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Operational decision support system (ODSS) for integrated water resources management in Tanzania

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Outline of Presentation

- Background and Development Objectives of the ODSS
- Components of the ODSS
 - Water resources information system (WRIS)
 - Flood early warning system (FEWS)
 - Water use permitting analysis tool (WUPA)
 - Dam operation support tool for reservoir operations (DOS)
- Conclusion/Summary

Background

- Development of the ODSS is a component under the Water Sector Support Project Phase II (WSSP II) implemented 2017 – 2022.
- The project comprises the IWRM component of the WSSP II which includes development of an Operational Decision Support System (ODSS) linked to a modernised hydromet monitoring system.

Development Objectives (1/2)



To design, develop, install, and implement a comprehensive modern, modular, and customizable ODSS framework with:

- Water Resource Information System (WRIS) with hydro-met linkage, with integrated data management, analysis, and visualisation tools, as well as provisions for embedding models

Development Objectives (2/2)



To design, develop, install, and implement a comprehensive modern, modular, and customizable ODSS framework with:

- Prediction Tool for Water Resources Management for the Basin Water Boards
 - Flood Early Warning System (FEWS) (in Wami/Ruvu basin)
 - Water use permitting and water allocation (in Pangani and Rufiji basins)
 - DSS tools for Reservoir Operations (for Nyumba Ya Mungu Dam in Pangani basin and Mtera Dam and Kidatu Dam in Rufiji basin)



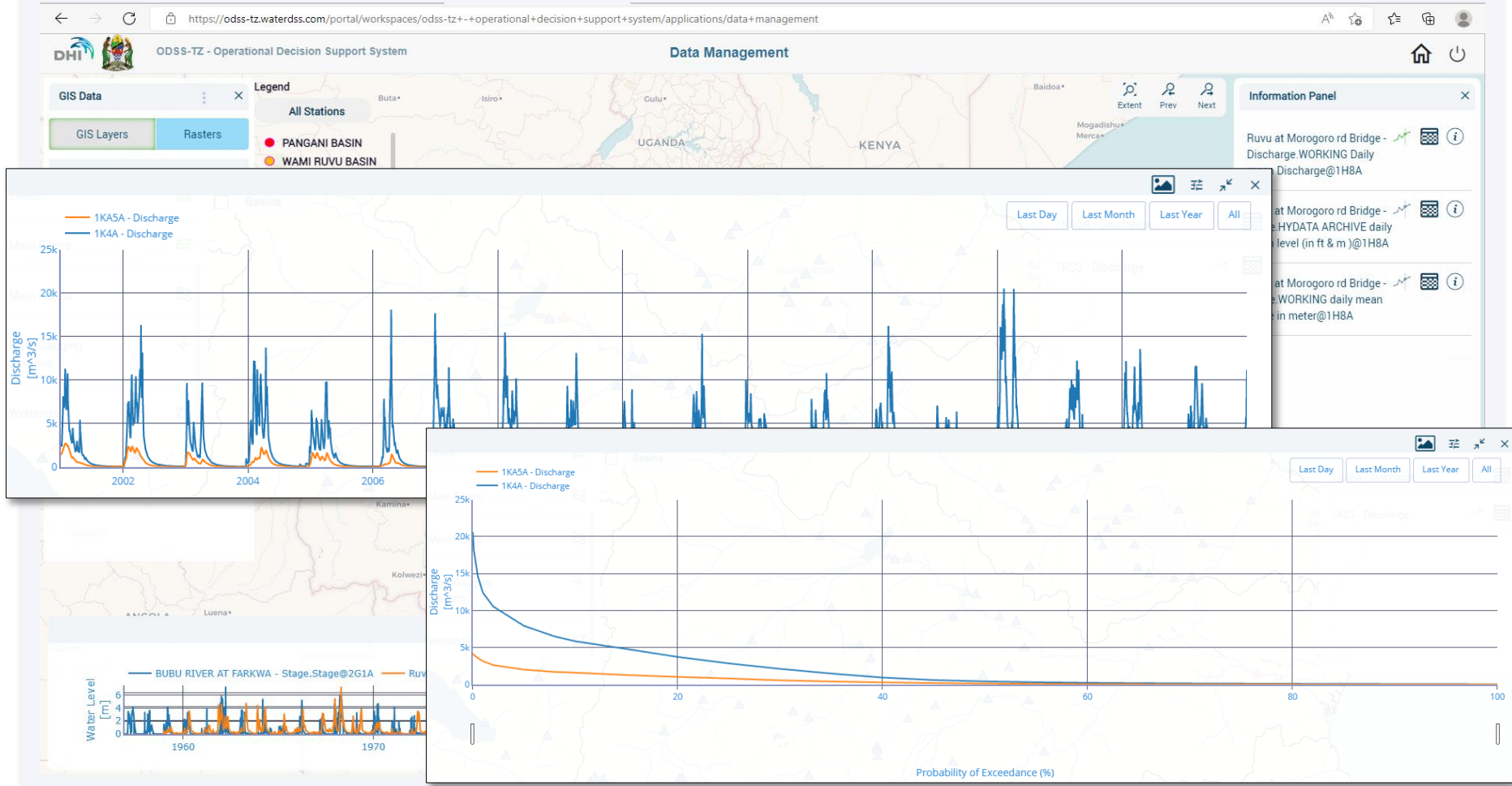
Purpose of the WRIS

- Enhance knowledge by sharing
 - water datasets
 - knowledge products
- Provide easy access to the latest relevant available datasets for water resources management and planning across Tanzania

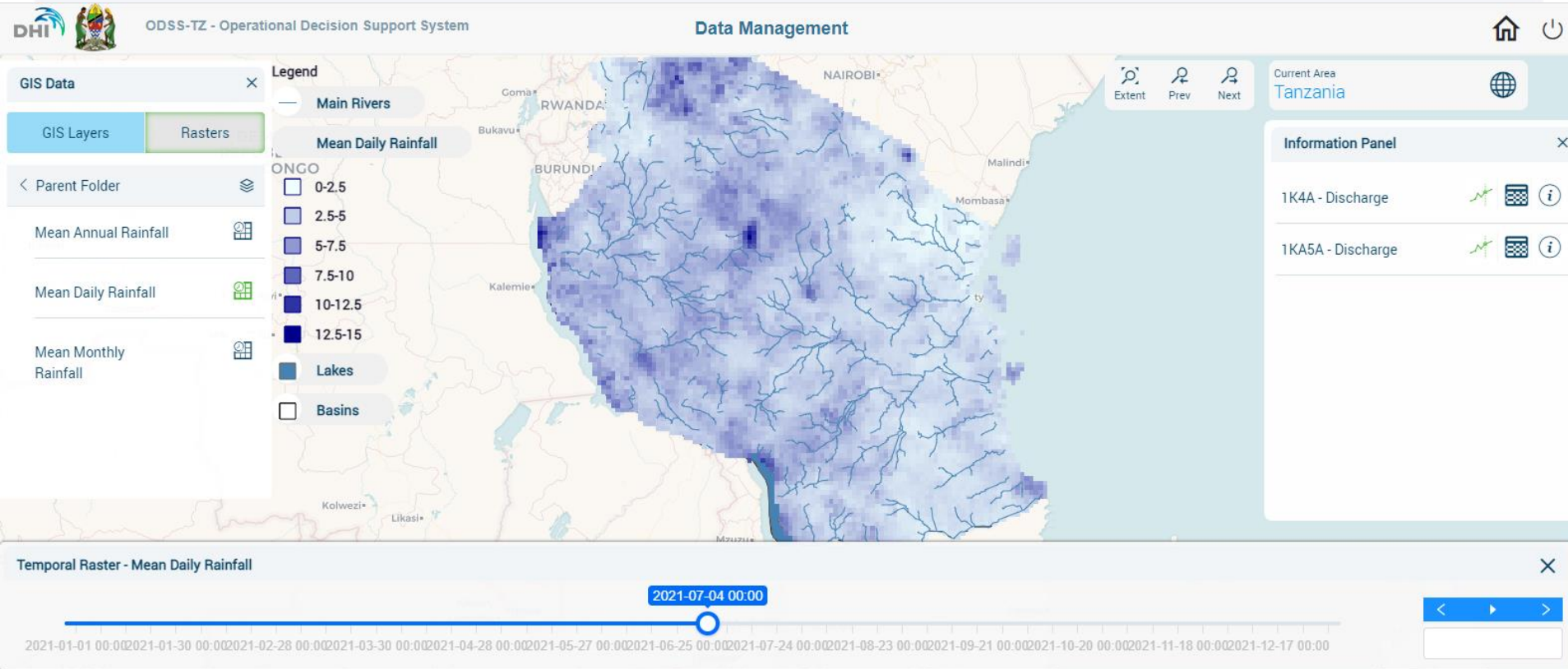
Key Features of the WRIS

- The WRIS
 - is linked to diverse data sources
 - shows latest data from external and internal sources
 - from public domain
 - from affiliated institutions
 - from own data repositories
- State variables in the WRIS include
 - historical
 - near real-time
 - forecast datasets

WRIS (selected features)



WRIS (selected features)



Components of the FEWS

- **Weather forecasting system** - using numerical weather prediction models (NWP) with quantitative precipitation forecasts (QPF) of the Tanzania Meteorological Authority (TMA)
- **Hydrologic forecasting system** - using rainfall-runoff models
- **Flood forecasting system** - with hydrodynamic modelling and data assimilation
- **Dissemination system** - to automatically alert stakeholders through different communication channels

FEWS – explore



11822985 - ODSS Tanzania - D... x Water Tools x +

https://watertools-portal.azurewebsites.net/portal/workspaces/odss-tz+-+operational+decision+support+system/applications/flood+forecasting+and+early+warning

DHI ODSS-TZ - Operational Decision Support System **Flood Forecasting and Early Warning**

Main view Dashboards Status board Configuration Scenario

← WamiRuvu 36.7471, -6.5297

By indicator By category

Q What are you looking for?

Observations Exceedance

- Water Level (32)
- Flow (6)
- Catchment Rainfall (10)
- Catchment Evaporation (10)
- Catchment Runoff (10)
- Combined Runoff (3)

WamiRuvu

Select a scenario:

Forecast Type
1D Flood Forecast

2023-04-11 07:45

Plot Table

TS plot option
Select TS, Create new plot

View 2D results:

Make longitudinal profiles:

Animations:

Type here to search

18:07 11-04-2023



FEWS – explore HYD forecast



The screenshot displays the 'Flood Forecasting and Early Warning' interface for the WamiRuvu region. The main view shows a map with several monitoring points marked by colored pins. A pop-up window for the '1GD2' point is visible, showing simulation settings for 'Timing of worst case event' (No exceedance), 'Simulation timeseries inputs' (Catchment Rainfall, Catchment Evaporation), and 'Simulation timeseries outputs' (Catchment Runoff, Thresholds). On the left, a sidebar lists various indicators such as Water Level (32), Flow (6), Catchment Rainfall (10), and Combined Runoff (3). On the right, a panel titled 'WamiRuvu' allows selecting a scenario (1D Flood Forecast) and displays a '1GD2 Catchment Rainfall' plot for the time of forecast from 09:00:00 to 17:00:00 on 2023-04-11. The plot shows a significant peak in rainfall around 13:00:00. Below the plot, there are controls for 'View 2D results', 'Make longitudinal profiles', and 'Animations'.



FEWS – explore HYD forecast



The screenshot displays the FEWS web application interface. The browser address bar shows the URL: <https://watertools-portal.azurewebsites.net/portal/workspaces/odss-tz++operational+decision+support+system/applications/flood+forecasting+and+early+warning>. The application title is "ODSS-TZ - Operational Decision Support System" and the main heading is "Flood Forecasting and Early Warning".

The interface is divided into several sections:

- Left Panel (WamiRuvu):** Contains a search bar and a list of indicators with toggle switches for visibility. The indicators are: Water Level (32), Flow (6), Catchment Rainfall (10), Catchment Evaporation (10), Catchment Runoff (10), and Combined Runoff (3).
- Map:** Shows a geographical map of the WamiRuvu region with various locations marked. A pop-up window for "1GD2" is displayed, showing "Timing of worst case event" (No exceedance) and simulation inputs/outputs.
- Right Panel (WamiRuvu):** Contains a "Select a scenario" dropdown set to "1D Flood Forecast", a timestamp "2023-04-11 07:45", and a plot of "1GD2 Catchment Runoff" showing a peak in runoff over time.

The Windows taskbar at the bottom shows the system clock as 18:09 on 11-04-2023.



FEWS – explore HD forecast



11822985 - ODSS Tanzania - D 2 x Water Tools

https://watertools-portal.azurewebsites.net/portal/workspaces/odss-tz-+-operational+decision+support+system/applications/flood+forecasting+and+early+warning

DHI ODSS-TZ - Operational Decision Support System

Flood Forecasting and Early Warning

Main view | Dashboards | Status board | Configuration | Scenario

WamiRuvu

35.7473, -6.3745

- Gulwe
- Kibaoni
- Kilosa Bridge 1GD2A - Misufini
- Malui
- Masanze Miyombo
- Masanze Mkondoa
- Miyombo village
- Mkata 1GD36
- Mkundi bridge
- Munisangara
- Railway Crossing Bridge
- Tindiga
- Ving'awe 1GD16A
- Zombo village
- 1GD16-Station
- 1GD35-Station

Flow (2)

Catchment Rainfall (0)

Ving'awe 1GD16A

Timing of worst case event
Water Level exceedance 2023-04-16 03:00

Simulation timeseries outputs

- Water Level (m)
- Thresholds

WamiRuvu

Select a scenario:

Forecast Type
1D Flood Forecast

2023-04-11 07:45

Plot | Table

TS plot option
Select TS, Create new plot

Ving'awe 1GD16A Water Level

View 2D results:

Make longitudinal profiles:

Animations:

© Mapbox © OpenStreetMap Improve this map

Type here to search

18:05 11-04-2023



FEWS – configure thresholds



Places Configuration

Run automatic setup

System: Ruvu | Forecast: Current 1D Flood Forec... | Indicator: Water Level

[Settings](#)

Name ↑	Calc. point/Feature association	Sim. Water Level	Obs. Water Level	Treh. 1 Water Level	Treh. 2 Water Level	Treh. 3 Water Level	Category	Quantile	Related doc.	Actions
Morogoro_Dwn_WL	Morogoro_Dwn_WL	River_Ruvu - 40237.232921601317 - HPoint-Water level		0 m	16 m	17 m	Water Level Locations			
Morogoro_Struct_Up_WL	Morogoro_Struct_Up_WL	River_Ruvu - 26953.79 - HPoint-Water level		0 m	24.5 m	25 m	Water Level Locations			
Morogoro_Up_WL	Morogoro_Up_WL	River_Ruvu - 14749.339211237992 - HPoint-Water level		0 m	24.5 m	25 m	Water Level Locations			
Mtoni_Dwn_WL	Mtoni_Dwn_WL	River_Ruvu - 99117.31 - HPoint-Water level		0 m	4.5 m	5 m	Water Level Locations			
Mtoni_Struct_Up_WL	Mtoni_Struct_Up_WL	River_Ruvu - 87988.69 - HPoint-Water level		0 m	3 m	3.5 m	Water Level Locations			



FEWS – explore flood forecast



The screenshot displays the FEWS web application interface. At the top, the browser address bar shows the URL: <https://watertools-portal.azurewebsites.net/portal/workspaces/odss-tz+-+operational+decision+support+system/applications/flood+forecasting+and+early+warning>. The application header includes the DHI logo and the text "ODSS-TZ - Operational Decision Support System". The main title is "Flood Forecasting and Early Warning".

The interface is divided into several sections:

- Left Panel (WamiRuvu):** Contains a search bar with the text "What are you looking for?". Below it are two toggle switches: "Observations" (turned on) and "Exceedance" (turned on). A list of indicators is shown with expandable arrows:
 - Water Level (32)
 - Flow (6)
 - Catchment Rainfall (10)
 - Catchment Evaporation (10)
 - Catchment Runoff (10)
 - Combined Runoff (3)
- Map:** A map of Dar es Salaam, Tanzania, showing the city layout, roads, and water bodies. The map is centered around the coordinates 39.2945, -6.9146. Several blue location markers are placed on the map, indicating specific points of interest or data collection sites.
- Right Panel (1D Flood Forecast):** Displays the forecast date and time: "2023-04-11 07:45". It includes a "Select previous forecast" button. Below this, there are options for "Plot" and "Table" views, and a "TS plot option" dropdown menu set to "Select TS, Create new plot". A large empty box is reserved for the forecast plot.
- Bottom Right Panel (View 2D results):** Contains a "View 2D results" toggle switch (turned on). Below it, there is a "Make longitudinal profiles" section with radio buttons for "Water Level" (selected) and "Discharge". A "Selected points" section has an "OK" button. At the bottom, there is an "Animations" toggle switch (turned on).

The Windows taskbar at the bottom shows the system tray with the date "18:24 11-04-2023" and the language set to "ENG".



FEWS – explore flood forecast



The screenshot displays the FEWS web application interface. The browser address bar shows the URL: <https://watertools-portal.azurewebsites.net/portal/workspaces/odss-tz-+-operational+decision+support+system/applications/flood+forecasting+and+early+warning>. The application title is "ODSS-TZ - Operational Decision Support System" and the main heading is "Flood Forecasting and Early Warning".

The interface is divided into several sections:

- Left Sidebar:** Contains navigation and filter options. The "WamiRuvu" location is selected. There are tabs for "By indicator" and "By category". A search bar asks "What are you looking for?". There are toggle switches for "Observations" and "Exceedance". A list of indicators is shown with expandable options: Water Level (32), Flow (6), Catchment Rainfall (10), Catchment Evaporation (10), Catchment Runoff (10), and Combined Runoff (3).
- Map:** A map of the WamiRuvu region in Tanzania, showing the Morogoro River and surrounding areas like Mikocheni, Oysterbay, and Mwananyamala. A red pin is placed on the Morogoro Bridge. A tooltip for "Morogoro Bridge" is visible, showing "Timing of worst case event: No exceedance" and "Simulation timeseries outputs: Water Level (m) and Thresholds".
- Right Panel:** Titled "WamiRuvu", it allows selecting a scenario. The "Forecast Type" is set to "1D Flood Forecast". The forecast date is "2023-04-11 07:45". There is a "Select previous forecast" button. Below this is a "Plot" section with a "TS plot option" set to "Select TS, Create new plot". A line graph shows "Morogoro Bridge Water Level" over time, with a peak around 2023-04-13 00:00. The y-axis ranges from 2.4 to 4.0 meters. There are horizontal threshold lines at approximately 3.5m and 3.8m. Below the graph are controls for "View 2D results", "Make longitudinal profiles", and "Animations", each with a toggle switch.

The Windows taskbar at the bottom shows the system time as 18:26 on 11-04-2023.



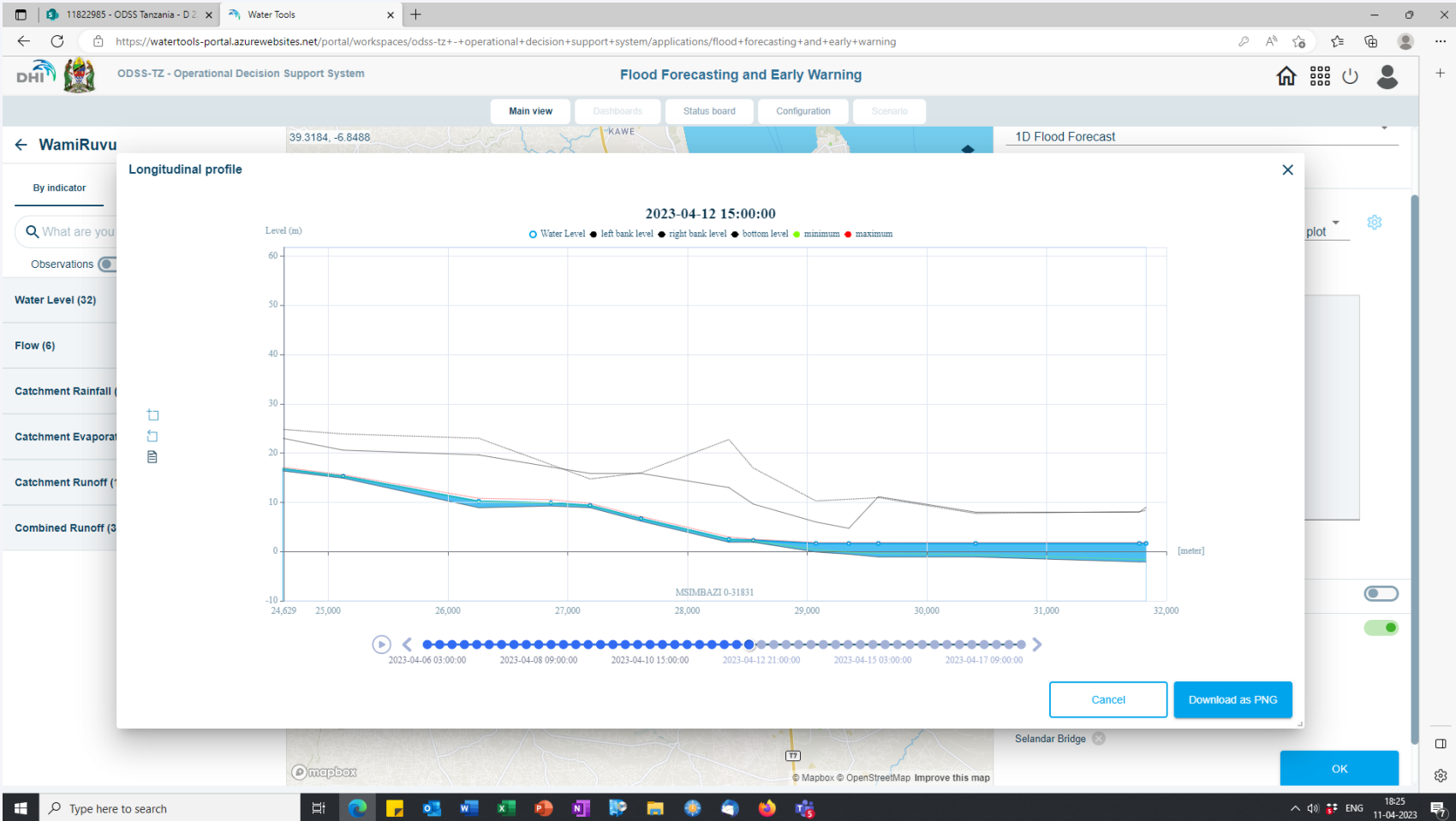
FEWS – explore flood forecast



The screenshot displays the 'Flood Forecasting and Early Warning' web application. The interface includes a navigation menu on the left with 'WamiRuvu' selected, a central map of Dar es Salaam showing a blue flood forecast line along the coast and inland, and a right-hand panel for '1D Flood Forecast' with options for 'Plot' and 'Table'. The bottom of the image shows a Windows taskbar with various application icons and a system tray with the date '11-04-2023' and time '18:24'.



FEWS – explore flood forecast



FEWS – disseminate alerts

Flood Alerts and Warnings 2023-01-01 @ ODSS-TZ FFEWS

odsstz@gmail.com

To: Jakob Luchner; Mekuria Beyene; bertha.tarimo@maji.go.tz; edward@wemaconsult.com; elijomassy@gmail.com; Elise Usaj; erasmotarimo@yahoo.com; fatuma.mambomlimbila@maji.go.tz; fmambo@rocketmail.com; george.lugomelo@maji.go.tz; hoseasanga@gmail.com; hoseasanga@yahoo.com; jknobert@gmail.com; jkwtiga@gmail.com; joseph.kwitiga@maji.go.tz;

generated: 2023-01-01 07:53
simulation: Simulation of Scenario of WamiRuvu_FFEWS_HD at 2023-01-01 07:46:14
start of simulation: 2022-12-27 12:00
time of forecast: 2023-01-01 12:00
end of simulation: 2023-01-08 12:00

Flood Forecast - forecasted Water Level (max. 168 hours)

Status	Location	Alert	Water Level [m]	Warning Threshold [m]	Danger Threshold [m]
 	Miyombo - 27170	Danger	469.09	468	469
 	Kinyasungwe - 17818	Warning	788.29	788	789
 	Miyombo - 17103	Warning	491.53	491	492
 	Miyombo - 29430	Warning	464.85	464	465
 	Miyombo - 32554	Warning	461.58	461	462
 	Mkondoa - 35570	Warning	476.03	476	477
 	Mkondoa - 98931	Warning	380.76	380	381
 	Diwale - 34270	Ok	358.74	361	362
 	Kinyasungwe - 37048	Ok	761.14	762	763
 	Miyombo - 8537	Ok	509.28	515	516
 	Mkondoa - 26059	Ok	498.11	500	501
 	Mkundi - 10470	Ok	763.12	772	773

Purpose of the WUPA

- WUPA supports decision making for **granting new water use permits** and evaluating existing permits.
- WUPA includes **water balance and allocation** functionality based on a dynamic water resources system model.
- WUPA enables **analysing the effects** of existing and applied for water abstractions on the basin's water balance.
- Risk of water shortages may vary according to monthly variation in water availability and permits. Therefore, new permits may influence the area in which a permit is given and other areas in the basin (e.g., downstream abstractions in a river).

WUPA – applications & permits



Water Tools | ODSS-TZ - Operational Decision Support System | Water Use Permit Application

Studies | APPLICATIONS | ASSESSMENTS

Brown
To create an assessment select the applications that should be assessed [Start new assessment](#)

Application ID	Name holder	Type of use
86	M/ki mradi wa maji kimasaki	Socio economic irrigation
196	Nest of god trust limited	Socio economic industrial
110	Excutive director kiliflora ltd	Environmental
1	Gustav makwela lyimo	Public supply
119	Omani ramadhani mshana	Socio economic industrial

ID	Applicant	Type of use	Abstraction type	Water demand	Date of application	Recommendation	
<input checked="" type="checkbox"/>	86	M/ki mradi wa maji kimasaki	Socio economic irrigation	Usa river	864 m3/d	7 Oct 2007	Not available
<input type="checkbox"/>	196	Nest of god trust limited	Socio economic industrial	Usa river	864 m3/d	8 Oct 2020	Not available
<input type="checkbox"/>	110	Excutive director kiliflora ltd	Environmental	Usa river	34560 m3/d	1 May 2018	Not available
<input type="checkbox"/>	1	Gustav makwela lyimo	Public supply	Usa river	1728 m3/d	1 Nov 2018	Not available
<input type="checkbox"/>	119	Omani ramadhani mshana	Socio economic industrial	Usa river	17.28 m3/d	1 Jan 2019	Not available

Rows per page: 10 | 1-5 of 5

Map Legend

- Included in assessment
 - Application (Pink circle)
 - Permit (Purple diamond)
- Applications: Water demand [m3/day]
 - > 5 000 (Red circle)
 - 1 000 - 5 000 (Orange circle)
 - < 1 000 (Yellow circle)
- Active Permits: Water demand [m3/day]
 - > 5 000 (Red diamond)
 - 1 000 - 5 000 (Orange diamond)
 - < 1 000 (Yellow diamond)
- Expired permits: Water demand [m3/day]
 - > 5 000 (Red diamond)
 - 1 000 - 5 000 (Orange diamond)
 - < 1 000 (Yellow diamond)



WUPA – applications & permits



Water Tools | ODSS-TZ - Operational Decision Support System | Water Use Permit Application

Home | Settings | Profile

APPLICATIONS | ASSESSMENTS

Studies

Brown
To create an assessment select the applications that should be assessed [Start new assessment](#)

Application ID	Name holder	Type of use
86	M/ki mradi wa maji kimasaki	Socio economic irrigation
196	Nest of god trust limited	Socio economic industrial
110	Excutive director kiliflora ltd	Environmental
1	Gustav makwela lyimo	Public supply
119	Oinari ramadhani mshana	Socio economic industrial

Rows per page: 10 | 1-5 of 5

Map Legend

Included in assessment

Name: MWENYEKITI MRADI WA MAJI BOMA LA LAIDESON

Permit ID: 45 y

Type of use: socio economic irrigation

Source: N DURUMA

Amount [m3/day]: 2246.4 y

Application Date: 18 Jun 2024

[Add to assessment](#)

Expired permits:

- > 5 000
- 1 000 - 5 000
- < 1 000

© Mapbox | © OpenStreetMap | Improve this map | Maxar

Windows taskbar: Type here to search | 18:33 | 11-04-2023



WUPA – analyse effects

Water Tools | ODSS-TZ - Operational Decision Support System | Water Use Permit Application

← Back to Assessments

Assessment November 2022

Model run progress 100% done

Note Edit

Applications included in assessment Edit

Id	Applicant	Type of use	Abstraction type	Water demand	Recommendation
110	Excutive director killiflora ltd	Environmental	Usa river	34560 m3/d	Undecided
196	Nest of god trust limited	Socio economic industrial	Usa river	860 m3/d	Undecided
86	M/ki mradi wa maji kimasaki	Socio economic irrigation	Usa river	864 m3/d	Undecided

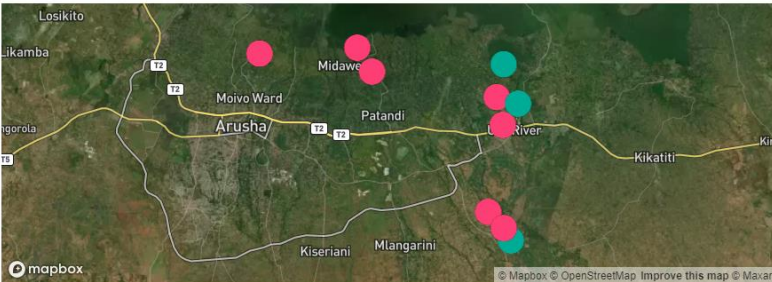
Permits and expired permits included

All

Scenario option Edit

Very dry year

Dashboard: Assessment November 2022



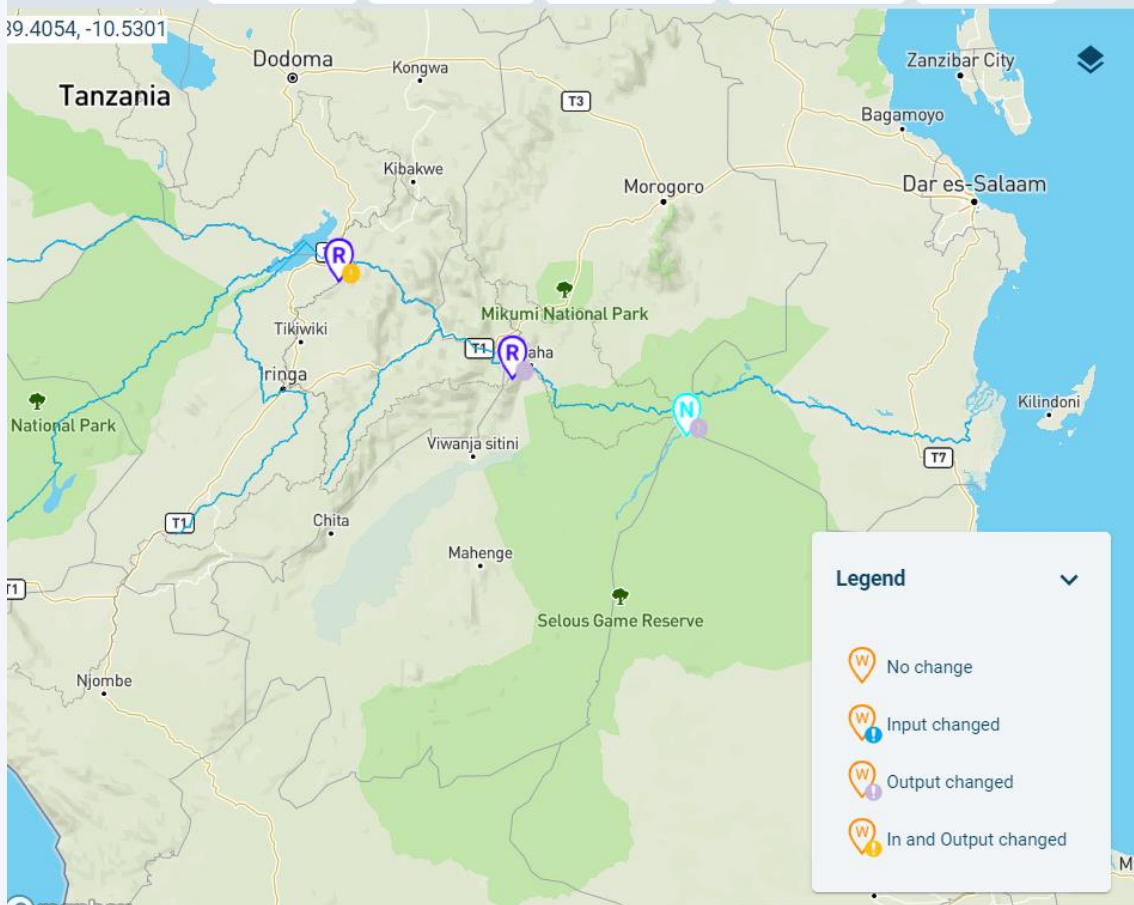
	Supply	Demand	Deficit
January	443,432	456,817	13,385
February	443,948	456,817	12,869
March	446,668	456,817	10,149
April	455,037	456,817	1,780
May	455,037	456,817	1,780
June	451,283	456,817	5,533
July	447,030	456,817	9,787
August	444,482	456,817	12,335
September	442,536	456,817	14,280
October	451,303	456,817	5,514
November	447,920	456,817	8,897
December	447,205	456,817	9,612

Purpose of the DOS

- Hydrological flow forecasting models based on **seasonal weather forecasts** and with **embedded operation rules** for reservoirs are used to support reservoir operations for improved and integrated water resources management.
- The tools support **decisions for efficient water allocation** from reservoirs in low flow periods: This allows minimising water shortages and optimising reservoir releases in high flow periods to reduce downstream floods.

DOS – dam release effects


Main view Dashboards Status board Configuration Scenario



View and create what-if scenario







Find simulation:


Forecast Type
Seasonal Forecast

2022-11-07 08:54  Select simulation by date

What if scenarios

+ Create new what-if scenario

<input checked="" type="checkbox"/>	pReduc80 2022-11-08 12:38:16			
<input type="checkbox"/>	pReducv2 2022-11-08 14:04:53			

Results TS plot option
Select TS, Create new plot 

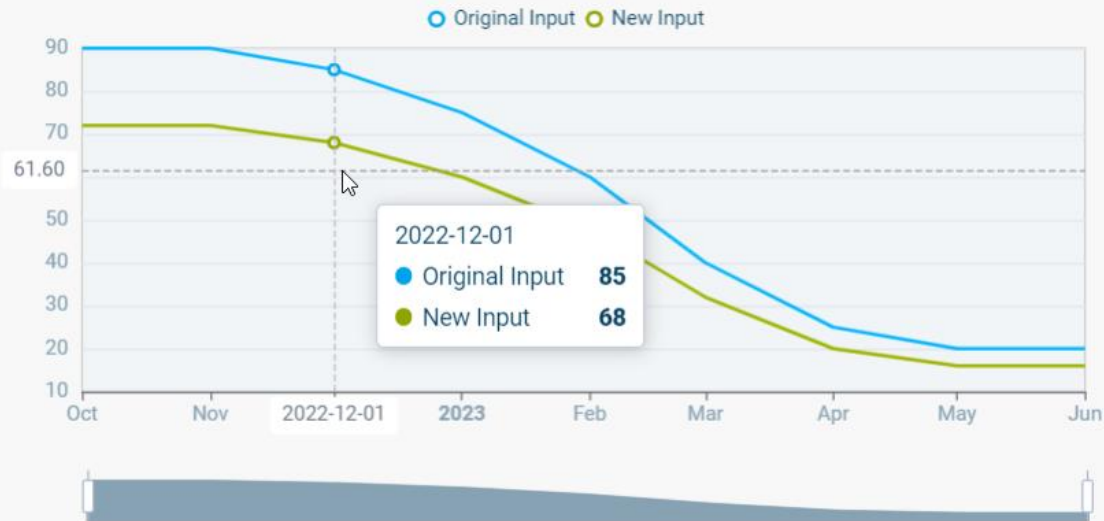
DOS – define scenario



Mtera



HP Target Power

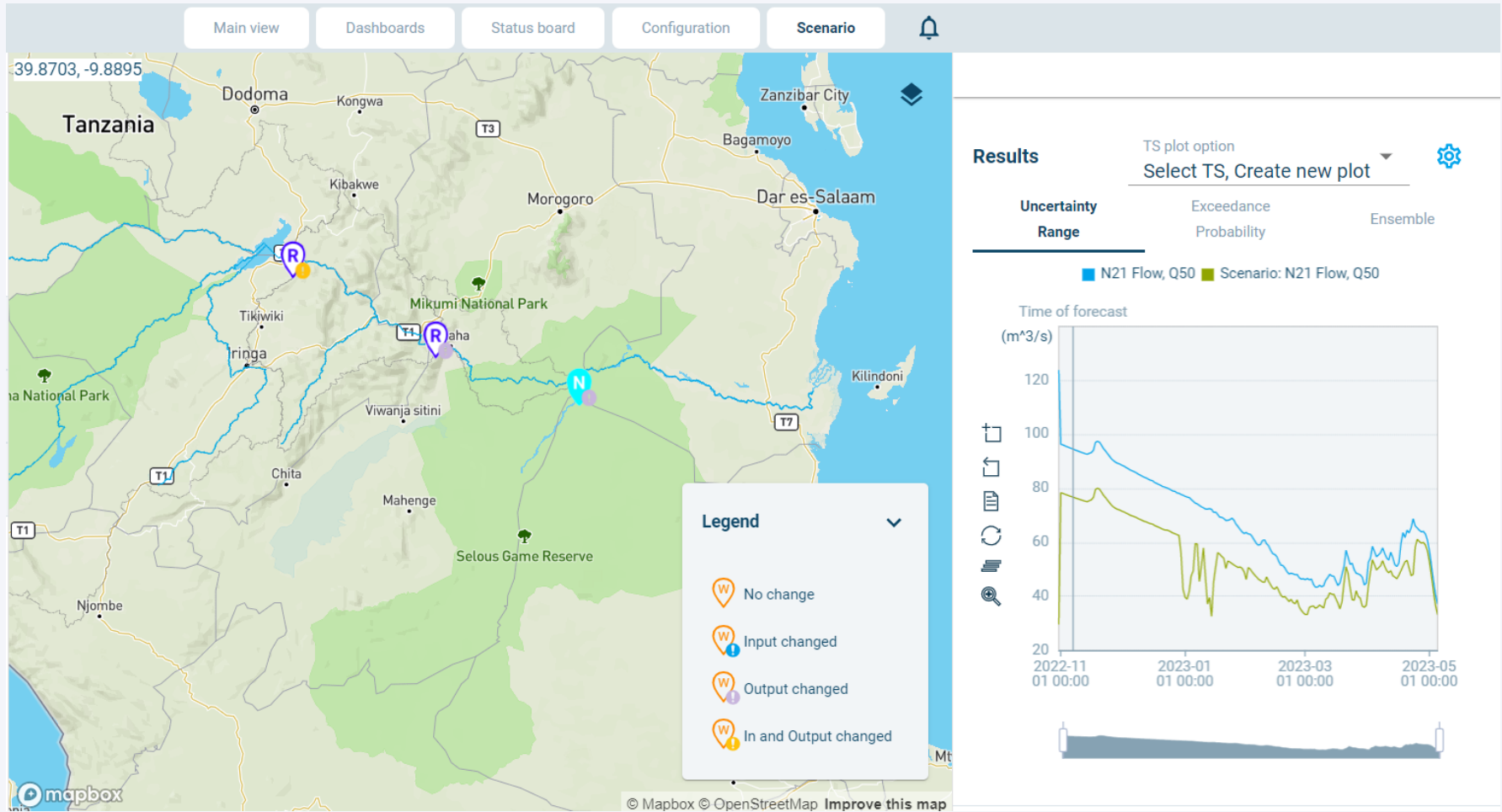


Chart

Duration

Table

DOS – compare scenarios



DOS – dashboard



ODSS – integrated solution

- Water resources information system (WRIS)
- Flood early warning system (FEWS)
- Water use permitting analysis tool (WUPA)
- Dam operation support tool for reservoir operations (DOS)

Decision Support System

various phases of Decision Support Systems

	data provided by	data analysed by	options generated by	decision selection by	decision implemented by	approach to decision making
1	decision maker					completely unsupported
2	GIS / DB	decision maker				information supported
3	GIS / DB	MODEL	decision maker			systematic analysis
4	GIS / DB	MODEL	ODSS		decision maker	sys. analysis alternatives
5	GIS / DB	MODEL			decision maker	system with over-ride
6	GIS / DB	MODEL				automated

E040325c

Computer-Aided DSS (Loucks & van Beek)



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INITIATIVE DU BASSIN DU NIL



**THANK
YOU!**