that once flow volume is infiltrated from the 2D surface it is not lost from the system.

The TUFLOW 1D engine, Estry, is subject to significant development to make it more suited for the UK and European market with arch bridges, CIRIA Culvert Inlet/Outlet losses as well as additional functionality to represent operational control being developed.

TUFLOW User Conference 2021 - Agenda

Presenter Bios

Duncan Faulkner
Head of Hydrology, JBA Consulting

Duncan is Head of Hydrology at JBA Consulting. After five years of research on rainfall and flood frequency at CEH in Wallingford, he joined JBA and moved north just in time to see in the new millennium. Since then, he has worked on a large portfolio of projects across the UK, Ireland, Australia, Canada and south-east Asia. Current topics of Duncan's consultancy and research work include application of non-stationary flood frequency estimation and improving methods of flood estimation for dam safety.

Will McBain
Associate Director, Arup

Will is Arup's flood resilience leader in the UK. He is also Arup's framework manager for the Environment Agency's Collaborative Delivery Framework across the Midlands and North East/Yorkshire. He has 26 years' wide-ranging experience of the appraisal, planning and design of projects to improve flood resilience and enhance the water environment. He also has extensive experience of assessing and mitigating the impacts of major infrastructure projects (eg roads, rail, nuclear and hydropower) on the water environment.

Bill Syme
TUFLOW Business Unit Leader, TUFLOW

Direct rainfall modelling has Bill has over 30 years' experience working on riverine, estuarine and coastal studies, of which most have been in the flood hydraulics field. During this time, he has successfully managed and led a wide range of flood and flood risk management studies in Australia and overseas. The widely used TUFLOW hydrodynamic modelling software was developed by Bill starting in 1989.

Today, Bill is BMT's TUFLOW Software Business Lead, managing TUFLOW Products and associated services, which won BMT a place in the prestigious 2020 Australian Financial Review's Most Innovative Companies Awards. He also continues to provide specialist flood modelling and flood risk management advice and was the Project Manager for the award-winning Brisbane River Flood Study Hydraulic Assessment.

Dr David Balmforth
Visiting Professor, Imperial College London

David is an independent consultant specialising in flood risk management and urban pollution control. He is a Past President of the Institution of Civil Engineers (ICE) and until recently worked as an Executive Technical Director with the international engineering consultancy Stantec. Formerly an academic, his recent work ranges from the delivery of £multi-million engineering programmes in the water industry, to flood advisory work for municipalities in the UK and overseas. He is an advisor to governments on flood risk management and has recently worked to alleviate flooding and water pollution in London, Auckland and Singapore. He is a member of the Defra Roundtable on Property Flood Resilience.

From 2013 to 2019 he was chair of the ICE's Reservoirs Committee which qualifies Reservoir Engineers on behalf of the member states of the UK. He was a Specialist Advisor to the EFRA Select Committee during their Inquiry into the Future of Flood Prevention in 2016, a member of Scientific Advisory Group to the National Flood Resilience Review, also in 2016, and a member of the Government Review (Pitt Review) of the 2007 Summer Floods.

David is a former Editor in Chief of the Journal of Flood Risk Management and currently a Visiting Professor at Imperial College, London. He has published over 50 journal papers, conference papers and design guides. At the present time David is leading the UK Government's Review of the Toddbrook Reservoir incident.

Clive Onions
Director, Clive Onions Ltd.

Clive Onions runs a company which specialises in flood risk and drainage advice. Clive set up his own company in 2010 after spending 35 years with leading Consulting Engineer, Arup. Clive has particular knowledge of flood risk and planning policy, partly through his active role as a Member and Vice Chairman of the Expert Panel on Water for the Institution of Civil Engineers. Clive has given Evidence at Lands Tribunal, Drainage Tribunal, Planning Inquiry, Local Plan Inquiry, Hearing, and Mediation. Clive has a particular interest in sustainable drainage techniques and has advised on floating reed beds, rain gardens, swales and other methods to deliver holistic solutions to reducing runoff rates and improving water quality by natural means and also enhancing biodiversity.

Dr Thomas Kjeldsen
Senior Lecturer, University of Bath

Dr Thomas Kjeldsen is trained as a civil engineer (MSc, PhD) and has more than 20 years research experience focusing on mathematical and statistical modelling of hydrological and environmental systems, with particular emphasis on extreme events and sustainable use of water resources. He led the scientific development of current industry standard methods for risk-based hydrological design in the United Kingdom. Recent research includes studies of: estimating the probable maximum flood, the effect of urbanisation on catchment hydrology, and the development of a statistical extreme value procedure for regional and non-stationary analysis of flood events.

Dr Chris Whitlow
Director, Edenvale Young

Dr Chris Whitlow is an expert in hydrometeorology, water quality, sediment transport and hydraulic modelling with more than 35 years postgraduate experience. Arguably his primary claim to fame is associated with the development of the ISIS (now Flood Modeller) software which is still the main software used to simulate river channels in the UK.

Chris has also published more than 30 technical papers and acted as a reviewer for the ASCE Hydraulics Division, the International Association of Hydraulic Research and the ICE Journal. He has also worked as a research fellow with the Universities of Birmingham and Nottingham and supervised or examined postgraduate level research at the University of Leeds, the Open University and the Institute of Hydraulic Engineering in Delft. Historically he was appointed to be a member of the Engineering and Physical Sciences Research Council College where he reviewed research application and reports.

He developed the first Environment Agency (EA) modelling strategy to draft level and was the technical advisor during the process to create the first National Flood Forecasting System, also for the EA. He also authored or co-authored EA documents such as the real-time modelling guidance and the extension of rating curves at gauging stations.

He retains a very strong capability in flood forecasting and led Edenvale Young in the development more than 50 forecasting models to support river and coastal flood warning in the cities of Manchester, Carlisle, Edinburgh, Perth, Leicester, Gloucester, York Bristol and London among others.

Overseas Chris has worked on projects in the US, South Africa and Australia, he was the expert modeller for the World Bank funded CRIP project in Sri Lanka between 2016 and 2018. Work on the latter project was a key reason that led to Edenvale Young winning the 2018 NCE 100 Award for Innovation in Design.

Chris is also proud to be a director of the Bristol Avon Rivers Trust consultancy and has developed close relationships with various rivers trusts in recent years which have included working on projects to quantify the impact of Natural Flood Risk management (NFM) interventions as well as small storage areas, constructed wetland design, weir removals, river restoration and reconnection of watercourses.

Sharla McGavock
Senior Hydrologist, Mott Macdonald

Sharla is a principal hydrologist Mott MacDonald in Singapore, with a background in flood modelling, water resources management and hydropower. She is currently leading the flood studies for two urban flood resilience projects in Bangkok and Ho Chi Minh City within the FCDO Global Future Cities Programme, providing targeted technical support which supports sustainable, inclusive and equitable urban development.

Quy Vu
Data Scientist, Mott Macdonald

Quy Vu is a Data Scientist within Mott MacDonald's Moata Division. He specialises in developing and productionising data science and machine learning products to save costs and increase efficiency in asset management and predict natural disasters. He has a proven track record of developing machine learning frameworks to support decision-making through data engineering and building data-driven models.

For the Bangkok Flood Management Decision Support System pilot, he has developed a machine-learning based surrogate model based on a TUFLOW-ESTRY model to deliver real-time surface water flood forecasts which are available to Bangkok Metropolitan Administration through Moata, Mott MacDonald' digital twin platform.

Dr Duncan Kitts
UK/Europe TUFLOW Lead, TUFLOW

Duncan is a principal scientist and UK/Europe lead for TUFLOW, with 15 years' experience in hydraulic modelling and flood risk management.

Duncan has worked in many different aspects of flood risk and erosion management with a particular focus on hydraulic modelling including fluvial and pluvial flood modelling, integrated urban drainage as well as flood forecasting, water quality and sediment transport modelling.

Duncan has spent the last 11 years working for various flood modelling software houses and has provided training to a range of governmental agencies and technical consultants internationally.

Rohan King
Senior Engineer, BMT

Rohan is a Senior Engineer at BMT with 10 years' experience across a wide range of hydrologic, 2D and 1D numerical modelling packages. Rohan completed his degree in Environmental Engineering (Hons) from the Royal Melbourne Institute of Technology (Australia) in 2010 and joined BMT's Melbourne office in June 2012 before relocating to London in 2014.

Rohan has a broad range of involvement in the consultant sector including catchment modelling, urban flooding, TUFLOW training and flood risk assessments within Australia and the UK using TUFLOW, TUFLOW FV and TUFLOW HPC.

He has also worked on a variety of civil design projects from road, drainage and WSUD/SuDS in Australia.

Presenter Bios

Ellis Symons
Senior Engineer, TUFLOW

Ellis is a senior engineer at TUFLOW and has a background in hydrologic and hydraulic modelling for a number of studies within Australia using a range of software. Ellis is responsible within the TUFLOW team for GIS tool developments and was instrumental in the development of the TUFLOW Viewer QGIS plugin. As well as GIS, Ellis also takes the lead developing and maintaining the TUFLOW utilities. Ellis is a python expert and has developed a range of eLearning training courses for TUFLOW modellers from introductory courses to advanced python training.

Rusty Jones
Developer,
Rising Water Software

Rusty Jones is the developer of the GIS Mesher. He also works for a US consultant as a water resources engineer with a focus on complex 2D models using TUFLOW. He previously worked for Aquaveo as a software developer and was the lead developer of the TUFLOW interface within the Surface-water modelling System (SMS).

Simon Jepps
Director, Thomas Mackay

Simon is a director and hydraulic modeller at Thomas Mackay Ltd. His time at work is split between undertaking hydraulic modelling for a variety of project types, review of hydraulic modelling undertaken by others and client or stakeholder liaison and engagement. Simon is particularly interested in selecting and developing specific strategies for the presentation of modelled analysis, enabling this to be clearly understood by the target audience.

David Hughes
Technical Specialist,
Waterco.

David Hughes is a technical specialist at Waterco with considerable experience of Flood Modeller Pro and ESTRY – TUFLOW modelling. In the 9 years at Waterco, Dave has led, checked and supported over 150 modelling projects. With a detailed understanding of a flood risk project's requirements David is involved at the project inception stage (assessing software requirements / modelling approach), quality process (check and approval) and troubleshooting (addressing instabilities, model performance). At a strategic level, David reviews our in-house modelling / GIS capabilities and supports the business with decision making for software investment, training and development

Dr Eric Gillies,
Technical Director, CBEC

For the last 8 years I have been technical director for CBEC eco engineering, a UK consultancy specialising in river restoration, leading both our field surveying and hydraulic modelling teams. We undertake flood modelling, natural flood management modelling, modelling of river restoration designs, bank and channel stability modelling, and sediment transport/ morphodynamic modelling, using a range of tools including TUFLOW FV. Prior to working with CBEC, I had 16 years' experience in computational and experimental aerodynamics/fluid dynamics, modelling a diverse range of phenomena from unsteady flows of rotary and fixed wing flight vehicles, bluff bodies, avalanche/debris flows, to bio-medical flows.

Dr Mat Roberts
Managing Director, BMT

Matthew is the Managing Director of Environment (UK) with over 15 years applied experience delivering private and public sector projects helping reduce risk to people, property and the environment. He is an expert in computational fluid dynamics, using numerical simulation as an engineering tool to predict and evaluate system behaviour, develop management strategies and support decision making. A key aspect of his work is developing long term, strategic relationships between industry, government and academic institutions. He collaborates across organisations as a member of the Flood & Coastal Erosion Risk Management Research Strategy, UK Flood Partnership and Future Water Association.

Danny Kennedy
Environment Consultant,
BMT

Danny Kennedy is an Environmental Consultant with wide-ranging experience in technical and client facing roles. Danny has led and contributed to several projects within the marine and coastal sector at BMT. Projects include recent studies which investigate solutions within the aquaculture and the offshore energy industry.

Mitchell Smith
TUFLOW FV Product Lead,
TUFLOW

Mitchell has 14 years' experience specialising in climate change adaptation, storm tide, flooding and coastal/floodplain management. He has a broad background in GIS systems and is a specialist user of several industry standard hydraulic and hydrodynamic modelling packages. In the role of TUFLOW FV Product Lead.

Mitch is heavily involved in the development and support of the TUFLOW software suite, including customised applications for fluvial/floodplain, estuarine and open ocean assessments. For several years Mitchell has also been the lead of TUFLOW's worldwide training operations, involved in the planning and facilitation of workshops and hands on computer-based training in TUFLOW and TUFLOW FV.

Antoine Lebrun
Senior Technical Advisor,
Environment Agency

Antoine works as a Senior Technical Advisor in the Evidence & Risk (E&R), Skill & Quality Assurance team at the Environment Agency (EA).

He has worked in many different sectors of the water industry including water and sewage treatment, water transportation and flooding for over 5 years. At the EA, Antoine's main work streams are standards for fluvial and coastal modelling, creation and maintenance of modelling quality assurance processes and training of E&R colleagues. He also is a member of the "Large Project Review Group", where he sits as an expert in modelling, assuring projects over 10million pounds.

Antoine is a Red Cross, Water Hygiene & Sanitation engineer and has been deployed during the Greece refugee crisis and latest Ebola Virus Disease outbreak in Democratic Republic of Congo.

Antoine was the EA project manager on the Fluvial Modelling Standards project. He led and shaped the project from scoping to completion as well as created and coordinated reviews of the documents. After completion, Antoine worked closely with the DEFRA publication team to create a more accessible version of the standards before their publication on gov.uk.

Kevin Haseldine
Principal Analyst,
JBA Consulting

Kevin has worked at JBA for over 12 years and is a Principal Analyst in hydrology and hydraulic modelling. He has managed many Environment Agency projects over the last seven years including the Vale of Pickering (150km of open watercourse), Model Package 19 (including five modelling projects) and the Fluvial Modelling Standards. He runs JBA's Introduction to Flood Modeller training course and has been a mentor to many new graduates. Kevin became chartered with CIWEM in 2016.

Kevin was JBA's lead author of the Fluvial Modelling Standards and developed the Excel based model review tool. He organised the testing of the tool on 12 existing models and facilitated workshops with other NGSA consultants to contribute to and review the documentation and tool.

Adam Parkes
Head of Discipline for
Hydrology, Jacobs

Adam is chartered scientist specialising in hydraulic modelling and hydrology in support of flood risk management schemes, with over 15 years' experience in the industry, including all types of flood risk. Adam works with a wide range of clients including the Environment Agency, Water Companies and Local Authorities to develop innovative solutions to flood risk management challenges and maximise the benefits of new technologies and tools.

In addition to projects, Adam is Head of Discipline for Hydrology at Jacobs, supporting and enhancing technical capability as well as working with the Flood Modeller team to develop new functionality, deliver technical training and technical support to clients.

John Young
Director, Edenvale Young

John Young is a chartered civil engineer and Director of Edenvale Young. John has been project Director for three projects which have gained awards from the Institution of Civil Engineers. This included the: Restoration of Duke's Lake at the Defence National Rehabilitation Centre, Rhiwbina Flood Alleviation Scheme and the Pont Briwet Transport Improvement Plan. John and the wider Edenvale Young team were responsible for winning the NCE100 Design Innovator Award in 2018.

Dr Gerald Morgan
Director, Edenvale Young

Dr Gerald Morgan is the Royal Academy of Engineering Research Fellow in Modelling for Natural Flood Risk Management and is also a director of Edenvale Young Associates.

He was one of the pioneers in the UK of the distributed modelling approach using TUFLOW and has extensive experience of hydrological and hydraulic modelling and development across the UK.

Chris Cameron Hann:
Director, Aegaea

Chris Cameron-Hann is a Director at Aegaea, a flood risk, water and environmental consultancy.

He is a registered consultant with the World Bank advising on the future of hydrometric systems and flood forecasting in developing countries and recently co-authored a paper on their behalf on how to use investment in flood risk management to help deliver economic, social and environmental benefits in "post covid".

Presenter Bios

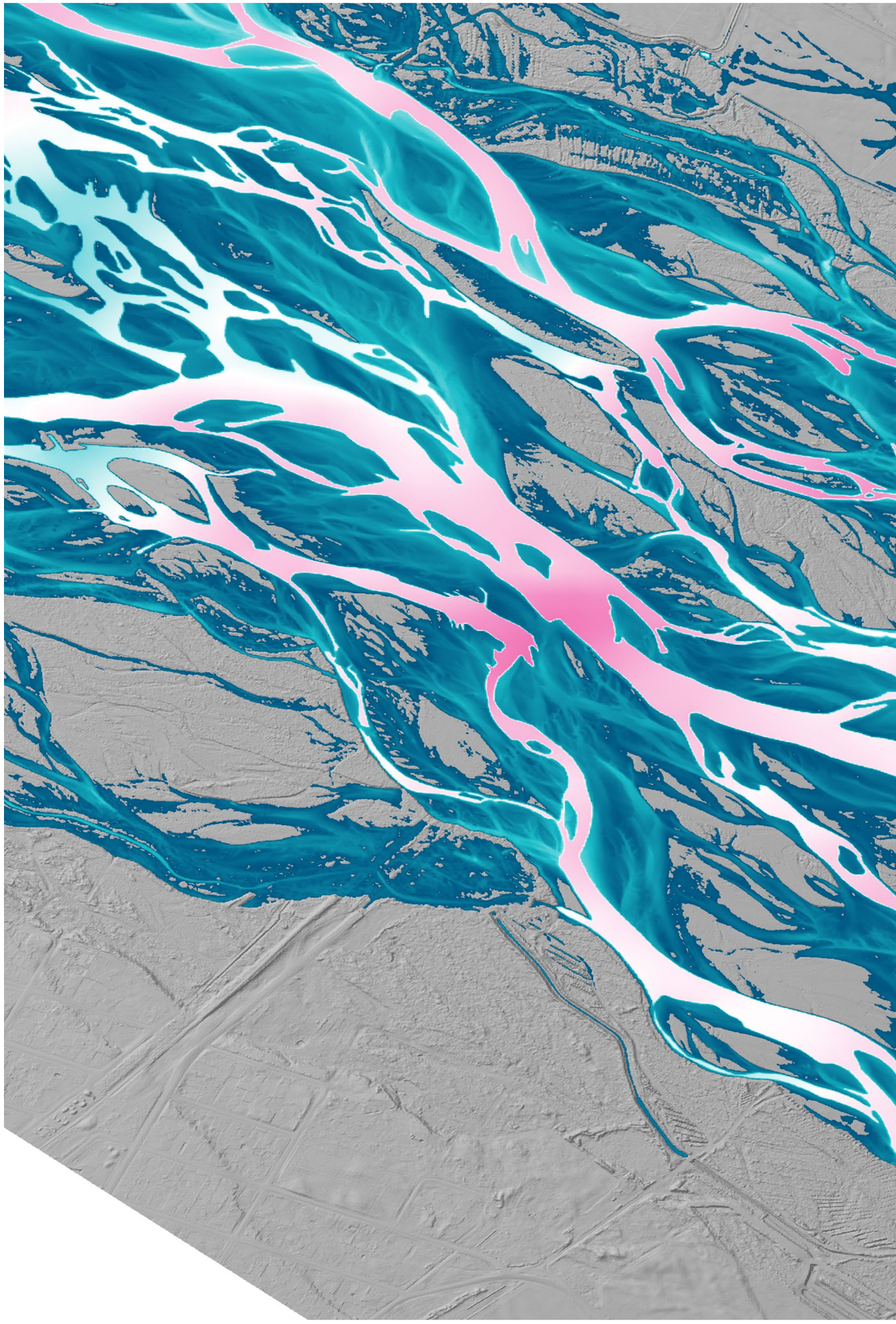
Brett Park
Senior Consultant,
Wallingford HydroSolutions

Brett is a civil engineer who has worked within commercial and project management roles on construction projects across the Middle East and North Africa. At Wallingford HydroSolutions, Brett finds himself leading on large scale hydraulic modelling projects for clients ranging from public sector regulators, Network Rail, Highways England and private development companies.

Peter Aylett,
Associate Director,
Edenvale Young.

Peter Aylett is a senior hydraulic modeller with a range of associated technical skills. He has worked extensively with FMP/ISIS and TUFLOW for various different project types since 2006, as well as other packages including Delft3D, TUFLOW FV and 3D modelling using OpenFOAM / InterFoam. Peter has reviewed over 200 models developed by Edenvale Young and other organisations including the UK Environment Agency and has established protocols for undertaking formal model reviews.

He has also undertaken development of flood forecasting and rating development models for the Mersey, Severn, Bristol Avon and fluvial Thames catchments, as well as modelling for numerous option appraisal studies for flood mitigation works and FRAs, FCAs, SFCAs and SFRM projects.



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