

Ask Tom! Column

Integrating Modeling in Urban and Rural Applications

Guest Article by Tony Andrews, Customer Services Manager, Wallingford Software

Overview

Numerical hydraulic modeling of the urban environment, water networks and rivers plays a vital role in providing the water industry with solutions for protecting the environment, meeting government regulations, and improving the efficiency of water companies in managing their assets.

Similarly, the water industry has invested heavily in GIS and asset databases. But until recently these have been under utilized by the modeling community, partly because GIS and asset databases have fallen short on delivering well maintained, quality controlled network data, and also because traditionally GIS management and network modeling have been perceived as separate tasks, with the two communities regarding each other with suspicion.

However, new data extraction and cleansing techniques together with better linkages between GIS and modeling software, have produced good quality geographic data enabling modelers to build bigger networks faster and more reliably.

There is growing evidence that the closer integration of GIS with hydraulic modeling software can assist water authorities to meet regulatory requirements, achieve financial targets, carry out design work, and improve the operational and environmental management of rivers, water distribution networks and collection systems.

Integrated Network Models

The basic system architecture of an "Integrated Network Model" links data storage using a GIS to an hydraulic modeling software suite such as InfoWorks.

Specific data requirements are different between the three modeling areas of drainage, water supply and rivers, but the maintenance, versioning and auditing of 'static' asset data are fundamental requirements of an "Integrated Network System". GIS vendors and the many specialist asset information database suppliers now provide data models that can be adopted in the drainage, supply and river sectors.

Waste-Water Systems

Typical GIS data requirements for a wastewater hydraulic modeling study comprise:

- Network asset data (i.e. conduits, manholes and ancillaries)
- Sub-catchments (contributing areas)
- Surface area breakdown (road/roof polygon areas) from impermeable area study for area take off calculation
- Population data (address point)
- Rainfall profiles from Thiessen polygon analysis
- Viewing geographic information data types and image formats as background mapping layers

An excellent example of the integration of GIS and wastewater modeling can be seen in the surface area breakdown from an impermeable area study for area take-off calculation. Impermeable area surveys are

conducted to establish an understanding of the distribution of impermeable and permeable areas in catchments in order that the correct “surface type” can be assigned to features in the urban environment. This is typically carried out through a survey of the catchment, and represented digitally in a GIS using a combination of data acquired from the UK Ordnance Survey and aerial photography. The analysis of the different areas is conducted using GIS, with the hydraulic modeling software providing area take-off tools to calculate the runoff surface areas and the contributing area for a sub-catchment using the data imported from the GIS (see Fig.1)

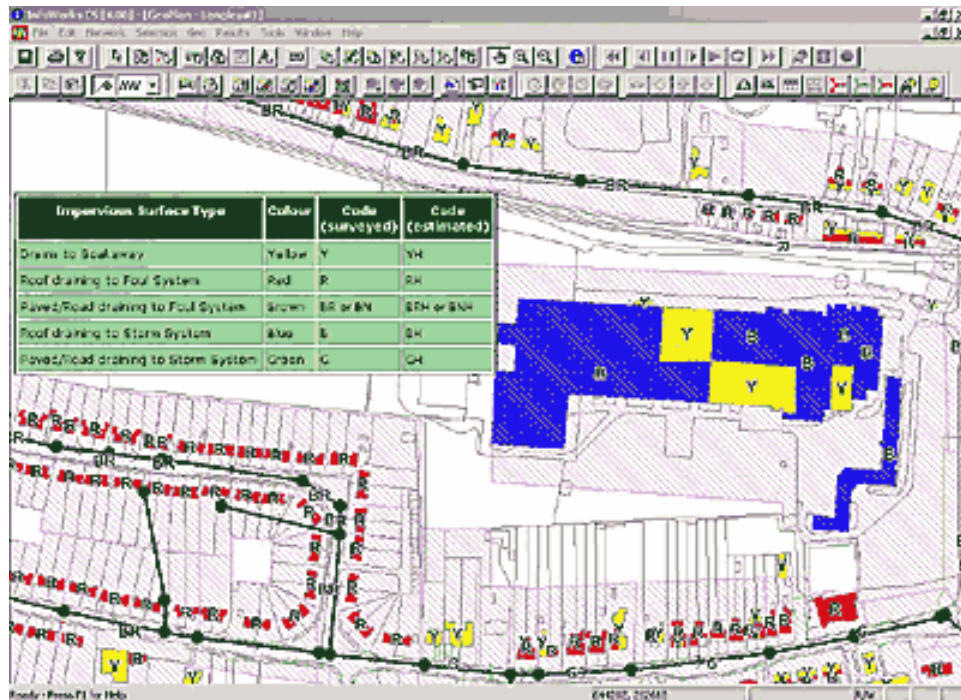


Figure 1. Impermeable Area Survey for Area Take Off Analysis

Water Supply Systems

In the water supply environment, GIS and GI data assist modelers through the incorporation of supporting asset information (pipe condition, class, material, age etc.). It provides the functionality to assign elevation to nodes and customer points using digital elevation data, and to associate spatial information such as bursts and customer complaints with hydraulic data.

Hydraulic modeling software is designed to streamline the modeling process by automating the most repetitive tasks and providing flexible links to all the source data. The functionality of modeling software has extended well beyond just simulation; examples include:

- GIS data cleanup and connectivity checking
- Links to logger and telemetry in their own formats
- Automatic demand allocation
- Automatic setting of elevations
- Look-up tables to set asset attributes (e.g. pipe diameter and roughness)

The main purpose for providing the direct link between GIS and modeling software is to facilitate model building and automatically allocate demand using a combination of GI data, Microsoft Office data files (e.g. Access, Excel) and text files (e.g. comma-separated variable). The most fundamental requirement of any hydraulic modeling package is the provision of tools to enable the:

A TIN dataset represents a surface derived from irregularly spaced sample points and breakline features, with the points comprising x, y, and surface or z-values, and a series of edges joining these points to form non-overlapping triangles. The triangular mosaic forms a continuous faceted surface. TINs offer an alternative to the raster data model for representing surfaces.

Using TIN/GRIDDED elevation data in modeling software such as InfoWorks RS enables the direct take-off of elevation data to facilitate the extraction of model sections and floodplain storage properties based on overlaid section locations and boundaries. The TIN/GRID is also used to generate and display ground level contours, and forms the basis for dynamic flood mapping. River modeling products now have full flood-mapping capability based on sophisticated flood-interpolation models overlaid onto a TIN/GRID based ground model.

The flood-interpolation model enables:

- Instantaneous flood mapping of any simulated event, typically including the additional ability to replay dynamic results in animation, or display flood maximum extents
- Contouring of flood depths
- Flood graph of water level and depth at any point within the flooded envelope
- Interaction with imported geo-referenced seed point data (address-point) to produce reports of flooded-depth and duration at specified locations

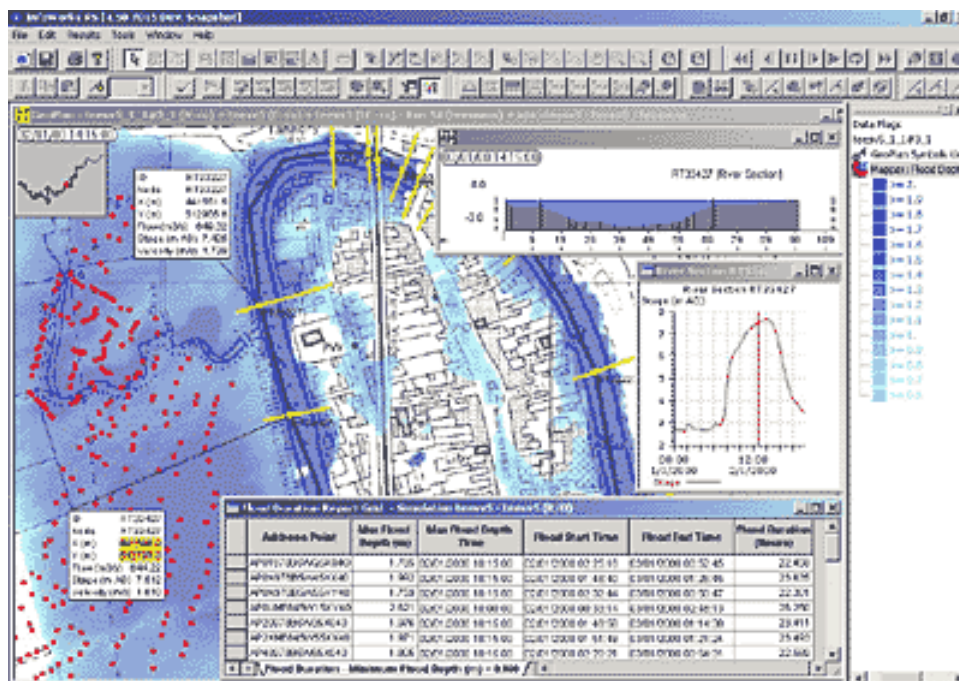


Figure 3. Maximum flood extent mapping, including flooded depth contours.

The Future of GIS and GI Data in Hydraulic Modeling

Hydraulic Network Modeling software in the UK has been essential in meeting expected levels of service and in reducing costs. Clearly, the closer integration of GIS and modeling software will advance the capability of water authorities to achieve regulatory requirements, meet financial targets, carry out design work, and improve the operational and environmental management of rivers, water distribution networks and collection systems.

Recognizing this, GIS service implementers and middleware providers have formed partnerships with businesses in the water industry whilst GIS vendors dedicate teams of specialists to focus on the water business.

Likewise, hydraulic modeling vendors continue to add new features and tools to automate much of the previous manual work of building models, and to ensure that their product is a component of the “integrated network modeling” strategy.

For more information contact our author:

Mr. Tony Andrews
Wallingford Software Ltd
Howbery Park
Wallingford, Oxfordshire
OX10 8BA, United Kingdom
Tel: +44 1491 824 777
Fax: +44 1491 826 392
Email: support@wallingfordsoftware.com
Web site: <http://www.wallingfordsoftware.com/>

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Welcome to Ask Tom!, a monthly column by our resident water treatment guru, Tom Keenan of National Environmental Services Agency (NESA). Tom addresses the issues that bug you the most. And Tom knows!! With 35 years experience in providing environmental support services to public and private sector clients on a wide range of environmental issues.

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Guest articles for the **Ask Tom!** Column are always welcome, for more information please contact Tom Keenan directly at his email address: info@nesa.ie

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