Integrated Decision Support Tools for water resources management

Jacob Høst-Madsen
COO, DHI

- Technology aspects

- What are the challenges?

- Examples to learn from

- Recommendations

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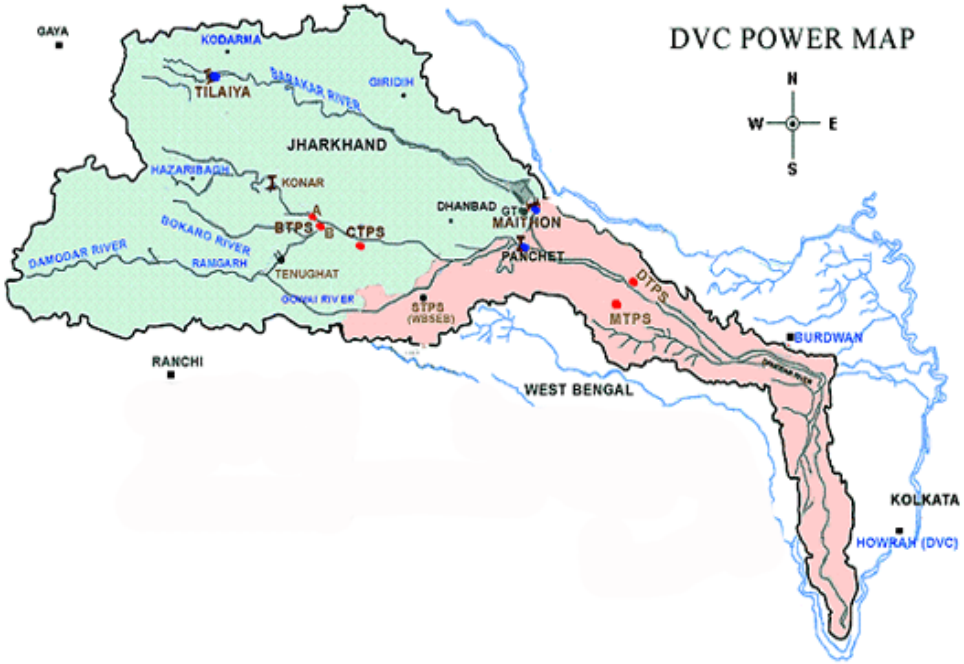
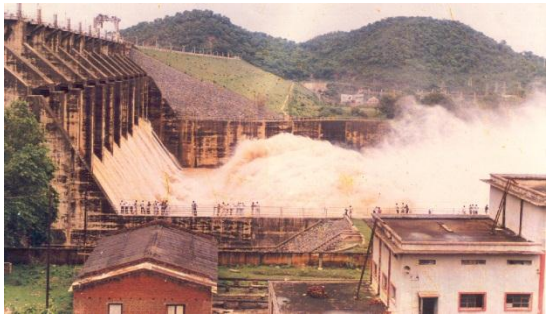
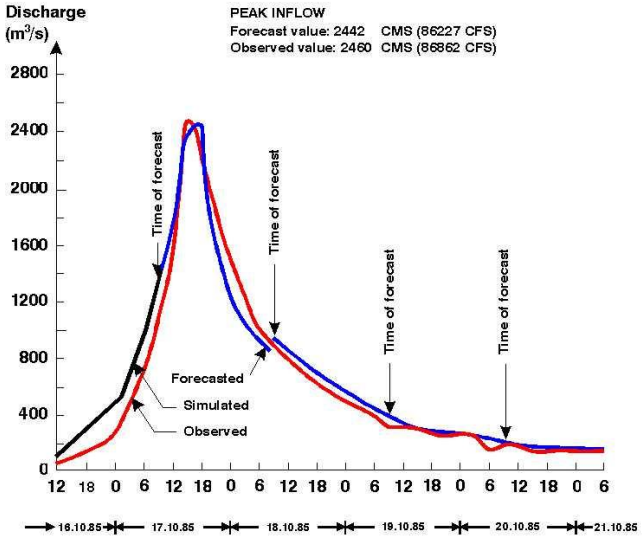
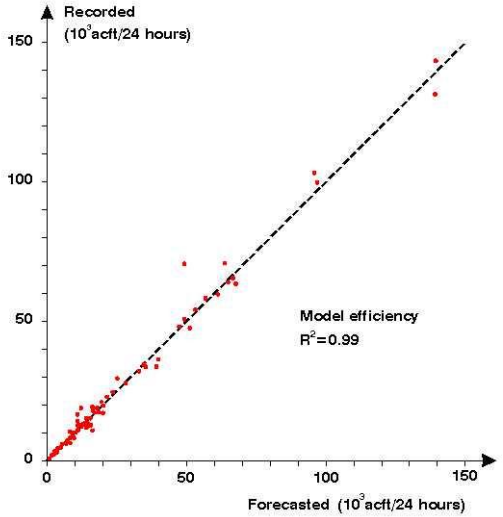
Damodar valley, India, 1985





Damodar valley, India, 1985





Forecasted and recorded Inflow Hydrographs for Maithon Reservoir during the Flood Event of 16-19 October, 1985.

Flood Forecasting & Warning Centre

Bangladesh Water Development Board (BWDB)

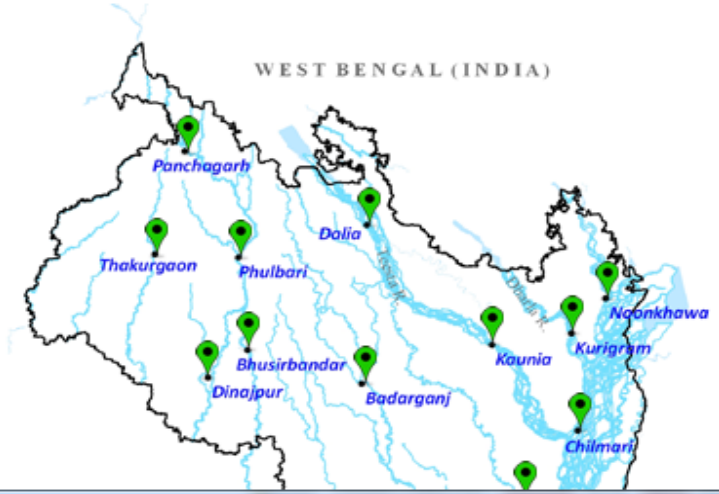
Updated On: 23 Apr 2014
Beta version! Information may vary with actual

darban Level : 4.78 Level : 15.25	Chiringa Water Level : 2.06 Danger Level : 5.75	Dohazari Water Level : 1.25 Danger Level : 7.00	Lama Water Level : 6.64 Danger Level : 12.25

Narayanhat

Severe | Danger | Warning | Normal | South Eastern Hill | Ganges | Meghna | Brahmaputra

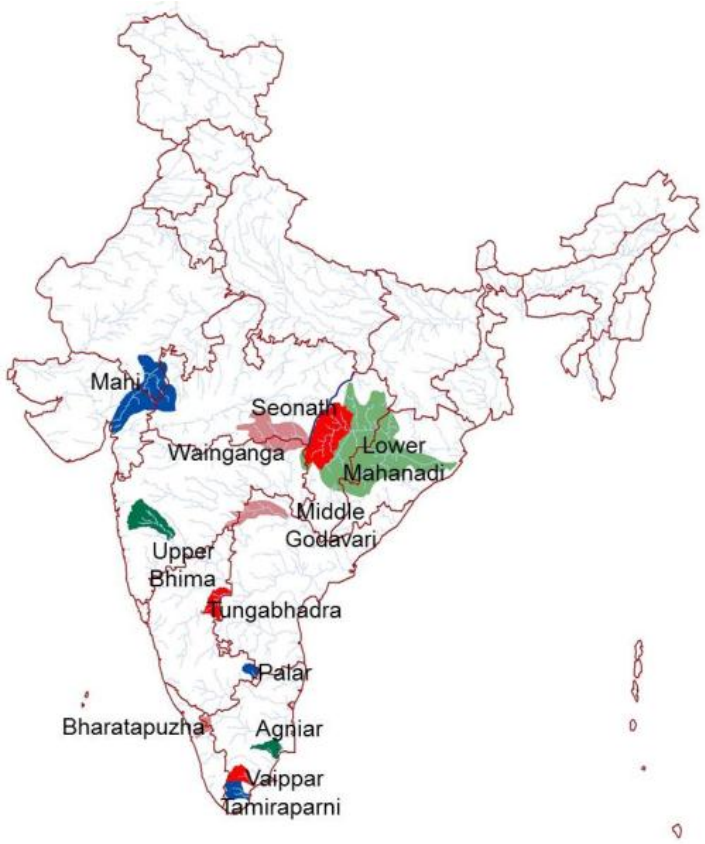
River Based Map | Division Based Map | District Based Map | Google Map



Level Status

Normal Level | Warning Level
Danger Level | Severe Level
Stations | Rivers

DSS Planning



Case studies selected in each state

Nine Participating States

- Andhra Pradesh
- Tamil Nadu
- Karnataka
- Kerala
- Maharashtra
- Madhya Pradesh
- Orissa
- Gujarat
- Chhattisgarh

Six Central Agencies

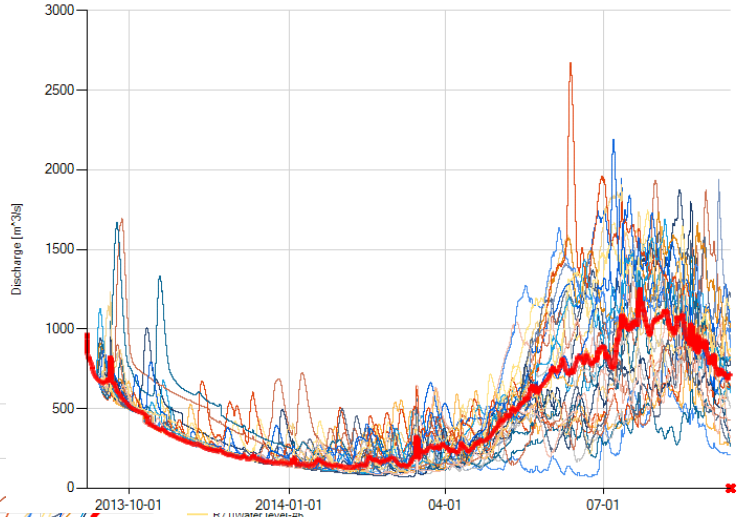
- National Institute of Hydrology
- Central Water Commission
- Central Ground Water Board
- Central Water and Power Research Station
- India Meteorological Department
- Central Pollution Control Board

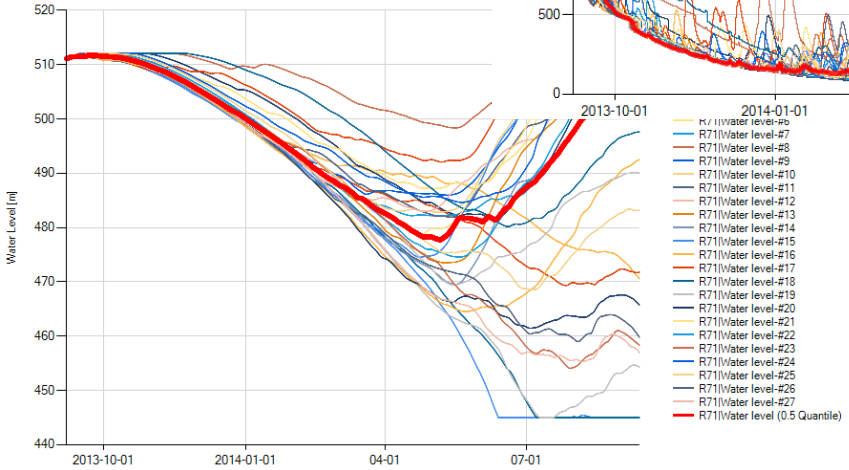
DHI

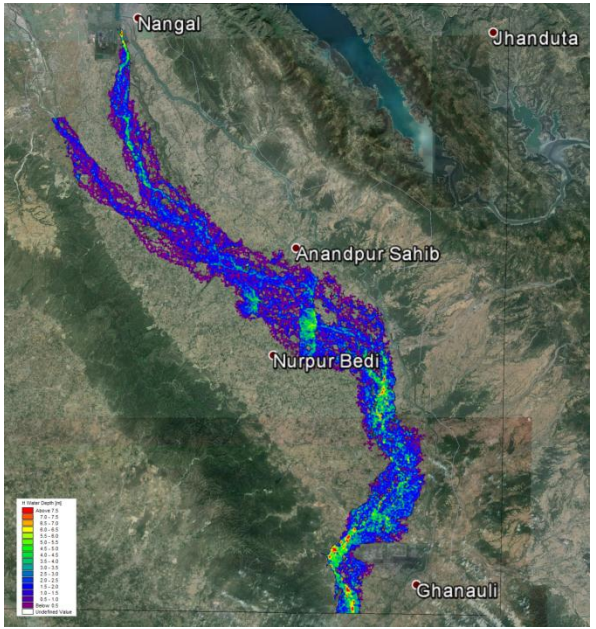
Real-time installations

© DHI

Ensemble Inflows, Reservoir storage levels, Downstream flooding







© DHI

Technology aspects

Integrated decision support tools for water resources management

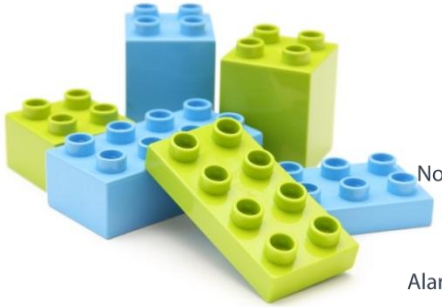
…get the full benefit of real-time **monitoring** and early warning systems

…manage, organise and analyse large amounts of **data**

…optimise **operations** and planning

…make wise and robust water management **decisions**

© DHI



System and database

Notifications

Alarms

Data acquisition

OPC/SCADA link

Data assimilation

Jobs and automation

EMERGENCY MANAGEMENT

DATA LOAD

PROCESSING AND ANALYSIS

OPERATIONAL FORECASTING

REPORTING

OPERATIONS

DATA

INFORMATION MANAGEMENT

SYSTEM OPTIMISATION AND CONTROL

PLANNING

CLIMATE CHANGE ADAPTATION

RESOURCE MANAGEMENT

Roles

Data brokering

Time series

GIS

Documents

Web publishing

Spreadsheets

Scripts

Indicators

Meta data Audit log

Audit log

Uncertainty

Optimisation

Ensembles

Models and Scenarios

Multi-Criteria-Analysis

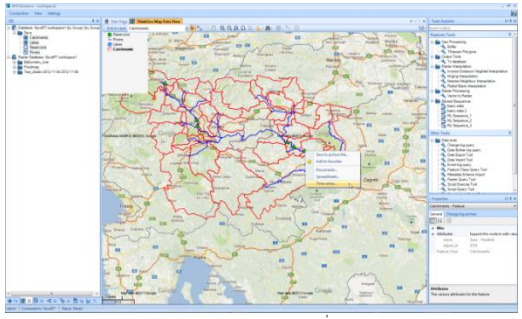
Cost-Benefit-Analysis

© DHI

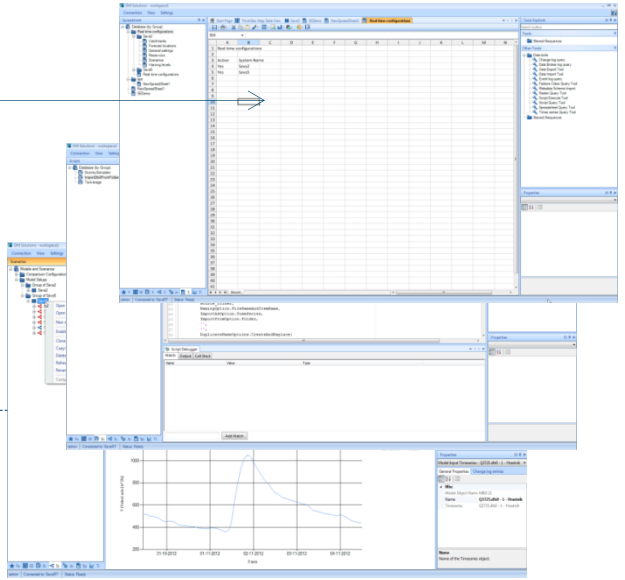
DHI

© DHI

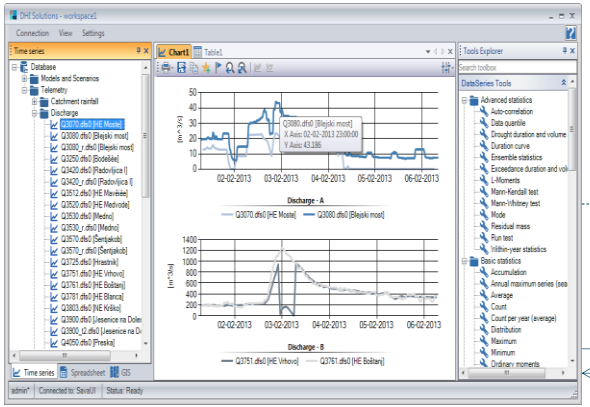
Maps (GIS)



Spreadsheets



Time series



Data base

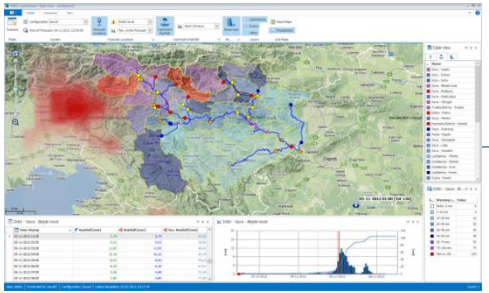
Open architecture (API)

Add User tools

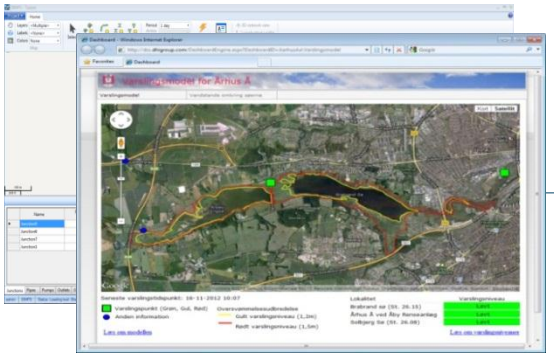
© DHI

Different users – Different views

Operator view (product)

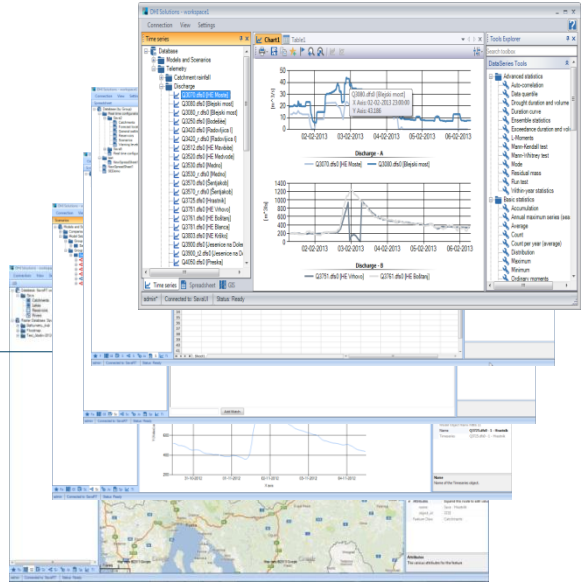


Tailor made view (client solution)



Data base

Scientific view (components)



© DHI

© L...

Challenges

HP3: What are the challenges?

Climate Chan

Water scarcity

Floods and droughts

Ground

Food produc

Energy

Urbanization and Mega-

The Enviro

Effective operations

Institutional development
Technology transfer
Capacity development
Knowledge sharing

Access to information
Effective real-time operations
Early warning systems
IWRM DSS

Legislation

acceptance

Stakeholders

ement

Transparency

ctivity

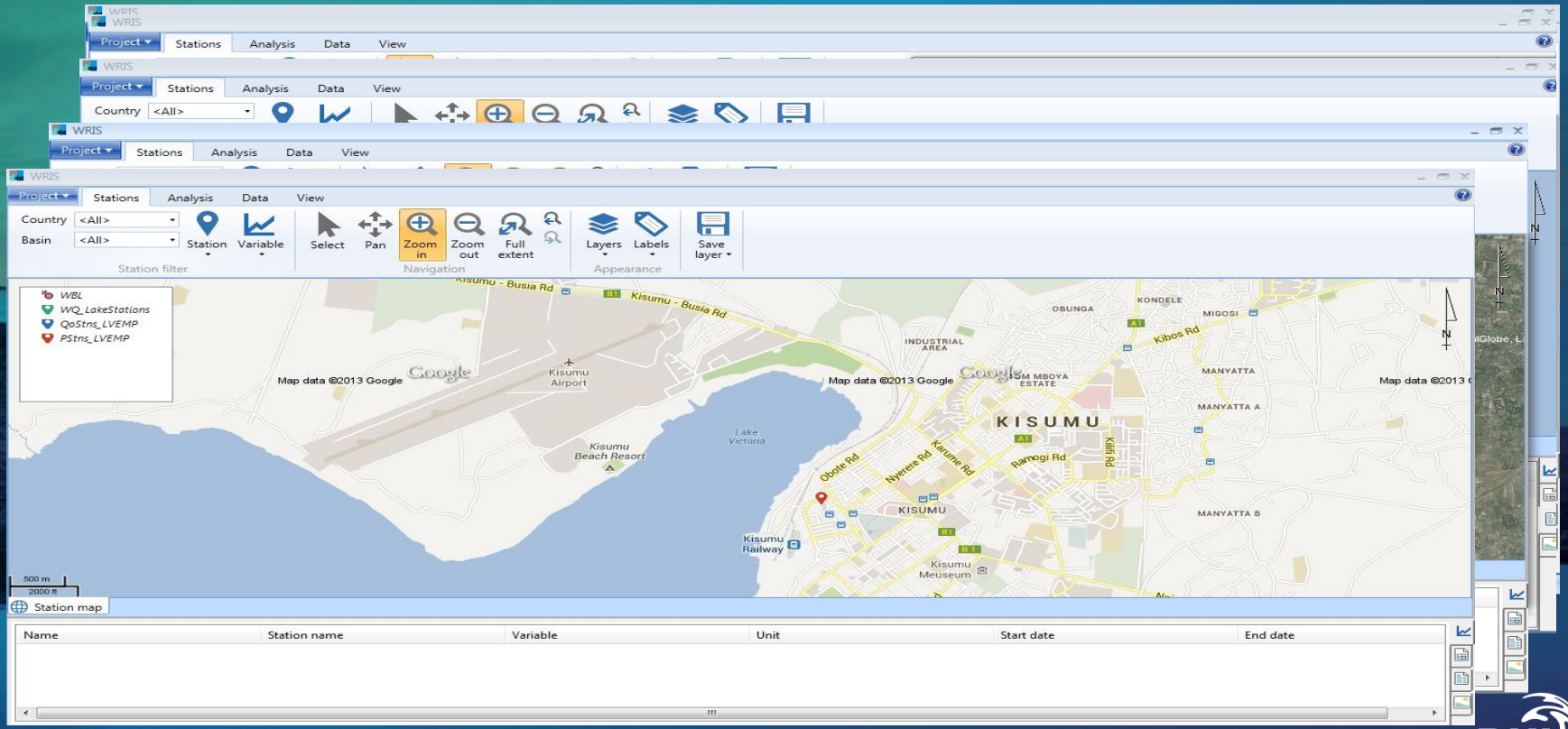
Development of a Water Resource Monitoring Information System (WRMIS) for the Lake Victoria Basin

Client: Lake Victoria Basin Commission

Period: Oct 2012 – Oct 2014

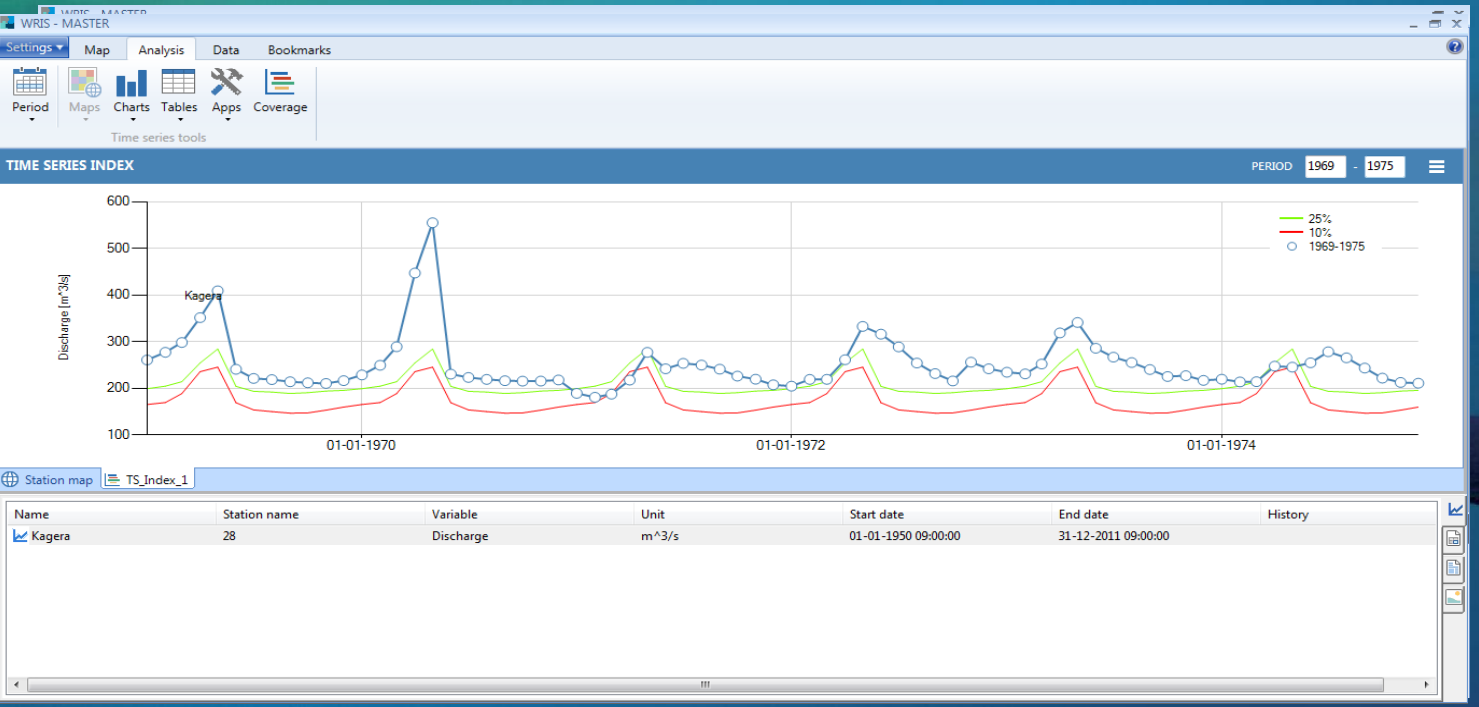
Viewing stations & points of interest

Where and what



Viewing data

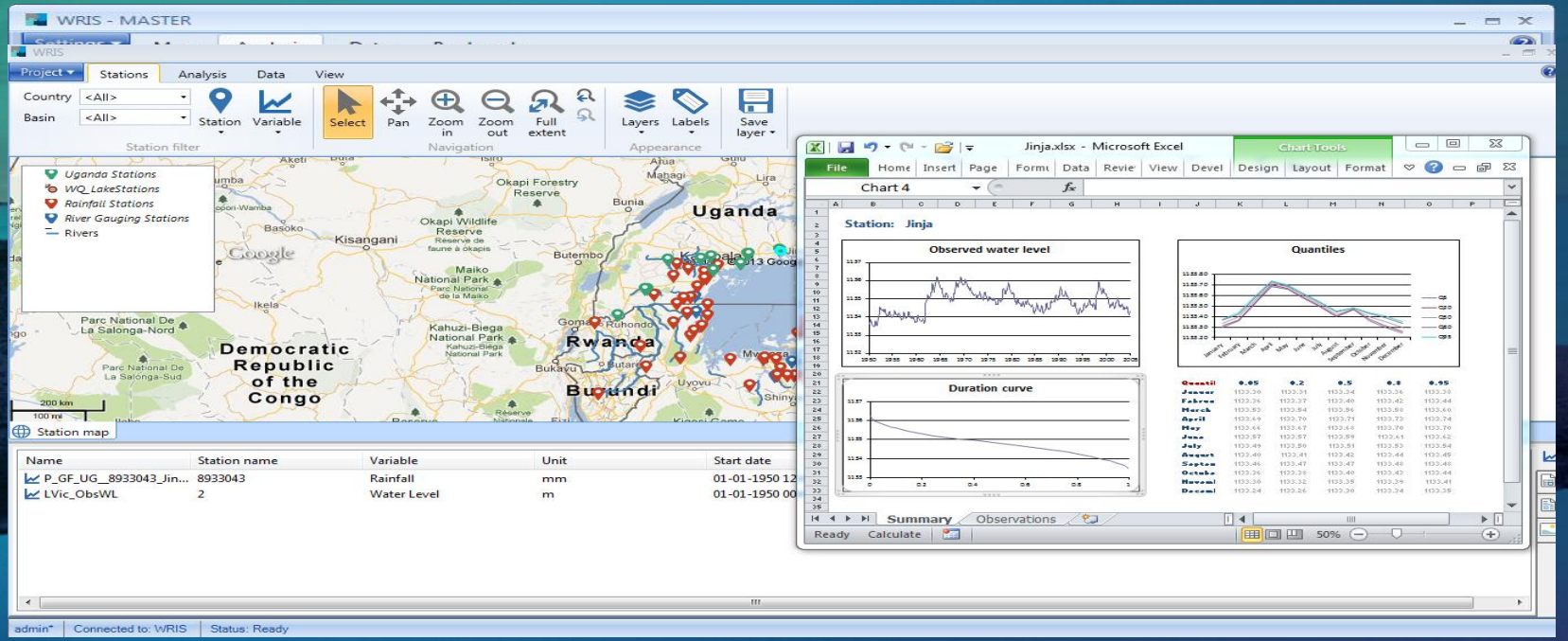
Tables & graphs of data stored in database



- Climate
- Streamflow
- Water level
- GW level
- Concentration
- Abstraction
- WW discharge
- Permits
- Counts
- Fish catches
- Indicators
- GIS information

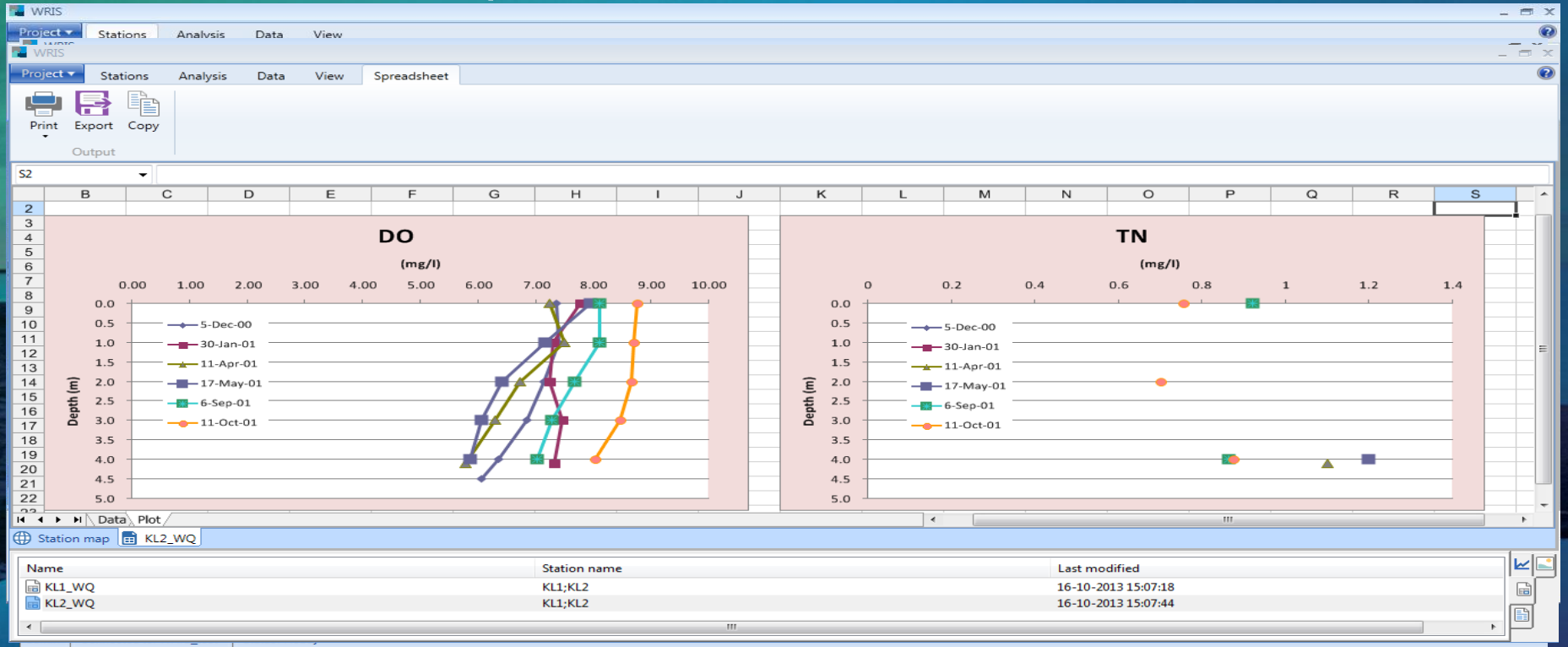
Making analyses

E.g. important statistics

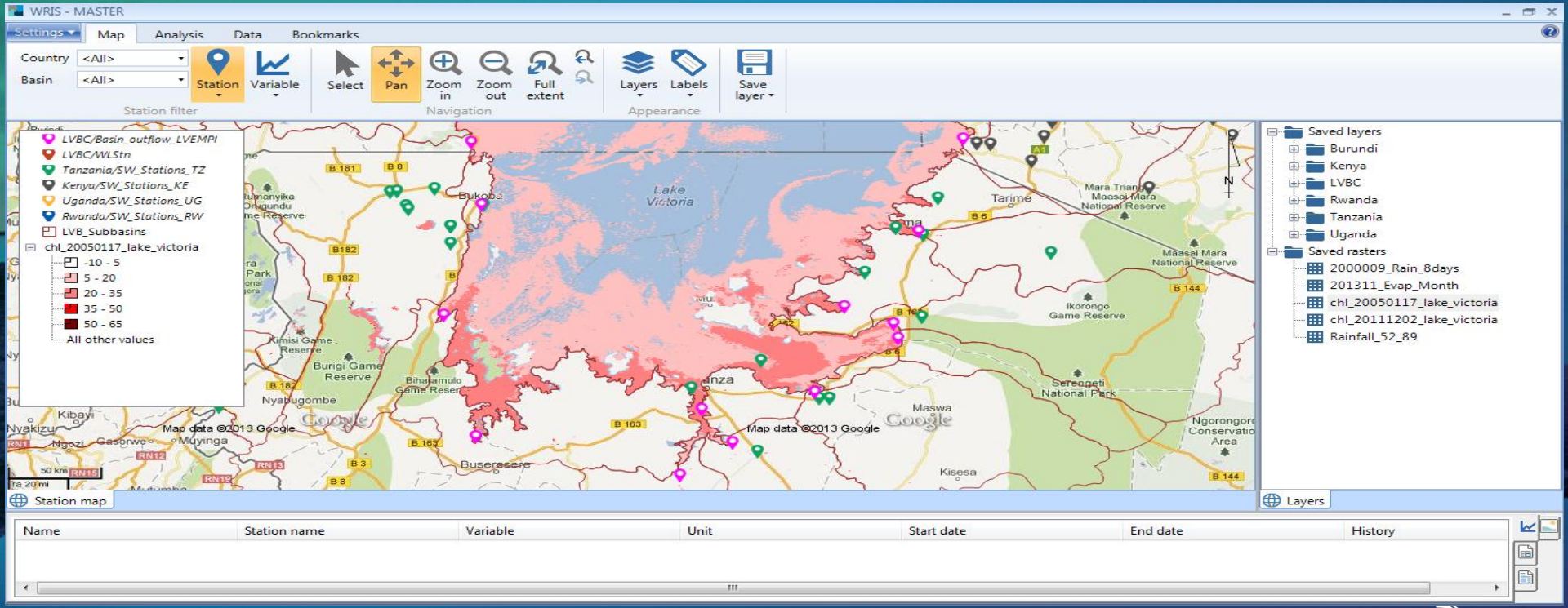


Viewing data

that are stored in spread sheets

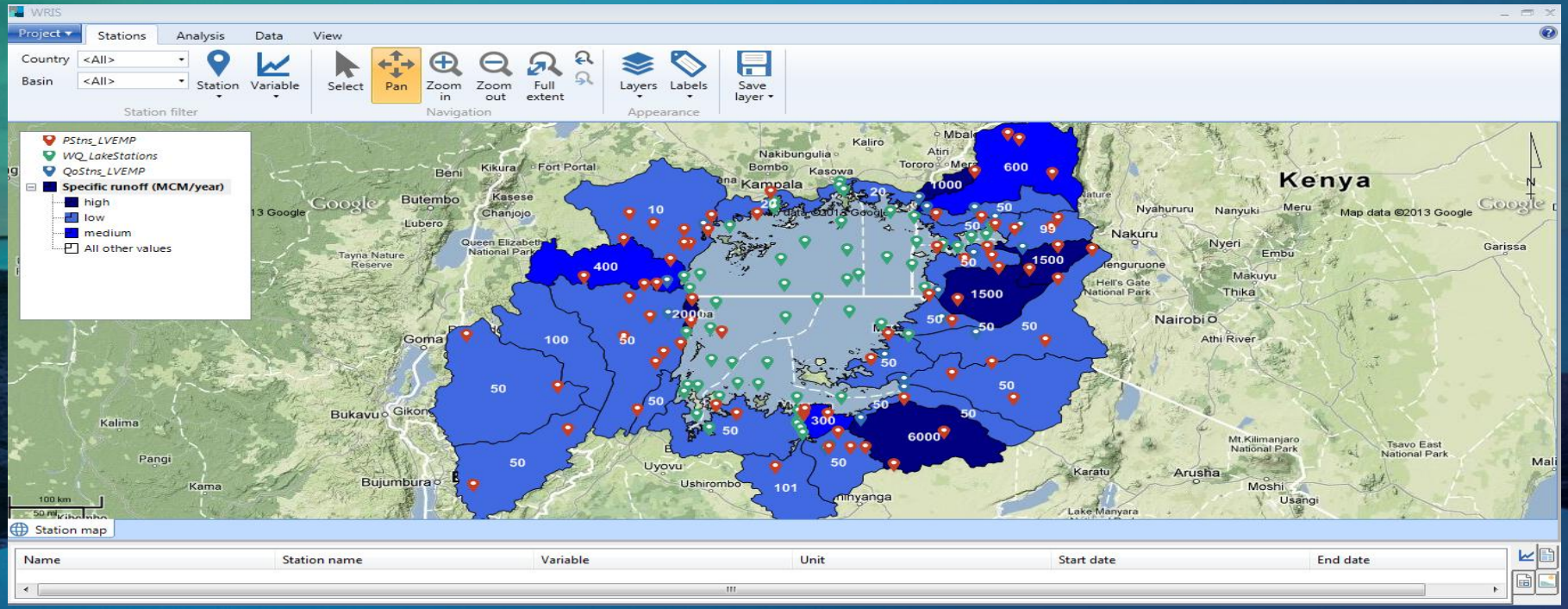


Importing data, e.g. from remote sensing sources

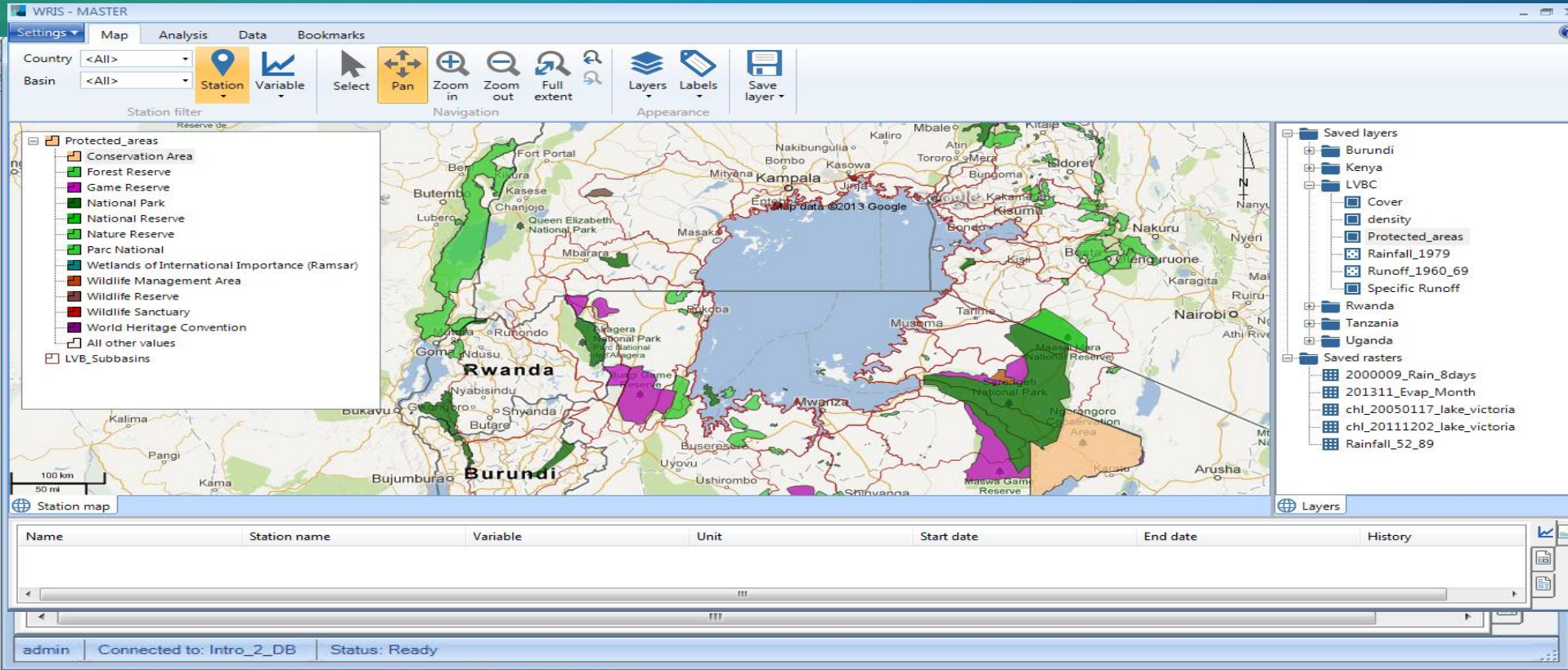


Making analyses

E.g. important indicators

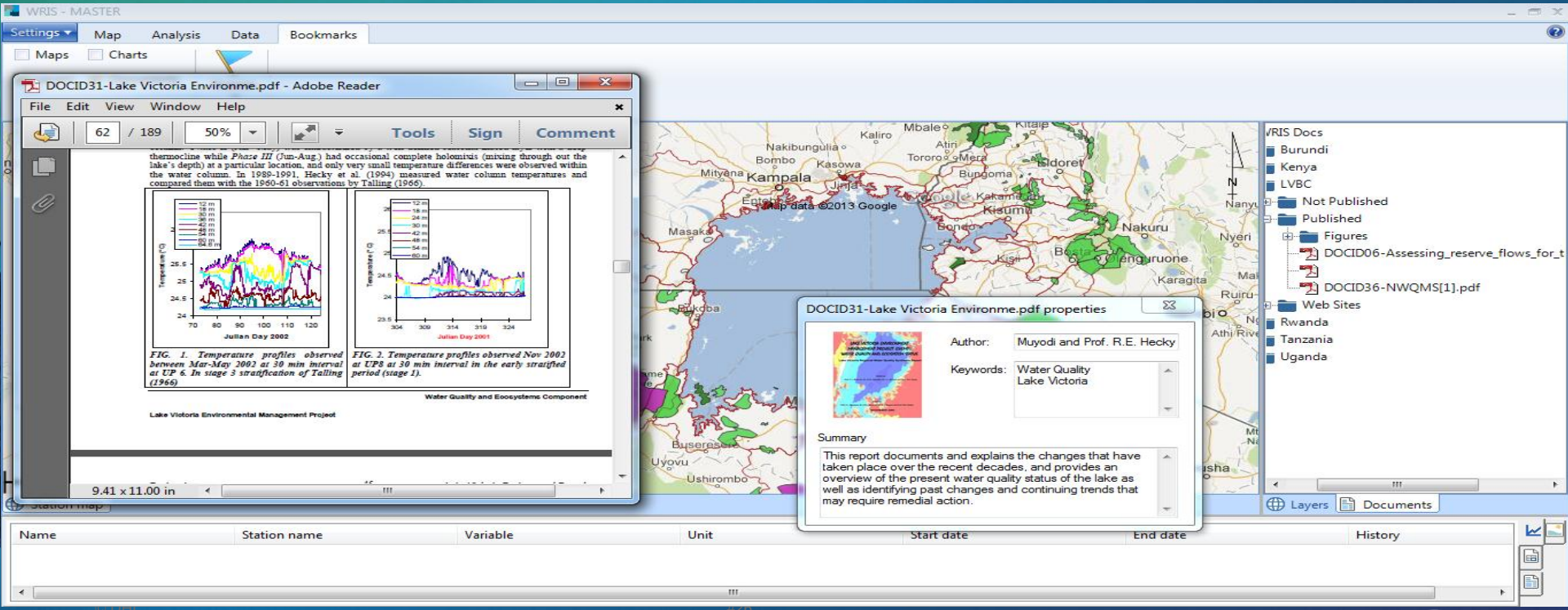


Viewing GIS Information



Publishing Information

Library of reports, analysis results



Training, Capacity Building and Support

Training classes

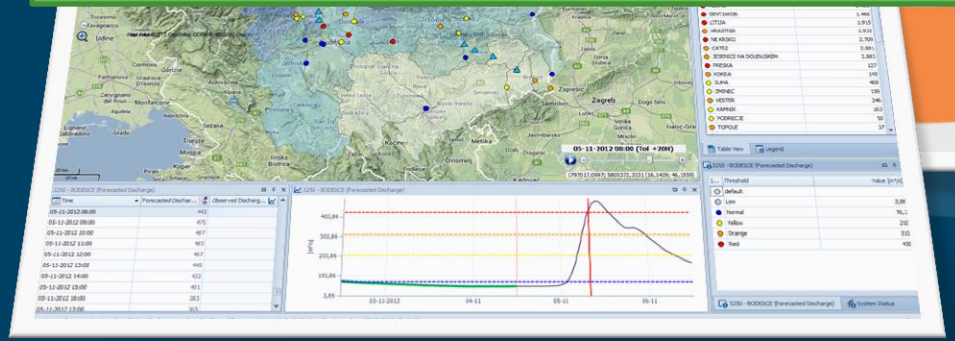
On-the-job training

Help when needed

© DHI

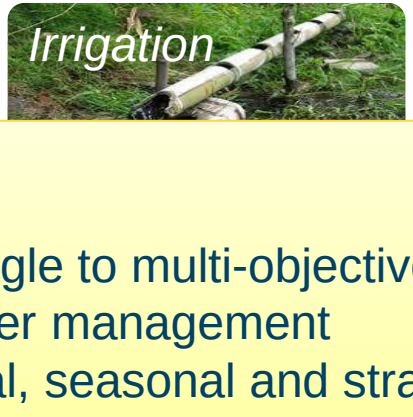
A tailormade solution

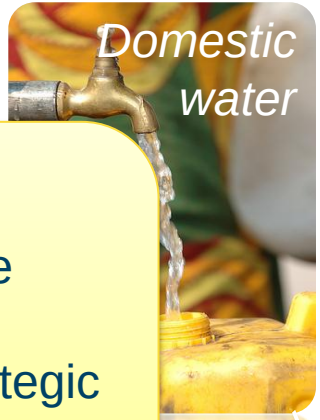
- Fitness to the purpose/applicability in Indian condition.
- User friendly (including accessibility to training facilities).
- Sustainability (including ongoing support and updating).
- Open sources, code flexibility for customizing, interfacing and further development.
- Cost.



Flood Forecasting and Warning System, Chaophraya, Thailand

Sample challenges in Thailand





From single to multi-objective water management at operational, seasonal and strategic level

The People of Thail

Minister of Science and Technology

Hydro and Agro Informatics Institute

Royal Irrigation Department

Electrical Generating Authority of Thailand

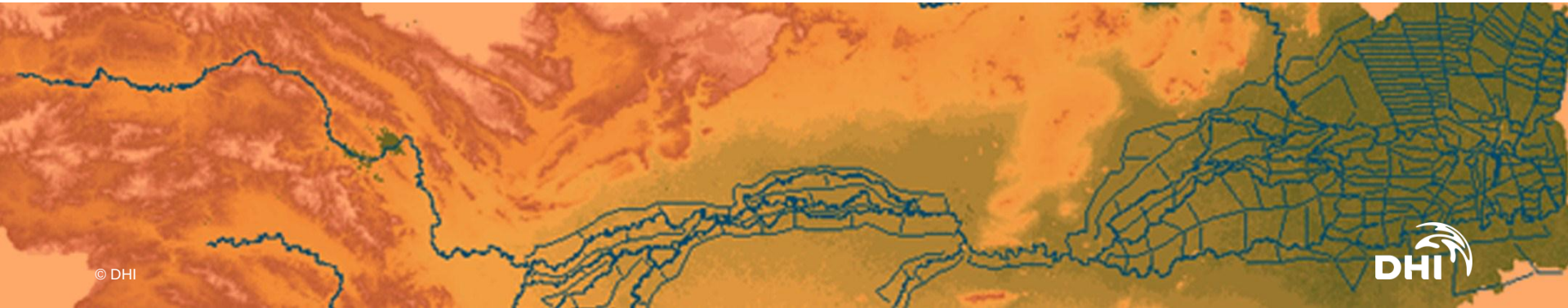
Early warning and forecast systems

Chao Phraya, Thailand

The Chao Phraya River Basin. 160,000 km^2.

One Decision Support System to protect against devastating flooding.

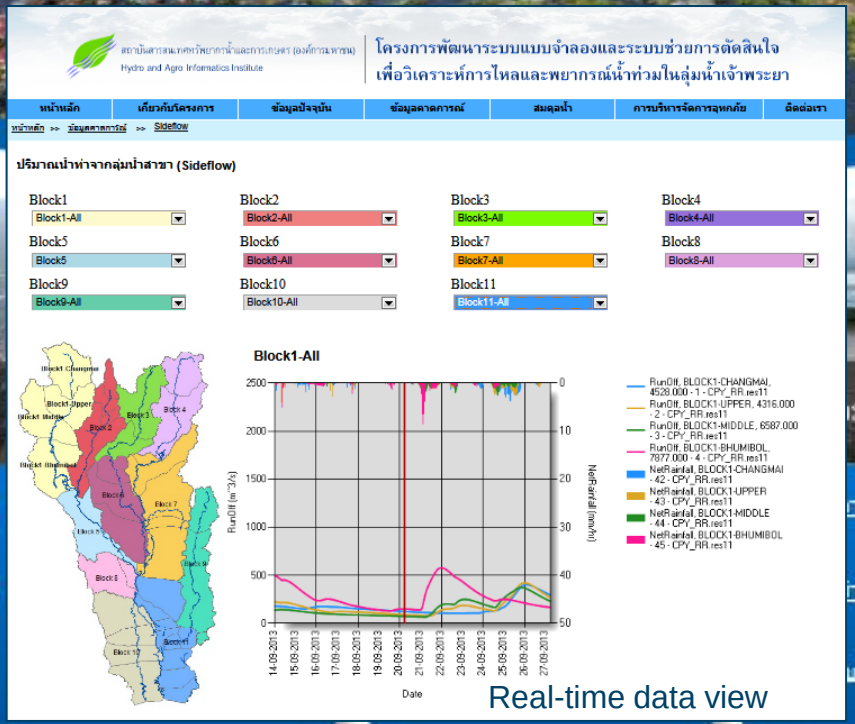
> HAII highly appreciates DHI for their excellent job, especially on the close collaboration and hands on experience that made us become a good partner."
>
> *Dr. Piyamarn Sisomphon, Project Leader, Hydro and Agro Informatics Institute*



© DHI

Chao Phraya Flood Forecasting and Management DSS system

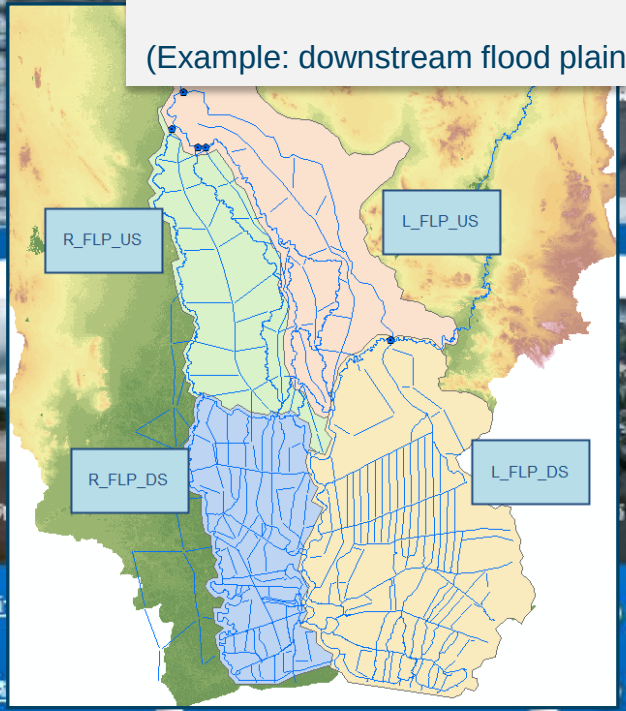
Customised Project Web page Designed by end client



Real-time data view

One- and two-dimensional flood modelling applied

(Example: downstream flood plains).



Courtesy of HAII, Bangkok, Thailand

MIKE Customised - Real-time - workspace1

Home | Publish | View

Real-time | Mode

BMA_RR | 30-09-2012 23:00... | Configuration

Catchment Precipitation | Catchm...

Stations | Water Level | Stations

Area | District Area | Dike | Floodweak Road | Stations | Sub Polder | Tunnel | Floodweak Road | Rainfall | Radar | Layers and Grids

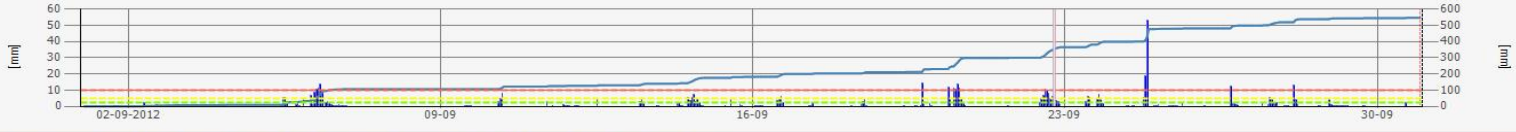
...	Name	Value [mm]
	PHRA NAKHON	63.83
	DUSIT	58.56
	NONG CHOK	64.21
	BANG KHEN	60.17
	BANG KAPI	54.00
	PATHUM WAN	64.21
	PHRA KHANONG	64.21
	MIN BURI	63.83
	LAT KRABANG	52.59
	PHAYA THAI	64.21
	HUAI KHWANG	63.83
	BANGKOK YAI	34.30
	KHLONG SAN	63.83
	BANGKOK NOI	58.56
	BANG KHUN THIAN	38.50
	PHASI CHAROEN	34.30
	NONG KHAEM	64.21
	TALING CHAN	49.52

Table View | Legend

BANG KAPI - BANG KAPI

I...	Threshold	Value
	Default	
	Low	20
	Medium	50
	High	100

BANG KAPI - BANG KAPI



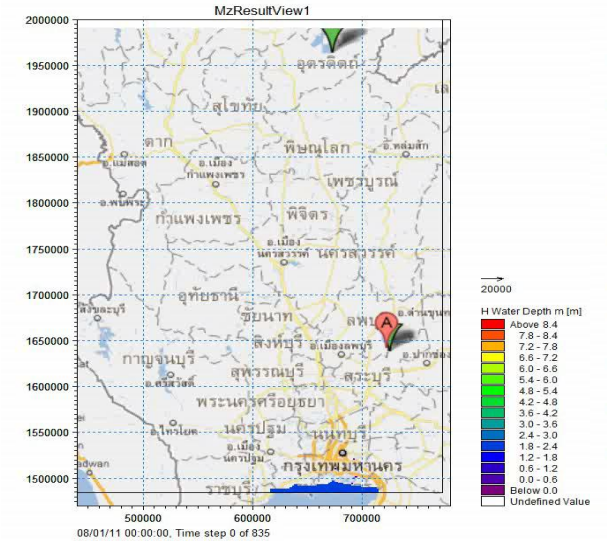
BAN... | Syst... | BAN...

User: admin | Connected to: BMA | Configuration: BMA_RR | Time of Forecast: 30-09-2012 23:00:00 | Simulation Run: 27-08-2013 10:41:24 | Count: 1

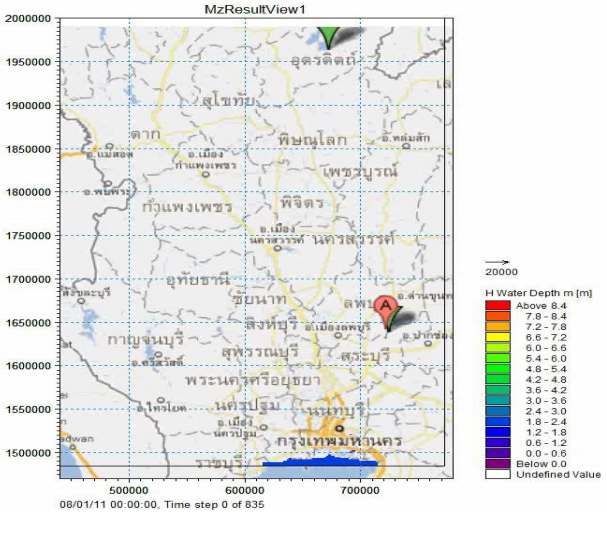
DA | 100% | 16:22 | 10-09-2013

What happens if a dike is constructed around Bangkok?

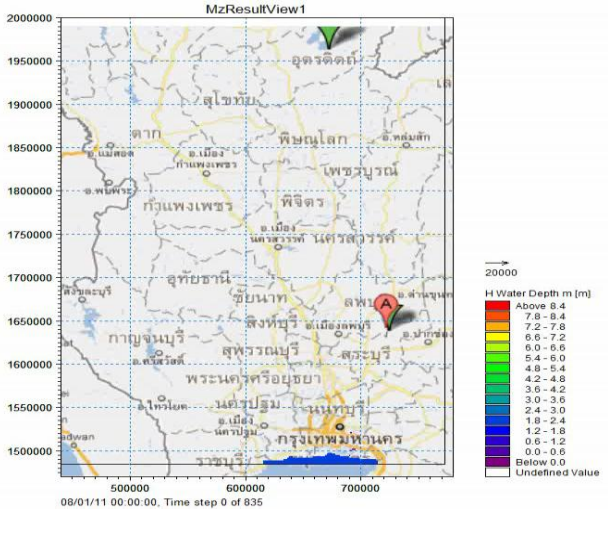
Current



3m dike



4m dike



Nile basin decision support system

Nile Basin Decision Support System

Accepted tools
Sharing of data and knowledge
Cross boundary cooperation

> The Nile Basin Decision Support System will provide the basis for agreement on and development of sustainable water resources projects in the Nile Basin”

Dr. Abdulkarim H. Seid, Head, Water Resources Management, Nile-Sec

Need for wise and robust water management decisions

© DHI

Priority Concerns

Water resources development:
Focus on infrastructure (e.g. new dams)

Coping with floods:
focus on flood protection and impacts

Optimal water resources utilization:
Focus on optimal use (e.g. reservoir operation rules)

Energy development (hydropower):
focus on development of hydropower potentials

Rain-fed and irrigated agriculture:
focuses on crop-production and irrigation

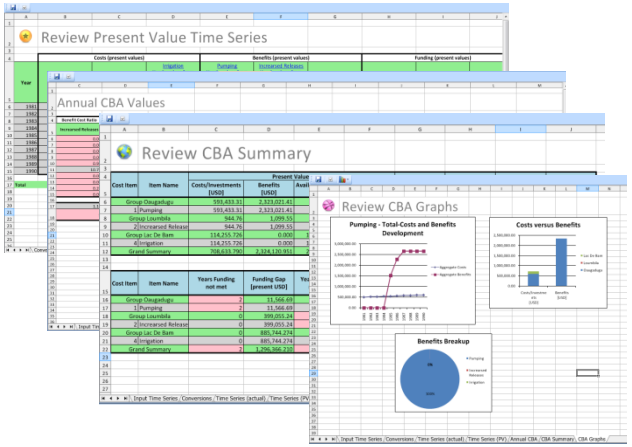
Navigation:
Focus on impacts on river navigation

Coping with droughts:
Focus on drought management

Watershed and Sediment Management:
Focus on land-use, soil erosion, sediment loads

Cross cutting issues :
Climate change and Water quality

Sharing water resources fairly



Nile Basin DSS

- Time series
- Spread-sheets
- GIS
- MCA/CBA
- Scenarios
- Dashboard (web publishing)
- Optimisation
- Work spaces
- Ensembles
- Meta data
- Scripting
- Indicators

Data base

© DHI

Client Focused Solutions and Collaborative development approach

Use Cases – Rooted in real problems in the basin

- Lk. Victoria, the Sudd wetlands, Blue Nile Hydro Power

Decision driven – Decisions and Actors drive the requirements

Decisions ← Questions ← Information ← Tools/Data

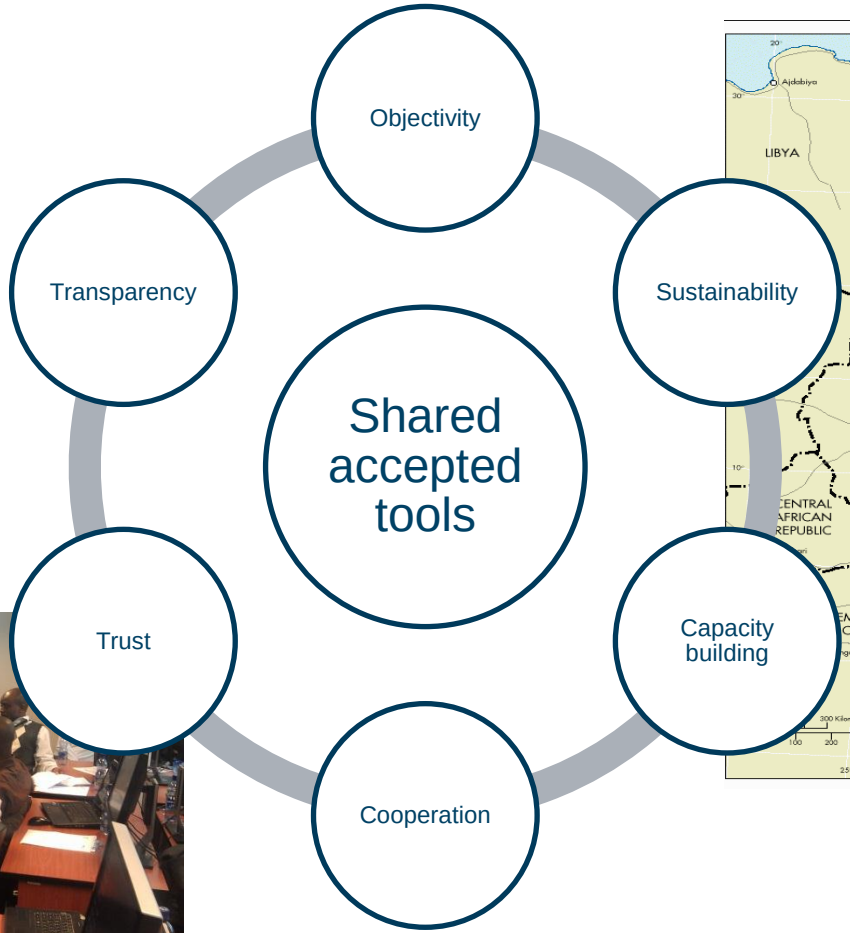
"The Actors"

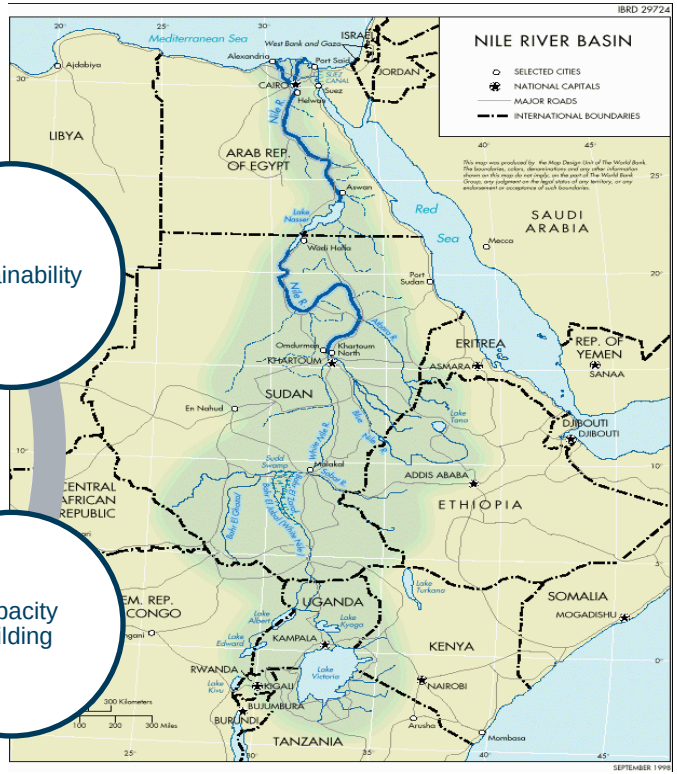
Q: Design and operation of Sudd bypass channel?

Q: Design and operation of Sudd bypass channel?

Q: Design and operation of Sudd bypass channel?

Key value





© DHI

Computer Assisted River Management System (CARM), Australia

Innovation

Over 1,600km of river with two dams and thousands of water users. **One** river management system.

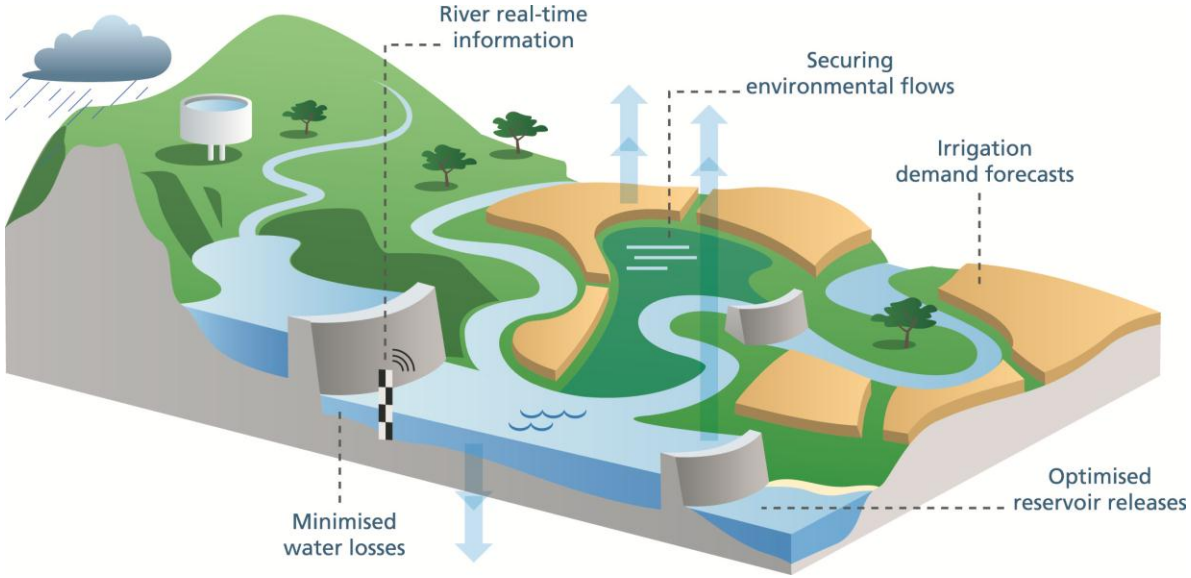
Precision releases to deliver the right flows at the right time

New South Wales, Australia

> CARM is a world class development designed to maximise the efficiency of the Murrumbidgee River system."
>
> *Brett Tucker, Chief Executive Officer, State Water Corporation, New South Wales, Australia*

River operations

New South Wales, Australia



"The CARM project will make control of water flows more responsive and more precise."
State Water Corporation

© DHI

Recommendations

Recommendations

- Be clear on technical and institutional challenges (use also wheel).
- Focus on potential value creation.
- Be clear on roles and responsibilities.

- Clear up misunderstandings on: Open sources, code flexibility for customizing, interfacing and further development.
- Focus on benchmarks, proven performance etc. rather than Fortran code and isolated price.

© DHI

Be clear on technical and institutional challenges (use also wheel)

…get the full benefit of real-time **monitoring** and early warning systems

…manage, organise and analyse large amounts of **data**

…optimise **operations** and planning

…make wise and robust water management **decisions**

© DHI

Set high requirements and use benchmarks
Suggestion:

Flexible access and execution	• A range of licensing possibilities • Parallelisation, GPU, HPC
Recognition, quality and future	• Worldwide recognition • Certified development procedures
Help and support	• Professional support • Extensive training programmes
Productivity: Easy data access	• Data from online sources in relevant formats • Easy data exchange
Productivity: Usability	• Interface, manuals, examples • Productivity tools
Science and versatility	• Proven versatile software packages • Consolidated and new research

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Thank you

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