

# Latest advances of the BASHYT framework: a web, GIS oriented, interface for SWAT

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**CRS4 (<http://www.crs4.it>)**

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# Presentation outline

- 1. Description of BASHYT and LIVE Demo**
- 2. Technologies**
- 3. Interoperability and Interfaces**
- 4. Conclusion**

**BASHYT** is a web based software to expose **SWAT** results on the WEB. A free open to use service is available at: <http://swat.crs4.it/Home>

BASHYT is a Collaborative Working Environment (CWE): a easy to use and extensible development framework, for constructing spatially enabled web applications based on the SWAT model (but not only).

**BASHYT** is a *problem-solving* platform for the **Environmental Sciences** for the integration of

- *resources for*
  - *communication*
  - *computation*
  - *data storage*
  - *visualization*
- *simulation software*
- *instrumentation*
- *human know-how*

# Objectives of the framework

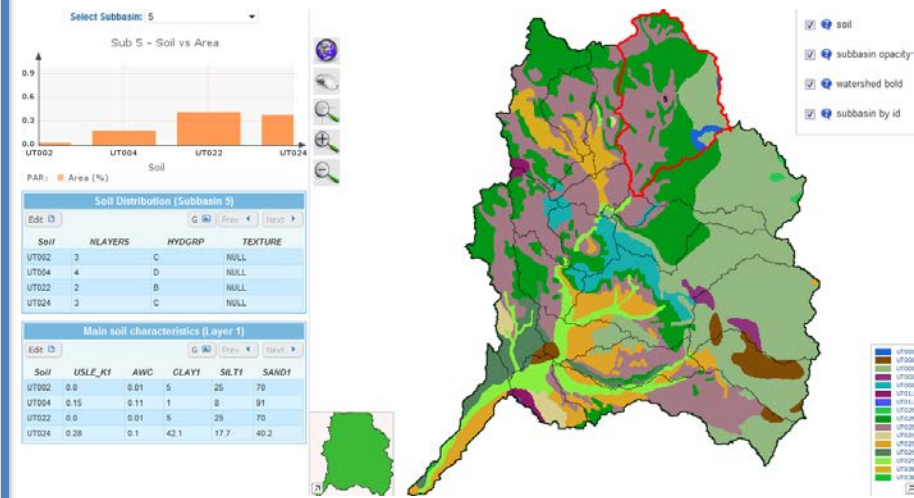
- ✓ Enable users to expose their SWAT simulation on the WEB and to ease the **report production mechanism**
- ✓ Share data, knowledge through a web based environment
- ✓ Expose **interoperability services** on the WEB to create a broader user experience
- ✓ Enable developer build applications based on other portals exploiting web interoperability services: **mesh up of web applications**
- ✓ **Bridge the gap between science and end users / citizens!**

## BASHYT works in tandem with the AvSWAT/ArcSWAT GIS desktop programs

### Home page / access point to the portal

<http://swat.crs4.it/Home>

### BSHYT digests SWAT data and expose on the WEB dynamic reports



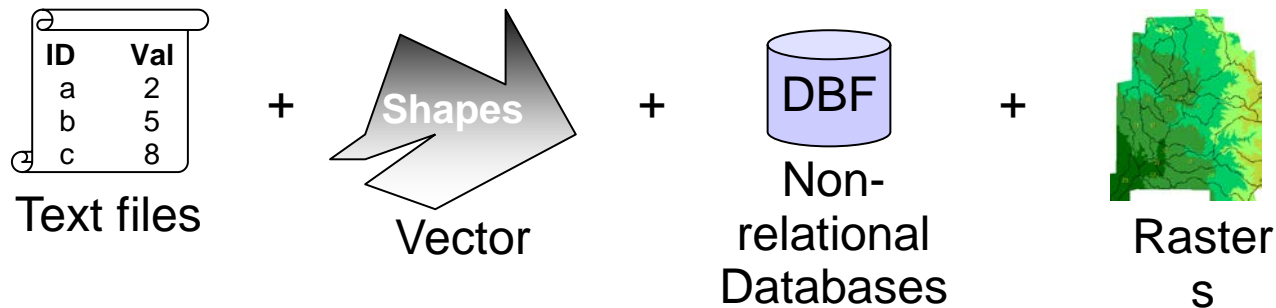
### Module section to design Applications

# The main features

- ✓ All the model-related data are organized **into complex Relational DB infrastructures**.
- ✓ Exploit user-roles policies to define complex security and access strategies and differentiate the interfaces;
- ✓ Applications can be edited directly using the browser (wiki like), no external plug-in is required;
- ✓ The BASHYT is developed using the **Argilla Java framework** and is exposed via the Tomcat servlet container
- ✓ Argilla provides a live programming web template environment, based on Apache Velocity
- ✓ The GIS rendering is based on the Mapserver technology (server-side) and visualized by **msCross**, a AJAX client-side interface

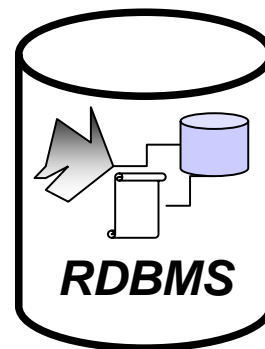
# SPRITE/SWATSL: SWAT Data processing

*The SWAT model uses several different data formats*



**BASHYT needs to access data through a relational database**

A client-server procedure, namely SPRITE and SWATSL, imports the data into relational databases on the server.



BASHYT natively implements JDBC connections.

The SpatiaLite engine is used for data archiving of GIS data.

Imported data include:  
*output.rch, output.sub, AvSwatDB/\*.dbf, ESRI Shapefiles, Toporep.txt, etc.*

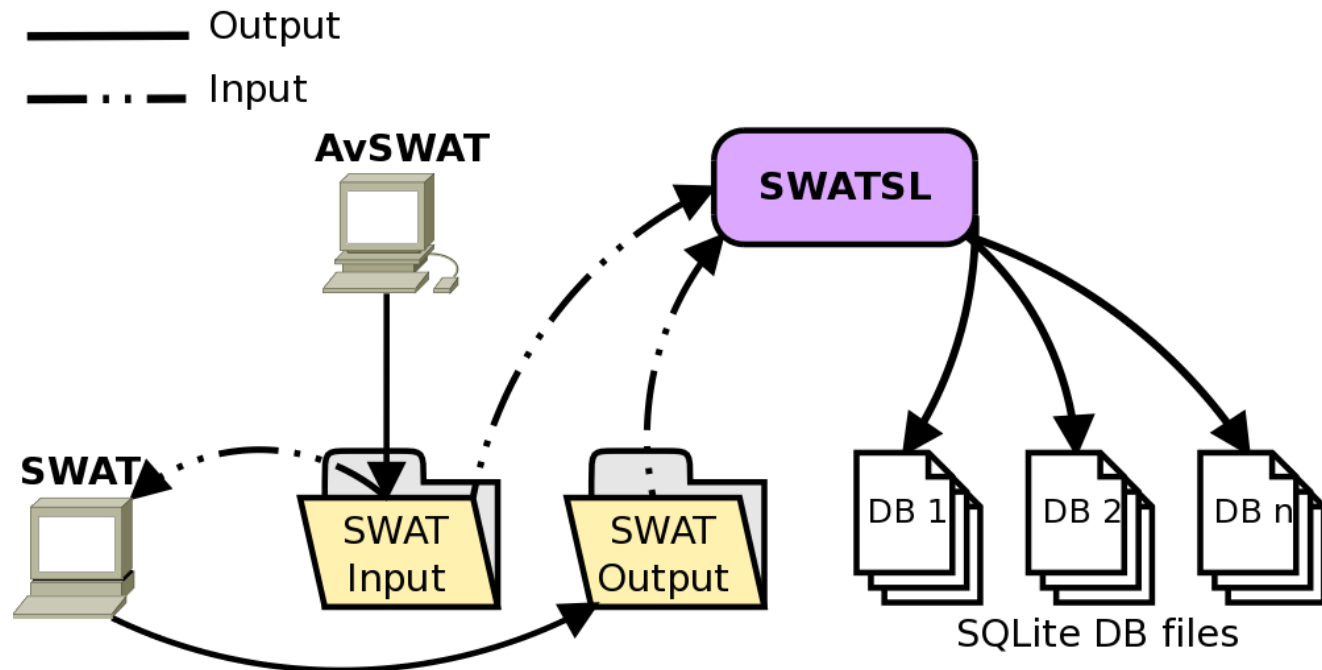
# SPRITE/SWATSL data flow

**SWATSL** is a C++ library that hide the complexity of the SWAT files architecture providing a uniform structured dataset for the user

**SWATSL** builds one or more SQLite database files and populate them with SWAT simulations (output/input)

After SWATSL has done its work, data can be accessed using common SQL queries

**SPRITE** is a Java windows program to retrieve I/O from a SWAT project and upload the data to BASHYT





# BASHYT Interoperability

## BashytAPI

The **BashytAPI** is the client library developed in the Java programming language to access and use the CWE web service interface.

The **BashytAPI** offers a uniform way of identifying and accessing to resources, and thus increasing the interoperability between applications.

The **argillaAPI** explicitly targets the needs of other web environment (e.g. **eGLE** or **gSWAT**)

# The WEB Front End

The application level of the CWE portal exposes a set of web applications and services:

- **Data Manager**
- **Basin**
- **Scenarios**
- **Documentation**
- **Argilla Control Menu**
  - **the Module section:** Connections, Users, Charts, Tables, Maps/Layers, Forms, etc.

# Example of a Web applications

BASHYT DSS
Basin Scale Hydrologic Toolkit

[» Log Out](#)  
[» Settings](#)

[Modules]

[Home](#) | [Studies](#) | [Basin](#) | [Current State](#) | [Scenarios](#) | [Documentation](#)

Percorso: / / Italiano English

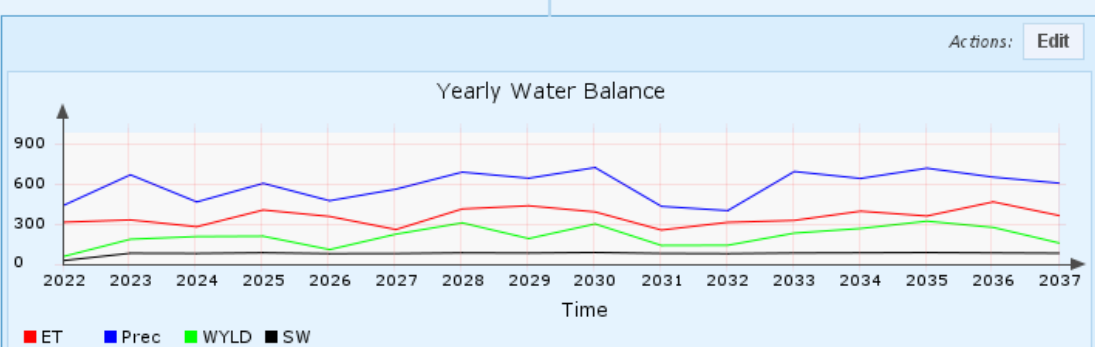
User **root** - Edit Contents:

Page
JavaScript
Title
Menu
Buttons
Tabs

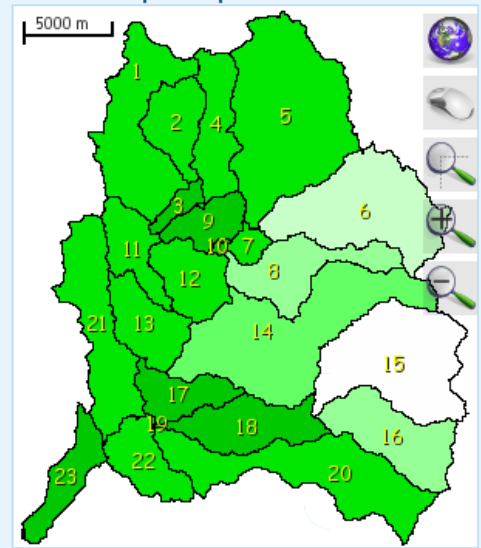
Env ON/OFF

Select time range:

Actions:



Potential Evapotranspiration



**The Water balance**

The climate of the area is Mediterranean with long hot dry breezy summers and short mild rainy winters. The temperature regime has been registered by the Donori S. Michele climatic gage, located close to the basin. Average monthly temperature ranges from 8 C (January and February) to 25 C (July and August). Precipitations are largely confined to the winter months, the rainfall regime is characterized by a peak rainfall in December (83 mm) and a minimum in July (8 mm), with an average value of 591 mm/year.

The spatial distribution of the water balance components is not homogeneous. Yearly average precipitation (standard deviation) values over a 70 year period simulation (22-92) range between **473.17 (120.78)** and **640.11 (163.28)**. Yearly average evapotraspiration (standard deviation) values range between **221.15 (45.79)** and **431.05 (87.27)**. Yearly average water yield (standard deviation) values range between **367.18 (120.78 )** and **367.18 (163.28)** on the North-East.

# The Argilla engine

The engine allows to **integrate several client and server technologies** in a single **development environment**, fully programmable and **accessible** by the **web browser**.

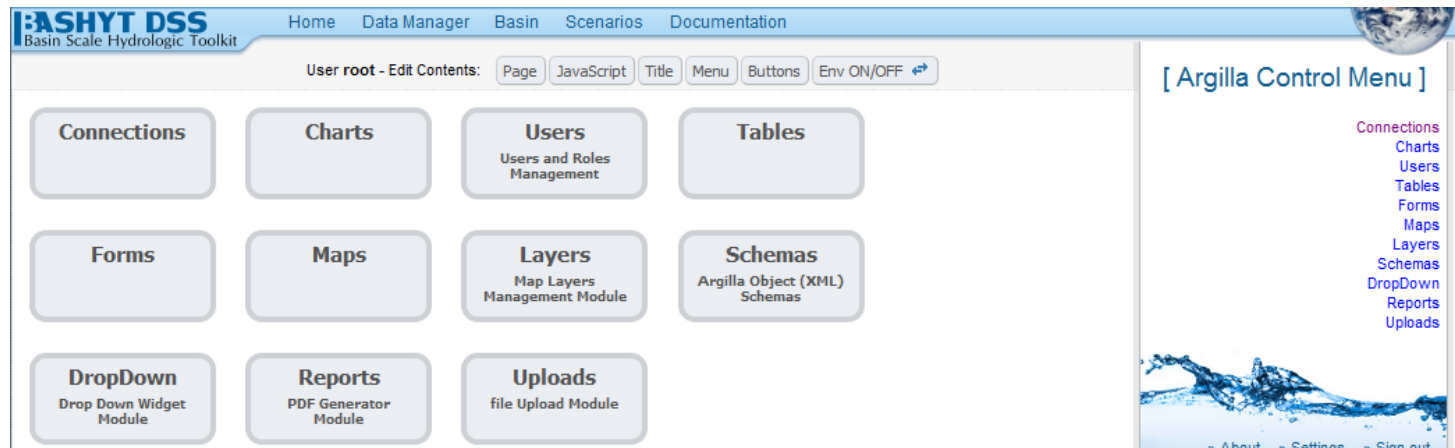
Developers can write **server side codes**, and use the **framework tool for debugging and validation**. The Velocity Template allows a strong integration with low-level API written in Java (working as PHP does).

All web applications and pages exposed are described in a **structured and hierarchical way within the virtual filesystem**:

- In such hierarchy, each folder is a node of the portal: each node is accessible from the browser via a specific URL, and contains (virtual) data files such as the Velocity scripts, HTML, JavaScript, which contribute to the composition of the page

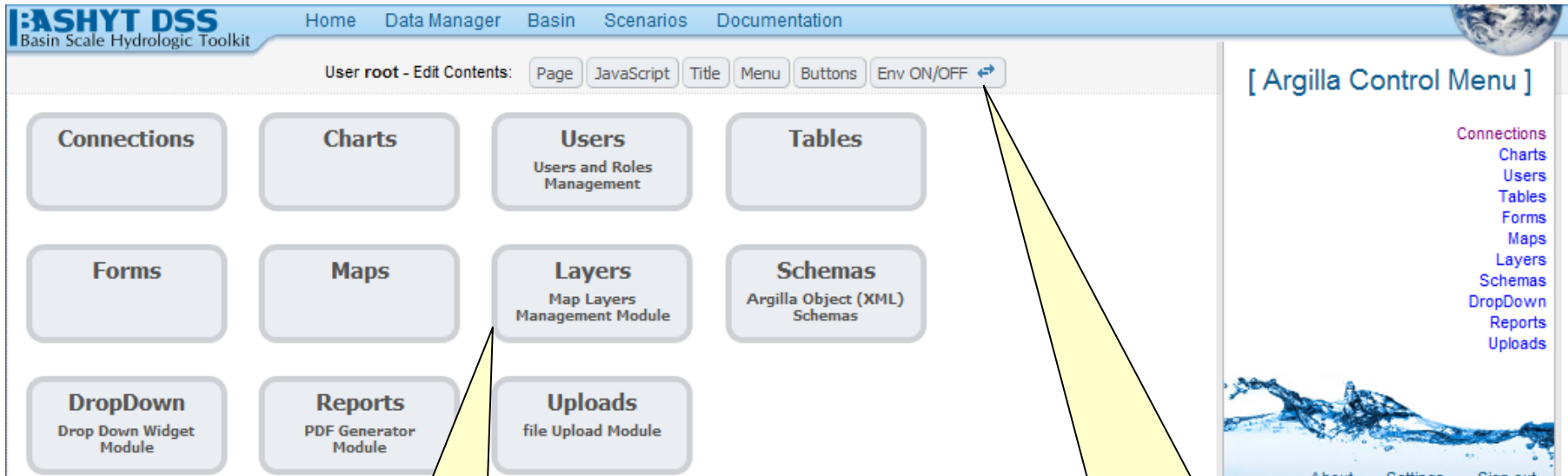
## The Modules

The module section exposes through easy to use web interfaces a variety of services to **shape XML objects for charts, maps, tables, PDF, and forms production.**



Modules permit the massive use of **preset schemas** stored in the database in a structured XML form. Each object refer to its schema and describes parameters (e.g. to control layout) and data sources.

## The CWE report production environment



**BASHYT DSS**  
Basin Scale Hydrologic Toolkit

Home Data Manager Basin Scenarios Documentation

User root - Edit Contents: Page JavaScript Title Menu Buttons Env ON/OFF

**Connections**

**Charts**

**Users**  
Users and Roles Management

**Tables**

**Forms**

**Maps**

**Layers**  
Map Layers Management Module

**Schemas**  
Argilla Object (XML) Schemas

**DropDown**  
Drop Down Widget Module

**Reports**  
PDF Generator Module

**Uploads**  
file Upload Module

[ Argilla Control Menu ]

- Connections
- Charts
- Users
- Tables
- Forms
- Maps
- Layers
- Schemas
- DropDown
- Reports
- Uploads

About Settings Sign out

Click on this object to show the list of available layers

Users with the *administrator* role can controll the page layout directly on the WEB














## The report production

[Modules] [Home](#) | [Studies](#) | [Basin](#) | [Current State](#) | [Scenarios](#) | [Documentation](#)

Percorso: / Modules / Layers / Italiano English

User **root** - Edit Contents: [Page](#) | [JavaScript](#) | [Title](#) | [Menu](#) | [Buttons](#) | [Tabs](#) | [Env ON/OFF](#)

[New](#) | [Make Dir](#) | [Remove](#)

	Name (lang)	Type	Size (Bytes)	Date/Time
	.. /			
	<input type="checkbox"/> river <i>(it)</i>		236	29/10/2009 11:43:07
	<input type="checkbox"/> watershed <i>(it)</i>		263	29/10/2009 11:43:19
	<input type="checkbox"/> subbasin <i>(it)</i>	layer	410	29/10/2009 11:43:37
	<input type="checkbox"/> point_sources <i>(it)</i>	layer	285	29/10/2009 11:44:26
	<input type="checkbox"/> pcp_out <i>(it)</i>	layer	558	29/10/2009 11:44:37
	<input type="checkbox"/> wyld_out <i>(it)</i>	layer	3514	29/10/2009 11:44:49
	<input type="checkbox"/> pet_out <i>(it)</i>	layer	3498	29/10/2009 11:45:09
	<input type="checkbox"/> et_out <i>(it)</i>	layer	3482	29/10/2009 11:45:22
	<input type="checkbox"/> sw_month_out <i>(it)</i>	layer	2512	29/10/2009 12:32:07
	<input type="checkbox"/> sw_avg_month_b <i>(it)</i>	layer		29/10/2009 12:33:16
	<input type="checkbox"/> sw_avg_month_out <i>(it)</i>			29/10/2009 12:34:12
	<input type="checkbox"/> sw_month_index <i>(it)</i>			29/10/2009 12:32:51

**Click *New* and create a new object instance**

**Click on a name and edit an existing object**

## The report production

**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/webapps/argilla/WEB-INF"
  data="SELECT * from FROM v_shp_sub_m"
  filter="([date_m]=%month%)"
  classitem ="subbasin"
  labelitem="subbasin"
>
  <class>
    <label
      color =' 0 0 0 '
      type ='truetype'
      font ='a020'
      size=' 8'
    />
    <style
      outlinecolor ='200 200 200' />
  </class>

```

**You can save or check your app syntax**

**Databases can be accessed directly through common SQL queries**

<input type="checkbox"/>	sw_monln_out (it)	layer	2512	29/10/2009 12:32:07
<input type="checkbox"/>	sw_avg_month_b (it)	layer	462	29/10/2009 12:33:16
<input type="checkbox"/>	sw_avg_month_out (it)	layer	2247	29/10/2009 12:34:12
<input type="checkbox"/>	sw_month_index (it)	layer	1432	29/10/2009 12:32:51



BASHYT PSS  
Basin Scale Hydro...
Argilla Web Editor ( layer )
Log Out  
Settings

[Modules] Editing Modules/Layers/data/swat

commands: Go Back Test Syntax

Percorso: / Modul

User

Select All

```

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

### Distribuzione Mensile Dicembre / 2007

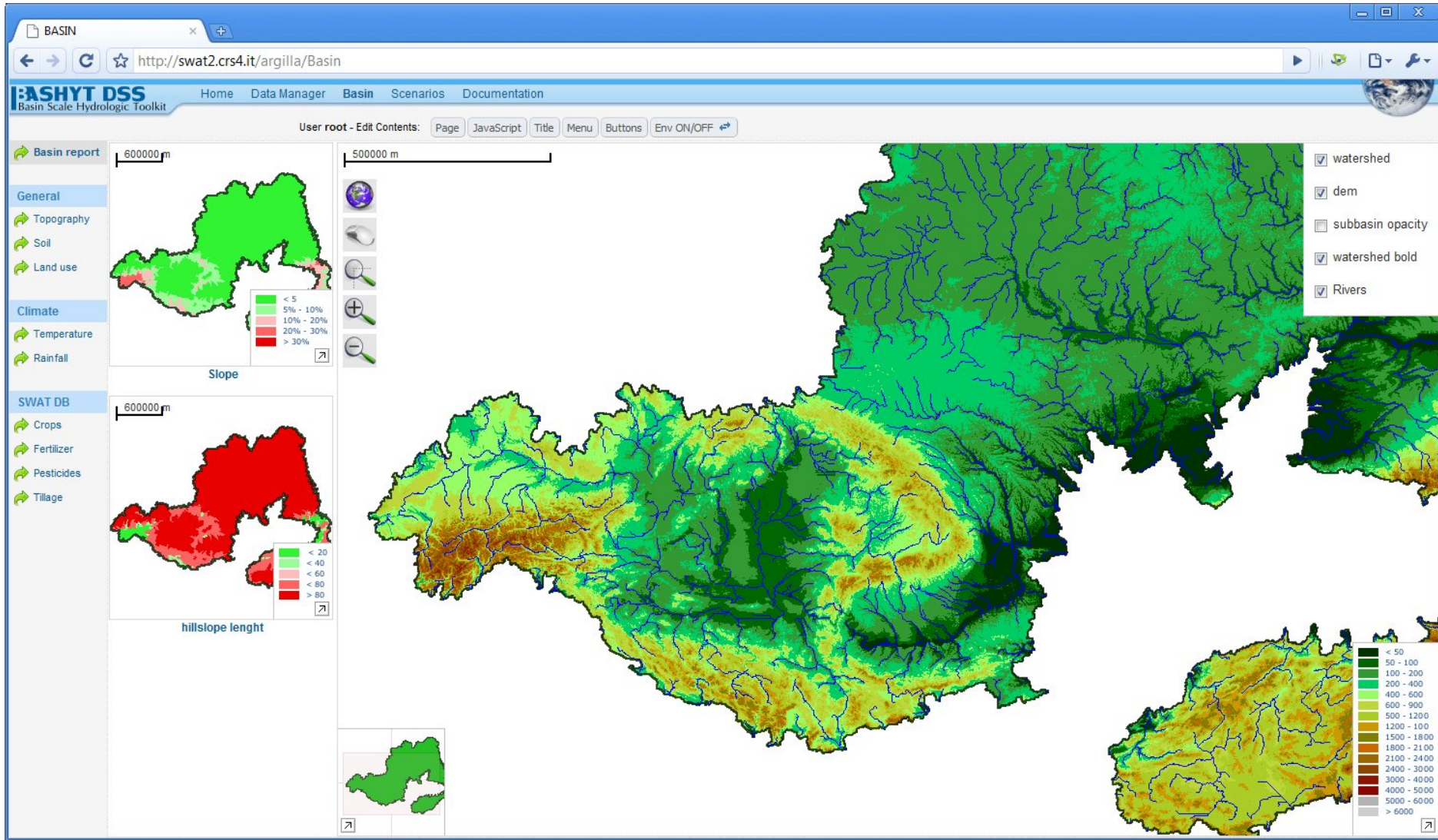
	< 10
	< 20
	< 30
	< 40
	< 50
	< 60
	< 70
	< 80
	< 90
	< 100
	< 120
	< 140
	< 160
	< 180
	< 200
	< 220

layer	2247	29/10/2009 12:34:12
layer	1432	29/10/2009 12:32:51

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



## The Black Sea Catchment



# The Black Sea Catchment

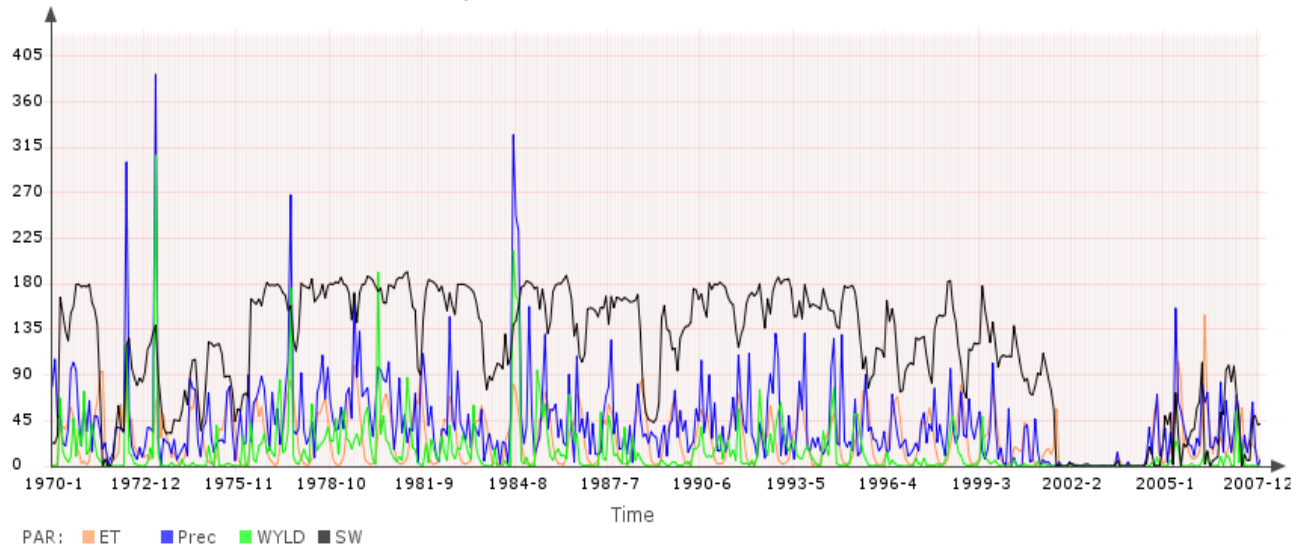
## Modeling Environmental Dynamics: water quality and quantity states on rivers



- Scenario
- Query
  - Output query
- Driving force and Pressure
  - Point pollution
  - Diffuse pollution
- State of the environment
  - Yearly Balance
  - Balance by Period
  - Monthly Balance
  - Soil Water
- State of the environment
  - Yearly Quality
  - Quality by Subbasin

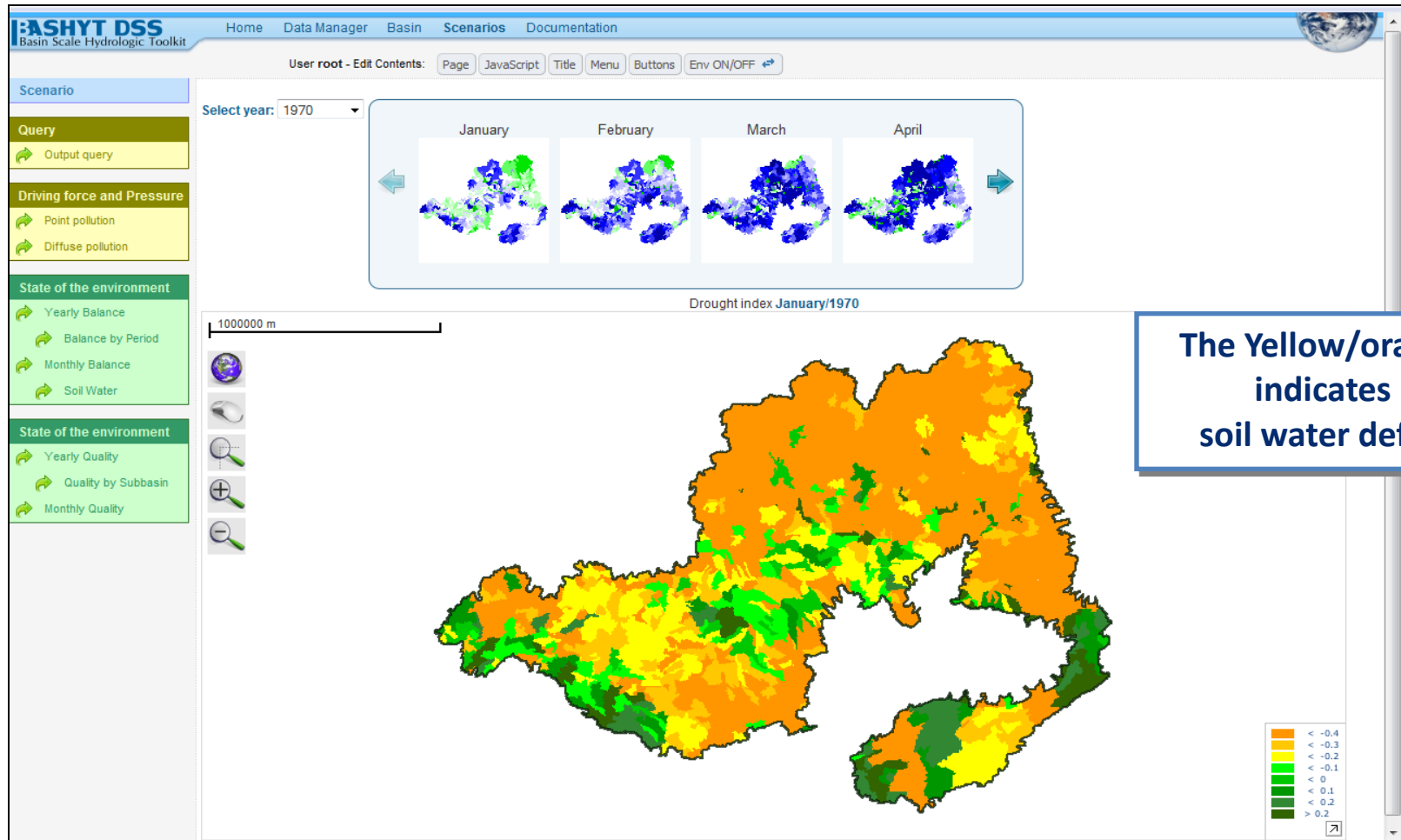
Select time range: 1970 1970 Redraw

Monthly Water Balance - from 1970-1 to 2008-1



# Modeling Environmental Dynamics: the agricultural drought for the Black Sea catchment

## The Black Sea Catchment



Future work will be done to:

- improve web services (**O.G.C.** services: **WFS, WMS, ...**)
- expose **catalogs of geodata** and simulations

We will be working on **scenarios production mechanisms** to be run directly on the web

We will integrate climate (ensemble, ERA 40, etc.) data into BASHYT data flow from web data providers.



**BASHYT** works in tandem with the pre-processing **AvSWAT** and **ArcSWAT** GIS production environment.

BASHYT is the first web interface to SWAT that exposes a **fully programmable environment** to construct spatially enabled applications on the WEB.

It has been widely tested on real case studies on available datasets: Gange (India), Cedrino (Italy), San Sperate (Italy), Black Sea Catchment, ...

*first working version of BASHYT is up and running at:*

**<http://swat.crs4.it/>**

*Register to use the system*

# This work has been supported by:

**EnviroGRIDS** (<http://envirogrids.net/>): With 30 partners distributed in 15 countries, the project is contributing to the Global Earth Observation System of Systems (GEOSS) by promoting the use of web-based services to share and process large amounts of key environmental data.....

**CLIMB - Climate Induced Changes on the Hydrology of Mediterranean Basins** (<http://www.climb-fp7.eu/>): Innovative scientific and technological measures will play an important role in addressing projected climatic changes and their impacts on the freshwater resources of the .....

Regione Autonoma della Sardegna – RAS (Italy).

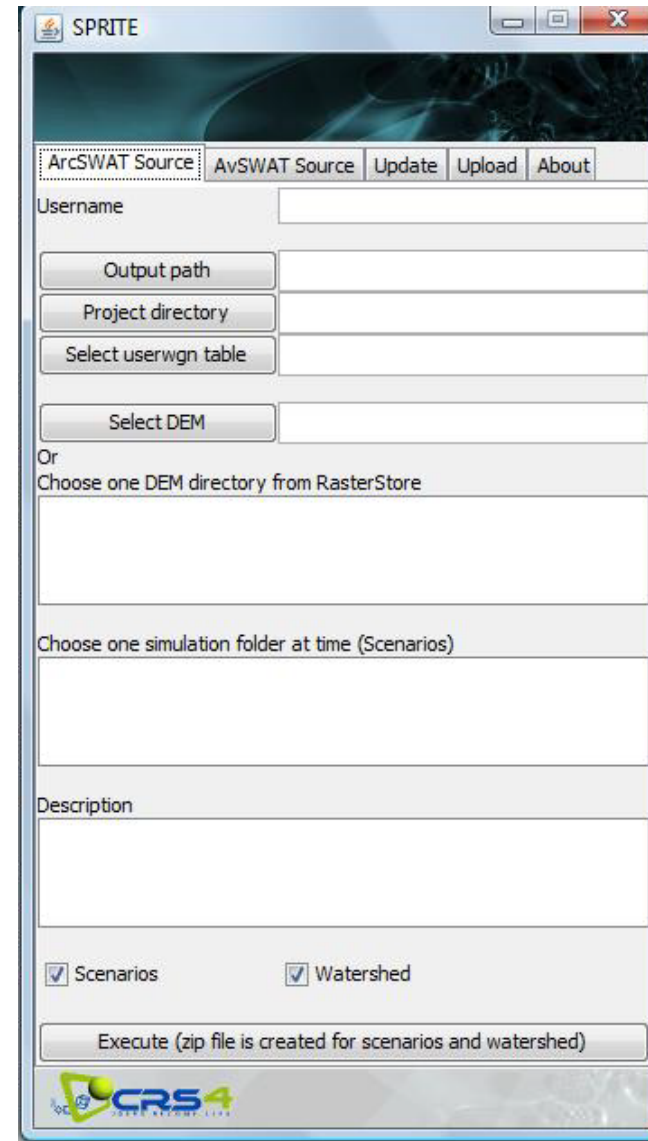


# SPRITE

*Sprite* is a stand alone Java program that process AvSWAT/ArcSWAT projects to extract the necessary information to be uploaded on BASHYT:

The main tasks performed by SPRITE are:

- *Extract* a minimum dataset
- *Transform* it (normalize its content)
- Populate a XML metadata file
- archive the data in 2 zip folders:
  - Watershed
  - Scenarios
- connect and *upLoad* the data to any BASHYT server



# SWATSL

*SWATSL* is the server side application and work also as a standard ETL. It is programmed in C and its purpose is:

1. *Extract* the data,
  2. *Transform* it to fit the operational needs
  3. **Create an empty logical schema** of the geo-relational database (a spatialite db file). Such schema is fixed.
  4. *Populate* it. SWATSL will import the data within the schema.
- The transform stage applies a series of rules and functions to the extracted data from the source to derive the data for loading into the db file.
  - SWATSL can be commanded from the application side, so each user of the portal with the privileges will be allowed to run it to import the uploaded projects within the system.