GIS tools for water supply systems: an implementation using JGrassTools and gvSIG

Franceschi Silvia & Antonello Andrea

gvSIG Festival – May 2016

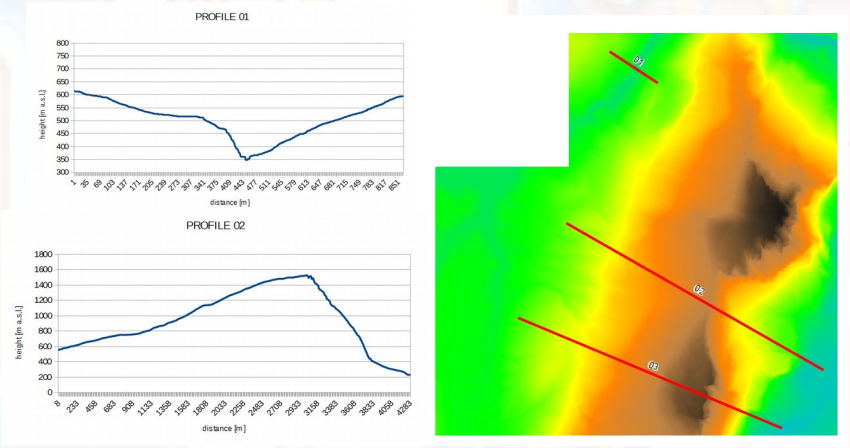
WHO AM I?

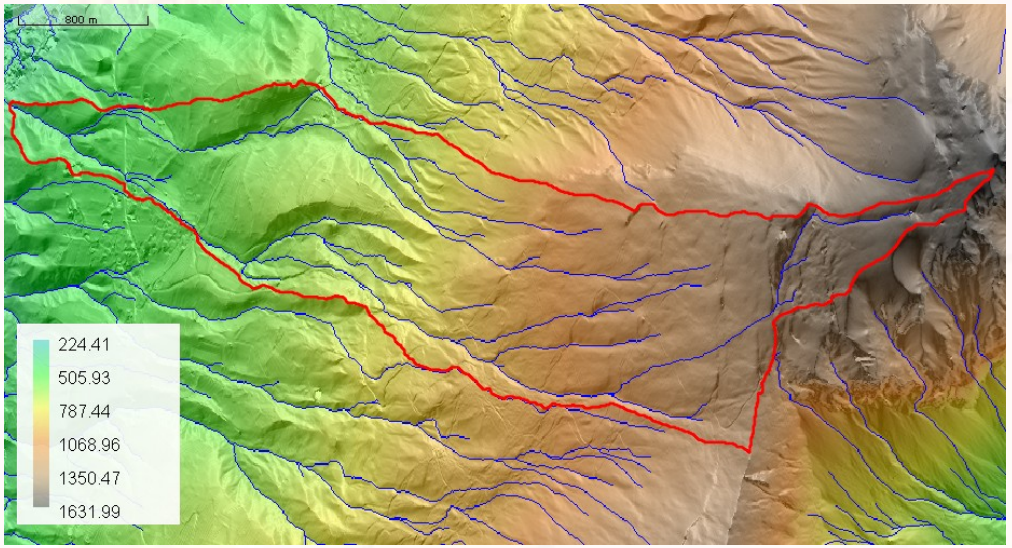
- environmental engineer specialized in hydrology, hydraulics and geomorphology
- co-founder of HydroloGIS with Andrea Antonello
- developed scientific models contained in the JGrassTools library in the field of:
  - hydrology
  - hydraulics
  - forestry
- PhD student of Science and Technology at the Free University of Bolzano (Italy)
- OSGeo Charter Member

HydroloGIS
Environmental Engineering

JGRASSTOOLS

- geospatial Open Source library containing modules for:
  - vector and raster processing
  - geomorphology
  - forestry
  - mobile mapping connection
  - LiDAR data analysis

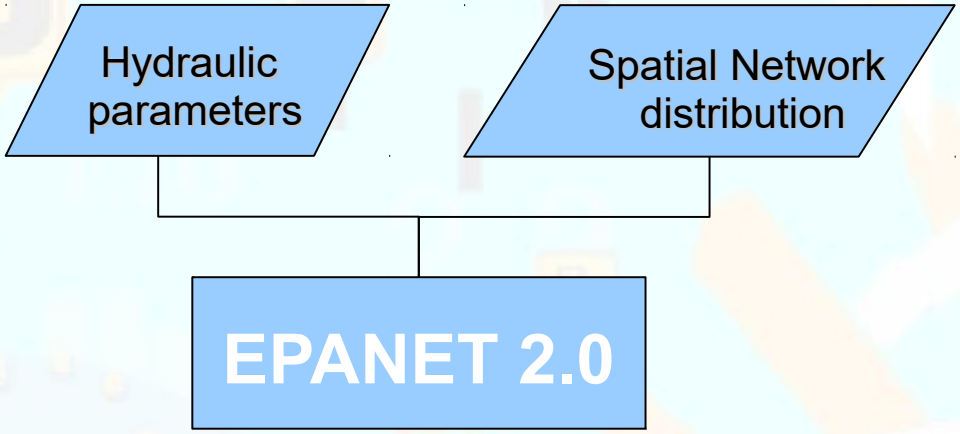




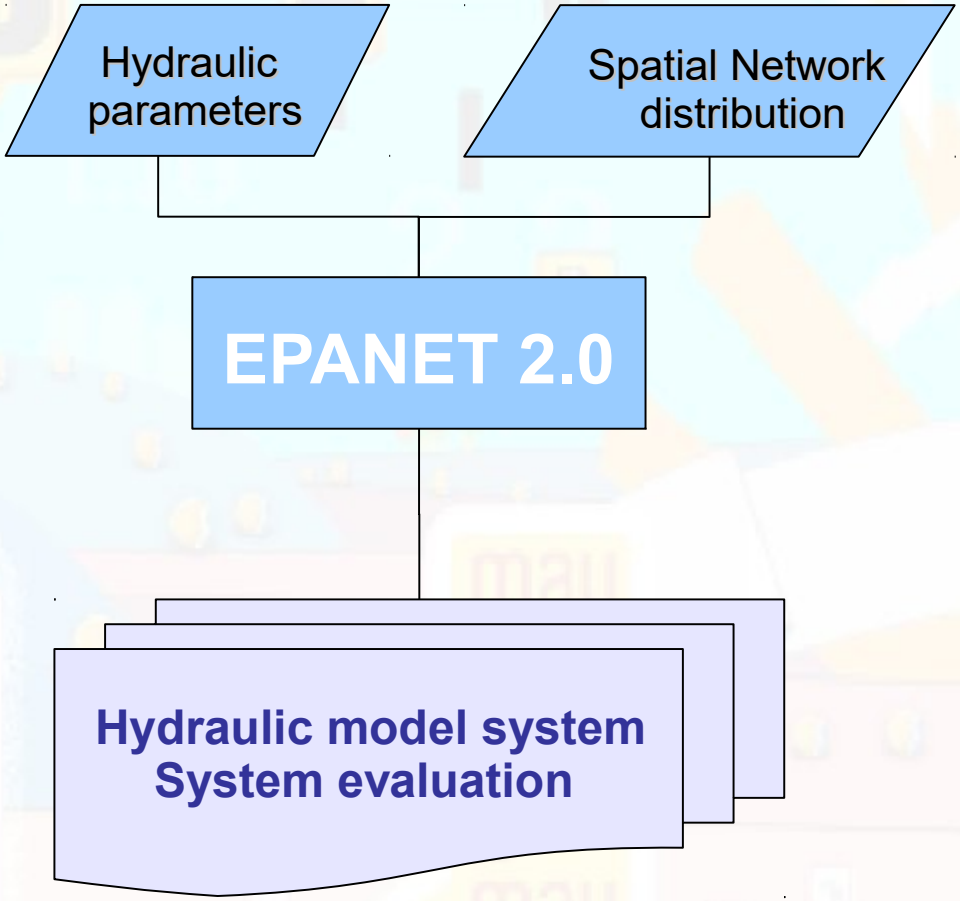
EPANET

- a powerful and well known software for water supply system management (analysis) and design
- developed by EPA (United States Environmental Protection Agency)
- predicts the dynamic hydraulic and water quality behavior within a drinking water distribution system operating over an extended period of time
- research tool for improving the understanding of the movement (flow and direction) of the water within a distribution systems

EPANET & GIS


Hydraulic parameters
Spatial Network distribution
EPANET 2.0

EPANET & GIS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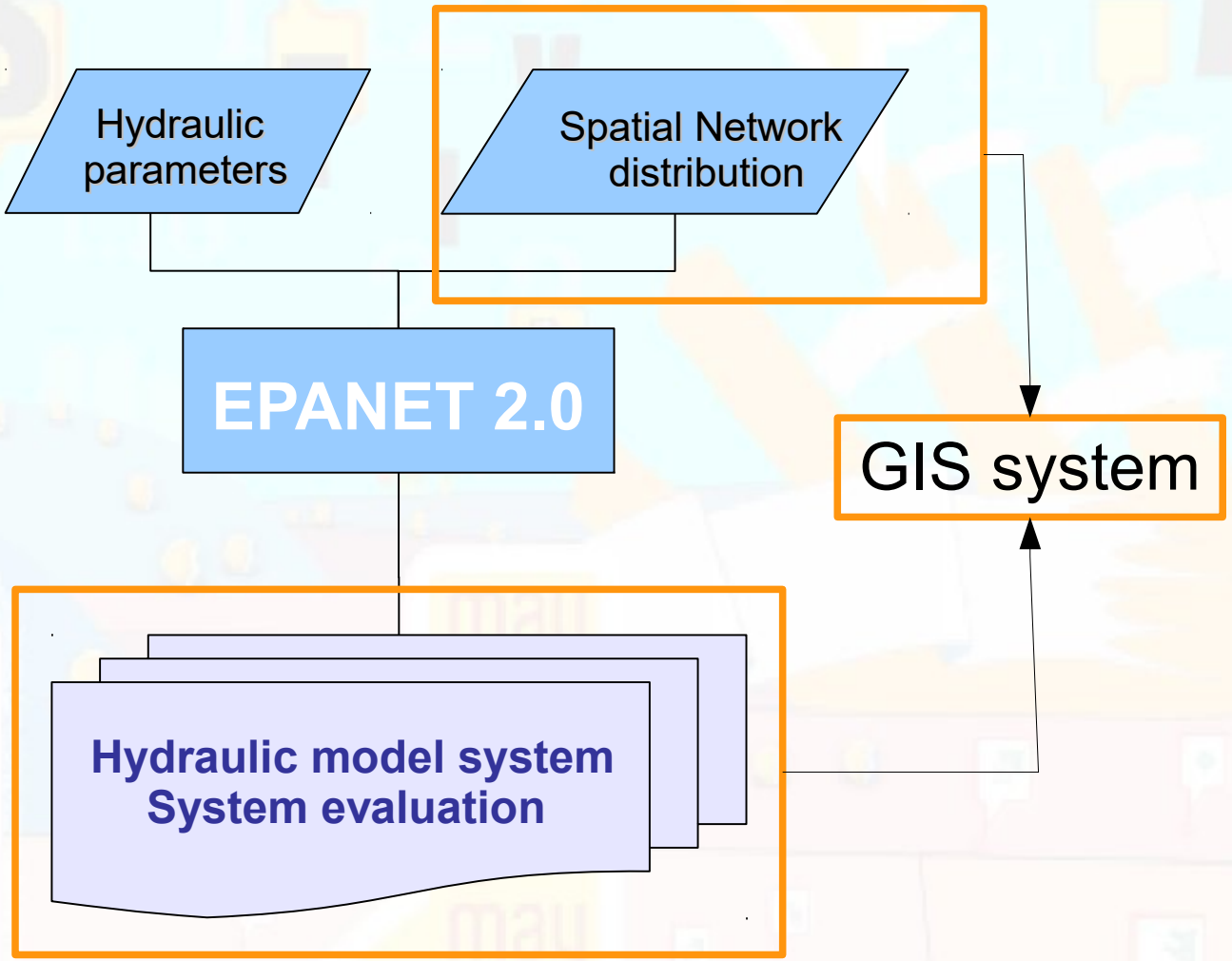
System evaluation

EPANET & GIS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EPANET & GIS

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- a plugin in gvSIG is developed that supplies a graphical interface to prepare the data for EPANET in a GIS way
- this plugin provides all of EPANET → there is no need to install EPANET software itself, it comes automatically with the plugin

EPANET & GIS

4 STEP SIMULATION RUN

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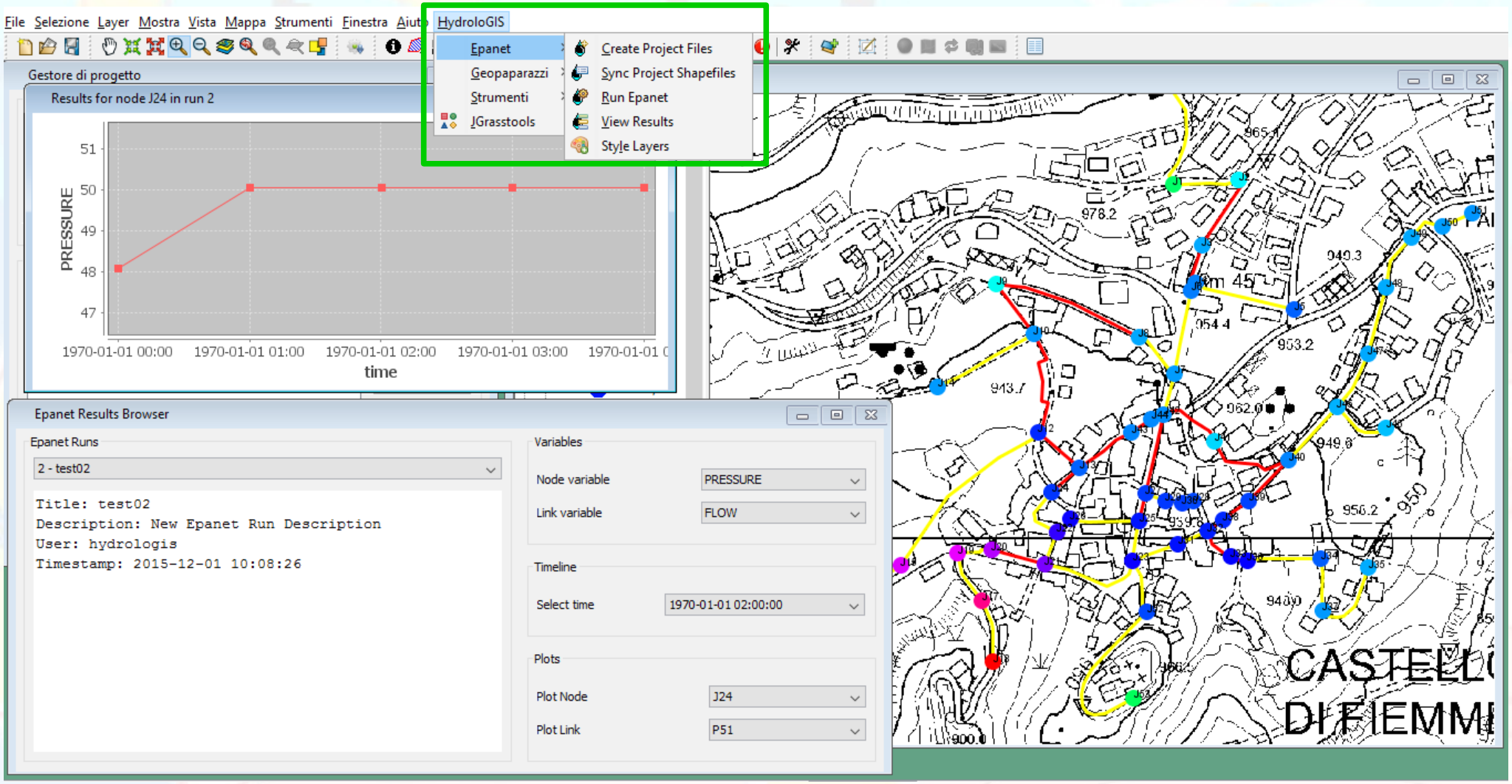
3. run EPANET simulation: hydraulic parameters definition and insertion of other information to be added for the simulation
4. open the EPANET result viewer: visualization of the results, spatial maps and charts with the evolution of local variables in space and time

EPANET & gvSIG

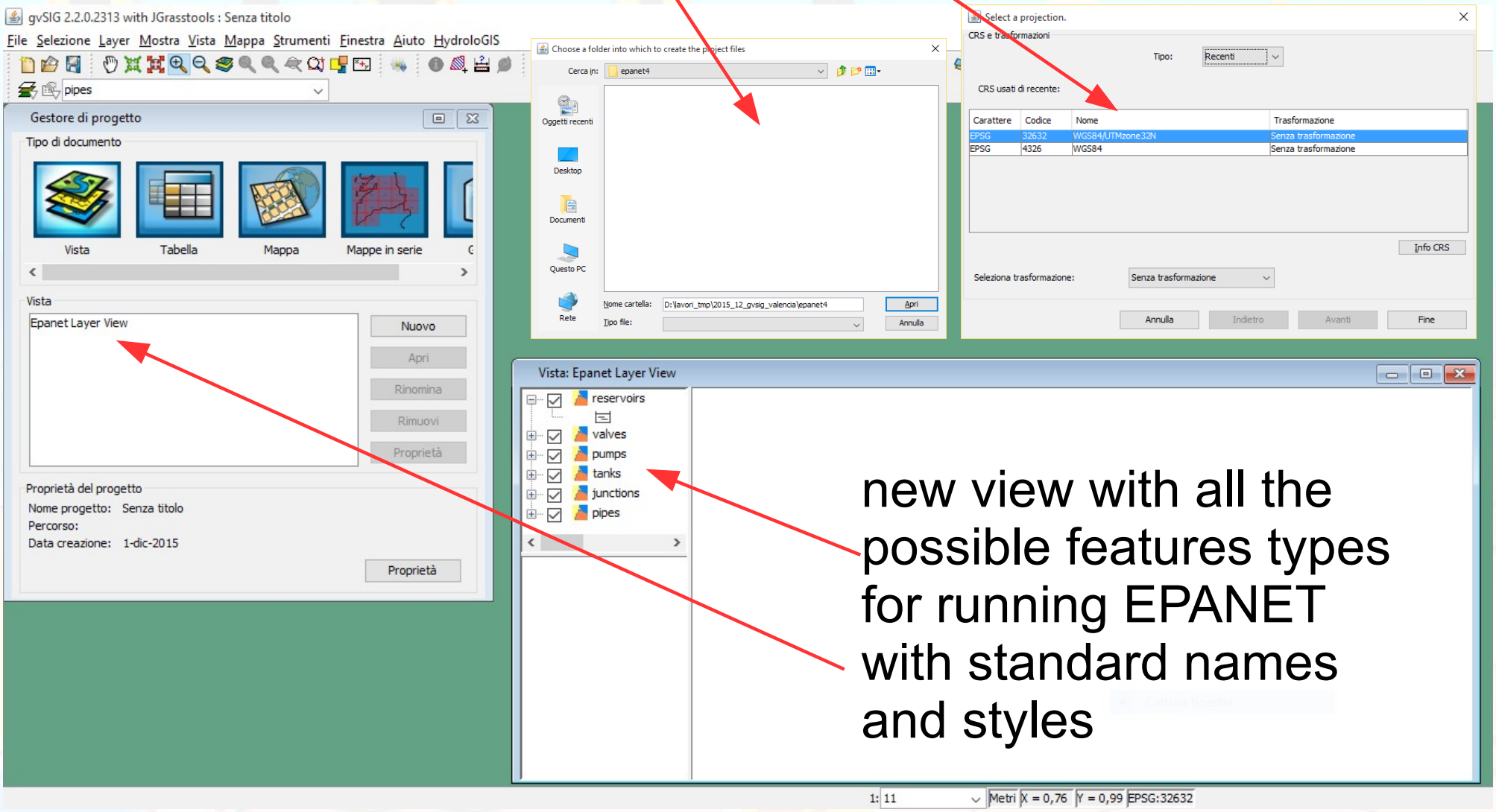
The tools are available from the menu:

HydroloGIS → Epanet



1. CREATE PROJECT FILES

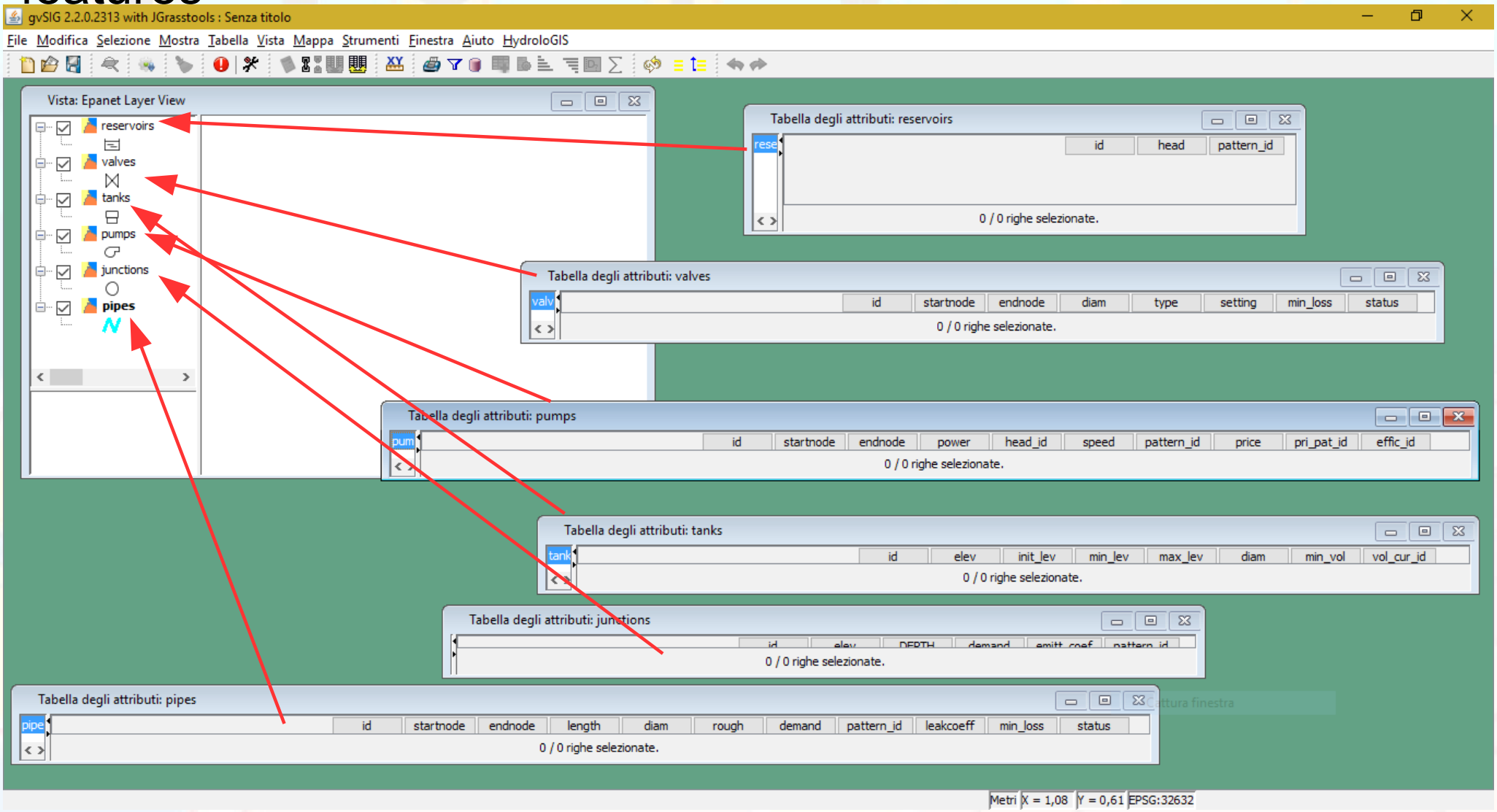
Select the folder and the projection of the project



new view with all the possible features types for running EPANET with standard names and styles

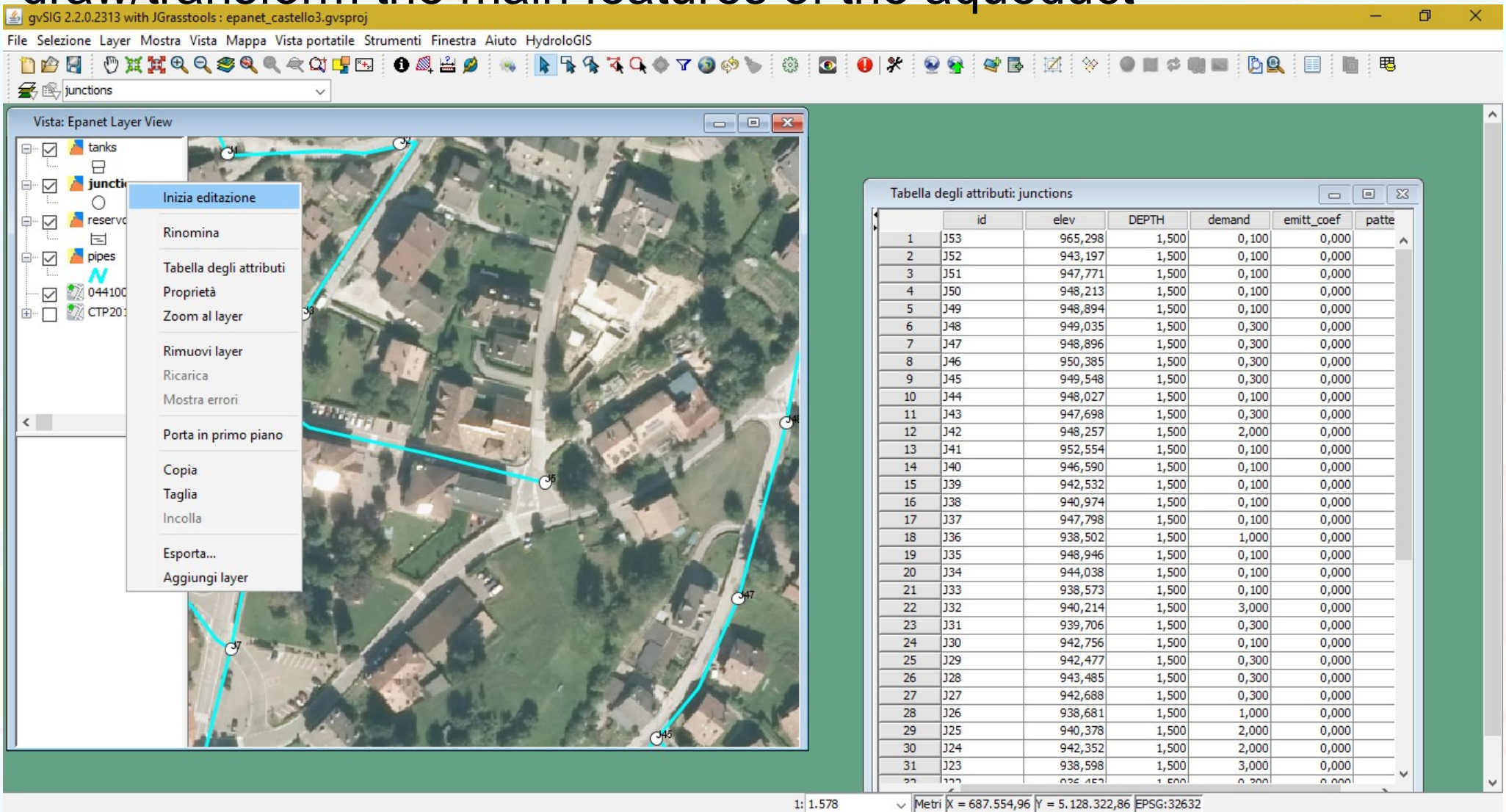
1. CREATE PROJECT FILES

Shapefiles attributes contain the required parameters for the features



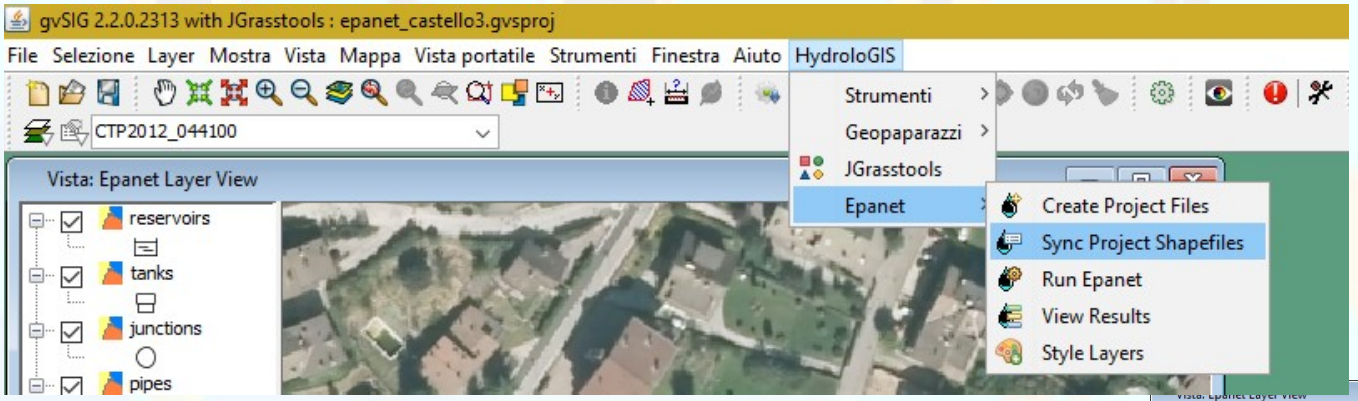
1. CREATE PROJECT FILES

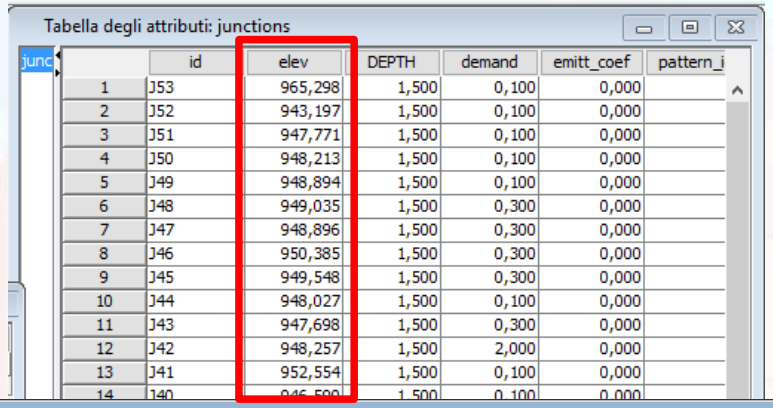
GIS layers (orthophoto or technical maps) as background to draw/transform the main features of the aqueduct



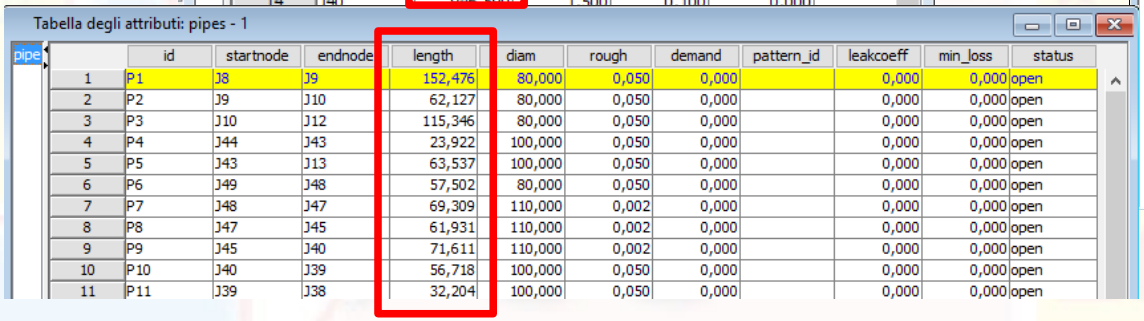
2. SYNCHRONIZE ATTRIBUTES

DTM for **elevation** and pipes' **3D length** evaluation

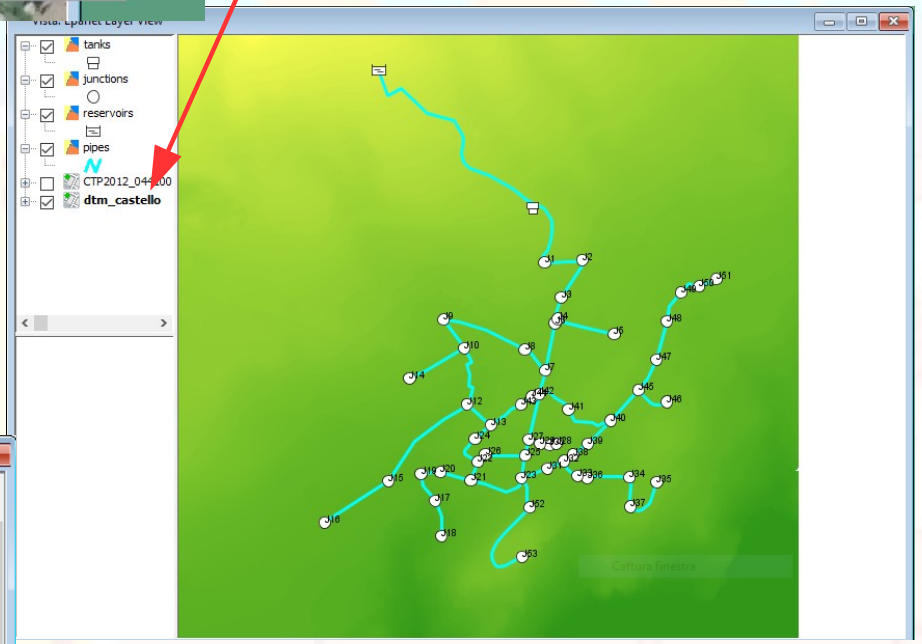




	id	elev	DEPTH	demand	emitt_coef	pattern_i
1	J53	965,298	1,500	0,100	0,000	
2	J52	943,197	1,500	0,100	0,000	
3	J51	947,771	1,500	0,100	0,000	
4	J50	948,213	1,500	0,100	0,000	
5	J49	948,894	1,500	0,100	0,000	
6	J48	949,035	1,500	0,300	0,000	
7	J47	948,896	1,500	0,300	0,000	
8	J46	950,385	1,500	0,300	0,000	
9	J45	949,548	1,500	0,300	0,000	
10	J44	948,027	1,500	0,100	0,000	
11	J43	947,698	1,500	0,300	0,000	
12	J42	948,257	1,500	2,000	0,000	
13	J41	952,554	1,500	0,100	0,000	
14	J40	946,599	1,500	0,100	0,000	

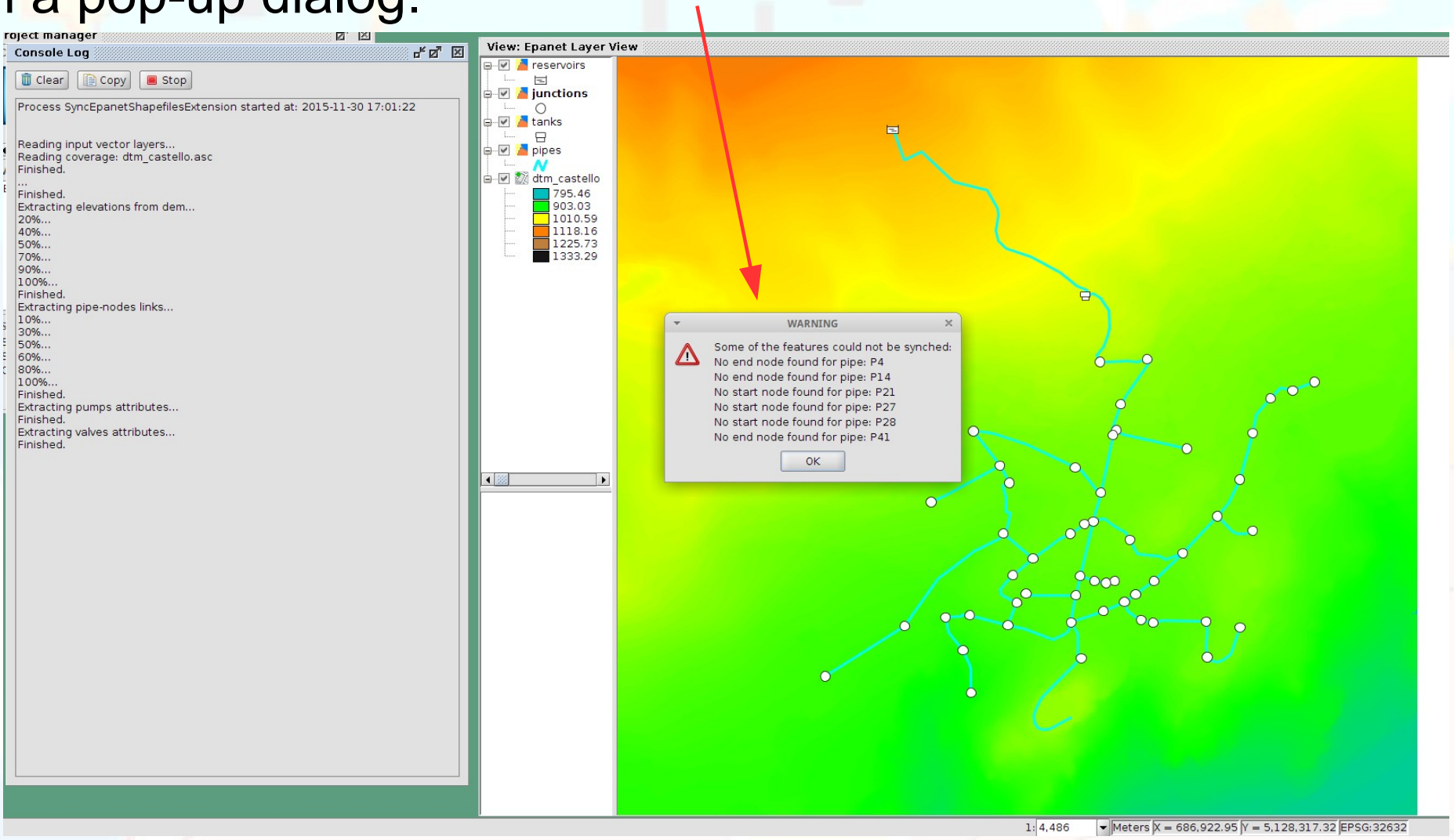


	id	startnode	endnode	length	diam	rough	demand	pattern_id	leakcoeff	min_loss	status
1	P1	J8	J9	152,476	80,000	0,050	0,000		0,000	0,000	open
2	P2	J9	J10	62,127	80,000	0,050	0,000		0,000	0,000	open
3	P3	J10	J12	115,346	80,000	0,050	0,000		0,000	0,000	open
4	P4	J44	J43	23,922	100,000	0,050	0,000		0,000	0,000	open
5	P5	J43	J13	63,537	100,000	0,050	0,000		0,000	0,000	open
6	P6	J49	J48	57,502	80,000	0,050	0,000		0,000	0,000	open
7	P7	J48	J47	69,309	110,000	0,002	0,000		0,000	0,000	open
8	P8	J47	J45	61,931	110,000	0,002	0,000		0,000	0,000	open
9	P9	J45	J40	71,611	110,000	0,002	0,000		0,000	0,000	open
10	P10	J40	J39	56,718	100,000	0,050	0,000		0,000	0,000	open
11	P11	J39	J38	32,204	100,000	0,050	0,000		0,000	0,000	open



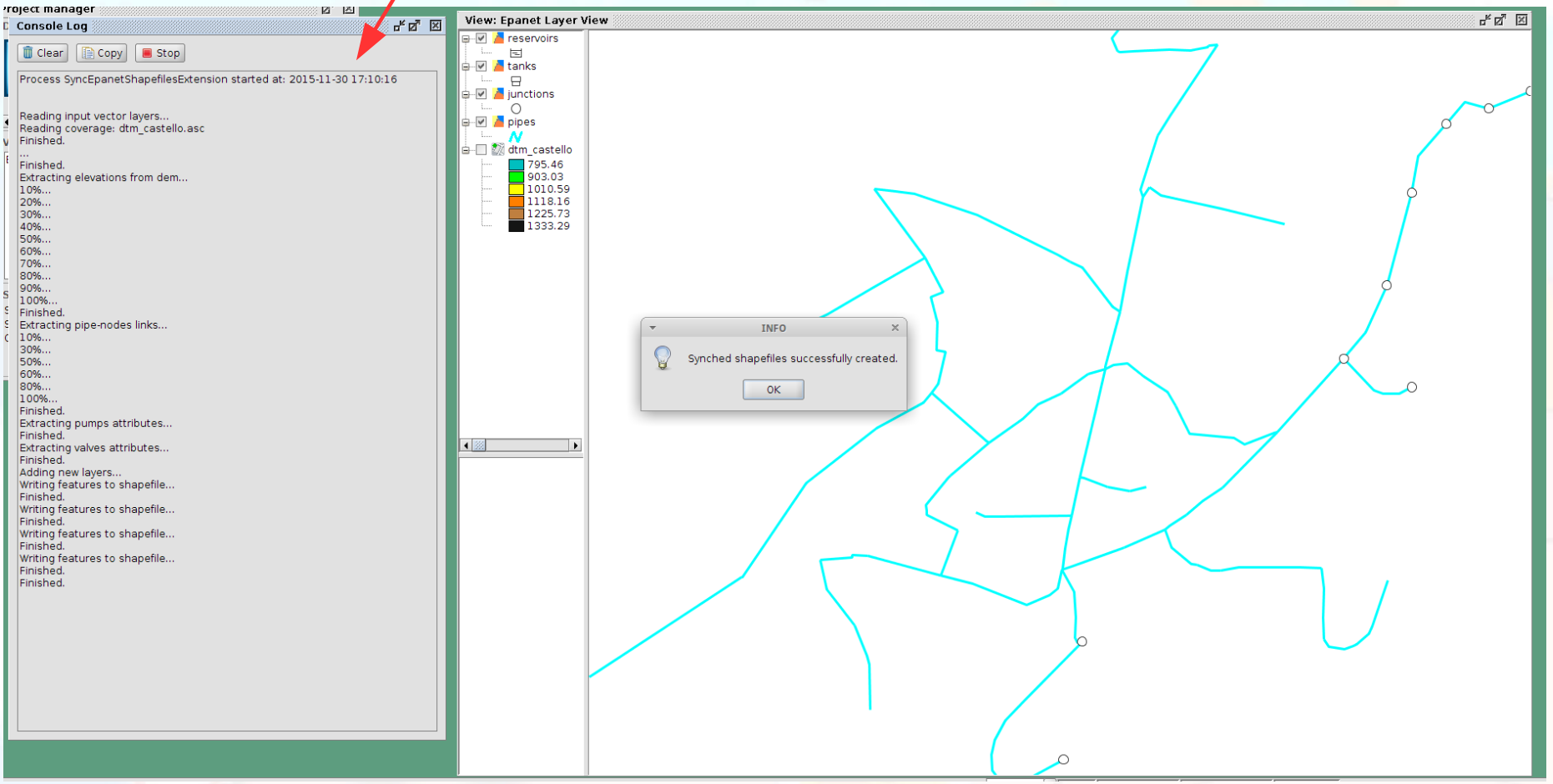
2. SYNCHRONIZE ATTRIBUTES

Warnings and errors messages from the tools are highlighted in a pop-up dialog.



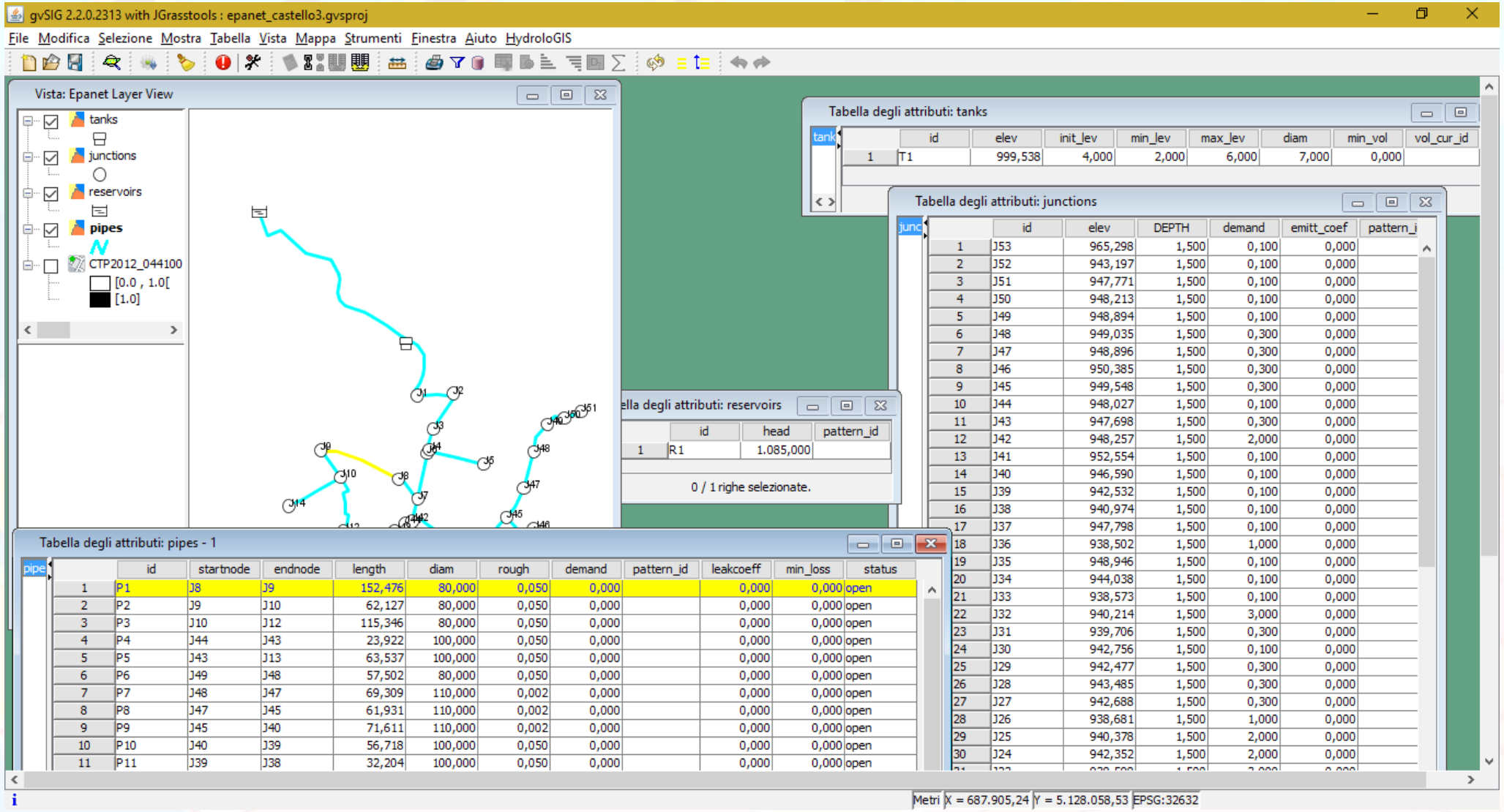
2. SYNCHRONIZE ATTRIBUTES

Progress state and general information are displayed in a dedicated Console



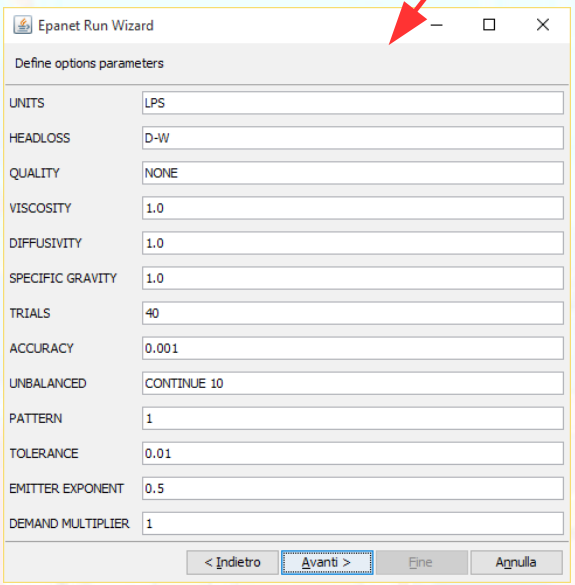
2. SYNCHRONIZE ATTRIBUTES

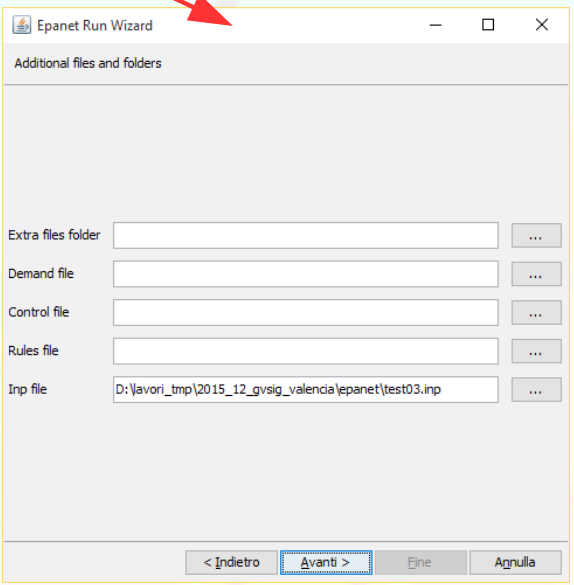
Complete all the required parameters for the features

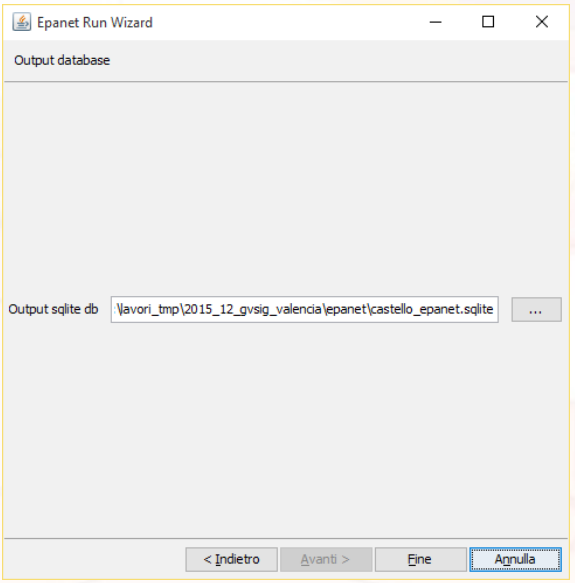


3. RUN EPANET SIMULATION

Simplified wizards help the user to fill in the main hydraulics parameters



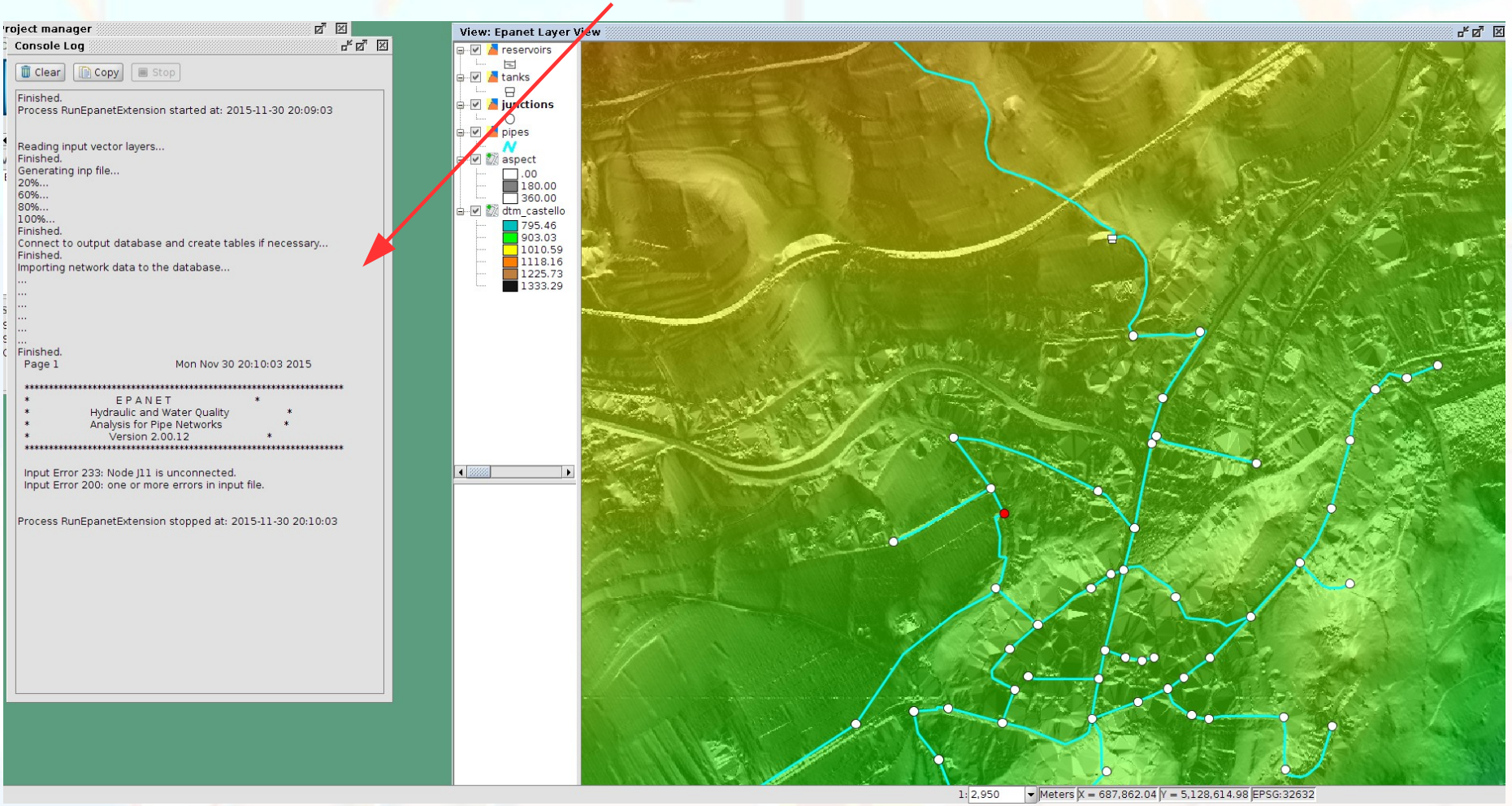




The results are stored in a local database (sqlite)

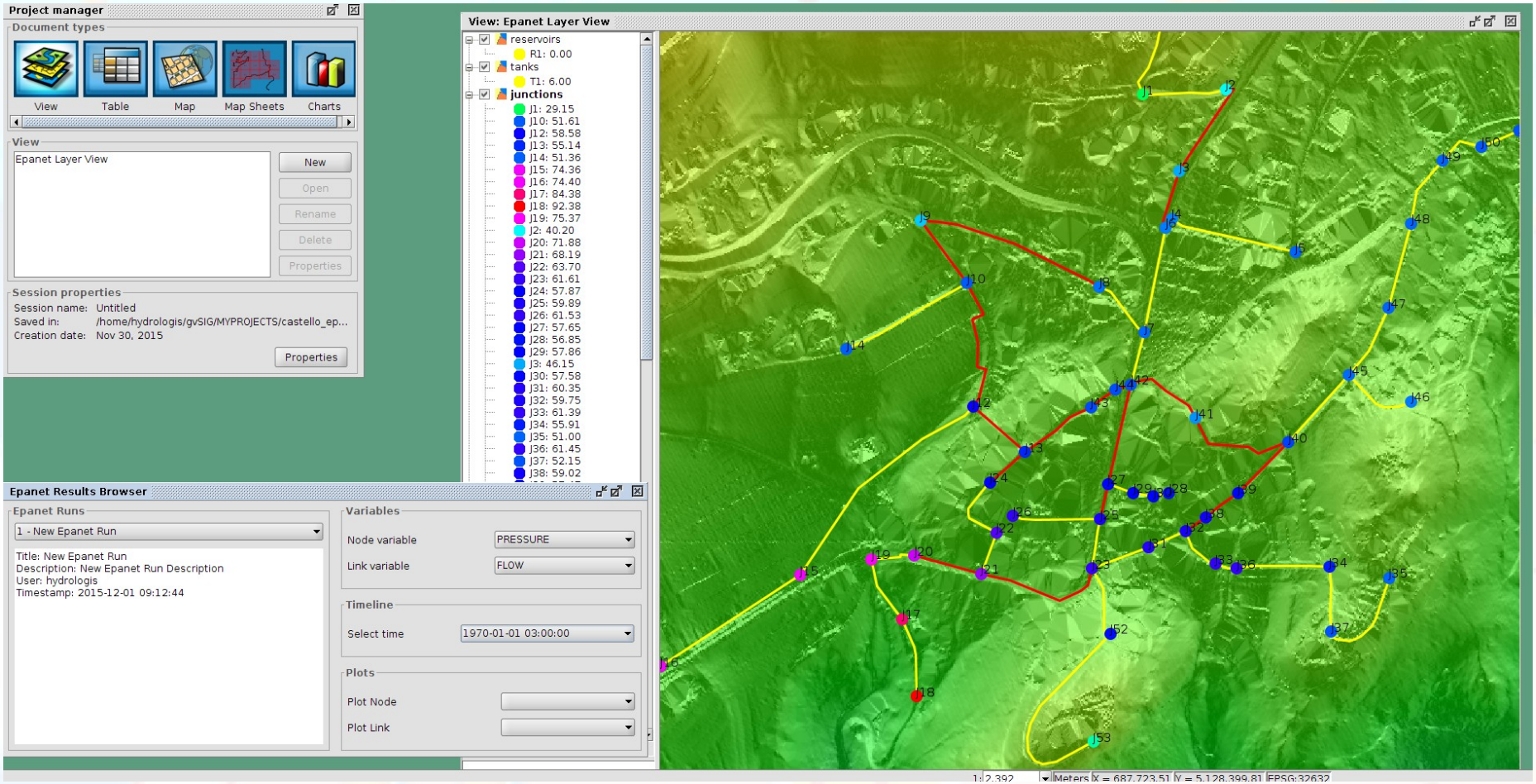
3. RUN EPANET SIMULATION

Progress state and log messages from EPANET code are displayed in a dedicated Console



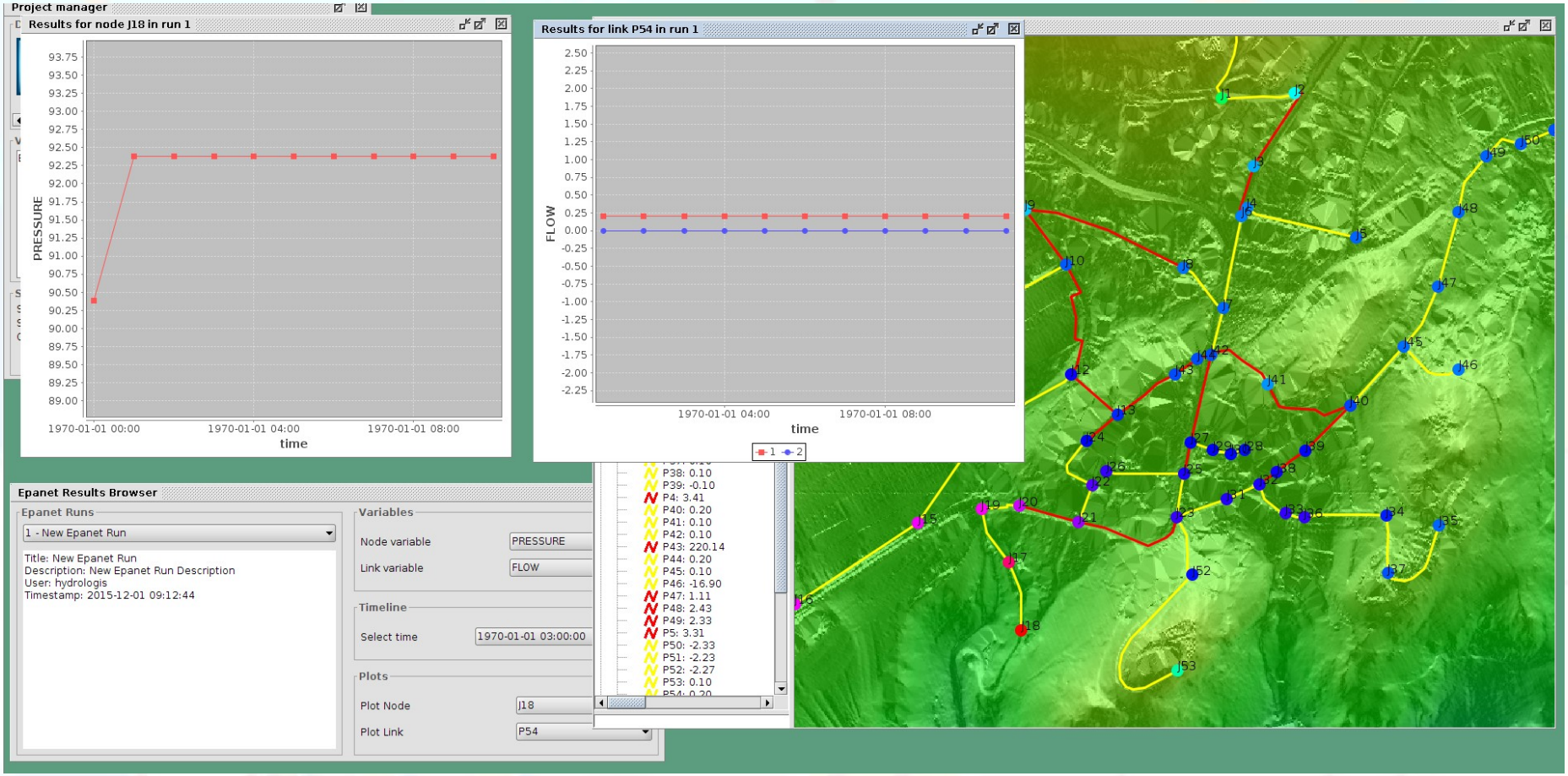
4. VISUALIZATION OF RESULTS

- selection of the timestep, variable and elements to visualize
- visualization of results on the map (pipes, junctions)



4. VISUALIZATION OF RESULTS

- selection of the timestep, variable and elements to visualize
- visualization of results on charts (nodes, pipes)



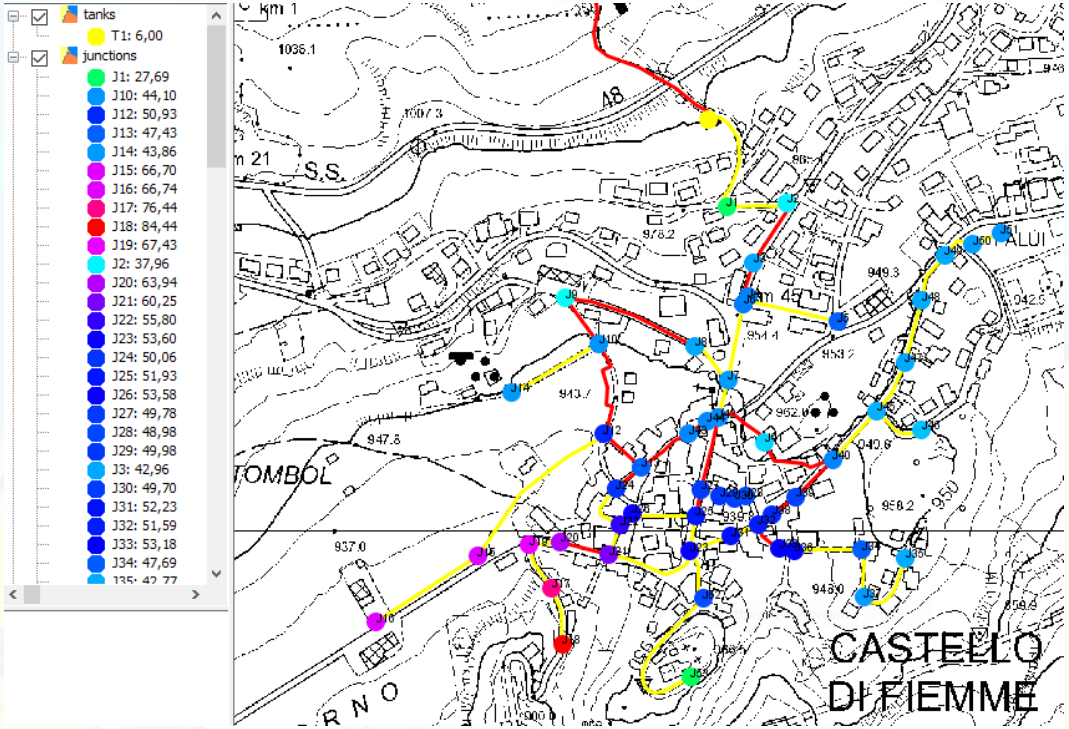
EPANET & gvSIG

Can help assess alternative management strategies for improving the performance of the system by:

- altering source utilization within multiple source systems
- altering pumping and tank filling/emptying schedules
- targeted pipe cleaning and replacement
- pre-localization of leakages

EPANET & gvSIG

- problems are highlighted in the results
- test new design solutions: Pressure Reducing Valve



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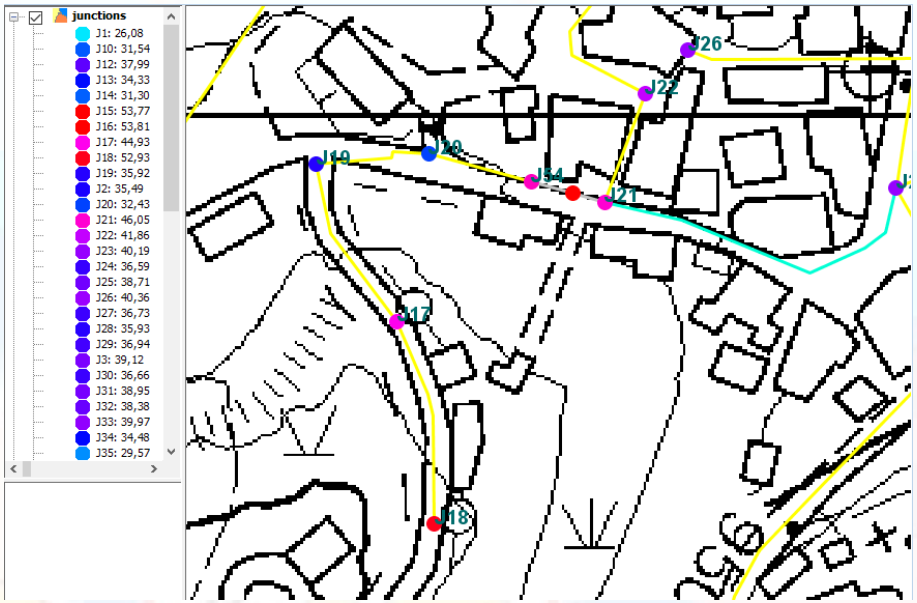
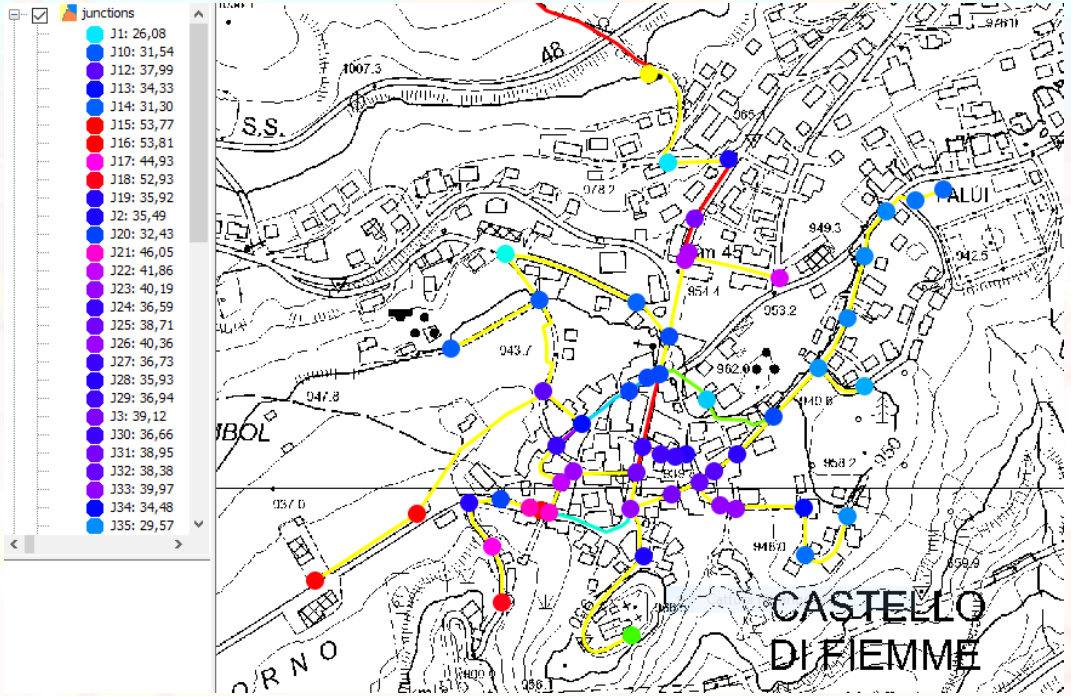
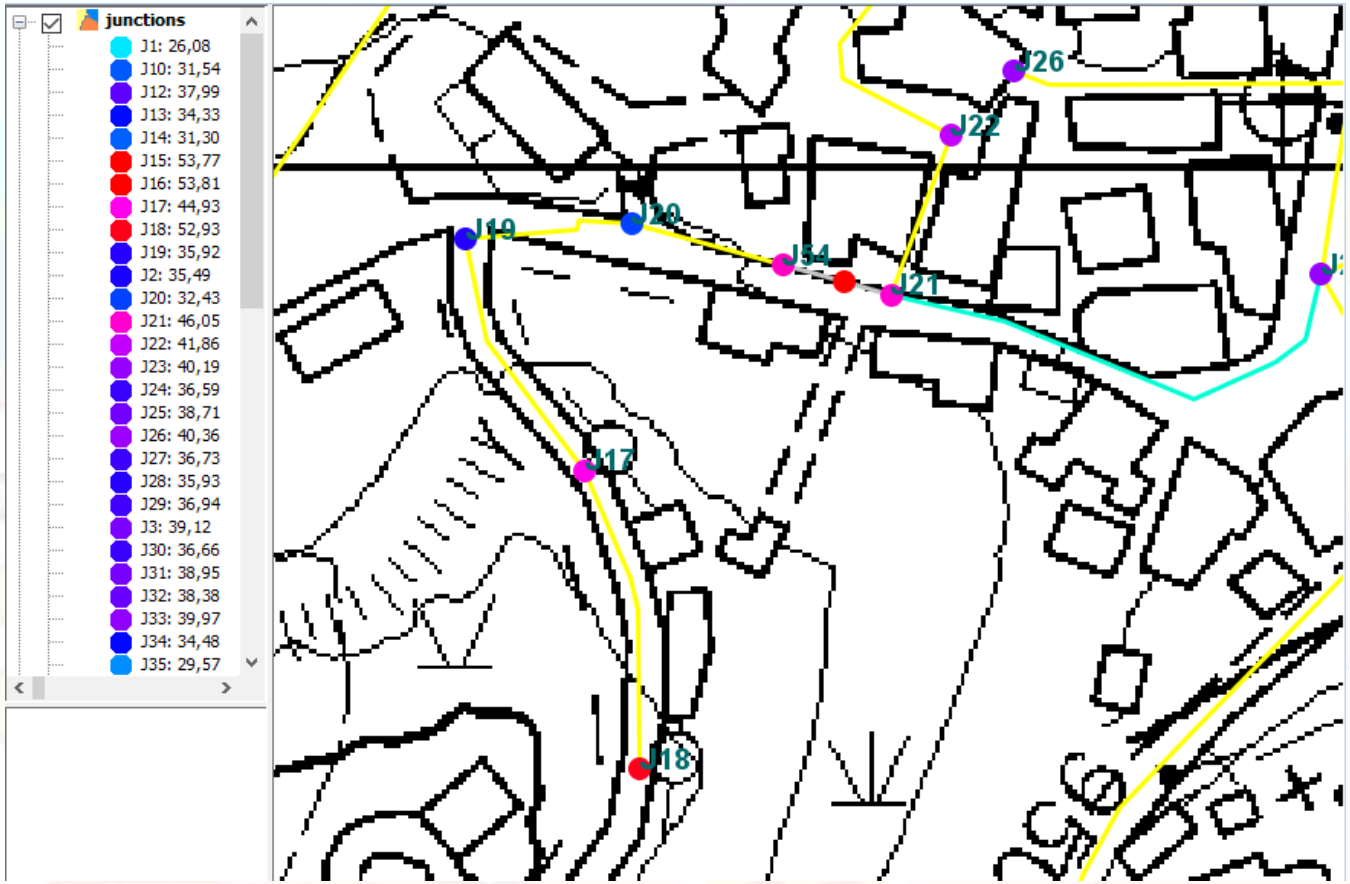




EPANET & gvSIG

- problems are highlighted in the results
- test new design solutions: change volume of tank



FUTURE PLANS

- finalize the implementation and testing of Epanet in gvSIG in different areas and scenarios
- integrate the support for simulation of the water quality in Epanet
- integrate a new model for design and verification of systems for collecting rain water and sewage in urban environments

THANKS FOR THE ATTENTION!

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