

3D/2D modelling suite for integral water solutions

**DELFT3D**

**Deltares systems**



**Deltares**  
Enabling Delta Life 

## Deltares systems

Wind, waves and currents shape our coasts. Climate change and rising sea levels add further to this pressure. To enable us to live safely along our shores, we need effective coastal and marine management. Moreover, these coastal processes do not present the only threat. We must also protect ourselves against excess river water, while on the other hand we need that water for transport, irrigation, energy, cooling, recreation, environmental protection and as a source of drinking water. Consequently, design and management procedures become more complex and require an integrated approach. Usually, a range of conflicting aspects needs to be evaluated and it is crucial that the compound impact may be surveyed from any desired viewpoint also in terms of time and space. In response to this challenge, Deltares has developed powerful modelling suite software called Delft3D, focusing primarily on application in the free surface water environment.

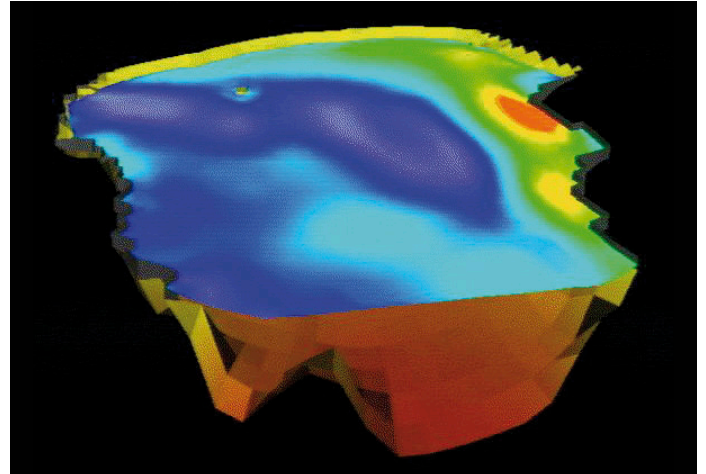
### General

Delft3D is a flexible integrated modelling suite, which simulates two-dimensional (in either the horizontal or a vertical plane) and three-dimensional flow, sediment transport and morphology, waves, water quality and ecology and is capable of handling the interactions between these processes. The suite is designed for use by domain experts and non-experts alike, which may range from consultants and engineers or contractors, to regulators and government officials, all of whom are active in one or more of the stages of the design, implementation and management cycle.

### Features

Some of the typical key features of Delft3D are:

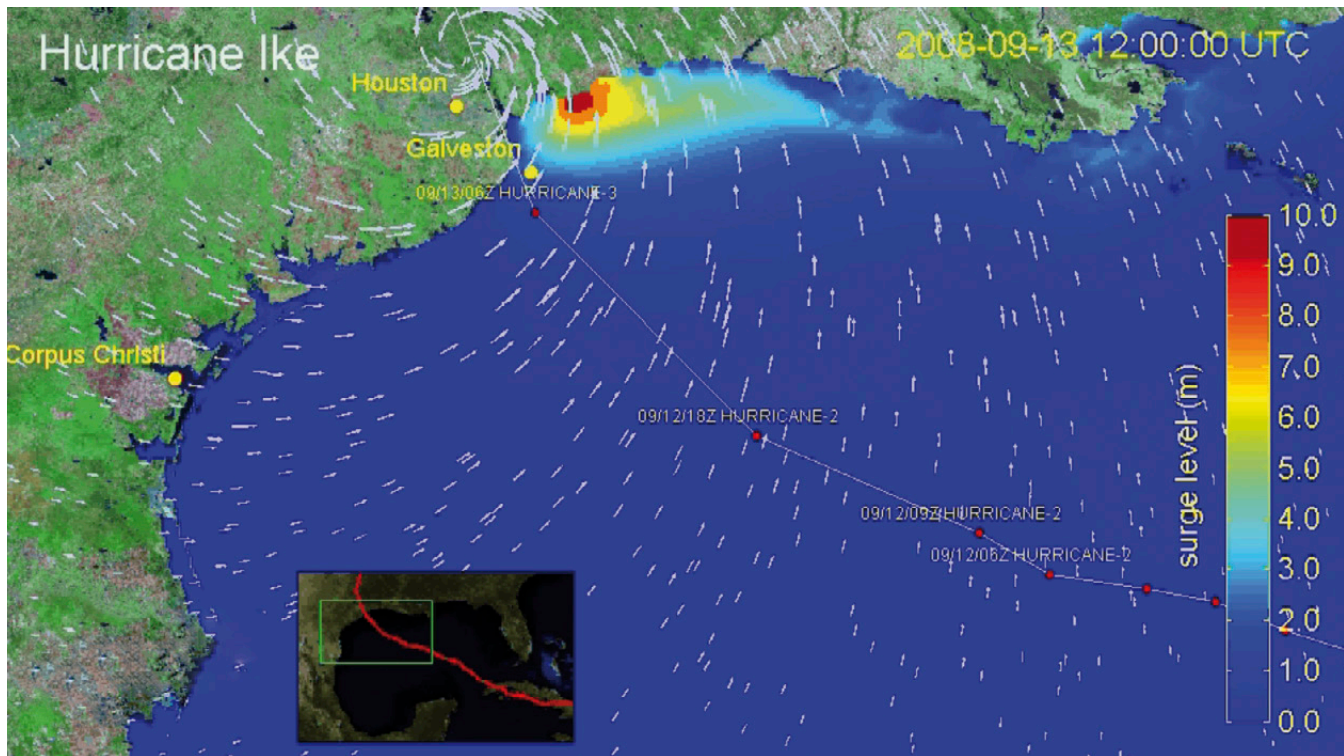
- the suite gives direct access to state-of-the-art process knowledge, accumulated and developed at one of the world's most renowned hydraulic institutes
- the Graphical User Interface (GUI) is one of the most user-friendly in the market
- all programmes show a high degree of integration and interoperability.



Powerful visualization with Delft3D

### • 3D/2D software

Natural phenomena have inherent spatial characteristics, i.e. variations may occur in the two horizontal directions and along the vertical axis. Likewise, elementary natural processes often require a three-dimensional (3D) description, are time dependent and mostly interrelated. For instance, local hydrodynamic conditions determine the local sediment transport rates. However, the gradients of those rates determine the bathymetry, which in turn affects the hydrodynamic basis of the process. Appreciating nature's complexity, we at Deltares have always incorporated these interrelationships into our work. And this notion has been a crucial design aspect in the development of reliable, modular 3D/2D software.



D-Flow results of hurricane Ike

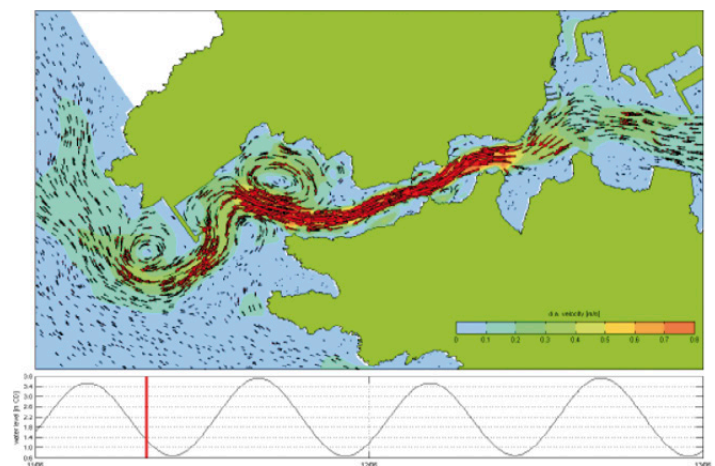
## Programmes

Delft3D allows you to simulate the interaction of water, sediment, ecology and water quality in time and space. The suite is mostly used for the modelling of natural environments like coastal, river and estuarine areas, but it is equally suitable for more artificial environments like harbours, locks, etc. Delft3D consists of a number of well-tested and validated programmes, which are linked to and integrated with one-another. These programmes are further described separately hereafter.

### D-Flow

This programme simulates non-steady flows in relatively shallow water. It incorporates the effects of tides, winds, air pressure, density differences (due to salinity and temperature), waves, turbulence (from a simple constant to the  $k-\epsilon$  model) and drying and flooding. With the integrated heat and mass transport solver, Deltares' front running knowledge of stratified hydrodynamics has been built into this programme. The output of the programme is used in all the other programmes in Delft3D suite.

D-Flow is the standard programme and covers curvilinear and rectilinear grids, full 2D hydrostatic flow, advection-diffusion module for salinity, temperature and substances, density driven



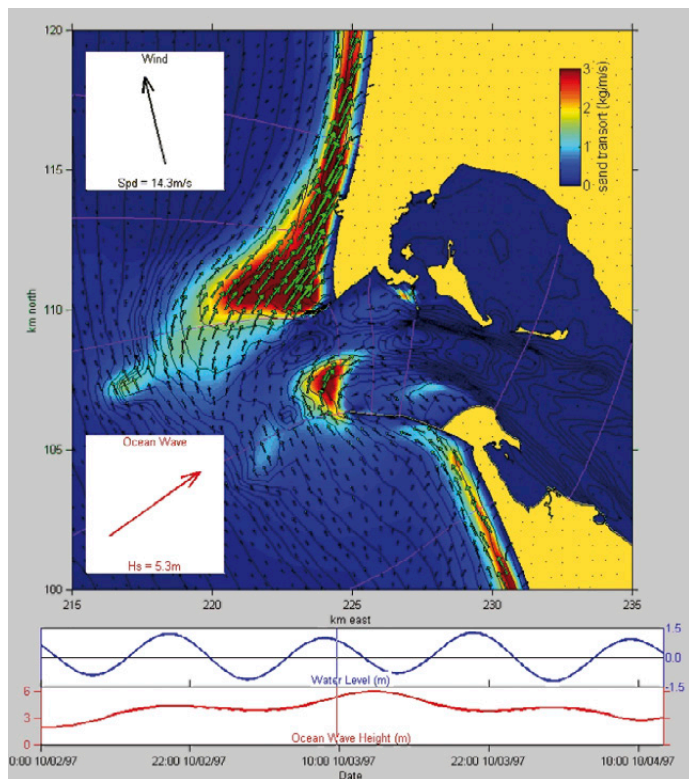
Example detailed modelling of flow circulation to support nautical and safety studies, Reganossa, Spain

flows, float (drogue) tracking, meteorological influences, on-line visualization and wave-current interaction. The D-Flow includes 3D flow and turbulence modelling, spherical grids, domain decomposition (connect multiple grids; refinement in both horizontal and vertical direction allowed), structures (weirs, gates, floating structures, semi-transparent structures) and horizontal large eddy simulations (sub-grid turbulence in horizontal).



## D-Morphology

This programme computes sediment transport (both suspended and bed total load) and morphological changes for an arbitrary number of cohesive and non-cohesive fractions. Both currents and waves act as driving forces and a wide variety of transport formulae have been incorporated. For the suspended load this programme connects to the 2D or 3D advection-diffusion solver of the D-Flow programme; density effects may be taken into account.

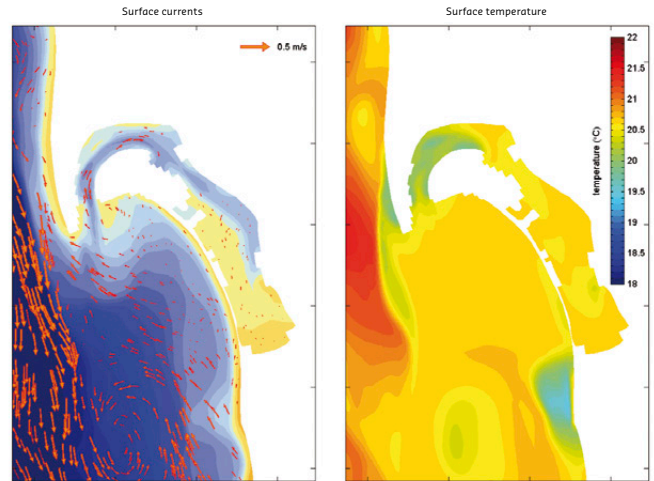


Example sand transport during storm event, Columbia River Estuary and Coast, USA

An essential feature of this programme is the dynamic feedback with the D-Flow and D-Waves programmes, which allow the flows and waves to adjust themselves to the local bathymetry and allows for simulations on any time scale from days (storm impact) to centuries (system dynamics). It can keep track of the bed composition and thus build up a stratigraphic record. The programme includes extensive features to simulate dredging and dumping scenarios. For over 30 years, Deltares has been at the forefront in the development of this type of combined morphological simulation techniques.

## D-Waves

Computes the non-steady propagation of short-crested waves over an uneven bottom, considering wind action, energy dissipation due to bottom friction, wave breaking, refraction (due to bottom topography, water levels and flow fields), shoaling and

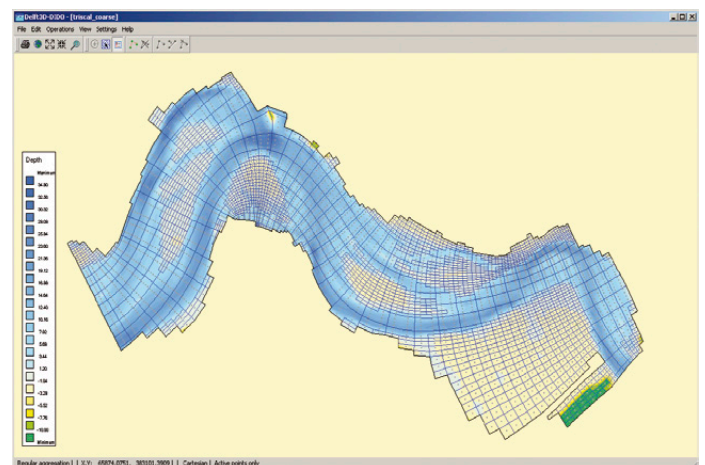


Example surface currents and surface temperature, San Diego Bay, USA

directional spreading. The programme is based on the spectral model SWAN. This model is a development of the Delft University of Technology, which is a close partner of Deltares in a number of research fields. For many decades, both institutes have been prominent in the field of wave modelling.

## D-Water Quality

This programme simulates the far and mid-field water and sediment quality due to a variety of transport and water quality processes. To accommodate these, it includes several advection diffusion solvers and an extensive library of standardised process formulations with the user-selected substances. Default processes allow you to simulate for instance the decay of BOD and nitrification, elementary growth of algae and nutrient cycling, exchange of substances with the atmosphere, adsorption and desorption of contaminant substances and the deposition and re-suspension of particles and adsorbed substances to and from the



Impression of the DIDO tool for grid aggregation for water quality computations

bed. Deltares' unsurpassed level of knowledge in the field of water quality is made available to the professional world by means of this module. The D-Water Quality programme is also available as add-on for TELEMAC users.

D-Water Quality is including the D-Water Quality Open Processes Library. This is an open system to define additional substances, processes acting on new and existing substances, additional coefficients to be used in the formulae, the external forcing and auxiliary output. For grid aggregation we offer a powerful tool called DIDO.

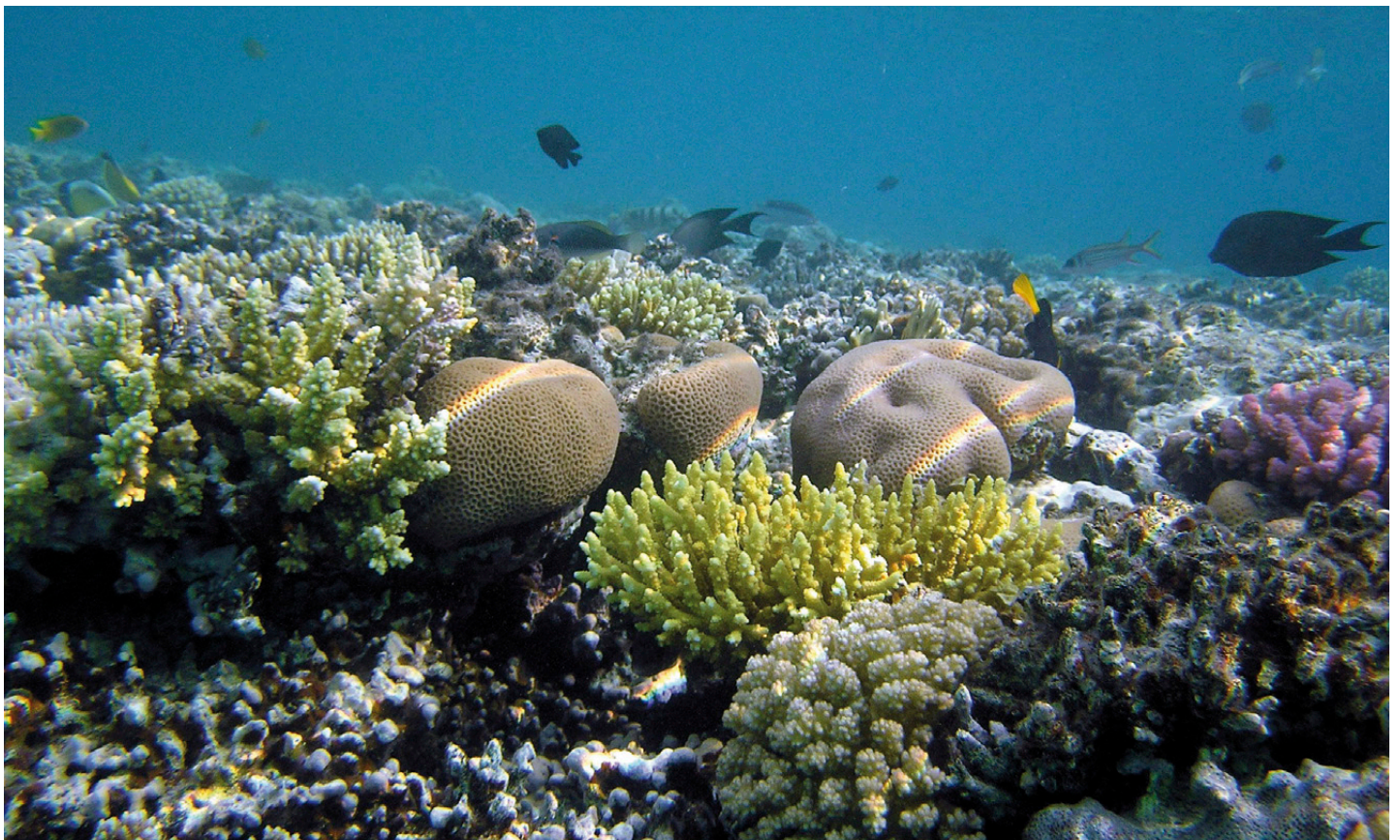
### **D-Sediment Transport**

This sub-programme of D-Water Quality simulates the transport, erosion and settling of cohesive and non-cohesive, organic or inorganic, suspended or bed sediments. The programme includes several standard transport formulae and considers different particulate fractions independently. The effect of changes in bottom topography is neglected, so that only short-term transport can be assessed. As sediment is a dominating factor in water quality and ecology studies, the inclusion of Deltares' leading-edge knowledge of sedimentation and silt transport processes makes this programme the vital base tool for a large range of environmental studies.



### **D-Ecology**

A variety of algae growth and nutrient dynamics programmes have been incorporated into the Delft3D suite. For instance, programmes describing the governing processes of biotic and abiotic ecosystems and the interaction between these have been inserted into the process library, all of which are relevant to the study of eutrophication phenomena. Delft3D includes all algae-connected water quality processes considered in the D-Water Quality programme plus a variety of more detailed processes.



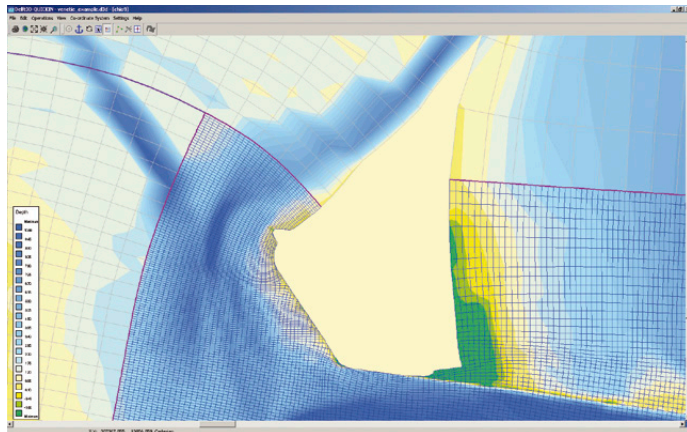


### D-Particle Tracking

This short-term, near-field water quality programme estimates the dynamic, spatial (on a sub-grid scale) concentration distribution of individual particles by following their tracks in time. The waste substances may be conservative or subject to a process of simple, first order decay; a typical application is oil spill modelling. The programme is also used for near-field fate simulations of dredging spillage.

### Graphical User Interface

The Graphical User Interface (GUI) is one of the most user-friendly in the market. Under the umbrella of this GUI, the programmes combine to form an exceptionally versatile, powerful and easy-to-use suite. The GUI allows the user to visualize model input, reference data and simulation results as time series and animations of one-, two- and three-dimensional data sets. The moving image of the flows in and out of an estuary, for instance, can be observed and examined in gradual, fast forward and



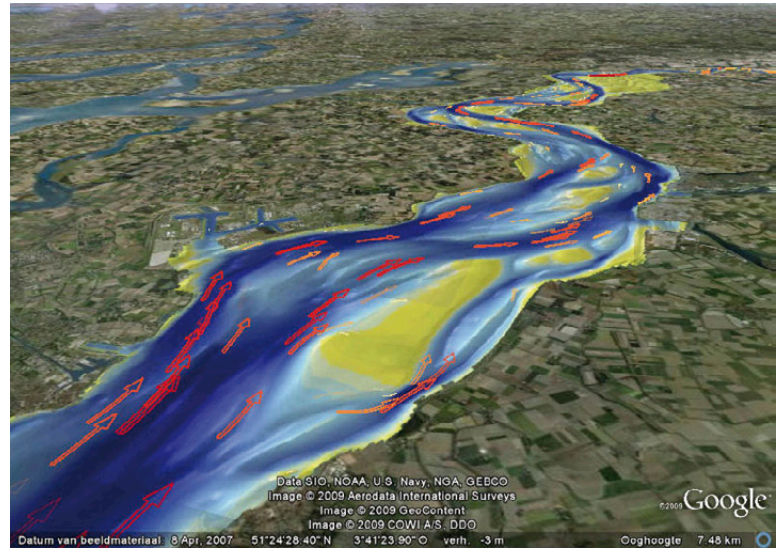
QUICKIN, a powerful editor of grid related data, such as bathymetries, running standalone and as ArcGIS plugin

fast backward mode. The user can also gather a wide, overhead perspective of his entire system or, by contrast, zoom in on a site of particular relevance or difficulty.

Delft3D is open to various data visualizations. One of the most powerful tools is the option to export data to Google Earth.

### Validation

The validation of a modelling system such as Delft3D requires continuous attention. Even though the individual programmes of the suite have been thoroughly tested during their development, the suite as a whole requires intensive testing and also validation. To this end, a regular programme has been established and tests of many of the most likely combinations are continually performed. As a policy, new versions are released only after an extensive beta



D-Flow results presented in Google Earth, using Open Earth tools

testing period, to ensure that our users are provided with stable and validated products.

### System requirements

Delft3D is supported on both Microsoft Windows and Redhat/ Linux. The advised minimum requirements are a configuration consisting of:

	Minimal	Preferred
Processor	1,5 GHz	3 GHz
Memory	2 GB	4 GB
Disk free	10 GB	100 GB



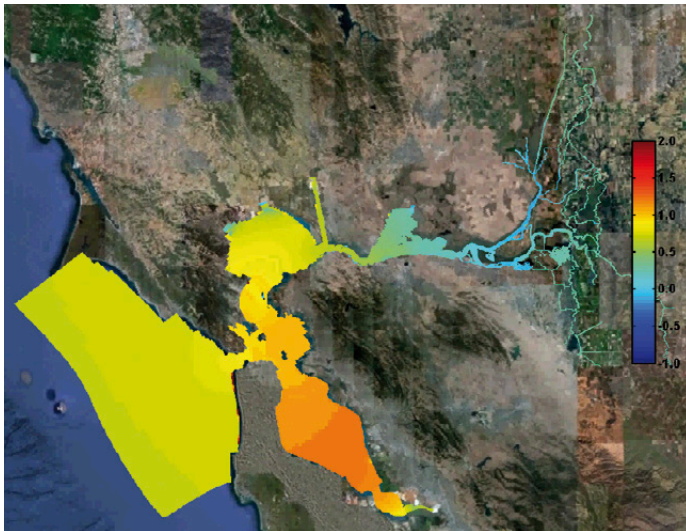
## Service packages

Deltares offers high quality services to consultancy firms, governmental organizations, universities and research institutes worldwide.

Several Delft3D service packages, including fully validated high quality Delft3D distributions, are available to suit your specific needs!

- For consultancy firms, governmental organizations and research institutes worldwide we have designed our Basic Service Packages, Advance Service Packages, Professional Service Package, Premium Service Package and Enterprise Service Package.
- For universities and schools, we offer our Education Service Package.
- Code developers are supported with our Developer Service Package.

Designed with you in mind, they offer you your requested level of convenience.



Example D-Flow Flexible Mesh, San Francisco Bay, USA

## Support desk

The Delft3D support desk is the user's instantly accessible contact point for all questions and problems concerning the software. The support team answers the majority of questions instantly or ensures that a timely reply is given by one of the other Delft3D team members. All incoming queries on the programmes, current or future performance, are recorded in our professional issue tracker system. This system is an important instrument in the realisation of improvements to the programmes, the manuals and the Deltares Academy training courses. New versions of Delft3D will be released once a year to all users, as part of their software package.



## Users meetings

Deltares organizes an annual international Delft3D users meeting. Several smaller Delft3D users meetings are organized at international conferences worldwide. These are excellent venues for receiving updates on the latest developments and for meeting other Delft3D users.

## Deltares Academy

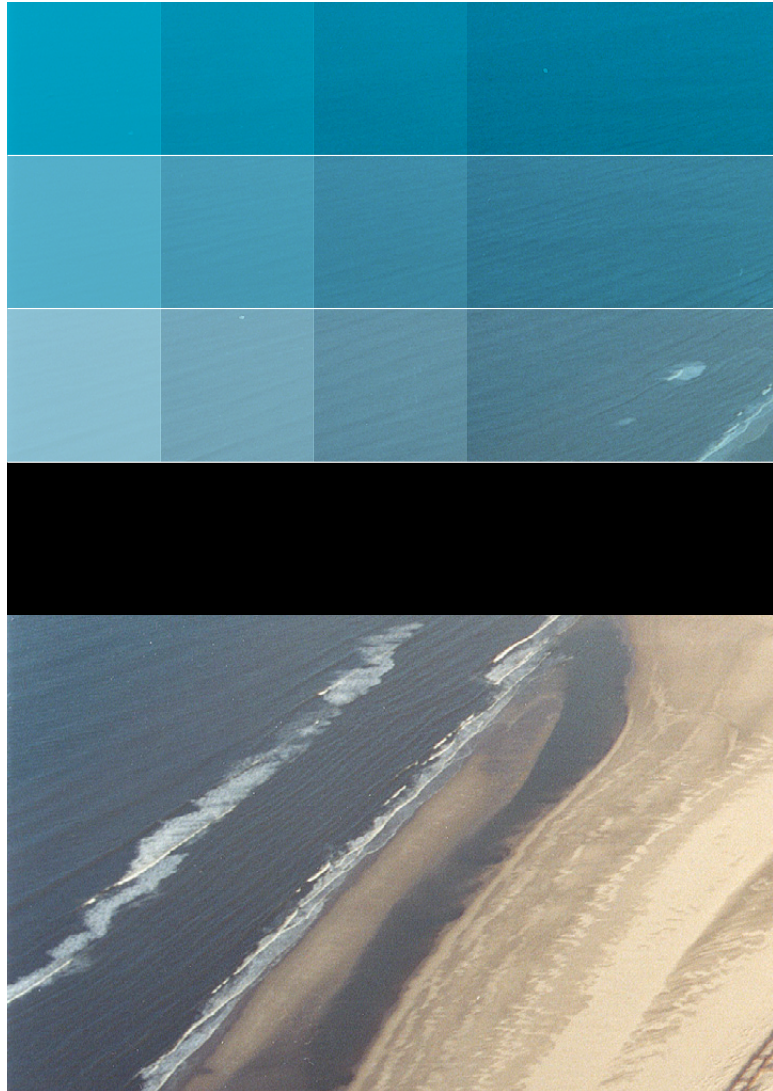
Please visit the [www.deltaresacademy.com](http://www.deltaresacademy.com) for all information about our Delft3D training courses.

## Ongoing developments

To keep Delft3D up-to-date with state-of-the-art knowledge, we constantly update and extend the system. Please contact us if you are interested in particular features that go beyond the default functionality mentioned. Developments in the Delft3D suite currently include:

- Flexible Mesh support: an integrated engine based on 1D networks and 3D/2D layered mesh of mixed triangles, quadrilaterals, and more complex cells
- Non-hydrostatic option for the D-Flow and D-Morphology programmes
- Z-layer option
- Parallel computing for D-Flow, D-Waves and D-Water Quality
- DeltaShell, open flexible modelling suite for 0D-3D programmes
- OpenMI compliant (in DeltaShell).

For our beta testing programme, please contact [sales@deltaresystems.nl](mailto:sales@deltaresystems.nl)



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