

Quarte Giornate Italiane di gvSIG
Udine 19 | 20 e 21 aprile 2011

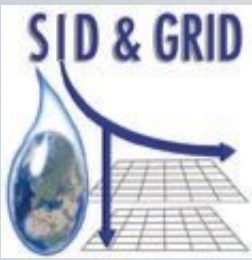


SID&GRID: Simulazione e sistemi IDroinformatici per la Gestione delle Risorse IDriche

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Web: <http://sidgrid.isti.cnr.it>





PROJECT
SCENARIO
ARCHITECTURE
ROAD MAP

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Project **SID&GRID**

Simulazione e sistemi **ID**roinformatici per la **G**estione delle **R**isorse **ID**riche

POR FSE 2007-2013

Duration: April 2010 -- March 2013

Scientific partnership:

Dep. of Mathematics, University of Firenze
Land Lab, Scuola Superiore S.Anna, Pisa
CNR--ISTI, Pisa



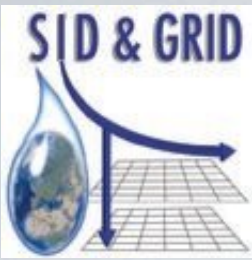
End-users partnership:

Acque Ingegneria S.r.l., Pisa
Autorità di Bacino del Fiume Serchio, Lucca
H2O Ingegneria S.r.l., Pisa



See also:

Rossetto, R., Borsi, I., Schifani, C., Bonari, E., Mogorovich, P., Primicerio, M., 2010. *SID&GRID: hydroinformatics system for the management of the water resource*. Società Geologica Italiana 85° Congresso Nazionale. Bonaccorsi, E., Carmina, B., Marchetti, D. & Pappalardo, M. (Eds.).



Final goal of the project

To develop a **DSS (Decision Support System)** for water use management and planning based on results derived from a 3D physically based hydrological (surface+subsurface) model to be used as helpful tool by public bodies devoted to the management of the water resources (possible applications for private companies as well).

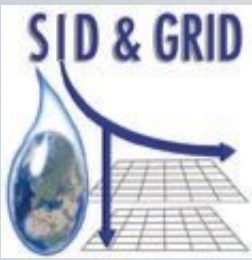
Water Framework Directive 2000/60/CE - D.G.R. Toscana 225/2003

based on

Open source and free software

Main actions:

- development of DBMS schema(Data Base Management System)
- development of tools/toolbar of wrapper and algorithm into a GIS framework to:
 - query the DBMS
 - elaborate data by means of numerical models to simulate coupled surface/subsurface flow at a watershed scale



Guidelines to build up the *SID&GRID* system

We decided to use "reference codes" and software packages among several existing examples, but we have to take into account the following aims and constraints:

- all codes and sw applications have to be *free and open source*
- we need to rely on a deep and *extensive documentation* (because we might decide to change parts of the existing codes)
- GIS system has to be developed in a *user friendly* way (GUI)
- the final system should run first in the Tuscany Region public offices: all the data needed by the applications have to match the *really available data* [otherwise...an useless instrument :- (]

we have (only) 3 years to finalize the code!!

Hydrological modelling process (numerical)

Saint-Venant

$$\frac{\partial(uH)}{\partial t} + \frac{\partial(u^2H)}{\partial x} + \frac{\partial(uvH)}{\partial y} + gH \left(S_{f,x} + \frac{\partial H}{\partial x} \right)$$

$$\frac{\partial(vH)}{\partial t} + \frac{\partial(v^2H)}{\partial y} + \frac{\partial(uvH)}{\partial x} + gH \left(S_{f,y} + \frac{\partial H}{\partial y} \right)$$

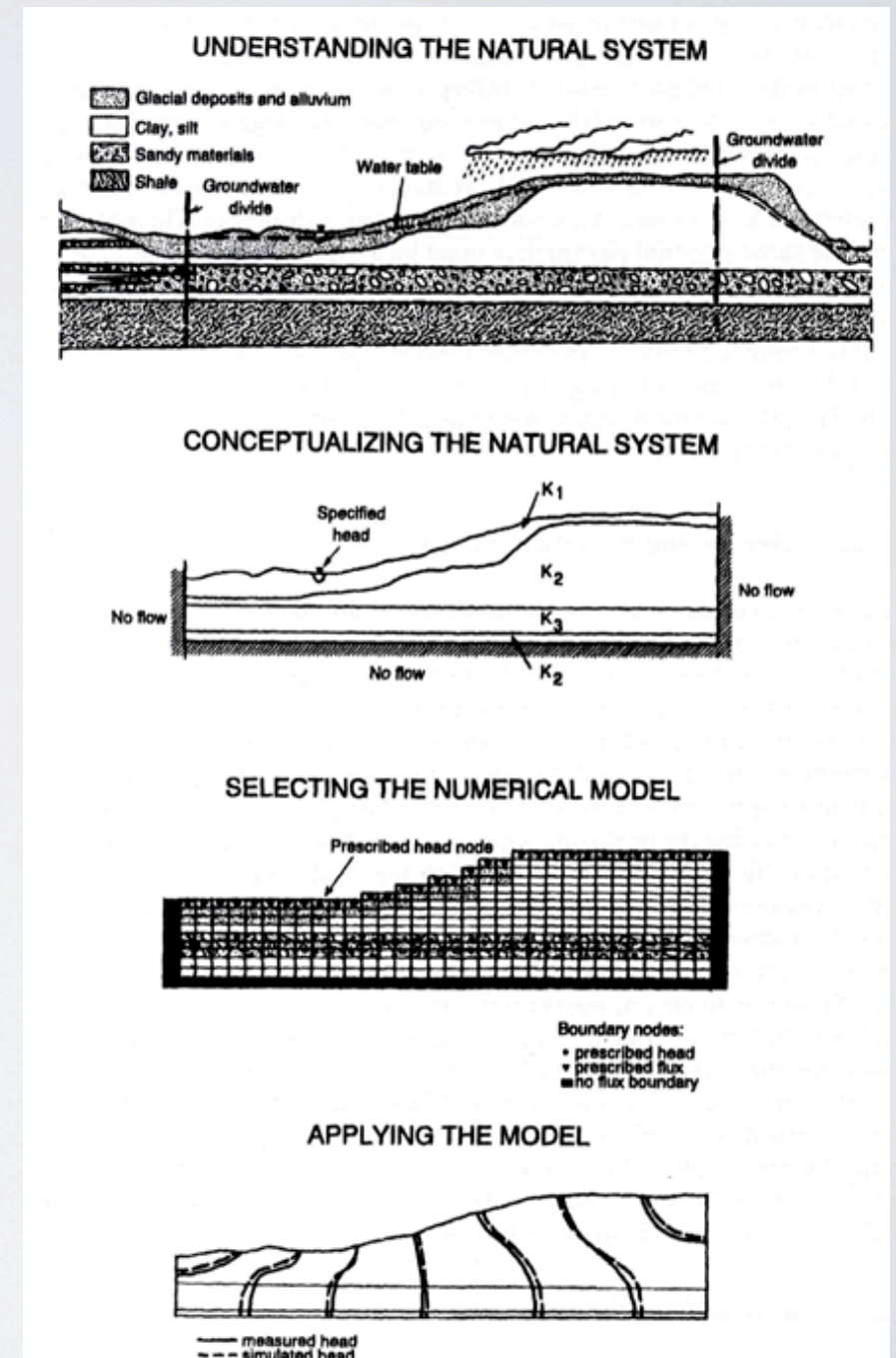
$$\frac{\partial H}{\partial t} + \nabla \cdot (H\mathbf{v}) = q_{atm} - q_e$$

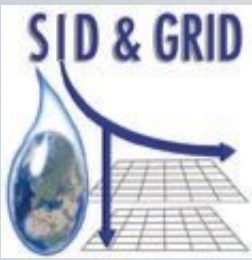
Richards/Darcy

$$(S_y \theta(\psi) + C(\psi)) \frac{\partial h}{\partial t} = \nabla \cdot (\mathbb{K}(h) \nabla h) + U$$

Many numerical code are in Fortran 90
 Input files are formatted or unformatted txt.

How can we prepare them?

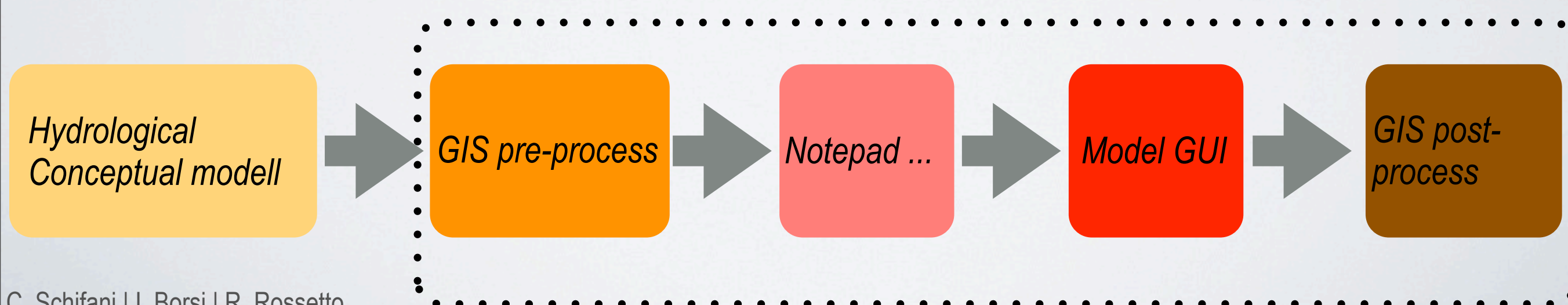
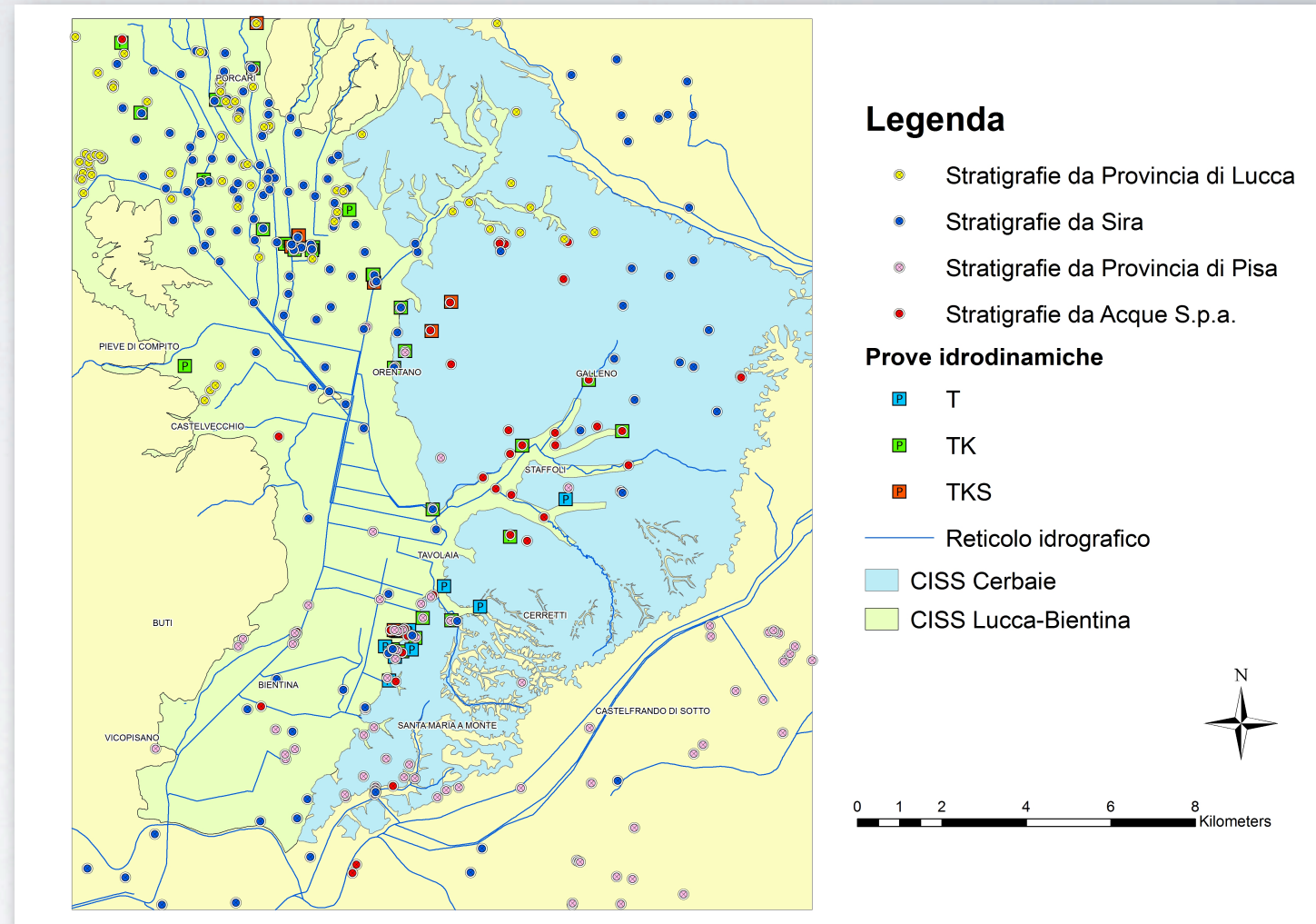




...by Geographic Information System!

and...

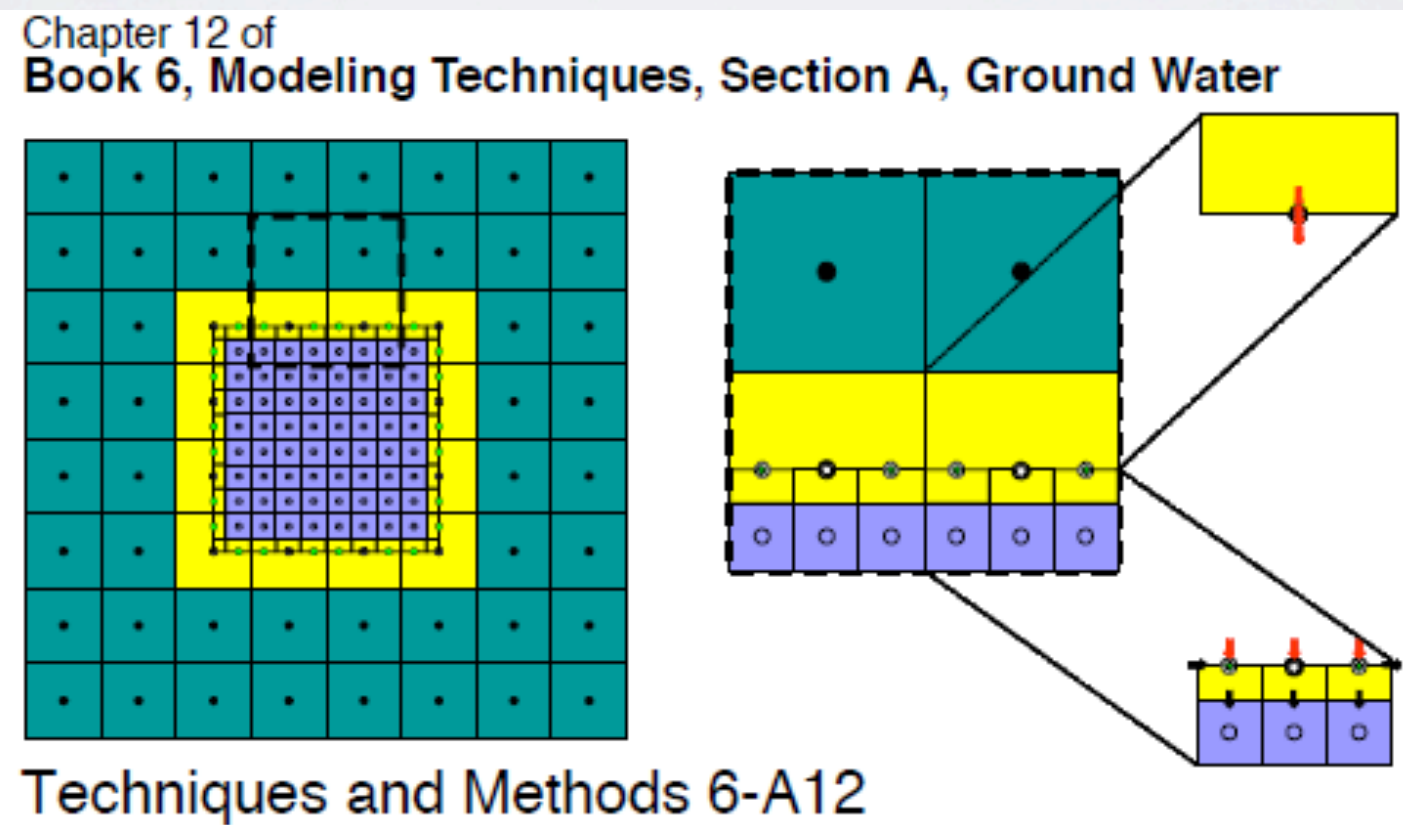
Notepad, spreadsheet, Model GUI (if exist), etc..

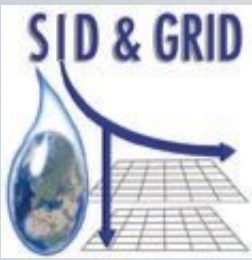


Open Source reference code

SID&GRID numerical code core

Based on MODFLOW2005-LGR (*Local Grid Refinement*), endowed with an updated version of the VSF Package (*Variable Saturated Flow*): the present version is not compatible with LGR procedure



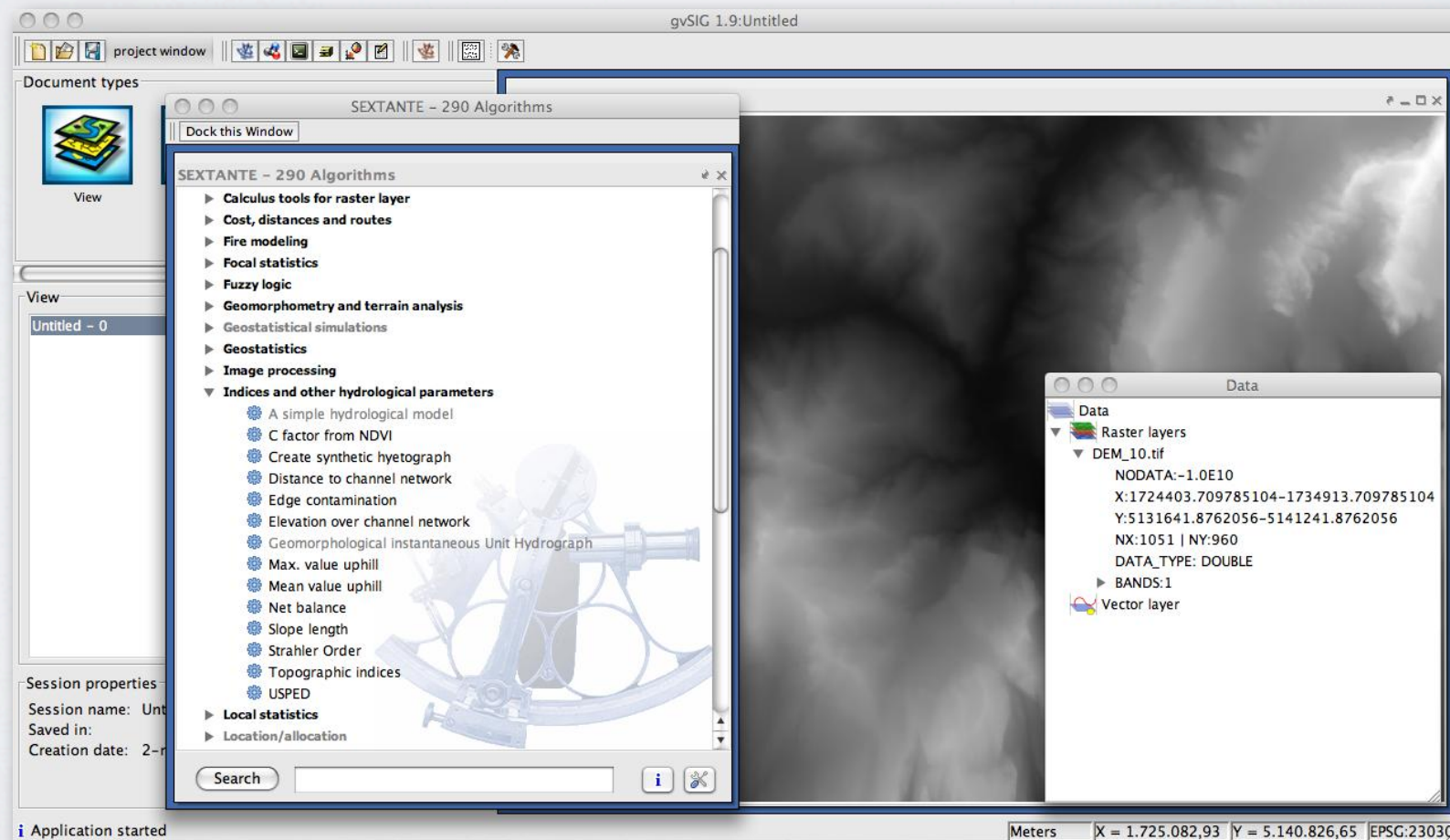


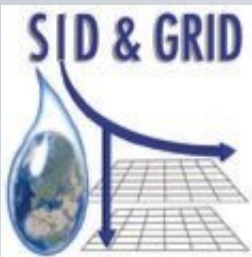
Open Source reference code

SID&GRID GIS Framework

Following our *guidelines* we selected:

- The **DBMS PostgreSQL1** as object-relational database system
- **PostgreSQL/PostGIS** as Geo Data Base Managment System
- **gvSIG** endowed with **Sextante** library and **GRASS** as GIS framework



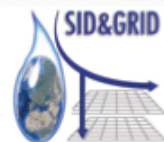


Open Source reference code

SID&GRID GEO-WEB Framework

Implementation of the **geoportal SID&GRID**, able to provide web services based on standard OGC (Open Geospatial Consortium).

Geoportale del progetto SID&GRID



Il Geoportale del progetto SID&GRID costituisce lo strumento per l'erogazione di servizi a supporto della gestione integrata della risorsa idrica e la condivisione delle informazioni geografiche.

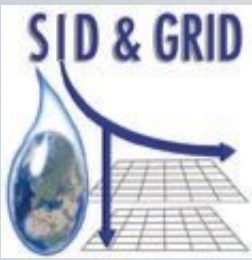
Il Geoportale SID&GRID adotta soluzioni Open Source.



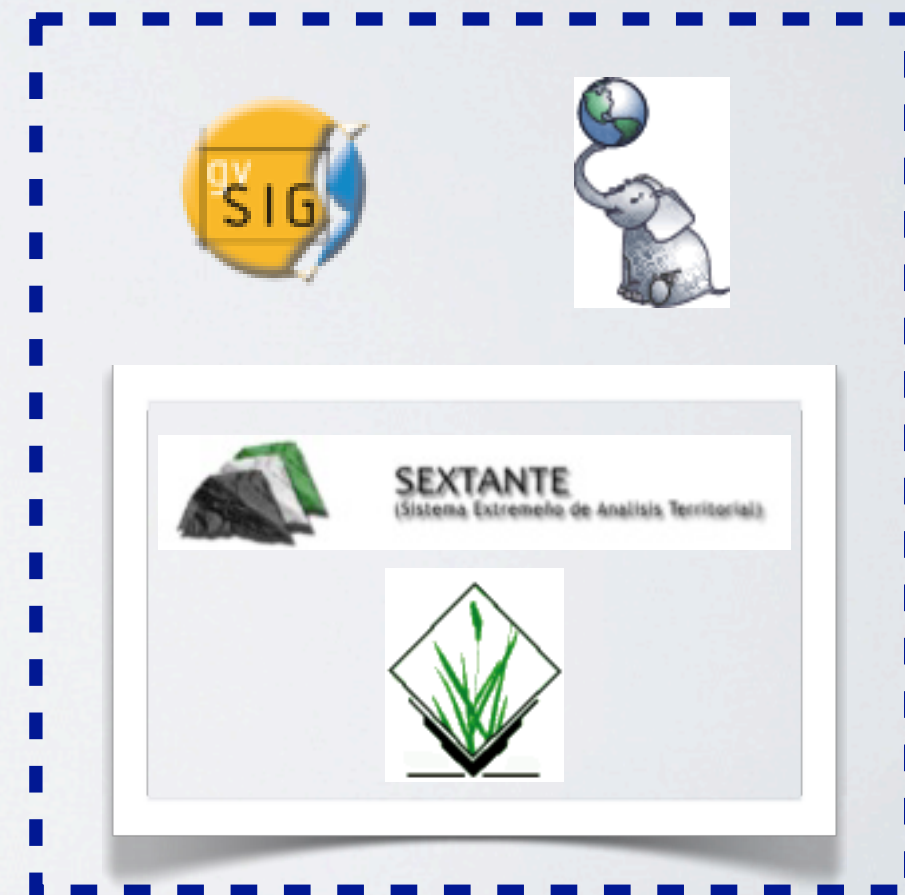
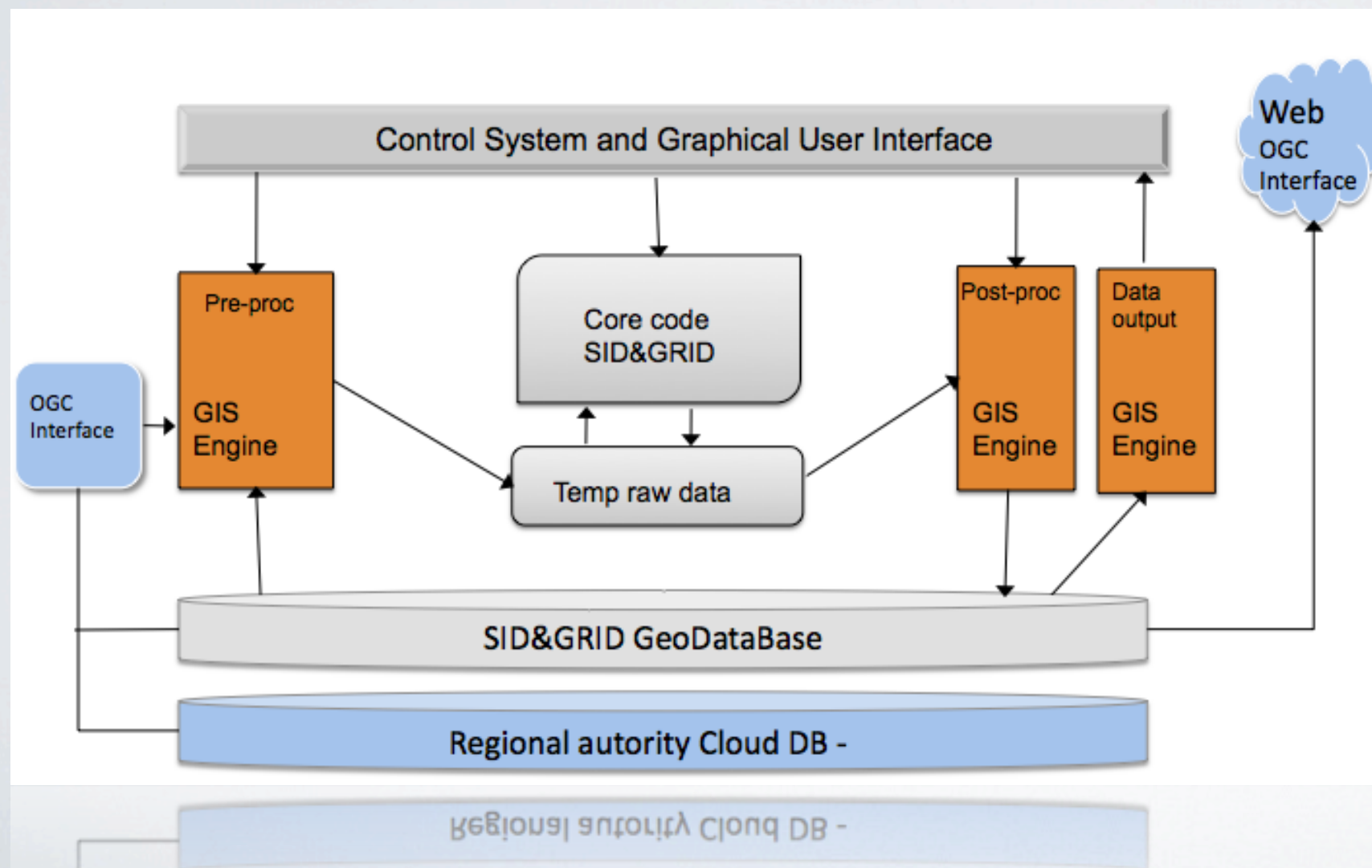
Server per l'erogazione di servizi OGC

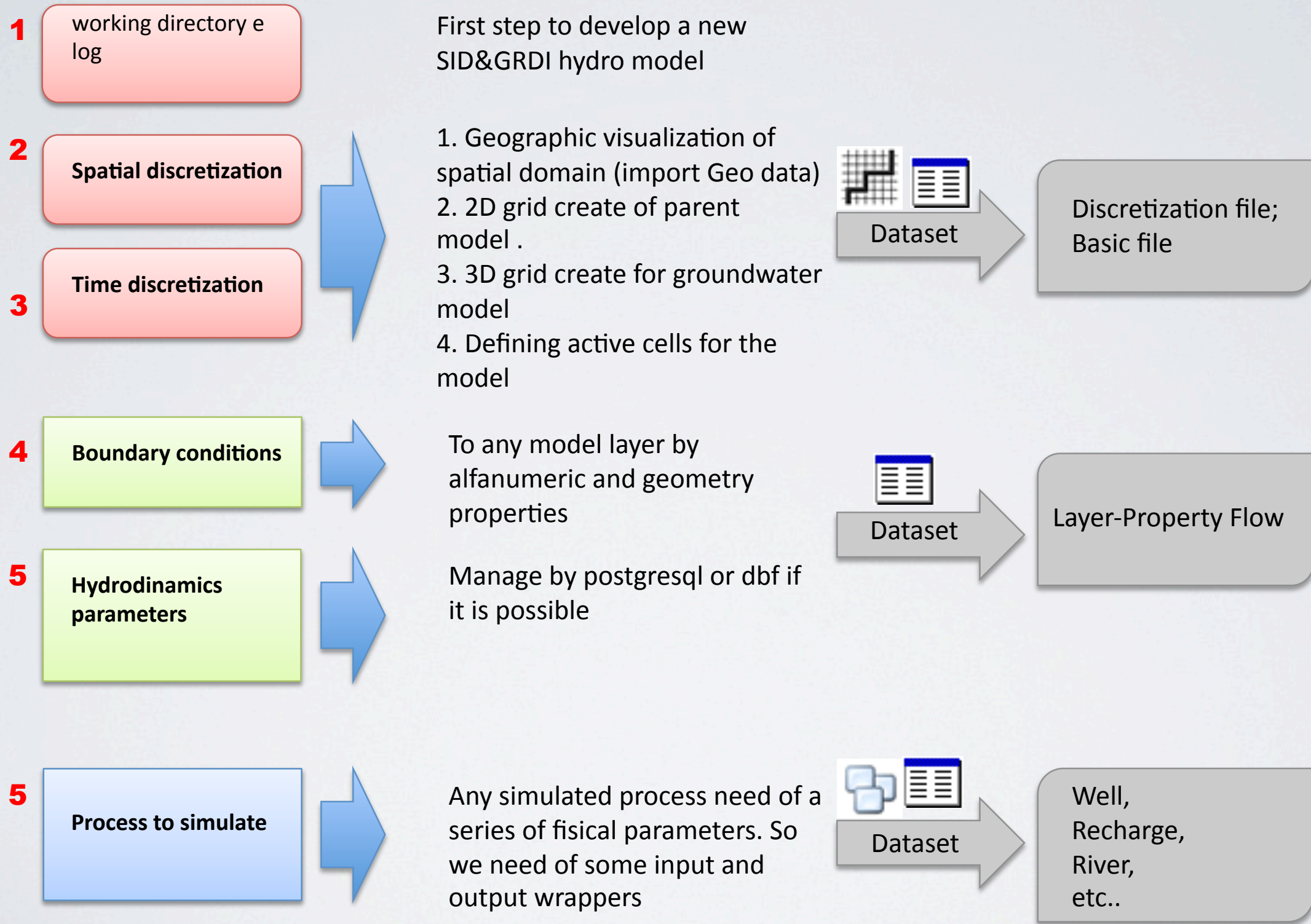
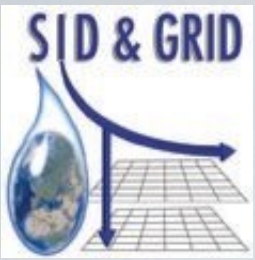


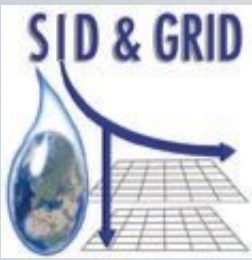
Servizio di discovery dei metadati



A graphical user interface to manage, analyze and run the SID&GRID hydrological model will be developed; it is thought as a “master control panel” able to guide the user from pre-processing spatial and temporal data to run and analyze the hydrological model outputs. This master control panel will be based on gvSIG open source GIS framework and a Spatial Data Infrastructure to share and interoperate with distributed geographical data.

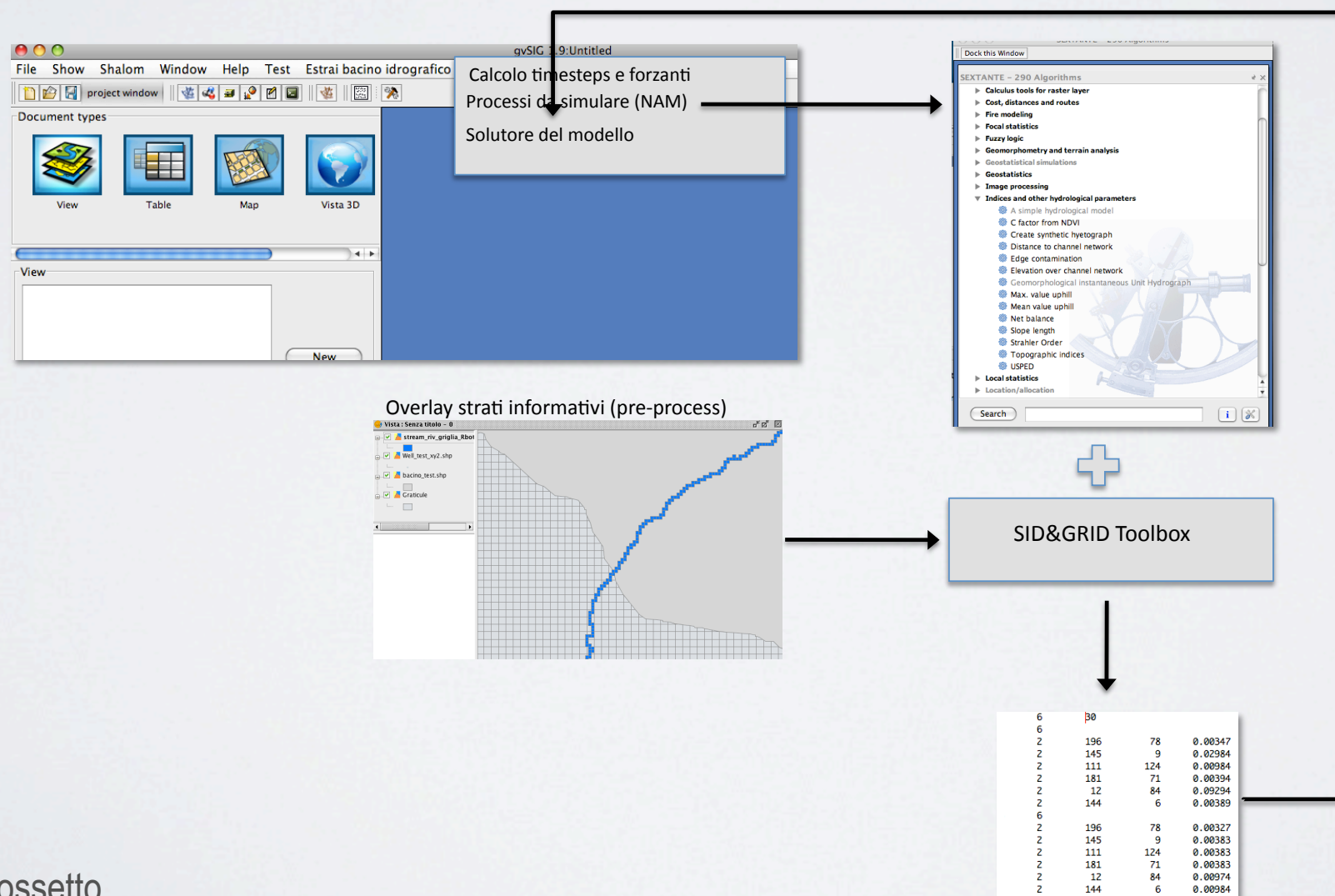


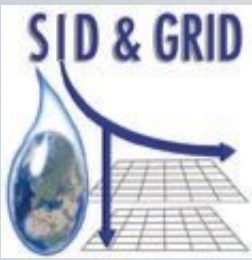




The SID&GRID approach is based on the library Sextante, interfacing with gvSIG GIS and GRASS tools. According to this framework, two primary components of the master control panel were identified:

1. a SID&GRID toolbar integrated into gvSIG map context;
2. a new Sextante set of geo-algorithm to pre and post process of spatial data for the hydrological model.



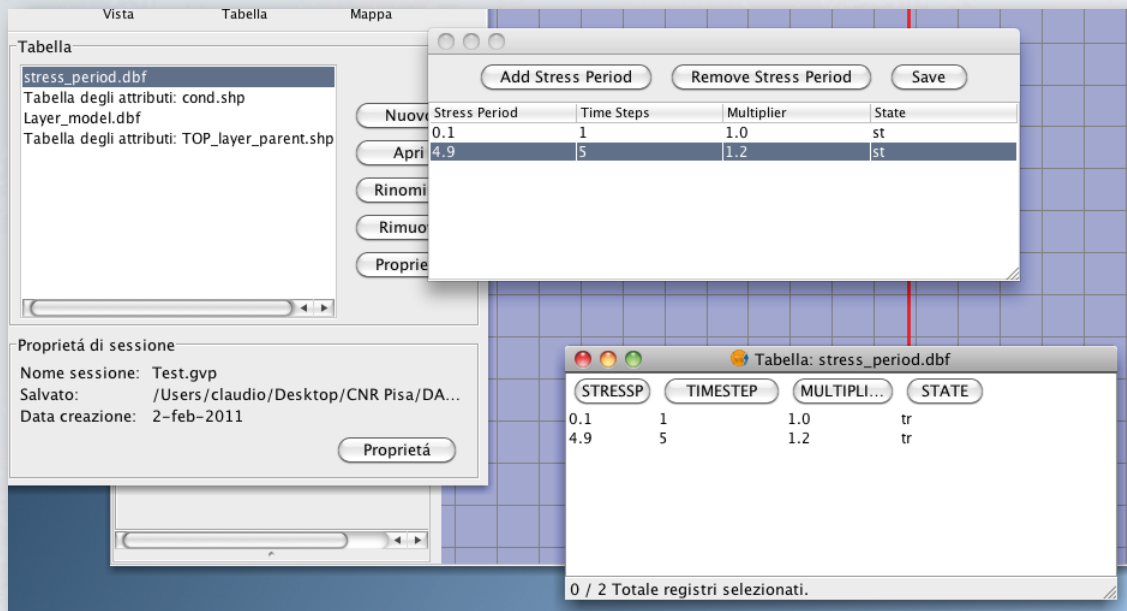


In order to develop the SID&GRID master control panel, the research group started a first “test step”. The test step is based on some preprocess algorithms that were developed in beta version into gvSIG and Sextante Java spatial framework:

The work done so far [GIS and DBMS part]

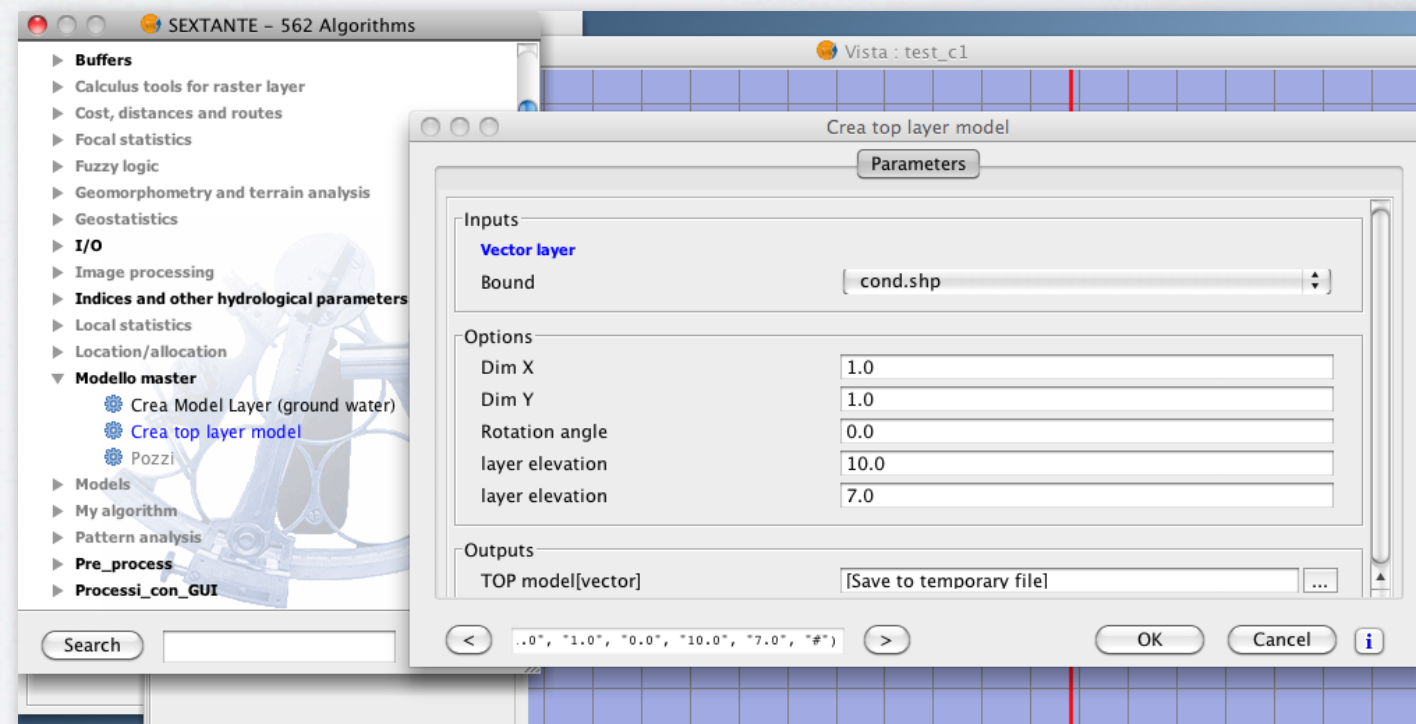
1. a tool to calculate stress periods from time series and to refer them to the spatial domain;
2. a geo-algorithm to create the 2D grid for the numerical model from a spatial region like a watershed;
3. a geo-algorithm to implement the 3D layers for the groundwater analysis;
4. an algorithm to wrapper the spatial wells data to the input file for the model;
5. a number of wrapper for the discretization and basic configuration model input parameters

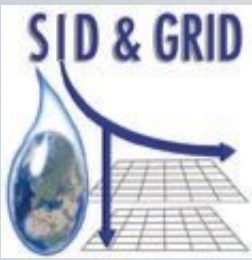
The work done so far [GIS and DBMS part]



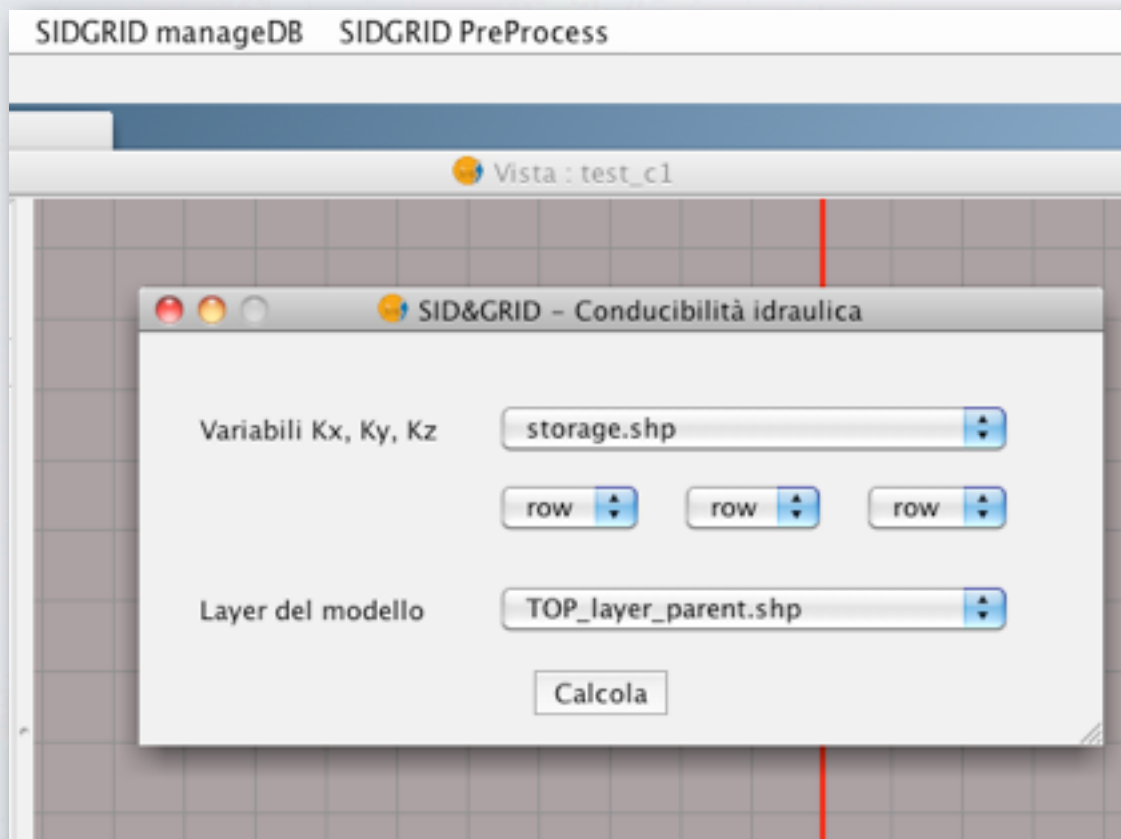
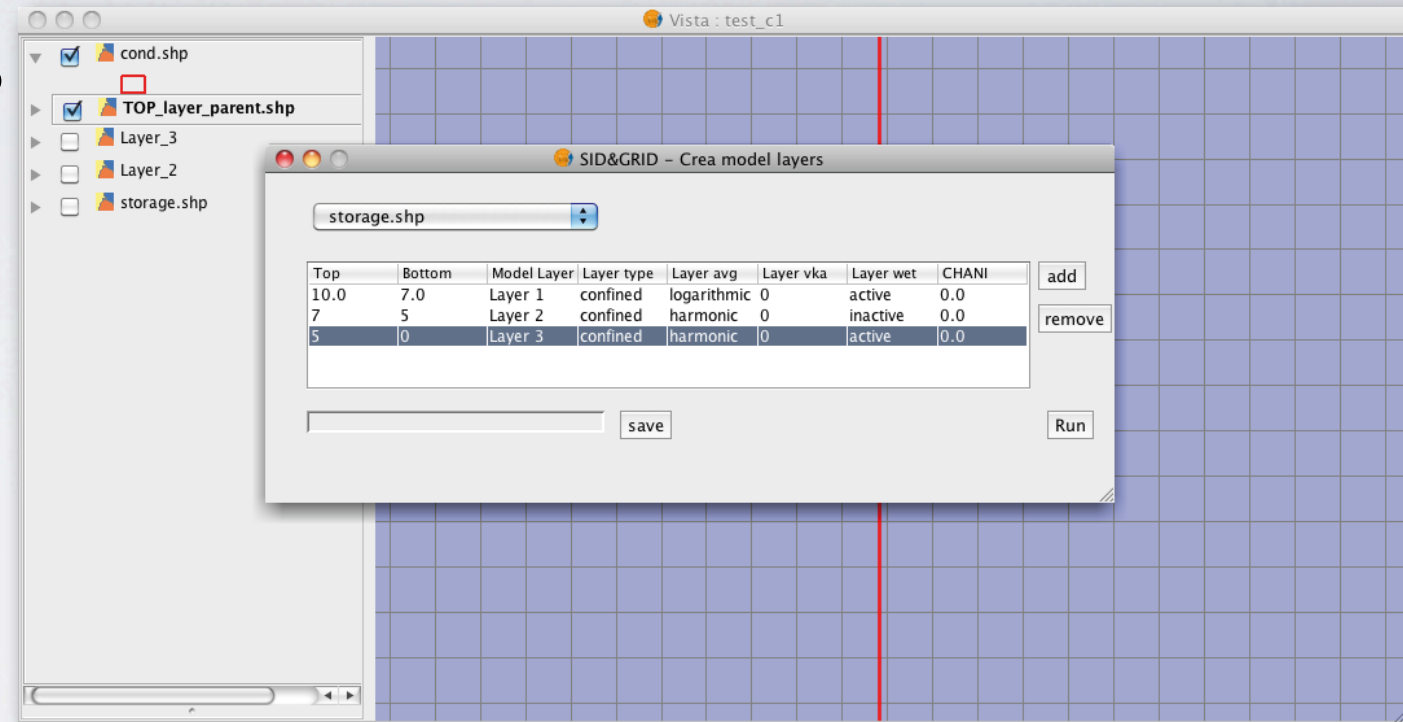
The algorithm to automatically calculate the **time discretization** (“stress periods” and time step), starting from data, has been developed.

The method to create the **numerical grid** has been developed, together with the algorithm to assign the hydraulic parameters.

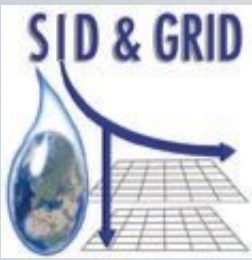




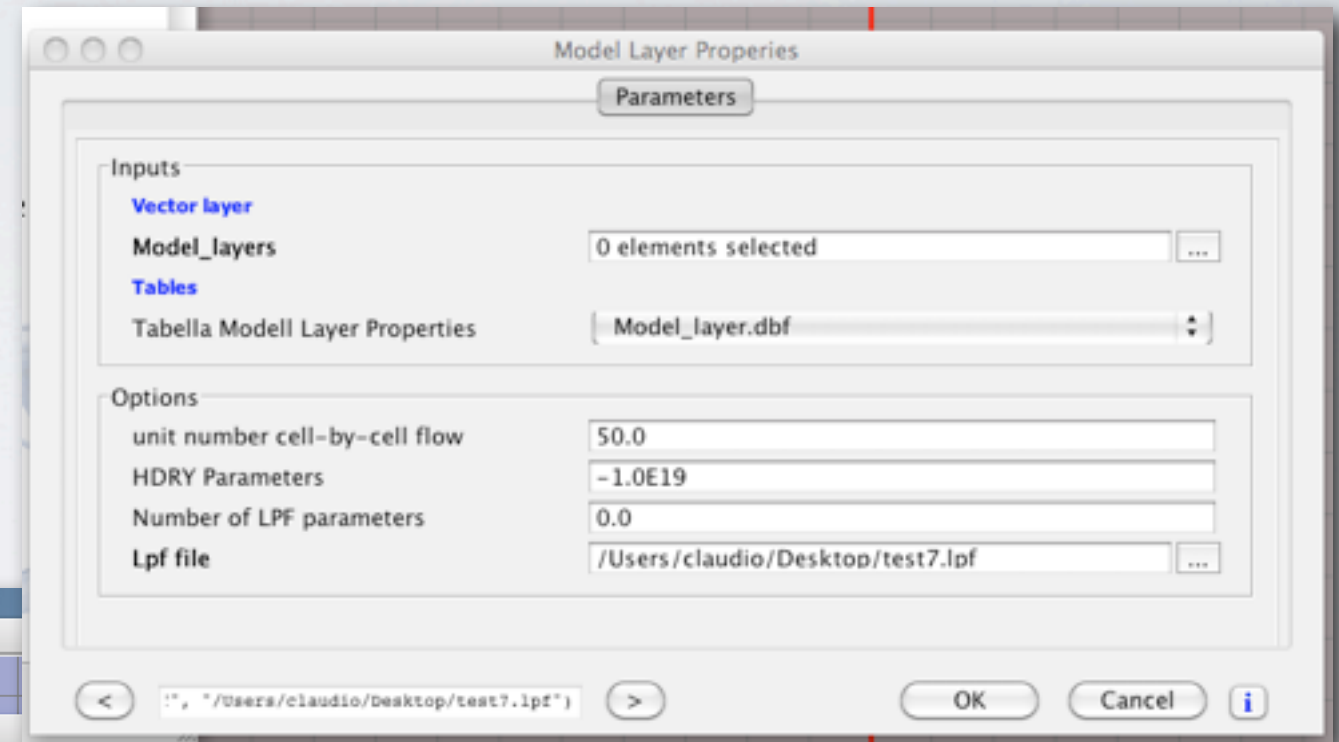
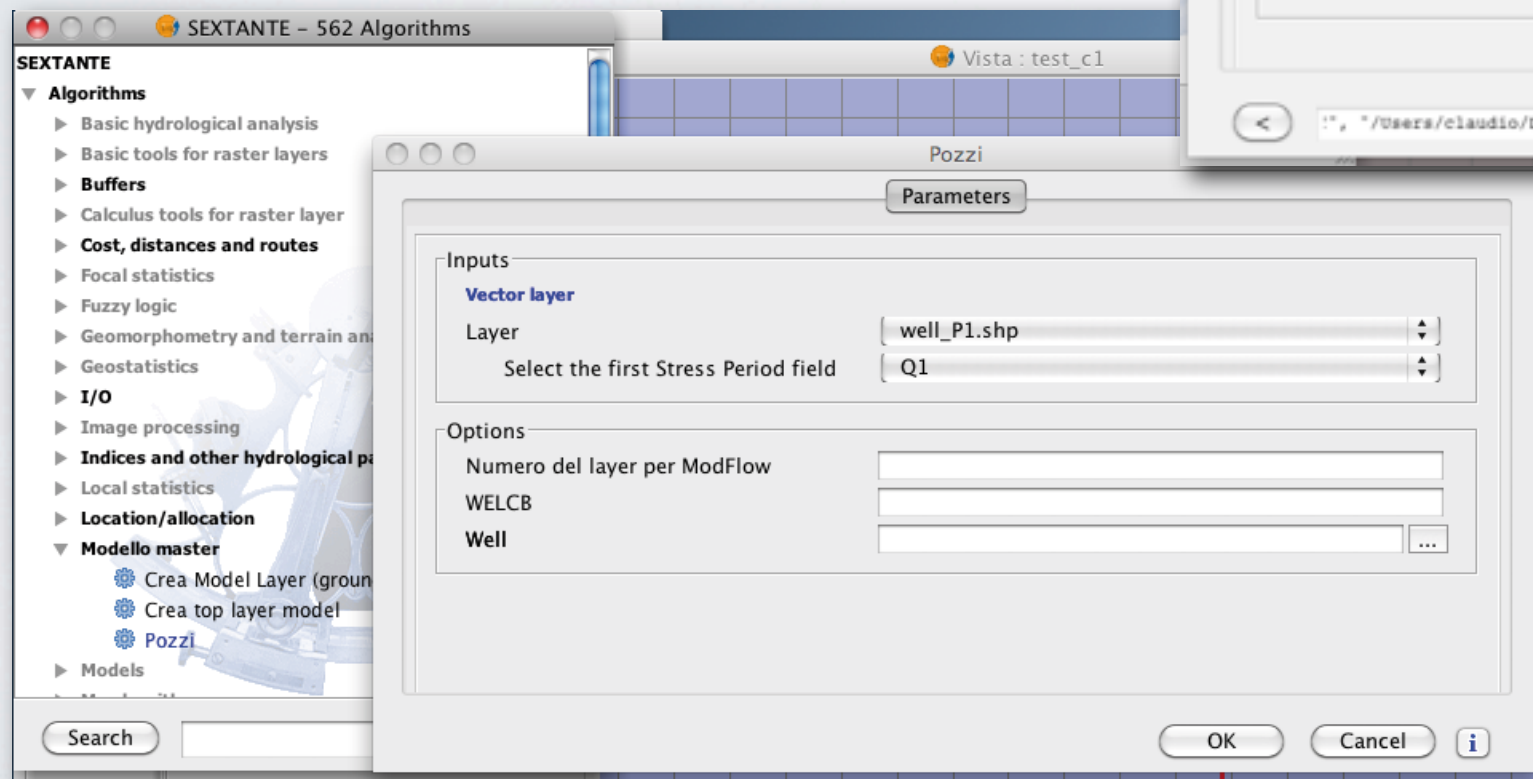
a geo-algorithm to implement the 3D layers and hydrodynamics parameters for the **groundwater** analysis;

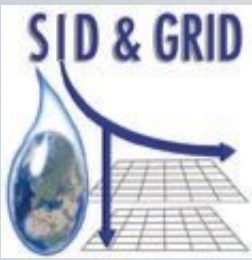


some tools to **pre-process** data to set the hydrological parameters from existing dataset to model layer dataset



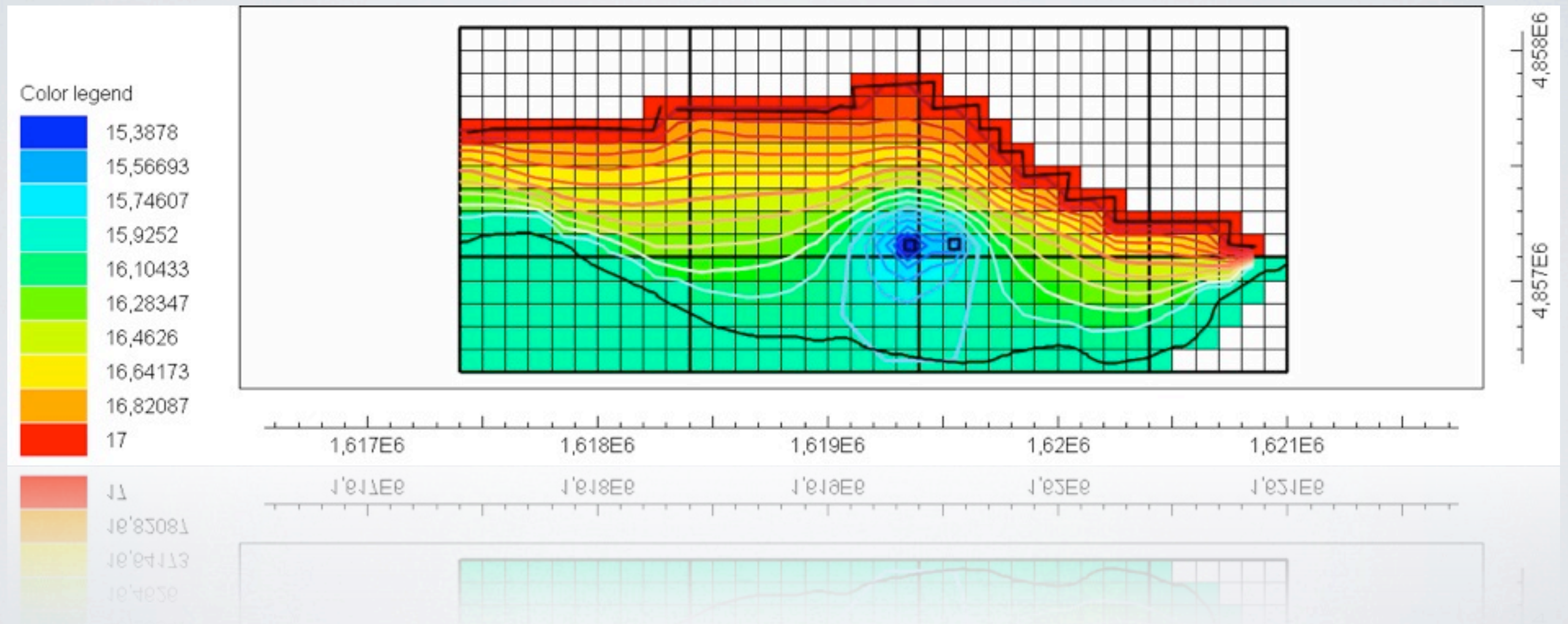
Development of algorithms to write the MODFLOW **input files** directly from GIS (e.g. DIS, LPF, WELL and RIVER package)



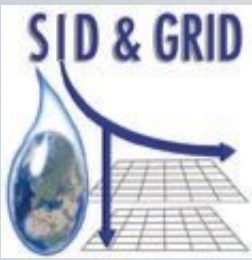


The postgresql/postgis connection is in progress like the algorithm integration into gvSIG GUI.

and finally...



it is only one time step output...
..and we have many code to develop to do this!



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THANK YOU FOR YOUR ATTENTION!

To be updated about the project, please, follow our work at:

<http://sidgrid.isti.cnr.it>