



UNESCO-IHE  
Institute for Water Education



# Earth Science Oriented Data Processing Tools and Applications for Black Sea Catchment Basin

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MINISTRY OF EDUCATION AND RESEARCH



**TECHNICAL UNIVERSITY**  
OF CLUJ-NAPOCA

**C G I S**  
Computer Graphics  
and Interactive Systems

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# Workshop subjects



Time	Subject	Instructor
13:45 - 14:05	enviroGRIDS project overview: Portal, Tools and Applications	Dorian Gorgan
14:05 - 14:25	Grid based processing and data management	Victor Bacu, Denisa Rodila, Dorian Gorgan
14:25 - 15:15	SWAT model calibration and execution by gSWAT application	Victor Bacu
15:15 - 15:45	coffee break	
15:45 - 16:00	Interoperability between Geospatial and Grid infrastructures	Denisa Rodila
16:00 - 17:00	Spatial data visualization by BASHYT	Pierluigi Cau, Simone Manca
17:00 - 17:15	Remote sensing applications	Victor Bacu, Dorian Gorgan
17:15 - 17:30	Training in Earth Sciences by eGLE	Dorian Gorgan



# enviroGRIDS Project



- **enviroGRIDS** - Gridifying the Black Sea catchment to support its sustainable development (<http://www.envirogrids.net>)



- Founded by the European Commission FP7 framework (Theme 6: environment), April 2009 – March 2013, 27 partners, 7.9 mil EUR.



- Coordinator

- University of Geneva, Switzerland



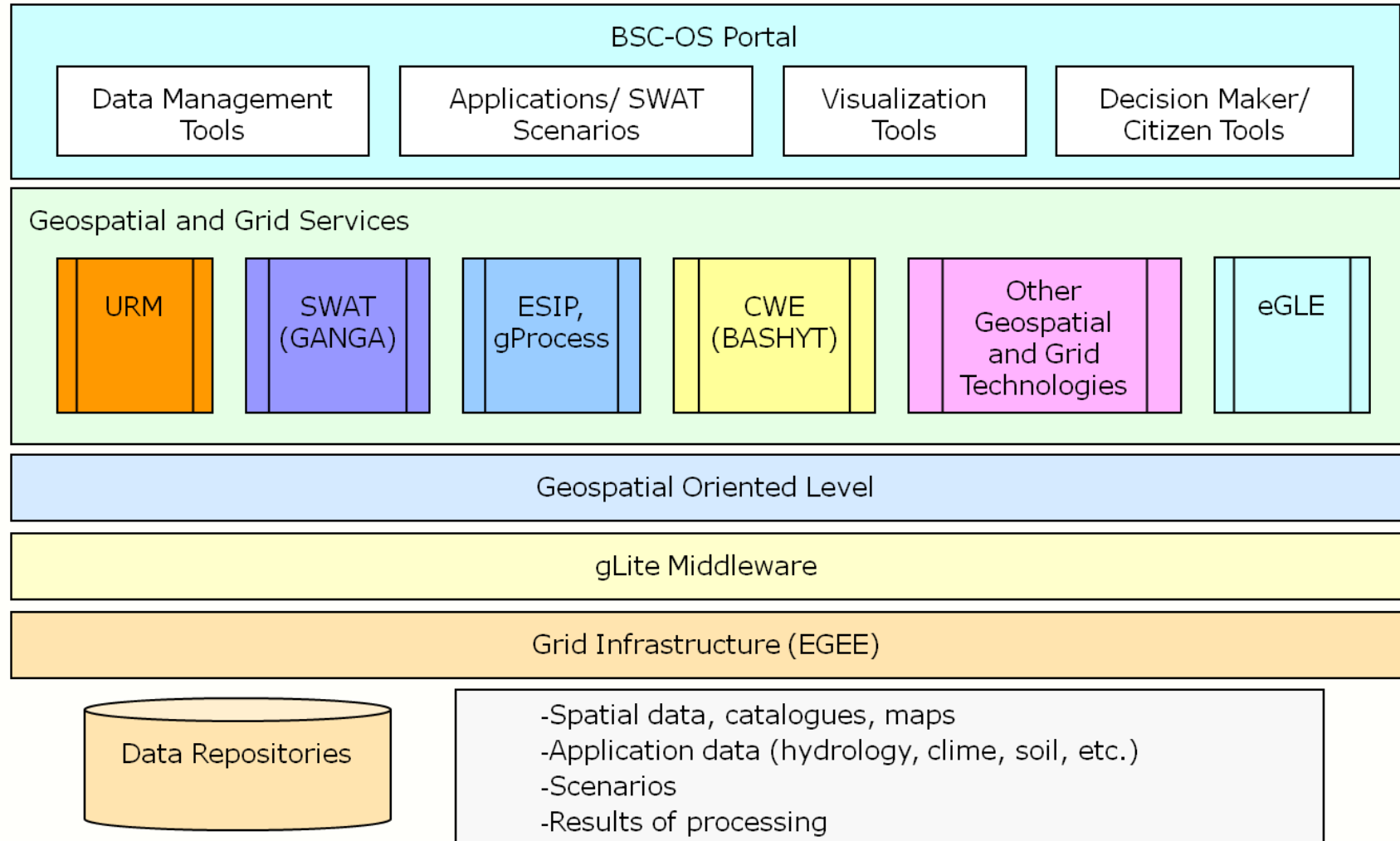
- Objectives:

- Develop a SDI (Spatial Data Infrastructure) targeting the Black Sea catchment region
- Use new international standards to store, analyze, process, and visualize important information regarding this area
- Perform distributed spatially-explicit simulations of environmental changes

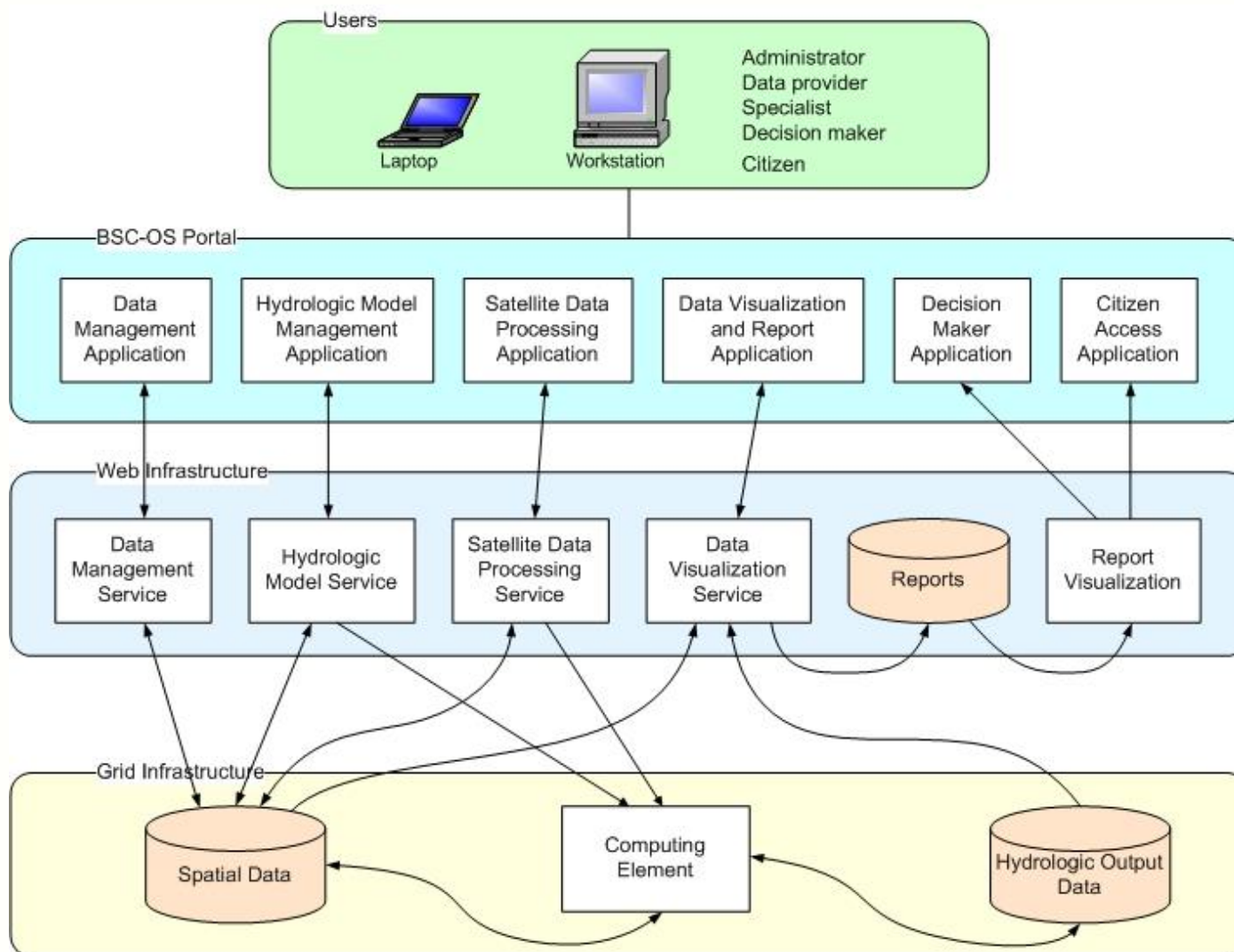


- Single way of the user to get into the enviroGRIDS system
- Exposes personalized tools for different category of users: data manager, earth science specialist, decision maker, citizen, and system administrator.
- Provide applications for:
  - data management
  - hydrologic models calibration and execution
  - satellite image processing
  - report generation and visualization
  - virtual training center
- Support interoperability between the Geospatial and Grid infrastructures on security, heterogeneous data access, distributed data processing
- EnviroGRIDS functionality gathers services provided by various technologies such as SWAT related modules, Collaborative Working Environment (CWE), Uniform Resource Management (URM), gProcess, ESIP, and eGLE platforms

# Portal Architecture



# Data Flow Throughout the Portal



# Specific Objectives

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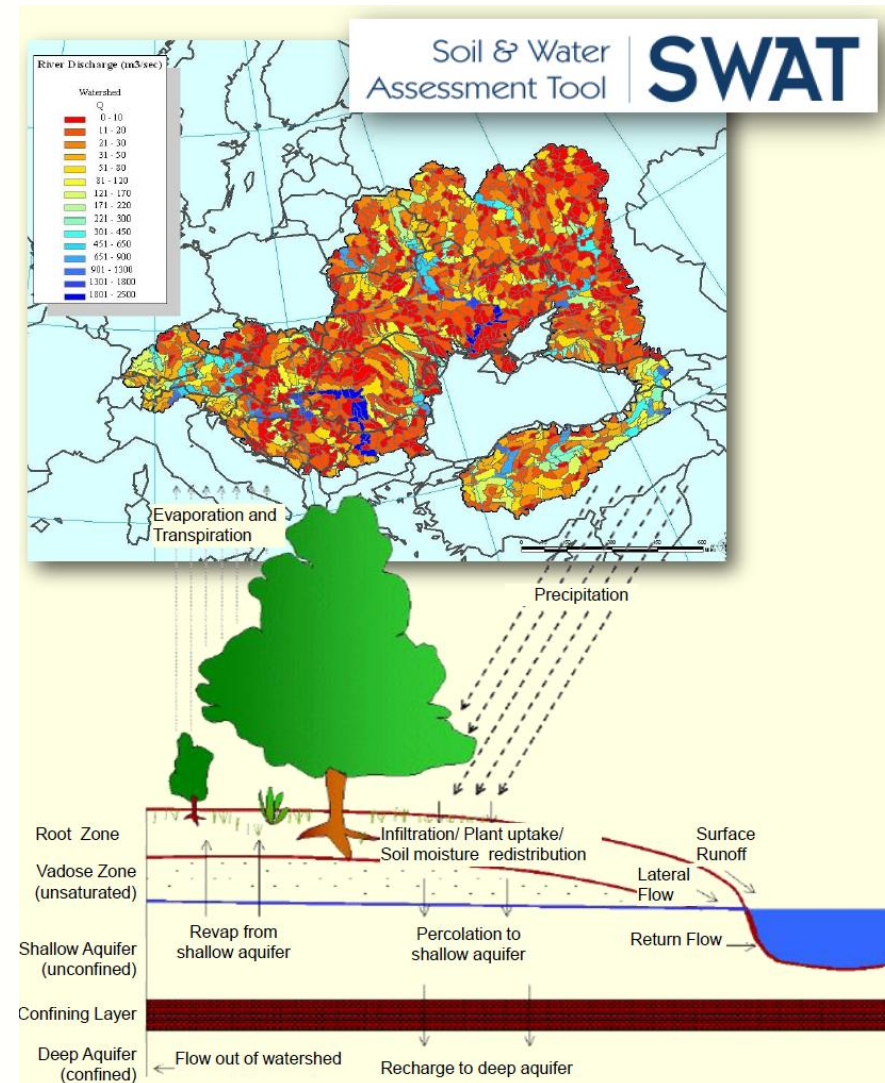
- ❑ Link, gather, store, manage and distribute key environmental data concerning the Black Sea Catchment Basin
- ❑ Large scale and high resolution distributed hydrological models
- ❑ Gridification of tools and applications
- ❑ Model and process huge spatial data over the Grid (e.g. hydrological models, satellite images, and maps)
- ❑ Develop early warning and decision support tools at regional, national and local levels





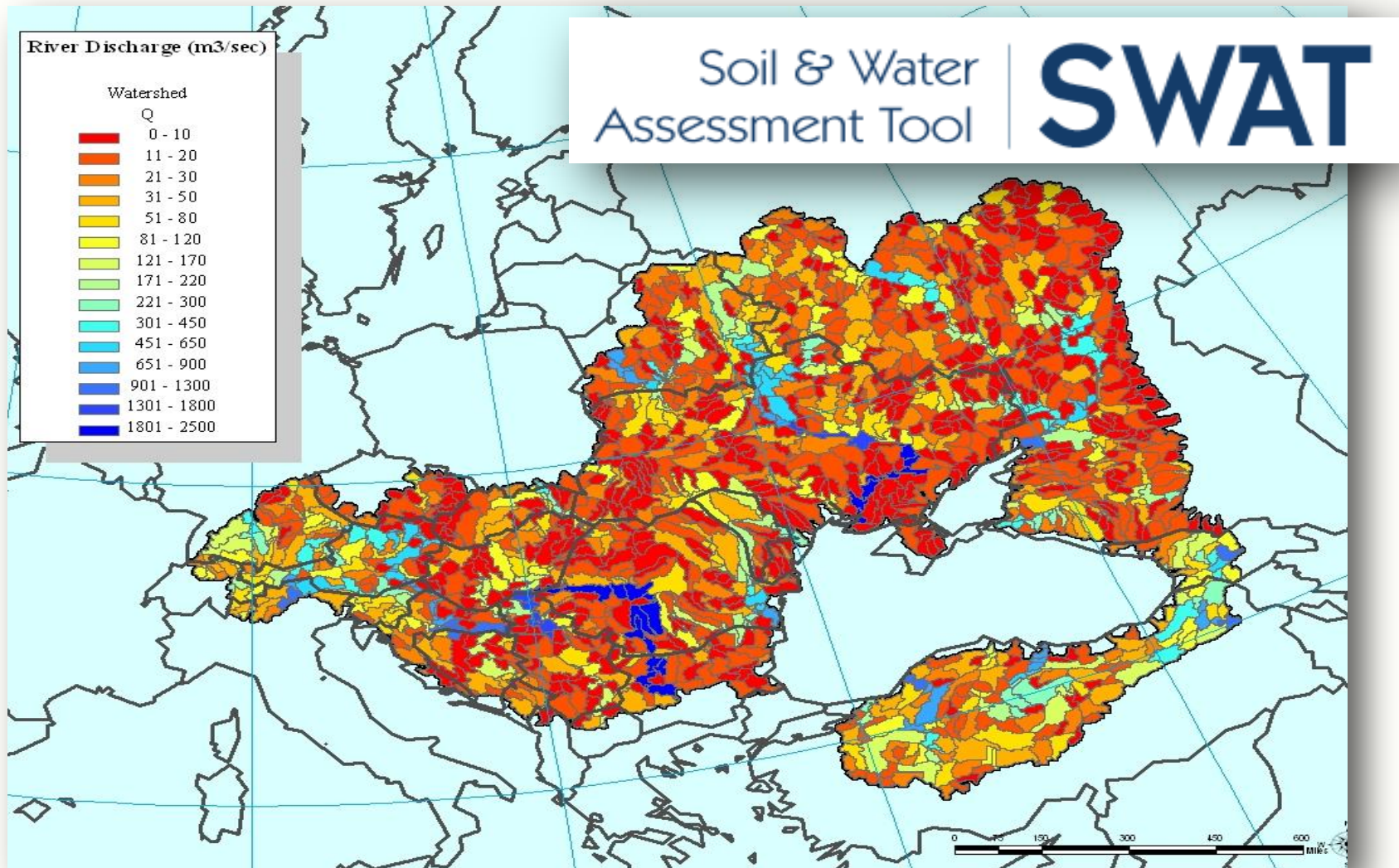
# Hydrological Models - SWAT

- SWAT (Soil Water Assessment Tool)
  - hydrological model
  - operates on a daily time step
  - used for predicting the water resources, sediment, and chemical yields in a specific watershed
- Input data: weather, soil properties, topography, vegetation, and land management practices of the watershed
- SWAT estimates the impact of land management practices on water quantity and quality in complex watersheds
- The SWAT model must pass through a careful calibration and uncertainty analysis





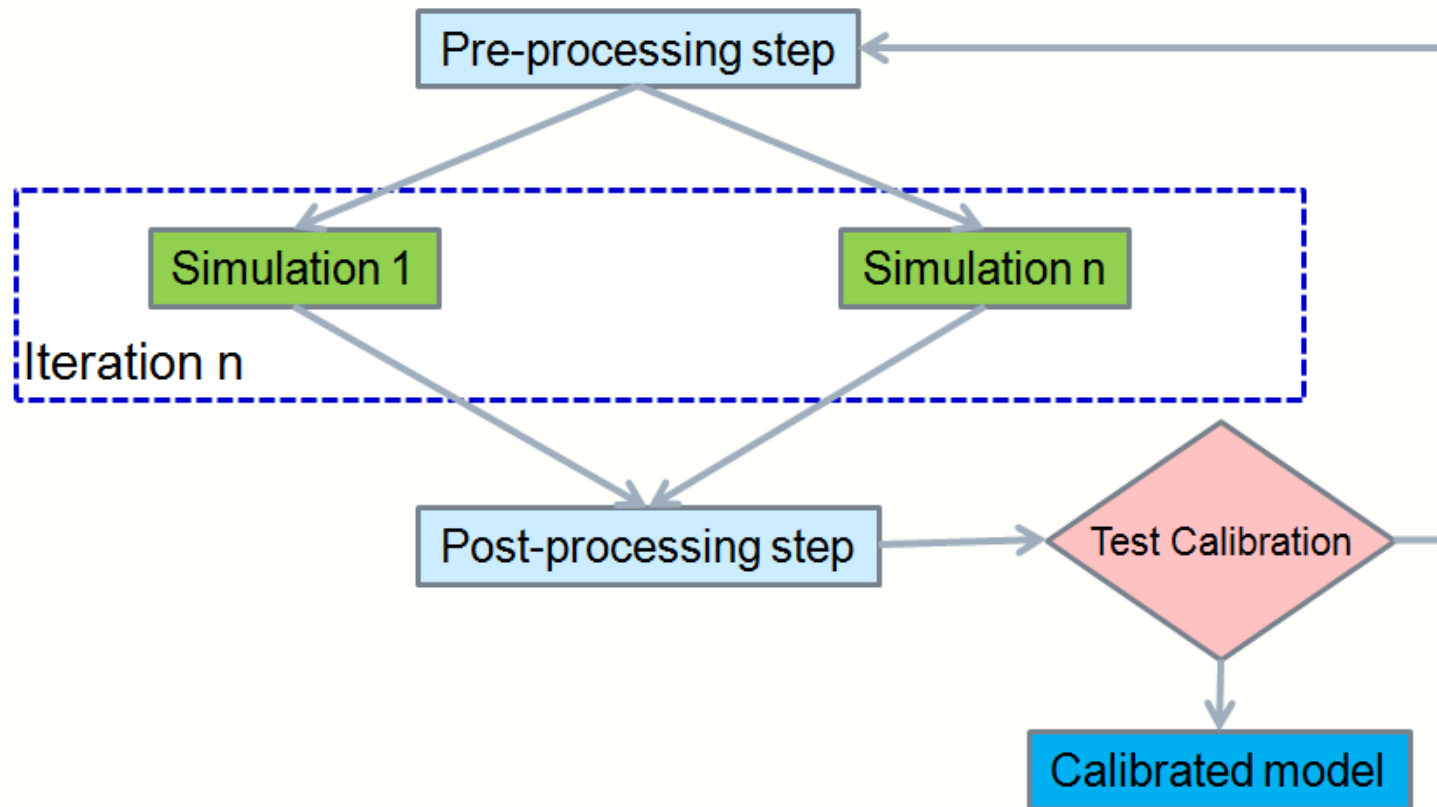
# Black Sea Catchment Basin



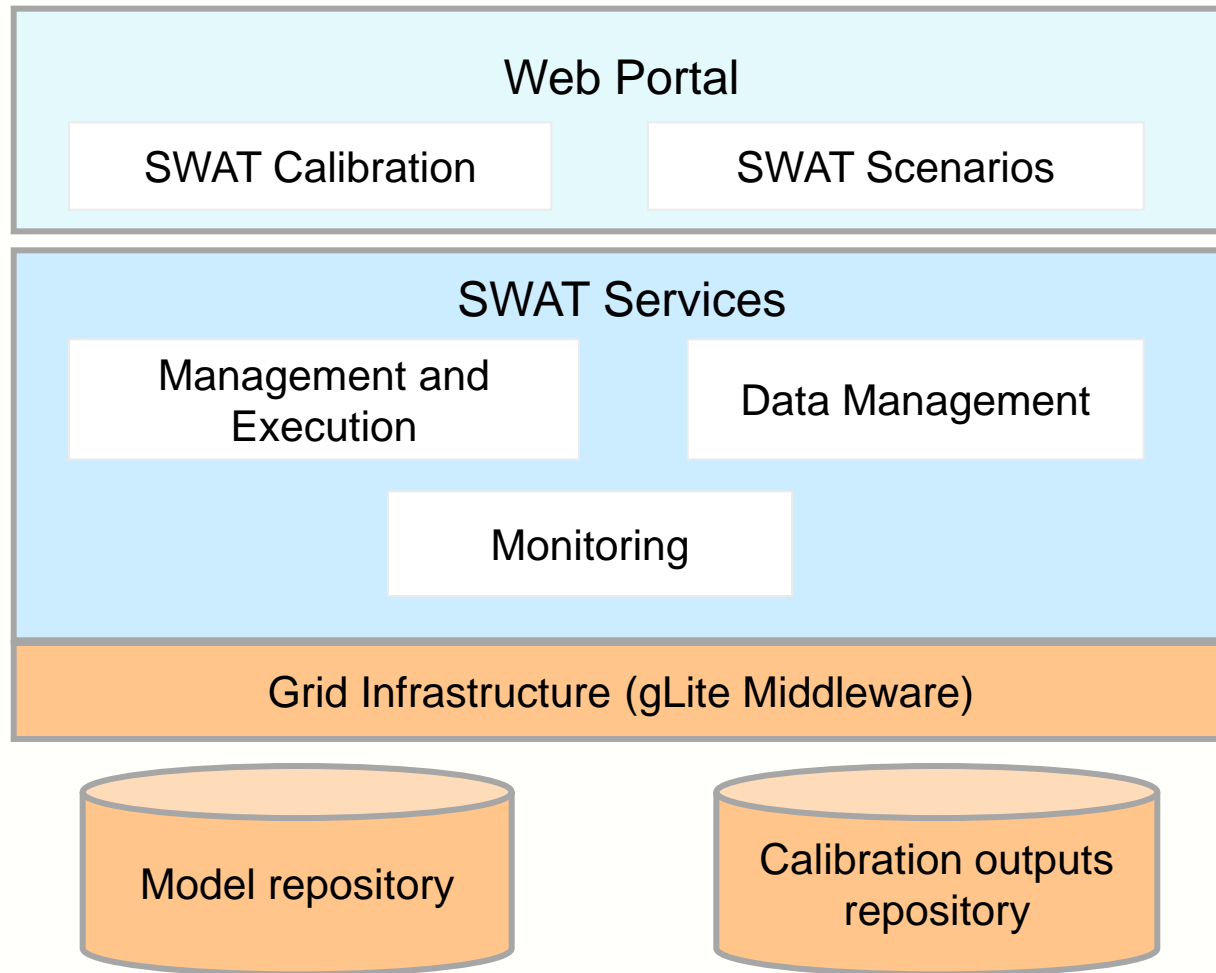
- ❑ Many input data required by the SWAT model -> store the data on Storage Elements
- ❑ The calibration process requires running a high number of iterations, each iteration consisting in a high number of simulations -> execution on different Grid Worker Nodes
- ❑ Allows the calibration of the SWAT models and the execution of different scenarios based on a calibrated SWAT model on GRID infrastructures

- ❑ Support the SWAT model development in the BSC-OS Portal
- ❑ Model calibration and execution over the Grid infrastructure
- ❑ Project management of the hydrological model
- ❑ SWAT data visualization
- ❑ Project upload and download
- ❑ Support interaction with visualization tools
- ❑ Support interaction with scenarios development tools

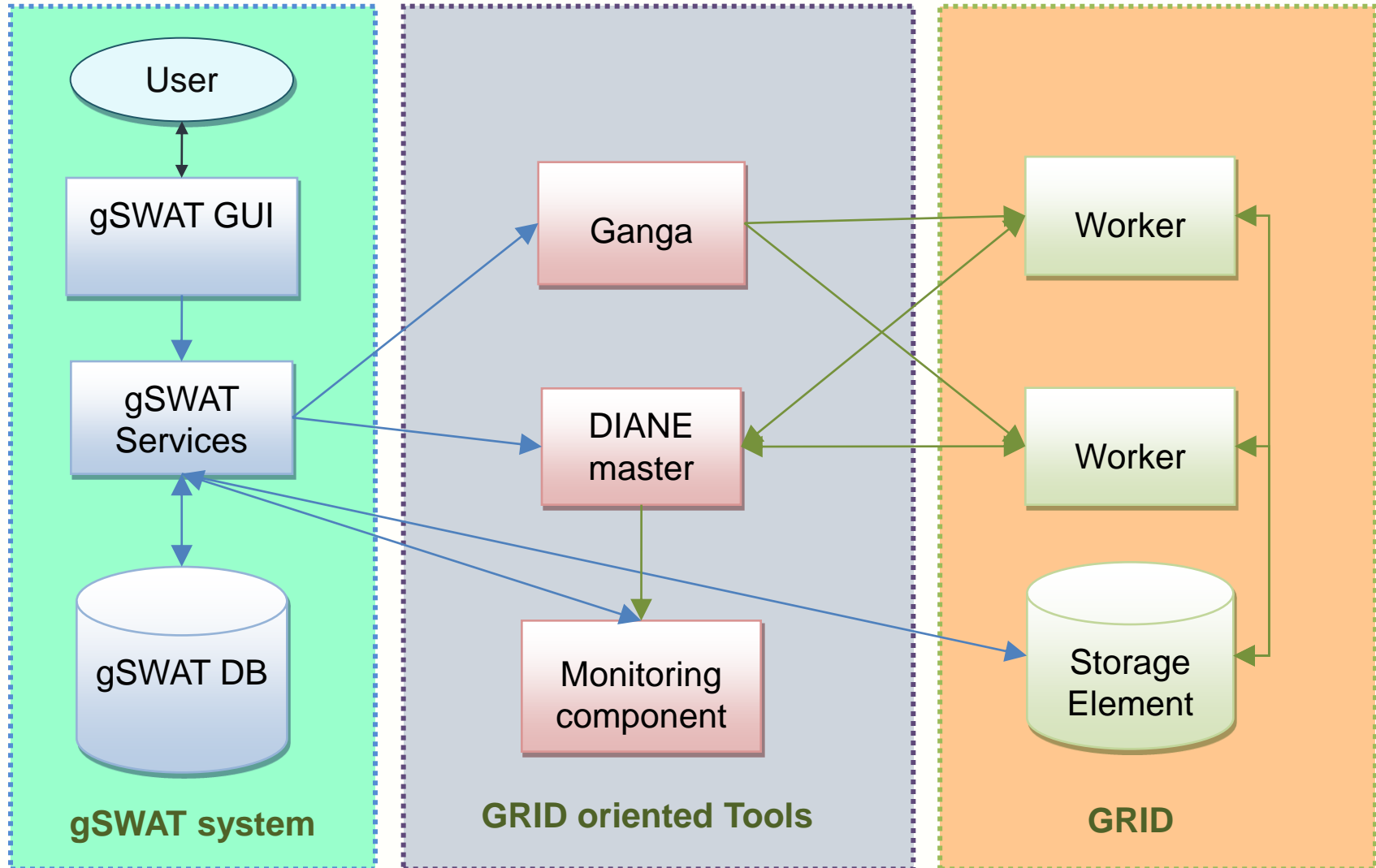
# Processing Steps



# gSWAT Application - Architecture




# gSWAT Control Flow




- Project list and detailed information on the selected project

**Projects List**

**Project0**  
Created at: Sat Jan 29 20:21:57 GMT+0200 2011  
Status: Uploading project 

**Project1**  
Created at: Sat Jan 29 20:21:57 GMT+0200 2011  
Status: Incomplete uploading

**Project2**  
Created at: Sat Jan 29 20:21:57 GMT+0200 2011  
Status: Loaded project

**Project3**  
Created at: Sat Jan 29 20:21:57 GMT+0200 2011  
Status: Running iteration 

**Project4**  
Created at: Sat Jan 29 20:21:57 GMT+0200 2011  
Status: Finished iteration

**Name:** Project4

**Created at:** Sat Jan 29 20:21:57 GMT+0200 2011


**Executing since:** Sat Jan 29 20:21:57 GMT+0200 2011 (13min ago)

**Status:** SWAT model calibration ended successfully

**ArcSwat model:** ArcSwat 2009

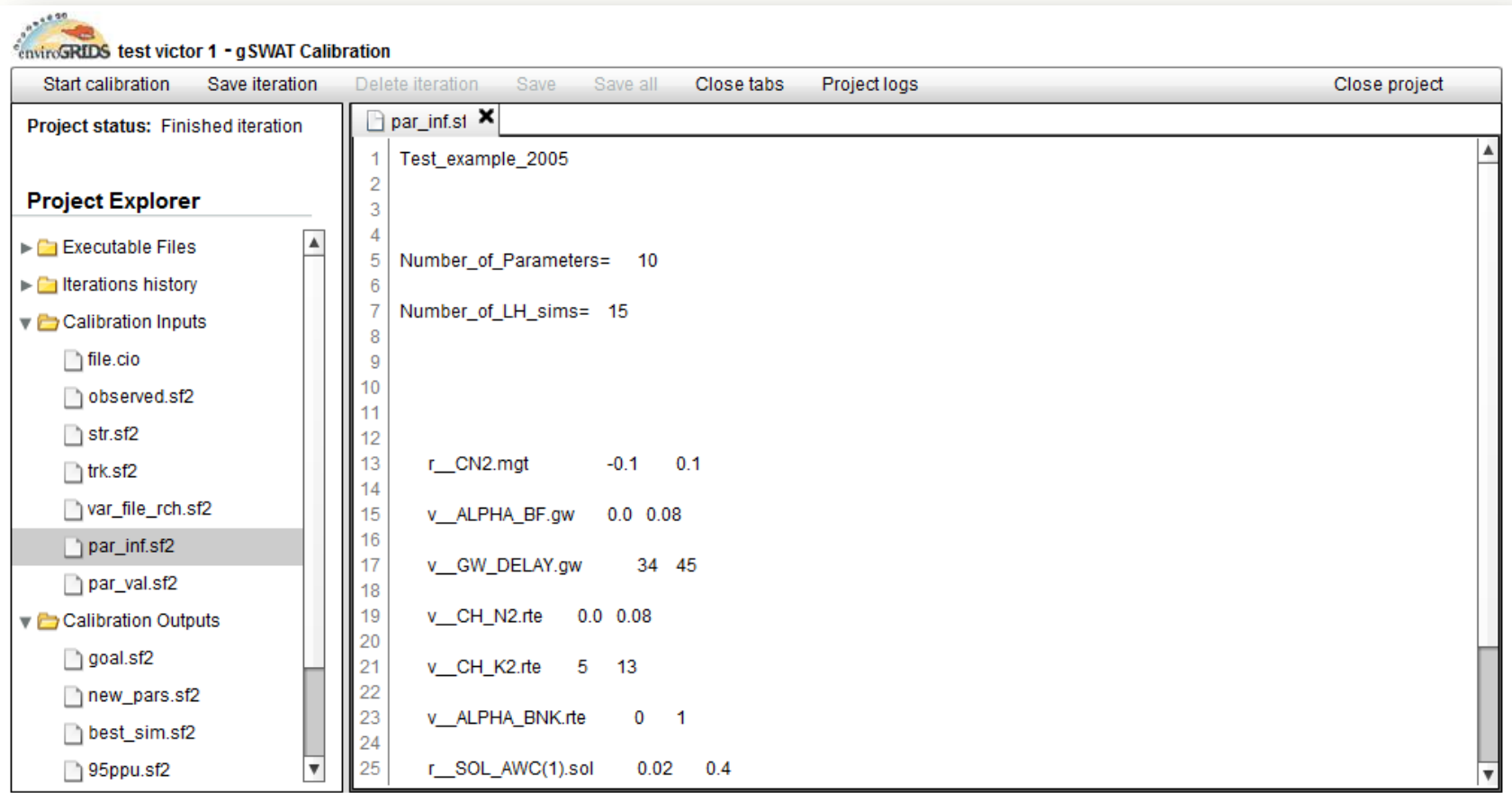
**Description:**

Project 4 description

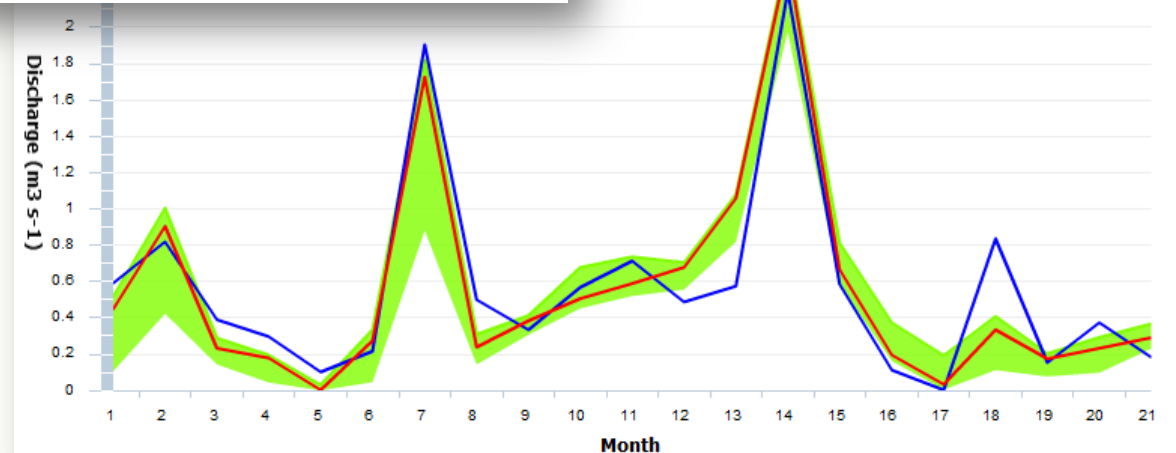
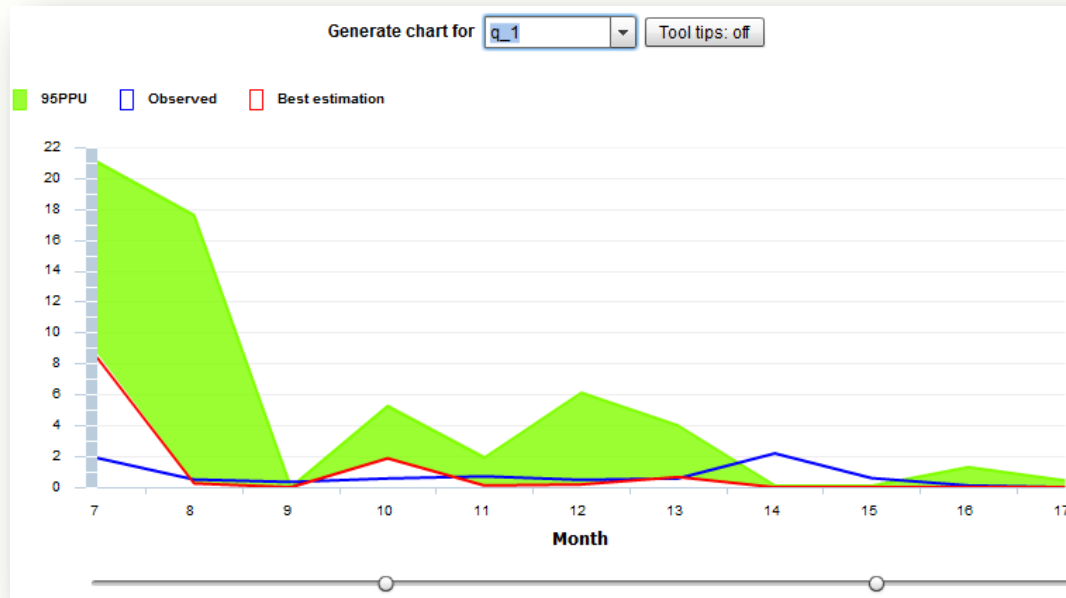
[Output results:](#) 



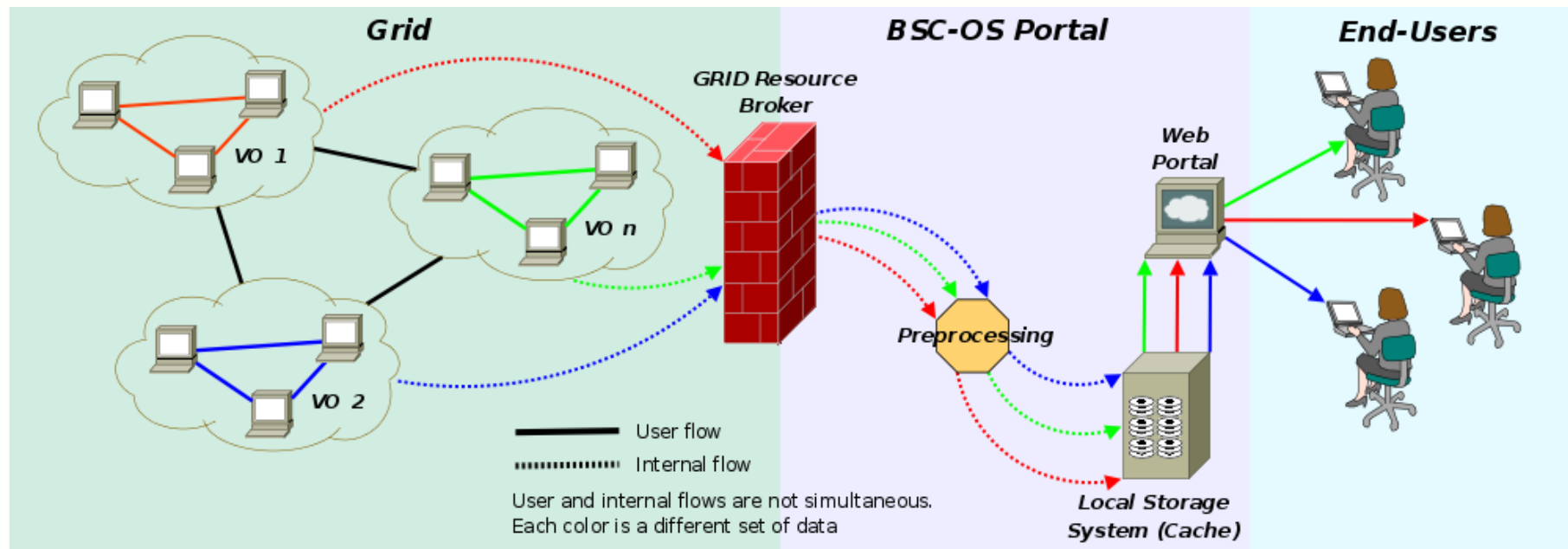
# Modify SUFI2 Calibration Parameters



# Calibration Output Visualization



# Spatial Data Visualization by BASHYT



# Graphical User Interface Development



**ASHYT DSS**  
Basin Scale Hydrologic Toolkit

Argilla Web Editor ( layer )

Editing Modules/Layers/data/swat/spatialite/sw\_avg\_month\_b (d: 1063 / f: 237)

commands:

**Select All**

```
<layer
  type="polygon"
  connectiontype="ogr"
  connection="/var/lib/tomcat-6/web
  data="SELECT * from FROM v_shp_su
  filter="([date_m]=%month%)"
  classitem ="subbasin"
  labelitem="subbasin"
>
<class>
  <label
    color =' 0 0 0 '
    type ='truetype'
    font ='a020'
    size=' 8'
  />
```

**Distribuzione Mensile Dicembre / 2007**

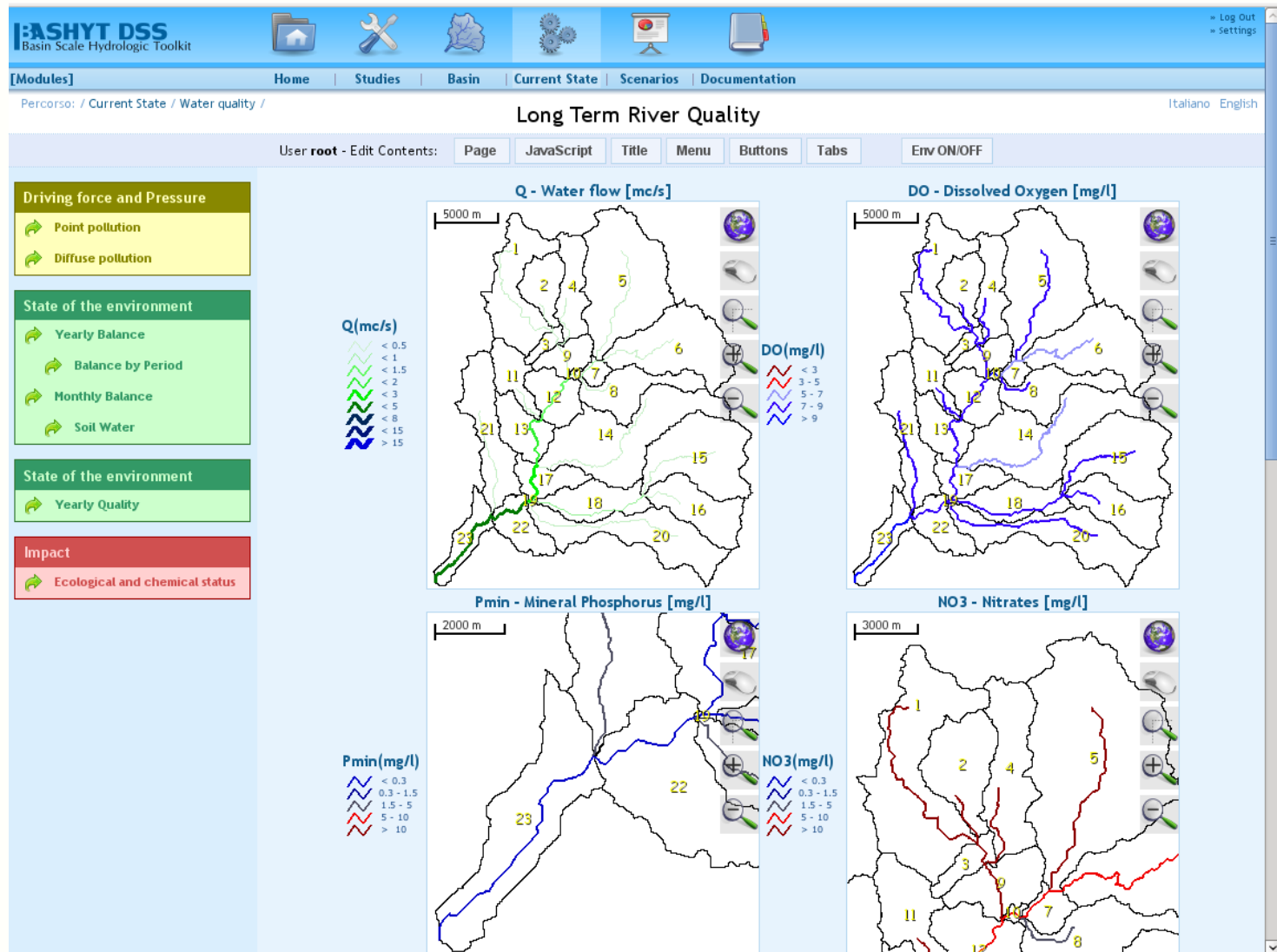
**SW(mm)**

< 10
< 20
< 30
< 40
< 50
< 60
< 70
< 80
< 90
< 100
< 120
< 140
< 160
< 180
< 200
< 220

The output is shown on the portal using widgets like maps, charts or tables. They can be organized using HTML and javascript



# Spatial Data Visualization



- Explore images to identify objects and give them a significance
- Analysis: detect, identify, classify, measure and evaluate the significance of physical and cultural objects, their patterns and spatial relationships
- Applicability in different Earth Science domains
  - Land cover
  - Air pollution
  - Hydrology
  - Ecology
  - etc

- Satellite image types used for different purposes
  - Landsat
  - MODIS
  - Aster
  - Quickbird, etc
- Size: depending on the geographical region size and on the containing information, satellite images could reach a couple of Gb in size



# GreenLand Vegetation Indices

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- Vegetation index based image classification
  - NDVI (Normalized Vegetation Index)
  - EVI (Enhanced Vegetation Index)
  - IPVI (Infrared Percentage Vegetation Index)
  - GEMI (Global Environment Monitoring Index)
  - SAVI (Soil-Adjusted Vegetation Index)
- Classification process - combines different bands in the Landsat satellite images in order to correctly make the classification



# GreenLand App. - Satellite Image Proc.



GreenLand Interpolation Interface

Input data selection    Processing status

victorbacu ( Logout )

Select geographical area

Input processing data selection

Upload all    Remove all

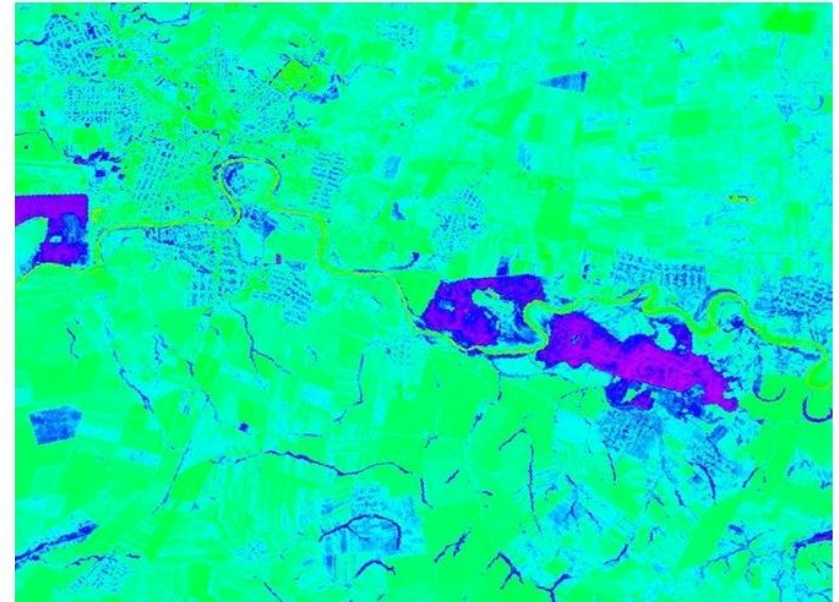
Check all	Image name	Options	NDVI	EVI	IPVI	SAVI	GEMI
<input checked="" type="checkbox"/>	romania1		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	romania2		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/>	romania3		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	romania4		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	romania5		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	romania6		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Map



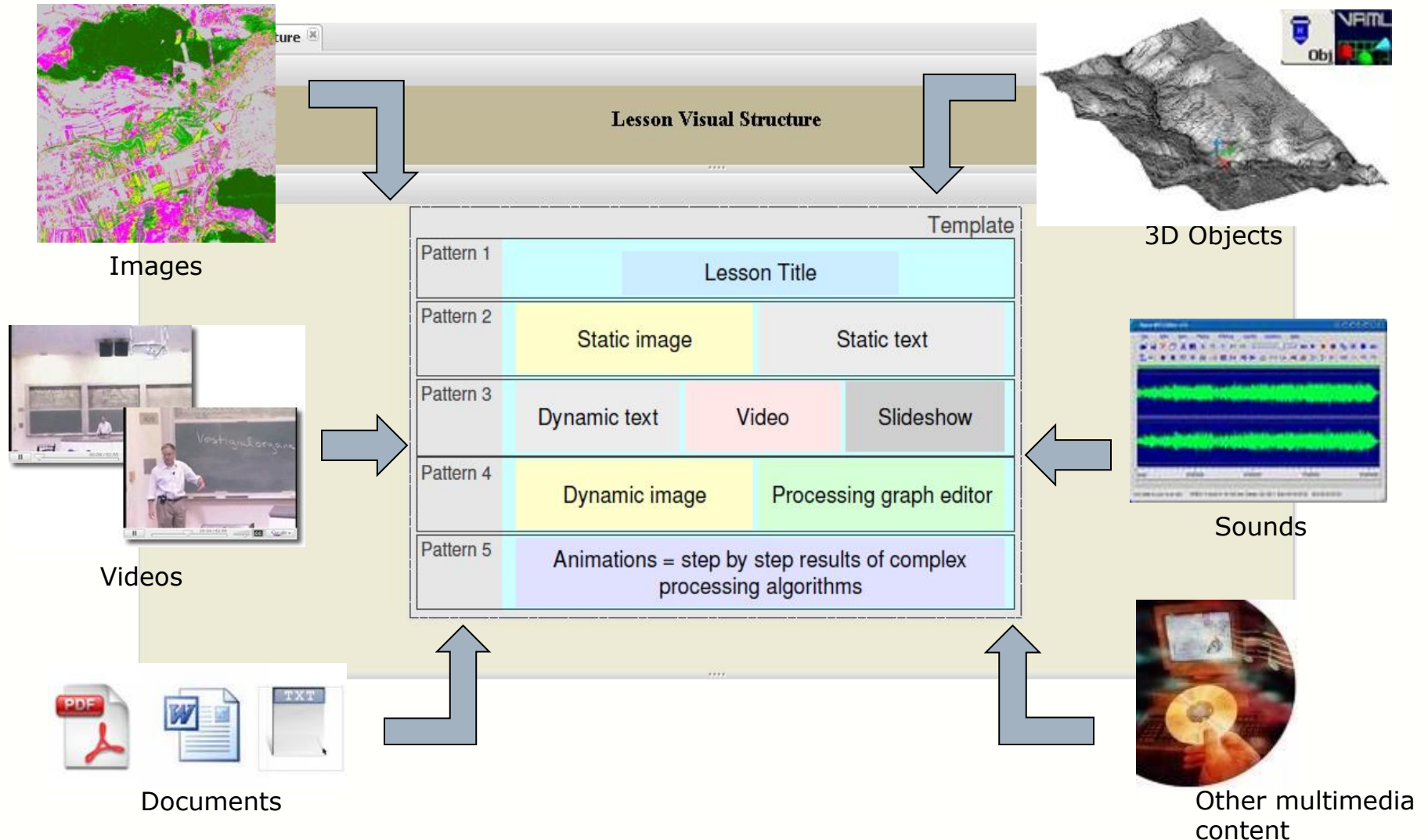
# GreenLand Application

- Classification output (right image) based on input satellite image (left image)

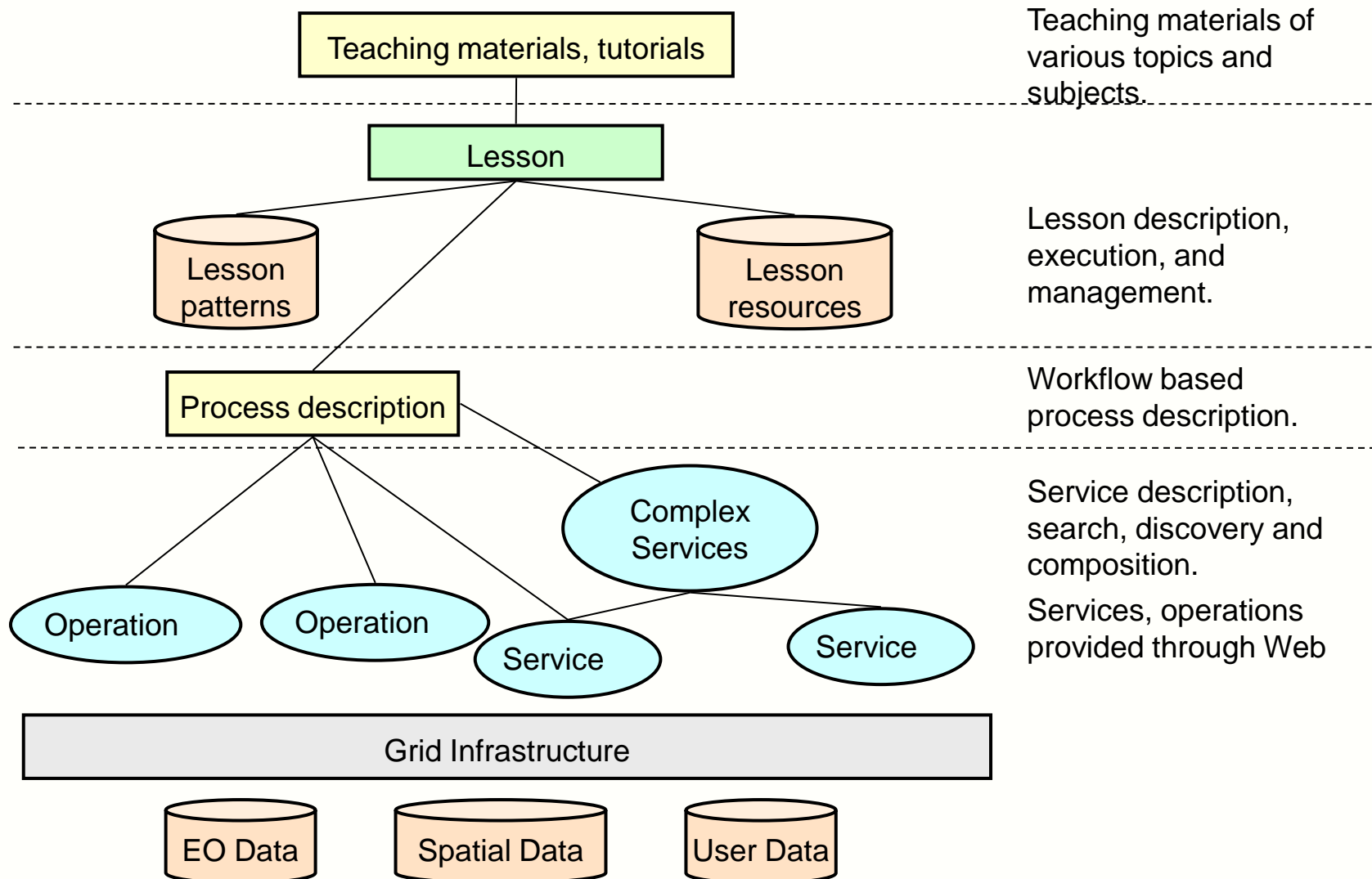




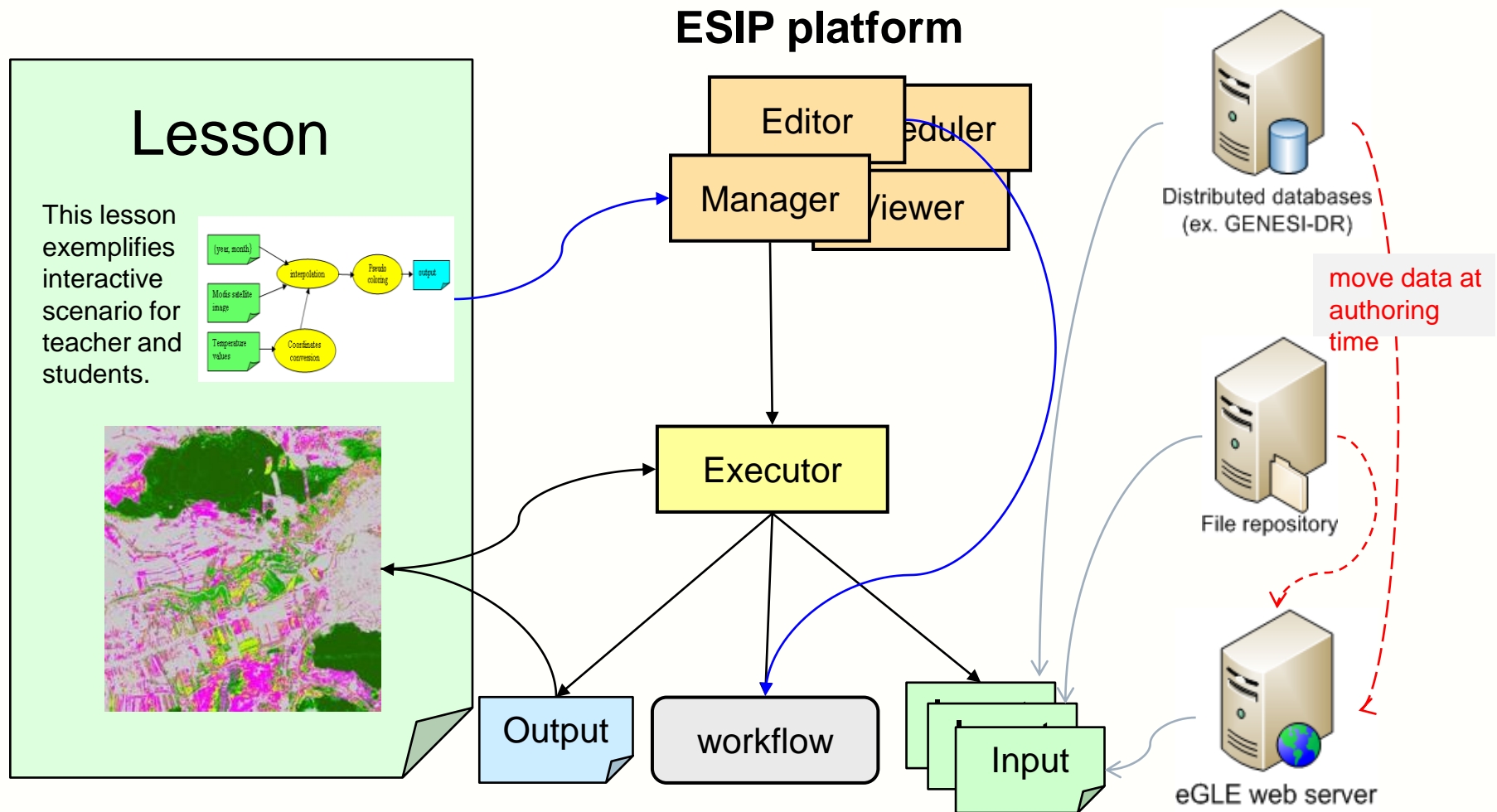
# Virtual Training Center -Lessons



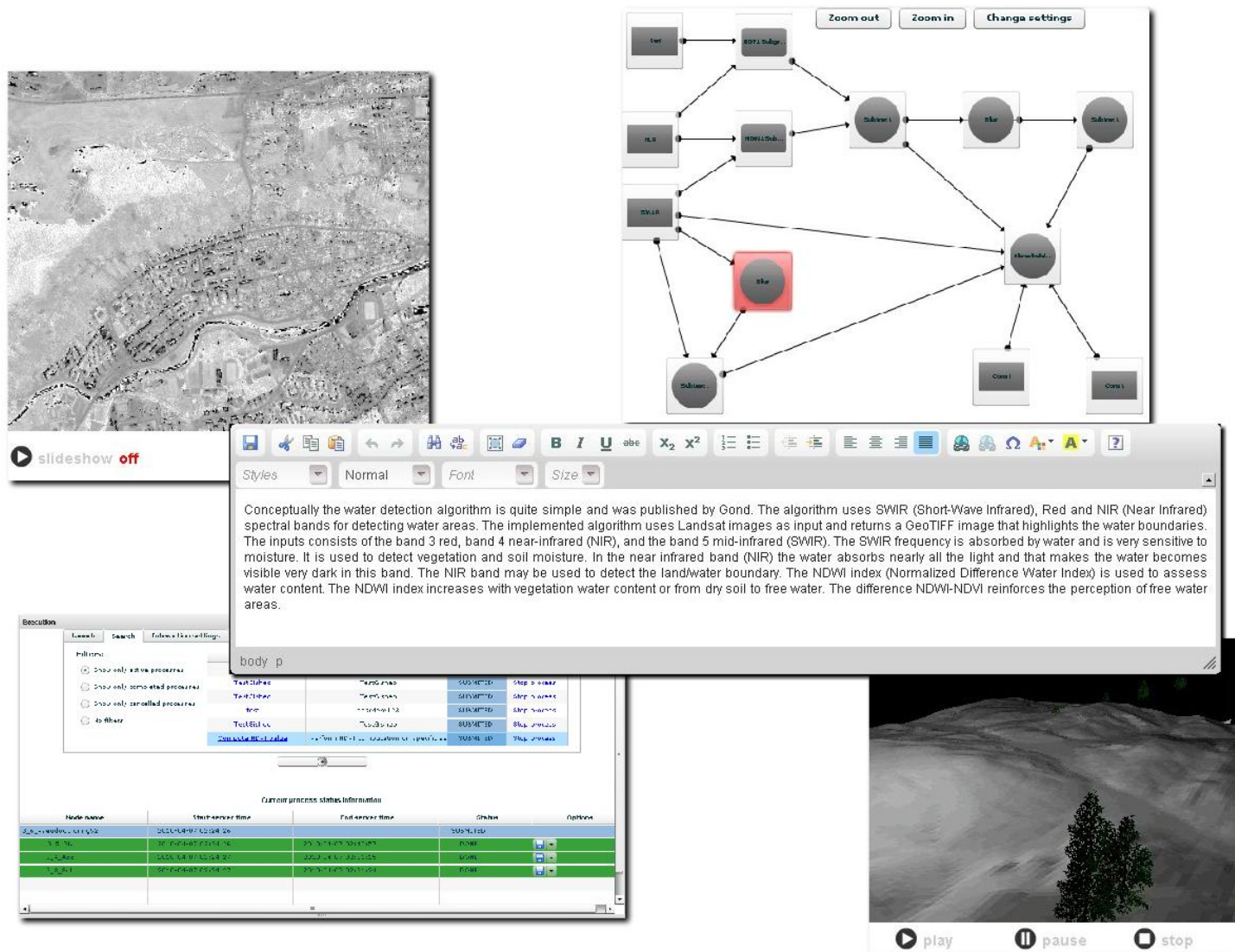
# Teaching Material Description



# Grid Based Execution of Env. Scenarios

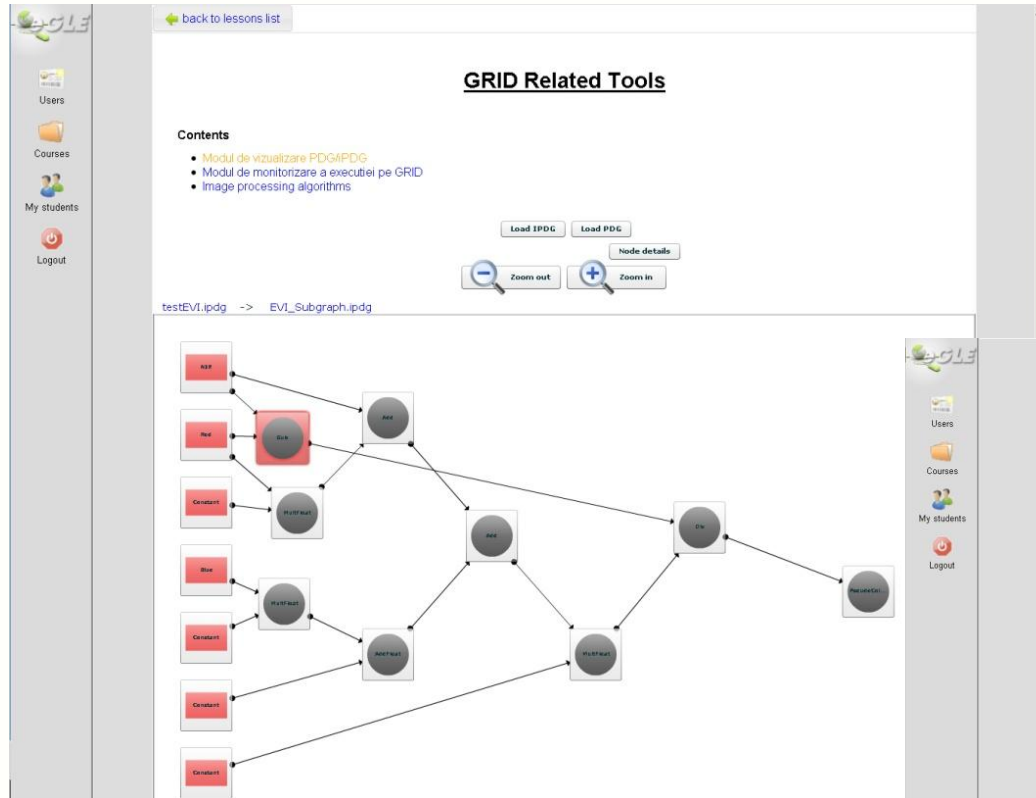


# eGLE Tools





# Lesson Samples – GRID Oriented Tools



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## GRID Related Tools

Contents

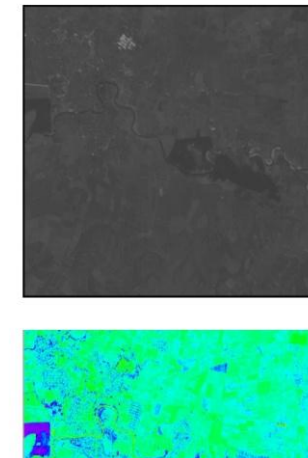
- Modul de vizualizare PDG4PDG
- Modul de monitorizare a execuției pe GRID
- Image processing algorithms

### NDVI - normalized difference vegetation index

The **Normalized Difference Vegetation Index (NDVI)** is a simple numerical indicator that can be used to analyze remote sensing measurements, typically but not necessarily from a space platform, and assess whether the target being observed contains live green vegetation or not.

Live green plants absorb solar radiation in the photosynthetically active radiation (PAR) spectral region, which they use as a source of energy in the process of photosynthesis. Leaf cells have also evolved to scatter (i.e., reflect and transmit) solar radiation in the near-infrared spectral region (which carries approximately half of the total incoming solar energy), because the energy level per photon in that domain (wavelengths longer than about 700 nanometers) is not sufficient to be useful to synthesize organic molecules. A strong absorption at these wavelengths would only result in over-heating the plant and possibly damaging the tissues. Hence, live green plants appear relatively dark in the PAR and relatively bright in the near-infrared. By contrast, clouds and snow tend to be rather bright in the red (as well as other visible wavelengths) and quite dark in the near-infrared.

Since early instruments of Earth Observation, such as NASA's ERTS and NOAA's AVHRR, acquired data in the red and near-infrared, it was natural to exploit the strong differences in plant reflectance to determine their spatial distribution in these satellite images. The NDVI is calculated from these individual measurements as follows:

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$


# Lesson Execution Monitoring

Execution

Launch Search Interaction settings

Available IPDG: **NDVI**

Execution title:

Execution description: Perform NDVI computation on specific satellite images.

Launch

No process is selected for monitoring.

Execution

Launch Search Interaction settings

Filters:

- ☒ Show only active processes
- ☐ Show only completed processes
- ☐ Show only cancelled processes
- ☐ No filters

Process name	Description	Status	Cancel
TestGisheo	TestGisheo	SUBMITTED	Stop process
TestGisheo	TestGisheo	SUBMITTED	Stop process
TestGisheo	TestGisheo	SUBMITTED	Stop process
test	descriere123	SUBMITTED	Stop process
TestGisheo	TestGisheo	SUBMITTED	Stop process

Compute NDVI value

Current process status information

Node name	Start server time
3_6_PseudoColoringV2	2010-04-07 02:24:26
3_5_Div	2010-04-07 02:24:26
3_4_Add	2010-04-07 02:24:27
3_3_Sub	2010-04-07 02:24:27

Execution

Launch Search Interaction settings

Processes that can be monitored by students:

Title	Description
Compute NDVI value	Perform NDVI computation
TestGisheo	TestGisheo

Add Remove

IPDG's that can be launched in execution by students:

Title	Description
EVI	EVI Vegetation Index
IPVI	IPVI Vegetation Index
NDVI	NDVI Vegetation Index
SAVI	SAVI Vegetation Index

Add Remove

Save these settings

Current process status information

Node name	Start server time	End server time	Status	Options
3_6_PseudoColoringV2	2010-04-07 02:24:26		RUNNING	
3_5_Div	2010-04-07 02:24:26	2010-04-07 02:40:57	DONE	
3_4_Add	2010-04-07 02:24:27	2010-04-07 02:31:15	DONE	
3_3_Sub	2010-04-07 02:24:27	2010-04-07 02:31:24	DONE	

# Future Works

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- ❑ Improve the functionality and the performance of the applications
- ❑ Tools and applications for the interactive development of hydrological scenarios
- ❑ Interoperability between different technologies involved in the enviroGRIDS project
- ❑ Include and develop new tools and applications required by the partners (e.g. RIONI River hydrological model, Vegetation development in Istanbul, etc)
- ❑ Develop training materials in the domain of Earth Sciences



Thank you for your attention!

Questions?

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