Dr Sébastien E. Bourban

Technical Director / Team Leader / Project Director

December 2020

Position

Technical Director
Team Leader
Project Director

Profession

Applied Mathematician

Qualifications

- PhD degree on Stratified Shallow Flow Modelling
- French Ingénieur degree in scientific computing and applied mathematics
- French Scientific Baccalauréat in mathematics and physics

Nationality

French
Swiss

Languages

French
English

Areas of expertise

- Over 20 years of experience in managing and delivering outside-the-box environmental hydraulics studies to a high quality standard, on time and within budget

- Significant experience in managing inhomogeneous teams whether on interdisciplinary projects and proposals or as a group leader

- A strong experience in writing and negotiating inter-organisation contracts, frameworks, memoranda and license agreements in French and English

- A current and in-depth experience of developing and using free surface flow solvers, the open TELEMAC system in particular, on multiple computers and platforms, with a precise technical knowledge of their strengths and restrictions when applied to projects

Sébastien is passionate, driven and genuinely committed in managing and delivering environmental hydraulics consultancy and research projects with large numerical modelling components. He has over 22 year experience in Europe (with HR Wallingford in the UK) and in North America (with the Canadian Hydraulics Centre). After a short stay at ARTELIA in France in 2019 as team leader and project director in all aspects of maritime hydraulics, he has now joined the LNHE department at EDF R&D near Paris in 2020. As shown below, Sébastien's career is obviously intertwined with the story behind the TELMAC project and its applications.

Pen portrait

Sébastien has a strong track record of managing and working on challenging projects, for which numerical modelling is critical and outside the norm. For instance, he led the modelling component of the environmental impact assessment of the Petitcodiac River and Estuary, Canada, for AMEC between 2002 and 2004. The "chocolate river", so-called for its sediment laden waters, is subject to some of the largest tides in the world. Its width reduced to a tenth of its original size after the construction of a causeway in 1968. The modelling component included short term and long-term predictions of a number of scenarios, considering environmental factors such as wetland preservation and tidal bore, and morphological factors such as evolution of the tidal prism and seaward dispersion of sediments. As a result, one of the scenarios was implemented in 2010 and the river is re-opening as predicted with a strong tidal bore. Back in the UK, Sébastien led and delivered the modelling component of a tidal renewable impact assessment of the entire Northern European Continental Shelf, for Black & Veatch and the ETI between 2011 and 2013. A high-resolution tidal energy resources model was validated against records from more than 80 gauges. It was subsequently used to identify how the interactions between different sites around the UK combine to form overall flow effects, and what constraints these interactions would place on the design, development and location of future tidal barrage and tidal farm systems between now and 2050. The resulting model has now been automated and delivered to the wider marine industry to help inform future plans and strategies through a web service provided by HR Wallingford. Subsequently, the model won the "Most Promising New Tool to Support Developers and OEMS" at the International Tidal Energy Summit 2015.

Sébastien is a proven team leader valuing the most efficient use of the personnel he relies on. For almost 7 years, he led the Environmental Hydraulics Group at the Canadian Hydraulics Centre and formulated and followed through business plans. Back at HR Wallingford, he was leading the Hydro Team, responsible for all free-surface hydrodynamics modelling activities, including overseeing the quality assurance of the team's deliverables as Project Manager and Project Director. More recently at ARTELIA, he led the Marine & Maritime Team with similar responsibilities. Sébastien is flexible, open minded and experienced in leading inhomogeneous teams of engineers and scientists across multidisciplinary projects.

Sébastien has a precise knowledge of the capabilities and restrictions of the numerical modelling tools used and, consequently, of the risks of project specific developments and modelling challenges, valuing a no-surprise relationship with clients. He remains a lead developer of the numerical solvers he uses and of their applications to environmental hydraulics studies. For instance, Sébastien started his career by developing his first 3D finite difference, hydrodynamics solver, which he named SULIS, to study eutrophication and mixing of reservoirs along the Thames River, UK. In 1998, he produced a water

Professional memberships

- Former long-term member of the Steering Committee of the TELEMAC-MASCARET Consortium since creation in 2010 and President of the same committee between 2012 and 2015.

- Member of the Evaluation Committee of the French journal "La Houille Blanche", edited and published by the Société Hydrotechnique de France

Publications

- S.E. Bourban et al, "The Earth by TELEMAC", Key Note in proceeding of the XXIIIrd TUC, 19-20 October 2017, TU-Graz, Austria.
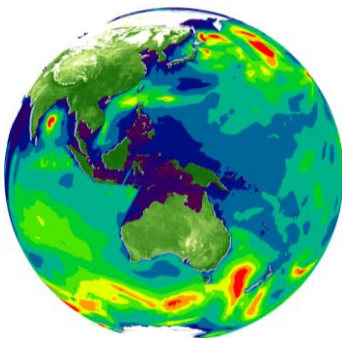
- S.E. Bourban et al, "Welcome to our world. Our new detailed global model bridges the gap between environmental hydraulics and oceanography", article in the magazine Edge, pp 10-11, Issue No.5, HR Wallingford, September 2017

- S.E. Bourban, et al, "The TELEMAC's automated management and continuous integration and validation system", in proceeding of the XXIInd TUC, pp. 91-100, 15-16 October 2015, Daresbury Laboratories, UK.

quality module for EDF's industrial modelling suite TELEMAC to investigate the impact of land reclamations on the Hong-Kong waters, China. In 2001, he led HR Wallingford's first industrial use of computational fluid dynamic solvers, using the first unstructured mesh version of CFX-5, for application to eddy-driven erosion around piled jetties at Dahej, India, and to vortex formation at the cooling water supply and return structures of Al Jubail pumping station, Saudi Arabia. In 2006, he led the Canadian Hydraulics Centre's first industrial use of computational fluid dynamic solvers, using FLUENT, to study discharges over Hydro-Quebec's flood management spillway structures. More recently, Sébastien developed the most detailed numerical modelling resources of the world waters, which he named the Earth by TELEMAC, a model far more detailed than currently available datasets while combining waves, tides, surges, and ocean circulation processes.

Sébastien is a keen business relationship developer valuing face-to-face contacts. He is experienced in authoring and negotiating licensing terms, high-level memorandum of understanding and joint commercial agreements both in French and English, including with large administrations such as Environment Canada, Natural Resources Canada, Electricité de France and the UK's Energy Technology Institutes. He has organised international workshops at national and international conferences, such as the Canadian Dam Association Conference in 2004 and 2006. He has travelled east and west to transfer his numerical modelling knowledge to clients for instance in Beijing (China), Chenai and Ahmedabad (India), Abu Dhabi (UAE), Graz (Austria), Zurich (Switzerland), Paris (France), Quebec, Montreal, Niagara-Falls, and Vancouver (Canada), Lafayette (Louisiana, USA). Sébastien fosters strong relationships with clients, partners as well as peer organisations.

Finally, Sébastien has strong personal organisational skills valuing self-motivated discipline. In 2001, he organised the UK's CFX Seminar at HR Wallingford. In 2006, he organised the North American TELEMAC User Club Meeting in Ottawa. More recently in 2012, he organised the XIXth international TELEMAC User Conference in Oxford, UK. Last but not least, Sébastien also obtained his PhD through the UK's Open University, under the supervision of Oxford Pr Alistair G.L. Borthwick and the sponsorship of HR Wallingford. His 7-year research was entirely taken up from his spare time, outside his full-time employment. Sébastien is a "completer-finisher", a team player and self-motivated with a can do attitude.

Employment record

- Sep. 20020 – Present: Ingénieur Chercheur
  EDF R&D, Laboratoire National d'Hydraulique et Environnement, Paris, France

- Feb. 20019 – Oct. 2019: Maritime Team Leader / Project Director
  ARTELIA, Europe & Afrique Moyen Orient, Grenoble, France

- Sep. 2014 – Jan. 2019: Technical Director / Team Leader
  HR Wallingford, Coasts & Ocean Group, UK

- Sep. 2008 – Sep. 2014: Project Manager, Principal Scientist
  HR Wallingford, Coast & Oceans Group, UK

- Oct. 2001 – Aug. 2008: Environmental Hydraulics Group Manager, Project Manager
  Canadian Hydraulics Centre, National Research Council Canada

- Feb. 1997 – Oct. 2001: Project Ingénieur, Numérical Modelling and Development
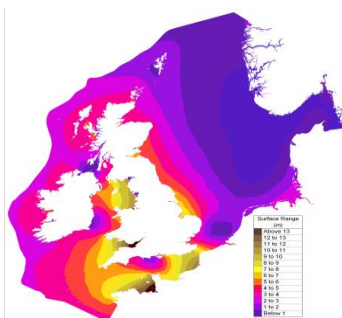 **HR Wallingford**, Water & Industry Group, UK

Consultancy Highlights
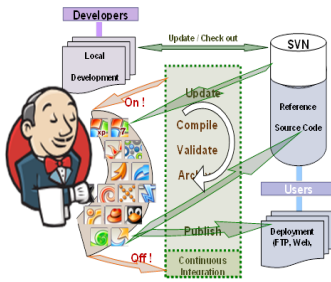
N. Durand, S.E. Bourban, et al, "Ichthys LNG Project, Australia: hydrodynamic modelling to inform management activities during dredging", in proceedings of the XXIst TUC, Grenoble, October 2014
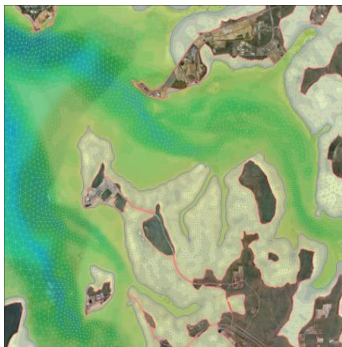
S.E. Bourban, "Coastal shelf model of northern European waters to inform tidal power industry decisions: SMARTtide", in Journal of Underwater Technology, pp 15-26, Vol.32, No1, March 2014.

S.E. Bourban, N. Durand, et al , "High resolution modelling of tidal resources, extraction and interactions around the UK", in proceeding of the GMREC conference, 2013, Washington, USA

Blayais Nuclear Power Station coastal works, France (2018)
Investigation of the risk to frazil ice presence at the intake grids of a Nuclear Power Plant along the Gironde Estuary, France, and study of possible mitigation measures. Sébastien delivered a comprehensive hydrodynamic modelling study to EDF, including a complete thermal budget with the atmosphere and the formation and transport of frazil ice and build-up of ice cover. Five of the coldest historical events were modelled to investigate frazil ice risk to the intake together with a sensitivity analysis. The KIONE component of the TELEMAC system, developed in part by Sébastien, was used to model all ice aspects including the clogging period of the intake grid itself.

Wylfa Newydd Nuclear Power Station coastal works, UK (2017-18).
Delivery to Bechtel of a detailed TELEMAC-3D hydrodynamic model to support the design of the new Wylfa Nuclear Power Plant coastal infrastructure. Sébastien was in charge of the hydrodynamic modelling studies to inform the design of the intake channel (under extreme conditions, and corresponding loading on the trash rack), and supporting the thermal recirculation model, the sediment geomorphological model and the ship navigation simulations. The work included the preliminary design optimisation of a skimmer wall to straighten the approach flows towards the intake pumping station.

Metocean Design Basis study for LNG facilities, Mozambique (2015-17).
Application and development of a series of 2D and 3D hydrodynamics, waves and sediment transport models to support a metocean design study in Mozambique. The models were used to derive a comprehensive number of natural and extreme conditions, including nearshore and offshore areas, the pipeline route down to 2 km depths, cyclonic and non-cyclonic conditions, a tsunami risk assessment for various return periods and maritime and underwater infrastructures. Sébastien was in charge of the delivery of the project to EniProgetti.

Tsunami assessment for a Far East Russian LNG terminal, Russia (2015)
Sébastien was in charge of the delivery of an extremely wide area hydrodynamic modelling study covering the north-west part of the Pacific Ocean, including major tectonic fault lines in the area. A TELEMAC-2D model was used to simulate tens of tsunami events, historical and probable, characterising return periods for surges up to 1,000 years for the design of the LNG terminal. The study was completed for AMEC Foster Wheeler and followed up by other hydrodynamics studies to support design validation plan for Exxon Mobil.

EIA for a Saudi to Bahrain Rail Link bridge, Kingdom of Bahrain (2015)
Delivered the modelling component of an EIA undertaken for a feasibility study to construct a Railway Link between the Kingdom of Saudi Arabia and the Kingdom of Bahrain. Two different alternatives were considered in this project. A TELEMAC-2D hydrodynamic and recirculation model, a TOMAWAC wave transformation model and a sediment transport SISYPHE model were developed to cover these waters in detail, down to the bridge piers over the entire route, and answer some of the environmental concerns. Sébastien delivered the study to Environment Arabia Consultant.

Payra Port, Bangladesh, (2015)
Delivery of the hydrodynamic modelling component for a feasibility study at a deep sea port in the Rabnabad Channel, for the Payra Port Authority. A TELEMAC-2D hydrodynamic model was used to support port master planning, channel design, economic and financial analysis.

Thames Tunnel interception works fluvial modelling, UK (2014)
Delivered a highly confidential project involving the organisation and supervision of multiple teams of hydrodynamic modellers within HR Wallingford, each being attributed different tendering organisations without being able to share activities and files with one another. Modelling activities included impact study of interception points on multiple areas along the Thames River to enable the redirection of the combined sewer outfalls to the London Tideway Tunnel. Sébastien delivered the project to Thames Waters.

**Extreme waves and overtopping at a nuclear site, France (2013-14)**
Delivered the development of an extremely fine resolution agitation model, based on ARTEMIS, of the Gravelines Nuclear Power Station, north of France. EDF R&D provided site drawings, bathymetry and topographic data and wave conditions issued from an offshore wave model. The model includes all structures and building on site and was eventually delivered to EDF R&D.

**Tidal resource modelling and impact assessment, UK (2011-12)**
Delivered the development of coarse and fine resolution TELEMAC-2D models of the whole of the

■ S. Wilson, S.E. Bourban, etal, "Understanding the interactions of tidal power projects across the UK Continental Shelf", in proceedings of the 4th ICOE, October 2012, Dublin, Ireland

■ A.J. Cooper, G. Cuomo, S.E. Bourban, et al, "Testing TELEMAC-2D suitability for tsunami propagation from source to near shore", in proceedings of the XIXth TELEMAC-MASCARET User Conference, October 18-19, 2012, Oxford, UK
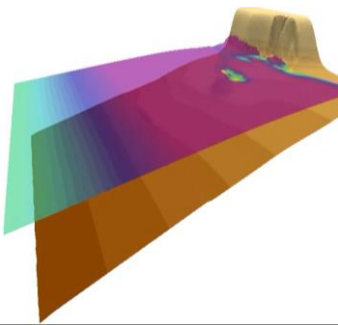
■ S. Bourban, N. Durand, et al, "Coastal shelf model of Northern European waters to inform tidal power industry decisions", in proceedings of the XIXth TELEMAC-MASCARET User Conference, October 18-19, 2012, Oxford, UK
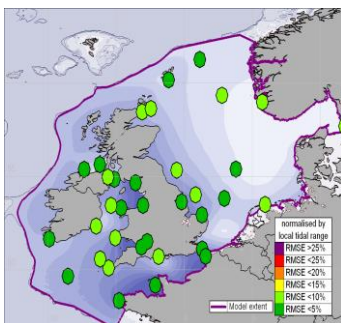
■ C.T. Mead, S.E. Bourban, et al, "The importance of model plane location and movement in dense discharge assessment" in proceedings of the ISOS, 2011, Mar del Plata, Argentina

Northern European Continental Shelf (1km and 200m resolution at the coast respectively) to assess impact of tidal current and tidal stream developments to the 2050 horizon. The models were validated against more than 80 tidal gauges throughout northern Europe and used to assess the impact of more than 50 scenarios. The model were delivered to the UK **ETI** and some of its members including **Rolls-Royce** through **Black & Veatch**.

Tsunami wave propagation, French and UK coasts (2011-12)
Development of a TELEMAC-2D spherical model to study the propagation of tsunami waves from a range of possible sources (undisclosed amplitudes and locations) to a number of sites of interest (undisclosed site locations) in France and in the UK. The resulting model was handed over to **EDF R&D** at completion.

Thermal recirculation at power plant, Oman (2010-11)
Development of a TELEMAC-3D model to study thermal recirculation for multiple combinations of intake-outfall layouts of a coastal power plant in Oman (undisclosed location). The 3D model was used to predict a 14-day tidal cycle, including adjacent facilities with and without the proposed developments and to evaluate reciprocal impacts with other nearby plants. Sébastien delivered the project to **Fichtner GmbH & Co KG**.

Ichthys development, Darwin Harbour modelling, Australia (2009-11)
Part of an EIS for **INPEX Browse Ltd**, development of a hydrodynamic (TELEMAC-2D) and wave (TOMAWAC) model of Darwin Harbour and of Beagle and Van Dieman Gulfs, Australia, for the purpose of dredge sediment dispersion modelling on mangroves. The hydrodynamic and wave models were setup together to predict multi-year durations of dredging activities.

Tidal energy resource assessment near Torr Head, UK (2009-10)
Development of a TELEMAC-3D model of the North Channel to assess tidal energy resource near Torr Head, Northern Ireland. The model was validated in 3D against bed and vessel mounted ADCPs. The resulting 3D model was used to predict current velocities and to extract maps of kinetic power density. Sébastien delivered the project to **B9 Energy Offshore Development**.

Flushing capability and marine assessment, UAE (2009)
Assessment of the flushing capability of a small bay close to a recreation park (undisclosed location) to help **ARENSCO** with the design of the opening to the main sea. A TELEMAC-2D hydrodynamic model was developed to predict flushing time and to compare flushing efficiencies between designed culvert and opening scenarios.

Design assessment of a shipping canal, Oman (2008)
Assessment of the suitability of a navigation canal (undisclosed location) for super tankers. A TELEMAC-2D model was developed to predict currents within and at the entrances of the canal for comparison against navigation requirements. Sébastien delivered the study to **Pell Frischmann Consultants**.

Tidal energy resource assessment, Bay of Fundy, Canada (2007-08)
Setup of a TELEMAC-3D numerical model for the Bay of Fundy and of the Gulf of Main, on the east coast of Canada. The 3D model was used to provide **New Brunswick Power**, **Nova Scotia Power** and **Natural Resources Canada** with an accurate tidal current energy map of the entire region for prospective turbine prototype implementation.

Sediment and sand bank movement study at Port Stanley (2007)
Assessment of bed evolution processes across the entrance of Port Stanley Harbour under the combined action of waves and currents along the shores of Lake Erie, Canada. A coupled TELEMAC-2D hydrodynamic and SISYPHE sediment model driven by SWAN wave results was validated against 4 years of observed bed evolution and used to identify and evaluate different port layout solutions to alleviate or eliminate the need for maintenance dredging. Sébastien delivered the work to **Public Works and Government Services Canada**.

Study of the Chute-Hemmings spillway, Canada (2005)
Study of the spillway hydraulics of Chute-Hemmings, in Québec. The main objective was to validate the use of CFD codes such as FLUENT to produce nominal capacity curves for that structure and others structures where these type of data are missing. Joint publication with **Hydro-Quebec** followed.

EIA study of the Petitcodiac River and Estuary, Canada (2002-04)
Study of the environmental and geomorphic dynamics of the estuary over short-term (2 years) and long-term (20 years) periods. Hydrodynamic GEN 1D and TELEMAC-2D were combined with

■ N. Durand, S.E. Bourban, C. et al, "HPC for sensitivity studies: simulations with TOMAWAC and TELEMAC-3D" in proceedings of the XVIIIth TUC, 2011, Paris France
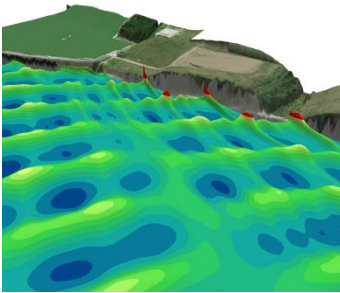
■ C. Cawthorn, S. Bourban, et al, "Adaptive vertical layering in TELEMAC3D", in proceedings of the XVIIIth TUC, 2011, Paris France
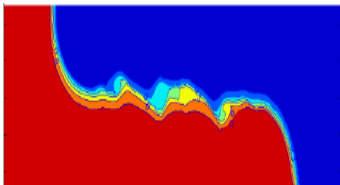
■ R.J.S. Whitehouse, S.E. Bourban, "Assessment of scour development at a deep-water marine jetty using 3D computational fluid dynamics", in proceedings of the ICSE-5, 2010. American Society of Civil Engineers.
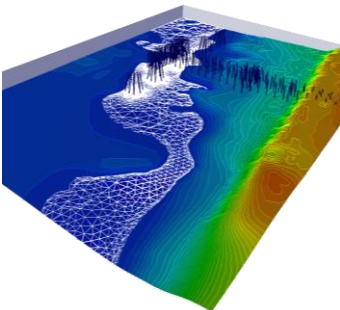
■ S. Bourban, N. Durand, et al, "Modelling tidal energy resource and extraction", 32nd ICCE Conference, Shanghai, China, 2010.

sediment transport SISYPHE and consolidation CUMSED models to predict results of alternative engineering designs for the Petitcodiac Causeway and associated operating procedures. The Petitcodiac River is subject to one of the largest tide in the world and is so-called the Chocolate River for its high sediment content. Sébastien delivered the entire study to AMEC.

Water balance of the Peace Athabasca Delta, Canada (2002-03)
Study of the flow distribution in one of the largest fresh water delta in the world in collaboration with BC Hydro, Canada, including joint field surveys. A TELEMAC-2D model was validated to assess flooding and replenishment of marshes and wetlands under seasonal changes and handed over to BC Hydro at completion with hands-on training course.

3D siltation modelling in the Coquitlam Reservoir, Canada (2001-02)
Study of the flow, thermal and sediment distribution of the 250 m deep Coquitlam Reservoir, used for Vancouver's drinking waters. Sébastien own 3D model SULIS was setup, validated and delivered to GVRD, Vancouver, Canada, as a numerical model to look at the impact of thermal stratification on sediment yields in the reservoir and at the drinking water intake tower.

Wind load and jet fan modelling at rail tunnel portals, UK (2001)
Seconded to and, on behalf of Bechtel Ltd, Sébastien worked on CFD studies within the second phase of the Channel Tunnel Development Project. Various CFX-5 models were developed to predict wind loading on London tunnel portals with back-pressure calculation, jet controlled pressure fans and smoke re-entrainment at portals to support emergency ventilation procedure guideline.

Moray coast waste water outfall and risk assessment, UK (2000)
Hydrodynamic numerical and risk assessment study for the North of Scotland Environmental Services using QUERY, a risk analysis tool developed by Sébastien. A TELEMAC-2D model of the Moray Firth was coupled to QUERY to determine optimum outfall locations and minimise storm water storage requirements within the upgraded sewerage systems. The work was delivered to the Mott MacDonald and Jacobs Babtie joint venture.

Modelling mixing of thermal plumes, Japan (2000)
Validation of a TELEMAC-3D model against Electric Power Development Co. data for 3D thermal jet plume dispersion. Data were drawn from a very large cooling water discharge from a power station on Tsugaru Kaikayo, the strait between Hokkaido and Honshu islands. The study was used in an assessment of modelling methods, particularly the detail of the nearfield discharge.

Studies of Dounreay coastal sediment movements, UK (1999 – 2000)
Setup of a local TELEMAC-3D model of the Dounreay Bay, on the North Coast of Scotland, in order to study long term transport of radioactive particle attached to sediments. A regional 2D flow model of the Pentland Firth was also setup. The project was delivered to the UK Atomic Energy Agency.

Marchwood energy recovery facility, cooling water discharge, UK (1999)
Development of near field model of cooling water discharge and abstraction. Hampshire Waste Services planned an ERF near Marchwood for which Environmental Assessment and IPC license documentation had been required regarding the discharges from the facility and its impacts. A TELEMAC-3D model was developed for the impact assessment.

Thermal discharge, Pelican Point power plant, Australia (1999)
Development of far field TELEMAC-2D and close field TELEMAC-3D models to ensure compliance of the power station cooling water discharge with Australian environmental regulations. The 3D model was driven by the 2D through the exchange of binary files. The project was delivered to ABB Power Generation.

Vietnam First Refinery Project, Vietnam (1999)
Development of a TELEMAC-3D model to study the impact of the refinery on the environment. Scenarios tested included the construction and operation phases, oil spill response plan and environmental management plan for the maritime facilities to support Foster Wheeler Energy Ltd.

Central III reclamation, Water Quality and EIA, Hong Kong (1999)
Study of the Hong Kong bay using a newly developed 3D water quality code. A TELEMAC-3D hydrodynamic was built and coupled to a water quality module written by Sébastien, TELEMAC-WQ, and to a suspended sediment plume modelling for a proposed reclamation in Victoria

- S.E. Bourban, "Numerical modelling for free surface water flow", article in the newsletter of Innovation & Research Focus, Issue No.85, May 2010
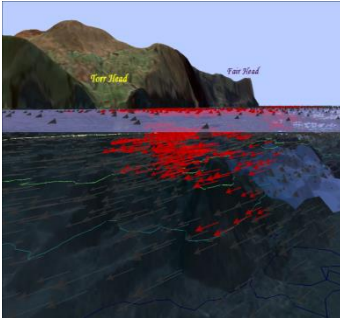
- S.E. Bourban, N. Durand, et al, "3D Modelling as an alternative to comprehend the hydraulic behaviour of spillways", in the proceedings of the Canadian Dam Association Conference, 2006, Quebec, Canada.
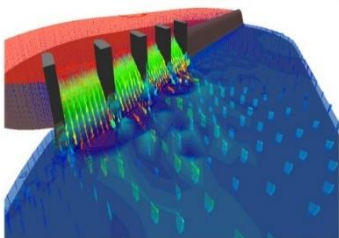
- W.M. Johnstone, D. Sakamoto, H. Assaf and S.E. Bourban, "Architecture, modelling framework and validation of BC Hydro's virtual reality Life Safety Model" presented at the ISSH Stochastic Hydraulics 2005 conference, May 23-24 2005, Nijmegen, The Netherlands
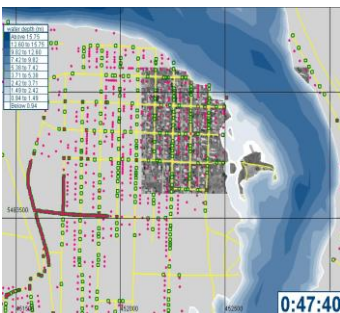
- T. Faure, S.E. Bourban,

Harbour. The EIA was delivered to **WS Atkins and partners**.

Green Island reclamation, Water Quality and EIA, Hong Kong (1998-99)
Water quality calibration and validation study using a newly developed 3D water quality code, written by Sébastien, to examine the impacts on the Hong Kong waters of the completed Green Island reclamation and intermediate stages for **Scott Wilson Kirkpatrick**.

Great Yarmouth CEGB power station, Cooling water dispersion, UK (1998)
East Anglia Pipeline Ltd proposed to re-commission the former CEGB power station at Great Yarmouth using modern CCGT equipment. A proposed port development nearby was expected to affect the existing outfall, and TELEMAC-3D was used to study cooling water from existing and proposed outfalls.

Highlights in Research and Development

Ice modelling, (2016-18)
Sébastien has been managing and implementing an ambitious research project carried out in collaboration with **Clarkson University**, USA, and **EDF R&D**, France. The principal objectives were to acquire expert knowledge and advanced numerical modelling capabilities in predicting and / or reviewing ice processes and the assessment of possible safety measures to mitigate or lower risks around critical infrastructures, whether coastal or riverine. Sébastien has been working closely with the developments made by **Clarkson University** while recoding and testing these into the official release of the TELEMAC system. A new module of the TELEMAC system was built and delivered to **EDF R&D**. Practical ice modelling studies followed for one site along the Rhone River, France, as well as comparisons against observed data along the Yellow River, China and the St Lawrence River, Canada.

The Earth by TELEMAC, (2016-present)
Through an internal research project, Sébastien has started working on delivering the most comprehensive and detailed global modelling resources yet, which he named the Earth by TELEMAC, to support all sorts of shallow- and deep-water environmental hydraulics and metocean studies, providing hind-casts and forecasts at local, national or global scales. The work is based on a finer spatial resolution than what is offered by others, at a temporal resolution below the minute, and an impressively short simulation time on a few dozens of compute-cores only. The Earth by TELEMAC has proven effective to model tides, surface waves, severe storms, tsunami propagation from one end of the world to the other, as well as other aspect of global ocean circulation.

Algorithmic Differentiation, (2013-18)
Sébastien has led an internal research collaborative project to create a paradigm shift in the range and type of answers one would typically get from predictive modelling suites such as based on 2D/3D solvers by combining the mathematically more advanced adjoint modelling methods (which incorporate payoff functions and optimisation procedures within the 2D/3D predictive solution itself) and the most recent computationally advanced Algorithm Differentiation methods (automatically creating adjoint and linear tangent models), referred to as AD methods. Collaboration was established with **Aachen University**, Germany, **EDF R&D**, France, **BAW**, Germany and **NAG**, UK. As a result of this multi-year project, inverse dependency problems such as data assimilation, parameter estimation, uncertainty quantifications, automated calibration, multi-objective optimisation of designs to support engineers and scientists become effective and possible at a fraction of the computing cost of current stochastic methods.

Open source TELEMAC and core developments, (1997-present)
While Sébastien started coding in the TELEMAC system in 1997, he has been instrumental in the transformation of the system into a very successful open source software. Since early 2010, he led the development of a central source code repository, an automated validation and continuous integration system, the translation of all codes into English, and the setup of various websites. Additionally, he is the principal author of the very majority of all python scripts now managing the entire system from compilation, pre- and post-processing, validation, etc.

Company strategy, 2D/3D Flow Modelling Advances (2009-13)
After writing the company 5-year 2D/3D flow modelling strategy document, management of a number of advanced modelling tasks to address known challenges and lead of research activities on the implementation of novel numerical schemes. One of the objectives of the project was to

"Experience de modélisation 2D pour la simulation de propagation d'ondes de crue" in proceedings of the Canadian Dam Association Conference, 2004, Ottawa, Canada

■ D. Violeau, S.E. Bourban, et al, "Numerical Simulation of Cohesive Sediment Transport: Intercomparision of Several Numerical Models" in Fine Sediment Dynamics in the Marine Environment, Hrsg. Winterwerp, J.C. und Kranenburg, C., Elsevier Verlag, 2002

■ S. Bourban, "CFX-5 in action at HR Wallingford", in the international magazine CFX Update, October 2001
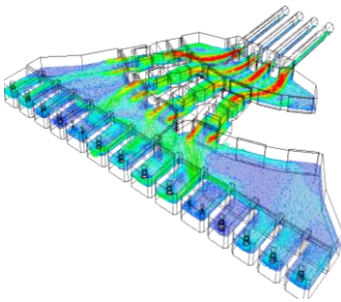
■ S.E. Bourban, "Modelling water quality", article in the newsletter of Innovation & Research Focus, Issue No.39, November 1999
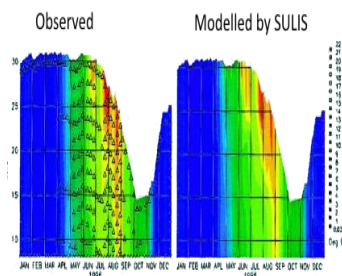
rewrite the TELEMAC advection and diffusion schemes to include features such as monotonicity, implicitness, positive-depth preservation, anti-diffusion, and shock capture, while remaining practical for real applications.

The OpenMI standard, Phase I (2007)

Development of an OpenMI standardisation procedure for the possible transformation of the entire TELEMAC system. The main objective was to develop a simple FORTRAN 1D tank model for illustration purposes, inspired by internal objects and structures of TELEMAC, and delivered with a few Java couplers extended from the Java implementation of the OpenMI standard. The OpenMI standard has been developed through the HarmonIT European project of the European Union.

Spillway discharge curve prediction (2006)

In collaboration with Hydro Quebec, comparison of 3D numerical solvers using both TELEMAC-3D and FLUENT. The main objective was predict discharge curves for various spillways. Hydro Quebec used FLOW3D on the same cases. Comparison were made against data held by Hydro-Quebec.

Data management framework #6, Canada (2004-05)

Technical adviser to Environment Canada for the development of the DMF#6 to store and analyse, in real time, data coming from Environment Canada's gauged stations nationwide. The main objective was to develop and apply automated QA/QC procedures to produce real time stream flow predictions.

Stream flow prediction (2003)

In collaboration with Environment Canada, management and participation in the development of numerical 1D and 2D models to predict stream flows and comparison with information at gauges. Hydrodynamic model based on GEN1D and TELEMAC-2D where used to extend existing flow measurements.

Collaborative research program, Vortex prediction at pump sumps (2000)

In partnership with Bechtel Power (Washington and San Francisco) and AEA Technology, Harwell UK, management and participation in an experimental and numerical modelling comparisons of vortex prediction at pump intake. A CFX model was developed to predict vortex of type 1 to 6 using available turbulence and unstructured 3D meshing capabilities.

Sediment flocculation – Mast funded European COSINUS project (1999)

Further enhanced the 3D code SULIS to simulate flocculation of sediments in schematic 3D estuarial conditions part of the COSINUS European Programme. Solvers such as TELEMAC-3D and MIKE-3 were compared with one another under the same conditions.

Bubble mixing applied to reservoir eutrophication, UK (1999)

Further enhanced the 3D code SULIS to solve the non-linear buoyancy equations (entrainment flows induced by air bubble rising). The main objective was to use of bubble diffusers as re-circulation and de-stratification devices in reservoirs.

Linear Algebra solver upgrade for the NEWMOTICS VOF method (1999)

Upgrade of the finite difference Volume-Of-Fluid model with advanced iterative solvers such as the Conjugate Gradient Squared. NEWMOTICS was previously based on a Gauss-Seidel solver. The main objective was to speed up computation time.

Development of a thermal balance solver for lakes and reservoirs (1998)

Enhancement of SULIS in order to encode the full water/atmosphere thermal balance. The main objective was to enhance the physics of SULIS to include a dependency between water temperature and solar radiation, cloud covering, humidity, and wind.

Development of a water quality module for TELEMAC-3D (1997-1998)

Development of the so-called WQ3D module of the TELEMAC-3D system. The chemistry between more than 20 tracers (sediment, oxygen, nitrogen, ecosystem) was implemented within TELEMAC-3D and validated against field data (from the Hong Kong bay waters in terms of suspended sediment oxygen and algae).