JGRASS UDIG'S SENSE OF CLIMATE CHANGE

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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)
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:
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:

- 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
JGRASS AND CLIMATE CHANGE

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➢ handles both raster and vector data: meteo data or DTM based data
JGRASS AND CLIMATE CHANGE

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➢ extract morphological attributes from a DTM
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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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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

Main model parameters
Here the main model parameters are inserted.

- Start date [yyy-MM-DD HH:MM]: 2005-05-01 00:00
- End date [yyy-MM-DD HH:MM]: 2005-05-01 03:00
- Timestep in minutes: 30

Variogram panel
Settings panel for the calculation of the variogram.

- The monitoring point id field for variogram:
- Distance for variogram:
- Variogram rain stations layer: rainstations
- Variogram input rain data: /Users/silli/lavori_tmp/THEBIGTEST/simulazione2005/rain_variogram.csv

Kriging panel
Settings panel for the Kriging

- Field of the monitoring point id for kriging: id_punti_m
- Id field of interpolated points:
- Maximum points: 4
- Minimum points: 2
- Model: 1-spheric, 2-exp, 3-gauss
JGRASS RASTERS AND VECTORS

Detailed view of a software interface for geographic information systems (GIS) with various menu options and sections such as 'Pannello principale del modello', 'Pannello del Varigramma', 'Pannello Kriging', and 'Pannello Jami'. The interface includes input fields for data inputs and options for various GIS functionalities.

Additional details include a list of datasets and parameters such as 'basins_passaggio_width1', 'basins_passaggio_block', 'basins_passaggio_2', 'net_passaggio', 'windstations', 'tributaries', 'temperaturesstations', 'rainstations', 'offakes', 'pressurestations', 'dams', 'gpmis', 'gpmis', 'humiditystations', 'basins_passaggio_width1', 'basins_passaggio_width0', 'basins01'.
JGRASS RASTERS AND VECTORS
### JGRASS RASTERS AND VECTORS

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

```java
jgrass {
  h.kriging
  --idfield "NETNUM"
  --idfieldinterpolated "NETNUM"
  --maxpoints 4 --mirpoints 2 --model 2 --nugget "0.05"
  --sill 0.6 --range 500000 --covariance "true" --searchradius 100000
  --itscalar-inputvalues "/media/BUDELE/newage/modelli_nuovi/THEBIGTEST/pioggia_2005/rain2005_all.csv"
  --iflayer-positions "stazioni_rain_all"
  --iflayer-interpolatedpositions "bacini_bz_idlikedb0_uso_suolo"
}
```

```java
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"
}
```
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

- Jami panel
  - Settings panel for the Jami interpolator
  - The data type to be interpolated: 1-T, 2-P, 3:RH, 4:W, 5:DTday, 6:DTmonth
  - Maximum number of stations to use per elevation band
  - Number of bins to use
  - Field of the monitoring point id for Jami
  - Field of the station elevation
  - Field of the basin netnum
  - Layer of stations
  - Layer of basins (polygon or point)
  - Altimetry input data
  - Meteo input data
  - Interpolated meteo output data

JGRASS RASTERS AND VECTORS
JGRASS CALCULATION ON MAPS

- `r.mapcalc` and `r.summary` provide general calculation on maps
  - average, max & min values
  - mathematical operations over values in a map
JGRASS CALCULATION ON MAPS
JGRASS CALCULATION ON MAPS
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
JGRASS CALCULATION ON MAPS

Input map with independent variable: mybasin_topindex_corr
Input map with dependent variable: mybasin_topindex_corr
First moment: 1
Last moment: 2
Number of bins: 100

Create the peakflow input file
Peakflow output file:
Create the complete output file
Full output file: /media/BUNDELE/lavori/bacimontani/lezioni_jgras
Output table widget
Output histogram chart
Output line chart

OK  Cancel
JGRASS CALCULATION ON MAPS

- input map with independent variable: mybasin_topindex_corr
- input map with dependent variable: mybasin_topindex_corr
- first moment: 1
- last moment: 2
- number of bins:

[Histogram chart showing distribution of data]

- Create the peakflow input file
- peakflow output file:
- Create the complete output file
- full output file:
- output table widget
- output histogram chart
- output line chart

Title

Bins

meanx

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000 8,000 9,000 10,000 10,500

-4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

moment1
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)
JGRASS CALCULATION ON MAPS

```
--bins 50
--chart-hypsographic "LINE#hypsographic curve#height[m]#area[km2]#hypso"

def matrix = fromMap("adige_bz_slope_deg");
def maxvalue = 0.0;
def res = WRES();
println res;
def total = 0.0;
for (int i = 0; i < matrix.length; i++) {
    for (int j = 0; j < matrix[i].length; j++) {
        def value = matrix[i][j];
        if(value > maxvalue){
            maxvalue = value;
        }
        total+=total + 1;
    }
}
println maxvalue;
println total;
```

energy_balance_2005.jgrass
energy_balance_2005.jgrass - 0 model/s compiled, total compilation time: 269 ms
GroovyShell, Version 1.5.5, http://groovy.codehaus.org
Reading raster map: adige_bz_slope_deg
68.0...48.0...30.0...20.0...10.0...0.0...90.0...80.0...70.0...60.0...50.0...40.0...30.0...20.0...10.0... Finished.
386.31702568488881
1658191.0
Total run time: 54149 ms
JGRASS MORPHOLOGICAL ATTRIBUTES

➢ DEM manipulation
➢ subbasins extraction
➢ watershed definition
JGRASS MORPHOLOGICAL ATTRIBUTES

➢ DEM manipulation
➢ DTM derived information
  • slope
  • curvatures
JGRASS MORPHOLOGICAL ATTRIBUTES
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- DEM manipulation
- DTM derived information
- Network related measures
  - distance to outlet
  - Strahler
JGRASS MORPHOLOGICAL ATTRIBUTES
JGRASS MORPHOLOGICAL ATTRIBUTES

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

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

UNSATURATED ZONE
JGRASS h.peakflow

SATURATED ZONE

UNSATURATED ZONE

Funzione d'ampiezza per deflusso superficiale

Funzione d'ampiezza per deflusso subsuperficiale
JGRASS h.peakflow

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>input file with the superficial width function</td>
<td>/lezoni_jgrass/dati/mybasin_rescsup10</td>
</tr>
<tr>
<td>input file with the subsuperficial width function</td>
<td>/lezoni_jgrass/dati/mybasin_rescsub10</td>
</tr>
<tr>
<td>a parameter of IDF curves [m/h^n]</td>
<td>43.91</td>
</tr>
<tr>
<td>n parameter of IDF curves</td>
<td>0.48</td>
</tr>
<tr>
<td>channel celerity [m/s]</td>
<td>2</td>
</tr>
<tr>
<td>diffusion [m^2/s]</td>
<td>1000</td>
</tr>
<tr>
<td>output file timestep [s]</td>
<td>300</td>
</tr>
<tr>
<td>write an output discharge file</td>
<td></td>
</tr>
<tr>
<td>output discharge file</td>
<td>/media/BUNDELE/lavori/bacinimontani/le</td>
</tr>
<tr>
<td>create the discharge chart</td>
<td></td>
</tr>
</tbody>
</table>

OK  | Cancel
JGRASS h.peakflow

Portata calcolata

area [km²] = 4.1806
velocità [m/s] = 2.0
diffusione [m²/s] = 1.000.0
Tₚmax [s] = 17.57.0
Qₚmax [m³/s] = 33.23

Portata calcolata

area [km²] = 4.1806
velocità [m/s] = 2.0
diffusione [m³/s] = 1.000.0
Tₚmax [s] = 45.79.0
Qₚmax [m³/s] = 14.17

HydroloGIS s.r.l. - Via Siemens, 19 – 39100 Bolzano
www.hydrologis.com
Portate relative a saturazione del bacino del 50%
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 transmittivity)

➢ requires the precipitation as input
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.
Soil thickness
Basin stability classification
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
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,
## Campi degli shapfiles
Di seguito devono essere inseriti tutti i parametri correlati alle geometrie. Tutti i campi sono necessari.

<table>
<thead>
<tr>
<th>Campo uso suolo</th>
<th>Campana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campo quota del biancone</td>
<td></td>
</tr>
<tr>
<td>Campo numerazione pfaś</td>
<td></td>
</tr>
<tr>
<td>Campo elevazione intera rete</td>
<td></td>
</tr>
<tr>
<td>Campo elevazione fine rete</td>
<td></td>
</tr>
<tr>
<td>Campo ID punti monitoraggio</td>
<td></td>
</tr>
<tr>
<td>Campo della distanza media sup. (sat &lt; 20%)</td>
<td></td>
</tr>
<tr>
<td>Campo della distanza media sup. (sat &gt; 50%)</td>
<td></td>
</tr>
<tr>
<td>Campo distance media sup. (sat &gt; 50%)</td>
<td></td>
</tr>
<tr>
<td>Campo della varianza sup. (sat &lt; 20%)</td>
<td></td>
</tr>
<tr>
<td>Campo della varianza sup. (sat &gt; 50%)</td>
<td></td>
</tr>
<tr>
<td>Campo della varianza sub.</td>
<td></td>
</tr>
<tr>
<td>Campo della varianza sub.</td>
<td></td>
</tr>
</tbody>
</table>

## Parametri del modello
Di seguito devono essere inseriti tutti i parametri del modello.

<table>
<thead>
<tr>
<th>Velocità superficiale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocità subsuperficiale</td>
</tr>
<tr>
<td>Evapotraspirazione con Penman</td>
</tr>
<tr>
<td>Numeri di pfas per output</td>
</tr>
<tr>
<td>Portata per unità di area intesa</td>
</tr>
<tr>
<td>Frazione di portata sup iniziale</td>
</tr>
<tr>
<td>Frazione di portata sub iniziale</td>
</tr>
<tr>
<td>Conducibilità idraulica saturo (m/mk)</td>
</tr>
<tr>
<td>Coefficiente misteo</td>
</tr>
<tr>
<td>Coefficiente specifide</td>
</tr>
<tr>
<td>Porosità del suolo</td>
</tr>
<tr>
<td>Valore costante per evapotraspirazione</td>
</tr>
<tr>
<td>Costante di saturazione</td>
</tr>
<tr>
<td>Frazione di portata sup/veloce per ghiacciai</td>
</tr>
<tr>
<td>Frazione di portata superfice per ghiacciai</td>
</tr>
</tbody>
</table>

## Plan delle geometrie di input
Di seguito devono essere inseriti i nomi dei piani delle geometrie necessari per il modello.
### Piani delle geometrie di input

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

<table>
<thead>
<tr>
<th>Piano degli idrometri</th>
<th>hydrometers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piano delle dighe</td>
<td>dams</td>
</tr>
<tr>
<td>Piano delle immissioni laterali</td>
<td>tributaries</td>
</tr>
<tr>
<td>Piano delle derivazioni</td>
<td>offtakes</td>
</tr>
<tr>
<td>Piano del reticolo idrografico</td>
<td>net_passirio</td>
</tr>
<tr>
<td>Piano dei bacini</td>
<td>basins_passirio</td>
</tr>
</tbody>
</table>

### 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**: INDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/hydrometers.csv
- **Dati immissioni laterali**: BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/tributaries.csv
- **Dati delle derivazioni**: ...
- **Dati di pioggia**: uovl/THEBIGTEST/simulazione2005/energy_swe100_glacier_2005_05_new.csv
- **Dati della vegetazione**: BUNDELE/newage/modelli_nuovi/THEBIGTEST/simulazione2005/vegetation.csv
**Parametri del modello**

Di seguito devono essere inseriti tutti i parametri del modello.

- Velocità superficiale: 0.5
- Velocità subsuperficiale: 0.5

**Campi degli shapefiles**

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

<table>
<thead>
<tr>
<th>Campo</th>
<th>Valore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campo uso suolo</td>
<td>uso_reclas</td>
</tr>
<tr>
<td>Campo netnum</td>
<td>netnum</td>
</tr>
<tr>
<td>Campo quota del baricentro</td>
<td>height</td>
</tr>
<tr>
<td>Campo numerazione pfafs.</td>
<td>pfafstette</td>
</tr>
<tr>
<td>Campo elevazione inizio rete</td>
<td>elevfirstp</td>
</tr>
<tr>
<td>Campo elevazione fine rete</td>
<td>elevlastpo</td>
</tr>
<tr>
<td>Campo ID punti monitoraggio</td>
<td>id_punti_m</td>
</tr>
<tr>
<td>Campo della distanza media sup. (sat &lt; 20%)</td>
<td>mean_10</td>
</tr>
<tr>
<td>Campo della distanza media sup. (sat &lt; 50%)</td>
<td>mean_30</td>
</tr>
<tr>
<td>Campo distanza media sup. (sat &gt; 50%)</td>
<td>mean_60</td>
</tr>
<tr>
<td>Campo della varianza sup. (sat &lt; 20%)</td>
<td>sd_10</td>
</tr>
<tr>
<td>Campo della varianza sup. (sat &lt; 50%)</td>
<td>sd_30</td>
</tr>
<tr>
<td>Campo varianza sup. (sat &gt; 50%)</td>
<td>sd_60</td>
</tr>
<tr>
<td>Campo della distanza media sub.</td>
<td>mean_sub</td>
</tr>
<tr>
<td>Campo della varianza sub.</td>
<td>sd_sub</td>
</tr>
</tbody>
</table>
### Pannello principale del modello

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

<table>
<thead>
<tr>
<th>Parametro</th>
<th>Valore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data inizio [yyyy-MM-DD HH:MM]</td>
<td>2005-05-01 00:00</td>
</tr>
<tr>
<td>Data fine [yyyy-MM-DD HH:MM]</td>
<td>2005-05-10 00:00</td>
</tr>
<tr>
<td>Passo temporale in minuti</td>
<td>30</td>
</tr>
<tr>
<td>Output completo del modello</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
<tr>
<td>Output modello Livelli</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
</tbody>
</table>

### 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.

<table>
<thead>
<tr>
<th>Dati di input</th>
<th>Valore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portata di testa</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
<tr>
<td>Input portate artificiali</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
<tr>
<td>Input portate da confluenze</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
<tr>
<td>File delle sezioni in input</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
<tr>
<td>Input livello di valle</td>
<td>/media/BUNDELE/newage/modelli_nuovi/THEB</td>
</tr>
</tbody>
</table>
➢ 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: 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
  ➢ ...

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Thanks for the attention...

Questions?