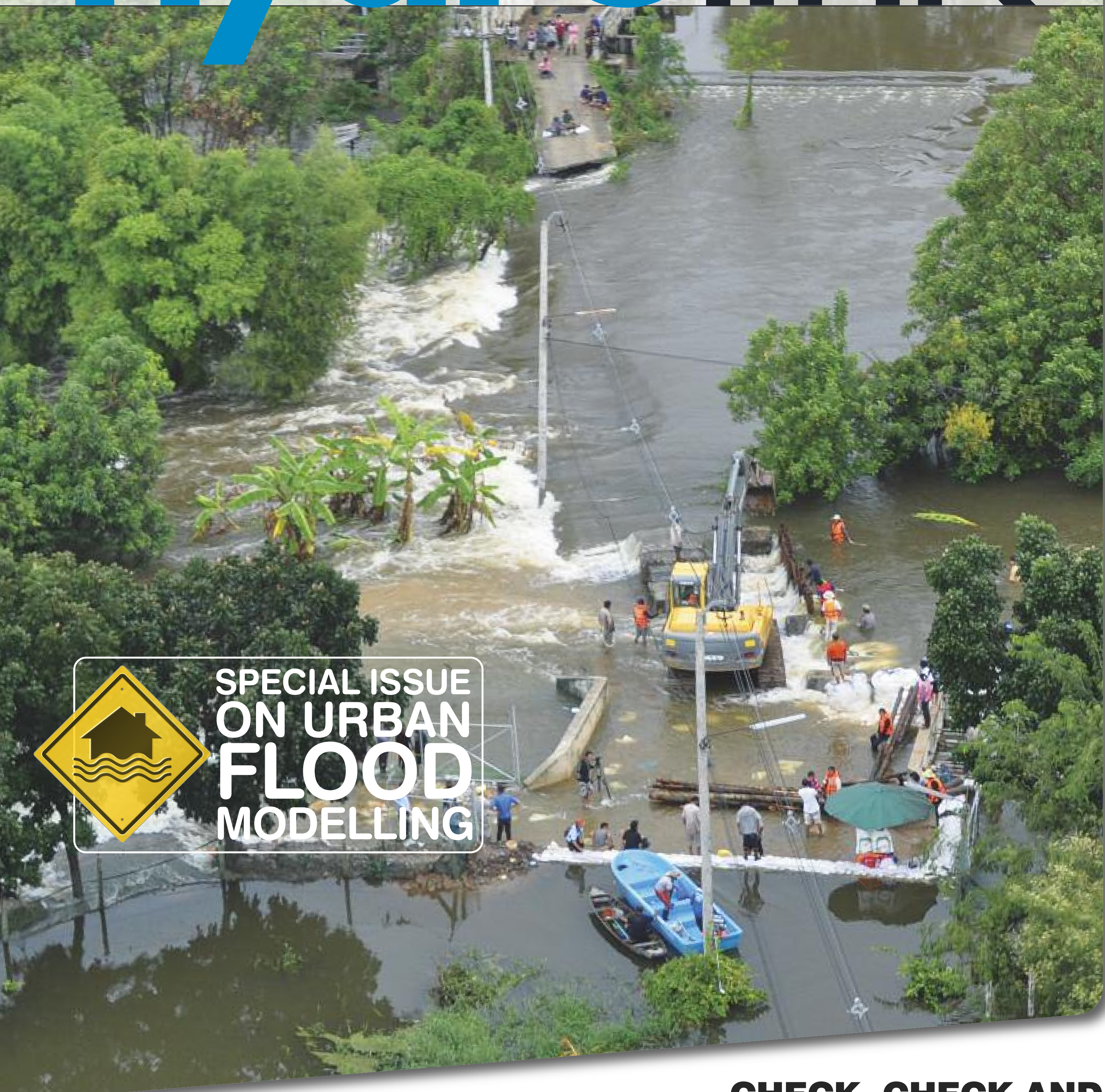
INTERNATIONAL ASSOCIATION FOR HYDRO-ENVIRONMENT ENGINEERING AND RESEARCH

hydrolink

NUMBER 3 / 2012



SPECIAL ISSUE ON URBAN FLOOD MODELLING

CHECK, CHECK AND DOUBLE CHECK

SEE PAGE 68

ADVANCES IN OIL SPILL MODELLING

SEE PAGE 88

TOWARDS FLOOD RESILIENT CITIES

SEE PAGE 78

IAHR AIRH
Supported by CEDEX

10 QUESTIONS TO...

Professor Guus Stelling about 3Di Water Management

INTERVIEWED BY ELGARD VAN LEEUWEN PHD. 3DI CONSORTIUM AND SENIOR RESEARCHER AT DELTARES WYTZE SCHUURMANS PHD. 3DI CONSORTIUM AND CEO AT NELEN EN SCHUURMANS

Since January 2002 Prof. Stelling is professor of fluid mechanics in the Civil Engineering and Geosciences faculty of the Technical University in Delft. Until July 2010 he was the head of the environmental fluid mechanics section. Presently professor Stelling is also visiting professor at the National University of Singapore in the Faculty of Engineering. In addition he is senior advisor at Deltares.

1. What is 3Di Water Management?

"3Di Water Management is an ambitious 4-year research programme that started in 2009. The challenge is to use detailed digital elevation maps (with a resolution of 0.5 x 0.5 m) for detailed flood computations on a large scale. While existing mathematical flood models can deal with schematisation of 1 million cells, the 3Di algorithm currently deals with schematisations consisting of more than 1000 million cells. Normally models of this scale would require calculation times of days, weeks or months. With the newly developed flexible mesh technique, however, computation times can be restricted to minutes or hours."

2. What's the secret?

"The crux is focussing on the important details: the locations in which the flow patterns are complex. In these areas the free water surface can be represented with far less grid points than the bottom bathymetry. This is the crucial component of the sub-grid approach. So although we process much more elevation information and generate high resolution calculation grids, the hydrodynamic 1d/2d calculations with our prototypes are still faster than the models currently available."

3. How do you do that?

"We simply keep an accurate record of how much water and how much momentum comes in and how much flows out. The accounting is very precise, despite the non-linear volumes. You see, if the amount incoming does not tally exactly with the amount outgoing, that's when accountants cry 'fraud'. In order to keep this water account, geographical areas are divided into blocks. This enables you to take into account fast streams through narrow streets and the influence of dikes and obstacles that slow down the current. It makes sense physically too, as phenomena like hydraulic jumps are also accounted for. So in order to calculate a flood, the landscape is divided up into small blocks where water flows in and out. The 'accounting' is the water balance: incoming minus outgoing = increase in storage. There is accounting at system level and accounting at block level. Both of them have to add up. Nothing new so far, as this calculation method has long been used in the Sobek calculation models. What's new is the block pattern. Until recently, blocks of equal size were used in calculations, and a fixed ground level per block. In the case of the latter, that was the only possibility, with the poor ground-level data available."

4. So the new elevation data is the trigger?

"Certainly for the innovations concerning the calculation grid. Thanks to the laser altimetry technology, much more detailed information is now available. And I use this data to determine a more complex block pattern. Rather than refining the whole block pattern, we work more intelligently. As I have said, we refine only those places where the current is complex, and those are the locations with greater height differences. The result is that a flat area like a field becomes one large cell while the blocks are divided up in larger so called 'quadtrees' around a dike or a discharge channel. With the old-style calculations, the field would have comprised too many blocks, while the defining elements like dikes would be contained entirely within a single block, rendering them 'invisible' for the purposes of calculation. Height differences used to be averaged within the block, giving rise to unrealistic flood zone forecasts. The new approach is more complex for each calculation stage but, as larger areas are calculated more quickly, the calculation as a whole is ready much more quickly. That's our big secret. For instance in practice, it provides a better grasp of the escape routes that will remain available during a flood, which is essential information for safe evacuation. And everyday water management benefits, too. Investments can now be made in exactly those places where flooding would cause the greatest damage. Tailored work for focussed investment."

5. Who is involved in the 3Di programme?

“The nice thing about the 3Di project is the close and inspiring collaboration between the scientists, consultants and water managers involved. The core of the project team is a small group of creative professionals covering different fields of expertise such as computational hydraulics, software development, virtual reality and water management. In this team my ideas are developed further and translated into software prototypes. The latter is done by Deltares engineers. Next, these prototypes are tested in case studies in two waterboards by the consultants of Nelen & Schuurmans. These waterboards ‘Hollands Noorderkwartier’ (the regional water board for North Holland province) and ‘Delfland’ (the regional water board for South Holland province) are our launching customers. They support the research programme, and, as members of the steering group, play a part in deciding the desired functionalities.”

6. You describe the 3Di team as ‘inspiring’, how do you build such a team?

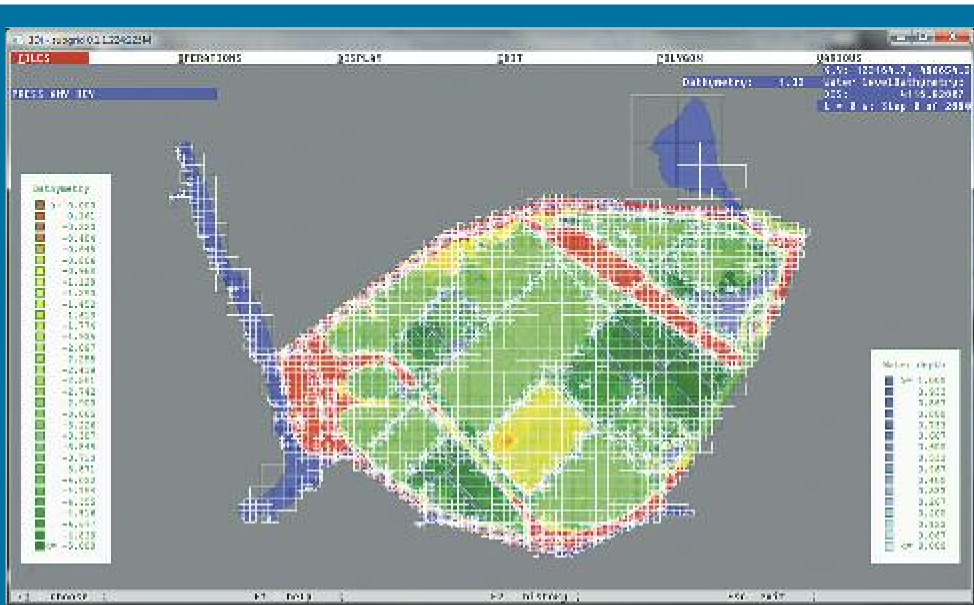
“By working with people, professionals as well as students and PhD’s, who do their work with passion, because they love their job and are really curious as to what we can achieve together. These people with their different backgrounds, ages and experience form a colourful small community with an amicable but professional way of doing things. There is plenty of room for laughter but in the end we all focus on creating software with an outstanding performance.”

7. What has been achieved so far?

“Well, apart from the 3Di algorithm I mentioned before, the Delft University developed a 3D environment based on the mapping of detailed elevation data, in which the results of our high resolution flood simulations can be projected. The result is a 3D stereo visualisation of floods. Believe me, it’s quite impressive to see how the water visibly swirls through the streets in 3D, accumulating on the left and accelerating to the right, flowing around buildings and under sheds. You can even determine waves from a vantage point directly above the action. And all with respect to the underlying physics. Another interesting innovation is the possibility of interactive modelling. Because the presentation of simulation results and model adaptations can be made during the actual simulation, the tool is especially suitable for decision support in calamity situations and design table situations. With three mouse clicks, the dikes can be raised while the effect on the course of the flood is visualised immediately. In projects on land-use, planning the possible interaction and advanced visualisation can be used to show policymakers, governments and water boards the effects and consequences of improvement works. Especially for the identification of climate adaptation measures such as green roofs and other forms of retention measures, interactive modelling has proved to be very effective. And it is also a way of enthusing the public. The tool will contribute to the public being progressively more aware of water management problems and possible solutions.”

8. Who benefits from 3Di?

“The real beneficiaries are the water authorities, who can save billions. How is that possible? If we don’t know what happens, civil engineers tend to overdimension dikes, water retention basins, drainage channels, etc. With more accurate models, we are able to design tailor made solutions. The Eiffel tower is more than 100 years old. If we were to design the same tower today, I am sure we could save more than 30% on the amount of



Example of a quadtree grid for calculating a flood in polder Watergraafsmeer. Around flood defence structures and discharge channels a much higher resolution is used than for the flat areas in between them. In these areas the free water surface can be represented with far less grid points than the bottom bathymetry.

Visualisation of an historic inundation of the polder Wieringermeer during the second world war (1945). The 3Di model was calibrated on the basis of written eyewitness information. With a space mouse the user can 'fly' over the inundated area and zoom in on specific locations.

steel used. Simply because we now know more precisely where extra strength is needed en where not."

9. What is the philosophy behind 3Di?
"In the early days, computer programmers made simulation models and used the models. Later on, the computer programmers made more sophisticated programs and specialists used these programs to make complex models. In 3Di we go one step further, we want other people to use these complex models to discover for themselves the impact of extreme storms, or man made measures."

10. And the danger for improper use of models?
"We must not be too afraid for that. Focussed investments in infra-structure is very important nowadays. This means more flexible and integrated measures: not simply rigid dikes, but measures integrated in the public space. Not merely raising the dikes, but also changing street profiles, building retention basins, beach replenishments, emergency overflow zones and the like. Safety is combined with requirements concerning the environment and creating pleasant living spaces. All these things are interdependent. Processing detailed information is a prereq-uisite. 3Di is part of that."

video of the presentations:
Click here
or scan the QR-CODE