JGRASS UDIG'S SENSE OF CLIMATE CHANGE

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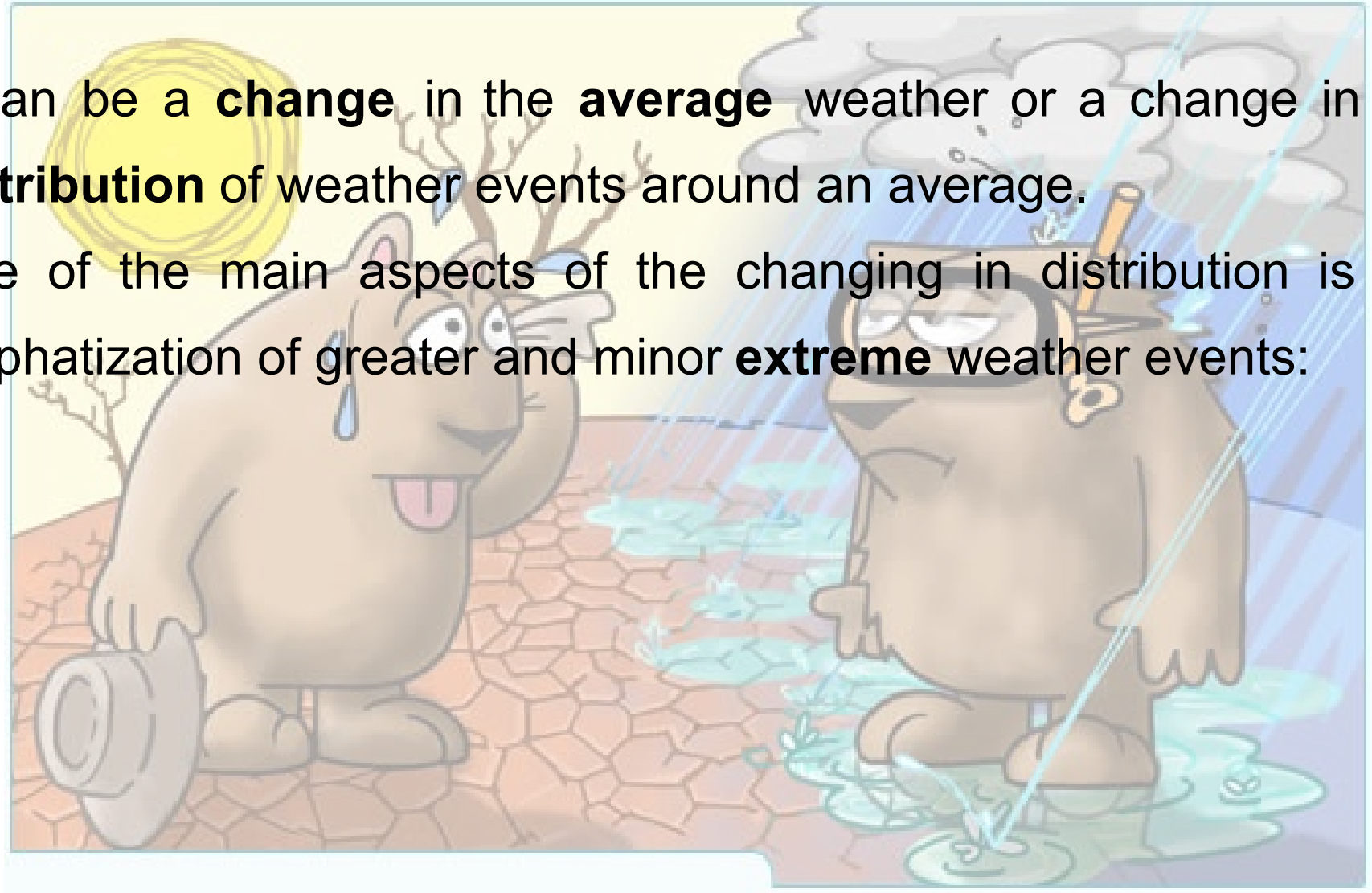
Sydney 23 October 2009

CLIMATE CHANGE

- a change in the statistical distribution of weather over periods of time
- climate forcing (natural causes): variation in solar radiation, Earth's orbit, mountains building
- human activities that change the environment (anthropogenic factors)

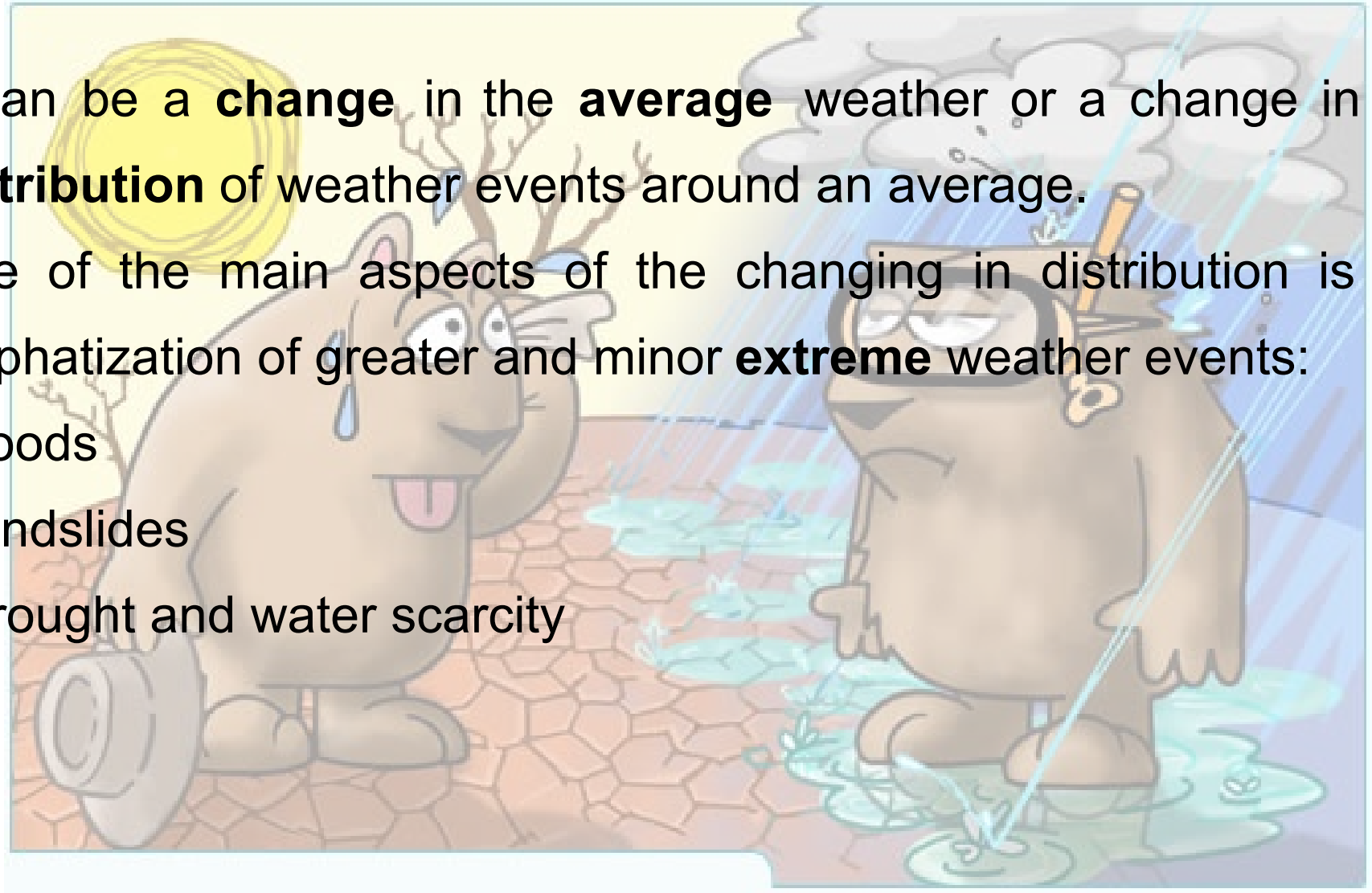
CLIMATE CHANGE



It can be a **change** in the **average** weather or a change in the **distribution** of weather events around an average.

One of the main aspects of the changing in distribution is the emphatization of greater and minor **extreme** weather events:

CLIMATE CHANGE



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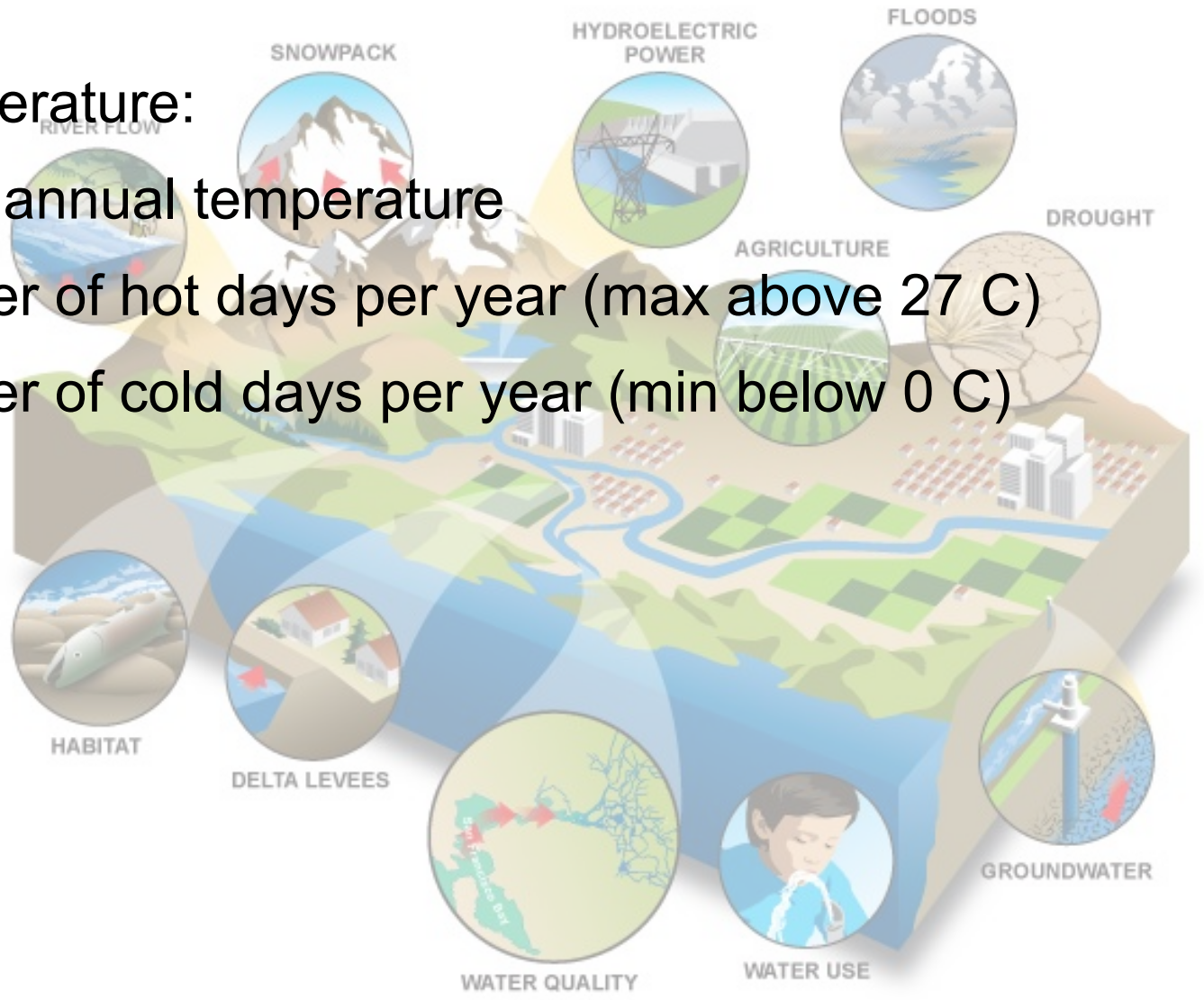
One of the main aspects of the changing in distribution is the emphatization of greater and minor **extreme** weather events:

- floods
- landslides
- drought and water scarcity

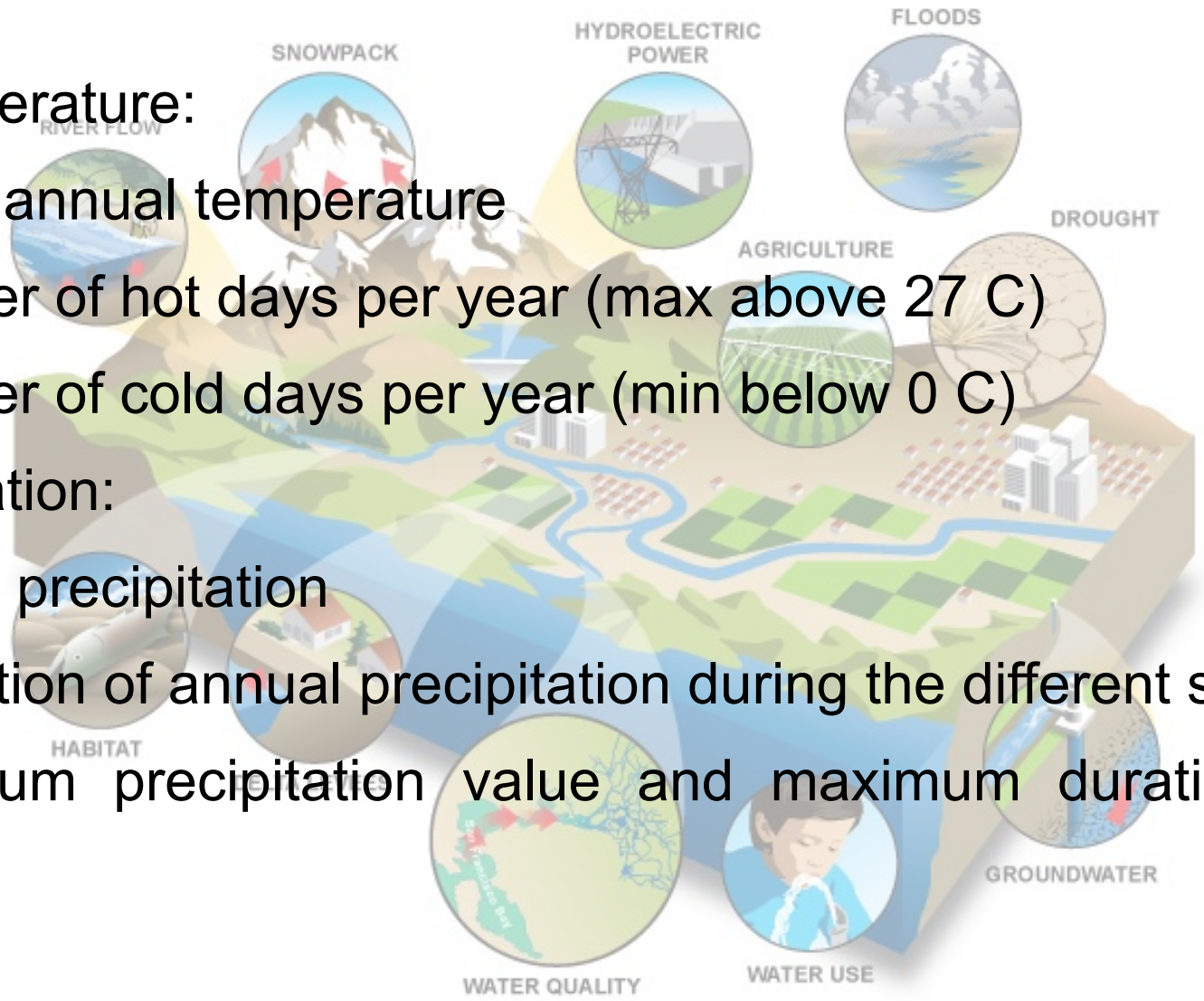
CLIMATE CHANGE INDICATORS

- air temperature:
  - mean annual temperature
  - number of hot days per year (max above 27 C)
  - number of cold days per year (min below 0 C)



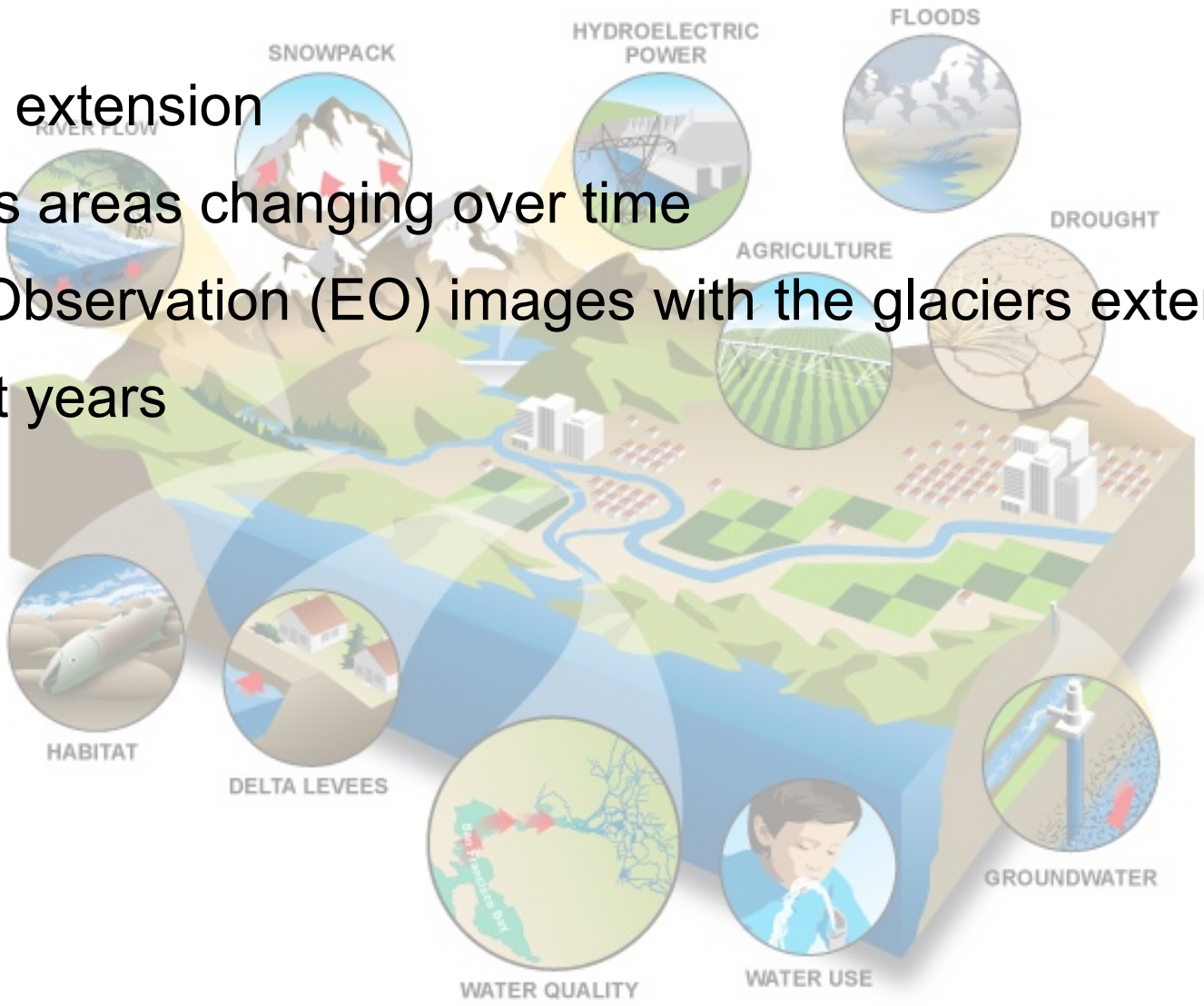
CLIMATE CHANGE INDICATORS

- air temperature:
  - mean annual temperature
  - number of hot days per year (max above 27 C)
  - number of cold days per year (min below 0 C)
- precipitation:
  - annual precipitation
  - proportion of annual precipitation during the different seasons
  - maximum precipitation value and maximum duration of the events



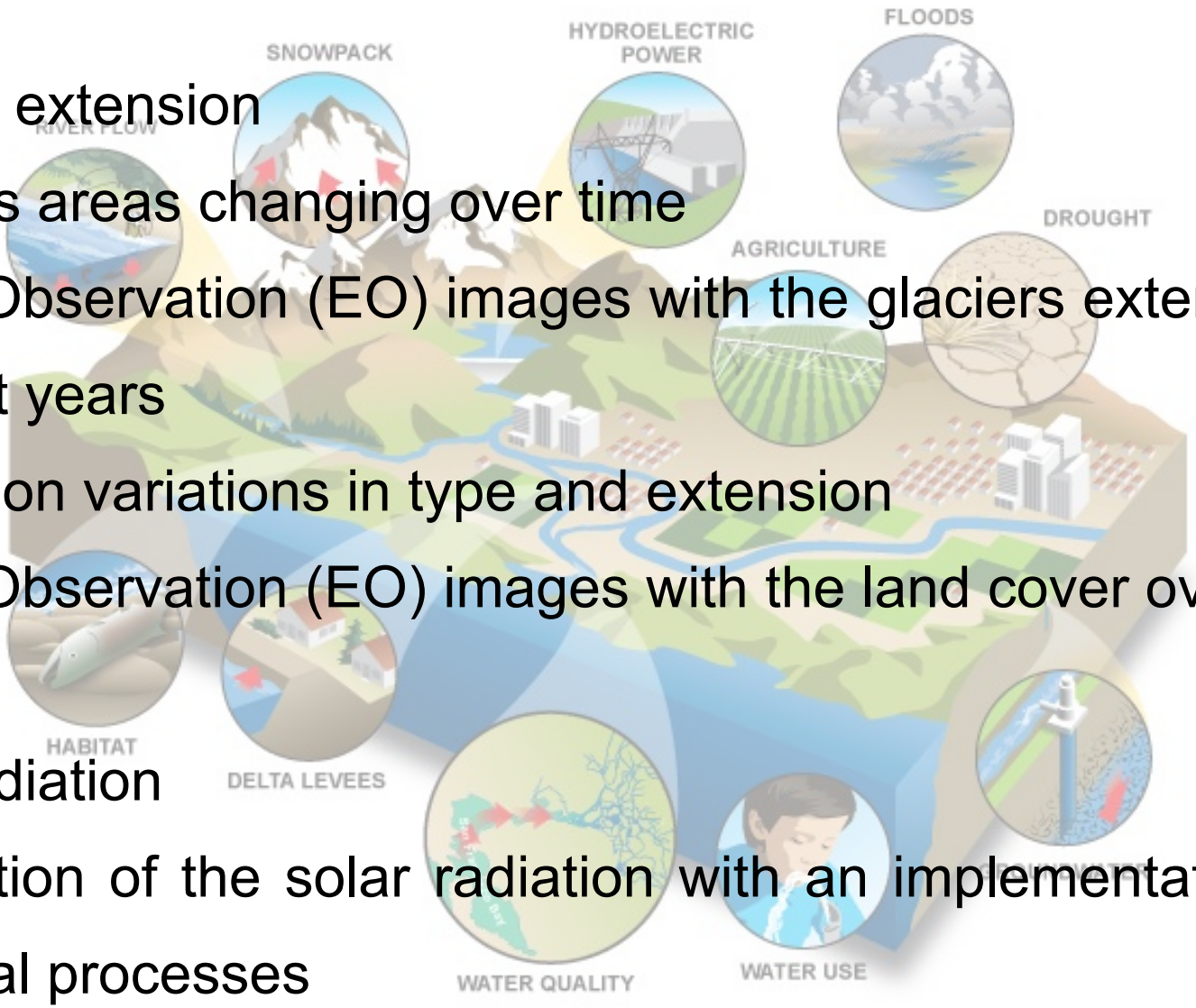
CLIMATE CHANGE INDICATORS

- glaciers extension
  - glaciers areas changing over time
  - Earth Observation (EO) images with the glaciers extension over the last years



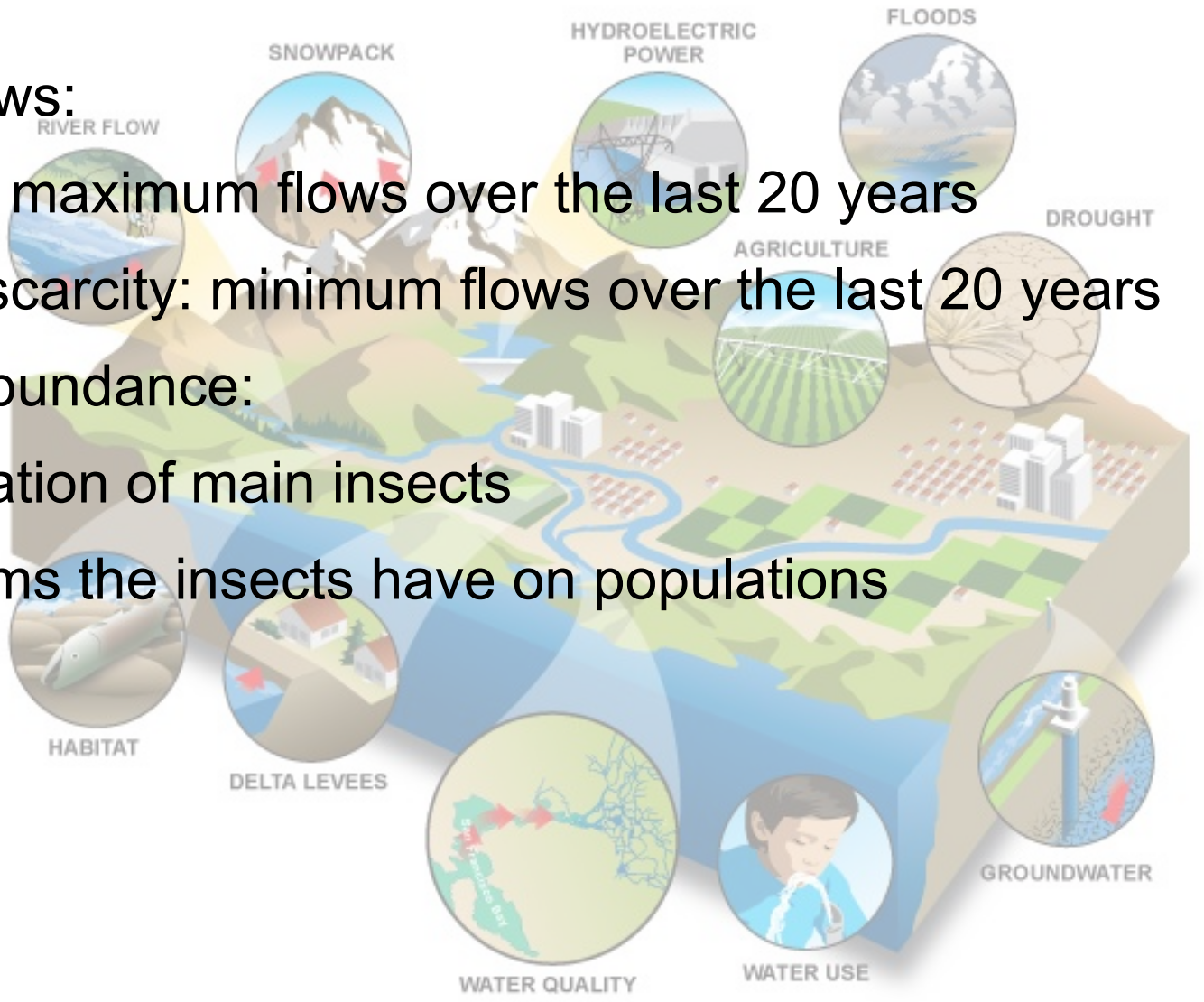
CLIMATE CHANGE INDICATORS

- glaciers extension
  - glaciers areas changing over time
  - Earth Observation (EO) images with the glaciers extension over the last years
- vegetation variations in type and extension
  - Earth Observation (EO) images with the land cover over the last years
- solar radiation
  - evaluation of the solar radiation with an implementation of the physical processes



CLIMATE CHANGE INDICATORS

- river flows:
  - floods: maximum flows over the last 20 years
  - water scarcity: minimum flows over the last 20 years
- insect abundance:
  - localization of main insects
  - problems the insects have on populations



JGRASS AND CLIMATE CHANGE

- GIS mainly dedicated to environmental analysis

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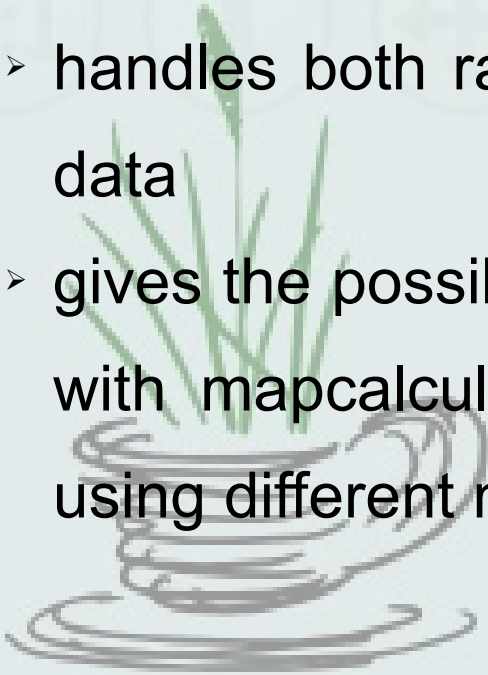

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- modeling past scenarios with hydrologic and stability models

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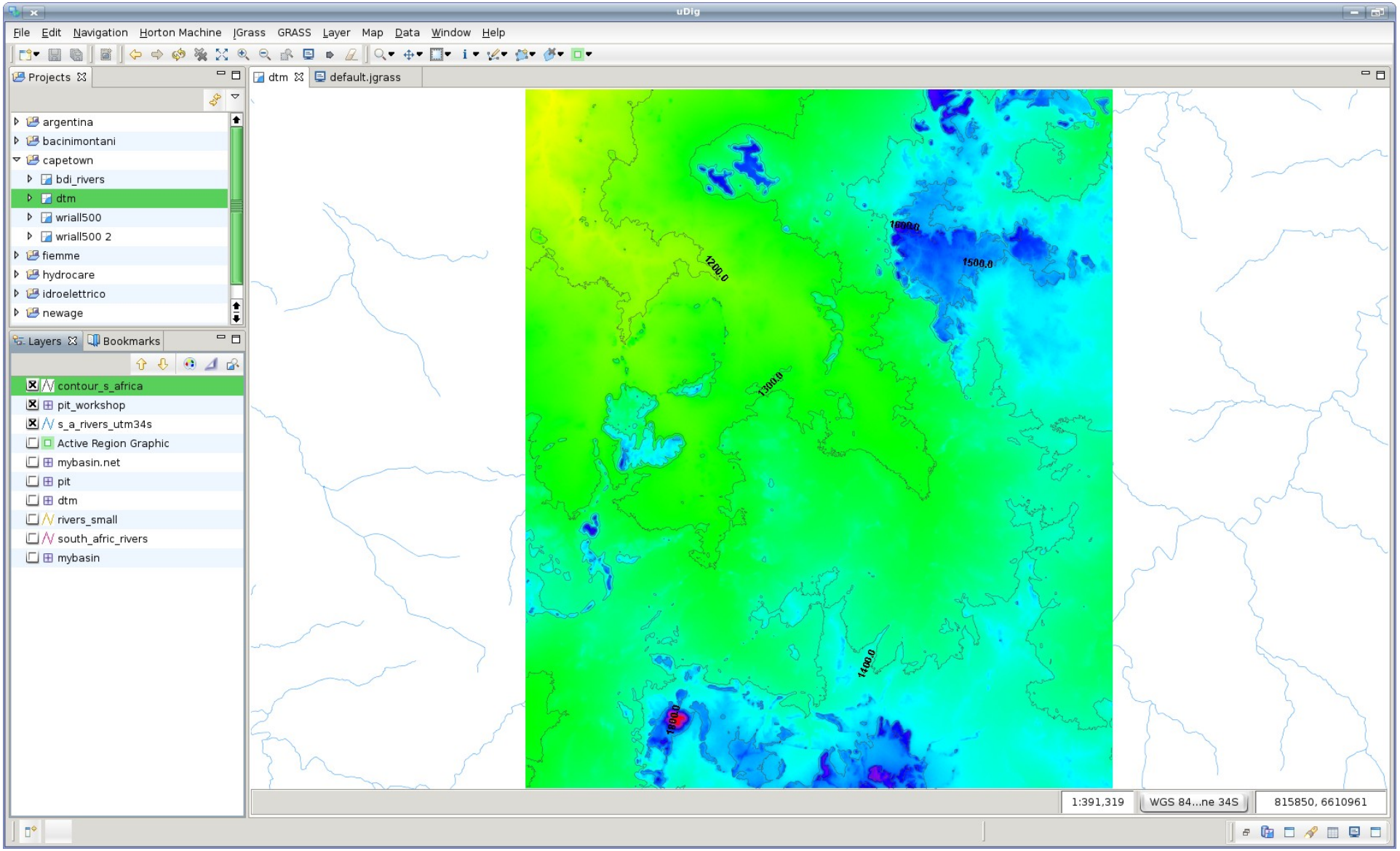
- gives the possibility to do calculations on maps: direct calculation with mapcalculator or other complex and recursive calculation using different modules and the scripting environment
- extract morphological attributes from a DTM
- modeling past scenarios with hydrologic and stability models
- creating a new scenario and run simulations on this
- analyzing the results starting from maps and charts

JGRASS RASTERS AND VECTORS

- r.contours: interpolate contours lines to obtain a DTM map or extract the contours line from a DTM
  - h.hypsographic: calculation of the hypsographic curve (cumulative height frequency curve for the Earth's surface or some part thereof)

JGRASS RASTERS AND VECTORS



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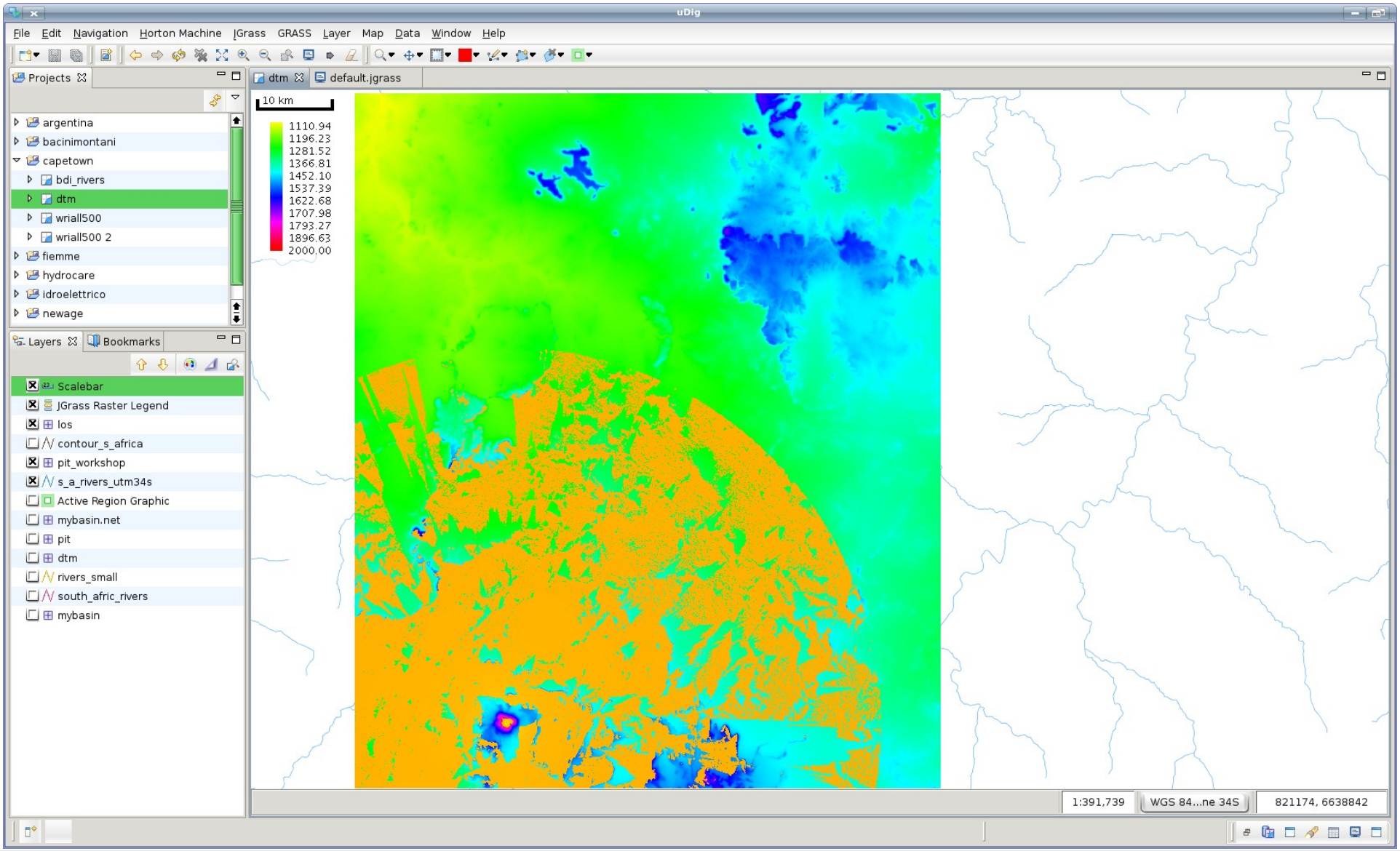

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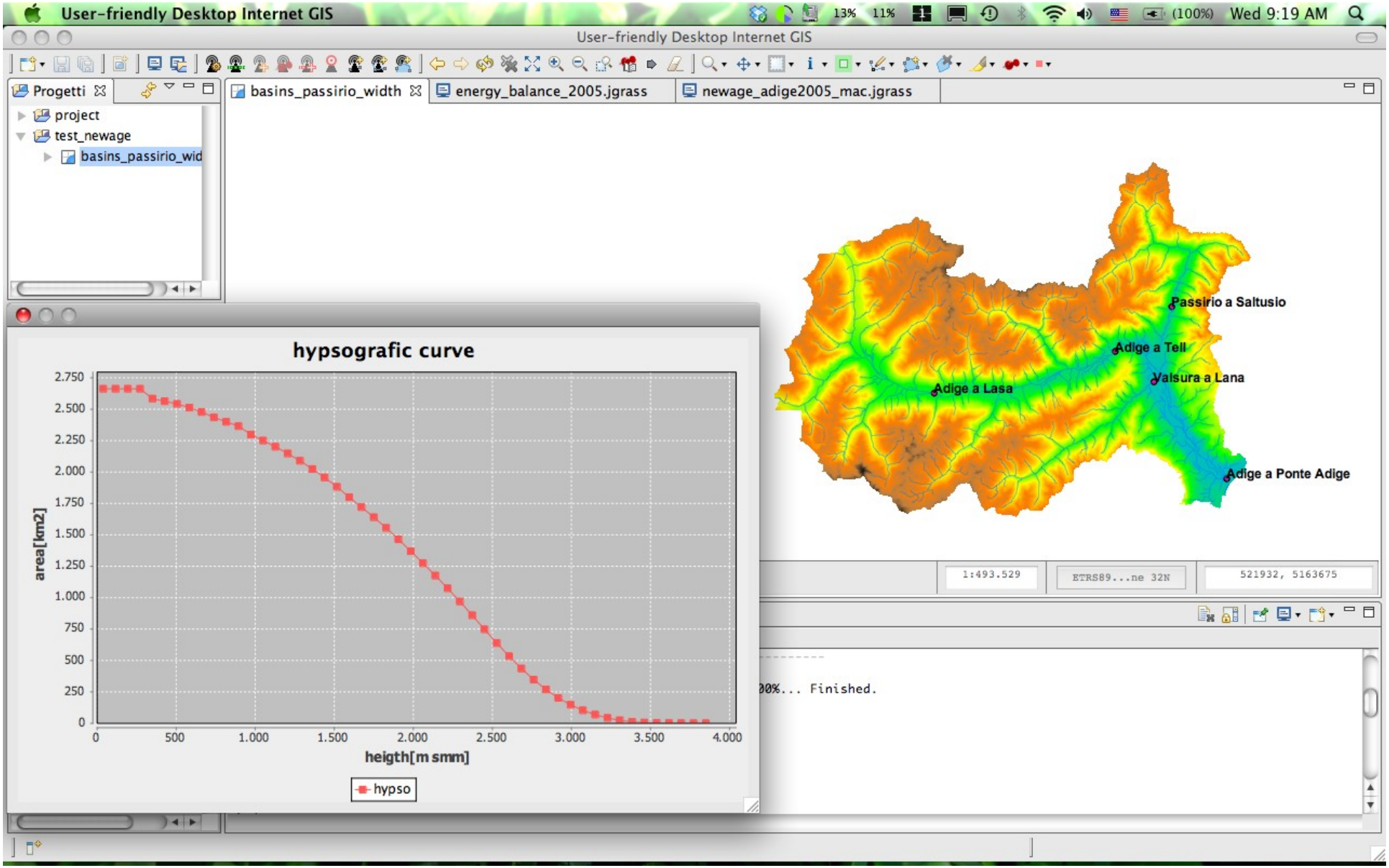
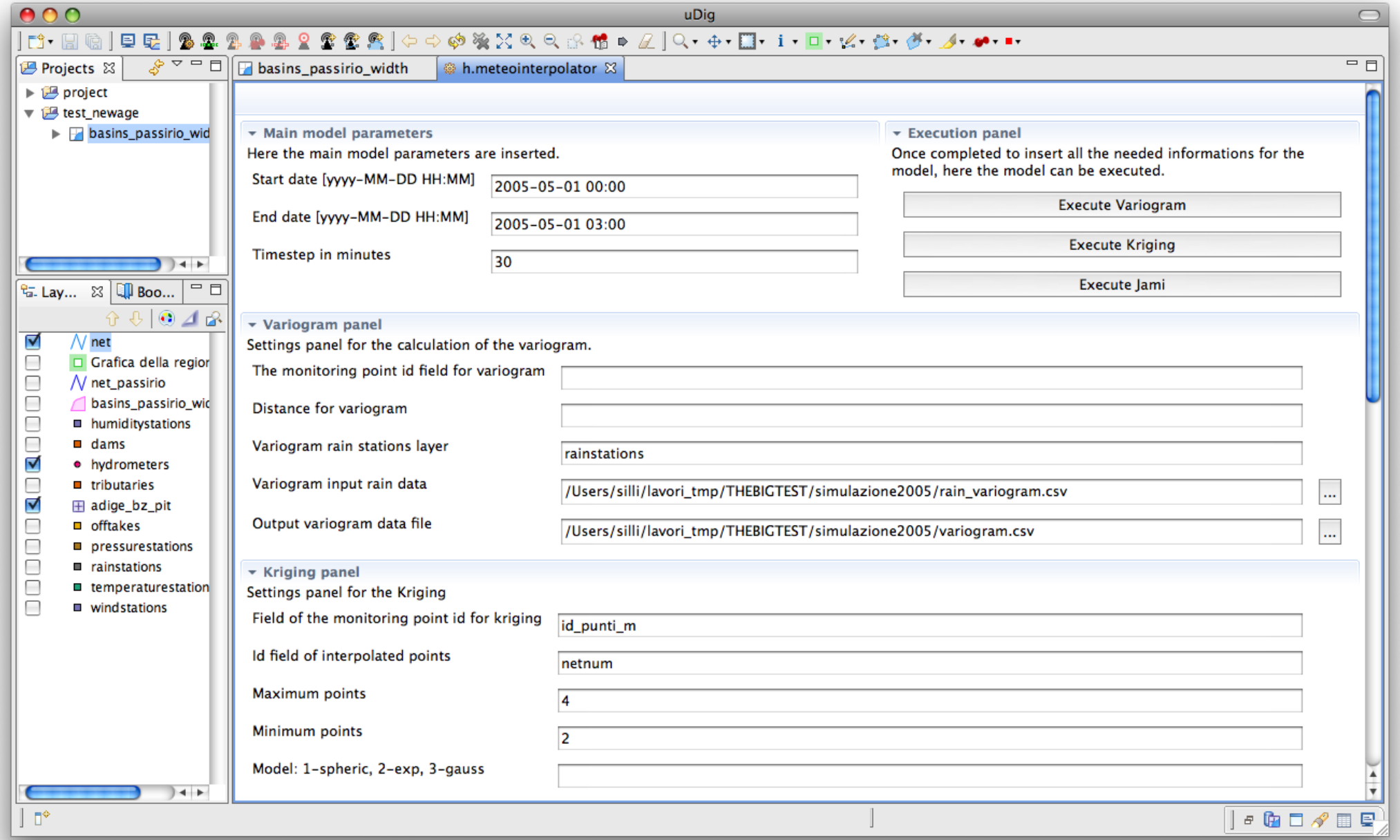


JGRASS RASTERS AND VECTORS

- h.kriging: interpolate measured rainfall data in monitoring points using the kriging model
  - h.variogram: create your own variogram based on measured data distribution and values
  - create raster maps starting from discrete measured data
  - interpolate values in discrete points such as the barycenter of subbasins

JGRASS RASTERS AND VECTORS



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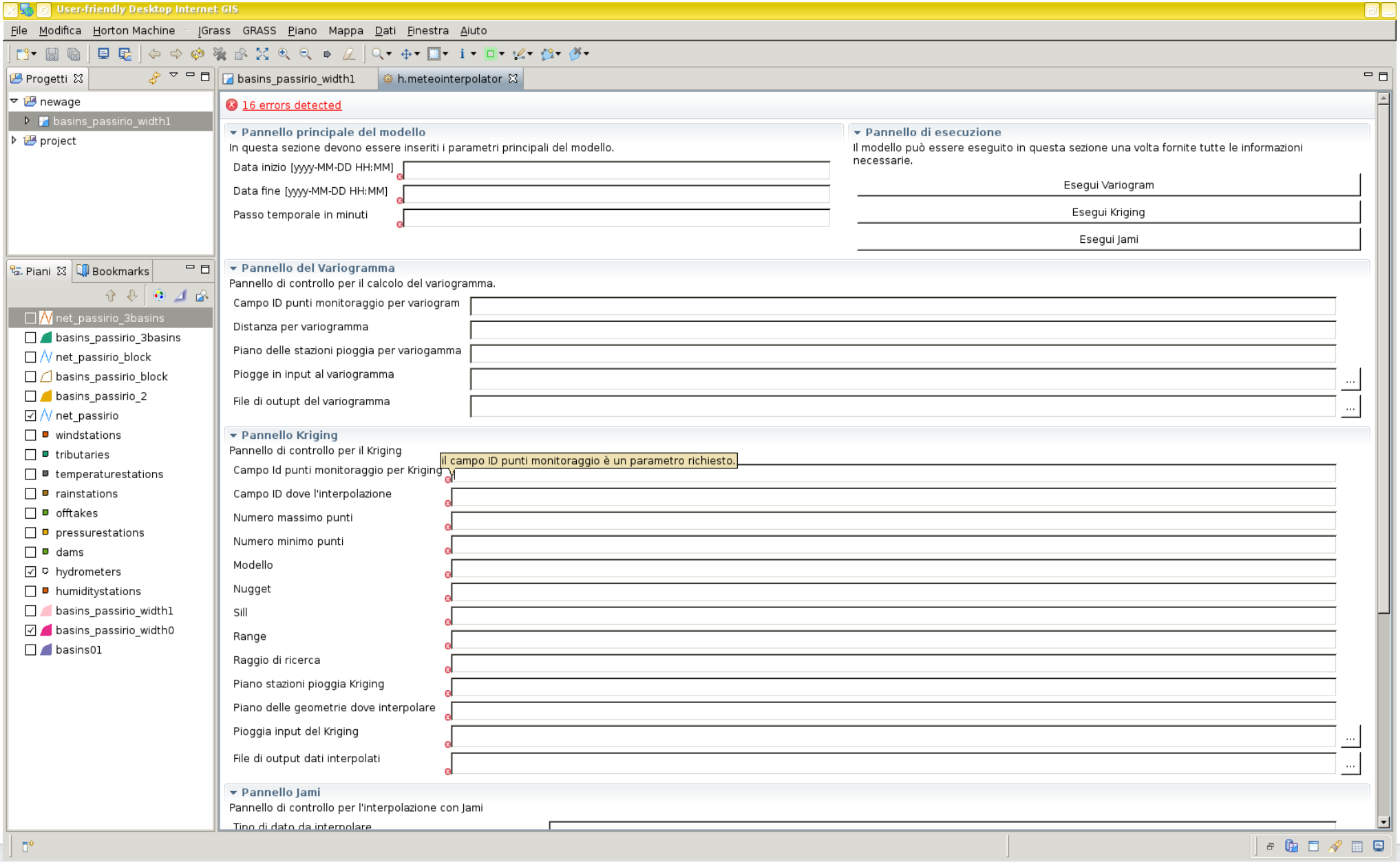

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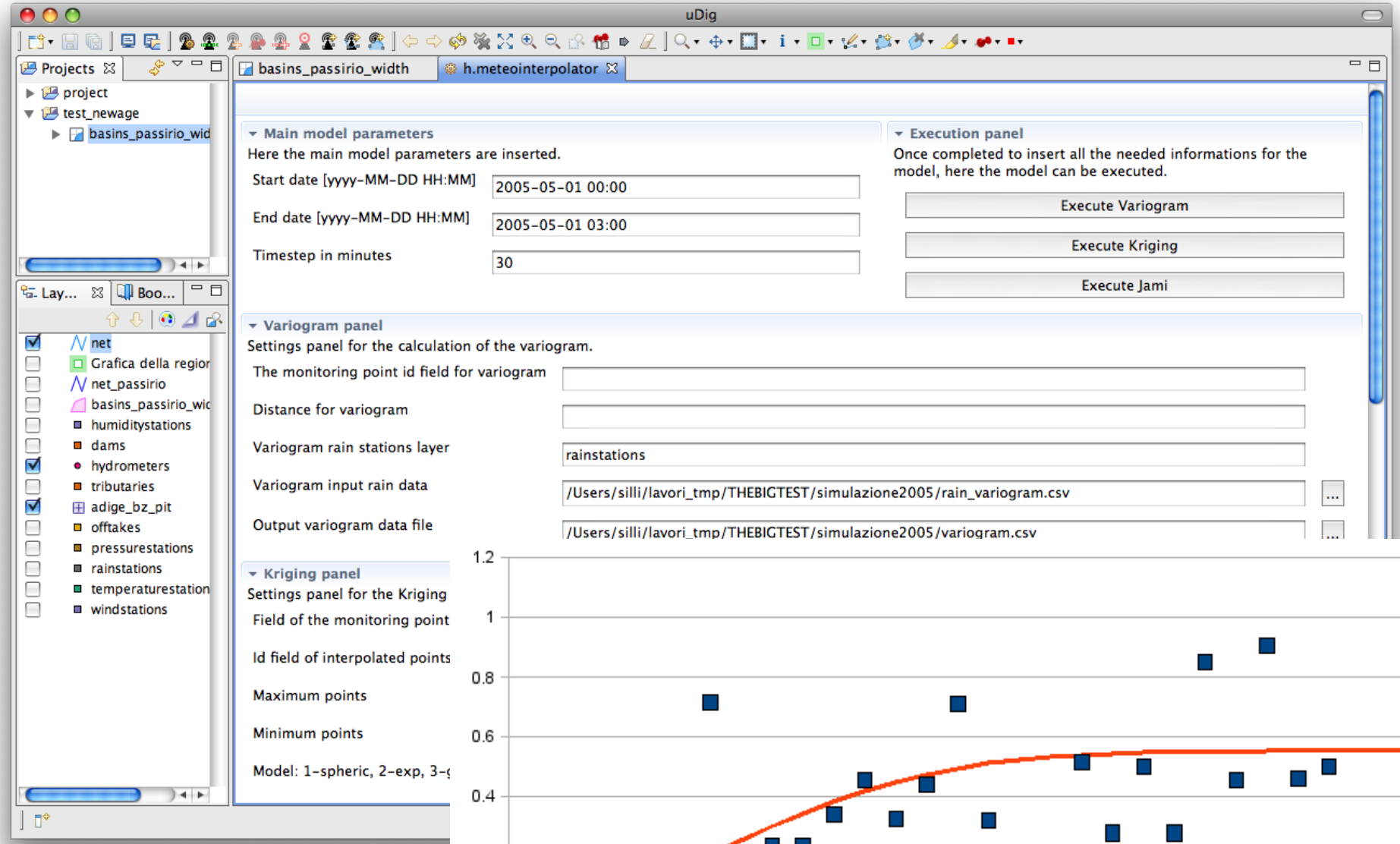

JGRASS RASTERS AND VECTORS

Kriging panel

Settings panel for the Kriging

Field of the monitoring point id for kriging	id_punti_m
Id field of interpolated points	netnum
Maximum points	4
Minimum points	2
Model: 1-spheric, 2-exp, 3-gauss	
Nugget	0
Sill	0.85
Range	75000
Search radius	100000
Kriging rain stations layer	rainstations
Interpolated positions layer	basins_passirio_width
Kriging input rain data	/Users/silli/lavori_tmp/THEBIGTEST/simulazione2005/rain2005_all.csv ...
Interpolated output data	/Users/silli/lavori_tmp/THEBIGTEST/simulazione2005/test_kriging.csv ...

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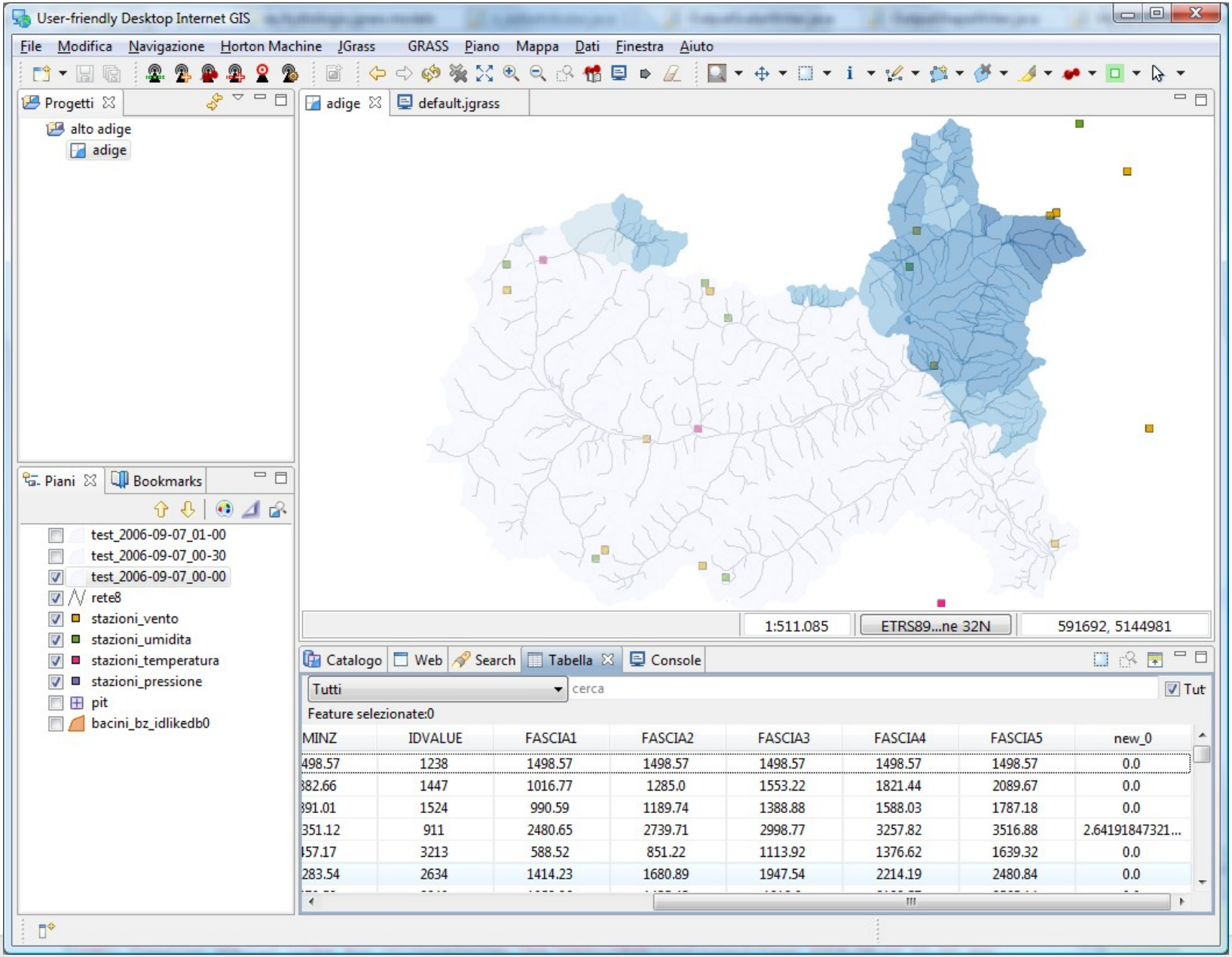

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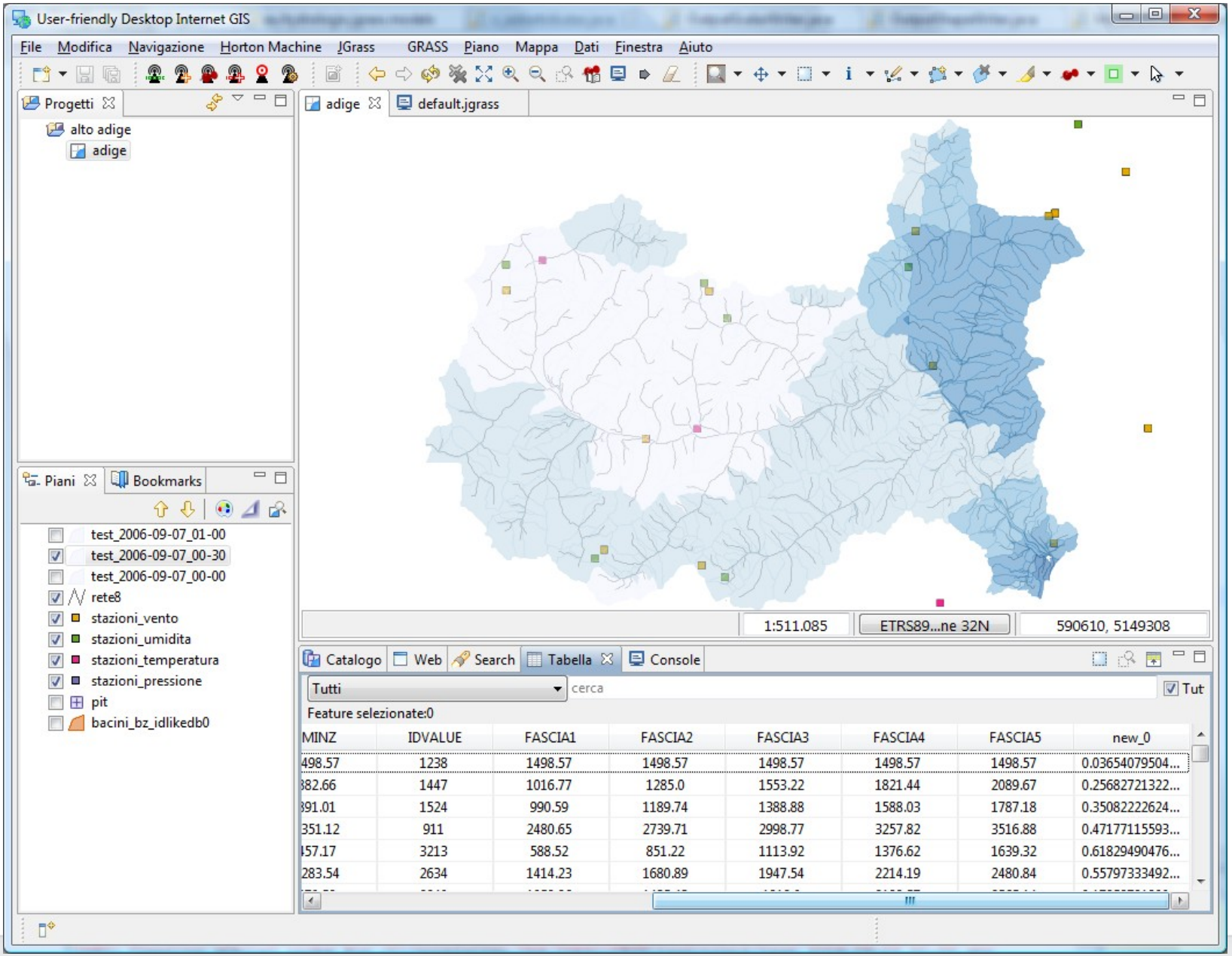

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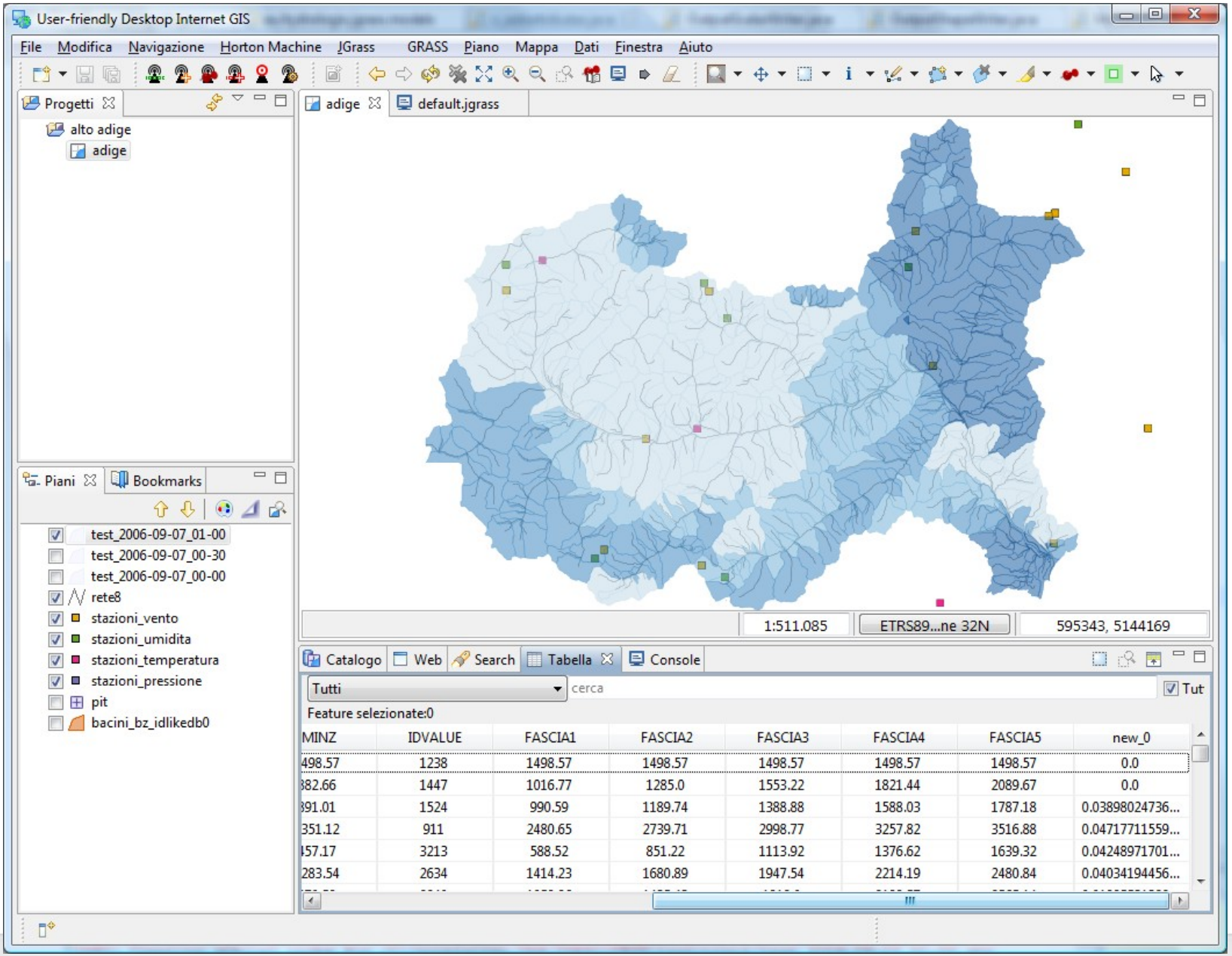


JGRASS RASTERS AND VECTORS

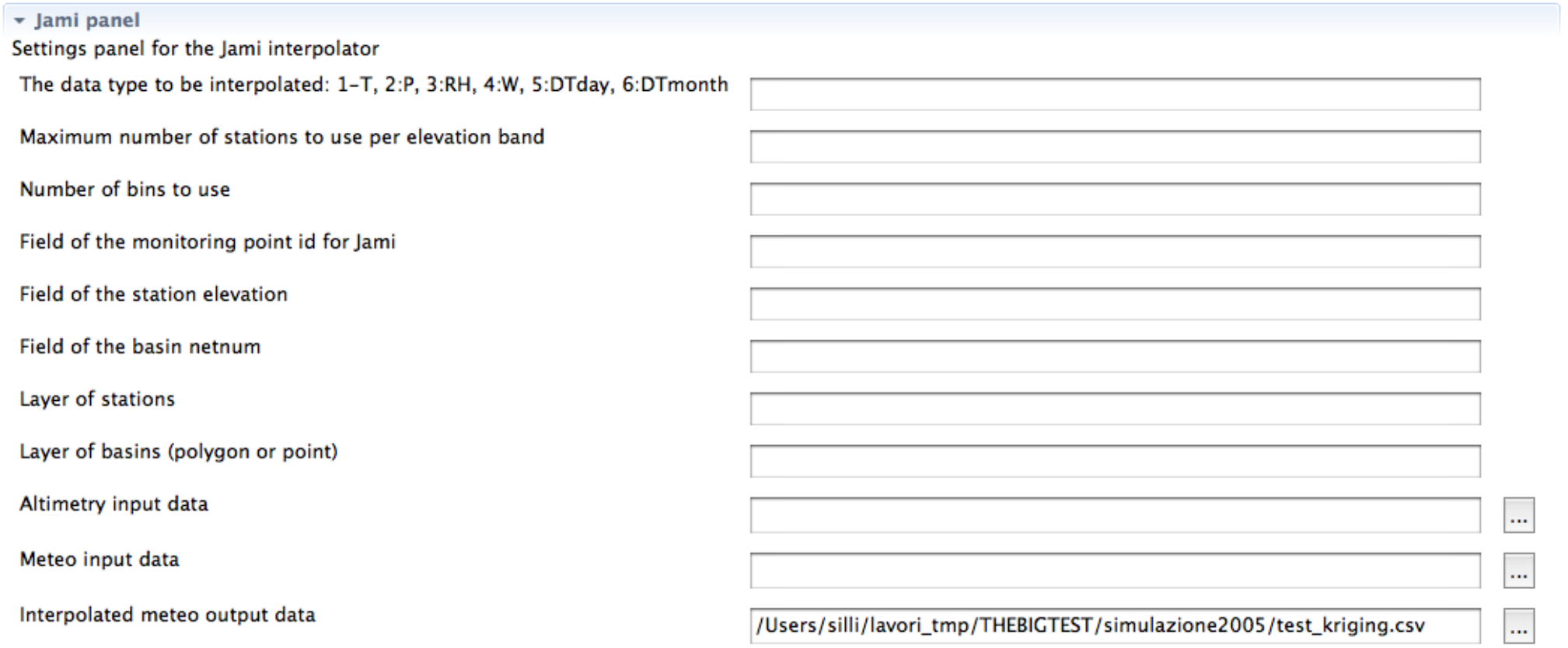
```
jgrass {
    h.kriging
        --idfield "NETNUM"
        --idfieldinterpolated "NETNUM"
        --maxpoints 4 --minpoints 2 --model 2 --nugget "0.05"
        --sill 0.6 --range 50000 --dovariance "true" --searchradius 100000
        --itscalar-inputvalues "/media/BUNDELE/newage/modelli_nuovi/THEBIGTEST/pioggia_2005/rain2005_all.csv"
        --iflayer-positions "stazioni_rain_all"
        --iflayer-interpolatedpositions "bacini_bz_idlikedb0_uso_suolo"
        --oscalar-outputvalues "/media/BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/kriging2005.csv"
}

jgrass {
       v.addattributes
      --iflayer-infeatures "bacini_bz_idlikedb0"
      --itscalar-attributes "/Users/silli/lavori_tmp/THEBIGTEST/pioggia_2005/rain_krigged_small2"
      --oshapefile-outfeatures "/Users/silli/lavori_tmp/THEBIGTEST/pioggia_2005/shape_rain/rain2"
      --joinfield "NETNUM"
}
```

JGRASS RASTERS AND VECTORS

- h.jami: interpolate other measured quantities in monitoring points using particular physical based models, taking into account
  - spatial distribution of monitoring points
  - monitoring points height
  - number of available valid measures
  - used for temperature, pressure, wind celerity, relative humidity, daily and monthly temperature range

JGRASS RASTERS AND VECTORS



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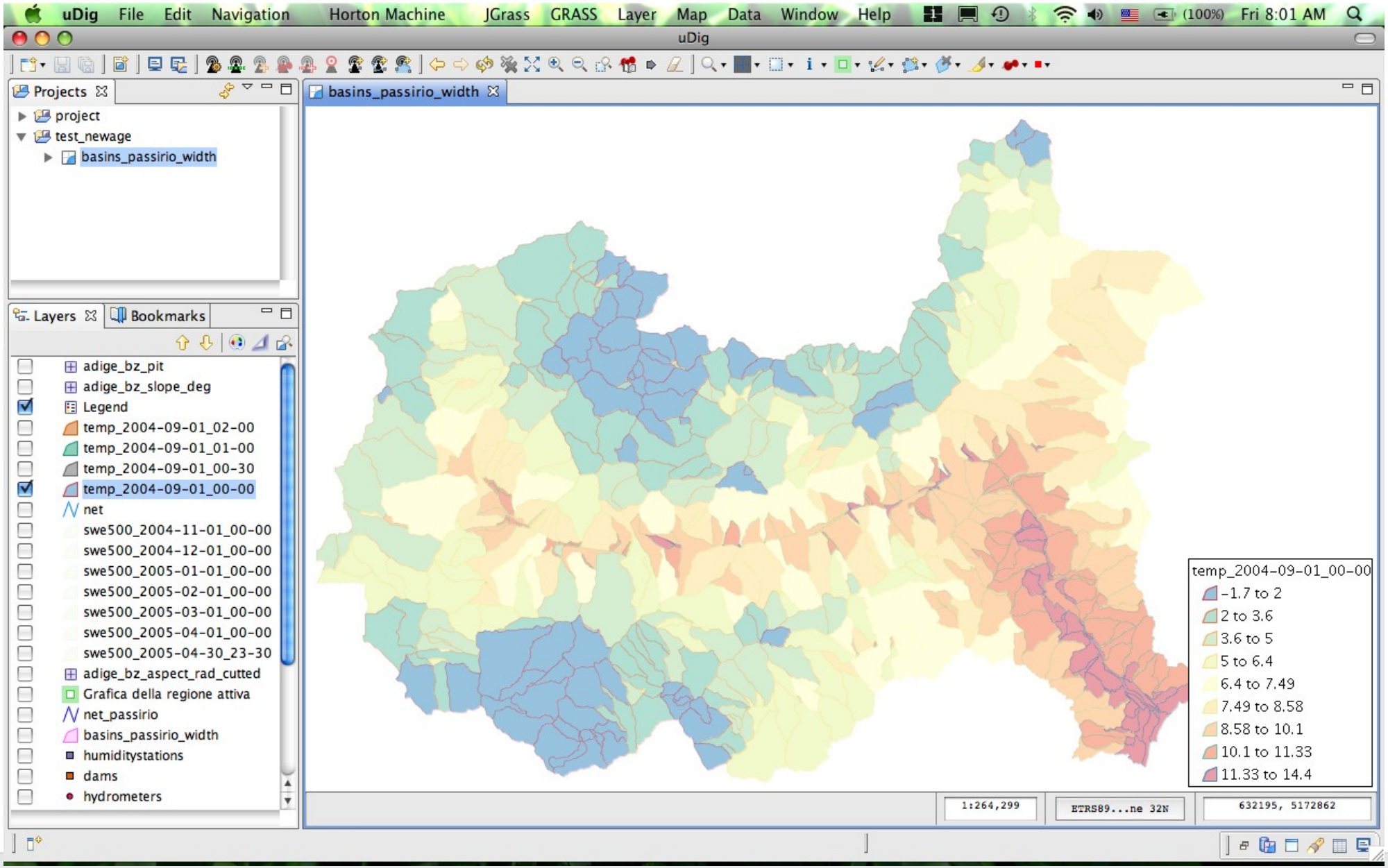

JGRASS CALCULATION ON MAPS

- r.mapcalc and r.summary provide general calculation on maps
  - average, max e min values
  - mathematical operations over values in a map

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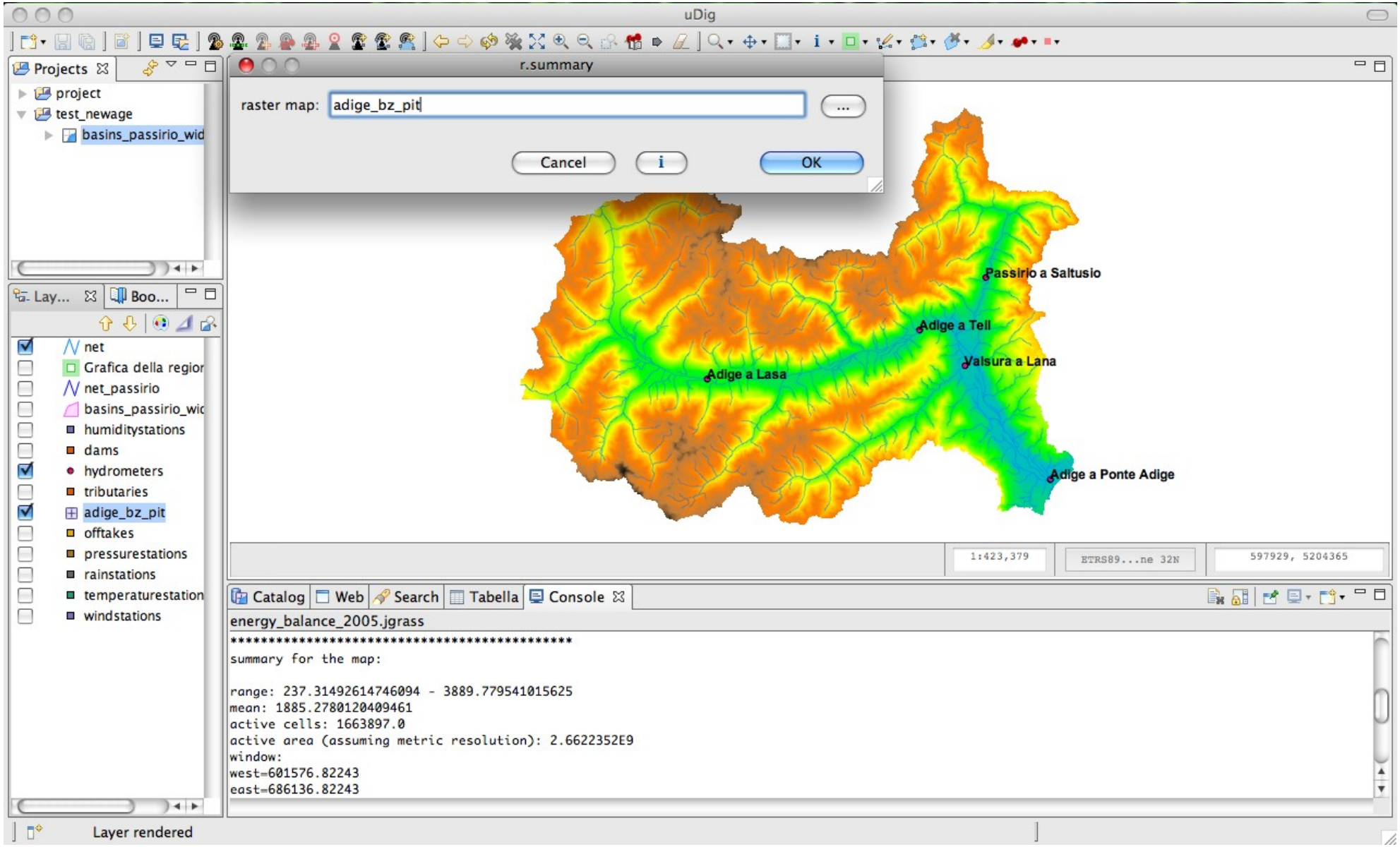

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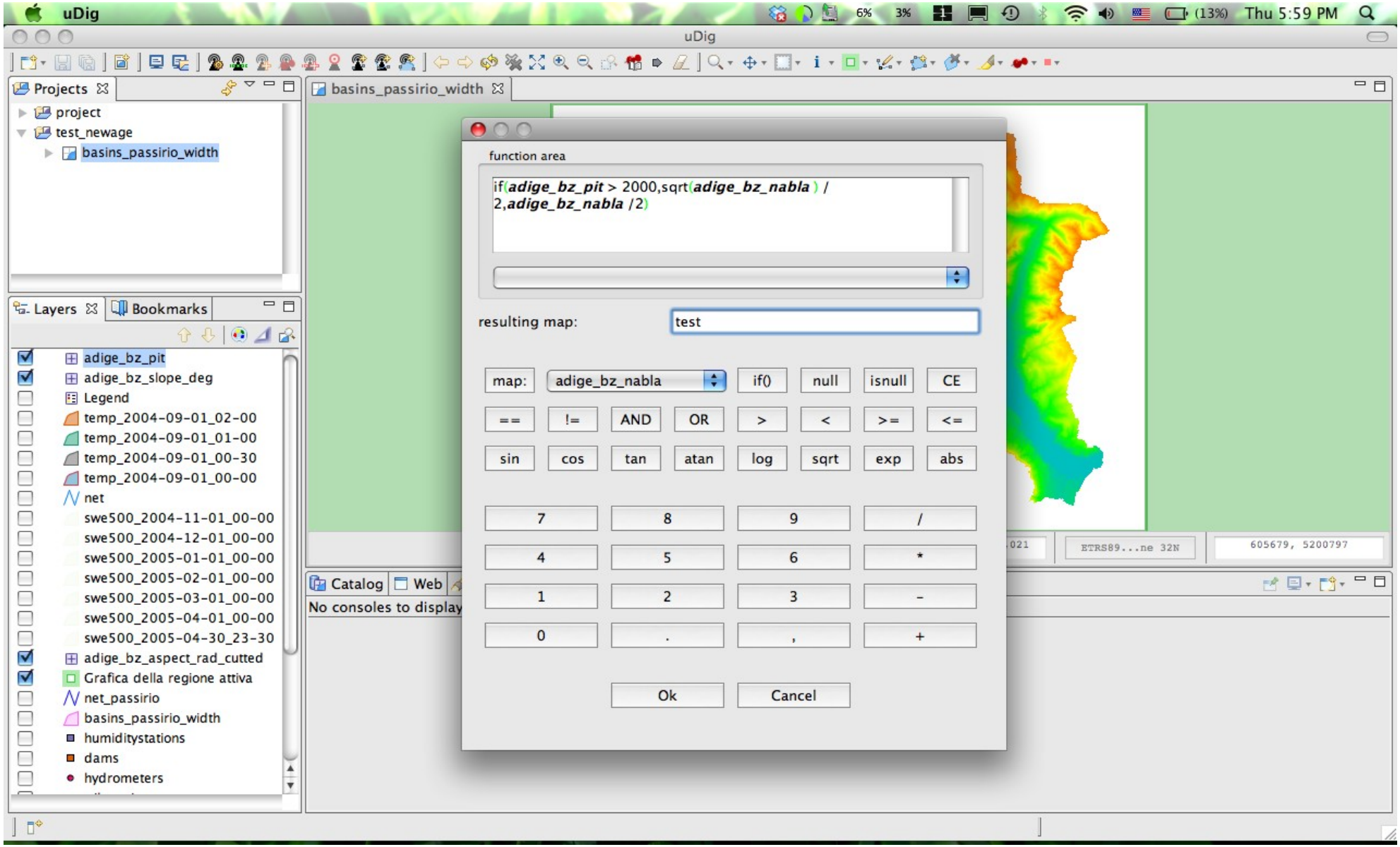


JGRASS CALCULATION ON MAPS

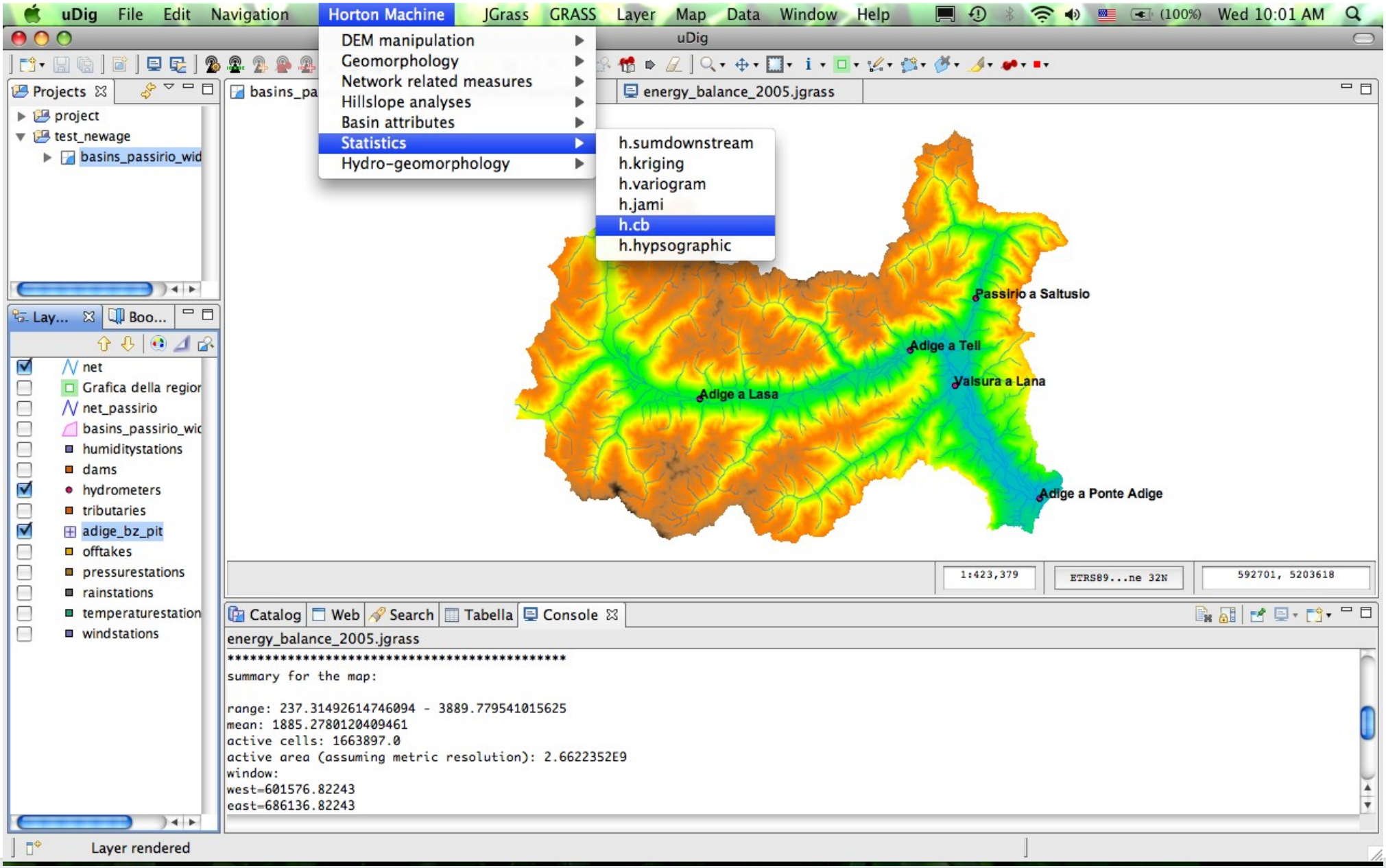
r.mapcalc and r.summary provide general calculation on maps

- average, max e min values
- mathematical operations over values in a map

➢ h.cb for statistical properties on the maps

- average and standard deviation values
- possibility to combine values of two different maps (slope against height, temperature against rain, ...)

JGRASS CALCULATION ON MAPS



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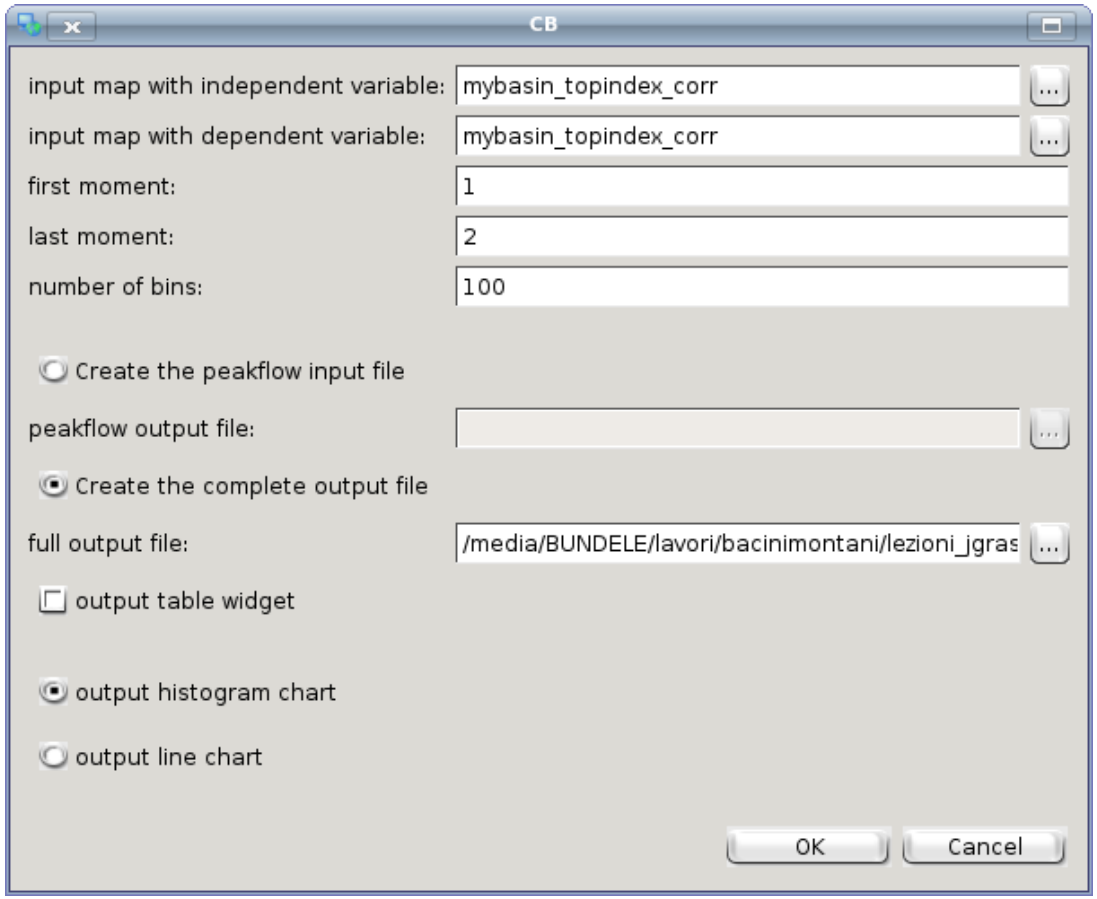

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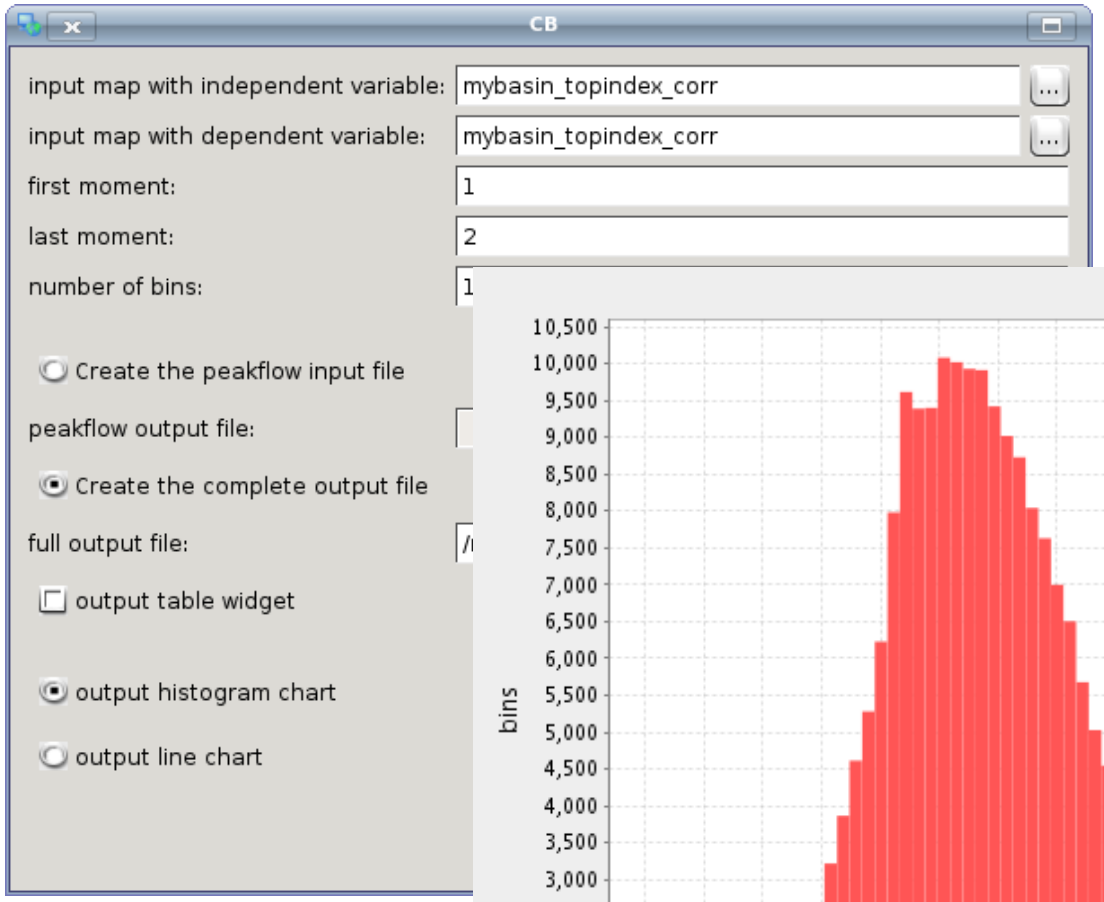

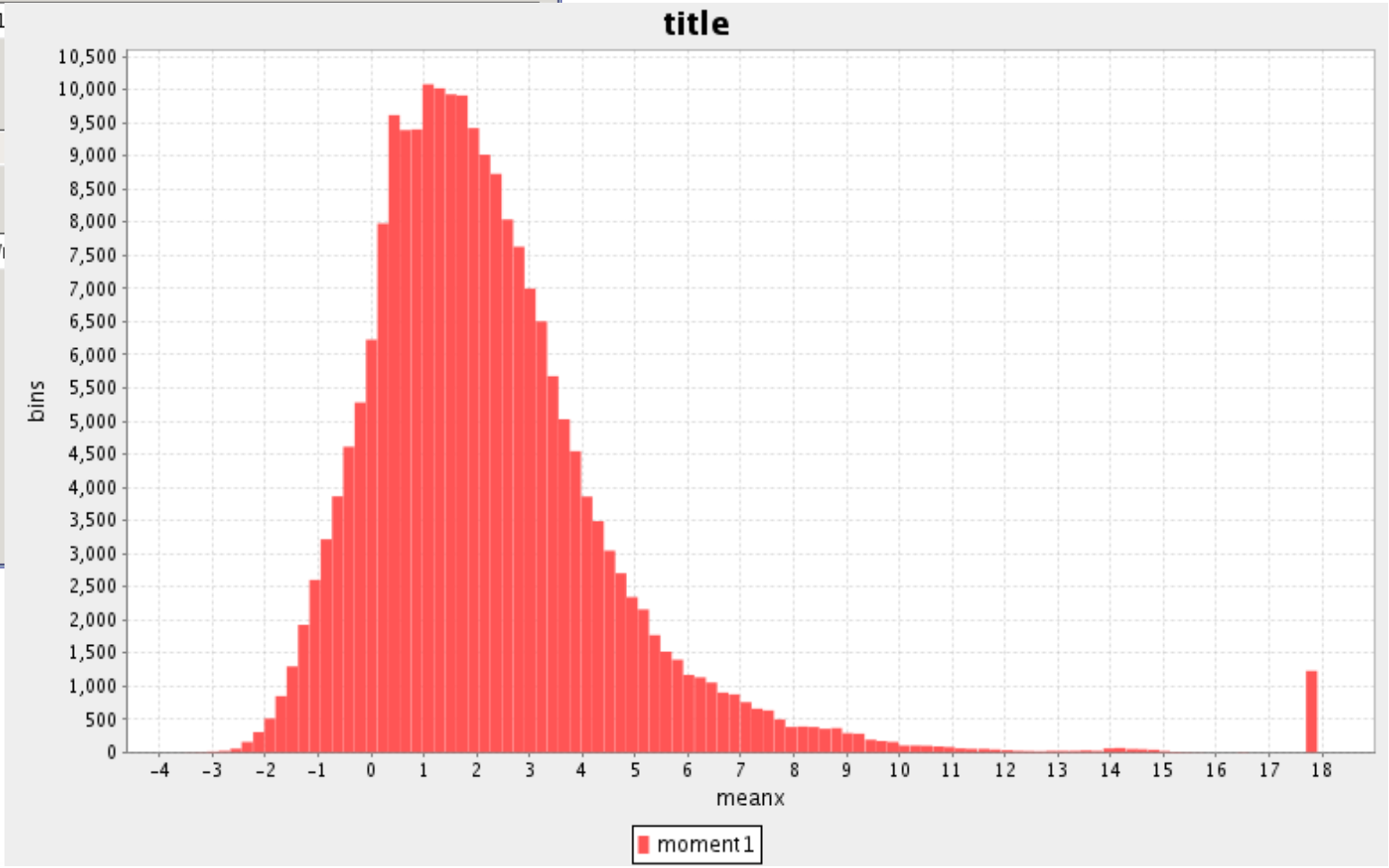

JGRASS CALCULATION ON MAPS

- r.mapcalc and r.summary for general calculation on maps
  - mean, max e min values
  - mathematical operations over values in a map
- h.cb for statistical contents on maps
  - mean and standard deviation values
  - possibility to combine values of two different maps
- scripting environment for recursive calculation an other statistical elaborations
  - calculation of the number and frequency of sites with hot or cold days in a year (temperature over or less than a fixed value)

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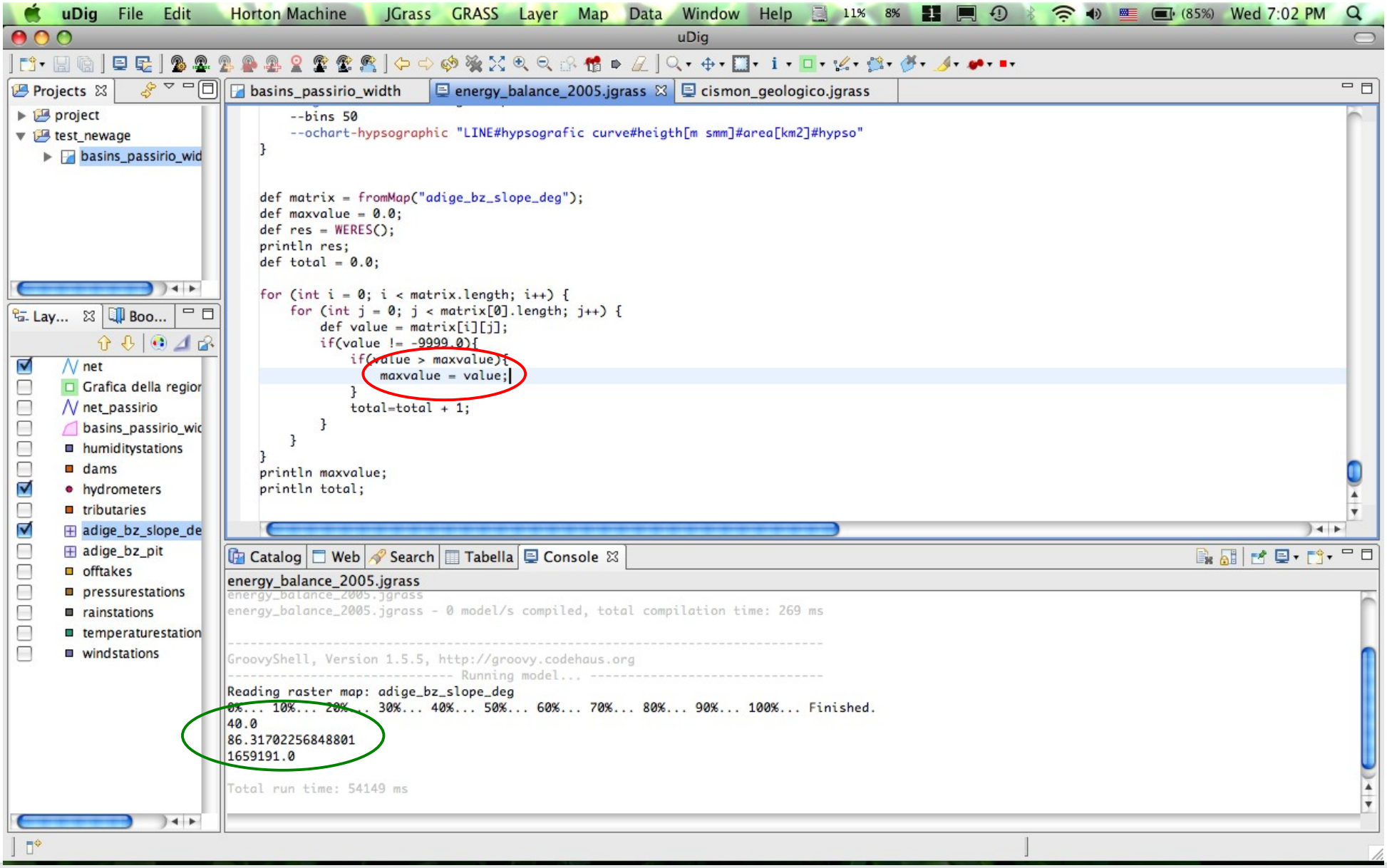
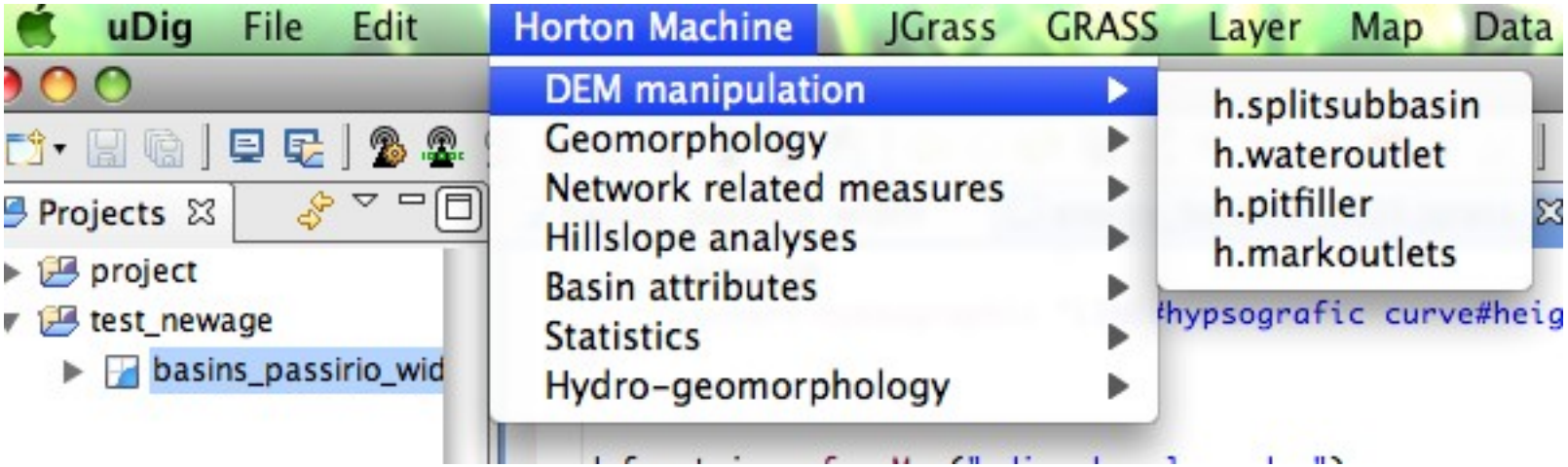


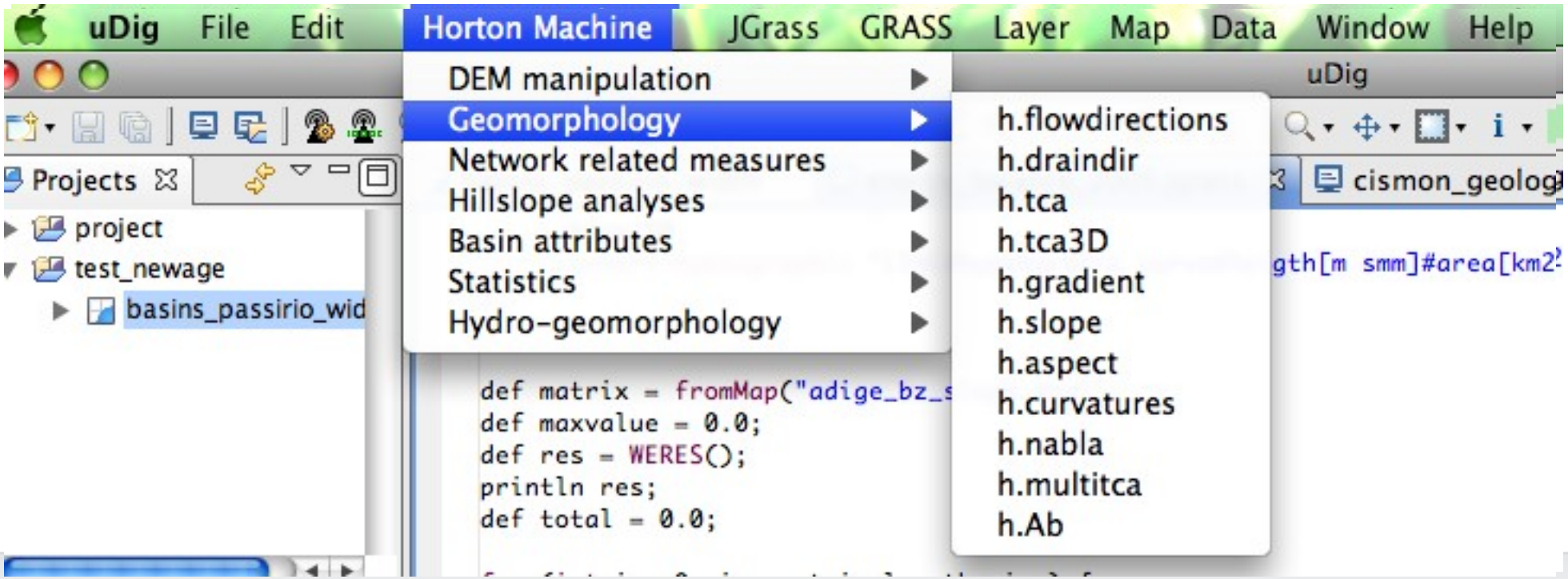
JGRASS MORPHOLOGICAL ATTRIBUTES

- DEM manipulation
  - subbasins extraction
  - watershed definition



JGRASS MORPHOLOGICAL ATTRIBUTES

- DEM manipulation
- DTM derived information
  - slope
  - curvatures



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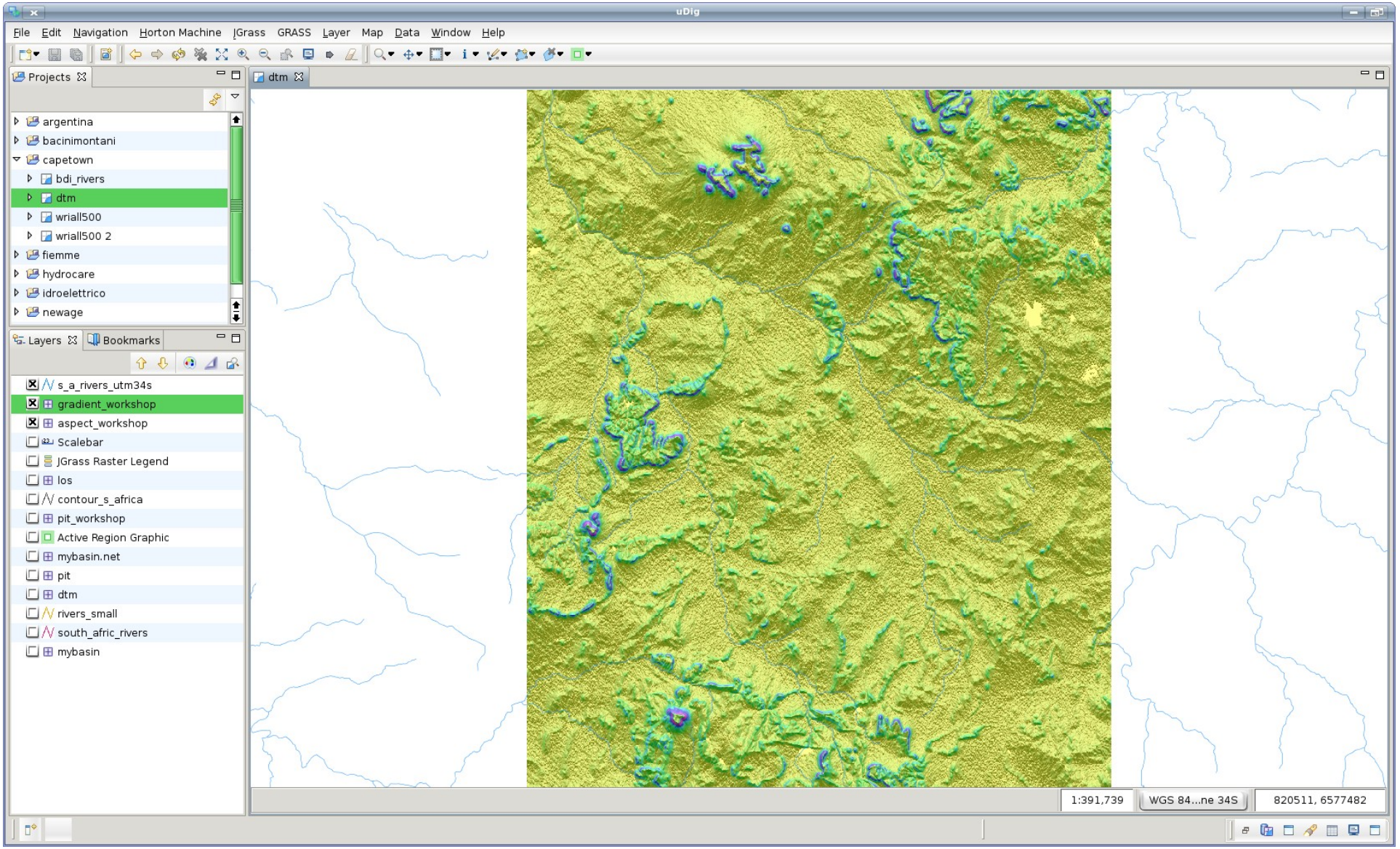

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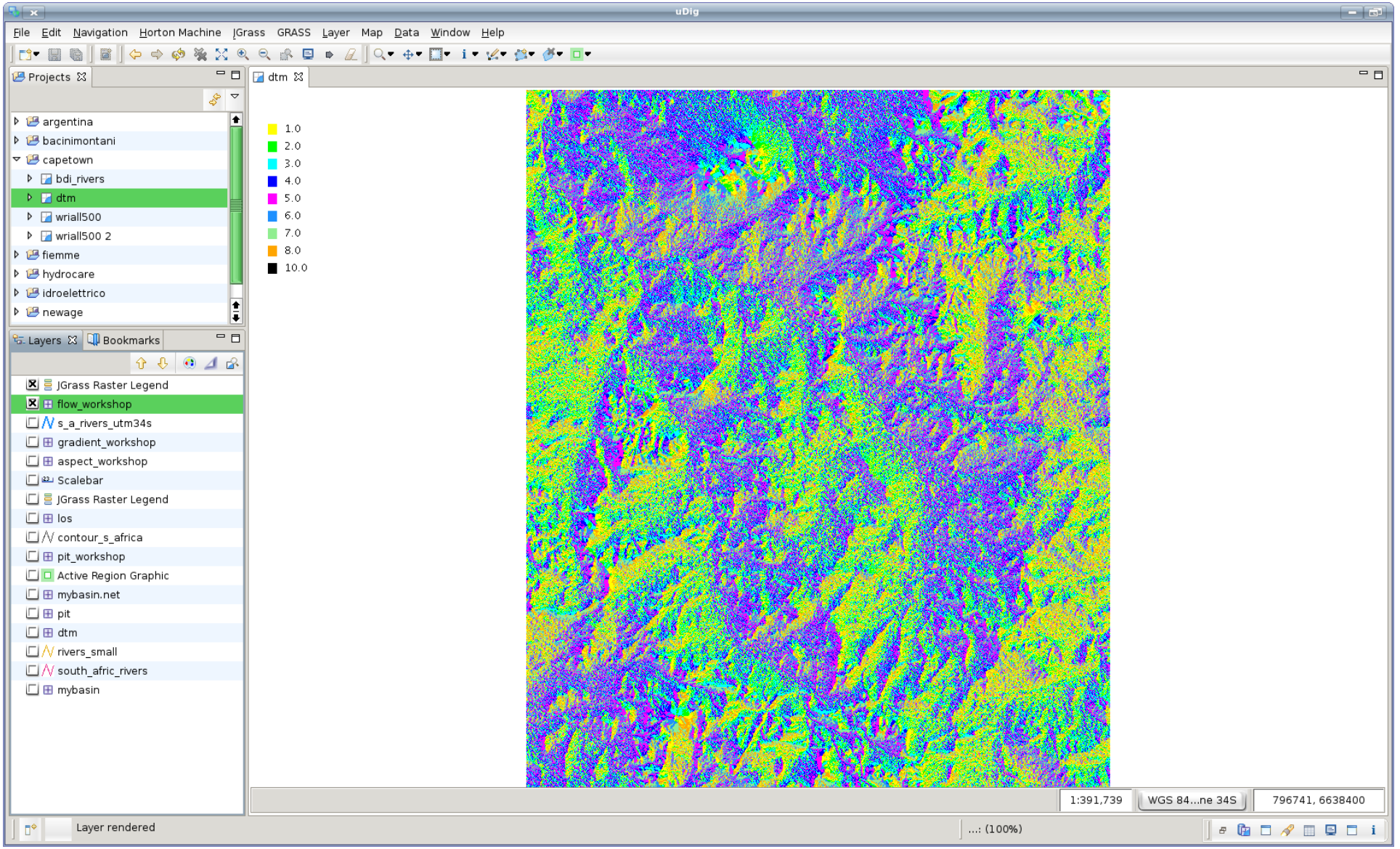
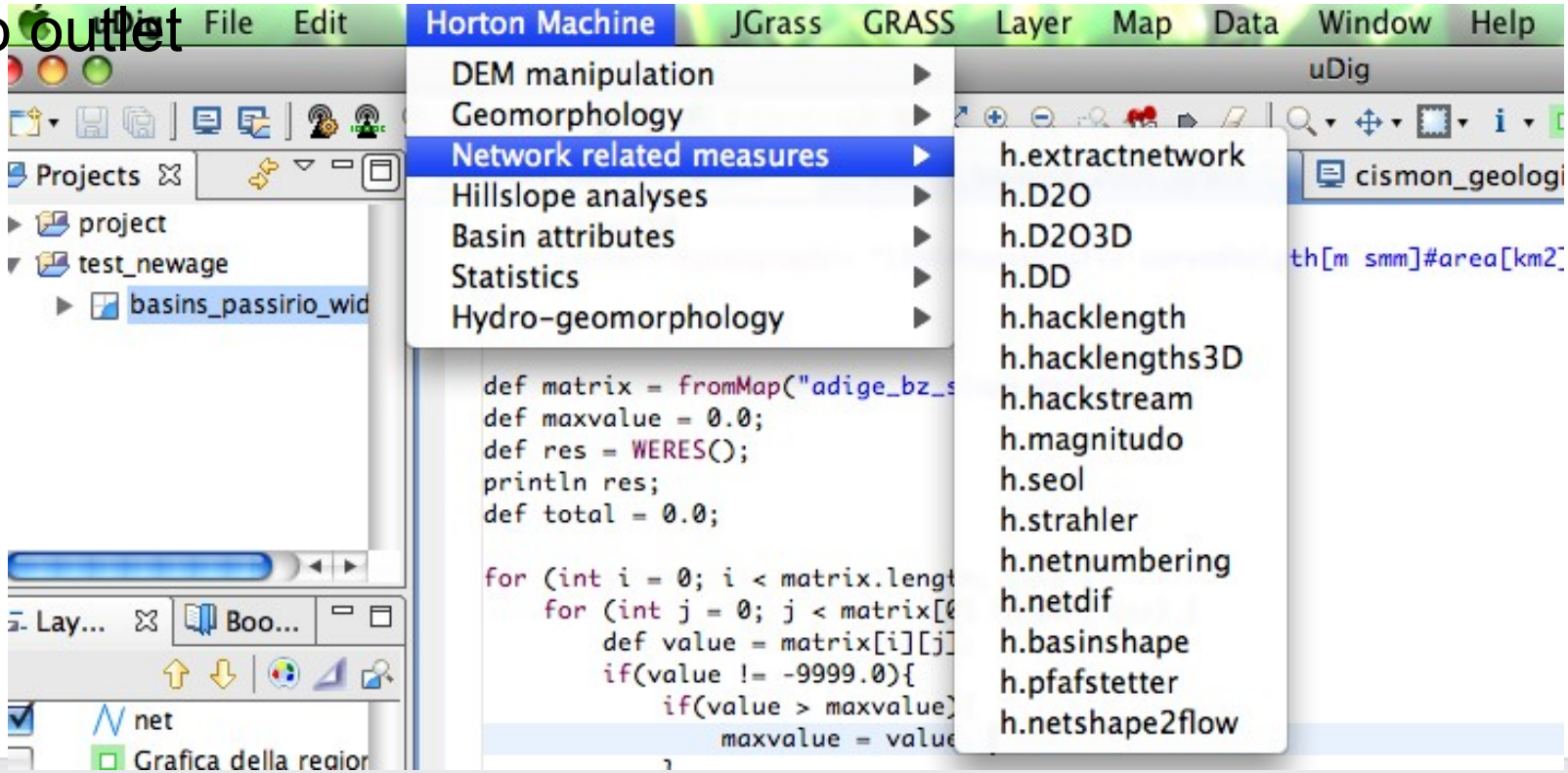


JGRASS MORPHOLOGICAL ATTRIBUTES

- DEM manipulation
- DTM derived information
- Network related measures
  - distance to outlet
  - Strahler



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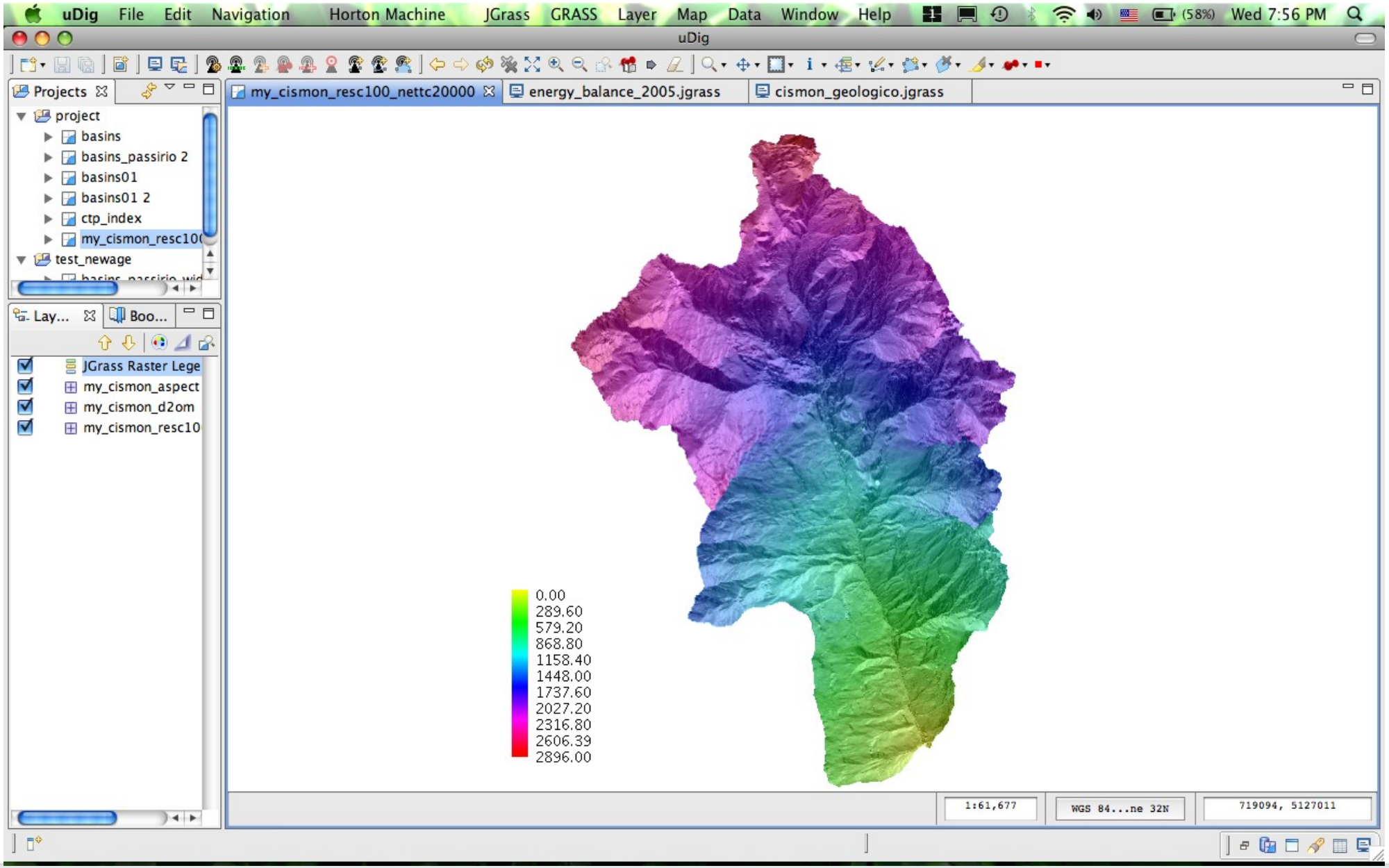
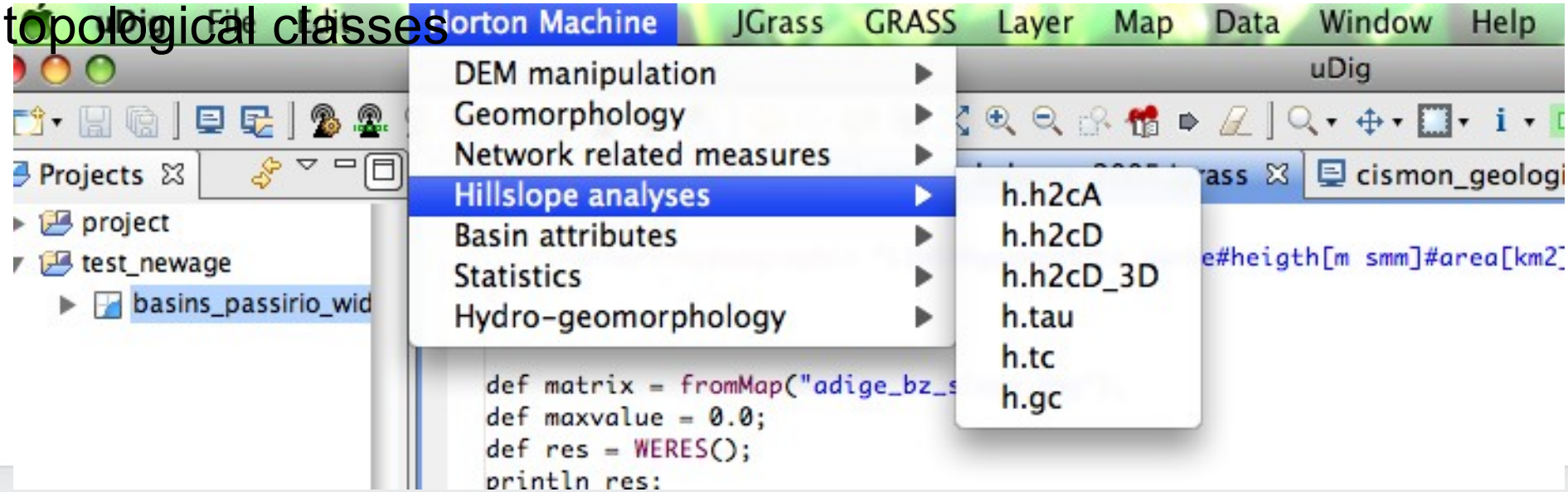


JGRASS MORPHOLOGICAL ATTRIBUTES

- DEM manipulation
- DTM derived information
- Network related measures
- Hillslope analysis
  - hillslope to channel distance/attribute
  - topological classes



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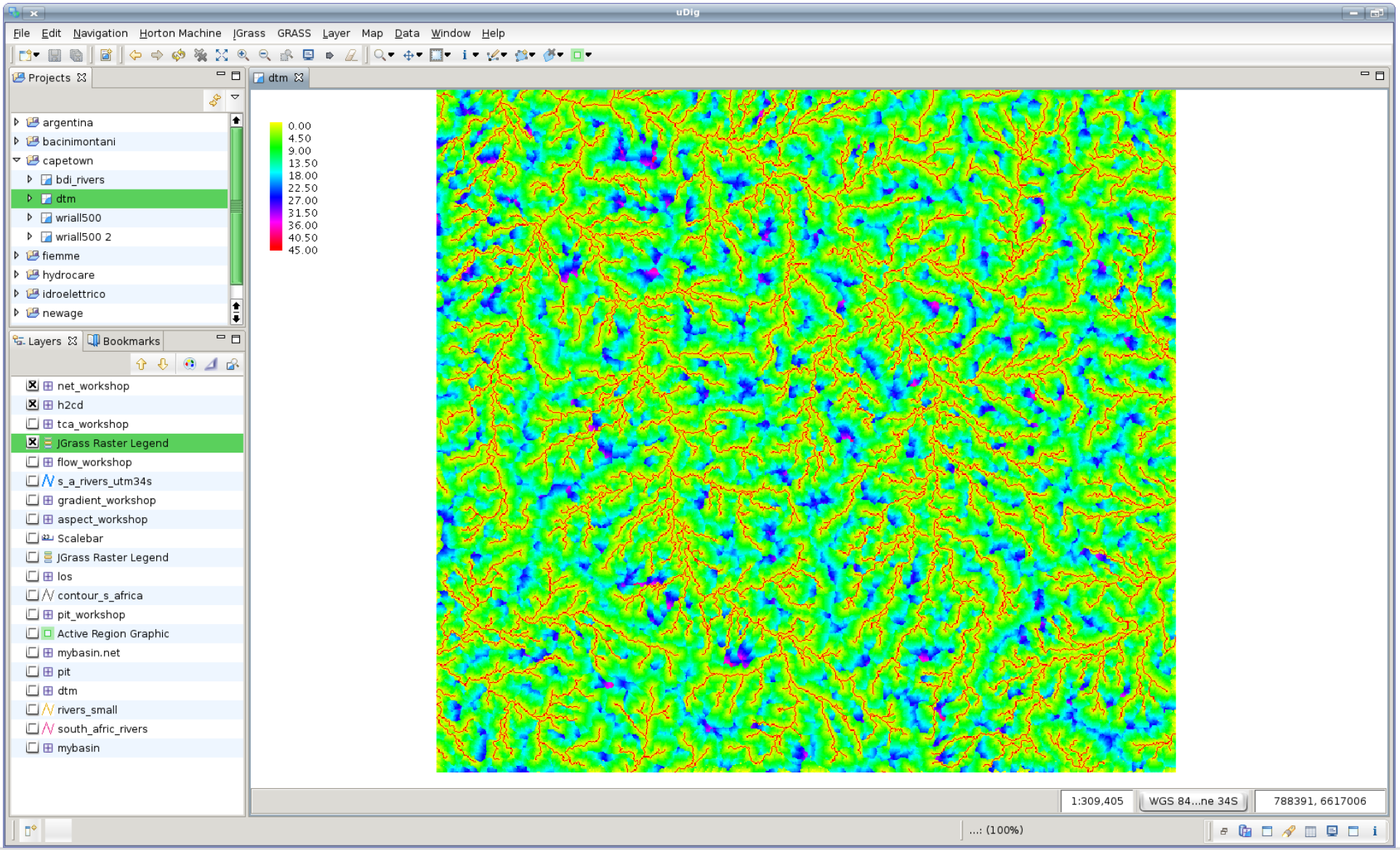
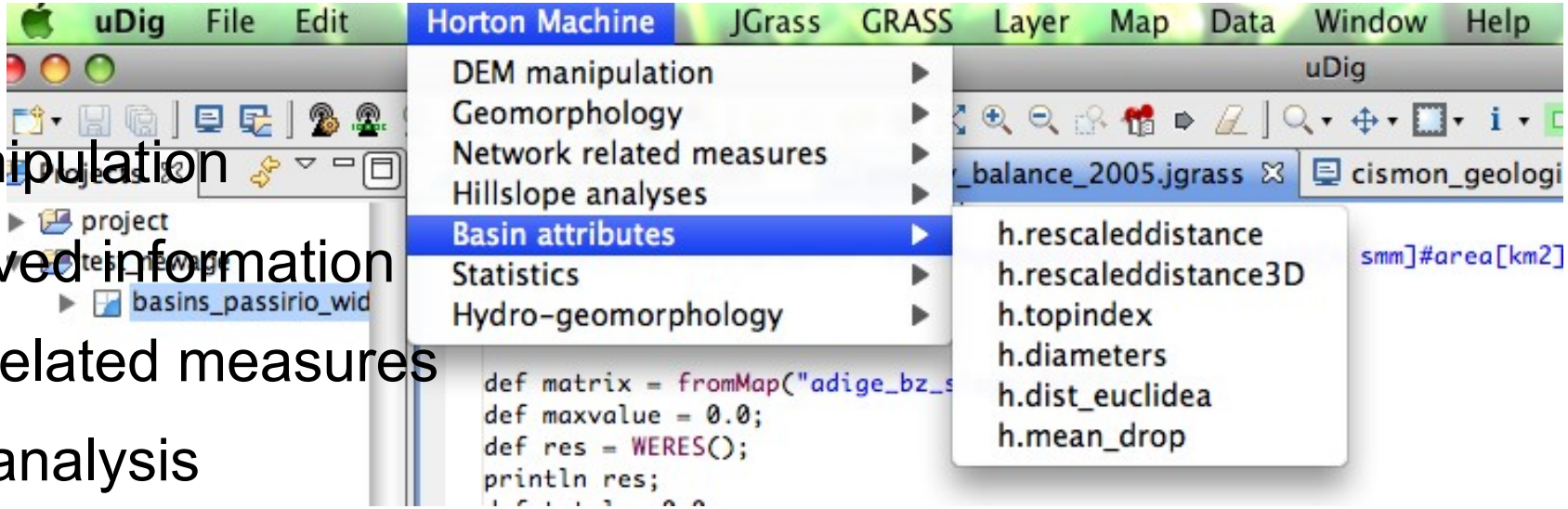


JGRASS MORPHOLOGICAL ATTRIBUTES

- DEM manipulation
- DTM derived information
- Network related measures
- Hillslope analysis
- Basin attributes
  - rescaled distances
  - topindex



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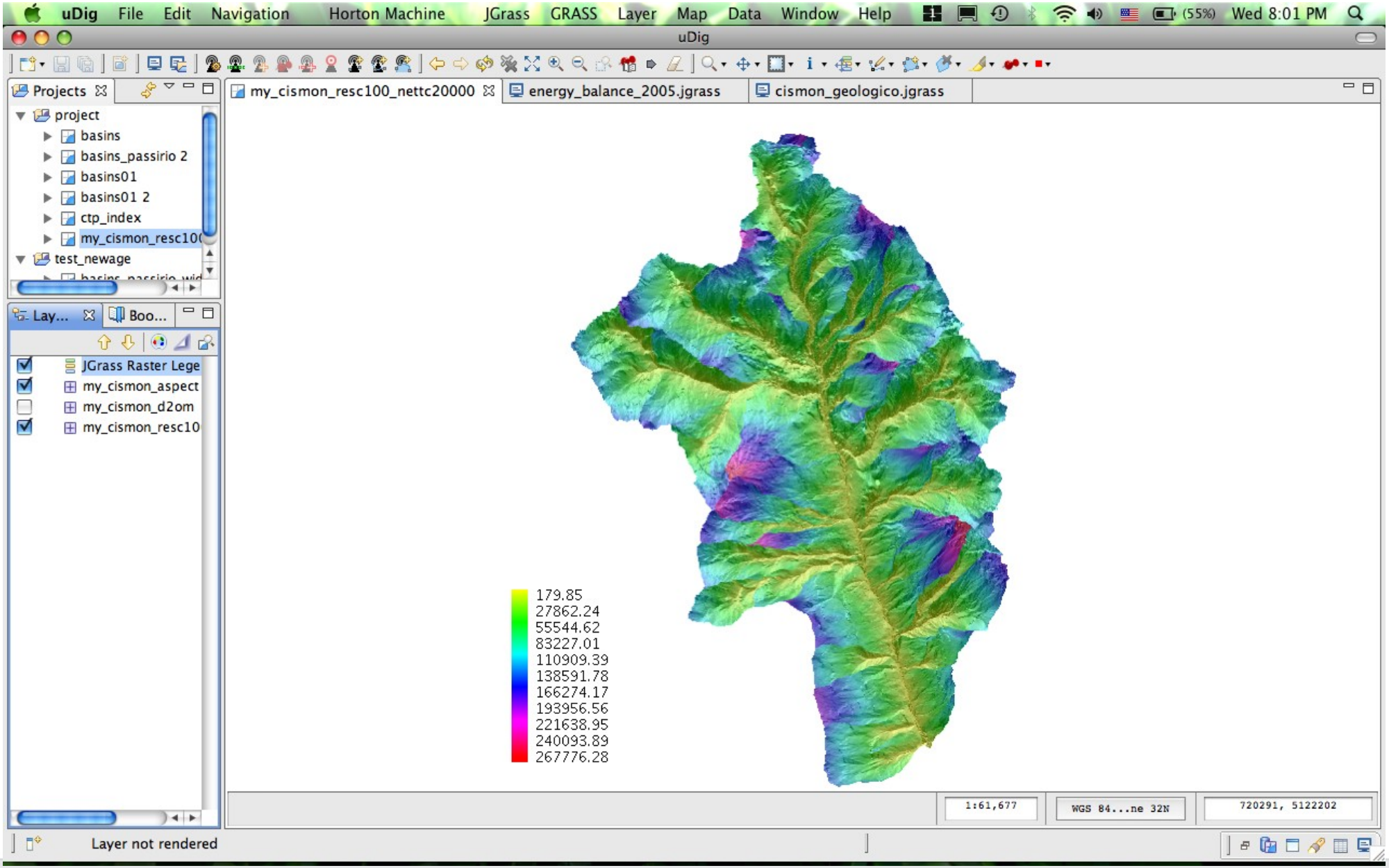


JGRASS h.peakflow

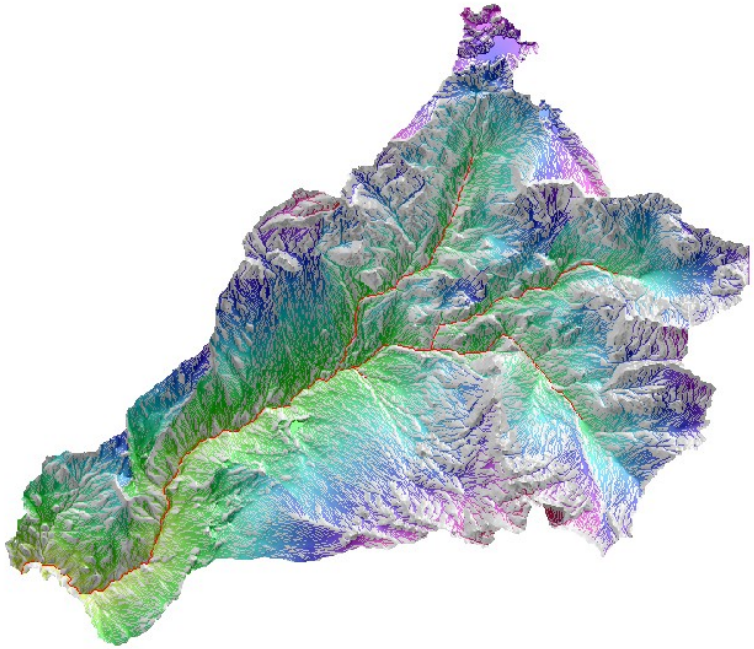
It calculate the maximum discharge in a basin for a given rainfall event

- based model is the GIUH and the width function
- rainfall event can be given in term of return period event or measured rainfall for each timestep
- required parameters are:
  - ➔ saturated percentage of the basin
  - ➔ flow channel celerity

Case study: many applications in Italy and in Switzerland for the evaluation of the maximum discharges and flood risks.

JGRASS h.peakflow

SATURATED ZONE



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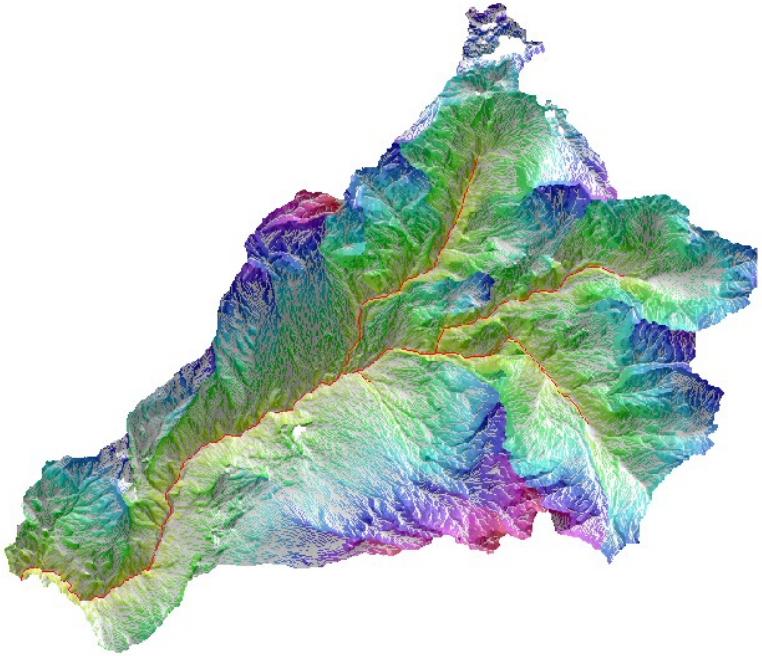

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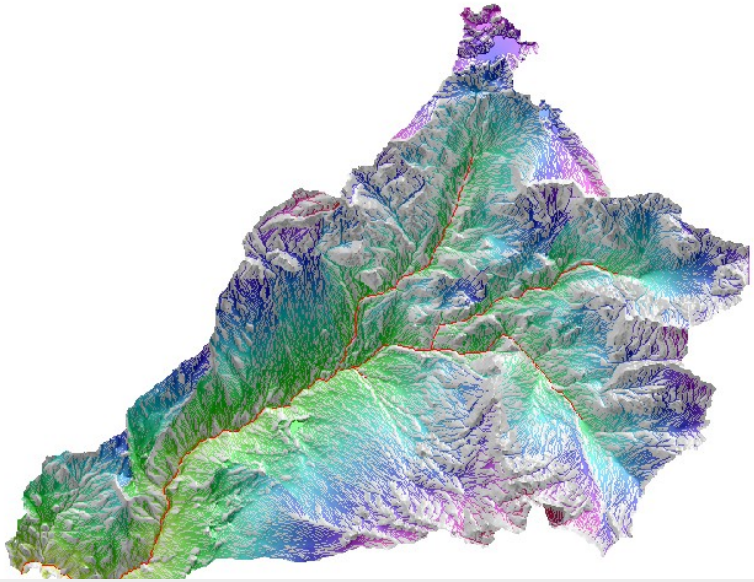
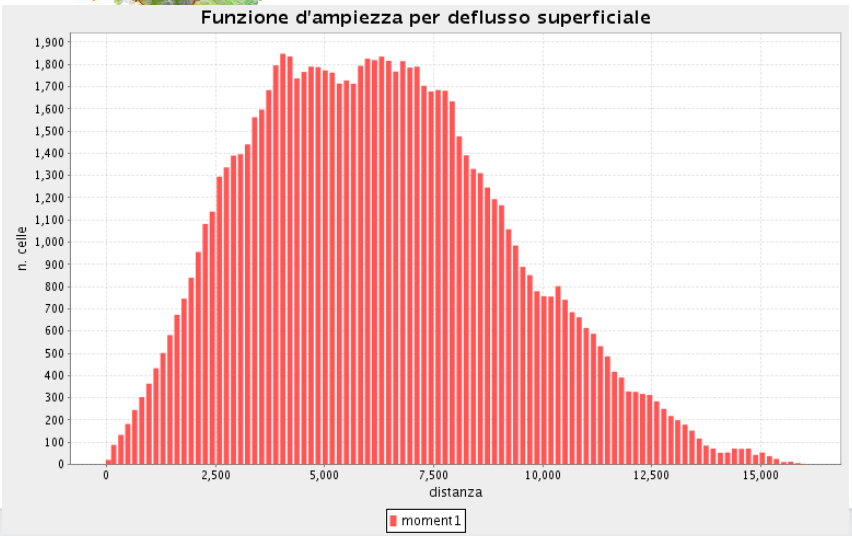
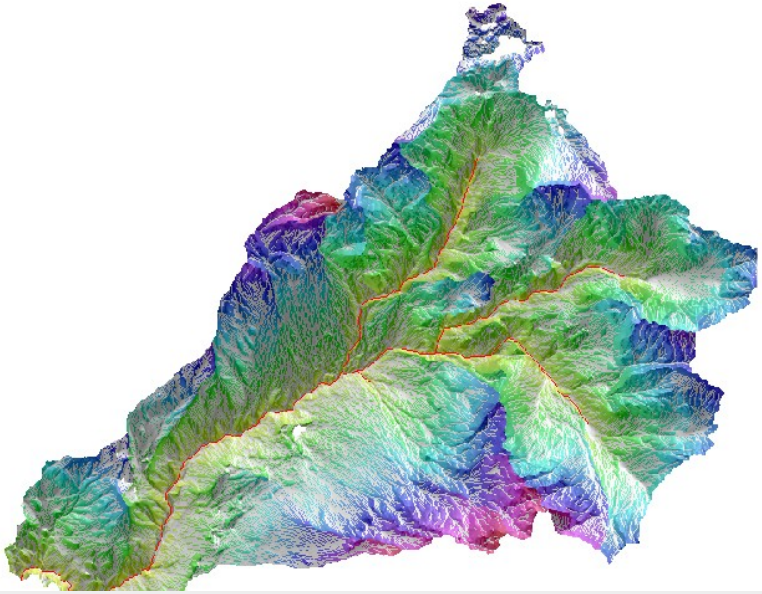
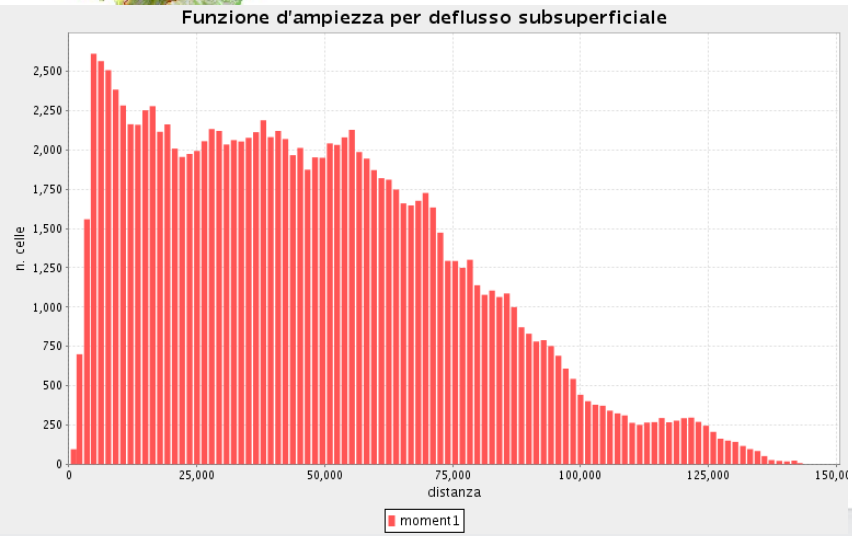


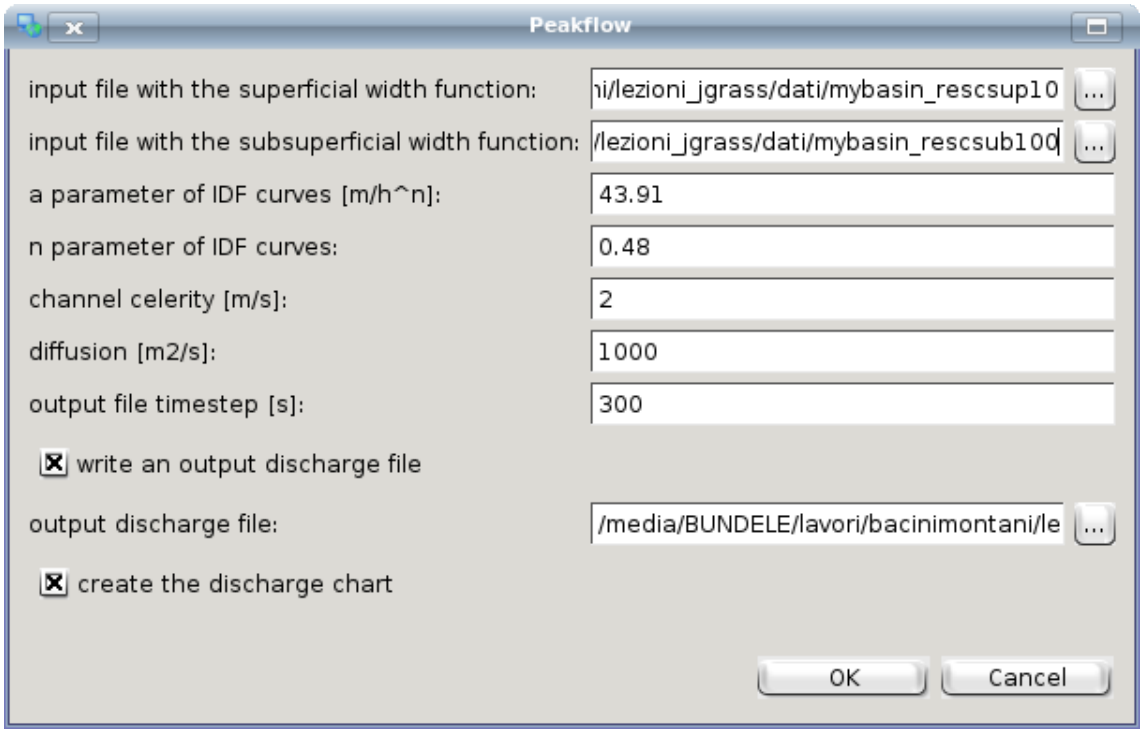


UNSATURATED ZONE

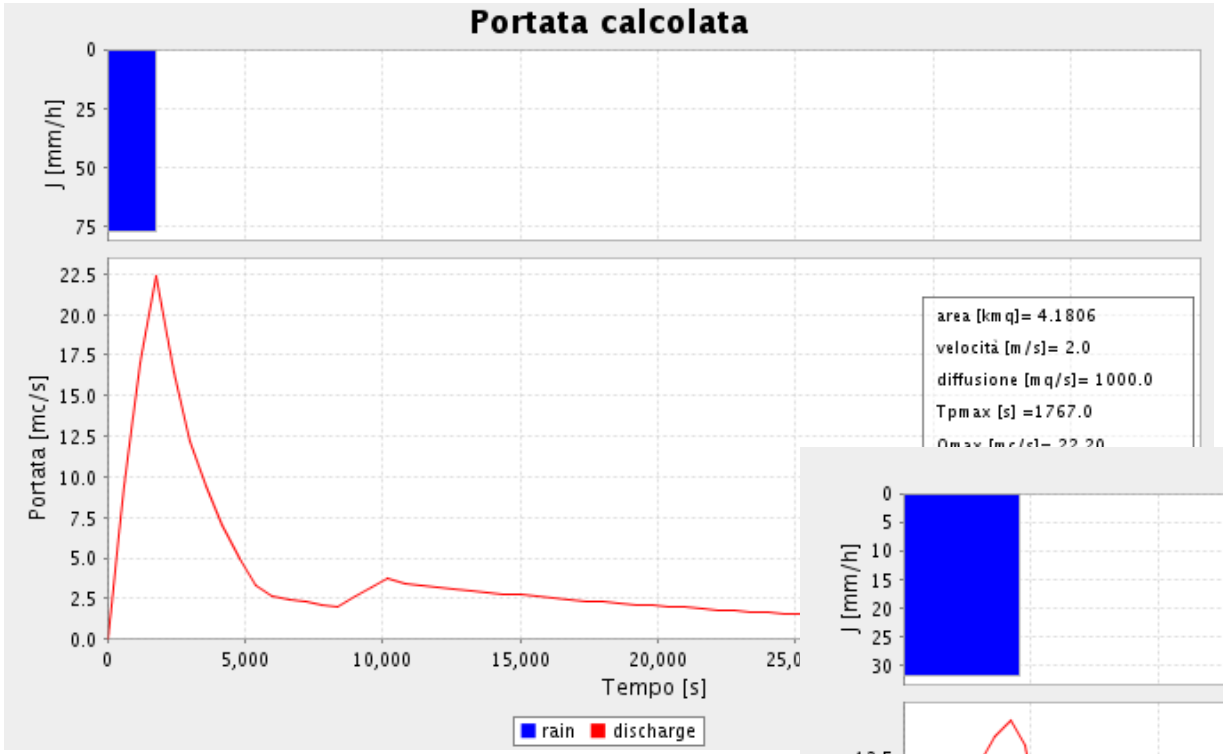


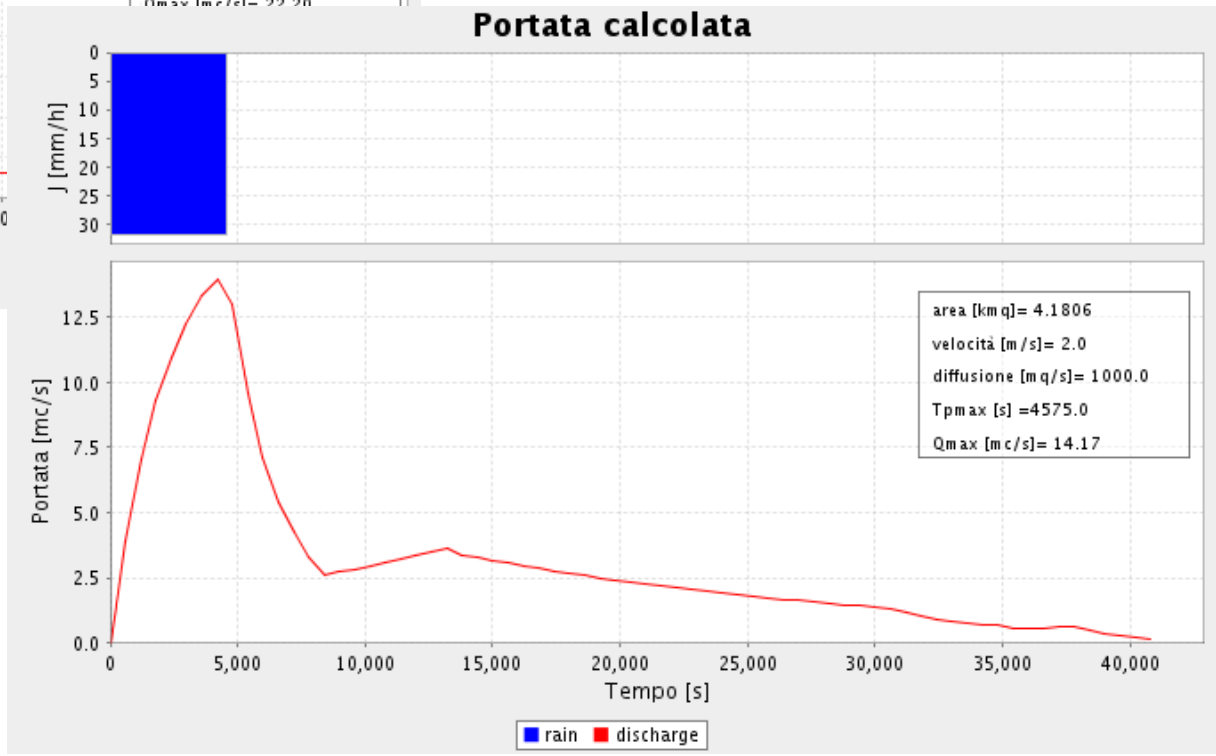


JGRASS h.peakflow

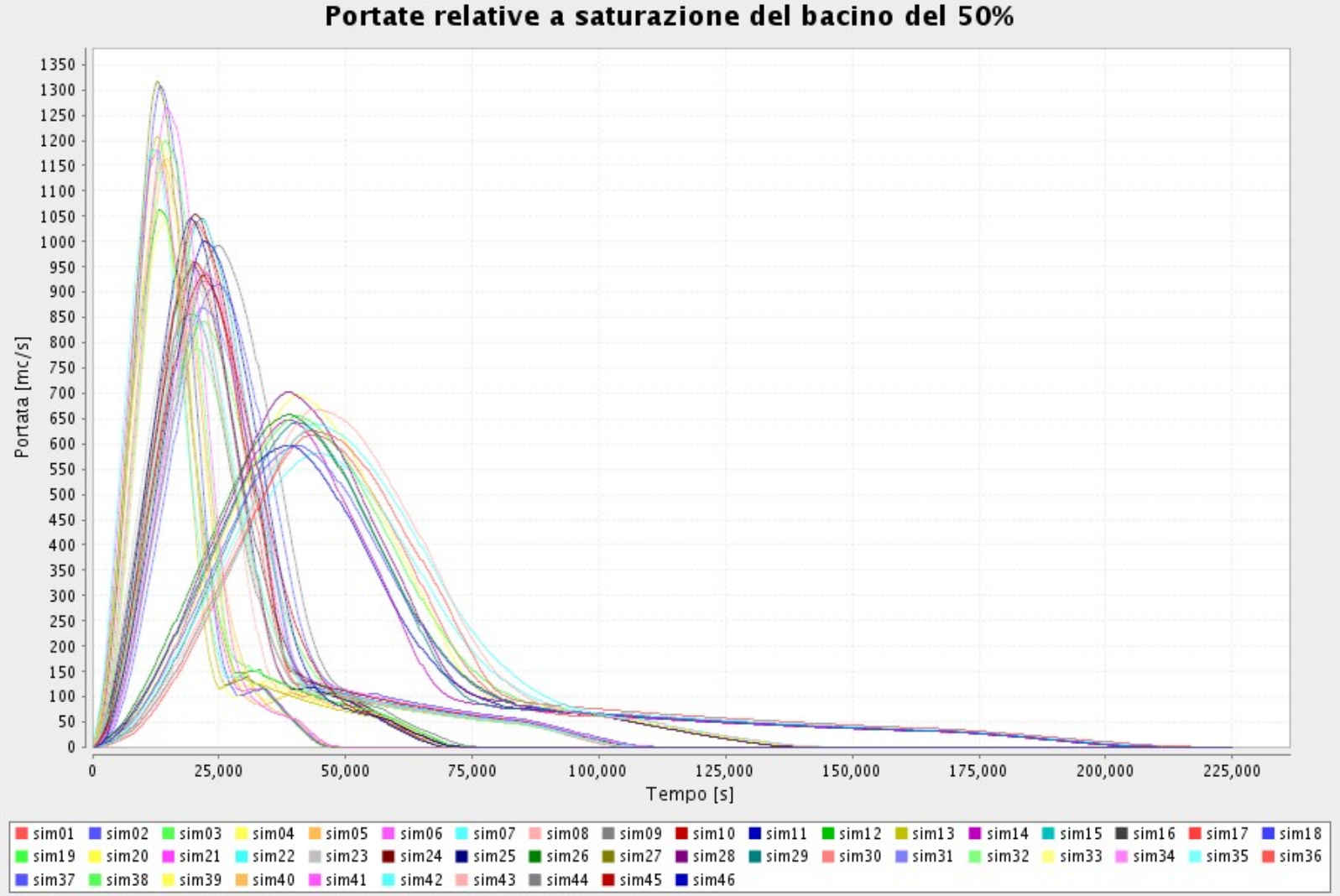


JGRASS h.peakflow





JGRASS h.peakflow



JGRASS h.shalstab

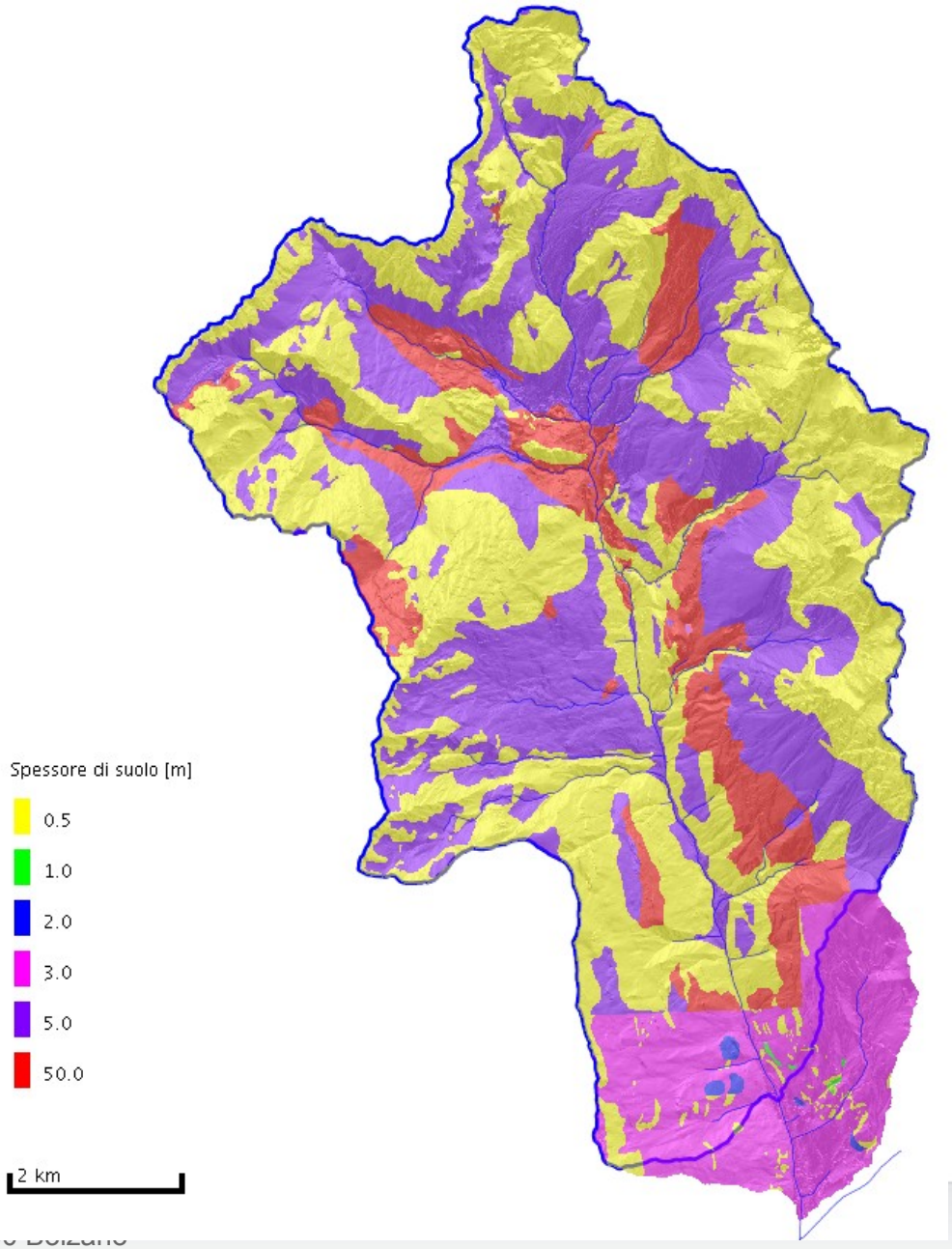
- implementation of the model done by Montgomery and Dietrich (1994)
- combines slope steepness with flow accumulation and a simplified hydrological model to classify the stability conditions
- standard soil parameters are employed to redefine the model as the mechanical properties of soils can profoundly affect slope stability (soil density, angular slope, friction angle, soil trasmittivity)
- requires the precipitation as input

JGRASS h.shalstab

Case study: application of the model for the evaluation of the potential availability of sediment in case of debris flow in four basins with different size and morphology in the Trentino region in Italy.

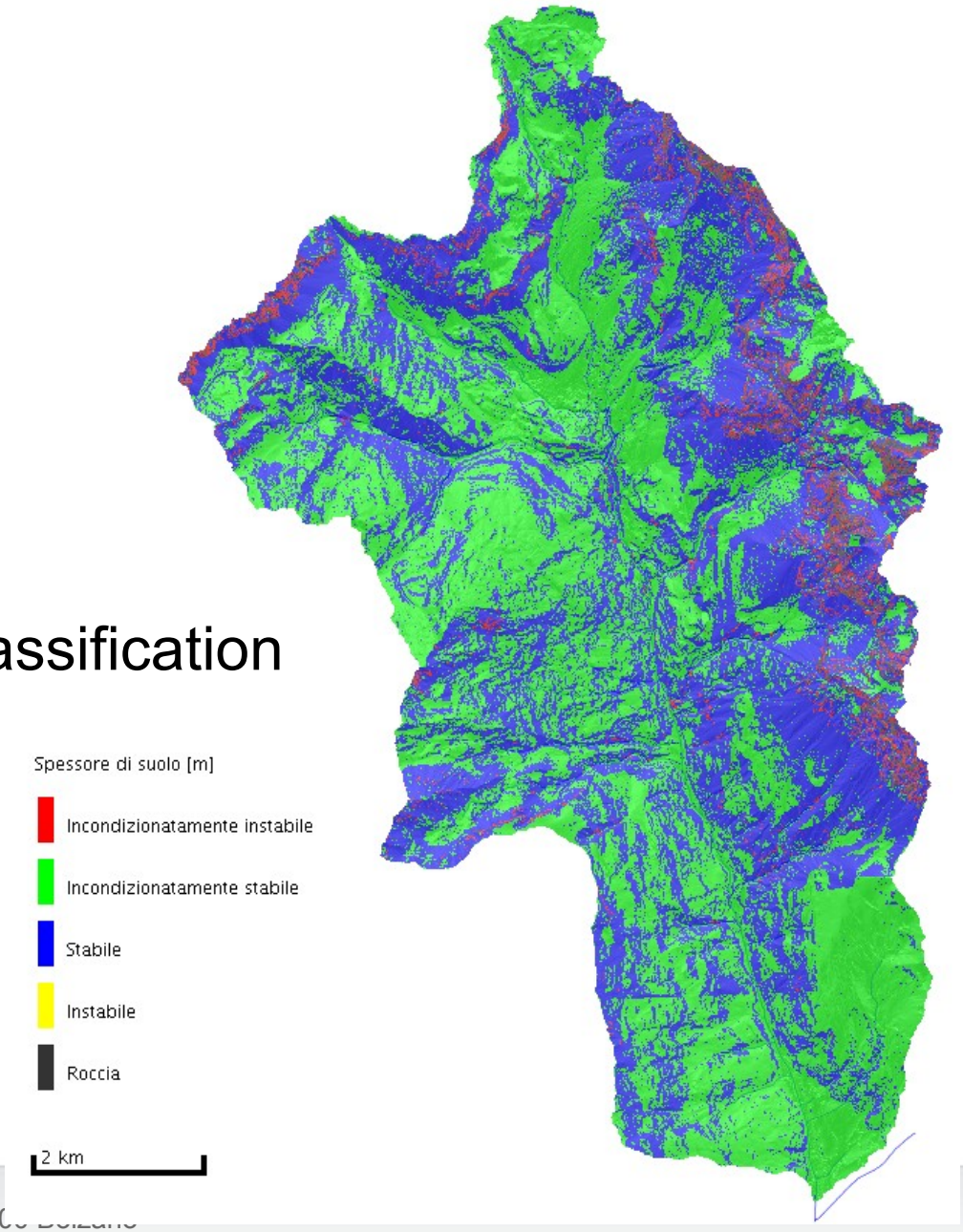
JGRASS h.shalstab

Soil thickness



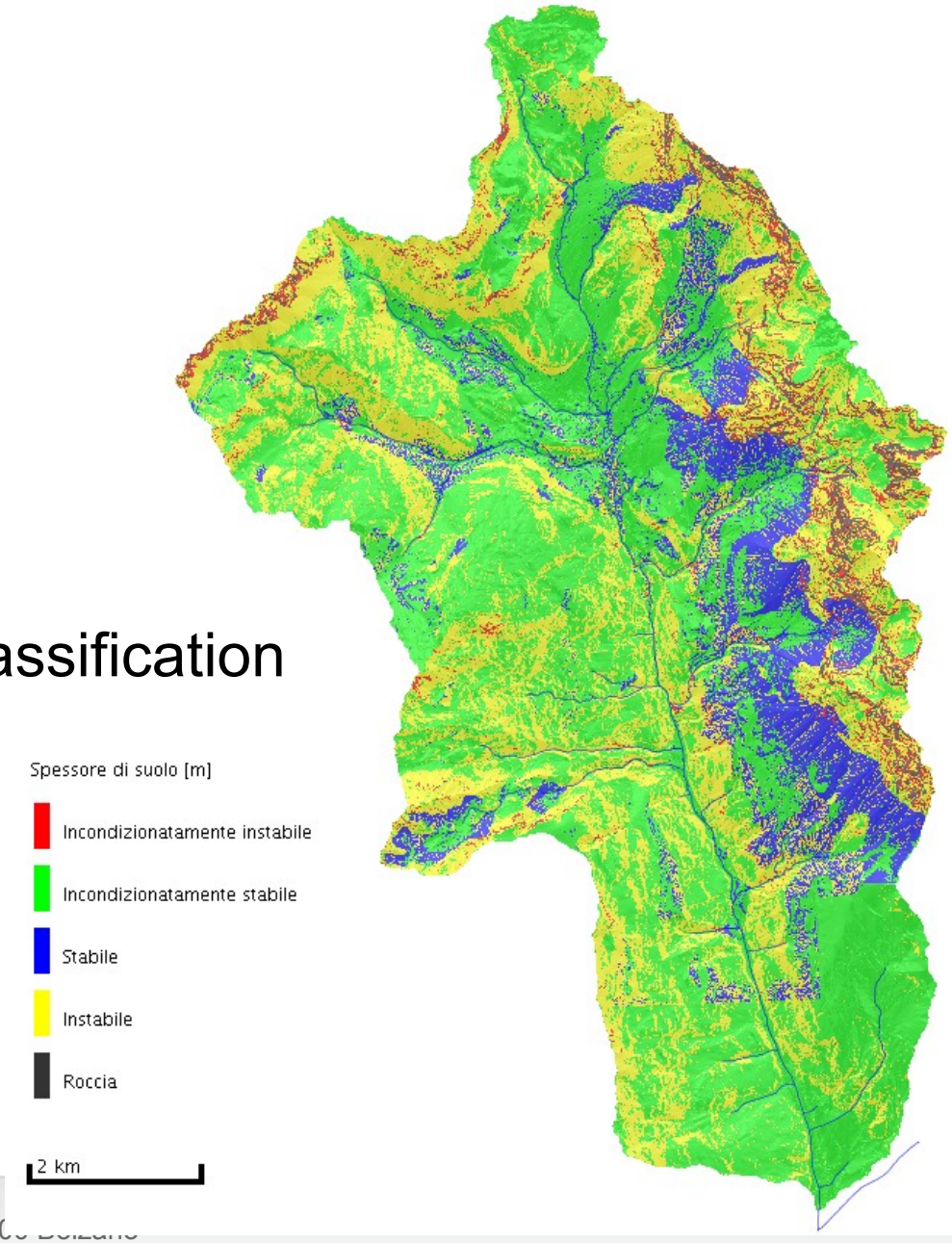
JGRASS h.shalstab

Basin stability classification



JGRASS h.shalstab

Basin stability classification

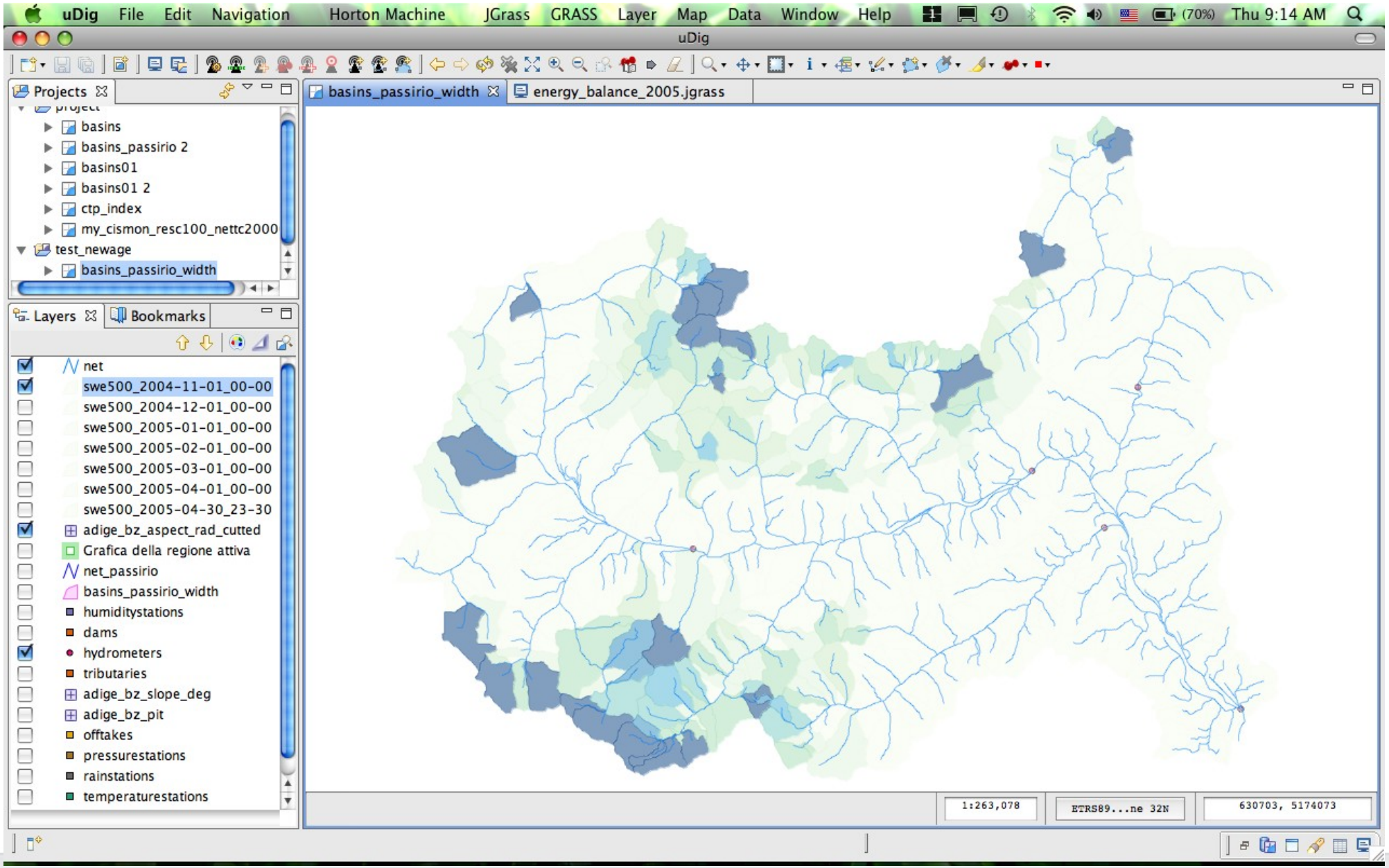


JGRASS h.energybalance

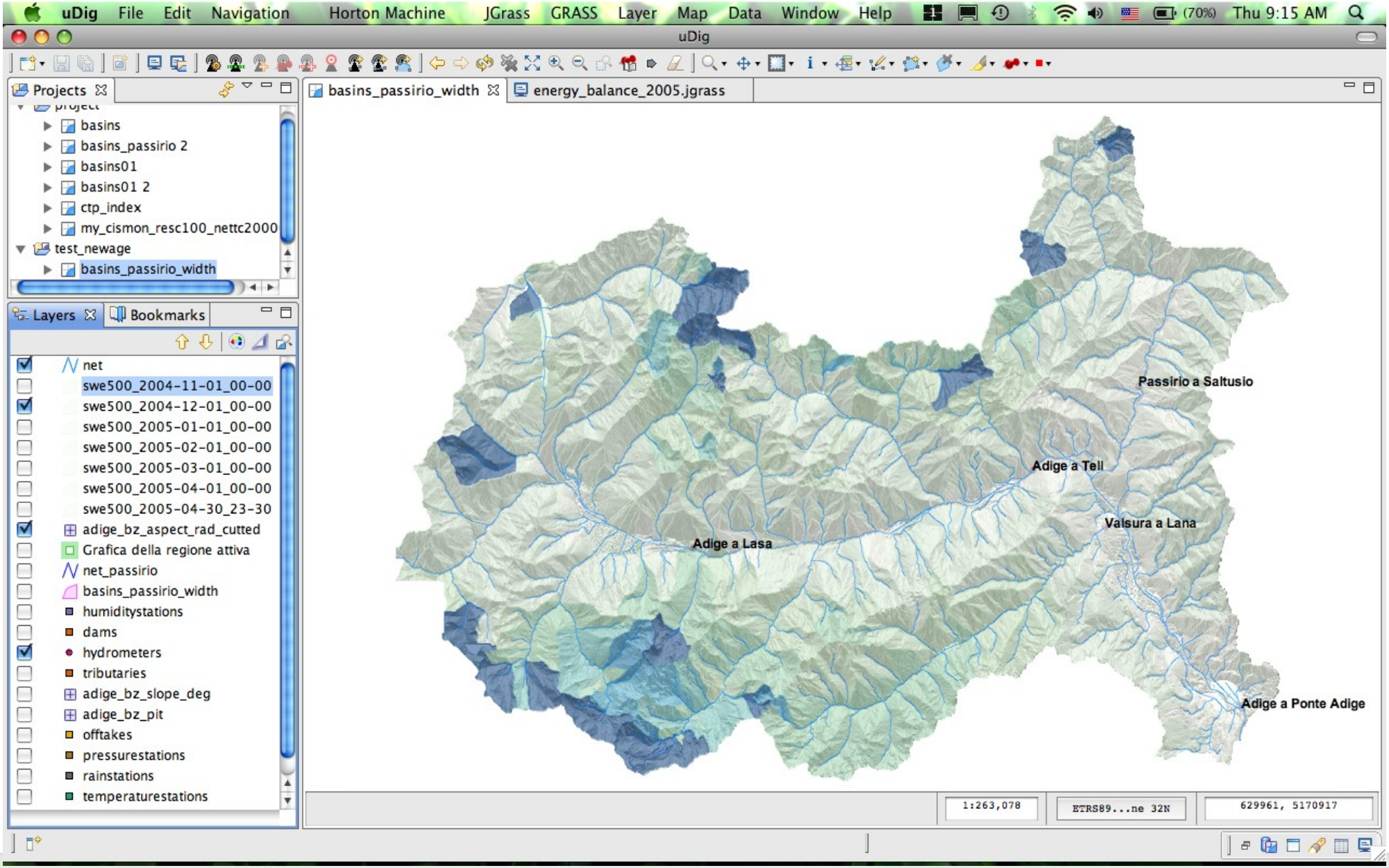
- solves the energy balance for each hillslope dividing it in altimetric and energetic bands
- contains a sophisticated snow module with which it is possible to calculate the SWE for all the basins
- evaluation of the contribution to the discharge from the glaciers during summer time in term of net precipitation (P + SM - SA)
- results are presented in term of average in watershed

Case study: comparison of the results in term of SWE during winter 2008 with MODIS satellite images.

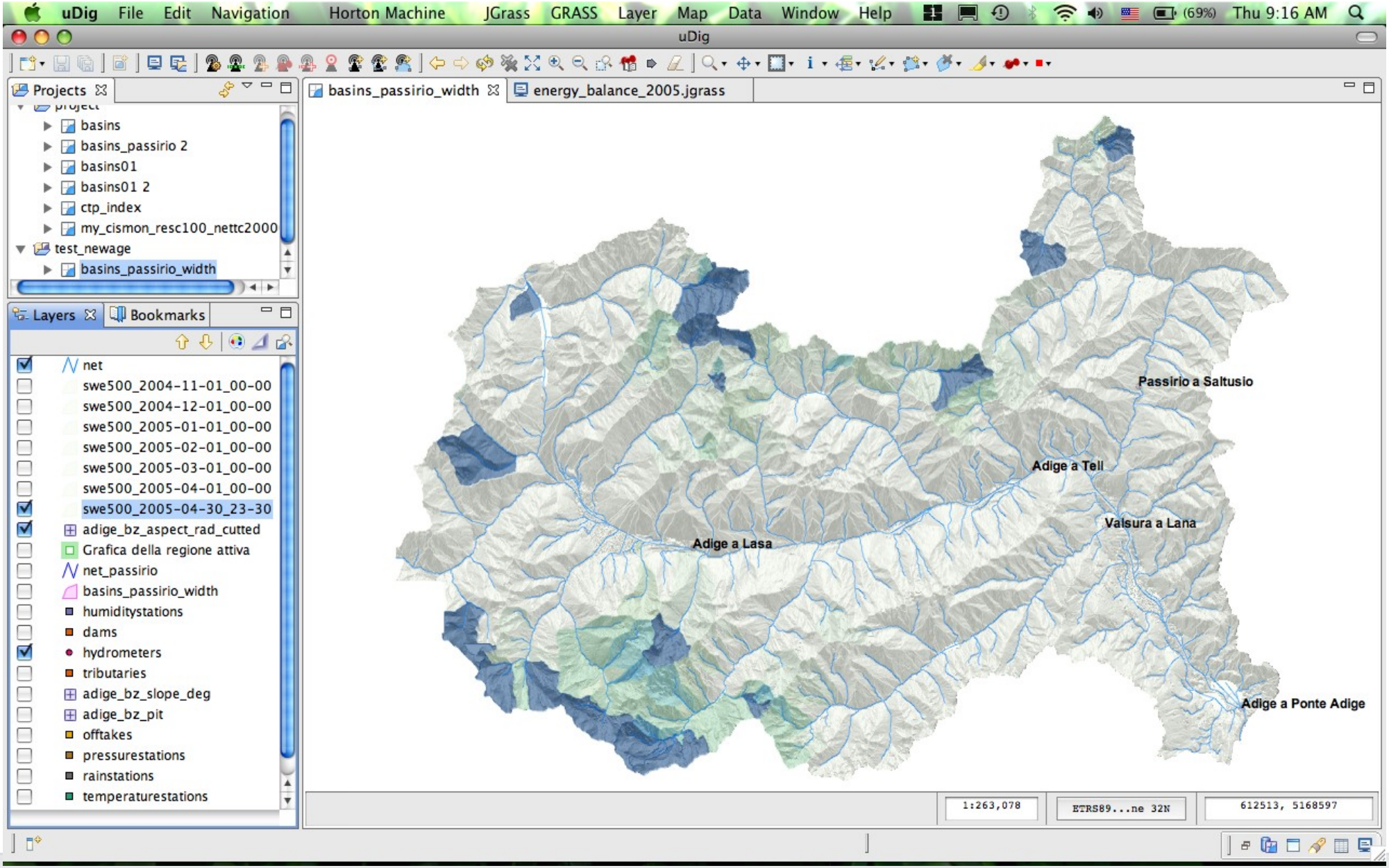
JGRASS h.energybalance



JGRASS h.energybalance

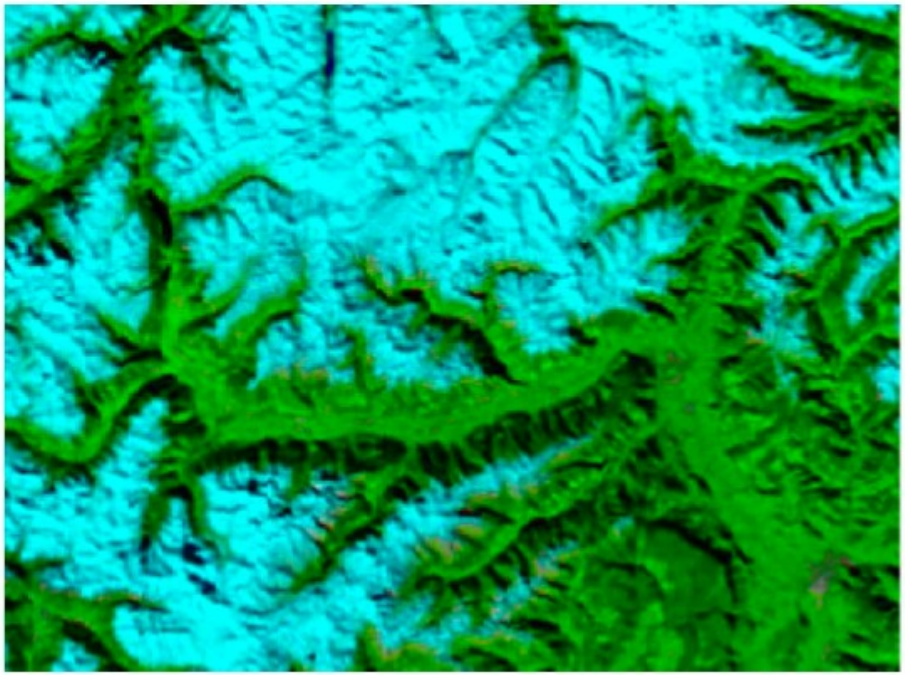


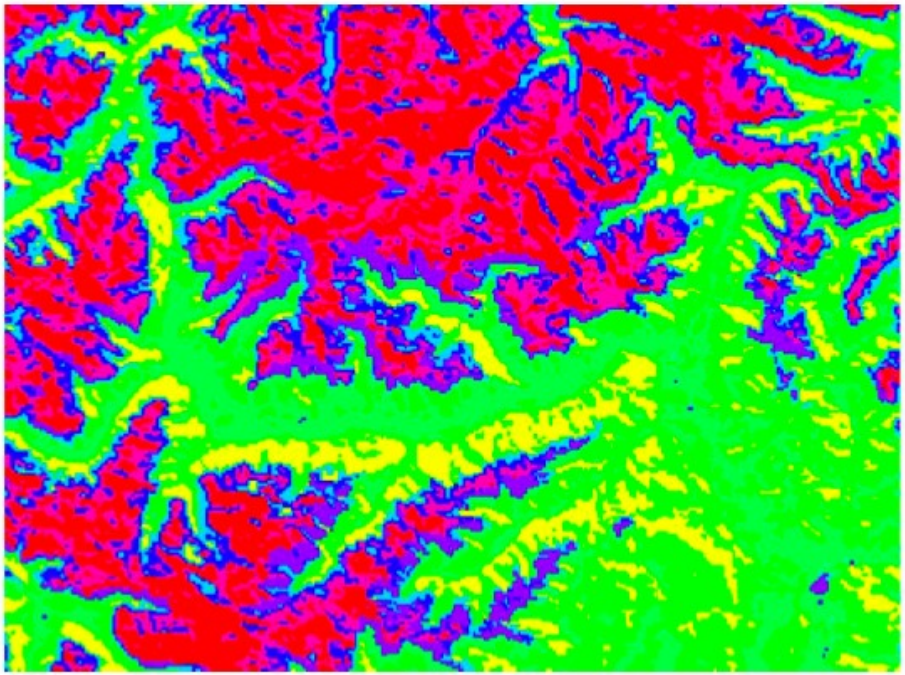
JGRASS h.energybalance



JGRASS h.energybalance

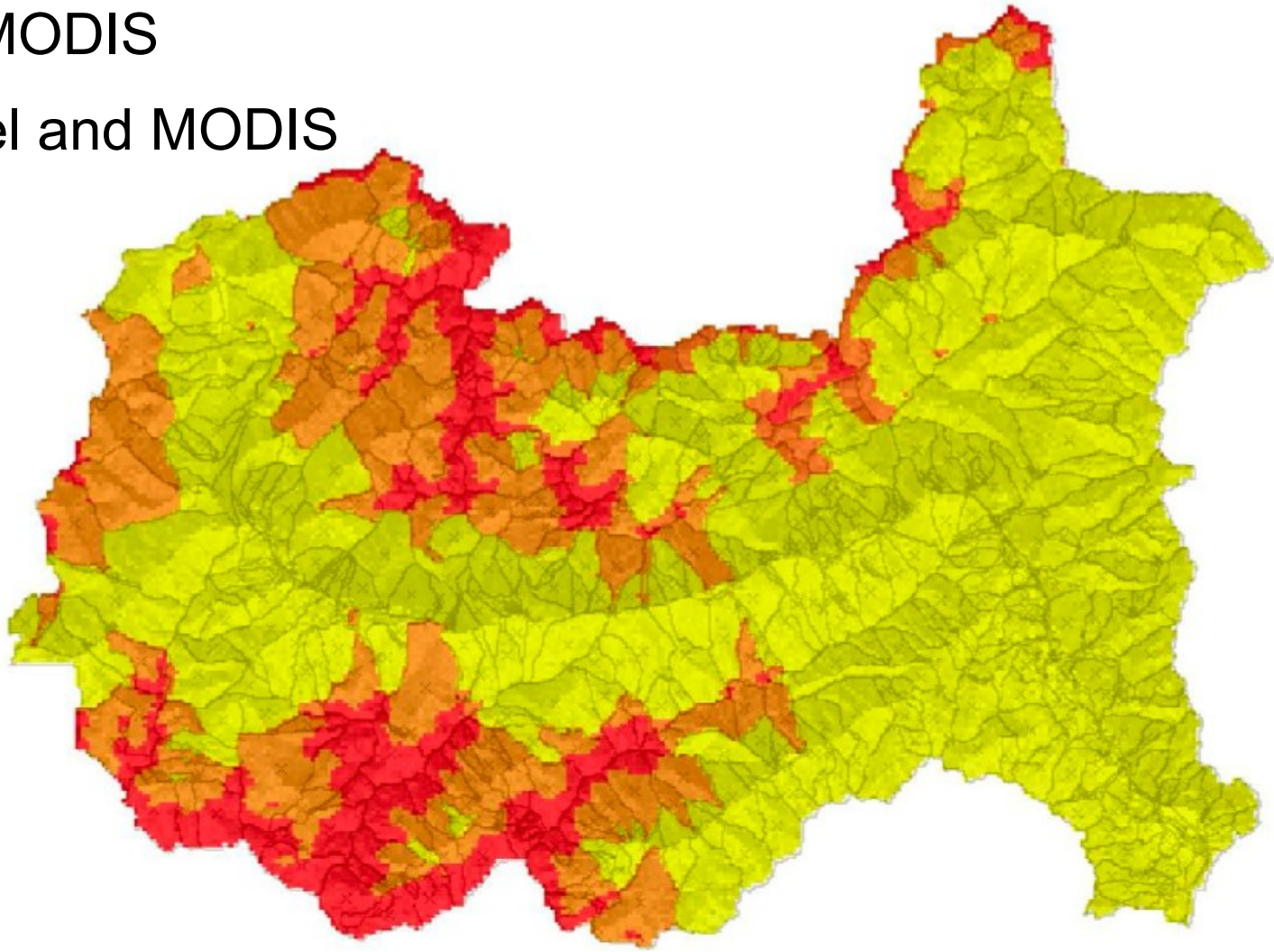
MODIS image and its unsupervised classification – winter 2008





JGRASS h.energybalance

- No snow
- Snow just for MODIS
- Snow for model and MODIS



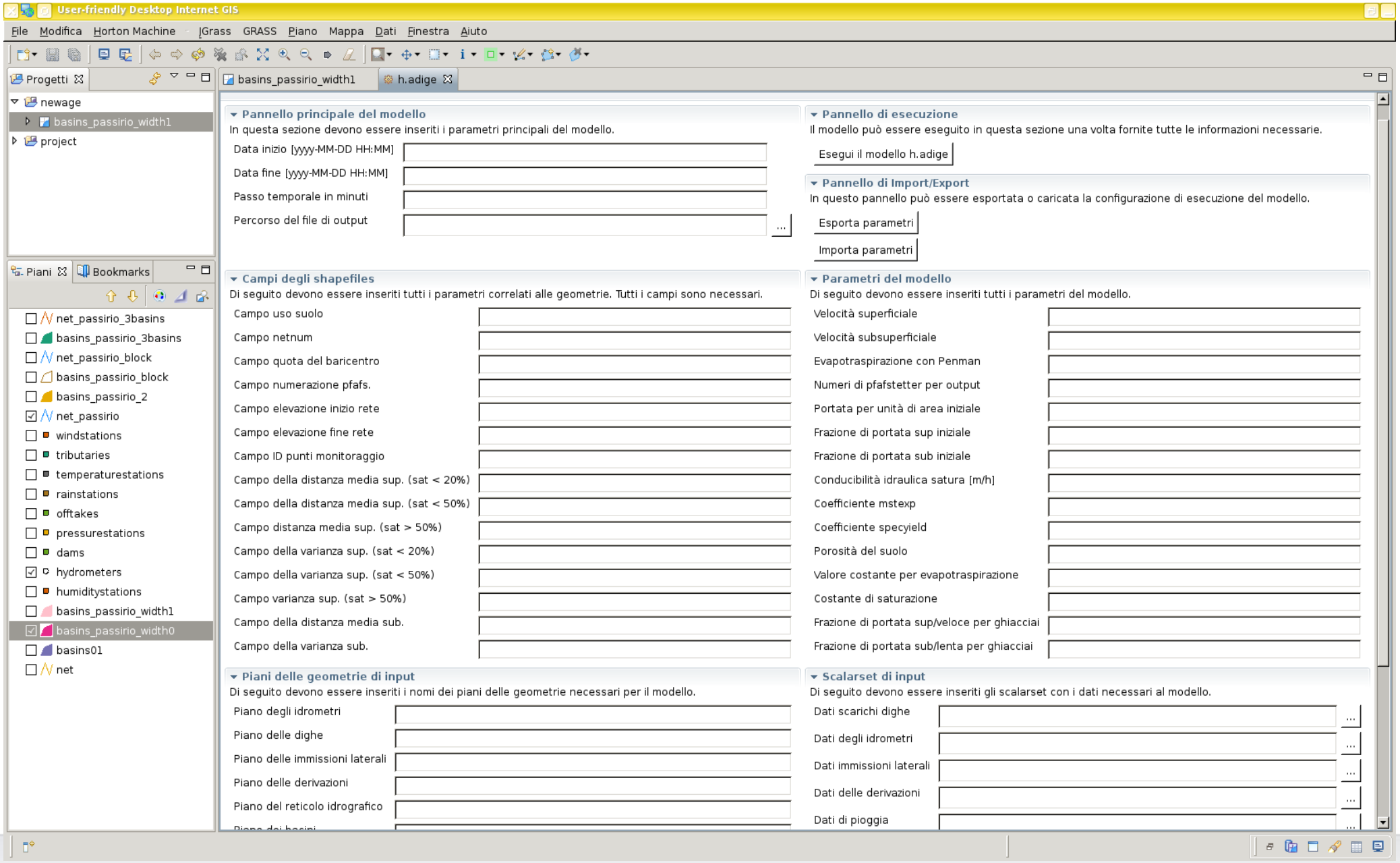
JGRASS h.newage

- implementation of the Duffy model
- works on a structure of hillslopes and links
- calculates the full mass balance considering also the evapotranspiration
- outputs are:
  - discharge in every point of the basin
  - saturated water content for each hillslope
  - unsaturated water content for each hillslope

JGRASS h.newage

Case study: development and application of the model for the whole Adige basin in Italy. Evaluation of the component of the hydrological balance in case of water scarcity for the local water administration authority,

JGRASS h.newage



JGRASS h.newage

Piani delle geometrie di input

Di seguito devono essere inseriti i nomi dei piani delle geometrie necessari per il modello.

Piano degli idrometri	hydrometers
Piano delle dighe	dams
Piano delle immissioni laterali	tributaries
Piano delle derivazioni	offtakes
Piano del reticolo idrografico	net_passirio
Piano dei bacini	basins_passirio

Scalarset di input

Di seguito devono essere inseriti gli scalarset con i dati necessari al modello.

Dati scarichi dighe	edia/BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/dams.csv	...
Dati degli idrometri	NDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/hydrometers.csv	...
Dati immissioni laterali	BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/tributaries.csv	...
Dati delle derivazioni		...
Dati di pioggia	uovi/THEBIGTEST/simulazione2005/energy_swe100_glacier_2005_05_new.csv	...
Dati della vegetazione	BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/vegetation.csv	...

JGRASS h.newage

Parametri del modello

Di seguito devono essere inseriti tutti i parametri del modello.

Velocità superficiale	0.5
Velocità subsuperficiale	0.5
Evapotraspirazione con Penman	
Numeri di pfafstetter per output	
Portata per unità di area iniziale	
Frazione di portata sup iniziale	
Frazione di portata sub iniziale	
Conducibilità idraulica satura [m/h]	
Coefficiente mstexp	
Coefficiente specyield	
Porosità del suolo	
Valore costante per evapotraspirazione	
Costante di saturazione	
Frazione di portata sup/veloce per ghiac	
Frazione di portata sub/lenta per ghiacci	

Campi degli shapefiles

Di seguito devono essere inseriti tutti i parametri correlati alle geometrie. Tutti i campi sono necessari.

Campo uso suolo	uso_reclas
Campo netnum	netnum
Campo quota del baricentro	height
Campo numerazione pfafs.	pfafstette
Campo elevazione inizio rete	elevfirstp
Campo elevazione fine rete	elevlastpo
Campo ID punti monitoraggio	id_punti_m
Campo della distanza media sup. (sat < 20%)	mean_10
Campo della distanza media sup. (sat < 50%)	mean_30
Campo distanza media sup. (sat > 50%)	mean_60
Campo della varianza sup. (sat < 20%)	sd_10
Campo della varianza sup. (sat < 50%)	sd_30
Campo varianza sup. (sat > 50%)	sd_60
Campo della distanza media sub.	mean_sub
Campo della varianza sub.	sd_sub

JGRASS h.newage

Pannello principale del modello

In questa sezione devono essere inseriti i parametri principali del modello.

Data inizio [yyyy-MM-DD HH:MM]	2005-05-01 00:00
Data fine [yyyy-MM-DD HH:MM]	2005-05-10 00:00
Passo temporale in minuti	30
Output completo del modello	/media/BUNDELE/newage/modelli_nuovi/TH ...
Output modello Livelli	/media/BUNDELE/newage/modelli_nuovi/TH ...

Pannello di esecuzione

Il modello può essere eseguito in questa sezione una volta fornite tutte le informazioni necessarie.

Esegui h.saintgeo

Pannello di Import/Export

In questo pannello può essere esportata o caricata la configurazione di esecuzione del modello.

Esporta parametri

Importa parametri

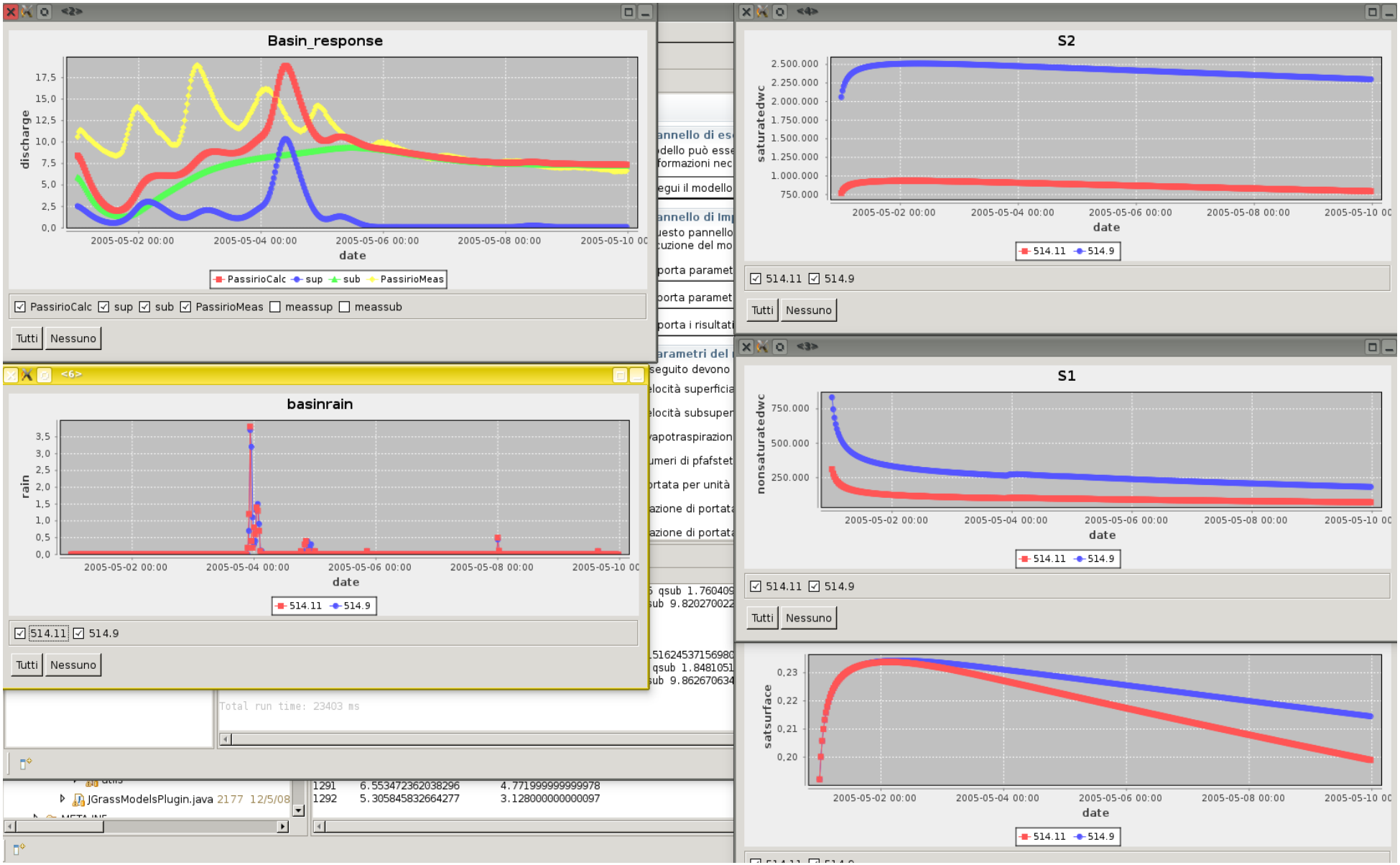
Esporta i risultati nel database

Sezione dei dati di input

In questa sezione devono essere inseriti i dati di input per il modello

Portata di testa	/media/BUNDELE/newage/modelli_nuovi/THEB ...
Input portate artificiali	/media/BUNDELE/newage/modelli_nuovi/THEB ...
Input portate da confluenze	/media/BUNDELE/newage/modelli_nuovi/THEB ...
File delle sezioni in input	/media/BUNDELE/newage/modelli_nuovi/THEB ...
Input livello di valle	...

JGRASS h.newage



JGRASS h.saintgeo

- one dimensional steady flow model
- intakes and outflow downstream are considered
- real sections can be modeled
- different roughness coefficients can be considered for each part of a section
- case study: flow propagation in the rivers of the Venice lagoon basin to predict the flow of salt water that tends to rise the river at its mouth

JGRASS h.saintgeo

Main model parameters

Here the main model parameters are inserted.

Start date [yyyy-MM-DD HH:MM]

End date [yyyy-MM-DD HH:MM]

Timestep in minutes

Full model output ...

Level model output ...

Input data section

In this section the input data to the model have to be supplied

Head discharge ...

Input artificial flow ...

Input confluence flow ...

Input sections file ...

Input downstream level ...

Execution panel

Once completed to insert all the needed informations for the model, here the model can be executed.

Execute h.saintgeo

Import/Export panel

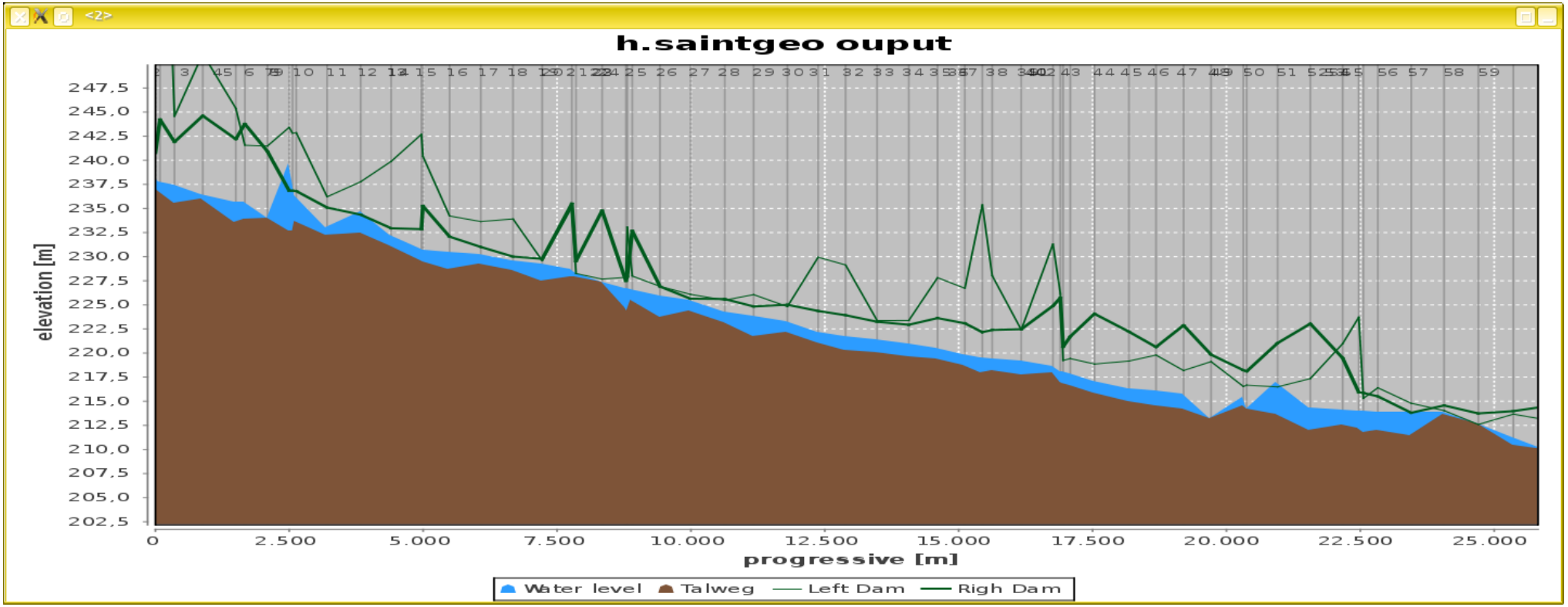
In this panel the configuration of a model execution can be exported to file or loaded from file.

Export settings

Import settings

Export results to database

JGRASS h.saintgeo



JGRASS: OPENMI - OMS

- JGrass models are planning to be ported into OMS framework
- JGrass will be compatible with the standards OMS
- other OMS applications will be integrated in JGrass:
  - Basin
  - GwflowCasc
  - Soltab
  - Debris flow
  - ...

Thanks for the attention...

Questions?