International MIKE by DHI Conference Copenhagen 2010

'Modelling in a World of Change'

6 - 8 September 2010

Hotel Clarion Copenhagen

Conference Handbook

MIKE BY DHI

WELCOME

On behalf of DHI, I would like to welcome all of you to the International MIKE by DHI Conference 2010. For those of you from abroad, welcome to Copenhagen. Despite the financial crisis, more than 200 colleagues from 40 countries are attending this event. Over the next five days, you will all have the chance to exchange experiences and enjoy the stimulating company of modellers and water professionals from around the world.

The MIKE user conferences and user group meetings are always a valuable opportunity to learn from one another. Our goal is to provide software that is at the cutting edge of water science, while at the same time
relevant and practical for our users. We cannot do this without your inspiration, guidance and help.

The conference theme, "Modelling in a World of Change", embodies the challenges facing the water industry today. The most prominent of these is climate change, which is causing us to completely rethink the way we address water issues.

Following the Conference are two days of free seminars and training courses out at the DHI campus in Hørsholm, where you will be able to brush up on what's new in your current tools, or introduce yourself to a new MIKE by DHI product. The DHI staff is looking forward to seeing many of you in Hørsholm later this week!

I want to extend a special thanks to our keynote speakers, who will be providing food-for-thought to all of us - each of whom is bringing a different perspective to the discussion. Our sponsors also need special mention. Your generosity has helped ensure the success of this conference. Finally, we are grateful to Dr. Lykke Friis, the Danish Minister for Climate and Energy, for accepting our invitation to open the International MIKE by DHI Conference 2010.

We look forward to a memorable conference with you.

Jørgen Bo Nielsen
Managing Director
DHI Software Products
Denmark

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Spildevandscenter Avedøre

Avedøre Wastewater Services (AWS) is a municipal company jointly owned by 10 municipalities 10 km west of Copenhagen, the capital of Denmark. The company's responsibilities comprise the operation and maintenance of wastewater and sludge incineration facilities. The company receives and treats roughly 25 - 30 million m^3 of wastewater annually.

Avedøre Wastewater Services (AWS) presents the following projects at the International Conference:

Local Area Weather Radar (LAWR) System to Approve Drainage Systems Capacity - Case Study from Egedal, Denmark (P079)
By Sabah Al-Shididi

Performance of MOUSE UPDATE for level and flow forecasting in Uran Drainage Systems (P063)
By Lisbet Sneftrup Hansen

www.spildevandscenter.dk

AQUAMARINE POWER

Aquamarine Power is a wave energy company with head offices in Edinburgh, Scotland and further operations in Orkney and Northern Ireland. The company is currently developing its flagship technology, an innovative hydro-electric wave energy converter, known as Oyster. Aquamarine Power's goal is to develop commercial Oyster wave farms around the world.

Aquamarine Power presents the following projects at the International Conference:

Wave Modelling for Wave Farm Development (P106)
By Sandra Lengden

www.aquamarinepower.com

Grontmij | Carl Bro

Grontmij | Carl Bro is part of the Dutch company Grontmij, one of Europe's largest consultant engineering companies. Grontmij provides consultancy services within the fields of transportation, building, environment, water, industry and energy, and is represented in the Netherlands, Denmark, the United Kingdom, Germany, Belgium, Poland, Ireland, Sweden and Vietnam, among others.

Grontmij | Carl Bro presents the following projects at the International Conference:

Integrated Flood Modelling with 3D Highway Design (P080)
By Alvaro Fonseca

3D Watercourse Modelling of Sneum River in Denmark (P086)
By Jimmy Teilmann

www.grontmij-carlbro.com

COWI

One-Stop consultancy. With more than 6,000 employees on five continents, COWI is able to provide world-class consultancy services within economics, management & planning, water & environment, geographical information & IT, railways, roads & airports, bridge, tunnel & marine structures, buildings, industry & energy around the globe.

COWI presents the following projects at the International Conference:

Numerical Wave Modelling for a Semi-Enclosed Bay with Complex Bathymetry (P094)
By Haiwen Zhang

Climate Change Risk Assessment for Northern Zealand and Detailed Analysis of Climate Change Adaptation Measures for Copenhagen (P136).
By Arne Bernt Hasling

COWI also sponsors the event "Canal Tour in Copenhagen Harbour - *The Role of Water in Sustainable Development of Copenhagen Harbour",* Wednesday 8 September at 16:00

www.cowi.com

With advances in technology - sophisticated sensor networks, smart meters, deep computing and analytics - IBM is helping clients and partners make smarter decisions about water management. By monitoring, measuring and analyzing water systems, from rivers and reservoirs to pumps and pipes, we can better understand the issues around water. IBM is applying its expertise in smart systems and data analysis to help companies, governments and citizens understand and more effectively deal with these issues.

IBM presents the following Keynote at the International Conference:

IBM's Big Green Innovations
By Dr Sharon Nunes, Vice President, Smart Cities Strategy & Solutions, Big Green Innovations, IBM, United States

www.ibm.com

EnviDan is an engineering company specializing in the field of wastewater treatment. Through the years EnviDan has become one of Denmark's leading companies in this area. EnviDan's main business areas include: planning, development, counselling, delivery of equipment, total enterprises, partnering and financing of environmental technical plants.

Wide-ranging and extensive professional expertise, sophisticated technology and a responsible approach to efficiency and the environment form the basis of the solutions.

EnviDan has been an important urban software client for more than a decade.

www.envidan.com

The NIVUS group is a leading developer, manufacturer and supplier of ultrasonic measurement instruments for water economy. Our product portfolio comprises metering devices for flow, level, pressure, density and turbidity. Furthermore, NIVUS provides devices and software for detection, transfer, recording and evaluation of data. A high-performance telecontrol system with multiple functions particularly for water economy completes the product range. NIVUS is in the position to be a full-range supplier on the water economy market.

NIVUS collaborates with PVK a.s., Czech Republic and DHI a.s. Czech Republic in the collection system of Prague. This project is presented at the International Conference:

Complex Monitoring of the Collection System of The City of Prague (P120)
By Petr Sykora, PVK a.s., Czech Republic

www.nivus.de

Graz is a town in the south of Austria with 250.000 inhabitants. It has a sewer system of about 849km, which are maintained by the Sewer Department Graz (Kanalbauamt). Because the urban drainage is for the most part a combined system, one of the main aims of the Sewer Department is to reduce the amount of pollution flowing into the rivers during rain weather. The strategy is to reduce the rain water in the sewers and to build storage for wastewater management, especially the Main Storage Sewer (ZSK).

Graz Kanalbauamt presents the project at the International Conference:

The New Storage Sewer in Graz (P018)
By Werner Sprung

www.graz.at

KEYNOTE SPEAKERS

Dr. Lykke Friis, Minister for Climate and Energy

Welcome and Opening of International MIKE by DHI Conference 2010, Monday 6 September 2010, 09:00

During the period 2006-2009 Dr. Lykke Friis was the Pro-Vice Chancello, University of Copenhagen, prior to which she was the Director of European Affairs, Confederation of Danish Industries.

Dr. Lykke Friis was awarded PhD at the University of Copenhagen, (1997); M.A. in Political Science from the University of Copenhagen, (1993); Msc. Econ., London School of Economics and Political Science, (1992).

Keynote Speakers, Monday 6 September 2010, 09:10 - 10:10

Mr. Asger Kej, Chief Executive Officer of DHI

Mr. Kej has a professional background in numerical modelling of flows and ecology in rivers and coastal waters. Mr. Kej graduated from the Technical University of Denmark in 1974 with majors in hydraulics and environmental engineering. From 1980 he obtained the post as the manager of DHI's R&D programmes and from 1983 through 1988 he was Head of DHI's Computational Hydraulics Centre (CHC). In 1988 he was appointed Deputy Director of the Institute; in 1996 he was appointed Managing Director and in 2007 he became the CEO of the DHI Group.

Mr. Sten Lindberg, Head of Urban & Industry, DHI Denmark

Urban & Industry is DHI Denmark's competence centre within water supply, drainage, waste water treatment, industrial water treatment and reuse, solid waste and contaminated soil.

With more than 25 years' experience Sten is the "Father of MOUSE" - the first product in the MIKE family and he was the development director of MIKE URBAN, the successor of MOUSE. Sten has extensive working experience with urban waters projects in Europe, USA, Middle East, Latin America, and the Asia-Pacific Region.

Mr. Jørgen Bo Nielsen, Managing Director of DHI Software Products

Mr. Jørgen Bo Nielsen has a professional background in physical and numerical modelling of flows and waves in rivers and coastal waters. Graduated from the Technical University of Denmark in 1978 with majors in hydraulics and coastal engineering. 1988 - 1993 he worked as Head of DHI's Hydroinformatics Centre (HIC). In 1993 he was appointed Corporate Development Manager responsible for the global network of software agents. In 2000 he became Director, DHI Software and in 2007 he was appointed Managing Director.

Keynote: "History, Present and Future"

"The first part of this joint keynote will start off by giving a historical review of the strategic milestones in relation to numerical modelling and software product development which have generated DHI's position as a leading global provider of water modelling software. The first part will finish with a short story about the pioneering days in DHI's Computational Hydraulics Centre. The second part of the keynote will focus on the development of MOUSE, the very first product of the MIKE product family. MOUSE has subsequently been developed further as part of MIKE URBAN. The third part of the presentation will focus on new developments in the coming release of the MIKE products and on some of the strategic development initiatives and trends that will form the basis for the next releases".

Professor Roland K. Price, UNESCO-IHE, Delft, Netherlands

Keynote Speaker, Monday 6 September 2010, 14:00-14:30

Dr. Roland Price a PhD in mathematics at Essex in 1969 on shallow water waves. He joined HR Wallingford in 1971. There he developed a new non-linear approach to flood routing in rivers and began the development of software for urban drainage design and analysis within a team of people from different institutes. This resulted in the Wallingford Storm Sewer Package (WASSP), first released in 1981 for mainframe computers and subsequently for PCs in 1984. This was followed by WALLRUS in 1989, SPIDA in 1989 and eventually HydroWorks in 1992. In 1987 he was responsible for setting up Wallingford Software as a commercial software house providing professional software products to the water industry world-wide. This eventually became a separate subsidiary of the privatised HR Wallingford in 1994. He left HR Wallingford in 1997 to take up the Chair of Hydroinformatics at UNESCO-IHE Delft. Since then he has been responsible for the Hydroinformatics Core at the Institute.

Keynote: "Computational Hydraulics to Hydroinformatics: Drivers for Change"

"The generations of computational hydraulics are described in terms of advances made in the modelling products and of the drivers that have made them possible. The consquences brought about by the changes that have occurred are also described. In particular, hydroinformatics is viewed as having evolved from computational hydraulics. The emergence of hydroinformatics points the way to the future role of modelling products in facilitating social change".

KEYNOTE SPEAKERS

Dr. Sharon Nunes, Vice President, Smart Cities Strategy & Solutions, Big Green Innovations, IBM, United States.

Keynote Speaker, Tuesday 7 September 2010, 09:30-10:00

Dr. Sharon Nunes is currently Vice President of Smart Cities Strategy & Solutions, Big Green Innovations in IBM. This organization has the mission to launch new businesses for IBM using our information technology expertise, and materials & processing expertise to solve critical problems around environmental issues. Together with clients and partners, IBM is demonstrating how information technology plays an important role in managing the world's critical resources. In 2009, Sharon launched IBM's program in Advanced Water Management as part of Big Green Innovations, and she is an executive leader in IBM's Smarter Planet program. Dr. Sharon Nunes has held numerous executive positions leading new growth initiatives in IBM as well as a number of academic advisory board positions. Dr. Sharon Nunes received her PhD in Materials Science in 1983 from the University of Connecticut.

Keynote: "IBM's Big Green Innovations"
"Discussion of IBM's strategy and solutions to build smarter cities in collaboration with clients and partners. Recognizing that Smarter Cities will be an economic growth engine for the 21st century, IBM is applying the company's unique capabilities to create, manage and run the world's most intelligent and interconnected infrastructures and systems in every industry".

Ms. Helen James, Senior Advisor, Flood and Coastal Risk Management, United Kingdom Environment Agency

Keynote Speaker, Tuesday 7 September 2010, 14:00-14:30

Helen James has worked for the Environment Agency for 8 years in various departments within Flood and Coastal Risk Management. She started out in the Environment Agency in Flood Forecasting developing models for the River Thames and its tributaries. Later on she has implemented aspects of the UK National Flood Forecasting System. Helen James is the author of the UK Flood and Coastal Risk Management Modelling Strategy and is today working to implement this strategy through various work streams including research and development, IT solutions and culture change in the Environment Agency. Helen James holds a BSc in Environmental Science and MSc Applied Meteorology.

Keynote: "The Future of Modelling at the UK Environment Agency"
"Flooding is a major challenge facing the environment in the UK. Understanding risk from flooding and communicating it effectively to enable others to make decisions is the key focus of the UK Flood and Coastal Risk Management Modelling Strategy 2010-2015. Modelling underpin the way we understand and communicate flood and coastal risk in the UK. The strategy addresses how we should do this in partnership for all sources of flooding, how we understand and communicate uncertainty, how we manage and value our models, and how we ensure skills, resources and technology do not constrain us in achieving our goals. We have to do this all as efficiently and effectively as possible and several projects are underway to enable us to do more for less".

Dr. Katherine Richardson, Professor, University of Copenhagen; Chairperson of **the Danish Government's Commission on Climate Change Policy.**

Keynote Speaker, Wednesday 8 September 2010, 09:00-09:30

Katherine Richardson is a vice Dean at the Faculty of Science at the University of Copenhagen. She is also a professor in biological oceanography. Her research focuses on the importance of biological processes in the ocean for carbon flux in the upper ocean. She is chairperson of the Danish Government's Commission on Climate Change Policy. In addition she is chairperson of the "Earth System Science" Evaluational Panel for ERC Starting Grants. She has been active both as a member and/or chairperson for a number of national and international research committees/advisory boards, including Vice President of ESF from 2001-2008.

Keynote: "The Changing Human - **Earth Relationship"**
"It is seldom that advances in scientific understanding cause the reverberations in society as a whole as is the case with climate change. Possibly the last time that this happened to such a degree was when Darwin introduced the concept of evolution in 1859. As in the case of evolution, the recognition of human-induced climate change challenges society's perception of the role of humans in nature. The knowledge that our species is influencing the Earth System brings with it the responsibility to manage our relationship with the planet. This talk reviews some of the evidence for human influence on the climate system and examines mechanisms for how management of the human-Earth relationship might be achieved".

Professor Toshio Koike, University of Tokyo, Japan

Keynote Speaker, Wednesday 8 September 2010, 09:30-10:00

Dr. Toshio Koike has been the Professor of the Civil Engineering Department, University of Tokyo, Japan since 1999. From 2006 the Executive Director, Earth Observation Data and Information Fusion Research Initiative (EDITORIA), the University of Tokyo, and from 2007 Special Adviser to the Minister of Science and Technology of Japan. Dr. Koike´s main areas of research include hydro-meteorological variability and its impacts on water resources, remote sensing and satellite hydrology, and hydrological processes in the monsoon Asia and their predictability.

Keynote: "To Create Knowledge that Leads to Adaptation to Climate Change"
"Climate change poses a fundamental threat which encompasses security in water, food, energy and health. It is not hypothetical, and its impacts are already evident, as both scientific observations and the experiences of the region's inhabitants confirm. The assumption of stationarity in planning must now be re-considered. We need to create knowledge and wisdom that leads to adaptation to climate change and builds the capacity of society to demonstrate resilience in the face of changing climate by improving community-based risk management capacities. Advanced data infrastructure and networking should be developed for sharing huge amount data and information with large variety from diverse sources to improve scientific understanding, to quantify and reduce the uncertainty related to climate projections, to raise public awareness, and to support sound decision-making. We should make a plan for incremental adaptation actions in tandem with improving climate projections, use an appropriate mix

BOOK-AN-EXPERT

During the Conference it is possible for you to book an individual meeting with one of our experts to discuss some of your projects or specific products.

Contact our Conference Secretariat and we shall book you a 20 minutes' talk!

Experts within the following modelling areas are present:

- Water resources management and planning
- Rivers and reservoirs
- Integrated catchment analysis (incl. WQ and Pollution loads)
- Groundwater water modelling
- Irrigation
- Flooding management and control
- Urban water management
- Coastal and marine projects, including waves; sediment transport; morphology and environmental processes

Experts in the following products are available:

COAST & SEA:	MIKE 21, MIKE 3, LITPACK
CITIES:	MIKE URBAN, MIKE FLOOD (Urban)
WATER RESOURCES:	MIKE 11, MIKE FLOOD (River), MIKE BASIN, MIKE SHE, FEFLOW
GENERAL:	MIKE ANIMATOR, MIKE C-MAP, Temporal Analyst

Date: Thursday 9 - Friday 10 September 2010, 09:00 - 16:00
Location: DHI's head office, Agern Allé 5, 2970 Hørsholm.

Training certificates, lunch and refreshments during the two training days are provided. The courses do not include hands-on exercises. Please contact the Conference Secretariat for available seats!

TRACK I - CITIES			
PRODUCT	COURSE TITLE & REFERENCE NUMBER	THURSDAY 9/9-2010	FRIDAY 10/9-2010
MIKE URBAN WD	Introduction to modelling of urban water distribution systems (CITY01)	09:00 - 16:00	
MIKE URBAN CS	Introduction to modelling of storm water and waste water collection systems (CITY02)	09:00 - 16:00	
MIKE FLOOD	Urban flood modelling (CITY03)		09:00 - 16:00

TRACK II - WATER RESOURCES			
PRODUCT	COURSE TITLE & REFERENCE NUMBER	THURSDAY 9/9-2010	FRIDAY 10/9-2010
MIKE BASIN	Introduction to river basin modelling (WR01)	09:00 - 16:00	
MIKE 11	Introduction to river and channel modelling (WR02)	09:00 - 12:00	
MIKE 11	Advanced hydrodynamic modelling (WR03)	13:00 - 16:00	
FEFLOW	Introduction to groundwater modelling (WR04)	09:00 - 16:00	
MIKE SHE	Introduction to integrated catchment modelling (WR05)		09:00 - 16:00
MIKE FLOOD	River flood modelling (WR06)		09:00 - 16:00

TRACK III - COAST & SEA			
PRODUCT	COURSE TITLE & REFERENCE NUMBER	THURSDAY 9/9-2010	FRIDAY 10/9-2010
MIKE 21 & MIKE 3 Flow Models	Introduction to hydrodynamic modelling (CS01)	09:00 - 16:00	
MIKE 21 & MIKE 3 Transport Models	Introduction to transport modelling (CS02)		09:00 - 16:00
MIKE 21 BW/SW	Wave modelling (CS03)		09:00 - 16:00

CONFERENCE EVENTS

In the afternoon of Wednesday 8 September two Conference events have been arranged.

Both arrangements are based upon a 'first-come first-served' basis as there is only a limited number of seats.

If you wish to join one of the Events, please contact the Conference Secretariat.

Canal Tour in Copenhagen Harbour - **"The Role of Water in Sustainable Development of Copenhagen Harbour"**

From Hotel Clarion you will walk to the boat through the Sluseholmen - a new, exciting residential area in the southern part of the Harbour. The boat will take you through the canals of Copenhagen. You will see how the harbour has developed from a polluted industry harbour to a clean, attractive residential area and workplace.

Departure at 16:00 hrs from Hotel Clarion at the reception. The tour ends at Nyhavn in the centre of Copenhagen at approximately 17:30 hrs.

The Canal Tour is sponsored by COWI

Visit to DHI's Model Test Facilities

For those interested in visiting DHI there will be an introduction to experimental modelling and a visit to DHI's model test facilities at the headquarters in Hørsholm.

Departure at 15:00 hrs from Hotel Clarion at the reception.

Visitors will be brought back to Hotel Clarion afterwards. Expected time of arrival at approximately 17:30 hrs.

URBAN FLOOD REAL-TIME FORECASTING AND MODELLING: A STATE-OF-THE-ART REVIEW (A028)

Justine Hénonin, Ole Mark, Nina Donna Sto. Domingo, Franz Thomsen

DHI Denmark

Presenter: Justine Hénonin - jsh@dhigroup.com

Keywords: urban flood, real-time forecast, urban drainage modelling, MIKE FLOOD, MIKE URBAN, DIMS, Dashboard Manager

More than half of the world's natural disasters are floods, affecting millions of people every year. In fact, more than 3 billion people have been affected by floods over the last century, i.e. half of the current world population! Urban floods have long been considered as unpredictable and unavoidable natural disasters. Continuously increasing urbanization has led to an increasing flood risk whereas technological growth has raised various new strategies to predict and face this risk. Most of the urban drainage networks are aging and have been designed to manage a maximum rainfall, or so-called design rainfall, which refers to a design return period (usually 10 to 100 years). Thus, this implies an "accepted" flood risk for a rainfall greater than the design rainfall. But this flood risk can be underestimated considering factors like city growth, flash floods and climate change. Thus, being able to forecast the flood is one of the main issues of integrated flood risk management. Various flood forecasting systems have been developed and used, a lot using a large range of advanced tools and some as part of integrated decision support systems. Runoff and hydraulic models are usually essential elements for such systems, as pre-studying tools or as components of the system. This paper intends to make a review of current urban flood forecasting systems as well as the available modelling technologies, focusing on urban drainage modelling. Different types of urban real time systems are assessed and evaluated to sort out the current state-of-the-art and to give recommendations for future urban flood forecasting systems.

INTEGRATED FLOOD MODELLING WITH 3D HIGHWAY DESIGN (A080)

Alvaro Fonseca and Uffe Gangelhof

Grontmij | Carlbro A/S, Denmark

Presenter: Alvaro Fonseca - avf@gmcb.dk

Keywords: surface flooding, digital design, highway, detention pond, stream, treatment plant, MIKE FLOOD

Expansion of a highway near Copenhagen, Denmark, is currently under construction. Design of the highway has been entirely digital, including the drainage system. Modelling of the drainage system was carried out with MIKE URBAN, allowing compliance with the criteria set up by the Danish Road Directorate. There was one particular catchment where an existing detention pond did not have the required capacity to delay and store the extra amount of storm water that would come due to expansion of the connected area. Due to space constrains, the remaining storage volume had to be dealt with 1.2km downstream by means of a new detention pond, connected by an existing stream. The conditions surrounding the project area, i.e. a bike lane, a residential area and a treatment plant close to the stream, combined with a very flat terrain, posed challenges in terms of surface flooding. Therefore, a high-resolution MIKE FLOOD model was applied to evaluate the capacity of the stream to transport the water from the existing pond to the new pond. The model was run with a 10-year rain event, including a climate factor, with the criteria being no flooding of the residential areas or the treatment plant. The results showed that the stream needed to undergo minor adjustments, which were implemented directly in the MIKE 21 Bathymetry, hence in the digital overall design. The final solution was tested with an extreme 50-year historic rain event. The results and details of the simulations will be presented and discussed.

REAL-TIME FLOOD RISK MAPPING USING RAINFALL PRODUCTS BY THE MP RADAR (A100)

Kazurou Nakane

National Research Institute for Earth Science and Disaster Prevention, Japan

Presenter: Kazurou Nakane - nakane@bosai.go.jp

Keywords: flood risk mapping, urban flood, real-time flood prediction, Web-GIS application

We have developed an innovative real-time system of the flood risk mapping in micro spatial resolution 10 by 10 metres and 10 minutes time series over the specific urbanized area. The real-time system mentioned above consists of four major components: 1) making input rainfall data from rainfall products produced by MP radar, 2) run-off simulation both of the river basin and the specific urbanized area, 3) the real-time flood risk mapping in 10 by 10 metres grid, and 4) dissemination of the flood risk map to the public through the internet in real time.

The real-time system have examined in the southern part of Fujisawa City, Kanagawa Prefecture for the feasible study. For evaluation of the real-time flood risk mapping, we carried out survey flood marks occurred on Oct. 9, 2004. As a result, most of discrepancy between estimated peak flood levels and surveyed one were within 30 cm, which is about a width of a sandbag used for a barrier preventing flood. We also have installed equipments measuring water level on roads in flood prone plots for getting the reference data and watching the characteristic of flooding on the road in the urbanized area. We had a one chance to observe the flooding on Oct. 8, 2009. Though the flood was small, we had get good agreement between estimated peak flood levels and observed one. The present paper provides an outline of the real-time system of the flood risk mapping. This paper also discusses accuracy of estimated flood peak by comparing to both flood monitoring and surveyed flood marks.

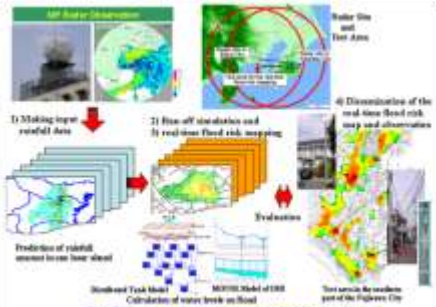


Fig.1 Outline of the Real-Time Flood Risk Mapping

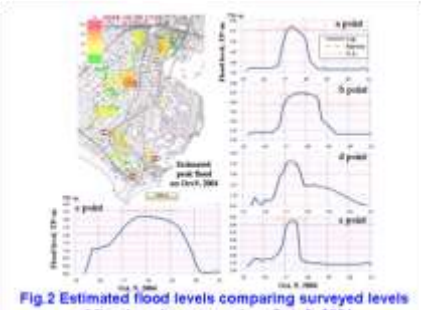


Fig.2 Estimated flood levels comparing surveyed levels of flood marks occurred on Oct. 9, 2004.

CITY OF LOS ANGELES PRIMARY SEWER SYSTEM WET WEATHER FLOW CALIBRATION (A057)

Robert Carr[1], Jessie Schroeck[2]

[1]DHI Inc., USA
[2]DHI Sverige AB, Sweden

Presenters: Robert Carr – rsc@dhigroup.com
Jessie Schroeck - jessie.schroeck@dhi.se

Keywords: MIKE URBAN, wet weather calibration, flow and rain gauging networks, radar

The City of Los Angeles contracted with DHI Water and Environment, Inc (DHI) in the fall of 2007 to perform a wet weather calibration of the MIKE URBAN (MU) model of the City's primary sewer system. DHI was selected as the prime contractor, with a project team consisting of DHI and seven sub-consultants. This was a three year project, designed to capture a minimum of two rain seasons (defined as October 1st – April 15th). The calibration process was dependent on accurate rainfall and flow measurements. A total of 93 flow gauges were installed to complement the City's existing real-time and near-time flow gauging network. Rainfall measurements were performed using the Los Angeles County ALERT rain gauge system, with the addition of a radar component to adjust gauge data to temporally and spatially distribute the rain over the region, thereby compensating for gaps created by gauge distribution.

The calibrated MU model is expected to assist the City in the performance of:

- Review and validation of Trigger Flow Levels
- Assessment of the City's Flow Monitoring Program
- Validation of the Primary Sewer Basin Master Plans
- Prioritization of the Wastewater Capital Improvement Plan

DHI was asked to calibrate and deliver a MU hydrodynamic model defined be the following parameters:

- Correlation coefficient (R-squared): 0.8 or better
- Maximum Volume difference: ±15%
- Total Volume error: ± 10%
- Peak Volume Error: ± 10%

This paper will present a summary of the steps performed and the situations encountered during the calibration process.

MODELLING RAINFALL DEPENDENT INFILTRATION AND INFLOW (RDII) IN A SEPARATE SEWER SYSTEM IN HUDDINGE, STOCKHOLM (A061)

A-M. Gustafsson[1], L-G. Gustafsson[1], S. Ahlman[1]
M. von Scherling[2] , M. von Scherling[2] , E. Wilmin[2],L. Kjellson[2]

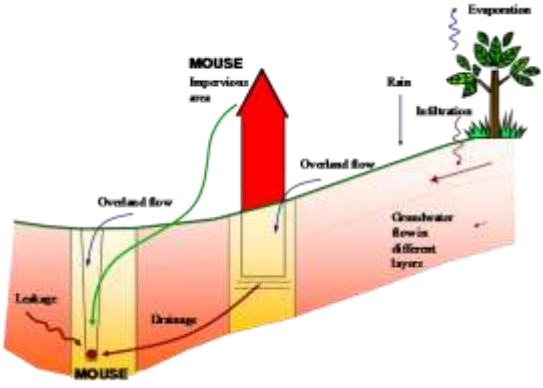
[1]*DHI Sverige AB, Sweden*
[2]*DHI Stockholm Vatten AB, Sweden*

Presenter: Stefan Ahlman – stefan.ahlman@dhi.se

Keywords: coupled hydrologic-hydraulic model, RDII, MOUSE-SHE, field measurements

The studied area has historically had repeated flooding of buildings with cellars. Earlier flow measurements show an extreme amount of Rainfall Dependent Infiltration and Inflow (RDII) in the sewer system. DHI has carried out additional flow measurements in the sewer system comprising automatic flow gauges over longer time and manual flow measurements during night time for momentary flow. Furthermore, groundwater levels have been observed and pipes with large inflows have been subjected to TV-inspections.

A coupled hydrologic-hydraulic model has been set up over the area using the collected information, where MIKE URBAN describes the pipe system and MIKE SHE describes the geohydrology. The MOUSE-SHE model was calibrated using the flow measurements, and subsequently used to describe the present conditions. Thereafter, different measures were simulated and evaluated in terms of their potential for reducing RDII. MOUSE-SHE modelling gave an understanding of the runoff and groundwater flow in the area. With the simulations it was possible to assess which pipes and areas that yielded the largest amount of RDII. The model concept also made it possible to separate the RDII that originates from direct inflow to pipes from that of inflow from drainage of foundations and service pipes. The proposed measures comprised sealing of pipes and manholes in prioritized subareas together with measures for improving the storm water runoff from certain streets. Simulation results of the sealing of pipes and manholes showed a 40% reduction of RDII volume, and improved storm water runoff from streets reduced the RDII volume an additional 10%.



MIKE by DHI TOOLS IN CENTRAL AND EASTERN EUROPE DURING THE LAST DECADE (A141)

Jan Krejcik, Tomas Metelka, Milan Suchanek, Evzen Zeman

DHI Czech Republic

Presenter: Jan Krejcik – j.krejcik@dhigroup.com

Keywords: MIKE by DHI, master plan, urban water, innovation technologies

During last decade the Hydroinformatics has been gradually developing its position in the water engineering sector, being complemented with adequate methodology and approaches which often much differ from widely accepted standards. The experience gained from the application of MIKE by DHI in Central and Eastern Europe during last decade shows up that at present they are widely accepted and applied in numerous civil engineering projects and studies bringing better insight into aquatic environment and its processes. The spread of use of Hydroinformatics technology is accelerated by transfers of know-how and technology to Central and Eastern European countries under the framework of European pre-accession or cohesion plans (e.g. ISPA, EUROPEAID).

The user demands requires from producers of simulation models search for new approaches and standards to be used in software development. The "openness" and "integration" ´are key elements of new system design and they are getting applied at distinct levels of system architecture including coupling with GIS system represents a common strategic feature for most of present simulation models, the concept of "geo-database", model coupling by new concept invented and gradually getting used called Open Modelling Interface (OMI) etc..

The experience gained from a number of projects executed in the Czech Republic, Poland, Bulgaria, Slovakia and Romania is discussed in the next paper to explain the present status of in CEE territory.

UTILIZING 2D FLOODING IN MIKE URBAN FOR STORMWATER INFRASTRUCTURE ASSESSMENT (A109)

Steven Chan

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Presenter: Steven Chan – steven.chan@edmonton.ca

Keywords: MIKE URBAN, integrated 2D flooding, City of Edmonton

The City of Edmonton has over 33 billion dollars worth of infrastructure assets that serve the diverse needs of its community. Maintaining and replacing this infrastructure is a continuous challenge for City Council and administration. Edmonton, like most cities, is faced with a significant "infrastructure gap" i.e. the difference between the perceived capital requirements and the available funding. To manage this infrastructure gap, the City proactively seeks out innovative and advanced approaches to best manage their limited resources available for infrastructure investment. In this instance, the City of Edmonton's Drainage Services used their detailed hydrologic and hydraulic models (prepared in MIKE URBAN) to evaluate the performance of the drainage infrastructure in the planned urban re-development of "The Quarters," a portion of its downtown core. The objective of the study was to assess the impacts of land-use changes, sewer separation and system expansion, and to identify, prioritize and optimize required upgrades.

Storm events in Edmonton's prairie climate are generally characterized by high intensity and short duration storms. The majority of the Edmonton's topography is flat and has naturally inadequate surface drainage. This combination of high intensity storms and inadequate surface drainage has historically resulted in a dependence on piped conveyance storage tanks, real time control and large number of stormwater management lakes to manage flooding during storm events. The integrated 1D and 2D overland flooding component of MIKE URBAN was a natural fit for efficiently integrating the existing collection system model with the 2D overland drainage flow in order to effectively evaluate and communicate the impacts of high intensity storms and inadequate surface drainage. The Integrated 1D 2D approach used for The Quarters study was an important step in quantifying and qualifying the tradeoffs of infrastructure decisions on risks associated with flooding. This information facilitates the clear communication of the issues to a non-technical audience and it facilitates prioritization of flooding areas and quantification of risk to human life and property on a fine scale.

CONCURRENT DUAL DRAINAGE MODELING OF URBAN WATERSHEDS (A110)

Andrew Wiens

Associated Engineering, Canada

Presenter: Andrew Wiens – wiensa@ae.ca

Keywords: PCSWMM, MIKE URBAN, urban watershed, Calgary - Alberta

Associated Engineering has recently completed four dual drainage modeling assignments. Each model was evaluated using a 1-Dimensional evaluation of the major (overland) and minor (pipe) system. The major and minor systems were connected in a single model to allow for concurrent analysis of flows in both systems.

The largest of the four models represented a 1450 ha fully developed urban watershed in Calgary, Alberta. For this model, nearly 4200 overland flow channels, primarily consisting of urban roadways, were developed by analyzing a Digital Elevation Model of the study area. The finished model included over 5100 conduits, of which about 900 conduits represent the storm drain system. The remaining 4200 links represent the overland flow linkages. The model included over 3100 nodes. One catchment was delineated for each of the 3000 catch basins.

Associated Engineering developed sophisticated, GIS-based, analysis routines to expedite the dual drainage model development. The presentation will provide important background information on dual drainage modeling techniques, specifically 1D and 2D analyses of overland flow systems coupled to 1D minor systems. The advantages of dual drainage modeling include the ability to model "uncaptured" flows. In the dual drainage model, uncaptured flows from each of the 3000 catch basins continued downstream in the models and could potentially combine with other uncaptured flows.

The objective of the City of Calgary project was to provide a detailed evaluation of the dual drainage system while allowing for dynamic flow exchange between the major and minor systems. This detailed modeling approach allowed for the quantification of overland flow depths, velocities and flooding durations throughout the watershed. By approaching the evaluation in this way, the study was able to challenge the results provided by applying typical modeling assumptions.

THREE-WAY COUPLING WITH MIKE URBAN FLOOD THE ROTBACH PROJECT (A113)

Georg Johann

Emschergenossenschaft/Lippeverband, Germany

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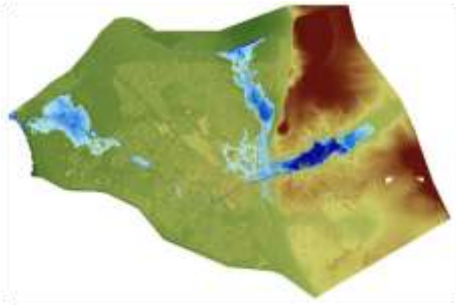
Keywords: flood risk management, urban, flash flood, three-way coupled modelling

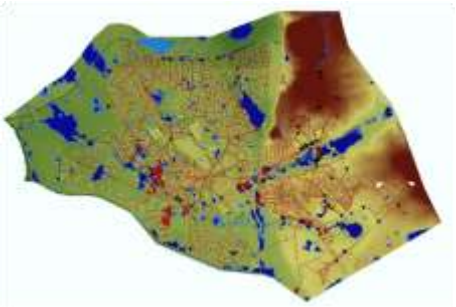
The figures on the flood damages in recent years in Germany have shown it: floods from rivers and flash floods from heavy rainfall events equally cause severe damages. Because of the high damage potential in urban areas there is a particularly high interest to manage these flood risks. But where are the flood areas located and which flow processes are going on when a flood event occurs? The spread of flooding in urban areas is influenced by many barriers, which can lead locally to exceptionally high flow speeds or water levels. In addition, the already complex flood scenario could be influenced by the interaction of surface runoffs and sewage systems.

So far, many studies have been conducted on the effects of river flooding. Beside this there are studies of flash flood events. This paper presents an integrated approach for the calculation of flood plains in urban areas, resulting both from river floods (Picture 1) as well as from heavy rain events (Picture 2).

Using an example of the Rotbach in Dinslaken the diversity of the flood risk from river floods and flash floods is shown here. Therefore a three way coupling with MIKE Urban Flood was used to model mid-size and extreme flood events with a dam break scenario.



Picture 1: flood plains from river flood and crevasse



Picture 2: flood plains from heavy rain event

AN INNOVATIVE MODELLING APPROACH TO ASSESS STORMWATER POLLUTANT LOADS FROM THE PORT OF BRISBANE, AUSTRALIA (A006)

Prasanna Egodawatta and Ashantha Goonetilleke

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Presenter: Prasanna Egodawatta – p.egodawatta@qut.edu.au

Keywords: stormwater quality, MIKE URBAN, port water quality

Port of Brisbane (PoB) is one of the main economic and transport hubs in Queensland, Australia. PoB is located at the mouth of the Brisbane River, adjacent to the Moreton Bay Marine Park, which is an area of high ecological and conservation value. This gives rise to significant environmental scrutiny of the operations at PoB as it can be the source of a significant array of pollutants which are transported by stormwater runoff to Moreton Bay.

Port land uses are unique in terms of the anthropogenic activities occurring on them. This uniqueness results in distinctive stormwater quality characteristics different to other typical urban land uses. This has made conventional approaches to the estimation of pollutant loads and strategies for the treatment of pollutants ineffective. In order to develop a targeted stormwater quality treatment strategy for PoB, a study was conducted to assess the pollutant contribution from Port specific land uses.

As part of the study, software modules embedded in MIKE URBAN played a key role. An innovative approach was adopted for the modelling component where the conventional model calibration step was not needed to be performed. Instead, equations and site specific parameters that were used to replicate pollutant build-up and wash-off were generated from an extensive field investigation and used in model simulations. Outcomes of the modelling exercise were used to identify the distinct pollutant contributions from different port land-uses and impervious surface types.

Build-up and wash-off investigations at Port of Brisbane

A STUDY ON THE INFLUENCE OF CATCHMENT AND RAINFALL CHARACTERISTICS ON URBAN WATER QUALITY USING MIKE URBAN (A024)

An Liu[1], Prasanna Egodawatta[1], Ashantha Goonetilleke[1]
Morten Just Kjølby[2]

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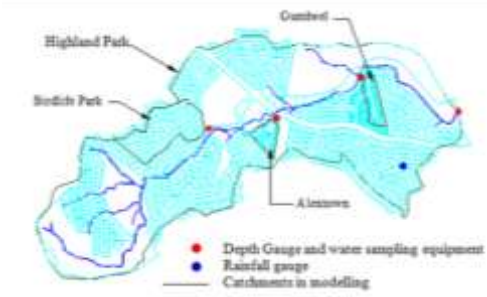
Presenter: An Liu - an.liu@qut.edu.au

Keywords: urban water quality, stormwater treatment, MIKE URBAN

The treatment of stormwater runoff originating from urban catchments is becoming common practice. Unfortunately, the effectiveness of some of the stormwater treatment devices is unsatisfactory due to the limited understanding of changes to stormwater quality with catchment and rainfall characteristics. This paper discusses a study conducted to investigate the influence of catchment and rainfall characteristics on stormwater quality. A range of catchment and rainfall parameters can influence stormwater quality and the combined effect of these parameters on stormwater quality is complex, and formed the basis for this study. Land use, percentage impervious area and impervious area location were the primary catchment characteristics whilst rainfall intensity and duration were the primary rainfall characteristics. MIKE URBAN software was selected due to its capability to simulate hydraulic, hydrologic and water quality processes.

The study was conducted at Gold Coast, Australia. Computer models were developed for a number of catchments with different characteristics including land use, percentage impervious area and impervious area location. Pollutant build-up coefficients for land use were obtained by analysing field samples collected from road surfaces. Rainfall events representing different rainfall characteristics were selected as input to run hydraulic, hydrologic and water quality simulations. The simulations were undertaken after model calibration and validation using historical data measured in study areas. The outputs from MIKE URBAN models have enabled the investigation of the combined influence of catchment and rainfall characteristics on urban water quality. The knowledge created in turn can provide guidance for the development of robust urban water quality treatment strategies.



Locations of catchment in modelling

CLIMATE CHANGE AND STORM SURGES: ASSESSING IMPACTS ON YOUR COASTAL CITY THROUGH MIKE FLOOD MODELLING (A052)

N.D. Sto. Domingo[1], B. Paludan[2], H. Madsen[1], F. Hansen[1] , O. Mark[1]

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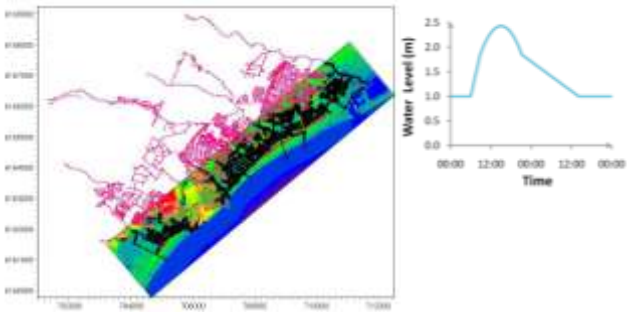
[2]*Forsyningsvirksomheden Greve, Denmark*

Presenter: Nina Domingo – nsd@dhigroup.com

Keywords: climate change, sea level rise, storm surge, urban flooding, MIKE FLOOD

Climate change effects on sea levels and its impacts on coastal flooding are some of the most prevalent issues in the Engineering industry today. In a coastal city in Denmark, a new comprehensive procedure for detailed analysis of flooding from the sea under climate change effects was developed and applied. Through hydrodynamic and statistical modeling, detailed analysis of flooding due to sea level rise and storm surges in an area could be performed starting off with widely available general climate change information. Time series data for extreme sea level events under various climate scenarios were derived through climate modeling and statistical analysis. Then, a MIKE FLOOD model for the area made up of a MIKE URBAN model and MIKE 21 surface model was used to simulate flooding from the derived extreme sea level events (See figure). The statistical analysis considers both peak and duration of the extreme events, and the flood modeling considers both terrain relief and presence of underground pipes in flow computations. The procedure has strong scientific bases in its use of hydrodynamic computations to simulate flow over surfaces and through pipes. It gives distributed, time-varying flooding information in all parts of the area for the duration of the event and it shows the role of drainage networks in conveying flooding further inland. The procedure provides useful flooding information for local decision-makers and communities for development of specific adaptation measures, which are also easily used for generating flood maps such as those required by the EU Flood Directive.



The MIKE FLOOD model (left) and example extreme water level time series used in the scenario analyses (above).

IMPACT OF DHI TECHNOLOGY ON THE BULGARIAN WATER SECTOR DEVELOPMENT WITHIN THE FRAMEWORK OF TECHNICAL AND INFRASTRUCTURAL AID BETWEEN 2006-2010 (A062)

Roumen Arsov[1], Kremena Gotcheva[2], V.Bojkov[3], T.Metelka[4]

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[2]Ministry of Environment and Water, Bulgaria
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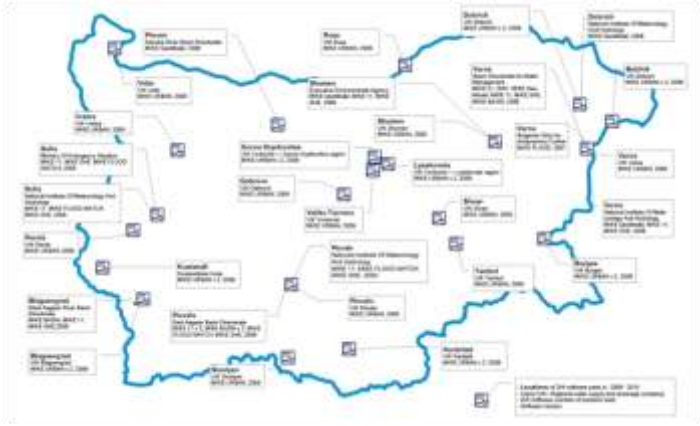
Presenter: Professor Roumen Arsov – r_arsov_fhe@uacg.bg

Keywords: Bulgarian water sector, DHI technology, Bulgarian water association, EU funding, challenges in water sector development

This paper presents the development of the Bulgarian water sector during last five years 2006-2010 and the DHI technology and know-how impact on this development.

During the period under consideration DHI was involved in more than 10 projects in Bulgaria related to water. All of them were with international financing mainly from different European Union funds. In these projects DHI Software products and training were provided and used.

Some of projects related to urban waters, and initiatives/events done in cooperation with Bulgarian water association are discussed in the paper. Challenges that now stay in front of Bulgarian water sector development, future steps, and role of DHI are also considered. At the end of the paper are mentioned all lessons learned during the period, and are given conclusions about future of the water sector/ market in Bulgaria.



DHI Software commercial licenses distribution in Bulgaria (2006-2010)

COST-EFFECTIVE URBAN MODELING BY DYNAMIC BASIC DATA MANAGEMENT (A111)

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Keywords: MIKE URBAN, ArcGIS, Geodata, basic data, calibration

Urban models created during a general plan-project are commonly still used after the main project is finished to deal with actual urban drainage challenges. For this an adaptation of the model data may become necessary. In order to receive an optimal adaptation to the individual task, it is imperative that basic data (catchment loads and system loads) can be altered easily. It is important to distinguish between input data (i.e. different surfaces or amount of sewage) and reduced model data (i.e. impervious area or the water load). Mostly, model data is summarized by catchments or nodes. Given that the process of this generalization is also included in the geodata model, it is possible to undo this later or to update the data in the same way. Because of different problems with the handling of polygon themes, altered load sources should be administered as single database information which is more dynamical. Public and private properties which are no traffic areas are affected in this way. Single database information (i.e. annual amount of sewage of a household) can be linked to the sewer system by a vector object. This data model is base on the geo-referenced street number of each main building.

The image shows the coordination of street numbers to the according links of the sewer system. Each street number details the impervious area and the annual wastewater amount. Depending on the net type (separate or combined) different coordination is required. Such detailed and dynamic basic data management allows a suitable alteration of the loading for:

- *Extension of the development structure (impervious area)*
- *Redirection of the service lines*
- *Filling of empty sites*
- *Change / renovation of the sewer*
- *system*
- *Update / adjustment of loads or load direction*
- *Calibration*

An update of a model is cheaper than realignment. For this a comprehensive protection of the investment is given and results of the model (i.e. MIKE URBAN, MIKE 11 and MIKE 21) based on the latest data.

WATER FOCUSED WEB BASED INFORMATION MANAGEMENT IN THE CITY OF CAPE TOWN (A133)

Philemon Mashoko[1], Zolile Basholo[1], Jaco de Bruyn[1]
Cornelius Strydom[2], Henrik S. Andersen[3]

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[3]*DHI Denmark*

Presenter: Jaco de Bruyn – jaco.debruyn@capetown.gov.za

Keywords: City of Cape Town, Information Management System, web-based IMS, database, dashboards

The City of Cape Town (CoCT) is a large Metro in South Africa whose Water and Sanitation Department provides 3.6 Million people with access to potable water. There are 13 Water Treatment plants which produce 330 000 Megalitres of water per year utilising 10 000 kilometers of pipeline. The CoCT is also responsible for wastewater and its treatment, with 21 Wastewater treatment plants. There are numerous existing information management systems in the CoCT, including water quality systems (LIMS), SCADA systems capturing flows, pressures and water levels, GIS systems and SAP to list a few. Water managers in the City of Cape Town were in the past unable to quickly and meaningfully get an overview of the status and health of water and sanitation and its infrastructure in the City of Cape Town. DHI has developed a state-of-the art Web-Based IMS (WB-IMS) to address the needs of the water managers (and some water operators) in the City of Cape Town. The system consists of a database that "pulls" information from the various existing data sources and displays the information required by managers using dashboards published on the intranet using DHI Technology. Tailored reports are automatically generated and disseminated to the relevant persons. WB-IMS has been designed to provide the water managers (and certain operational staff) with the information they require in an effectively and efficiently format. The WB-IMS has been very well received by CoCT, and there are plans afoot to further develop the system to cater for additional needs.

LOCAL AREA WEATHER RADAR (LAWR) SYSTEM TO APPROVE DRAINAGE SYSTEMS CAPACITY CASE STUDY FROM EGEDAL, DENMARK (A079)

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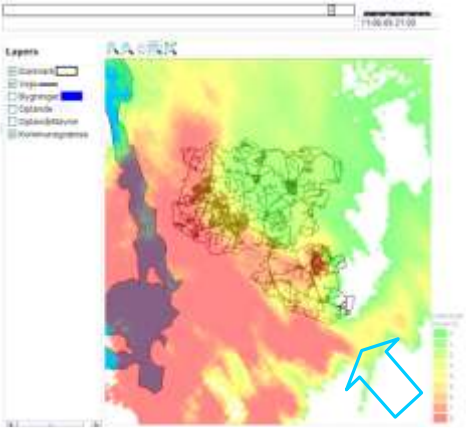
Presenter: Sabah Al-Shididi - sas@spvand.dk

Keywords: Radar, LAWR, x-band, Egedal, rainfall intensity, T, time series, flood, drainage system, service level, guidelines

Egedal Supply (Egedal Forsyning, EF) decided in autumn 2008 to implement a LAWR system due to future challenges of climate change and recent years' noticeable increase in the number of rainfall flood events. The objective was to provide modellers and operatives with better quantitative and qualitative data of local rainfall pattern. This was in order to monitor, evaluate and approve/improve the hydraulic capacity of local drainage systems in accordance with the service level of national guidelines and requirement. LAWR in Egedal has been tested for the first time in summer 2009, while under construction, with a 36-hour rainfall event starting on 11 June 2009 with an average accumulation of 111 mm. Catchments were visualized on a web site with dynamic monitoring of the event, where tabular data and time series plots were produced and analysed. Intensity and accumulation varied between 79 mm and 150 mm. Data were calibrated with local rain gauges. Local flood events could be related directly to local intensity and accumulation during the event and an extended understanding of the drainage system dynamics was conceived.



Publicly made reports about the event eased the communication with costumers. A warning system can be realized and hence an improved coordination can be achieved with other actors like the local civil emergency force. A procedure of testing drainage systems in flooded areas were established in EU. Forecasting rainfall events and online connection of LAWR data with hydrological and hydraulic calculations to evaluate and draw improvement scenarios can be the next implementations of LAWR in Egedal.

INTEGRATED REAL-TIME CONTROL OF SEWER SYSTEMS AND WASTEWATER TREATMENT PLANTS COMBINED WITH AN EARLY WARNING SYSTEM FOR WATER QUALITY IN LAKE, RIVER AND HARBOUR IN THE CITY OF AARHUS, DENMARK (A088)

Lene Bassø

Aarhus Vand A/S, Denmark

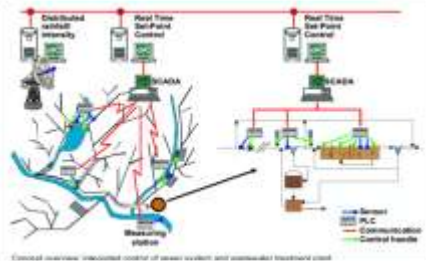
Presenter: Lene Bassø – lba@aarhusvand.dk

Keywords: water quality, early warning system

To support the opportunities for recreational use of Lake Brabrand, River Aarhus and the area at Aarhus Harbour very close to the city, the Municipality of Aarhus has decided (in 2005) to make an extraordinary effort to mprove the hygienic water quality in the area. The system design for integrated control to ensure the water quality in the given area consists of a hydraulic model super positioned with an advection/dispersion model which describes the transport and dilution of E.coli and a model describing the decay of E.coli.

The model is divided into four coupled parts:

- Rural catchment model (MIKE SHE) driven by rainfall. Calculating the run-off from the rural area as an input for Lake & River model
- Sewer catchments models (MIKE URBAN) driven by rainfall and dry weather flows. Calculating flows, run-off, CSO's and E.coli transport as input to the Lake & River model
- Lake & River model calculating flow pattern and E.coli transport as input to the Harbour model
- Harbour model calculating flow pattern and E.coli transport using results from a marine model as the "downstream" boundary



The early warning system shall be built on top of the integrated control system. It has to be implemented as a real time model, which means calculations twice a day with an increased frequency during rain (5-10 min).

SMART-OPS PROJECT, MWD LOS ANGELES A HYDRAULIC MODEL TOGETHER WITH A CUSTOMIZED APPLICATION PROVIDES A POWERFUL SYSTEM EVALUATION TOOL TO STAFF AT MWD (A077)

Bart Garcia[1], David Henry[1], Cello Vitasovic[1], Johan Spännare[2]
Petr Ingeduld[3], Trent Thacker[3], Gunvor Tychsen Philip[4]

[1]MWD, Los Angeles, [2]DHI Sverige AB, Sweden, [3]DHI Inc., USA, [4]DHI Denmark

Presenters: Johan Spännare – jsp@dhigroup.com /
Gunvor Tychsen Philip - gtp@dhigroup.com

Keywords: hydraulic model, calibration, verification, validation, SCADA, initial conditions, boundary conditions, Geodatabase, MIKE URBAN

The Metropolitan Water District of Southern California provides water to nearly 19 million people in parts of Los Angeles, Orange, San Diego, Riverside and San Bernardino and Ventura counties.

The SMART-OPS project was started in 2005 and was based on the following vision:

- Provide a hydraulic and water quality model that allows MWD staff to evaluate performance of the distribution system under different conditions
- Provide access for different users to an easy to use, but powerful design and analytical platform
- Leverage existing MWD data and applications

The SMART-OPS system is a combination of a Hydraulic Model and a Custom Application. The initial section covered by the Hydraulic Model was the Rialto area. The model has recently been expanded outward to different areas toward the east side of the distribution system. The hydraulic model is built in MIKE URBAN and uses data that is collected from various MWD data sources. A link has been developed between the hydraulic model and the SCADA database for automatic setup and run of model scenarios. The Custom Application allows MWD personnel to manipulate the collected data in order to create different scenario conditions and re-run the data to evaluate the impact of their changes on the system. The paper will describe the SMART-OPS system setup and how it can be used for system analyses and decision support by MWD staff. Visions forward and proposed development including the deployment of the whole service area will be presented and discussed.

HYDRAULIC TRANSIENT COMPUTER MODEL FOR SAN DIEGO WATER AUTHORITY (A003)

Robert Carr[1], Nona Yang[2], Gene Gemperline[3]

[1]*DHI Inc., USA*
[2]*San Diego County Water Authority, USA*
[3]*Franklin DeFazio, Inc, USA*

Presenter: Robert Carr - rsc@dhigroup.com

Keywords: hydraulic transient analysis, water supply

San Diego County Water Authority is a water wholesaler providing a safe and reliable water supply to its 24 member agencies in the San Diego region. The Water Authority has come to supply up to 90% of San Diego County's water, which serve more than 3 million residents. The water supply system consisting of approx. 300 miles of pipelines ranging from 48 to 108 inches in diameter, 103 active meter connections, 7 pumping stations, 4 hydroelectric facilities, one water treatment plant, and one reservoir. These facilities are been developed over the last 60 years through a sequence of individual projects and has significant hydraulic complexity.

DHI Inc has been awarded a contract to develop a dynamic transient flow model that will be suitable for modeling the Water Authority's conveyance and distribution system as well as relevant appurtenant facilities of other local agencies that have a significant hydraulic influence upon the Water Authority's system. The work includes modification to an existing Hydraulic Transient Engine known as FG3D (Frank DeFazio Inc) which will be incorporated into MIKE
URBAN Hydraulic Model to provide an integrated modeling system.

The project includes substantial programming of menu's and tools, as well as additional functionality in the Transient Model code. The transient model will be verified on the pilot reaches including Second Aqueduct untreated water pipelines from Twin Oaks Valley Flow Regulatory Structure (TOVFRS) to Otay Lake including Olivenhain Pipeline and Pump Station and inactive pipelines south of Miramar Vent. Project duration: 2008-2010, SDCWA project manager: Nona Yang, DHI Project manager: Petr Ingeduld.

MODELLING FOR INTEGRATED WATER SUPPLY MANAGEMENT IN BELO HORIZONTE METROPOLITAN AREA, BRAZIL (A091)

Carmen de Miguel[1], Sara Molinillo[1], Petr Ingeduld[2]

[1]Telvent, Brazil, [2]DHI Inc., USA

Presenter: Carmen de Miguel - carmen.demiguel@telvent.com

Keywords: hydraulic modelling, on-line simulation, SCADA system, hydraulic supervision, demand forecast, data validation, decision support, integration of applications

In November 2005 Telvent was awarded the 3T Project - Telemetering, Telesupervision and Telecommand, for the implementation of an automation system of the water supply and geographic information system (GIS) in Belo Horizonte metropolitan area, Brazil. COPASA MG (Companhia de Saneamento de Minas Gerais) is the public utility that supplies, transports, and distributes water to more than 5.3 million people in the Brazilian state of Minas Gerais, serving 34 municipalities on an area of 6,000 km^2. COPASA wanted a technology that would support the planning, engineering, real-time operations control and maintenance activities of the utility, reduce water losses, and enhanced customer services. To achieve that, an integrated information management platform including supervisory control and data acquisition (SCADA), GIS and hydraulic modelling technologies has been successfully implemented. An advanced simulation system based on MIKE URBAN Water Distribution and URBAN WD-OnLine has been designed, customized and integrated with the collaboration of DHI. Such system, in connection with Telvent's SCADA OASyS, allows for two on-line simulation modes: steady-state analysis for real-time hydraulic supervision, and extended-period simulation (EPS) for predicting the system performance for the next 24 hours. The hydraulic models were developed based on GIS data and calibrated based on historical SCADA data as well as real-time SCADA data; on-line models were used during the model calibration and verification. Additional applications such as extensive data filtering and validation and a demand forecasting tool have been developed and tailored for the project. Normal system operations e.g. control of hydraulic facilities, maintenance and/or short-term planning are now supported by the information provided by the on-line model.

Furthermore, off-line model based on SCADA historical data is being currently used to generate operational protocols in response to emergencies.

Control room equipped by the latest technology provided by TELVENT

DYNAMIC PUMP DESIGN OF COMPLEX RISING MAIN INJECTOR SYSTEMS (A010)

Morten Just Kjølby and Arne Møller

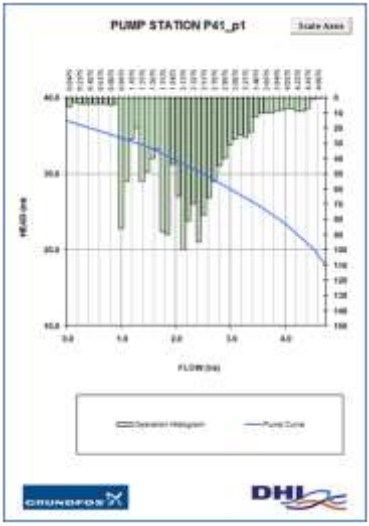
DHI Denmark

Presenter: Morten Just Kjølby – mjk@dhigroup.com

Keywords: dynamic hydraulic design, rising mains, complex injector systems, pump design and operation

In low laying coastal areas of Australia and Belgium the sewerage is usually conveyed in a system comprised of sewer pipe network, pumping stations and rising main networks. The rising main networks are often very complex with multiple injection points along a rising main line. In order to undertake detailed analysis of current pumping operation in existing systems as well as analysing the design of pumps in new residential developments a specialised pressurised MOUSE PCS feature has been applied. The MOUSE PCS feature is available in MIKE URBAN CS when using the MOUSE engine and has been developed in collaboration with Grundfos.

Two projects involving analysis of complex injector system as part of new developments in South Australia and Belgium was undertaken. For each project a hydraulic network model was established to represent 21 (South Australia) and 102 pump stations (Belgium) injecting into rising main systems.



Hydraulic analysis of the proposed pump capacities and operation was undertaken during different design flow scenarios. The pump operation during average dry weather conditions (ADWF) were analysed adopting design criteria that pumps were not exceeding a maximum number of 10 starts per hour and no pump dry stops. A design criterion during wet weather conditions was no wet well surcharging. It was assumed that all pumps were allowed to run concurrently.

The MOUSE PCS feature was used as part of the analysis to produce pump operation histograms ensuring that pumps were operating around duty points as well as producing various statistics including number of pumps running concurrently. Based on the histograms it was possible to select and verify the most suitable pump for each individual pump station.

THE NEW STORAGE SEWER IN GRAZ (A018)

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Keywords: storage sewer, Graz, MIKE URBAN, RTC, user written control

Graz (Austria) has 250.000 inhabitants and a sewage system with a total approximate length of 840 km. The river Mur divides the city into two parts and is a receiving water body. The wastewater treatment plant is situated in the south of Graz.

A new storage sewer for Graz is in progress to reduce the pollution of the river Mur caused by combined sewer overflows. The concept was designed using hydrologic and hydrodynamic models. The new storage sewer has redundancy to the main sewers as well as a storage function. The first two of three units of the project will reduce the pollution by 60%. Our models forecast a pollution reduction of 70% when a polluting load dependent storage management will be used.

The sewer is divided into cascades by controlled weirs. The control system will be an integrated system using DCS, SCADA and HMI systems. This control system is developed in our models utilizing user written controls of the RTC. The cleaning process of the new storage sewer starts within the storage process by generating waves and ends with flush of water of the river Mur.

PERFORMANCE OF MOUSE UPDATE FOR LEVEL AND FLOW FORECASTING IN URBAN DRAINAGE SYSTEMS (A063)

Lisbet Sneftrup Hansen[1,2], Morten Borup[1], **Arne Møller**[3], Anders Breinholt[1], Peter Steen Mikkelsen[1]

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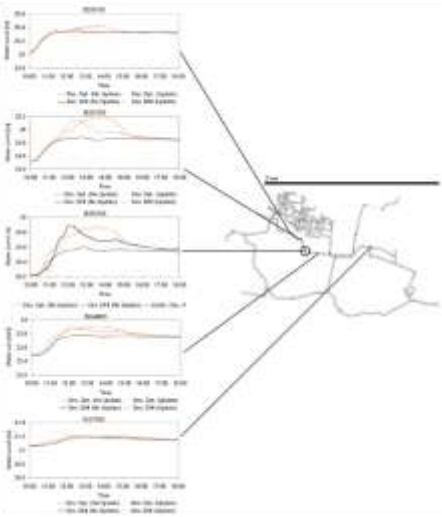
Presenter: Lisbet Sneftrup Hansen - lsh@spvand.dk

Keywords: urban drainage systems, modelling, MOUSE UPDATE, RDI, forecasting

MOUSE UPDATE is an additional package to MOUSE that enables generation of forecasts for urban drainage systems based on measured observations. In the investigated version, observed water levels are assimilated into specific nodes and the added/extracted water is distributed to the surrounding grid points as part of the standard hydro-dynamic computations of MOUSE. This study evaluates and documents the performance of MOUSE UPDATE for water level and flow forecasting.



MOUSE UPDATE is implemented in models for two real urban drainage systems, differing in size, model complexity and the availability of observations. In addition, one model is calibrated to obtain a better flow simulation during rain events using the rainfall dependent infiltration (RDI) module in MOUSE. Measured and synthetic water levels in combination with rain gauge input are used as basis for the evaluation. When compared to simulations without updating, the results show that it is possible to obtain an improvement in the 20 min forecast of the water level in an updated node and in the 3 hour forecast of flow through a downstream node. The results also show a slightly improved forecast when improving the RDI calibration prior to updating.

The analysis indicates that MOUSE UPDATE produces better forecasts when implemented in a network with slow flow dynamics and with measurements from nodes that are located upstream and contribute significantly to the flow at the forecast location. This work represents one of the first openly available studies on the performance of MOUSE UPDATE and provides a foundation for future developments and implementations.

INTEGRATED MODELS AND THE ASSESSMENT OF CUMULATIVE HYDROLOGIC IMPACTS (A011)

Sam Bellamy[1], David Van Vliet[1], Steven Murray[1], Patrick Delaney[2], Qiao Ying[2], Mike Garraway[3]

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Keywords: integrated modelling, cumulative hydrologic impacts, MIKE SHE, Canada

The Province of Ontario, Canada, is completing an assessment of integrated hydrologic models and their ability to better predict cumulative hydrologic impacts. Conjunctive models are developed to simulate coupled groundwater/surface-water flow in one or more watersheds by simultaneously simulating flow across the land surface, within subsurface saturated and unsaturated materials, and within streams and lakes. This assessment includes three integrated models including MIKE SHE (DHI), GSFLOW (USGS) and Hydrogeosphere (University of Waterloo) and evaluates each model with respect to its ability to meet the Province's objectives including cumulative hydrologic impacts considering water takings, land use change and climate change.

This presentation presents the results of this study and a case study which demonstrates the application of the models and the interpretation of results to evaluate cumulative hydrologic impacts.

INTEGRATED HYDROLOGIC MODELLING IN THE OKAVANGO DELTA, BOTSWANA (A147)

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DHI Denmark

Presenter: Douglas Graham – dng@dhigroup.com

Keywords: Okavango Delta, Flooding, Integrated modelling, SVAT, MIKE SHE

The Okavango Delta in Botswana is a vast wetland system, surrounded by the semi-arid Kalahari Desert. Depending on the year and season, the flooded area ranges from 4000 to over 15000 km2. As part of the Okavango Delta Management Plan a series of nested integrated hydrologic models were developed to help understand the complex hydrologic processes in the Delta and to evaluate alternate management scenarios.

The models were developed using MIKE SHE – a modelling framework for distributed, integrated hydrologic modelling. The regional Delta-wide model covered 29,000 km2, with a 1-km2 grid resolution, was calibrated against observed flood extents from satellite images and downstream river discharges. Climate change scenario analysis showed that significant hydrologic impacts are to be expected. A more detailed model of the channel and overland flow through the dense papyrus swamps was developed to assess the impact of removing channel blockages on river flows and flood levels. The regional/local scale modelling process developed in this project provides the Botswana Department of Water with a sustainable tool for water resources management in the Delta.

ENHANCEMENT OF WATER RESOURCES MANAGEMENT IN MURES RIVER BASIN (A092)

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Tomas Eidsmo[2], Pavel Tachecí[3]

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Presenter: Daniela Radulescu – daniela.radulescu@hidro.ro

Keywords: water balance, integrated surface-and groundwater, MIKE SHE, sustainable water resources management measures

Project focuses on strengthening the ability of Romanian authorities to protect the environment by assuring a sustainable use of water resources in particular basins, like Mures River basin. In connection with last socio-economic development, water demands in Mures River Basin have been fluctuating a lot. At the same time, further increase of average annual temperature and amplifying of extremes is expected for Romanian territory. Since 2002 trend of groundwater level across Mures Basin decrease is pronounced. As consequence, there is need for tools which quantify impacts to hydrologic regime at present and for future and enhance the water management in an integrated and consistent way. Those tools need to be combined to decision support system for simulation of water balance course under different future development scenarios. Within the project framework, observation network of Tarnava Mica river basin (sub-basin of Mures river basin) is optimized, integrated mathematical model focusing on water balance is established using DHI MIKE SHE 2009 software, combined with other tools to be easily used and maintained by Romanian water authorities. Scenarios of future course of water resources and integrated surface - and groundwater hydrologic regime in Tarnava Mica river basin are produced, resulting in recommendations of measures to be conducted.

Experience from Tarnava Mica river basin will be transposed to recommendations for observation network and sustainable water resources management measures applicable in whole Mures river basin and further to methodology applicable across Romanian territory.

This project started in 2009 and will be finished in 2011. It is supported from EEA financial mechanism. Main beneficiaries are National Institute of Hydrology and Water Management (leader of the project) and Mures Water Directorate in Mures River basin. Two Norwegian participants are: The Norwegian Water Resources and Energy Directorate and DHI Norway.

INTEGRATED WATER RESOURCES ASSESSMENT USING MIKE SHE AND FEFLOW MODELLING SYSTEMS IN RODOPI PREFECTURE, GREECE (A054)

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Greek Biotope/Wetland Centre

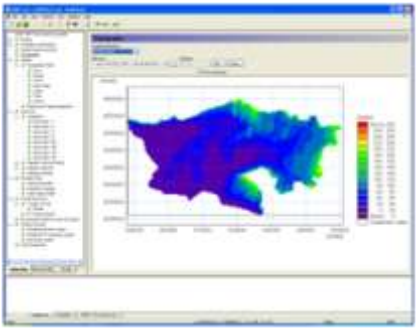
Presenter: Charalampos Doulgeris – haris@ekby.gr

Keywords: integrated surface-ground water assessment, MIKE SHE, FEFLOW, seawater intrusion

A modelling framework, combining MIKE SHE and FEFLOW, has been developed in Rodopi Prefecture (2550 km^2). Groundwater is the main source of fresh water for the area while surface water contributes subsidiarily. Intensive agriculture, which is the primary water user, has caused the lowering of water table in the aquifer systems and seawater intrusion has become a major threat.

MIKE SHE and FEFLOW were used for the integrated assessment of water resources. As a first step, MIKE SHE was used for the simulation of the actual evapotranspiration, water dynamic in unsaturated zone, groundwater recharge and abstraction for irrigation. FEFLOW was then used for a more detailed representation of the aquifer systems including water table fluctuation and seawater intrusion in coastal areas. The rates and distribution of both groundwater recharge and abstraction for irrigation, as have been estimated by MIKE SHE, were used as boundary conditions to FEFLOW.

The quantification in space and time of water resources availability as well as the pressure that human activities in the area exert on them constitute valuable information in the decision making process by the competent authorities. To this direction the combined use of the two modelling systems was proven substantial.



HYDROLOGICAL MODELLING OF A NUCLEAR REPOSITORY SITE DURING FUTURE PERIGLACIAL CLIMATE CONDITIONS - APPLIED NUMERICAL MODELLING WITH MIKE SHE (A027)

Emma Bosson[1] and Ulrika Sabel[2]

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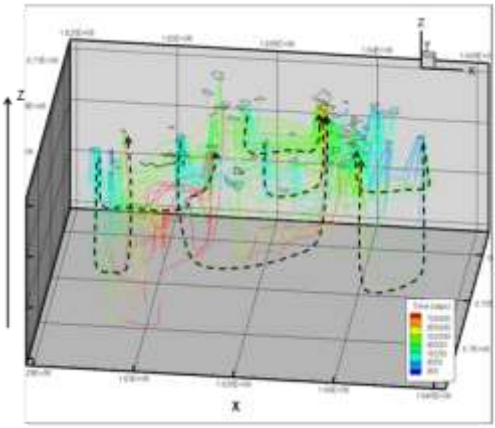
Keywords: hydrological modelling, MIKE SHE, nuclear waste, repository, safety assessment, climate change, periglacial processes, permafrost, taliks

Radioactive waste from nuclear power plants in Sweden is managed by the Swedish Nuclear Fuel and Waste Management Co, SKB. SKB has performed site investigations with the objective of siting and building a final geological repository for high-level radioactive waste at the selected Forsmark site.

In the hypothetical case of a release from the repository, radionuclides will be advected by the groundwater towards surface waters. The assessment of the long term safety of the repository is an important aspect and a climate change is consequently a parameter of high importance. Within the safety assessment, a case with a future periglacial climate has been studied and the impacts of continuous permafrost, interrupted by through taliks, on the hydrological and near-surface hydrogeological conditions have been analysed. Both for present and periglacial climate conditions the hydrology and near-surface hydrogeology have been modelled and analysed by using MIKE SHE. The periglacial conditions and processes have been modelled by proceeding from the model describing present conditions and then applying a periglacial climate, permafrost formations and through taliks to the model.

The results from the case study show that the periglacial conditions have a large impact on the water balance of the area, on the pattern of recharge and discharge and on the magnitude of groundwater flow when comparing with present conditions where the local topography is the strong influent on the hydrology. Thus, the periglacial flow paths from the repository towards the surface will deviate from the flow paths developed under present climate conditions.



HYDROLOGICAL AND HYDROGEOLOGICAL EFFECTS OF A DEEP ROCK REPOSITORY FOR SPENT NUCLEAR FUEL IN SWEDEN (A064)

Erik Mårtensson[1], Lars-Göran Gustafsson[1], Kent Werner[2]

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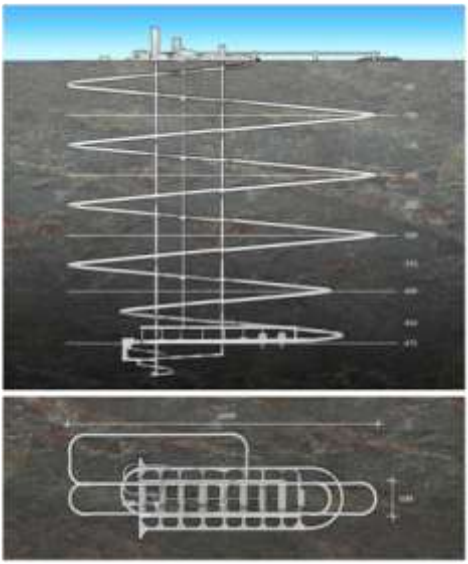
Keywords: hydrological modelling, MIKE SHE, MOUSE, nuclear waste, repository, grouted tunnels, groundwater inflow, coupling routine

The Swedish Nuclear Fuel and Waste Management Company (SKB) has performed site investigations for a deep rock repository for Sweden's spent nuclear fuel at the selected Forsmark site located in the municipality of Östhammar. A ramp and different shafts will be constructed down to approximately 500 metres in the rock, where the spent nuclear fuel will be deposited.

The hydrological and near-surface hydrogeological effects of the groundwater inflow to the planned repository during the construction, operation and closing phases are analysed with MIKE SHE. To model the inflow MIKE SHE is coupled with MOUSE, in which tunnels are described as a number of pipe links. In previous MOUSE applications, the coupling routine between MIKE SHE and MOUSE has primarily been used for calculating groundwater inflow to sewers. Test simulations show that the calculated inflow to a grouted rock tunnel is underestimated with up to 40% compared to an analytical solution. An improved coupling routine for the case with groundwater inflow to rock tunnels has therefore been developed. The new routine replaces part of the rock with a grouted zone, instead of adding the hydraulic properties of the grouted zone to the rock properties. Results using the new coupling routine show that the calculated inflow only differs a few percent compared to the analytical solution. The new coupling routine is used in the analysis of the hydrological and hydrogeological effects of the planned Forsmark repository. The results of the analysis will be used as an input to the Environmental Impact Assessment regarding the repository.



Overview of the ramp and central area of the planned repository for spent nuclear fuel in Forsmark.

FLOOD HAZARD AND RISK ASSESSMENT OF HOANG LONG RIVER BASIN, VIETNAM (A033)

Vu Thanh Tu[1], Tawatchai Tingsanchali[2]

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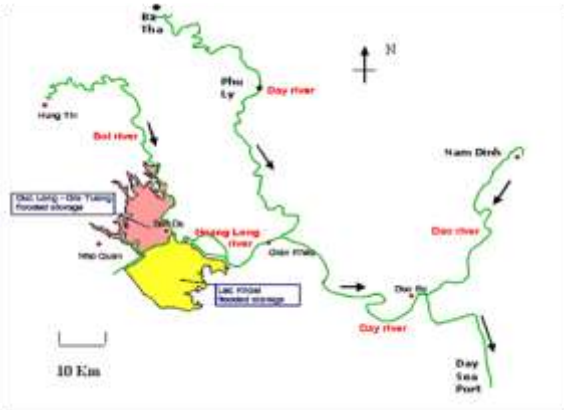
Keywords: flooding depth, inundation map, flooding damage assessment, hazard, risk

Hoang Long is the largest river in Ninh Binh province, Vietnam. This province is frequently affected by flooding due to heavy rainfalls in the river basin. Floods affect socio-economic activities and others. In this province, the socio-economic condition is developing and living standard is relatively high, it is necessary to have planning and preparedness to reduce the flood damages. Therefore, flood magnitude, flood damage and risk assessment for different return periods of flood should be considered in this basin. Rainfall frequency analysis was done to determine design hyetographs corresponding to 10, 50 and 100-year return periods. Design flood hydrographs corresponding to different return periods were obtained by using rainfall-runoff model (MIKE-NAM) and were used as input for simulating flood flow in Hoang Long basin by using MIKE 11 hydrodynamic model. The NAM and MIKE 11 models were calibrated and verified using past flood data in 1996 and 2000. Using the maximum water levels computed from MIKE 11, together with digital elevation map (DEM) of 90x90 meters, inundation maps were developed for Ninh Binh province. Flooding depth and total inundation area corresponding to various return periods were determined. From the inundation maps and field survey data, damage curves for residential, agri-cultural and roads damages were developed.

Maps showing levels of flood hazard and risk were determined according to the combined effect of flood depth and flood duration for each community in Nho Quan and Gia Vien district. These maps are useful for flood risk zoning and flood mitigation planning for the Ninh Binh province.



Hoang Long, Day, Boi and Dao Rivers and Flood Plains

EXPERIENCES FROM USING MIKE FOR FLOOD MODELLING IN SMALL AND MEDIUM RIVER SYSTEMS IN SCHLESWIG-HOLSTEIN, GERMANY (A070)

Thomas Hirschhäuser[1], Stephan Kräßig[2], Nils Petersen[3], Wolf Plöger[4], Kai Schröter[5]

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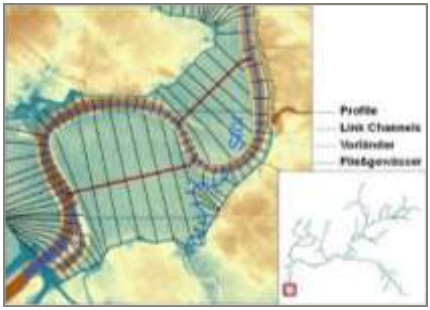
Keywords: MIKE FLOOD, flood modelling, lowland, small river systems, tidal influence, Schleswig-Holstein

The federal state of Schleswig-Holstein applies MIKE-flood modelling software for planning issues with respect to hydraulic modelling. The aim of this approach is to create an uniform data set, which allows to be further developed and updated by future planning activities. Examples will be presented, which focus on specific conditions in small river systems and modelling techniques to represent tidal influence and the corresponding technical structures. Also examples for applications to ecological river restoration will be given. Schleswig-Holstein is a federal state of Germany located in the very north of Germany close to Denmark. Its size is around 15.000 km², approximately 5.000 km² are lowland areas lying below + 5m NN. The water management in those lowland areas is dominated typically by small channels, which flow via sluices and pumping stations into the North Sea. Also in the other parts of Schleswig-Holstein water management is dominated by small and medium river systems.

From this conditions a lot of specific problems concerning water management arise, which will be presented in the paper. In detail the following topics will be discussed:



- restrictions to model size
- roughness approach
- dike overtopping
- structures and structure operation
- modelling of ecological installations
  - large woody debris and gravel embankments)
- flood map generation

Link channel in areas affected by dike overtopping

EXPERIENCES OF KRAKOW WATER BOARD (RZGW) IN THE APPLICATION OF MIKE BY DHI SOFTWARE FOR OPERATIONAL PRACTICE OF THE FLOOD COORDINATION AND INFORMATON DEPARTMENT(OKI) (P125)

Krysztof Kondziołka and Radoslaw Radon

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Keywords: flood management, flood hazard maps, Flood Directive, Poland

The territory of the Kraków Water Board covers 15% of Poland including the most flood-prone areas of the country. The reason for the frequent flooding is the topography of mountains areas within the Polish south border. Recently the Kraków RZGW territory has been affected by significant floods in years 1997, 2000, 2001, 2004, 2006 and 2010. The high frequency of floods forces high activeness of RZGW Kraków in the area of flood mapping and application f flood maps in operational work. The unit in RZGW Kraków responsible for flood monitoring and mitigation of flood effects is the Flood Coordination and Information Department (OKI). The 12 person OKI department reports directly to the Regional Water Board Director and assists him in decision making both in preventive and operational areas. The unit has been in recent years equipped in hardware and software and the personnel has been trained and gained experience in international projects. OKI cooperates actively with international partners – both commercial companies and administration units. One of these key partners is DHI, author of hydrological and hydraulic modelling software which is the basic tool used for flood hazard evaluations.

DHI tools are not only used in OKI basic operations but also requested in all projects in which RZGW is the Investor. This policy which has been continued for the past decade has led to a situation in which 60% of the RZGW territory is covered by hydraulic models developed in a unified, controlled and verified standard with the use of MIKE by DHI Software. The recent activities of OKI are concentrated on tasks related to the Flood Directive– an area in which OKI and consequently Kraków RZGW are one of the parties leading the implementation process in Poland. Also in this area RZGW uses the support of DHI experts from Polish, Czech, German and Danish offices – the cooperation being in our opinion beneficial for both sides.

DAMBREAK FLOODING SIMULATION USING ONE-DIMENSIONAL AND TWO-DIMENSIONAL MIKE 11 HD AND MIKE 21 HD MODELLING
(A078)

Zahrasadat Dastouri

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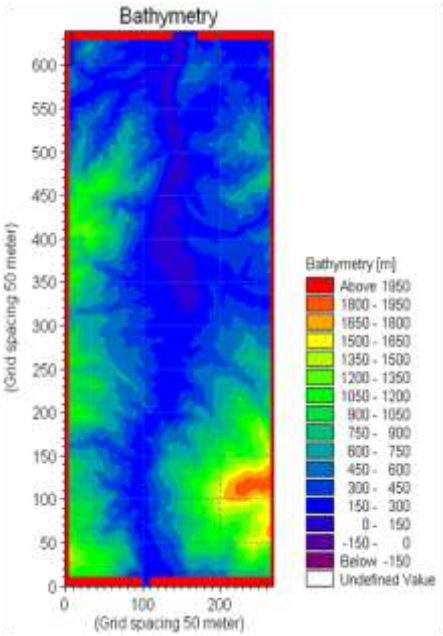
Keywords: dambreak, MIKE 11, MIKE 21, GIS, flood damage, Sefidrud Dam

With the advent of digital information and remote sensing systems such as GIS and DEM production, greater speed and accuracy has been provided for Dam-Break data interpretations. The core analysis is performed by a hydrodynamic model and the input data as well as output presentations are provided by GIS.



In this paper, input and output data have been analyzed using a mechanism for the transfer of data between the hydrodynamic models and the GIS tool. One dimensional MIKE 11 and two dimensional MIKE 21 hydrodynamic models are built upon the Saint-Venant equations for shallow water waves to estimate the maximum flood level down of the dam sites, these models have been combined to obtain river and floodplain flooding characteristics and Dam-break results have been developed using a GIS tool. Raster layers have been defined in order to obtain Flood Damage and Emergency Action Plans for the affected area using flood "criterion allocation" and "damage number".

The case of non Dam-Break flooding has also been studied for comparison Sefid-rud river basin has been used as the case study and the results are obtained for this case.

DAMBREAK MODELLING IN WEIJA, GHANA, AND ADVANTAGES OF 2D MODELLING (A085)

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Keywords: dambreak, flood modeling, MIKE 21, flood management, emergency preparedness

The case story is focused on the Weija dam, situated immediately upstream a large urban settlement in the outskirts of Ghana's capital Accra. State-of-the-art safety measures include the elaboration of an Emergency Preparedness Plan, based on an inundation map in case of a dam failure. The water volumes released by such a failure would inundate not only the mentioned urban settlement but the entire lagoon, separated from the Sea by a long sand bar. The area is extremely flat and the cross-channel flows would be very inaccurately simulated with a 1-dimensional model. Consequently, the dam failure wave propagation was successfully simulated with mike21. Results are in some respects surprising and even paradoxical, and demonstrate some of the dilemmas posed to the dam operators, that may in fact increase the risk of a dam failure, although the risk is caused by the dam operator's wish to avoid flooding of the downstream settlements. The case story also demonstrates how modelling has proven that a commonly assumed emergency measure – breaking the sand bar – does not have an significant impact on the water level formed on the lagoon behind the sand bar.

As side-cases, this presentation demonstrates other examples of the advantages of 2-dimensional modelling from Norwegian environments, some of which with high-gradient terrain slopes and thus very different from the Ghanaian environment.

CALIBRATION OF MIKE 21 WITH SUBMERGED WATER LEVEL RECORDERS. TWO MIKE 21 MODELS SIMULATING SPILLWAY RELEASES DOWNSTREAM UNTRA HYDROPOWER PLANT AND HYDRAULICS OF THE UPSTREAM LAKES AND CHANNELS (A089)

Anders Söderström

SWECO, Sweden

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Keywords: MIKE 21, hydropower, river hydraulics, flood risk management, calibration

Untra is a complex hydropower system in Dal River in central Sweden. The reservoir consists of a large lake located in a flat landscape. The dams surrounding the reservoir have a total length of 8 km. There are three spillway locations releasing water into different conditions in the downstream environment; lakes, rapids, swamp forests and a small village.

Downstream MIKE 21 GRID-model. The purpose of the downstream study was to quantify water level fluctuations in the rapids and describe how flood-depending wetlands are affected by inundations in the spring flood season. Calibration data was collected by installation of 13 submerged water level recorders during the spring flood 2008. The recorders were installed at the river bottom for two months. Discharge varied from 250 to 950 m3/s. The average accuracy of the calibration was 10 cm.

Upstream MIKE 21 FLEXIBLE MESH-model. The purpose of the upstream study was to see how energy losses cause water levels to drop near the spillway openings, thus reducing the spillway capacity. Other topics of the study included evaluation of new spillways, flood risk management and optimisation of higher dam crest elevations to withstand the 10000-year flood.

Downstream environment. Image from www.eniro.se.

Upstream environment. Image from www.eniro.se.

Downstream model.

Upstream model.

The models were built up by bathymetry drawings, echosoundings and laser scanning of the surrounding terrain. In May 2010 all spillways were opened and 12 water level recorders were installed during the spillway tests. Additional calculations will be presented in June 2010. Topics of the complimentary study are dam safety, flood risk management and verification of Manning's number on forested ground.

MIKE BASIN – AN EFFECTIVE TOOL FOR WFD IMPLEMENTATION IN CZECH REPUBLIC (A101)

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VRV a.s.[1], Czech Republic
DHI Czech Republic[2]

Presenter: Robin Hala - hala@vrv.cz

Keywords: MIKE BASIN, river basin planning, point and non-point pollution, effect of measures

By adopting the European Parliament and Council Directive 2000/60/EC of 23 October 2000 establishing a framework for Community action in the field of water policy, Europe has launched an ambitious process of unification of approaches to protect water and aquatic ecosystems, while promoting sustainable water use and mitigation of floods and droughts. The primary objective of the Framework Directive is to achieve a "good status" for all the surface water and groundwater.

In the Czech Republic, this objective is being achieved through measures designed and approved for every river basin district plan by the respective regional authorities. Individual measures within these plans are bound to individual sub-basin units – water bodies. In order to reach the maximal effectiveness of these measures, it is necessary to assess the combined effect of these measures in the basin downstream flow, not only the local impact of individual measures. To this end simulation models are being developed for all 8 sub-catchment areas in the Czech Republic as part of information support of the water planning process, in particular for the two successive planning cycles. As the first in a row, the simulation model of the river basin Upper and Middle Elbe was completed.

The primary objective of the simulation model is to evaluate the effectiveness of the measures by means of concentration changes of the monitored substances (BOD, COD, nitrate nitrogen, ammonium, total nitrogen, total phosphorus) in the respective water bodies. This model is a part of an information system enabling to create new variants of measures, and to compare these variants among each other by means of simulation. A possibility to evaluate the effect of a combination of different measures will be a starting tool for the next planning period with the aim to identify water bodies with „bad status" and to establish the most effective set of measures.

An example of a simulation of concentration of BOD in July

NATIONAL PROGRAMME OF MEASURES IN WATER FRAMEWORK DIRECTIVE. MIKE BASIN AS A TOOL FOR THE DEVELOPMENT OF DETAILED PROGRAMMES OF MEASURES AGAINST EUTROPHICATION (A073)

Jan Petersson[1], Willem Stolte[1], Niklas Holmgren[1], Dag Lestander[1], Cecilia Wennberg [2], Dick Karlsson[2], Flemming T. Hansen[3]

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[2]DHI Sweden, [3]DHI Denmark

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Keywords: WFW, Programmes of measures, eutrophication, nutrients transport, MIKE BASIN

The Water Framework Directive in Sweden has led to the production of a programme of measures, aided by the results of different analyses and modelling tools available on a national scale. The implementation of the proposed measures however needs a refined analysis of the different possible measures with regard to cost-effectiveness. The River Basin District Authority for the Southern Baltic Sea District has therefore started a participation-based modelling project, where in-data to a MIKE BASIN set-up has been discussed with municipalities, county boards, farmers organisations and others. The main goal of the project is to provide a basis for the development of detailed programmes of measures on water body level. Another goal is to assist water boards with the interpretation, analysis and evaluation of environmental monitoring data and programmes. Currently, 4 watershed models are set up, and another one is under development. After calibration, the model set-ups adequately describe nitrogen- and phosphorus transport from watersheds to the sea as compared to existing calculations. Comprising a module with the water shed model for calculation of the cost efficiencies of individual measures is under development.

Some problems dealing with calibration of phosphorus and to a lesser extent nitrogen concentrations in rivers remain. Methods for calculation of the effect of different measures such as wetlands and riparian buffer strips on nitrogen- and phosphorus transport have been developed and are currently implemented.

MULTI-OBJECTIVE OPTIMIZATION OF A LARGE WEST AFRICAN RESERVOIR (SÉLINGUÉ, MALI) (A149)

Bertrand Richaud, Henrik Madsen, Hans Christian Ammentorp

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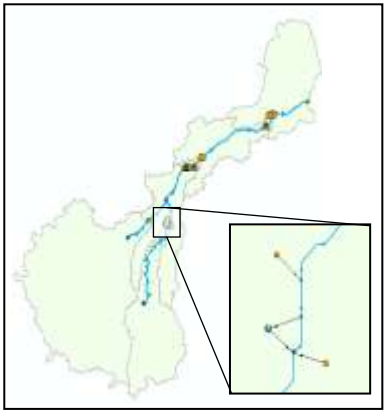
Presenter: Bertrand Richaud – ber@dhigroup.com

Keywords: MIKE BASIN, multi-objective optimization, NSGA-II, reservoir optimization, hydropower, rule curves.

Multi-objective optimization is proven suited to solve management problems of multi-purpose reservoirs, which are subject to conflicting objectives. This paper presents an approach that couples optimization with model simulations. The procedure is applied to the Sélingué reservoir, a large West African reservoir located in Mali. The Non-dominated Sorting Algorithm II has been applied to trade-off the conflicting objectives and to efficiently handle constraints between decision variables. The optimization finds a set of non-dominated solutions, which constitutes the Pareto optimal solutions. Then the decision maker has to express his/her preference between the objectives involved in order to select an optimal solution. Eventually an optimum is selected that balances the different purposes. Compared to the actual regulation of the reservoir the optimized operation leads to an increase of 1.15% of the hydropower production. Moreover, the overall water demand deficit for the users has been efficiently mitigated, and downstream low flow conditions have been improved.



MIKE BASIN model of the Sankarani River basin and the Sélingué reservoir. The green shapes represent the catchment areas, and the Sélingué reservoir is shown by a blue triangle. Water users are represented by orange symbols and the hydropower station by a yellow spark.

GENETIC ALGORITHMS FOR FLOOD RISK BASED OPTIMIZATION OF CONTROL STRUCTURES (A036)

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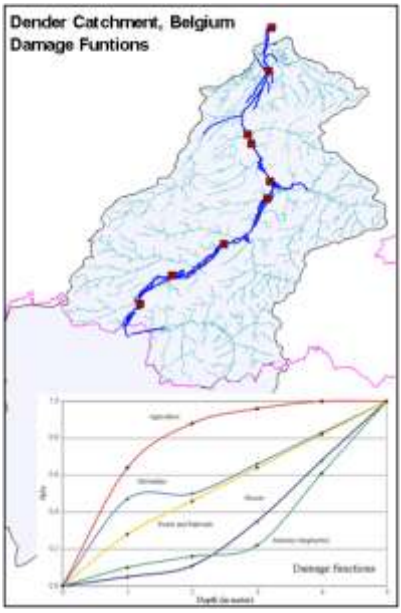
Keywords: flood risk assessment, optimization, genetic algorithms

Flood risk analysis is currently used in design of structures and for the realization of flood control plans. However, the computation of yearly expected damage for each analysed alternative is a time consuming process which demands the use of different programs and models (hydrodynamic, flood mapping, damage calculations, etc.).



A methodology has been developed in order to perform a flood risk based optimization of control structures, by using Genetic Algorithms. The present study locates at the Dender basin and has been requested by the department of navigable ways. Flood damage functions have been derived and each alternative is evaluated for 8 return periods with tidal boundary conditions. The methodology uses Genetic Algorithms to perform combinations in the logical operation rules of the gates, introduces the changes in the hydrodynamic model (MIKE 11) and asses the changes in terms of flood risk.

Results indicate that Genetic Algorithms appear to be an effective tool to optimize control structures on a risk based approach. The optimized set of rules led to a reduction of 40 % of the yearly expected flood damage. Further the methodology shows that it is possible to use MIKE 11 as part of an intelligent optimization tool which can itself formulate changes in the model en asses them in order to optimize a given objective function.

CONTROL MODEL FOR FLOOD MANAGEMENT AND SCENARIO TESTING IN THE HALDEN CATCHMENT, NORWAY (A102)

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Presenter: Peter Borsanyi – peter.borsanyi@nve.no

Keywords: MIKE 11, DEMs, flooding, automation, structures

The Halden watercourse is a highly regulated catchment with hydropower production, inland navigation, agriculture and recreation uses. Frequent inundations along the main watercourse impose problems for land use interests, but the causes of the floodings are not clear. Therefore a model is developed which considers the reservoir concession rules and other regulation parameters in the system and allows the investigation of flood propagation and scenario testing in order to improve the situation.

The model is developed in the MIKE 11 system. Topographical data is extracted from digital elevation models (DEMs) and adjusted according to reservoir parameters. The concession texts are translated into priority ordered mathematical formulae in which discharge releases are primarily functions of water level and calendar date. Historical discharge-and stage-time series are used for calibrating the model. Based on preliminary analyses of historical flood events, alternative operation scenarios are worked out to mitigate or avoid flooding at inundated locations. Furthermore the effects of physical measures are also tested for the same purpose. The soft and hard measures are summarized in cause-effect table showing the impact magnitudes for each of those.

The model system is developed in a way that allows its application for water level forecasting and other types of analyses, for example pollution propagation and large scale catchment management planning.

Svanedam locks and Tistedalsfoss hydropower station

HYDROECONOMIC ANALYSIS OF ALTERNATIVE INTERVENTION PLANS IN A RECLAIMED BASIN IN ITALY (A114)

Gianni Tebaldi[1], Marco Volpin[1], Silvia Caniati[2], Marco Franchini[2]

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Presenters: Gianni Tebaldi - gianni.tebaldi@bonificaferrara.it

Keywords: reclaimed basin; flood risk; intervention plans

The reclaimed basin of Argenta, situated in the Province of Ferrara (Northern Italy), extends over 80 km^2 and its territory, mostly agricultural land with the presence of a few urban centres, is fairly flat with and average altitude of -4 m below sea level. A well-organised hydraulic system, recently further developed and now made up of 131 km of canals, 60 control manufactures, an extended detection basin of 400.000 m^3 and a pumping station of 23 m^3/s located at the basin outlet, constitutes an efficient hydraulic defence for the area. This system is able to deal with rainfall events with a return period of 20 years, even if some localised crises can occur. After an accurate analysis based on the rainfall recorded from rain gauges positioned in the basin of interest and in those next to it, using the combined calculation codes of MIKE 11 and MIKE 21, flood maps were constructed and consequent estimates were made of the monetary damage relative to the hydraulic system due to design storms with a return period of Tr = 20, 50, 100 and 200 years and then, in accordance with the procedure described in Masaru Morita (2008) and Ven te Chow et al. (1988), estimates were carried out of the expected annual damage. Then the costs were quantified for "intervention plans" in relation to the various return periods; by "intervention plans" we refer to the series of improvement works each designed to stem or reduce flooding in relation to a selected return period.

At this point, a comparison could be made between the capitalisation cost trends and the expected annual damage corresponding to each intervention plan considered. In the context of this study case, it was observed that as the reference return period, linked to a specific intervention plan, increased, the expected benefit remained more or less unvaried while the investment cost highly increased, so much so as to recommend no further works and activities to reduce the risk of floods in the territory of Argenta.

MIKE FLOOD HYDROLOGICAL AND HYDRAULIC INVESTIGATION IN SLOVENIA (A039)

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Consulting, Designing, Agency and Research, Slovenia

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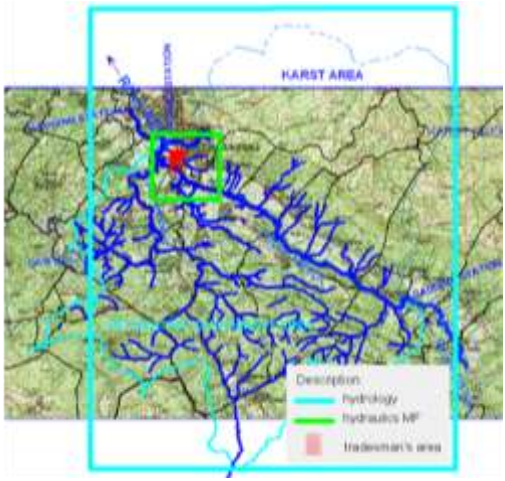
Keywords: spatial planning, river Reka, flood evaluation, hydrology, MIKE FLOOD, regional natural park, NATURA 2000

EU Directive(2007/60/EC) "Flood management and evaluation" established and actualized a part of EU Water Framework Directive (2000/60/EC) and charged local Communities, the subjects of spatial planning in our country with relative heavy duties. The obligatory groundwork of spatial plane is also the drawing up of flood risk management plan. Relative sensitive aspect of this groundwork requires relative sophisticated hydrology and hydraulic approach. MIKE by DHI software is very useful tools, such as MIKE FLOOD program package.

According to the financial possibilities of communities, the approach of preparing of plans is often particular, not even for the whole community, but the influence of such intervention on space is much larger.



Similar case is described above. The community Ilirska Bistrica is preparing the spatial plan for a new tradesman's area, which lies on the right embankment of the river Reka. Several problems had to be taken in account. At first, how to prepare reliable boundary conditions, not at last topography also, because of lack of data. At second, how to protect tradesman's area, which is often flooded, but not to deteriorate other settlements areas and infrastructure. Not at last, how to take in account limitations of ecological protection regulations. The actual tradesman's area lies directly to Regional Škocjanski Park, which protected the World Heritage Škocjanske Caves. The area on the left embankment of the river Reka and downstream wetland is covered by the Natura 2000. MIKE FLOOD was successful used for flood risk study and flood risk management plan.

3D WATERCOURSE MODELLING OF SNEUM RIVER IN DENMARK (A086)

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Grontmij | Carl Bro A/S, Denmark

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Keywords: constructed floodplains, MIKE FLOOD, flooding, public river control, MIKE 11, flood control

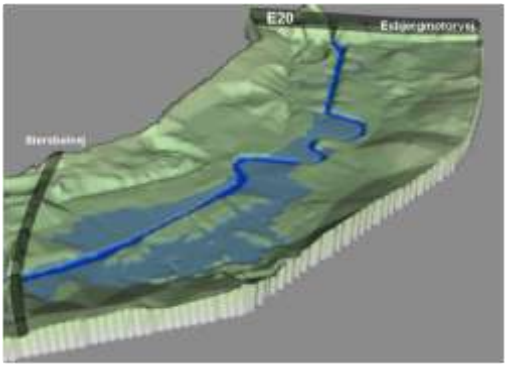
MIKE FLOOD (MIKE 21 and MIKE 11) used to ensure surface water drainage from motorway and flooding of river banks. Providing better living conditions for the rare fish species houting, among others.

The purpose of the 3D calculations of Sneum River is to ensure that the regular flooding of the river valley does not cause hydraulic problems in terms of drainage of surface water from the E20 Motorway.

For this reason, we first carried out all the necessary terrain adjustments in 3D, in collaboration with the Danish Forest and Nature Agency, and then used MIKE FLOOD to combine the watercourse model (MIKE 11) and the terrain model (MIKE 21).

The one-dimensional watercourse model with cross-sections of the watercourse makes it difficult to calculate and present the water level. The 3D-model gave good presentation options.

The combination of hydraulic models could be become an essential part of the risk management plans which Danish municipalities and environmental centres must prepare according to a new law on flood risk assessment and control of watercourses and lakes.



The presentation will concentrate on MIKE 11 and MIKE 21 combination and the possibility to use MIKE FLOOD for Water Framework Directive fulfilment (approx. 13,000 hectares of new wetlands in river valleys).

The 3D drawing shows the flood extent of Sneum River. The motorway shown above on the drawing will consequently not be affected by the floods calculated by Grontmij | Carl Bro

HYDRAULIC ANALYSIS OF A SET OF DRY RETENTION BASINS IN SAVINJA VALLEY (A097)

Miha Zidarič[1], **Gregor Petkovšek**[2]

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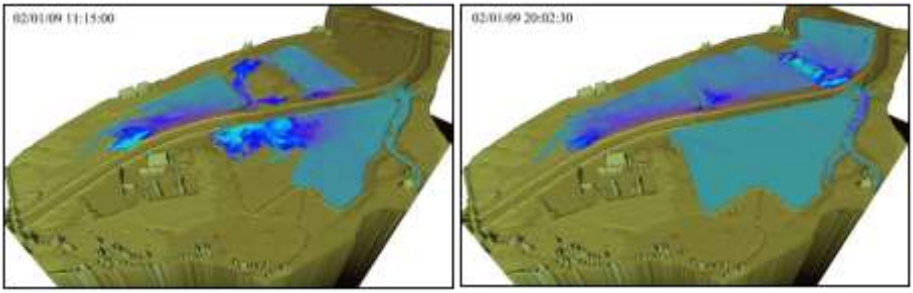
Presenter: Miha Zidarič – miha.zidaric@izvo.si

Keywords: modelling, flood protection, retention basin, operation strategy

In 1990 and 1998, severe flooding occurred in the lower Savinja valley, central Sovenia. A large area was inundated, including the substantial towns of Celje and Laško. Certain flood control measures were taken after the events, but they have only partially addressed the problem. There are still significant areas endangered by floods.

The desired goal is to reduce the peak discharges to the amount that can be conveyed by the river channel. Thus the peak should be reduced by about 25% for a flood with a 100 years recurrence period. For this purpose, a cascade-style set of dry retention basins and an optimisation of dyke position has been suggested.

In this paper, a study of the proposed measures is analysed using the MIKE FLOOD numerical model. Flood waves with a 10, 50, 100, 500 and 1000 years recurrence period have been studied. With the model, it was possible to determine the positions and the dimensions of the inflow and outflow structures of the retention basins, their operational schedules and propose the monitoring scheme.



ASSESSING POTENTIAL FOR CLOUD SEEDING IN THE SNOWY RIVER CATCHMENT ABOVE GUTHEGA RESERVOIR USING CATCHMENT MODELLING (A043)

Vladimir Stojnić[1], Stefan Paul Szylkarski[1], James Ball[2]

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[2]*University of Technology, Sydney, Australia*

Presenter: Stefan Paul Szylkarski - sps@dhigroup.com

Keywords: cloud seeding, snowmelt, runoff, streamflow, evaluation catchment modelling, MIKE SHE

The ultimate objective of cloud seeding in the Snowy Mountains region is to increase precipitation thereby increasing the runoff volume making it available for hydro power generation and irrigation. Full evaluation of the effectiveness of the cloud seeding requires assessment of the change in precipitation and the change in runoff due to this change in precipitation.

While, the cloud seeding program has been operating since 2004 and will continue until 2014, a statistically significant increase in precipitation and runoff is yet to be demonstrated as sufficient field data is not available yet. The aim of this paper is to evaluate the likely change in runoff from an assumed increase in precipitation in the Snowy River catchment above Guthega Reservoir using catchment modelling. The hydrologic model (MIKE SHE) was set up using available spatial information and model default values, calibrated to fit observed data, and used to assess the potential impact of cloud seeding.

HYDRO-ECOLOGICAL STUDY OF THE WOOD RIVER VALLEY AND SILVER CREEK, IDAHO (A067)

Maria C. Loinaz[1], Marta Paravidino[1], Peter Bauer-Gottwein[1]
Michael Butts[2]

[1]*Technical University of Denmark*
[2]*DHI Denmark*

Presenter: Maria C. Loinaz – macl@env.dtu.dk.com

Keywords: surface-groundwater interactions, MIKE SHE, temperature modelling

An integrated surface water and groundwater flow and temperature model is being developed to evaluate the effects of landscape changes and water management practices on a surface water ecosystem. The model area encompasses the Wood River Valley located in south central Idaho. The area consists of a 231 km^2 complex aquifer system in which surface water - groundwater fluxes are highly connected. The two river systems in the valley, Big Wood River and Silver Creek basins, are separated by a shallow surface water divide that cuts across the centre of the valley. The Big Wood River recharges the aquifer that feeds Silver Creek, which forms in the south-eastern portion of the valley, through numerous springs. Flows to Silver Creek are also influenced by urban and agricultural water use in the valley, for example, much the aquifer recharge comes from irrigation. Silver Creek is an important wildlife habitat and fish ecosystem that is sensitive to stream temperature changes.

Some studies hypothesize that the natural conditions of the stream have been altered by lower flows and fine sediment accumulation that cover the natural stream bed and increases the width-to-depth ratio of the channel. These altered conditions increase the potential for higher stream water temperatures. Higher stream temperatures can present a threat to certain species of fish, such as rainbow trout. The model will be used to predict the physical/environmental conditions under several restoration scenarios and relate these to the aquatic ecology of the Silver Creek.

INTEGRATED SURFACE WATER AND GROUNDWATER MODELLING TO SUPPORT THE MURRAY DRAINAGE AND WATER MANAGEMENT PLAN, SOUTH-WEST WESTERN AUSTRALIA (A115)

Joel Hall

Water Science Branch, Department of Water, Western Australia

Presenter: Joel Hall – joel.hall@water.wa.gov.au

Keywords: Murray River, drainage, urban, wetlands, groundwater, physical modelling, mathematical modelling, MIKE SHE

The Murray region in south-west Western Australia is characterised by a high water-table, sandy soils, wetlands of significance, and an extensive agricultural drainage system to relieve water-logging in winter months. Urban growth pressures in the region have led to the requirement of a Drainage and Water Management Plan (DWMP) to guide stakeholders in future urban water management.

A key component of the DWMP involved the development of a regional model to determine groundwater levels and flows under various climate, drainage and development scenarios. The Murray regional model was constructed using MIKE SHE, and consisted of unsaturated zone, saturated zone, channel flow and overland flow components. It had a constant grid spacing of 200 m, and covered an area of 722 km2. Calibration was from 1985 − 2000 and validation from 2000−2009 using 45 groundwater bores and 7 surface water flow gauges. The normalised root mean square error of the calibrated model was 2.02%.

The Murray River entering the Peel Inlet, facing east

Results of regional model scenarios based on climate change predictions, drainage and development options are discussed. Five fine-scaled wetland models were extracted from the Murray regional model. Wetland models were calibrated, and changes in wetland water levels under various climate and development scenarios are discussed.

DEVELOPMENT OF A REAL-TIME WATER MANAGEMENT FRAMEWORK FOR KEY CATCHMENTS IN KWAZULU-NATAL, SOUTH AFRICA (A071)

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[1]*Umgeni Water, South Africa*
[2] *DHI South Africa*

Presenter: Andrew Pott - anpo@dhigroup.com

Keywords: NAM hydrological model, transfer scheme, operating rules, investigation of high water conditions, MIKE FLOOD WATCH, MIKE 11, calibration, verification, validation

A real time water resources management framework has been developed for key catchments incorporating the Mooi-Mgeni Transfer Scheme in KwaZulu-Natal, South Africa. At the core of the framework is the Danish Hydrological Institute's FLOOD WATCH, coupled with the NAM hydrological model and a fully dynamic Mike 11 hydraulic model. The framework downloads key hydrological data including historical and forecast rainfall, measured river flow and reservoir levels from several sources including the Department of Water Affairs, South African Weather Services, National Oceanic and Atmospheric Administration in the USA and Umgeni Water's own Water Resources Management database. This data is used in the various models to model and thereby predict scenarios of current and near future water resources that may impact on Umgeni Water's ability to supply water or on disaster management preparedness related to possible flooding.

Undoubtedly, the main advantage of this framework is that decision makers have real time access to not only static water resources data, but also have insight into elements of the system that are not measured or predictions anywhere in the configured catchment, on a daily basis. This has huge potential to improve Umgeni Water's forecasting abilities.

REAL-TIME INTEGRATED SURFACE WATER-GROUND WATER MODELLING OF THE BIG CYPRESS BASIN, FLORIDA, USING MIKE SHE (A040)

Michael Butts[1], Ke. Feng[2], Anders Klinting[1], Ken. Stewart[3]
Ananta Nath[4], Preston Manning[5], Tim Hazlett[5], Torsten Jacobsen[1]

[1]DHI Denmark
[2]South Florida Water Management District, Hydrologic & Environmental Systems Modeling Department, FL, USA
[3]South Florida Water Management District, SCADA and Hydra Data Management Department, FL, USA
[4]South Florida Water Management District, Big Cypress Basin, FL, USA
[5]DHI Water & Environment, FL, USA

Presenter: Michael Butts - mib@dhigroup.com

Keywords: flood forecasting, surface water – groundwater interaction, wetlands, real-time operations, MIKE SHE, MIKE FLOODWATCH

Surface water and groundwater have been, by tradition, managed separately, often in completely different branches of government. However, water resources problems cannot be treated in isolation and it may be necessary tures, lakes, wetlands, aquifers and urban drainage systems as an integrated system.

The need to manage and protect water resources and the water environment in an integrated fashion has been recognised early on in the South Florida Water Management District (SFWMD) as the lead agency in restoring America's Everglades − the largest environmental restoration project in US history. The region has a unique hydrological regime, with close connection between surface water and groundwater, and a complex managed drainage network with many structures. Added to the physical complexity are the conflicting needs of the ecosystem for protection and restoration, versus the substantial urban development with the accompanying water supply, water quality and flood control issues. This paper describes a real-time surface water and groundwater modelling system for the Big Cypress Basin. Novel aspects of this system include the use of a fully distributed and integrated modeling approach and a new filter-based updating approach for accurately forecasting river levels. Because of the close interaction between surface- and groundwater a fully integrated real-time modeling approach is required and forecasts of both surface and groundwater levels are made. Results are presented for the Tropical Storm Fay in 2008 and show in some cases extremely rapid changes in ground water level in response to heavy rainfall.

FLOOD FORECASTING SYSTEM BASED ON THE DISTRIBUTED HYDROLOGICAL MODEL MIKE SHE-MIKE 11 (A087)

Christian Stocker[1], Ángel Eraso Alberdi[1], Torsten Jacobsen[1], Peter Torp Larsen[2], Jose Antonio Arenas[2]

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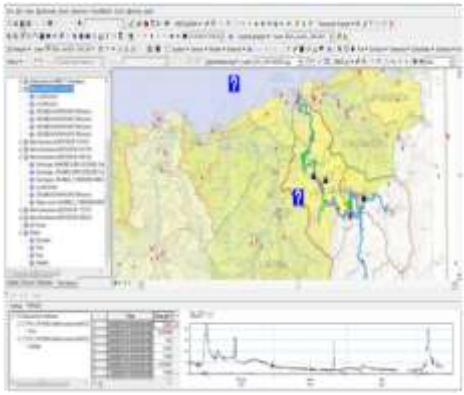
Presenter: Peter Torp Larsen - ptl@dhigroup.com

Keywords: real time flood forecast system, distributed hydrology MIKE SHE-MIKE 11

A pilot flood forecasting and alert system has been implemented for the Urumea catchment. The system consists of an area of 405 km^2, 25 km river (the Urumea and Añarbe rivers), the Añarbe Reservoir with floods laminations capacities.



The real-time operational system is based on MIKE FLOOD WATCH, the hydrological processes are modeled by the distributed model MIKE SHE (2D overland flow, 2D gravity flow in the UZ, and 3D in the SZ), the hydraulic part of the model includes rivers, channels, structures etc and simulated in MIKE 11. Due to the complicated hydro-metrological and physical conditions in the area, the Flood forecasting system requires both fast and reliable simulations for and therefore a careful balance between accurate representations of the catchment flood processes the flood wave movement and inundation extent and the need for rapid forecasts.

The present paper describes the formulation, calibration, validation and real-time implementation of the operational distributed model. The application shows that the MIKE SHE/MIKE11 distributed hydrological model is able to reproduce the rainfall-runoff processes and the propagation of the flood wave through the main river system including seven real medium size flood events. Lumped rainfall-runoff models (e.g. NAM) used with MIKE 11 hydrodynamic modeling has been widely used for years. The current approach adopts a physically based, distributed approach partly to simulate runoff considering catchment distributed features and partly to apply distributed rainfall forecasts. The benefits and drawbacks of using lumped rainfall-runoff models, linear reservoir modeling with MIKE SHE or fully distributed models with varying degree of complexity is discussed.

MORPHOLOGICAL CHANGES IN THE VICINITY OF DETACHED BREAKWATER AT SUNGAI HAJI DORANI, PENINSULA MALAYSIA (A038)

Roslan Hashim[1], Zubaidah Ismail[1], Babak Kamali[1]
Ahmad Mustafa Hashim[2]

[1]*Institute of Ocean and Earth Sciences, University of Malaya*
[2] *Department of Civil Engineering, Universiti Teknologi PETRONAS, Malaysia*

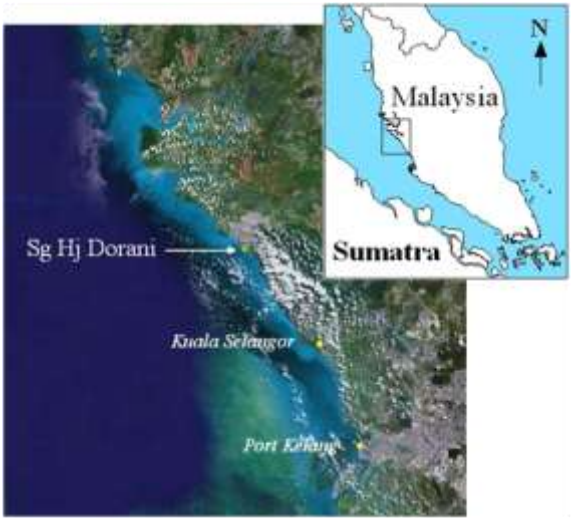
Presenter: Roslan Hashim – roslan@um.edu.my

Keywords: detached breakwater, morphological change, mangrove restoration project, coastal rehabilitation

Human activities in the coastal zones of Malaysia for the last fifty years had impacted its coastline. Serious efforts had been planned and implemented to improve or stabilize these affected areas. One of the relevant agencies, the Forestry Research Institute of Malaysia (FRIM), has carried out several coastal rehabilitation projects along the coast of Malaysia.

In one of the projects, mangrove replanting was initiated to restore the depleting mangroves due to development projects and illegal harvesting activities. A detached breakwater was introduced to shelter a mangrove restoration area in Sungai Haji Dorani, on the west coast of Peninsular Malaysia. Construction of the breakwater on this muddy coast was successfully completed in July 2008. One of the main objectives of the breakwater was to facilitate sediment accretion behind the breakwater.

The morphological changes in the vicinity of the breakwater have been monitored on a quarterly basis between July 2008 and December 2009. Numerical simulations with the 2DH model MIKE 21 have then been carried out in order to predict mud sediment transportation and deposition. Field monitoring indicates that a significant volume of sediments was deposited in the lee of the breakwater, which is in good agreement with the results of the numerical simulations.



CALIBRATION AND VERIFICATION OF A MIKE 21 MODEL FOR EVALUATING SHORELINE STABILIZATION ALTERNATIVES (A015)

Michael B. Kabiling and Kristen M. Odroniec

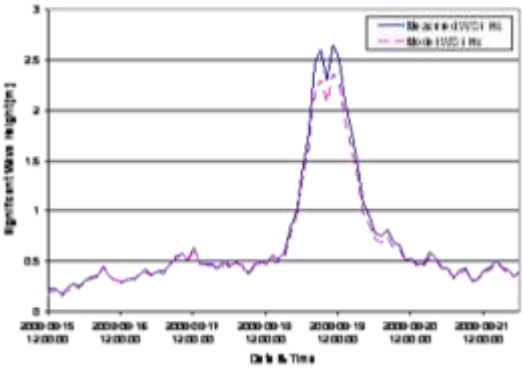
Taylor Engineering Inc., USA

Presenter: Michael B. Kabiling - mkabiling@taylorengineering.com

Keywords: MIKE 21, 2D modeling, hydrodynamic, spectral wave, Jupiter Inlet, Florida

This study describes the field measurements and numerical modeling of tides and waves south of Jupiter Inlet in Palm Beach County, Florida. As the area suffers from chronic erosion, the ultimate objective of the study is to assess the feasibility of stabilizing the shoreline and develop potential solutions with emphasis on coastal structures. The study includes evaluating historic beach performance, evaluating changes in beach behavior, collecting field data, calibrating and validating a numerical model, and evaluating design alternatives. The present paper summarizes hydrodynamic and wave models calibration and verification. The MIKE 21 hydrodynamic (HD) model calibrated and verified well with measured inlet tide levels. The strong influence of the Gulf Stream prevented good velocity calibration.

The MIKE 21 Spectral Wave (SW) model calibration consisted of fine-tuning the SW module parameters until the model produced a good match between the simulated and measured significant wave heights, peak and mean wave periods, and mean wave directions at the offshore and nearshore measurement stations. Also, test wave model simulations showed little difference in nearshore results between spectral formulation and directionally decoupled parametric formulation at the wave model offshore boundary. Further, the use of directionally decoupled parametric formulation decreased model computational time by 16 times. The study considers the MIKE 21 HD and SW models calibrated and verified to apply model tide - and wave-induced currents for the next phase of numerical modeling - sand transport (ST) modeling. The modeling challenge is to simulate long-term shoreline response due to a nearshore structure using the ST model built-in acceleration factor.



Comparison of measured and simulated wave height during model verification

IMPROVING BYPASS AND INCREASING NAVIGATION DEPTH: A VISION FOR HVIDE SANDE HARBOUR, DENMARK (A140)

Nicholas Grunnet

DHI Denmark

Presenter: Nicholas Grunnet – ngr@dhigroup.com

Keywords: sediment bypass, morphological modelling, nearshore bars, harbour breakwaters

A harbour on a coast blocks the littoral drift causing accretion and erosion at the up- and downdrift side, respectively. Eventually a significant part of the littoral drift may bypass the harbour. In this case it is important to minimize the deposition of the passing sediment in the harbour basin and the harbour mouth. Traditionally navigation channels are maintained, updrift sediment reservoirs are dredged and sand is bypassed mechanically or by repeated dredging and disposal. The sedimentation and depth in front of the harbour depends not only on the littoral drift but also on the layout of the protective breakwaters. The full paper presents an optimisation of breakwater layout in promoting bypass. Hvide Sande harbour in Denmark is protected by shore-perpendicular breakwaters (see Figure) and experiences considerable sedimentation in its access channel. Facing the need to accommodate larger fishing vessels, the harbour wishes to increase the navigation depth in front of the harbour entrance while at the same time reducing the sedimentation in the access channel. An new scheme is proposed (see Figure) consisting of a combination of new protective breakwaters and an updrift capital dredging of the coastline: while the streamlined breakwaters will increase the bypass of sediment past the harbour mouth by increasing the flow velocity due to contraction, the retreat of the coastal profile will help maintain the required additional water depth needed. The present morphological study shows that the proposed scheme results in an increased equilibrium depth of the bypass bar in front of the harbour without increasing the downdrift erosion, and an improved natural bypass of the littoral drift.

Present breakwater configuration of Hvide Sande harbour (left) and proposed breakwater configuration (right) with the new shoreline (dotted line).

QUANTIFYING STORM SURGE RISK FOR JAMAICAN COASTLINES (A022)

Graham Jervis, Philip Warner, Veronique Morin

Smith Warner International Ltd., Jamaica

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Keywords: hurricane, storm surge, risk analysis, Jamaica, MIKE 21/3, verification

A flexible mesh model was developed for the Caribbean Sea surrounding the island of Jamaica to investigate the storm surge risk characteristics at three locations, as shown in Figure 1. The sites included both open coastal areas and semi-sheltered waters, indicating that careful modelling would be required.

The NOAA database of hurricane parameters and tracks was searched, and this identified over 164 tropical cyclones passing close to Jamaica in the past 108 years. A filtering criterion, using the results of a parametric hurricane model, was employed to identify 21 hurricanes that affected the coastline. The Cyclone Wind model was used to compute the wind and pressure fields as these storms moved across the island, resulting in simulations between 18 and 180 hours, depending on the storm track. Operating in a coupled mode, MIKE21/3 determined the wave heights and storm surge levels at the three locations. To ensure that the model was predicting the correct storm surge levels, detailed comparisons between the predicted and observed storm surge levels for Hurricane Ivan were made at Portland Cottage and Manchioneal. MIKE21/3 produced very similar wave, storm surge and overland flow conditions when compared to the field data. Based on this verification, the peak storm surge levels were extracted and used to undertake an extreme analysis and define the values at each location for the 25, 50, 100 and 150 year return periods. Storm surge hazard maps were then prepared by combining the predicted water levels and topography of the study areas in a GIS-compatible environment. The final results were overlaid on top of satellite imagery as shown in Figure 2.

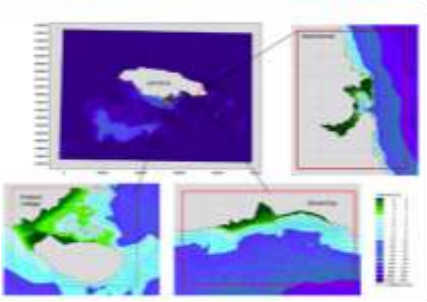

Figure 1 Finite element mesh used for storm surge modelling

Figure 2 Storm surge hazard map for Portland Cottage

RIVER AND SEA WATER INUNDATION ALONG THE ADRIATIC SEA (A128)

Barbara Zanuttigh[1], Luisa Perini[2], Paolo Mazzoli[3], Andrea Pedroncini[4]

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Presenter: Barbara Zanuttigh – barbara.zanuttigh@unibo.it

Keywords: coastal and river flood, boundary conditions, hydrodynamic module, flexible mesh

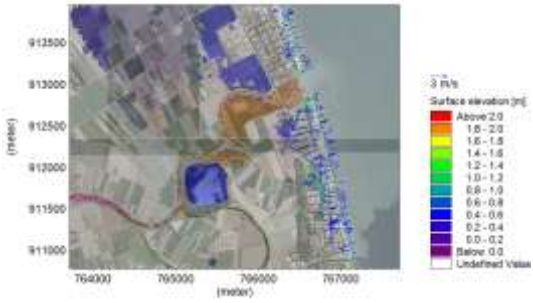
The coasts of the Emilia Romagna region, Italy, are located in low-lying areas of the Northern Adriatic Sea, characterized by a high anthropogenic subsidence. In the recent past several municipalities have been damaged by coastal flooding, so that some interventions were required as in Cesenatico, where a new defence from sea ingression ("Porte Vinciane") was built in 2006. The objective of this research is to analyse coastal flooding hazard and, more specifically, to answer the following issues:

- Which is the expected flooding frequency in a given area within a fixed time?
- Which is the effectively inundated zone and how quickly it is flooded, supposing that the soil and bank height are perfectly known?
- Which is the combined effect of sea and river during severe storming events?

Coastal flooding simulation is carried out with MIKE 21 FM, along a stretch of the coastal zone around Lido di Savio that approximately extends for 7 km longshore and 4 km from the shoreline inland. The input bathymetry is built-up on the basis of detailed LIDAR surveys in the area. The most interesting issue to deal with in the numerical modelling is represented by the boundary conditions to be imposed in the model, and specifically:

- Which is the most convenient seaward boundary to be used when dealing with complex flooding simulations and the known model limitations for wave run-up on steep beaches/dunes?
- How it can be represented sea-river interaction at the river mouth and at the same time speed up computational effort?
- How can conditions at the lateral sides not affect the numerical results?

The contribution will answer these questions and show flooding in time at Lido di Savio for combined scenarios in the short, mid and long term.



An example of simulated river and sea water inundation for a 100-years wave return period

MODELLING EARTHQUAKE AND SUBMARINE SLUMP INDUCED TSUNAMIS USING MIKE 21 (A017)

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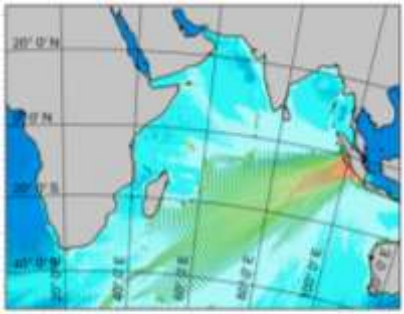
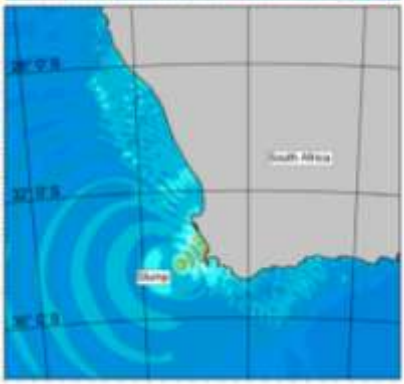
Prestedge Retief Dresner Wijnberg, South Africa

Presenter: Stephen Luger - sluger@prdw.co.za

Keywords: MIKE 21, tsunami, earthquake, submarine slump

MIKE 21 Classic is used to model tsunami run-up at a power station site in South Africa. Tsunamis due to both earthquakes and submarine slumps are simulated. For earthquakes the fault parameters (origin, strike, length, width, dislocation, depth and dip) are used to calculate the vertical displacement of the seabed using the method of Okada (1985).The vertical displacement of the seabed induces a corresponding displacement of the water surface, which is applied as an initial water level condition in MIKE 21 Classic. The model is verified using tide gauge measurements from the 2004 Sumatra event.





To simulate tsunamis due to submarine slumps on the continental shelf edge, the landslide option in MIKE 21 Classic is applied. The equation describing the slump motion follows Watts et al (2003), where the slump motion is modelled as a rigid body undergoing a rotation around a point described as the centre of rotation of a circle prescribed by the arc of the circular failure plane. The body has a Gaussian shape as specified in Grilli and Watts (2005).

The lack of geographical coordinates in MIKE 21 Classic can result in a distorted grid when simulating larger domains. Although MIKE 21 FM includes geographical coordinates, the numerical scheme (including the higher order option) appears to be too dispersive to simulate tsunami propagation over large distances, and the FM version presently does not feature a landslide option. MIKE 21 Classic is thus the preferred model for tsunami modelling at present.

MODELLING OF HARBOUR TRANQUILITY INTO THE LNG PORT (A124)

Babak Sherkati Azin[1], Alireza Vaselali[2]

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[2]*TMU University, Iran*

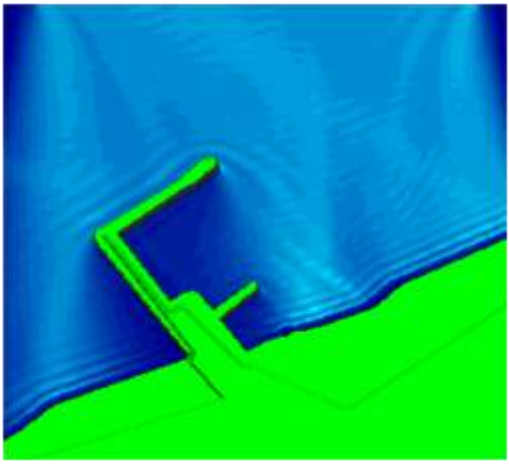
Presenter: Babak Sherkati Azin – b.sherkati@padyab.com

Keywords: wave diffraction, harbor tranquility, LNG port, MIKE 21

In order to facilitate ship berthing, obtaining an acceptable level of wave disturbance within harbor basin and its marine facilities is of significance and should be addressed in layout design of the breakwaters.

The pattern of wave propagation into harbor basin is mainly governed by diffraction and in specific cases by refraction. The sheltering provided by breakwaters against incoming waves, wave transmission and reflection caused by the porous breakwater body are the main items being considered. The LNG Plant will be located on the west coast of Iran, at Tombak, approximately 40 kilometers from Assaluyeh. The LNG Plant is located at the west end of the area where three other LNG plants are planned to be constructed. In this paper, the specifications of the layout proposed and the wave climate at the entrance of the Port are introduced. BW Module (Boussinesq Wave Module) of MIKE21 Software which is used to simulate the pattern of wave propagation into the basin is briefly introduced and the setup conditions used in the simulations are described next.

The wave disturbance modeling is carried out for a range of wave directions and periods and sample results of the penetrated wave patterns are presented. The accepted calmness criteria is reviewed and discussed and the probability of exceeding these criteria along the Port berths are calculated.



EXAMPLES OF METOCEAN MODELING FOR MARINE RENEWABLES (P123)

Ross Halliday

Natural Power Consultants Ltd., United Kingdom

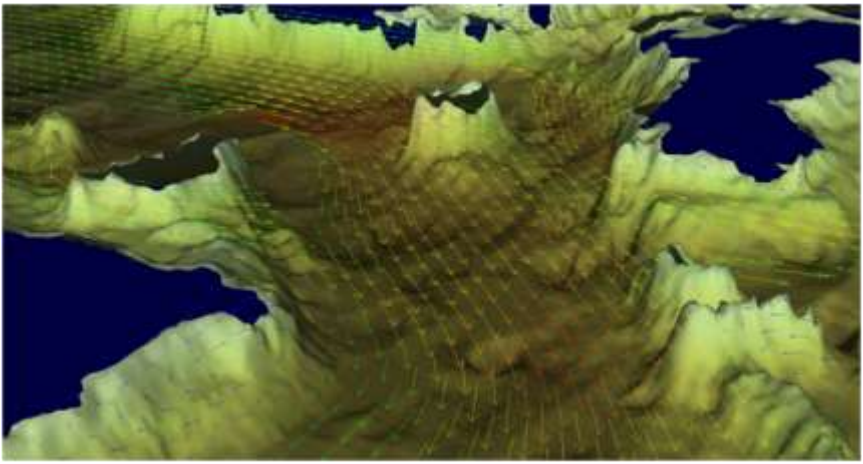
Presenter: Ross Halliday – rossh@naturalpower.com

Keywords: marine renewable energy, resource assessment, wave climate

The field of marine renewable energy is quickly approaching a commercial stage. Device developers are in the process of testing full scale technology in water and the recent seabed leasing rounds have presented the emerging industry with the opportunity to apply theoretical resource assessment procedures to commercial projects.

To advance the field of marine renewables engineers will have to borrow from and adapt tools from existing industries. With the MIKE 21 tools we have taken the industry standard in the field of environmental hydraulics simulations and manipulated its structure and inputs to provide us with the level of detailed required to isolate locations of wave and tidal energy potential and run energy yield predictions.

This paper presents a study of the available marine renewable resources in the Shetland Islands. The methodologies and tools applied to the calculation of the wave and tidal resource will be presented and discussed.



An example of a high energy flows through an area of interest

STORM SURGE HIND- AND FORECASTING USING MIKE 21FM - SIMULATION OF SURGES ALONG THE IRISH COAST (A127)

B. Elsäßer[1], A.K. Bell[2], N. Shannon[2], C. Robinson[2]

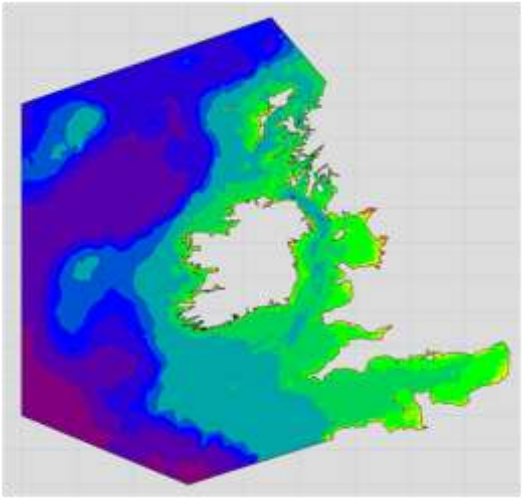
[1]Queen's University Belfast, [2]RPS Consulting Engineers Belfast

Presenter: Björn Elsäßer – b.elsaesser@qub.ac.uk

Keywords: storm surge, hindcasting, forecasting, Irish Sea, tidal modelling, extreme water levels, flexible mesh, depth averaged

This paper presents details on an Irish Sea Tidal and Surge Model, which has been developed as part of the Irish Coastal Protection Strategy. The main objective was to utilise the model in deriving extreme water levels to quantify the risk from coastal flooding. Initially the model was envisaged to be used for the Irish Sea only. However due to the flexible mesh capability in MIKE 21 HDFM it was possible to have one large model, which would allow the transformation of surges from the continental shelf to the coast in the Irish Sea. As a result the model has been used in a number of modifications for large sections of the Irish Coastline for a wide range of applications. The model uses a flexible mesh with cell sizes of several kilometres at the western Atlantic boundaries and reduces to several meters cell size in certain coastal areas. It is driven by a series of harmonics along the boundary including seasonal and annual components depending on the application. The wind and pressure field applied is derived from reanalysis or operational atmospheric data sets. The model has been calibrated against an extensive data set of tide gauges and tidal stream data.

More recently the model has been used as forecasting tool on an operational basis for the winter months, providing Irish authorities with estimates on likely flood risk at coastal locations. It has also been ported to the ICHEC (Irish Centre for High End Computing) and is currently tested for fully operational forecasting in collaboration with Met Eireann and the Office of Public Works.



Model domain and bathymetry of the Irish Sea Tidal and Surge Model

COMPARISON OF MIKE 21 BW AND PHYSICAL MODEL RESULTS USED FOR THE DESIGN OF THE MARTHA COVE BREAKWATERS (A055)

Andrew McCowan and Elise Lawry

Water Technology Pty Ltd., Australia

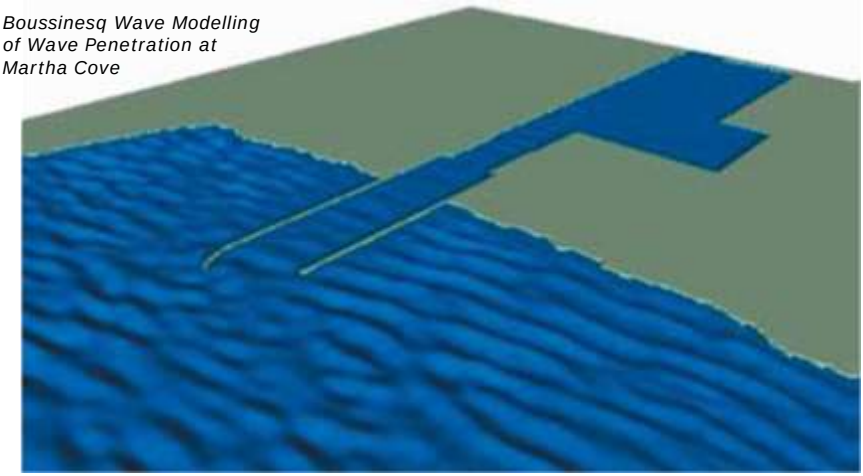
Presenter: Andrew McCowan – amc@watech.com.au

Keywords: breakwater design, MIKE 21 BW, physical modeling

Martha Cove is a water−based residential development that is currently being developed at Safety Beach on the southeast coast of Port Phillip Bay, Australia. The development includes three marina basins, with a total capacity for up to 1,000 boats, and a series of inland canals and residential islands.

The development is connected to the sea by a dredged entrance channel that is protected by rubble-mound breakwaters. The breakwaters were required to protect the entrance channel from wave action and to prevent infilling by along shore sand transport. There was significant evolution of the breakwater concepts as part of the design process. The final design concept was optimized using MIKE 21 BW numerical wave modeling. A physical model was then constructed to confirm the numerical model results, and to assess the navigability of the entrance under adverse wave conditions.

This paper will describe the evolution of the breakwater design, compare wave penetration results from the numerical and physical model studies, and discuss how they compare with the operational results of the now constructed breakwaters.



Boussinesq Wave Modelling of Wave Penetration at Martha Cove

MIKE 21 MODELING TO EVALUATE SHOALING REDUCTION ALTERNATIVES NEAR MATANZAS INLET IN FLORIDA (A016)

Michael B. Kabiling

Taylor Engineering Inc., FL, USA

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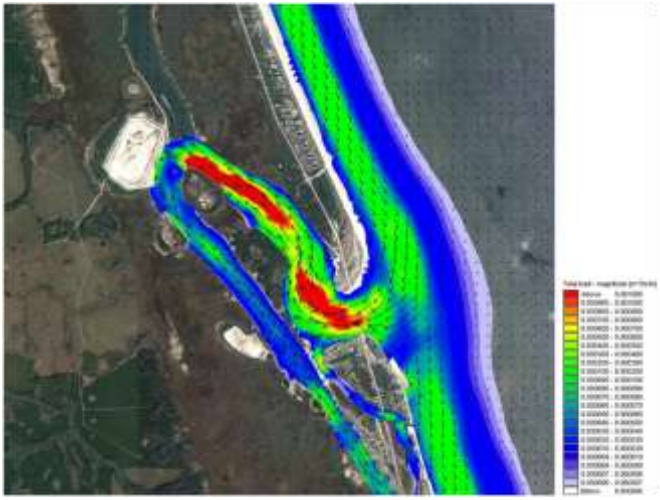
Keywords: MIKE 21, 2D modeling, sediment transport, Matanzas Inlet, Florida

This study describes the field measurements and MIKE 21 numerical modeling of tides, waves, sediment transport, and bed morphological changes in the Intracoastal Waterway (ICWW) near Matanzas Inlet in St. Johns County, Florida. The model results generally agree well with measured water levels, current speeds, current direction, and observed morphological patterns in the area. The models applications provided the means to (1) understand the transport of sediments and formation of the shoals in the ICCW, (2) identify various alternatives that could reduce ICCW shoaling rates, and (3) evaluate the performance and the associated cost and frequency of maintenance dredging for alternatives that show potential to reduce the ICCW shoaling. Model results show flood slows as it flows south around the northern tip of Rattlesnake Island. This rapid decrease in flow velocity explains the observed sediment deposition (shoaling) in the ICWW. Model results also show sediment basins located in the north arm of Matanzas River and north of Fort Matanzas will likely reduce shoaling in the ICWW and reduce maintenance dredging from the current once every three years to once every four years.



MID- AND FAR-FIELD MODELLING OF THE OUTFALL PLUMES FOR THE ADELAIDE DESALINATION PLANT USING MIKE 3 (A056)

Andrew McCowan[1], Tim Womersley[1], Søren Andersen[2]

[1]*Water Technology Pty Ltd., Australia*
[2]*Technical University of Denmark, Denmark*

Presenter: Andrew McCowan – amc@watech.com.au

Keywords: desalination outfalls, negatively buoyant plumes, MIKE 3 FM modeling

The Adelaide Desalination Project is currently being constructed at Port Stanvac on the east coast of Gulf St Vincent, Australia. When complete, the reverse osmosis plant will produce up to 300 ML/day of freshwater to supplement the water supply to the city of Adelaide. As part of the environmental investigations for the project, full 3D modeling using MIKE 3 FM has been used to investigate the mid-field and far field performance of the outfall diffuser. The model domain covered an area of 20 km by 11.5 km, and was selected to ensure that it contained the area covered by the movement of the saline plume. It used the flexible-mesh system that allowed for a significantly increased resolution in the vicinity of the diffuser. The model mesh used triangular elements with length scales of around 1000m in outer areas, reducing down to a much finer 8 m quadrilateral mesh in the immediate vicinity of the diffuser. "Sigma" coordinates were used in the vertical, with 17 equal thickness layers giving a vertical mesh spacing of around 1m in the vicinity of the outfall. Boundary conditions were provided by a MIKE 21 model of the whole of Gulf St Vincent, and the model included the effects of tide, wind and long-period meteorologically derived water level variations. The locations and strengths of source points used to represent the main characteristics of the plumes from each of the discharge ports were derived from the results of a combination of physical and numerical near-field models.

Physical Jet Model results showing the relative locations of the source points (arrows) used to represent the near-field discharge characteristics in the mid-field model, with coupled sink points (circles) representing entrainment of accumulated brine from the lower layers of the model

INTERNAL WAVE CLIMATOLOGY ON THE AUSTRALIAN NORTH WEST SHELF (A044)

Paul Van Gastel[1], Michael J. Meuleners[1,2], Gregory N. Ivey[2], Oliver B. Fringer[3]

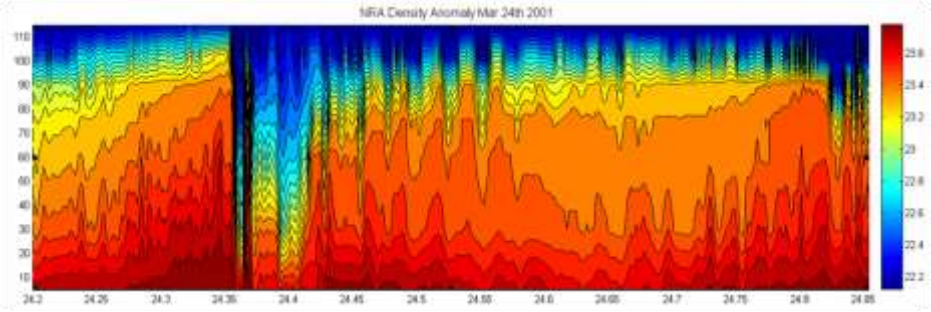
[1]*DHI Perth, Australia*
[2]*University of Western Australia*
[3]*Stanford University, USA*

Presenter: Michael Meuleners – mjm@dhigroup.com

Keywords: internal waves, tides, Baroclinic Energy Flux, Australian North West Shelf

Tidally induced internal waves are a dominant circulation feature on the Australian North West Shelf. These waves form due to the interaction of the strong barotropic tide with the complex and non-uniform bottom topography, and propagate shoreward along the thermocline. As these waves move inshore they steepen and may break creating strong near seabed currents which can affect the stability of submarine pipelines as well as being important for the marine ecology.

In this study, the results from a 4-month long field experiment at the North Rankin platform will be presented in which the character, duration and seasonal variability of internal wave events and associated bottom currents will be discussed. In order to understand the mechanism creating the energetic currents associated with internal waves observed at the North Rankin platform, the three-dimensional ROMS (Regional Ocean Modelling System) was applied to the region. The ROMS model was able to describe the tidal generation of internal wave events and examine their dynamics as they propagate towards the coast on the North West Shelf. The model output results are used to examine internal wave events over a much larger spatial scale than the field measurements in order to understand the generation, propagation and dissipation of internal waves on the North West Shelf.



TOWARDS AN ECOLAB MODEL FOR DETECTION OF TEMPERATURE, LIGHT AND SEDIMENT IMPACTS ON CORAL BIOMASS (A099)

T. Chiffings[1], K.E. Ulstrup[1,3], A. Erichsen[2], M. Jury[3]

[1]DHI Australia, [2]DHI Denmark,
[3]DHI Water & Environment (S) Pte Ltd., Singapore

Presenter: Tony Chiffings – twc@dhigroup.com

Keywords: corals, impact forecast, management, mitigation

Tropical reef-building corals (Scleractinia) provide goods and services for maintenance of ecosystem health and biodiversity. However, changes in coral health such as those resulting from temperature increases, light attenuation and sedimentation are mostly determined empirically making predictions of impact difficult. DHI's ECO Lab allows coupling of hydrodynamics, sediment transport and deposition as well as water quality impacts on ecological processes. A new ECO Lab template for corals is now available for impact assessment and management purposes and here we will present initial results from Singapore. The ECO Lab template presented is proposed to explain changes in coral biomass as a function of short-term disturbances from elevated temperature and/or suspended sediments.

The model includes autotrophic and heterotrophic production, respiration, as well as mucus and excretion release. These processes are forced by information on irradiance, temperature, concentration of suspended sediments and sedimentation rates. The model appeared successful at reproducing the observed changes to coral biomass following extensive dredging and reclamation projects in Singapore.

The model setup can be expanded and further customized to solve a variety of management problems on coral reefs including predictions of a range of sub-lethal coral indicators of impact to changes in for example water chemistry and presence of pollutants. As such, this model is potentially a strong tool for decision makers and managers to predict impact of environmental disturbances on corals, and to actively manage coastal construction activities and discharges to mitigate these impacts.



PARALLELIZATION OF THE FLEXIBLE MESH MODELLING SYSTEM WITH MPI (A030)

Ole R. Sørensen, Lars S. Sørensen, Jesper Carlson

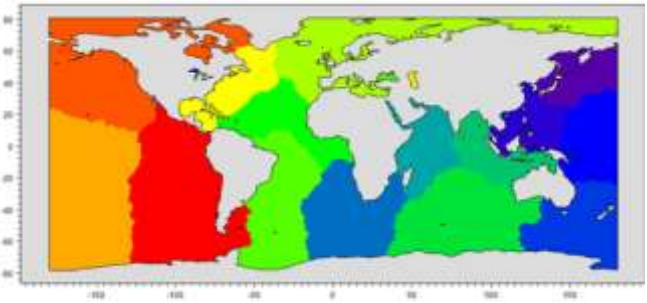
DHI Denmark

Presenter: Ole R. Sørensen – ors@dhigroup.com

Keywords: Message Passing Interface (MPI), domain decomposition, flexible mesh, High Performance Computing (HPC), distributed-memory

The demand on high-resolution and large-scale simulations and on the complexity of the numerical models is still increasing. To improve the performance of the most CPU intensive numerical engines, it is important to be able to utilize new technologies within High Performance Computing (HPC).The engines which are a part of the Flexible Mesh (FM) modelling system (MIKE 21/3 Flow Model FM and MIKE 21 Spectral Waves FM) have been parallelized based on the message passing paradigm and distributed-memory systems.

This new development makes it possible to utilize not only high-end laptop and desktop computers, but also massively parallel computers and clusters. For distributed-memory application the work and data must be distributed between the available processors. Here Message Passing Interface (MPI) is used for communication. The distribution of work and data is based on the domain decomposition concept. The computational mesh is partitioned into a number of sub-domains and the work for each sub-domain is processed by the individual processors. The data exchange between processors is based on the halo-layer approach with overlapping elements. To obtain an efficient parallelization it is important that the communication overhead is small compared to the computational work. Preliminary results show very good performance on small and medium-size clusters. Furthermore, the new approach shows improved scalability on shared-memory computers compared to the previous OpenMP based parallelization.



An example of a partitioning of a global mesh into 16 sub-domains

NUMERICAL WAVE MODELLING FOR A SEMI-ENCLOSED BAY WITH COMPLEX BATHYMETRY (A094)

Haiwen Zhang

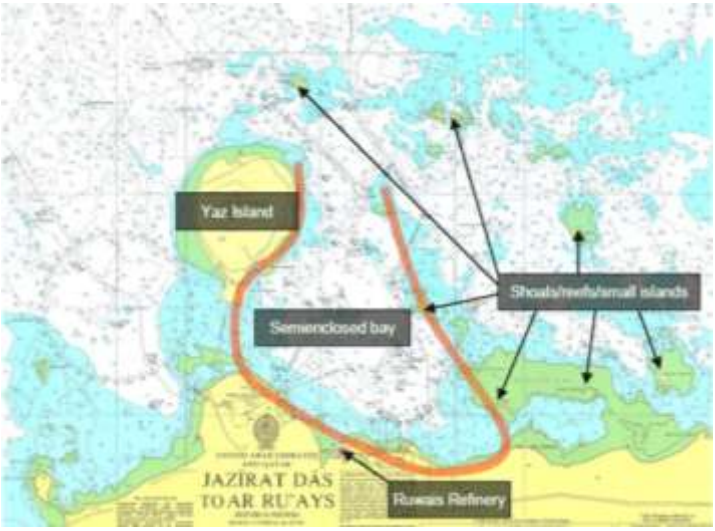
COWI, Denmark

Presenter: Haiwen Zhang - hazh@cowi.dk

Keywords: MIKE 21 wave modelling, United Arab Emirates

A numerical wave modelling study has been carried out to establish the near shore wave climate off the coast of Ruwais, United Arab Emirates (UAE). Though the site is located in an open sea coast, it is surrounded by reefs and islands on almost all directions see Fig.1 and hence considered a semi enclosed bay. The near shore wave climate is governed by both local wind seas within the bay and swells energy propagating from the offshore areas beyond the reefs.

The overall purpose of the study is to examine the near shore wave climate in these complex surroundings and to evaluate the performance of various numerical formulations available in the MIKE 21 SW module through comparisons to previous studies and site measurements.



Nearshore bathymetry off Ruwais (Sea Chart no. 3179)

APPLICATION OF MIKE 3/21 TO THE FEHMARN BELT (A145)

Jacob Tornfeld Sørensen, Ole Svenstrup Petersen, Ian Sehested Hansen

DHI Denmark

Presenter: Jacob Tornfeld Sørensen– jts@dhigroup.com

Keywords: MIKE 3 FM, EIA, Baltic Sea, oceanography, ecosystem

The use of unstructured models in marine planning has in recent year been increasing and is today part of many large infrastructure projects. The presentation will describe, what may be one of the most comprehensive coastal modeling applications today of the MIKE 3/21 modeling framework in one a very large bridge projects, the Fehmarn Belt, linking Denmark and Germany across the 20 km wide entrance to the Baltic Sea.

The focus of the modeling is to ensure a proper description of both the long term impact of the bridge on the Baltic sea environment, and to provide detailed impacts and design conditions for the construction. The modeling comprise 2D and 3D long term modeling of the impacts of the bridge pylons on the Baltic sea ecology, assessment of impacts on the sand transport affecting the seabed and waves and currents for design. The presentation will briefly describe the MIKE 3/21 models involved and the concept for how the modeling is integrated into the planning decisions. Emphasis will be on how the unstructured models are used to link the detailed design of bridge pylons to the long term (30 years or more) development of the Baltic ecosystem.

CELL ELEVEN WAVE, TIDE AND SEDIMENT STUDY (A90)

Darren Price[1], Mikkel Andersen[2], Brian Joyner[3], Nigel Pontee[4], Andy Parsons[5]

[1]*Halcrow Group Ltd., Manchester, UK;* [2]*Halcrow Group, New York, USA;* [3]*Halcrow Group, Tampa, USA*
[4]*Halcrow Group Ltd., Burderop Park, UK;* [5] *Halcrow Group Ltd., York, UK*

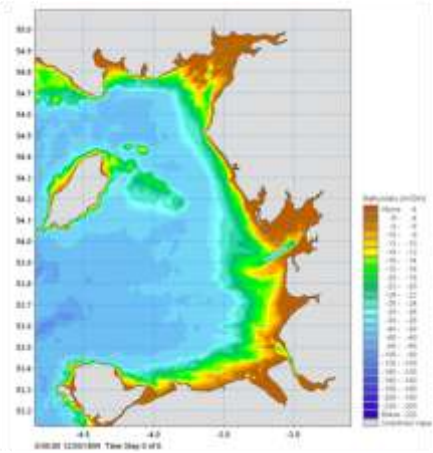
Presenter: Darren Price - pricedm@halcrow.com

Keywords: MIKE 21 FM, strategic management plans, flooding, erosion

This paper describes a programme of research specifically designed to support the development of strategic management plans, through an improved understanding of natural processes.

The research was commissioned to improve understanding of the coastal processes including tidal currents, water levels, waves and sediment transport in the Cell Eleven region, between the Great Ormes Head in North Wales, along the English coast to the Scottish Border. Large areas of land and thousands of properties are at risk of flooding or erosion. In many locations coastal defences depend upon extensive inter-tidal areas and there is presently uncertainty over future sedimentary process changes.

Numerical modelling studies were one way in which an improvement in our understanding of the coastal processes was undertaken. The studies included the Cell Eleven Tidal and Sediment Transport Study (CETaSS) and a Cell wide Joint Probability Study (JPS) for waves and water levels. The CETaSS work has involved the setting up and calibration of regional wave, hydrodynamic and sediment transport models using MIKE 21 FM. The data used and the calibration of these models will be discussed.



The results from the modelling are being used to help answer a range of uncertainties which include sediment pathways; linkages between offshore banks and beaches; role of surges in onshore sediment transport; and the response of inter-tidal areas and estuaries to sea level rise.

The paper will present the numerical modelling that has been undertaken and the key findings from this study.

THE IMPACT OF CDOM ON LIGHT TRANSPARENCY IN A DANISH LAGOON (A139)

Erik Kock Rasmussen[1], **Jens Würgler Hansen**[2]

[1]*DHI Denmark*
[2]*Environmental Centre Ringkøbing, Ministry of Environment, Ringkøbing, Denmark*

Presenter: Erik Kock Rasmussen – ekr@dhigroup.com

Keywords: CDOM, light transparency, lagoon, Ringkøbing Fjord, River Skjern, ecological model, MIKE 3

Ringkøbing Fjord is shallow lagoon, 280 km^2, with mean and maximum depth of 2 m and 5 m. The lagoon receives freshwater from a 3470 km^2 catchment mainly drained by River Skjern, and it is connected to the North Sea via a sluice. The retention time is 2-3 months. Strong westerly winds make the water turbid due to resuspension of fine sediment. This combined with phytoplankton and an elevated vertical background light extinction from yellow substance (CDOM) results in a relative low Secchi depth. In 1995 the sluice operation was changed allowing the salinity to increase from 5 PSU to 8 PSU in winter and from 8 to 14 PSU in summer. After 1995 the average summer Secchi depth increased from below 1 m to around 2 m, due to an invasion by the clam *Mya arenaria* which by filtration reduced the turbidity increasing the transparency. Model simulations of the Secchi depth with a constant background light extinction gave lower Secchi depth than measured during summer. It is known that "bleaching" of CDOM through photo oxidation in summer reduces the CDOM concentration. Therefore a seasonal background light absorption by the yellow substances was implemented in the model which increased the simulated summer secchi depth to measured level. This so far overseen feedback mechanism should be included when estimating future potential depth limits of vegetation in lagoons and fjords with a substantial input of riverine waters. The effect is positive when reducing turbidity and negative when increasing the turbidity.

COMPARISON OF FIELD MEASUREMENTS AND NUMERICAL SIMULATION OF HYDRODYNAMICS IN MUSA ESTUARY (A076)

S. Banisoltan[1], M.R. Kavianpour[1], H. Rahimipour[2]

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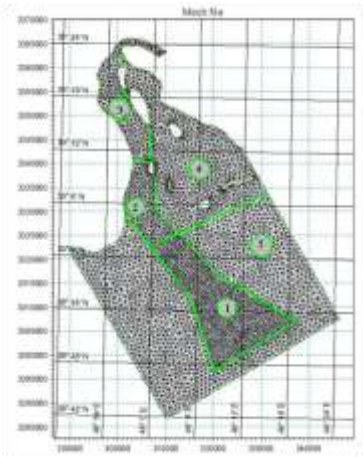
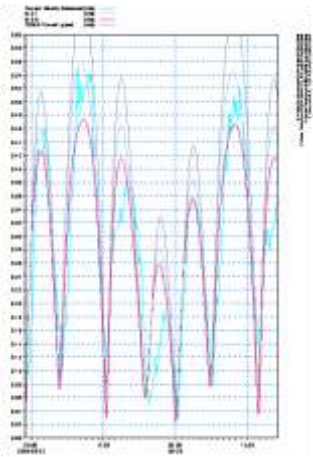
Presenter: Sahar Banisoltan- Sahar.banisoltan@gmail.com

Keywords: Musa Estuary, MIKE 3 Flow model FM, HD Module, sedimentation

Musa estuary is one of the main estuaries in south of Iran, which is always faces of sedimentation in its access channel. This has a significant impact on marine transport between the outside ports and the Imam Khomeini port in that area. Therefore, in this Study Mike 3 Flow model FM which is a modeling system based on a flexible mesh approach is applied. The hydrodynamic module is used in this research. In all preprocessing calculations, it was attempted to use field measurements. After sensitivity analysis and calibration process, long simulation was performed to study the hydrodynamic mechanism and its effects on sedimentation.

The result showed a reasonable agreement between the numerical result and those field measurements (such as current speed, current directions and water surface elevation). Vortex and its effect on sedimentation and the strong mixing tidal currents are remarkable results of this study. The result is compared with those of result which was previously performed with MIKE 21 Flow Mode in this area in Iranian Water Research Center.





BATHING WATER FORECAST FOR THE GENERAL PUBLIC COUPLING URBAN, RIVERINE AND COASTAL OPERATIONAL MODELLING OF BACTERIA (A020)

Dick Karlsson and Olof Liungman

DHI Sweden

Presenter: Olof Liungman – olof.liungman@dhi.se

Keywords: bathing water quality, forecast, faecal bacteria, operational modelling; MIKE 3, ECO Lab, web

The west coast of Sweden is well-known for its beautiful and numerous beaches. Tourism is of great importance to the local economy, and thus high-quality bathing water is paramount. Also, European and Swedish legislation requires municipalities to oversee the bathing water quality through continuous monitoring for various types of faecal bacteria.

Three municipalities contracted DHI to set up a bathing water forecasting system, available to the general public via the internet. This system combines several different models providing operational forecasts of the concentration of faecal bacteria. A high-resolution 3-D hydrodynamic model (MIKE 3 FM) of the coastal areas provides forecasts of currents, temperature, etc. This model is forced by a large-scale operational model of the seas surrounding Denmark and Sweden and atmospheric forecasts provided by a third-party supplier. The transport and decay due to mortality of faecal bacteria are modelled using a separate module (ECO Lab), which is forced by urban and rural sources of bacteria. Urban sources are calculated from forecasts of rain whereas river runoff is modelled using MIKE 11. The model outputs are post-processed and presented on a webpage using Google Maps technology in an easy to grasp format.

In this presentation the different parts of the system will be described and results will be presented.

WAVE MODELLING FOR WAVE FARM DEVELOPMENT (A106)

Sandra M. Lengden

Aquamarine Power, Scotland, United Kingdom

Presenter: Sandra M. Lengden - sandra.lengden@aquamarinepower.com

Keywords: Spectral Waves Modelling, Wave Energy Converter

Further to the installation of Aquamarine Power's prototype Oyster wave energy converter at the European Marine Energy Centre (EMEC) in Orkney, an additional 2.4MW demonstration project is under development. Phased installation of three next-generation Oyster devices will begin at EMEC in summer 2011.

There is a requirement for detailed and accurate wave modelling at the development site. Wave modelling informs the positioning of devices, projected power generation and estimated maintenance availability windows. As the Oyster device is a bottom hinged flap with fixed orientation, it is vital that the predominant wave direction is established at each location on site well in advance of installation, as any error in wave direction will reduce the power capture.

A detailed model of the near-shore wave climate at EMEC has been developed using MIKE 21 Spectral Waves. It has been forced by fully spectral measurements from a directional Waverider buoy in approximately 50m water depth, and calibrated and verified against an ADCP in 12m water depth. Directional Waverider data is available from 2003 to present, and the model has been run for six complete years.

Modelled results are in excellent agreement with verification data, giving a high degree of confidence in results.

MODELLING OF DISPERSION PATTERN OF HEAVY METALS FROM ENNORE CREEK, SOUTHEAST COAST OF INDIA (A025)

U. Natesan, A. Arun Babu, K. Deepthi

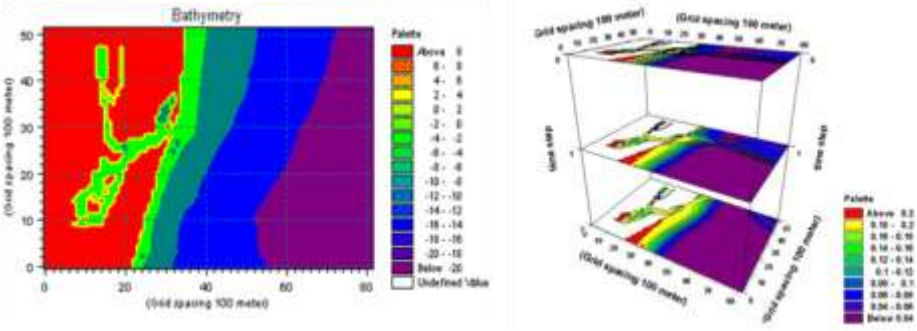
Anna University Chennai, Centre for Water Resources, Chennai, India

Presenter: Usha Natesan – u_natesan@yahoo.com

Keywords: dispersion, Ennore creek, Heavy metals, Hydrodynamics, MIKE 21 modelling

Numerical models provide a cost-effective method for evaluating hydrodynamics since they require limited data collection and may be utilized to numerically to assess a range of management alternatives. With the given rapid developmental activities during the past few decades along Ennore, southeast coast of India, there is a need to carefully evaluate the hydrodynamic and transport characteristics of the tidally influenced creek. MIKE 21 Flow Model was used to simulate the dispersion pattern of heavy metals - Ar, Cd, Cu, Fe, Pb, Ni and Zn along Ennore. Heavy metal concentration was analysed using argon gas in ICP – AES.

Zinc is present in higher concentration (0.612ppm) compared to other metals present (Fe 0.4852ppm, Ar 0.198ppm, Cr 0.159ppm, Cd 0.12ppm, Pb 0.065ppm and Ni 0.054ppm). Only Arsenic is found to be occurring in concentrations higher (0.201ppm) than the permissible limit (0.2ppm). Dispersion pattern depicts Minimum Concentration of metals in the Creek always during Ebbing conditions. Hence, it can be concluded that it is safer to discharge the pollutants from creek during ebb tides for better mixing and dispersion of pollutants. Dispersion pattern also sketches that the majority of the heavy metals are likely to be present within 1.5km from Ennore mouth after which there is a steady decline in their concentration and reaches BDL in some cases.



Slice plot variations in Arsenic concentration

WHAT´S NEW IN RELEASE 2011 COAST & SEA SOFTWARE?

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WHAT'S NEW IN RELEASE 2011 IN THE WATER RESOURCES SOFTWARE? (A144)

Børge Storm

DHI Denmark

Presenter: Børge Storm – brs@dhigroup.com

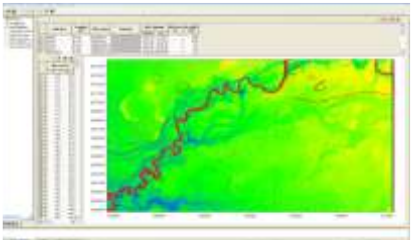
Keywords: Release 2011, MIKE 11, MIKE FLOOD, MIKE SHE, MIKE BASIN, MIKE 21C

The 2011 release of the Water Resources products: MIKE 11, MIKE FLOOD, MIKE SHE, MIKE BASIN and MIKE 21C has focused on faster computations, allowing larger models, and a large number of workflow improvements and new features proposed by the users.

In MIKE FLOOD the workflow has been improved by a better and enlarged graphical view for the river-floodplain processing, and more direct access to Bathymetry and Cross sections editors. MIKE FLOOD now also offer a new semi-implicit coupling scheme between river and the 2D floodplain flow exchange allowing larger time steps, which often has been the limiting factor in the simulation time step. New options for levee calculations have been introduced including time-varying levee heights.

MIKE 11 has also undergone a number of improvements based on user proposals, which enhance the work flow. Several major developments are currently under way in MIKE 11, which will not be part of the 2011 release, but will give a major jump in connection with the first release of the MIKE HYDRO in 2012, where MIKE 11 will be the first product to be ported to the MIKE HYDRO product.

MIKE SHE users will experience new opportunities with respect to computational speed and model size, as MIKE SHE engine has been modified for 64-bit memory and the individual components of MIKE SHE has been parallelized. Furthermore, the AUTOCAL tool has been developed for multi-core PCs, allowing users to run parameter estimation and uncertainty analysis with AUTOCAL taking advantage of multiple cores. In addition, ECO Lab is now available for MIKE SHE, which provides new opportunity for water quality in catchments and eco-hydrology.



Improved graphical working environment in MIKE FLOOD

MIKE BASIN is now offering a complete Irrigation module for crop water demand and crop yield assessments as part of river basin planning.

USABILITY ENHANCEMENT FEATURES IN MIKE FLOOD (A143)

Johan Hartnack[1], Torben Strange Jensen[1], Julie Landrein[1]

DHI Denmark

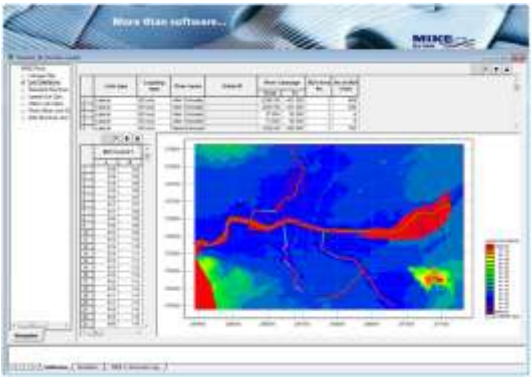
Presenter: Torben Strange Jensen – tsj@dhigroup.com

Keywords: MIKE FLOOD, usability enhancements, performance improvements, new features

MIKE FLOOD has over the past years gone through a number of developments with the primary focus on improvements of the flexibility and available options for applying and linking models through the MIKE FLOOD interface. Through these past developments, the applicability of MIKE FLOOD has been increased significantly and now covers a large variety of project types. Consequently, this has also increased the need for complementary developments tailored towards improved usability for users of MIKE FLOOD.

Developments for MIKE FLOOD Release 2011 have focussed primarily on the aspects of enhanced usability and improved model stability and performance, and a number of new or improved features have been implemented as part of the enhancements development project. An incomplete list of enhanced features comprises multi-link editing of parameters, direct access to cross sections and bathymetry data, side-structures as a new link-option, time-dependent levees for lateral links, GUI optimisation, search facility in link pages, semi-implicit coupling for improved stability, and others.

The technical session will present in more detail the range of features implemented as part of the Enhancement project for MIKE FLOOD Release 2011.



MIKE FLOOD Enhancements: Example of revised GUI for model linkages

BRIDGING THE GAP BETWEEN CAD AND THE MODELLING WORLD (A098)

Gregor Petkovšek

CGS Plus, Slovenia

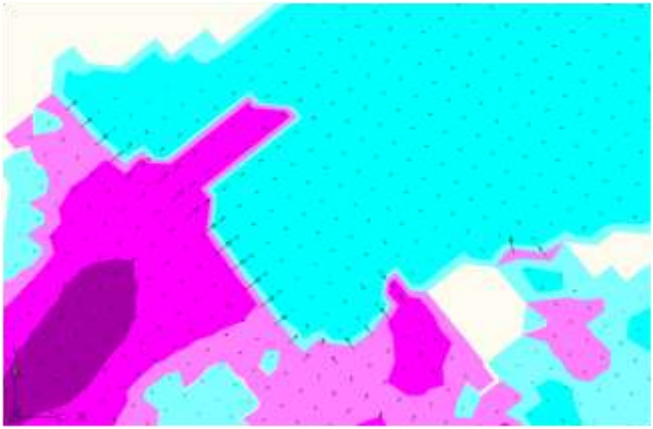
Presenter: **Gregor Petkovšek –** gregor.petkovsek@cgsplus.si

Keywords: AutoCAD, MIKE 11, MIKE 21, MIKE URBAN, AQUATERRA

The consultant companies often have to face the problem of different tools being used in a life cycle of a project. In the design phase, the engineers typically make use of CAD tools, while modellers often expect the input data coming from a GIS package, which in turn is also most likely to be used in the maintenance phase and by the authorities. The process of converting the data does not only mean the loss in time and productivity, but can also lead to errors in data and consequently in the errors in the modelled results.

In this paper, we present an automated transfer of the data between the most popular CAD program called AutoCAD and the MIKE 11, MIKE 21 and MIKE URBAN products. The transfer can be done on several levels, starting with the MIKE2CAD tools that allow simple exporting of the data from MIKE models to the AutoCAD environment, to the more advanced set of the interfaces that form a part of the AQUATERRA, a software suite for the canal and river works design. These allow for both import and export of the data.

An overview of software products, concepts and examples of application are given in the paper.



WHAT'S NEW IN RELEASE 2011 IN THE COAST & SEA SOFTWARE?

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CALIBRATING VADOSE ZONE MODELS WITH TIME-LAPSE GRAVITY DATA: INTRODUCING A NEW TYPE OF CALIBRATION DATA (A053)

Lars Christiansen[1], Allan B. Hansen[2], Majken C. Looms[3], Eline B. Haarder[3], Philip J. Binning[1], Dan Rosbjerg[1], Ole B. Andersen[4], Peter Bauer-Gottwein[1]

[1]*DTU Environment, Denmark*
[2]*Niels Bohr Institute, University of Copenhagen, Denmark*
[3]*Department of Geography and Geology, University of Copenhagen, Denmark*
[4]*DTU Space, Denmark*

Presenter: Lars Christiansen – lac@env.dtu.dk

Keywords: vadose zone, model calibration, time-lapse gravity

A change in soil water content is a change in mass stored in the subsurface, and when large enough, can be measured with a gravity meter. Over the last few decades there has been increased use of ground-based time-lapse gravity measurements to infer hydro-geological parameters. These studies have focused on the saturated zone, with specific yield as the most prominent target parameter and with few exceptions, changes in storage in the vadose zone have been considered as noise. Here modelling results are presented showing that gravity changes will be measureable when soil moisture changes occur in the unsaturated zone. These results are confirmed by field measurements of gravity and georadar data at a forced infiltration experiment conducted over 14 days on a grassland area of 10 m by 10 m.

An unsaturated zone infiltration model built in MIKE SHE is calibrated using the gravity data with good agreement to the field data. The potential for gravity data to be used for the calibration of unsaturated zone model parameters is discussed.

NEW TRENDS IN REMOTE SENSING OF WATER AND ENVIRONMENT (A075)

Mikael Kamp Sørensen

GRAS, Denmark

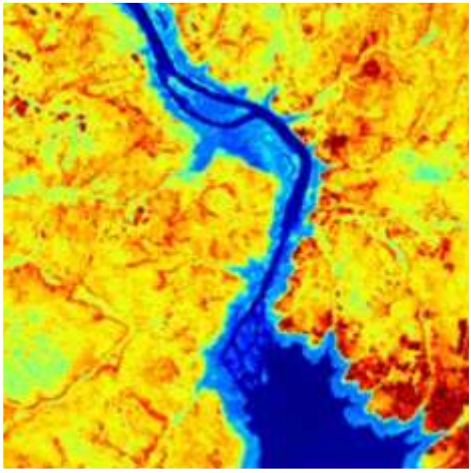
Presenter: Mikael Kamp Sørensen – mks@dhigroup.com

Keywords: remote sensing, satellite images, data assimilation, mapping

The availability and quality of satellite images has been increasing rapidly for decades. With repetitive and synoptic coverage of the entire planet and with archives going more than 40 years back in time remote sensing is a tool valuable technology for model calibration.

The presentation will outline some of the most important new trends in the use of earth observation data that are relevant for modeling of water and environment. This includes the latest generation of very high resolution satellites with increased accuracy within bathymetric and topographic mapping and extraction of surface imperviousness for urban storm water management. Time series of images can be used to detect changes in land use, coastlines, rivers, glaciers and other land features that are important to indicate the dynamics of a certain area.

New satellite sensors are also available to support near real time applications providing daily or even hourly updates of dynamic features such as surface temperatures, suspended sediment, chlorophyll and precipitation. Using data assimilation methods, satellite based information can be integrated directly into models.



The presentation will also present state-of-the-art methodologies for extracting the relevant thematic information from images. This conversion from raw satellite imagery to processed GIS layers enables the use of earth observation data in DHI software.

COMPLEX MONITORING OF THE COLLECTION SYSTEM OF THE CITY OF PRAGUE (A120)

Petr Sykora[1], Milan Suchanek[2], Laurent Solliec[3]

[1]PVK a.s.Czech Republic, [2]DHI a.s. Czech Republic, [3]NIVUS GmbH Germany

Presenter: Petr Sykora – petr.sykora@pvk.cz

Keywords: monitoring system, flow meters, raingauges, SCADA, data processing

Prague, the capitol of the Czech Republic, has approx. 1,2 mil inhabitants. The sewer network is mostly combined and only in the suburb areas some parts of the network were designed as a separate system. Wastewater is taken to CWWTP in two levels: trunk sewer A, C, K, F – high horizon and B, D, E – low horizon. The drainage area of Prague represents more than 500 km^2. The total length of the sewer network is about 3 750 km and it includes 144 CSO structures, 20 siphons and 292 pumping stations. Managing of the system requires a lot of information measured on site. In 1993 it was decided to establish a permanent monitoring system at main sewers in order to measure flow characteristics at the main trunks of the sewers. Since 1998 the area has been covered by a network of tipping-bucket rain gauges, at present the network includes 23 stations. In parallel of permanent sites a lot of short term campaigns are executed with different goals e.g. CSO behaviour, wastewater producers control, infiltration detection, waste water quality etc.. All measurements produce large amount of data. The SCADA system, using on radio telemetry, collects the data from permanent sites. Data from short campaigns are usually downloaded directly from devices during site visits. The data collected from devices are finally processed and stored in Gandalf (software).
The data are used for many purposes such as operational analyses of the sewer behaviour during storm events, studies, urban drainage mater plans, mathematical models calibrations etc. Details of current monitoring system, experiences collected during years and potential system extension will be discussed in presentation.

Technical drawings, picture and SCADA screenshot of one of permanent flow sites on Prague sewer network.

WHAT'S NEW IN RELEASE 2011 IN THE URBAN SOFTWARE?

Morten Rungø

DHI Denmark

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MIKE URBAN RADAR TOOL – A STRAIGHTFORWARD SOLUTION FOR INTEGRATING HIGH RESOLUTION RADAR DATA (A014)

A. P. Sloth, L. Pedersen, N. E. Jensen

DHI Århus, Denmark

Presenter: Anders Peter Sloth – aps@dhigroup.com

Keywords: MIKE URBAN, radar rainfall, urban runoff, hydrological modelling

Urban hydrological models have become increasingly spatially detailed with the introduction of geographical information systems. Unfortunately, a lot of this spatial information is lost since the primary source of rainfall input still is uniformly applied over either the whole model domain or sub-domains depending on the number of rain gauges available. In order to perform distributed modelling, distributed rainfall data in the same resolution as the model data must be applied. Traditional rain gauges cannot provide such information, but weather radars can. Radar data offers spatial information on the rainfall patterns that are not available with traditional rain gauges. In order to facilitate the use of radar data as input to hydrological models a new tool for MIKE uRBAN has been developed.

The major challenge when introducing radar data into hydrological modelling is that instead of having a limited number of time series representing rain gauges, you now have a time series of radar images consisting of thousands of pixels each representing an area of average rainfall intensity. This work focuses on the methods used for converting radar data into valid MIKE URBAN boundary items along with functionality for using and viewing radar data.

CITYLAB - A HOLISTIC PLANNING TOOL FOR THE URBAN WATER CYCLE (A134)

Lars Christian Larsen

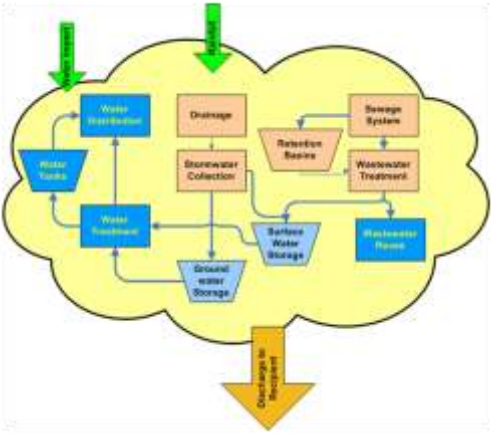
DHI Singapore

Presenter: Lars Christian Larsen - lcl@dhigroup.com

Keywords: hydroinformatics, urban water cycle, energy footprint

Today's standard for water infrastructure planning goes well beyond the mere delivery and removal of water in the needed quantities and quality. A considerable number of other factors need to be taken into account in the planning process. Obviously, economic factors are important, but also environmental sustainability of both water sources and receiving waters must be evaluated. Newer requirements, to account for energy efficiency, CO2 emissions and climate changes, all add to the complexity of the planning process and its decision-making.

This paper describes a possible new MIKE by DHI product in the pipeline meant to complement the existing product suite of urban applications. The product called CityLab includes the application of advanced hydroinformatics tools and decision support systems to assist in the holistic planning process for new urban development as well as major restructuring/renovation of existing systems. The tools take a top-down approach to evaluating different scenarios to test consequences of proposed solutions. The basis is a simple engine that can be utilized with very little data, gradually solutions can be fully or partly expanded with details until a complete set of networks is developed.



WHAT'S NEW IN RELEASE 2011 IN THE WATER RESOURCES SOFTWARE? (A144)

Børge Storm

DHI Denmark

Presenter: Børge Storm – brs@dhigroup.com

Keywords: Release 2011, MIKE 11, MIKE FLOOD, MIKE SHE, MIKE BASIN, MIKE 21C

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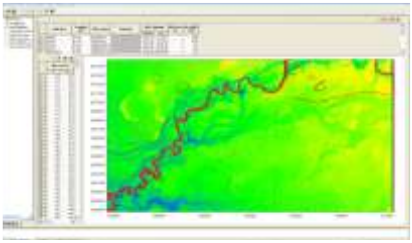

Improved graphical working environment in MIKE FLOOD

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3D MODELLING OF BRINE FLOW USING FEFLOW (A146)

Wolfram Rühaak

DHI-WASY, Germany

Presenter: Wolfram Rühaak – W.Ruehaak@dhi-wasy.de

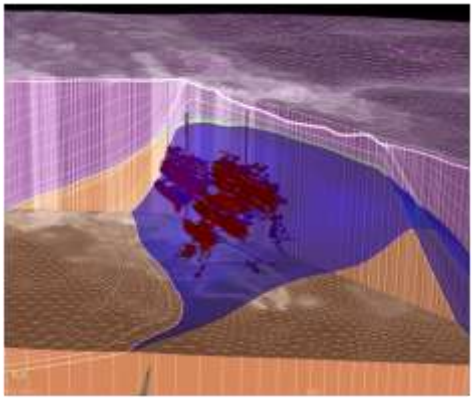
Keywords: FEFLOW, hydrogeology, mass-transport modelling, reactive transport, mine-water

An abandoned and flooded historical salt mine located in Stassfurt (Germany) is studied within a joint research project. The objective of this project is to gain a better understanding of the dynamics of naturally or actively flooded salt mines. Within this survey the stability of the salt mine and the surrounding caprocks is studied. One task within this research framework is the computation of different 3D groundwater transport models. Aim of these models is to improve the understanding of the impact of different remedial engineering solutions. For instance, it is studied which amount of salt will be dissolved due to pumping activities. Subsequently, the related potential of subsidence effects is assessed.

A further challenge is the analysis of effects of the underground cavities on the groundwater and mass-transport dynamics. Detailed geometry of the mine workings is included in 3D model schematizations.

Chemical reaction kinetics is also considered, where NaCl and $MgCl_2$ are the dominant salt species. Precipitation and dissolution are controlled by the amount of available $MgCl_2$. The consideration of these different salt types can be of importance as they possess different specific densities. Furthermore, permeability and porosity are also affected by precipitation and dissolution.

The modeling of such a complex scenario has become easier due to the availability of the new FEFLOW 6 with its powerful graphical user interface and extended 3D capabilities.



A MULTI-GRID APPROACH FOR EMBEDDING HIGH RESOLUTION TOPOGRAPHY IN A 2D SURFACE WATER MODEL (A142)

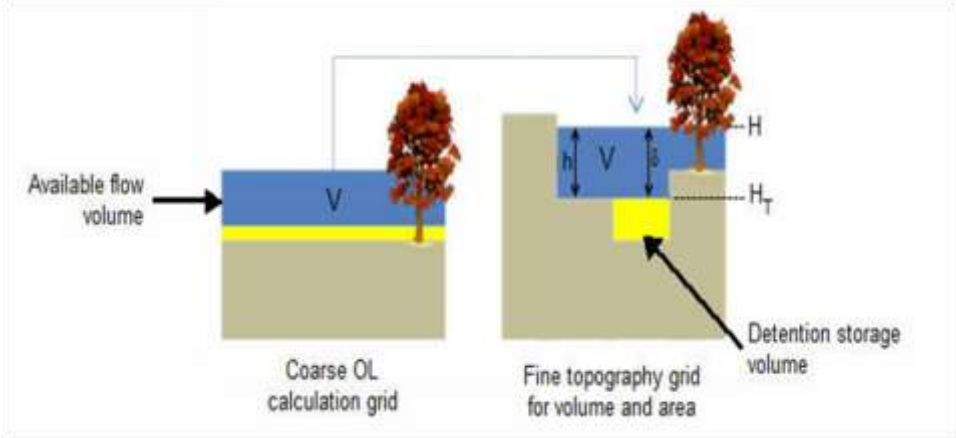
Johan Hartnack[1], Riccardo Corá[1], Douglas Graham[1], Marcelo Lago[2]

[1]DHI Denmark, [2]DHI USA

Presenter: Douglas Graham - dng@dhigroup.com

Keywords: MIKE SHE, multi-grid, fine-scale DEM, 2D flooding

Modern surveying technology is rapidly increasing the availability of very high resolution spatial data. Fine scale spatial data would seem ideal for 2D overland flow modelling. However, surface water modelling at such high resolutions is often impractical due to the long run-times. Thus, the choice of cell size becomes a compromise between feasibility and accuracy. To realise the benefit of high resolution topographic data without serious impacts on runtimes, we have developed a solution technique for MIKE SHE that embeds the detailed topography data into the coefficients of the St Venant equations for 2D surface water flow (diffusive wave). The flow equations are solved on a coarse numerical grid and the results mapped back onto the detailed topography grid. This leads to results that are similar to those obtained at a very fine scale − at a fraction of the run time − with improved estimates of infiltration, evaporation, and groundwater-surface water interaction.



WHAT'S NEW IN RELEASE 2011 IN THE URBAN SOFTWARE?

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SEAMLESS INTEGRATION OF MIKE URBAN WITH A PROFESSIONAL WEB AND DESKTOP BASED SEWAGE AND WATER UTILITIES APPLICATION (A045)

Matthias Egli[1], Ralf Engels[2], Pascal Megert[1]

[1]GEOCOM Informatik AG, Switzerland
[2]DHI-WASY GmbH, Germany

Presenter: Matthias Egli – matthias.egli@geocom.ch

Keywords: MIKE URBAN, GEONIS expert, sewage and water utilities management, Isybau, system integration, ESRI, ArcGIS, web

The integration of hydraulic models and professional GIS applications for utilities becomes increasingly important. GEONIS expert is a GIS framework for the desktop, server and web platforms, and allows the development of professional applications, among others, for sewage, water and gas management. Based on the widely used ArcGIS platform, MIKE URBAN was integrated with GEONIS expert sewage.

Pipe, damage and hydraulic data are initially created in the GIS environment using GEONIS expert sewage, either through the desktop or web interface. Additionally, as an example for an alternative workflow, data can be imported from standardized formats such as the German isybau XML format. Data used for hydraulic calculations is exchanged to MIKE URBAN using a special interface within the standard Import/Export functionality of MIKE URBAN. The results of the hydraulic calculations are then stored as statistics in the MIKE URBAN database, from where they are written back to the GEONIS expert sewage application. The results can now be visualized and used for additional analyses and processing (damage with integrated video, asset management, profiles…).

In addition, due to the integration of the desktop and web interface in GEONIS, reports, hydraulic maps, easy search interfaces, etc are available automatically for a wide public not only on the desktop, but also through a web interface. The integration of these two products has become a standard for users of both the MIKE URBAN and the GEONIS platform.

BUILDING AND MAINTAINING NETWORK MODELS IN MIKE URBAN (P148)

Gunvor Tychsen Philip

DHI Denmark

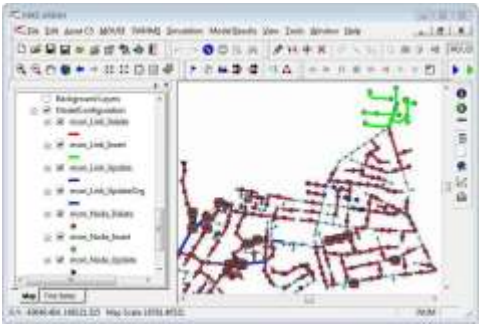
Presenter: Gunvor Tychsen Philip – gtp@dhigroup.com

Keywords: Model update, Model Configuration, Simplification, Result verification, MIKE URBAN

Often models are created through an import from an asset system, modified by modellers and calibrated based on the information in the asset system at the time of import. As asset systems are continuously extended and updated it is a challenge to ensure that also the models stay updated with new available information and to know the consequence for e.g. previously calibrations.

A new set of tools in MIKE URBAN targets this challenge. Through a workflow models can be regularly updated to include updates in the asset system. The tools help modellers to re-apply model specific changes, calibration parameters etc, view conflicts between updates in the asset system and updates by the modeller. Modifications are viewed visually and reports are generated to identify the impact on model results.

Working with large systems it is often unnecessary to include full details in the entire system when working on a localized problem. Depending on the area of interest different parts should be either detailed or simplified. A new tool enables the user to extract a model where only user specified areas are detailed and other areas are simplified.



Example of a visualization of a model configuration in MIKE URBAN

CLIMATE CHANGE TOOLS IN MIKE SOFTWARE (A138)

Jørgen Bo Nielsen and Morten Rungø

DHI Denmark

Presenters: Jørgen Bo Nielsen / Morten Rungø – jni@dhigroup.com / mor@dhigroup.com

Keywords: MIKE Products, Release 2011, Climate Change "button"

Climate change is a reality and it is hitting us through the water first.

We need to adapt our societies to increased frequency and intensity of precipitation – or the opposite. We also need to adapt to more severe storms and changes is sea levels and sea temperatures. We are starting to see the consequences of climate change in terms of increased frequency and intensity of floods and droughts, more extreme waves as well as changes in our ecosystems.

Decision makers around the world rely on water professionals to provide the best possible advice on how we can adapt to climate change in the safest and most cost effective way. Modelling can help us live up to their expectations – by enabling us to assess the most likely consequences of climate change as well as to test a range of engineering solutions in order to compare and select those that are the most efficient and cost effective.

With release 2011 the key MIKE products are equipped with a new Climate Change "button", which allows MIKE users to quickly change the boundary conditions of an existing model – based on results from recognized Global Circulation Models – so that the new boundary conditions correspond to a user selected climate scenario and a given year in the future. The new feature allows MIKE users to quickly and consistently screen a wide range of scenarios and use the results in assessment studies as well as in studies aiming at climate proofing of infrastructure.

The presentation provides details on how the new Climate Change "Button" has been implemented and how it is applied.

WEB-BASED CLIMATE DSS FOR DECISION MAKERS AND STAKEHOLDERS (A137)

Michael Butts[1], Mario T. de Sales[1], Truong Thanh Trung[2], Xue Lei[2], Veradej Phipatanasuphorn[2], Jacob Høst-Madsen[1]

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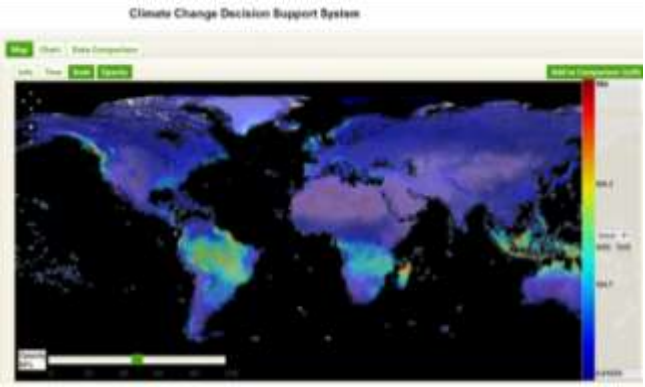
Presenter: Michael Butts - mib@dhigroup.com

Keywords: climate change, decision support systems, adaptation, uncertainty

While climate change impacts will obviously affect many sectors, the relationship between climate change and water is one of the most crucial for our society and for a wide variety of ecosystems. Climate change adaptation is about reducing the risks and costs (and exploiting possible benefits) from climate change and climate variability. The challenge for decision-makers and stakeholders in the water sector is to understand these climate change changes, to determine where and how regions and sectors are vulnerable and to implement appropriate adaptation measures.

To facilitate these processes a web-based decision support tool for climate change applications has been developed. The motivation in developing this tool is the need to provide the relevant information about climate change, climate vulnerability and the impacts of adaptation measures in a way that can be easily understood by policy-makers, decision-makers and stakeholders. A web–based approach was adopted as this provides an intuitive and easy-to-use presentation of data that can be accessed by a wide variety of users at different geographical locations. Powerful mapping and graphics allow climate information to be easily communicated among stakeholders and decision-makers. The system is illustrated using recent climate change projects carried out by DHI.



USING MIKE URBAN FLOOD FOR THE DESIGN OF MULTIFUNCTIONAL LAND USAGE IN MAJOR CITIES (A046)

Marko Siekmann, Nina Vomberg, Johannes Pinnekamp

RWTH Aachen University, Institute of Environmental Engineering, Aachen, Germany

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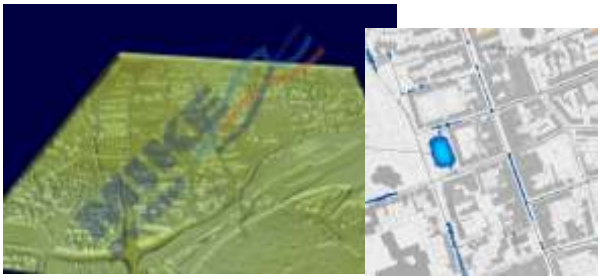
Keywords: climate change, urban flooding, adaptation, multifunctional land use

The proposed approach presents an assessment of problems caused by global warming in highly industrialised regions: increasing storm water intensities, demographic changes and migration. In order to distinguish this approach from already applied methods of "integrated water management" we have chosen an enhanced procedure of a water sensitive urban design (WSUD). In the future, the runoff following extreme rainfall events cannot be drained into the centralised sewage system. Even if such events occur more frequently in the future, the upgrading of the sewerage system will not be economically sensible. Therefore, as a first step runoff should be reduced through the construction of decentralised infiltration and retention facilities. Additionally, in order to cope with extreme rainfall, a controlled discharge of the storm water runoff across the surface is required. Buildings and infrastructure in the cities shall be protected from being flooded by intentional flooding of streets and public squares, where streets act as emergency flood paths. In addition to the above described controlled discharge, decentralised retention facilities are expected to limit the consequences of overflows.

The required storage capacity should be implemented in the environment, e. g. as water squares. The potential and the chances of such a multifunctional land usage in highly industrialised and highly populated regions are demonstrated by means of a 1D/2D modelling through MIKE URBAN FLOOD programme. It has been shown, that the controlled flooding of public parks or public squares facilitates the adaptation of the urban infrastructure to the consequences of climate change.



The presented results are part of the research project "*Wassersensible Stadtentwicklung*" funded by the federal ministry of education and research of Germany (BMBF).

CLIMATE CHANGE RISK ASSESSMENT FOR NORTHERN ZEALAND AND DETAILED ANALYSIS OF CLIMATE CHANGE ADAPTATION MEASURES FOR COPENHAGEN (A136)

Arne Bernt Hasling

COWI, Denmark

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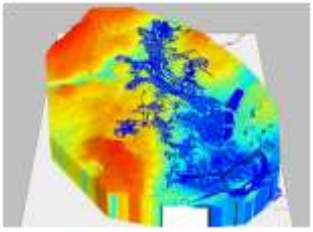
Keywords: Climate change adaptation, climate change risk assessment, adaptation measures, flooding, rising sea level, Copenhagen Climate Plan, climate resilient metro, GIS, MIKE Flood, Digital Height Models, DTM, DSM

Regional level: Climate change risk assessment and adaptation plan for Northern Zealand and Bornholm, based on climate scenarios, modelling of likelihood and consequences as flooding from sea, flooding from storm water, groundwater change, economical and environmental value of areas affected by climate change and extreme weather conditions. Workshops with stakeholders and climate experts for establishment of an innovative overall climate change adaptation master plan for the whole region of Northern Zealand incl. guidelines and catalogue for adaptation measures.

Municipal level: Very detailed dynamic analysis of flooding from rising sea level and heavy intense rain in Copenhagen Municipality. Suggestions for dams, dikes, sluices, diversion canals etc to protect the city from flooding from storm surge and heavy rain. Economical analysis of consequences and adaptation measures based on advanced statistical evaluations of the economical feasibility of adaptation measures. MIKE-Flood was used for the hydraulic modelling and advanced GIS applications were used for the illustrations and evaluation of consequences.

Project level: Design criteria and suggestions of climate change adaptation for the new metro, Cityringen in Copenhagen. Evaluate trend in rainfall, sea level, storm surge and waves and statistics for the present and future situation in accordance with different IPCC scenarios. Modelling the flooding, surface runoff and high water levels for different scenarios and detailed evaluation of all risks and identify the critical design levels for all openings to the metro (stations, ventilation shafts etc.)



Regional climate change risk assessment; Flooding in larger areas; Adaptation by increased level

CLIMATE CHANGE IMPACT ASSESSMENT OF WATER RESOURCES IN NORTH-EAST ZEALAND, DENMARK COMPARISON OF STATISTICAL DOWNSCALING METHODS (A069)

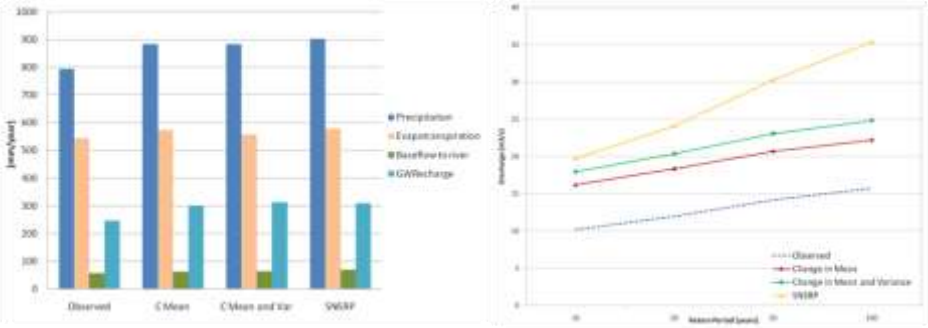
Henrik Madsen, Maria A. Sunyer, Keiko Yamagata

DHI Denmark

Presenter: Maria A. Sunyer – mpi@dhigroup.com

Keywords: climate change, downscaling, impact assessment, hydrological modelling

The study considers climate change impacts on the water resources in the North-Eastern part of Sealand, Denmark. Regional climate model (RCM) simulations performed as part of the ENSEMBLES project based on the IPCC SRES scenario A1B are used in the analysis. Three different statistical downscaling procedures are applied to downscale precipitation, temperature and potential evapotranspiration from the RCM. These include: (i) mean correction (often referred to as the delta change method), (ii) mean and variance correction, and (iii) a stochastic weather generator based on the Neyman-Scott rectangular pulse model. The downscaled climate data are used as forcing to a MIKE SHE integrated hydrological model of the region for analysing the impacts of climate change in relation to (i) regional and sub-catchment water balance components, (ii) droughts and low flow conditions, and (iii) high flows and flooding.



Main components of the water balance (left) and annual maximum discharge (right) in the Langvad river catchment, for the observed period and for the future scenario using each of the downscaling methods: change in mean (C Mean), change in mean and variance (C Mean and Var) and the SNSRP model (left)

ASSESSING CLIMATE CHANGE IMPACTS ON INFLOWS TO THE HIGH ASWAN DAM USING AN ENSEMBLE OF REGIONAL CLIMATE MODEL SIMULATIONS (A074)

Carlo Buontempo[1], Mohamed Ezzat Elshamy[2], Jens Kristian Lørup[3], Richard Jones[1], Mohamed Ahmed Hassan[2], Michael Butts[3], Richard Betts[1], Erika Palin[1], Michael Sanderson[1], Rachel McCarthy[1]

[1]Met Office Hadley Centre, United Kingdom
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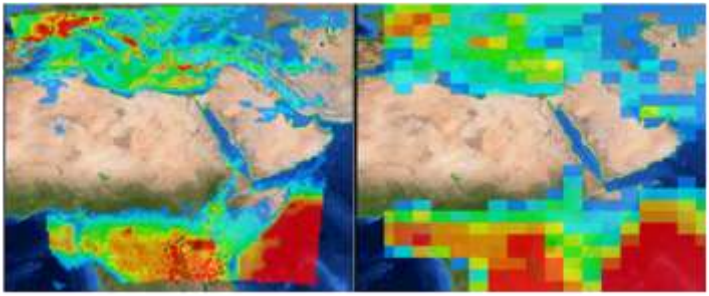
Presenter: Carlo Buontempo - carlo.buontempo@metoffice.gov.uk

Keywords: climate change, Nile Basin, ensemble climate models, uncertainty

The Nile River Basin, one of the longest rivers in the world and shared by 10 river basin countries (Burundi, the Democratic Republic of Congo (DRC), Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda), is the main source of water in the North Eastern region of Africa. This basin represents one of the most critical and important shared water basins in Africa. Therefore a proper understanding of the potential impacts on climate change is essential to the region. One of the most important challenges in assessing these impacts is how to address the inherent uncertainties in climate projections.

This paper presents a study, funded by the Spanish Government through UNEP Risø Centre and carried out in close collaboration between the Ministry of Water Resources and Irrigation in Egypt, Met Office Hadley Centre in the UK and DHI, that aims at assessing the potential impacts of climate change on the Nile River flow and in particular the inflow to the High Aswan Dam. The approach used here is to carry out a number of simulations using the PRECIS regional climate model to downscale several variants of the HadCM3 GCM model incorporating different representations of atmospheric physical processes. The Nile Forecast System (NFS) is then used to map the climate projections into changes in the river flows. The methodology and results from the RCM and NSF simulations will be presented together with preliminary results showing the impacts on inflows to the High Aswan Dam focussing on the important Blue Nile River.



MODELLING POTENTIAL CLIMATE CHANGE IMPACTS IN TWO GREEK LAKES (A029)

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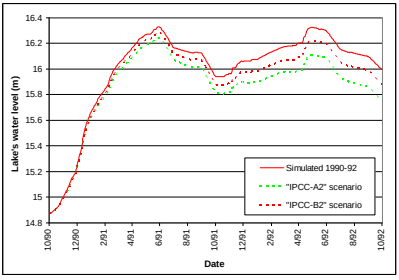
Hellenic Centre for Marine Research, Institute of Inland Waters, Greece

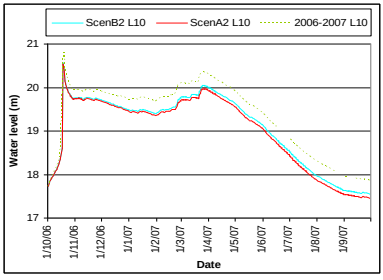
Presenter: Elias Dimitriou - elias@ath.hcmr.gr

Keywords: climate change, water balance, Kourna Lake, Trichonis, Mediterranean lakes

The influence of climate change scenarios on the water budget of two Greek Lakes (Trichonis and Kourna), have been quantitatively explored by using a physically-based, semi-distributed basin model (MIKE SHE). A water balance model was also set up to estimate net groundwater inflows for the two lakes and the respective basins. The water balance estimates and GIS tools were then used to set up the physically-based model. Calibration of the mathematical model was very good, while for the physically based model calibration was satisfactory. The model was then setup and simulated for two future IPCC scenarios (A2 – pessimistic scenario and B2 -more optimistic), which involved temperature/evaporation/evapotranspiration increase and small precipitation decrease. The modelled response of Trichonis lake water level indicated an average annual decrease of 24.2cm for scenario A2 and 12 cm for scenario B2 while the response of Kourna Lake water levels demonstrated a decrease of more than 40 cm for scenario A2 and more than 30 cm for scenario B2. These changes are not considered very large but in combination with higher water abstractions from the particular water bodies due to increasing demands can create important hydro-ecological problems. Therefore, water management mitigation measures should be designed and applied to minimize progressively these potential changes and the associated impacts on the riparian ecosystems.



Simulated water level fluctuation in 1990-1992 compared to water level fluctuation for two IPCC climate scenarios



Comparison of simulated Lake Kourna water level for the validation period 2006-2007 with IPCC predictions for scenarios B2 and A2

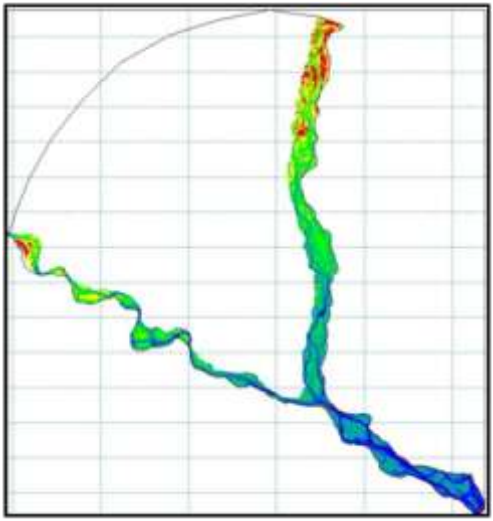
RESPONSE OF CLIMATE CHANGE ON THE MORPHOLOGICAL BEHAVIOR OF THE MAJOR RIVER SYSTEM OF BANGLADESH (A041)

Masum Ur Rahman, Sarwat Jahan, Mir Mostafa Kamal

River Engineering Division, Institute of Water Modelling, Bangladesh

Masum Ur Rahman - mur@iwmbd.org

Keywords: climate change, morphology, bank erosion, mathematical modelling, Bangladesh



Bangladesh is blessed with numerous rivers, which are characterized by unpredictability in their behavior. Every year many of the rivers pose different shape, follow different path showing their swinging nature. Being subject to upstream condition, which is beyond control, hydrological variability and different bed and bank properties make these rivers more unpredictable. On top of these uncertainties, climate change may bring changes at the upstream by changing rainfall intensity, severity, erratic occurrence, and at downstream by raising the level at the sea. More inundation due to sedimentation, hindrance to sediment flushing and at the same time more bank erosion may take place. These impacts could be phenomenal or insignificant. Theory gives an exponential increase of morphological activity with increased river flow, implying that bank erosion might substantially increase in the future. In assessing these impacts, exact quantification might not be possible at the moment but close to precision could be achieved that would assist the planners and policy makers in the process of formulating action plans to combat the adversities, which are supposed to be caused due to climate change. With this view, assessment of morphological changes of the major rivers of Bangladesh in response to anticipated climate change has been done with the application of mathematical modelling tool MIKE 11 & MIKE 21C.

This paper presents some of the key findings of some rivers, which are directly influenced by the climate change parameters.

CLIMATE CHANGE ADAPTATION IN FLOOD-PRONE COASTAL AREAS DYNAMIC FLOOD MODELING OF STORM EVENTS (A105)

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Keywords: MIKE 21 FM, flood modeling, dike breach modeling, risk assessment

In times of an accelerating sea level rise and increasing storminess there is the need for realistic dynamic flood simulations for both dike and dune protected areas. Based on a number of storm events representing different return periods now and in the future considering climate change, dike failure scenarios have been used for numerical flood modeling given by the use of GIS, digital terrain model, MATLAB and MIKE 21 FM by DHI.

Based on the coastal flood simulations and calculations of the flooded values for each storm event, a risk assessment has been carried out. Using a decision support system that includes decision criteria based on vulnerability analysis, possible solutions for reducing the risk have been identified. Precautions against flooding can then be initiated according to a cost-benefit analysis of certain flood-prone coastal areas.

VULNERABILITY OF COASTAL REGION DUE TO STORM SURGE INUNDATION IN CHANGING CLIMATE (A034)

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Institute of Water Modelling, Bangladesh

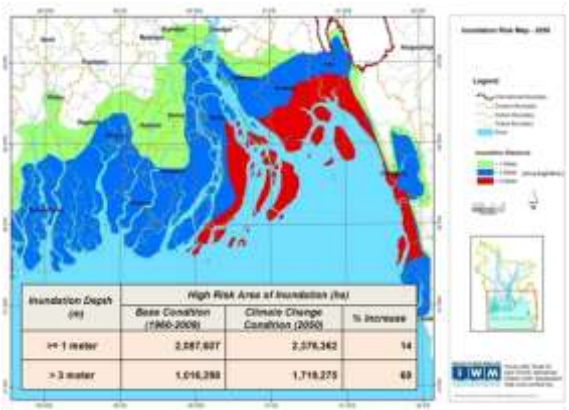
Presenter: Manjur Murshed Zahid Ahmed - mmz@iwmbd.org

Keywords: coastal region, cyclone-induced storm surge, mathematical modelling, MIKE 21, climate change prediction, sea level rise, GCM, inundation

Bangladesh is one of the worst affected countries of climate change impacted by Global warming triggered by Greenhouse Gas emissions. According to the Assessment Report-4 of IPCC, tropical cyclones, storm surges and severe floods are likely to become more frequent and severe in the future as a result of climate change, making Bangladesh even more vulnerable. Institute of Water Modelling (IWM) carried out a study under World Bank, where vulnerability of coastal region of Bangladesh due to cyclone-induced storm surge under climate change condition was assessed and adaptation measures to cope with climate change impacts was estimated.

The inundation in the coastal region due to storm surge for various scenarios of sea level rise for the projected year 2030 and 2050 were assessed using the existing Bay of Bengal model (which is based on MIKE 21 modelling system). The projections on precipitation and temperature for 2030 and 2050 were based on Global Circulation Model (GCM) MIROC3.2 (scenario A2).

The Bay of Bengal model was applied to simulate all the major cyclones from 1960 to 2009. For climate change condition the wind speed was increased by 5% and 10% for the projected years 2030 and 2050 respectively. The inundation due to storm surge for 2050 under climate change condition is shown in the figure. Finally the vulnerability zones of coastal regions due to storm surge under climate change condition was assessed based on this inundation risk map.



Projection of storm surge inundation in a changing climate 2050

HIGH-RESOLUTION MODELLING OF THE MARINE ENVIRONMENT AT FORSMARK BETWEEN 0 AD AND 9000 AD (A026)

Olof Liungman, Anna Karlsson, Christin Eriksson, Charlotta Borell Lövstedt

DHI Sverige AB, Sweden

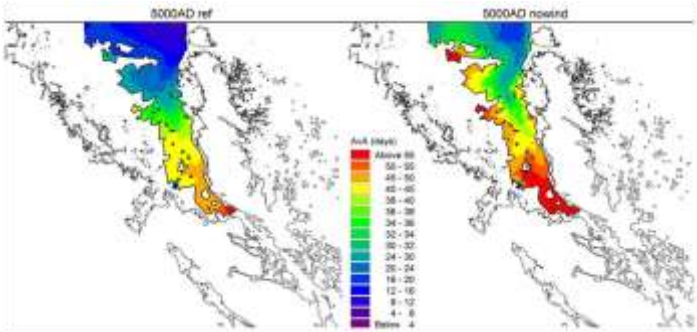
Presenter: Christin Eriksson - cer@dhigroup.com

Keywords: MIKE 3 FM, coastal circulation, land rise, AD, climate change, water exchange, residence time

The Swedish Nuclear Fuel and Waste Management Co. is investigating a long-term underground repository of spent nuclear fuel in the Forsmark area on the east coast of Sweden. DHI was contracted to model the hydrodynamic conditions and especially the water exchange characteristics of the area between 6500 BC and 9000 AD. The results are used as input to a dose model.

A MIKE 3 FM model was used to simulate the coastal region off Forsmark for ten representative years between 0 and 9000 AD. In order to accurately describe past and future conditions the model bathymetries have been modified according to simulated land rise. The model was forced by a combination of observations and a large-scale Baltic Sea model. The model was validated against observations of sea level, salinity and temperature. A measure of the residence time − and thus the water exchange − called the Average Age (AvA) has been calculated using the module ECO Lab. A sensitivity analysis has also been carried out on order to illuminate the importance of various forcing mechanisms. This analysis indicates how the water exchange is likely to be influenced by a changing climate and land rise.

The results show that over long periods of time the coastal area off Forsmark will change from a well-ventilated open sea area, via an open-ended embayment with a barotropically forced net through-flow to a typical estuary with gradually more restricted baroclinic circulation.



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