A web-based open-source geoinformation tool for regional water resources assessment

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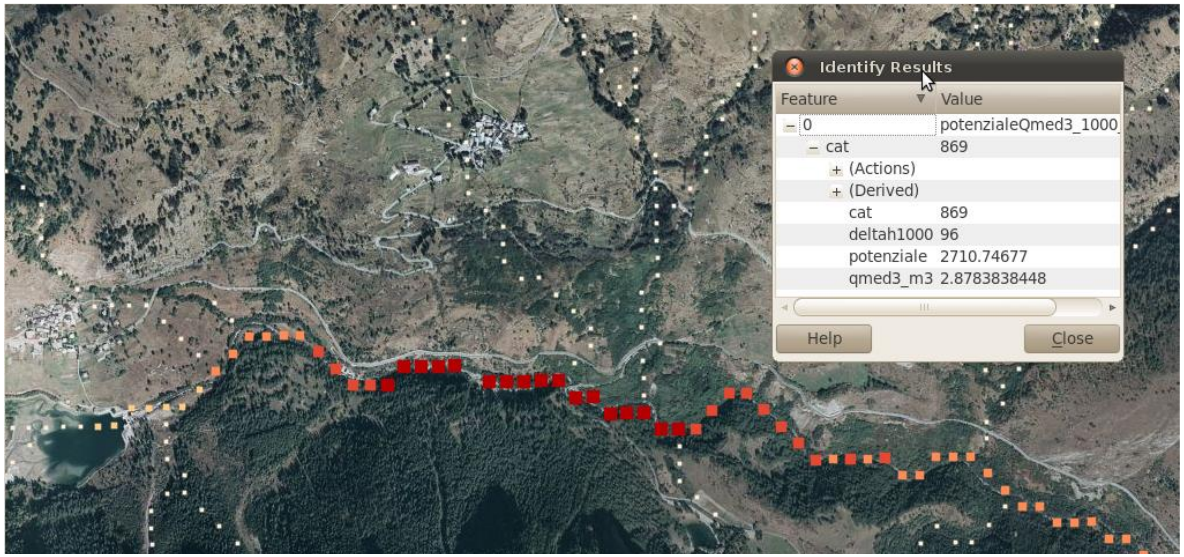
Water Resources Assessment: for what?

- In Europe: full application of the Water Framework Directive 2000/60 (*more water for the environment*)

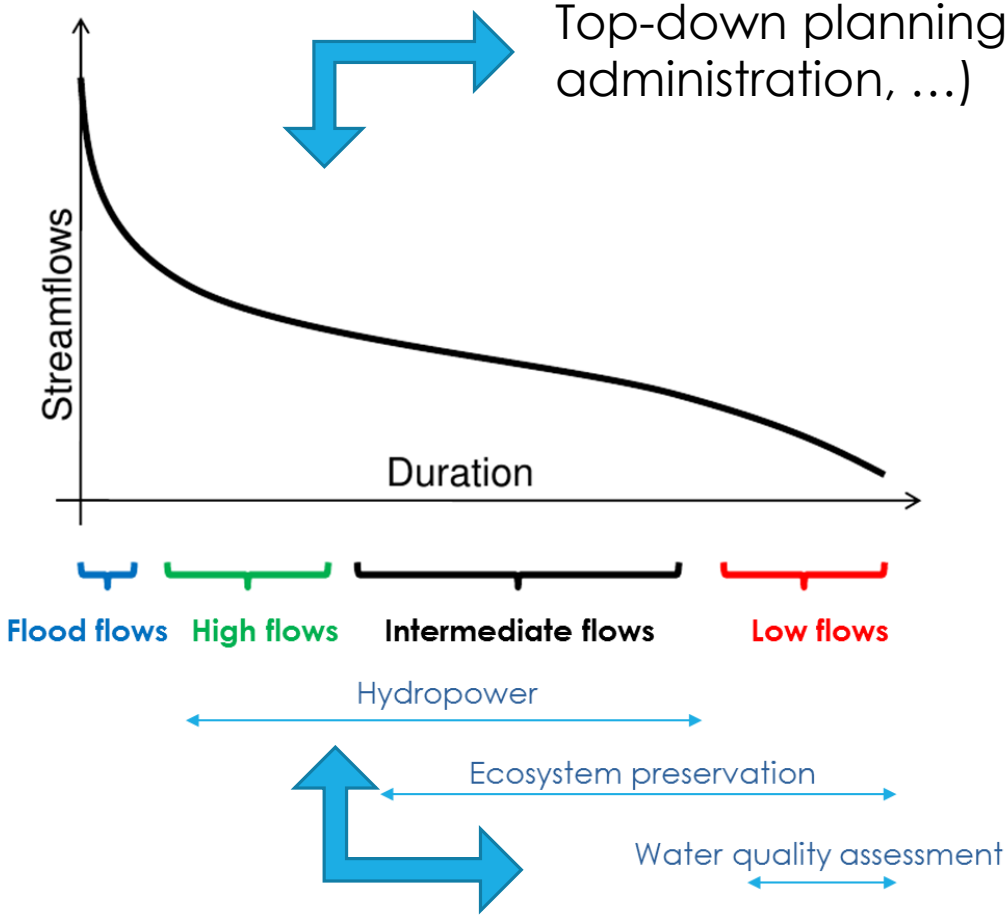


- Multiple users management
- EU 20-20-20 Goals*

(*) 20% increase in energy efficiency, 20% reduction of CO_2 emissions, and 20% renewables by 2020

WR Assessment tools?

Flow Duration Curves (FDC)
(i.e. distribution of daily runoff)

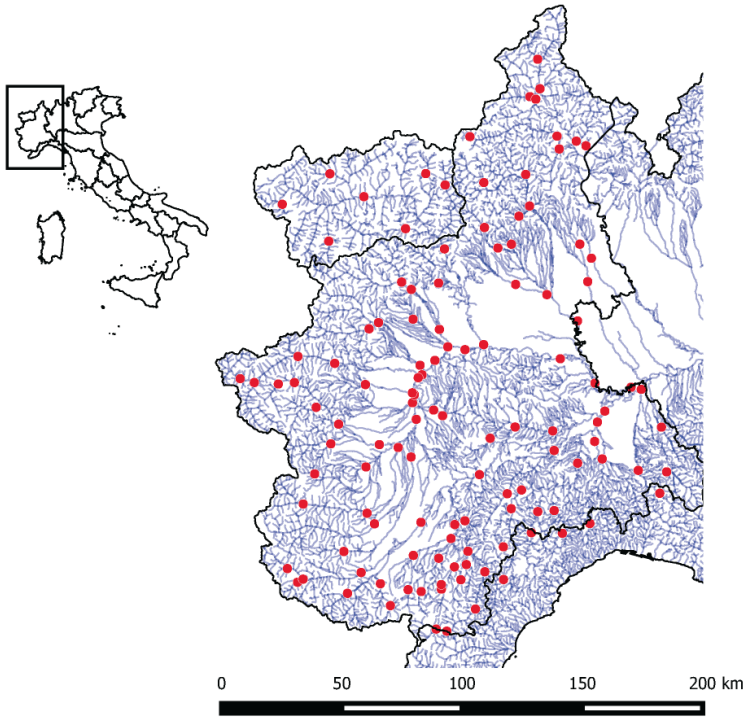


Top-down planning: large-scale view (policy, administration, …)

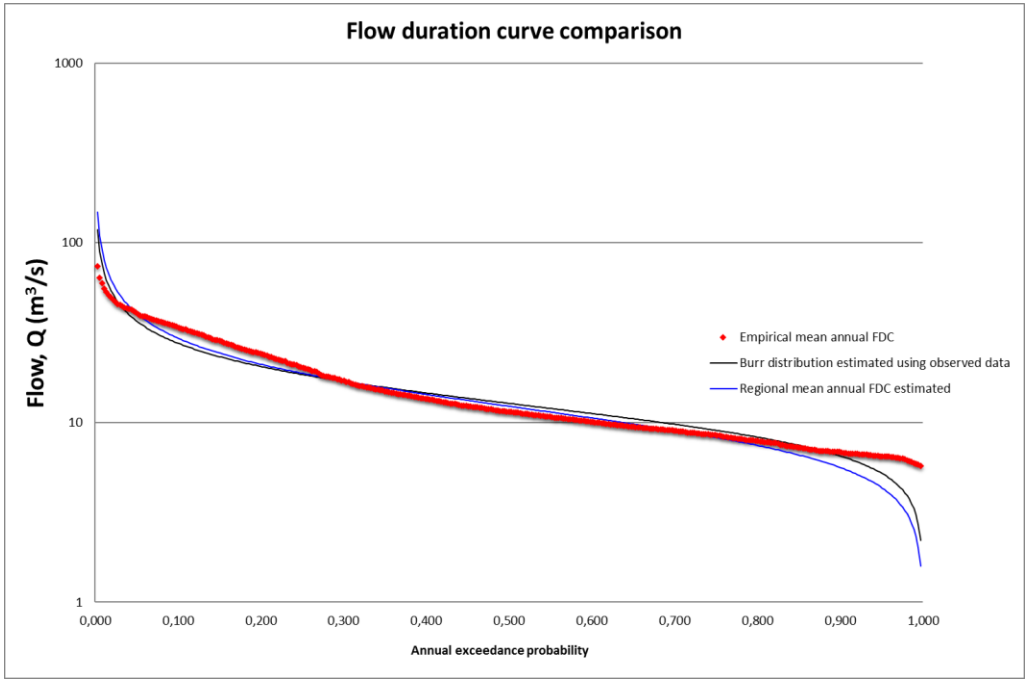
Bottom-up development: local-scale view (senctions of interest, irrigation districts, …)

Estimation of the Flow Duration Curves (FDC) in ungauged sites

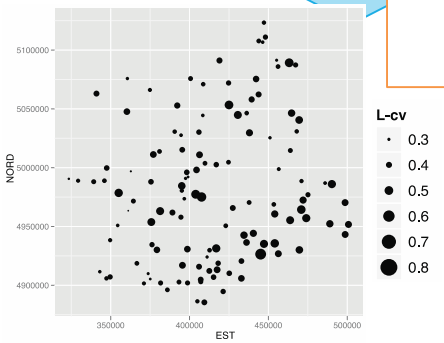
This work presents a WPS service, built up using PYWPS and GRASS as backend, for geoprocessing operations to estimate the FDC in ungauged basins in North-West Italy.



Study area and location of gauging stations used in the regional analysis

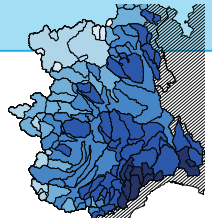


Spatially Smooth Estimation method (SSEM) for FDCs



OBSERVED FDC L-Moments

100+ Basin descriptors

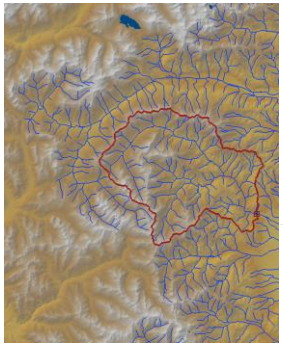


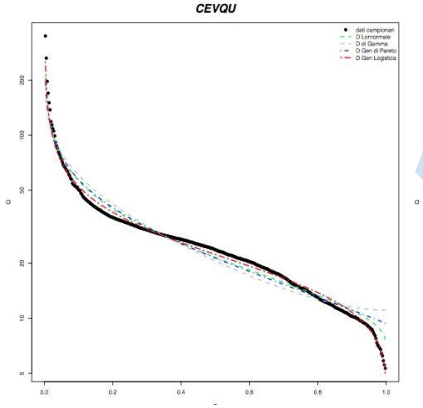
Multiple regression models

Ungauged site descriptors

L1
L-CV
L-CA

Estimated L-Moments



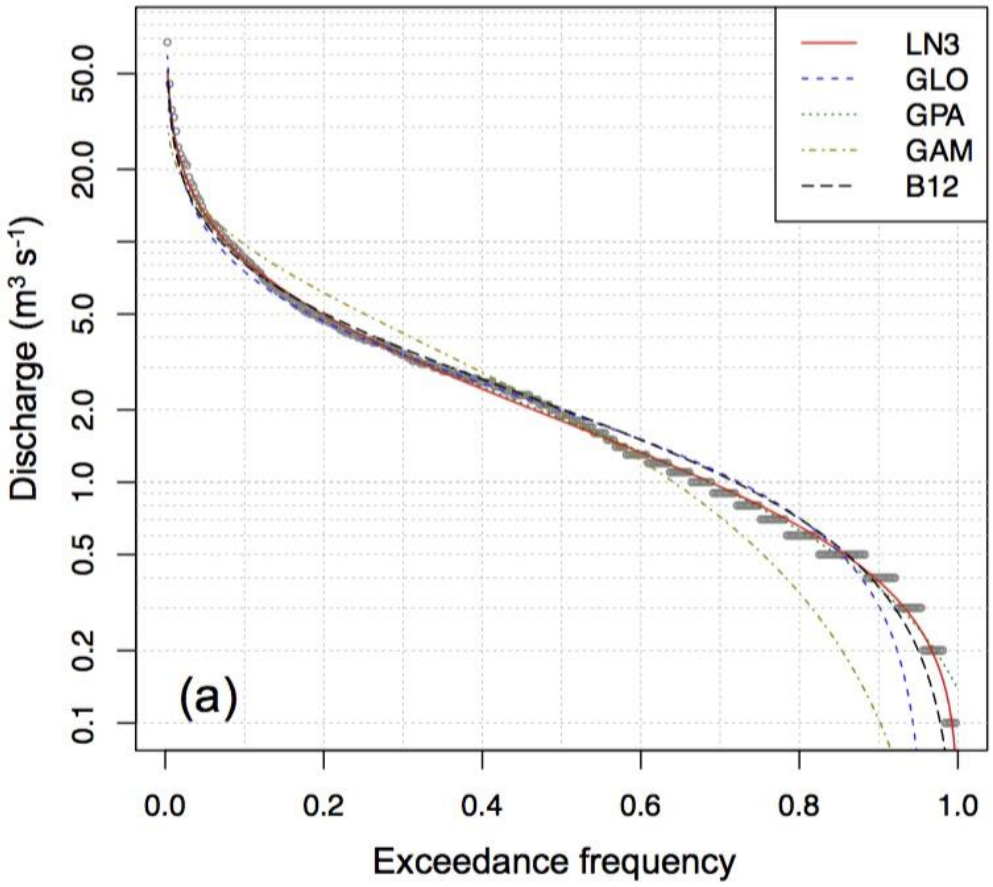


Choice of FDC analytical form

Method adapted from flood freq. analysis

- Laio et al. 2011, *J. Hydrology*
- Ganora & Laio 2015, *WRR*

FDC Model selection



LN3 – GLO best performing on average

but NEGATIVE Q values

Final choice

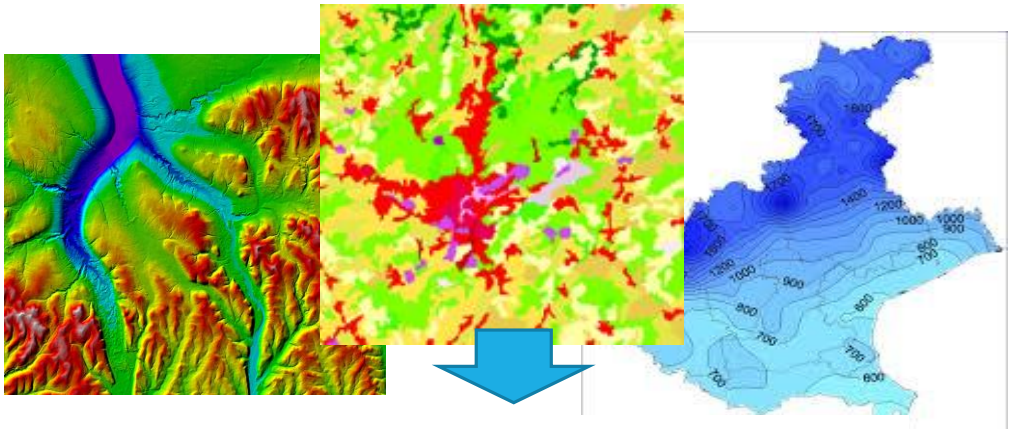
Burr-XII distribution

(NO Negative Values !)

$$F(x) = 1 - \left[1 - k\left(\frac{x}{\lambda}\right)^{c}\right]^{\frac{1}{k}} \quad k \neq 0$$
$$= 1 - \exp\left[-\left(\frac{x}{\lambda}\right)^{c}\right] \quad k = 0,$$

Ganora & Laio 2015,
j. Hydrologic Engineering ASCE

Relations between descriptors and L-Moments



$$Q(d) = a\left(\frac{\left(\frac{d}{366}\right)^{-b} - 1}{b}\right)^{\frac{1}{c}}$$

a = f(Y,b,c)
b= f(L_{CA}, L_{CV})
c= f(L_{CA}, L_{CV})

Estimation of the mean annual flow (mm):

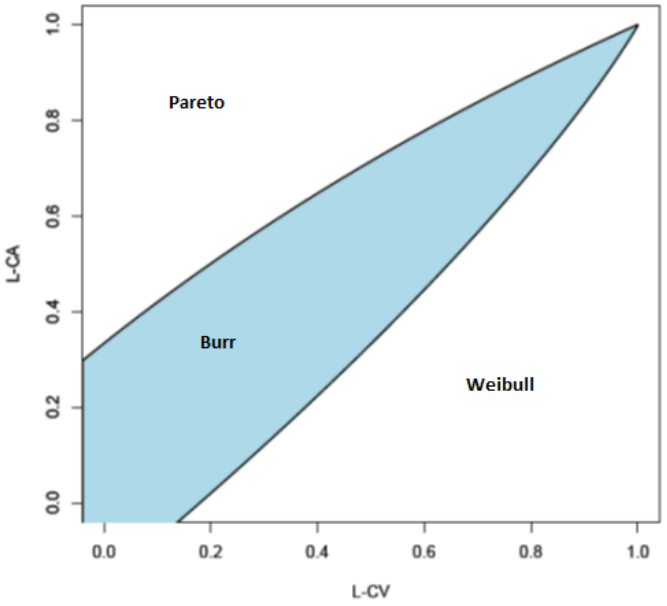
$$Y = -7.3605 \cdot 10^{2} + 1.2527 \cdot MAP + 3.2569 \cdot 10^{-1} \cdot h_m + 5.2674 \cdot fourier_{B1} - 6.7185 \cdot clc_2$$

Estimation of L-CV:

$$L_{CV} = -2.896 \cdot 10^{-1} - 2.688 \cdot 10^{-3} clc3 + 9.643 \cdot 10^{-5} a75percento + +1.688 \cdot 10^{-4} MAP + 2.941 \cdot 10^{1} c\_int$$

Estimation of L-CA:

$$L_{CA} = 4.7551 \cdot quota\_massima^{-0.2702} \cdot IDFa\_std^{0.06869} \cdot cv\_rp^{0.21055}$$



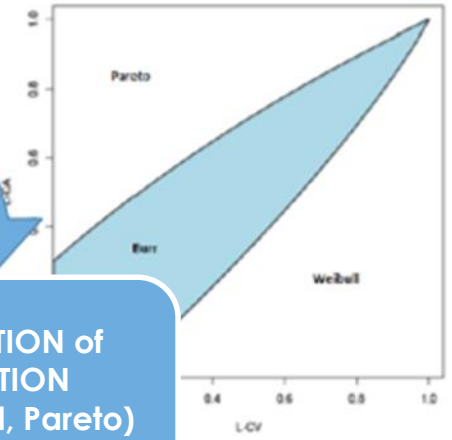
Application framework

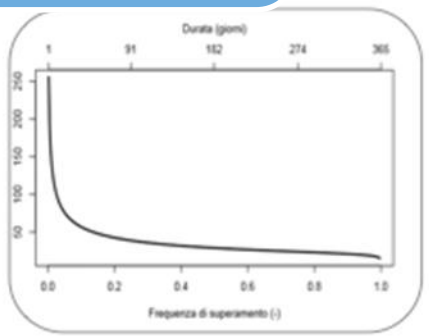
DELIMITATION OF THE BASIN

EXTRACTION OF THE GEOMORPHOLOGICAL AND CLIMATIC CHARACTERISTICS

APPLICATION OF REGRESSION MODELS FOR L-MOMENTS (Y, LCV,LCA) ESTIMATION

COMPUTATION of DISTRIBUTION (Burr, Weibull, Pareto) PARAMETERS





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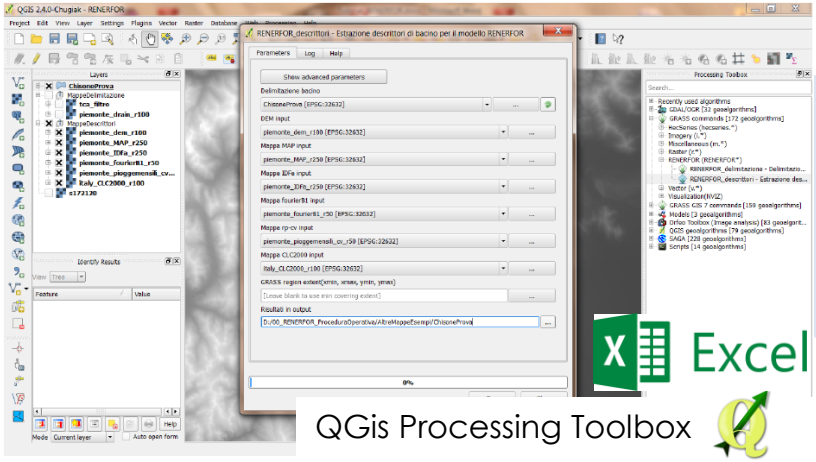
Geoinformation platform

First application (Qgis)



To WPS services

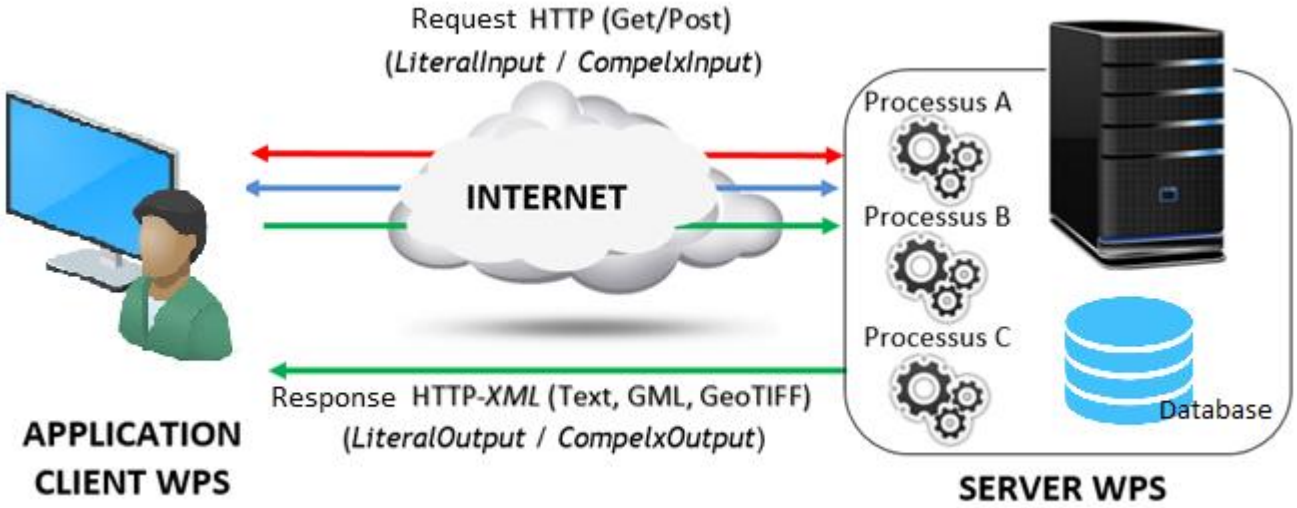
- Provide access to GIS data and functionality over the internet
- Allows users to access calculations independently of the underlying software
- Data does not need to be housed locally (client side) but are maintained by the hosting entity
- Server processing times faster than client side scripting

Tech advance: WPS implementation

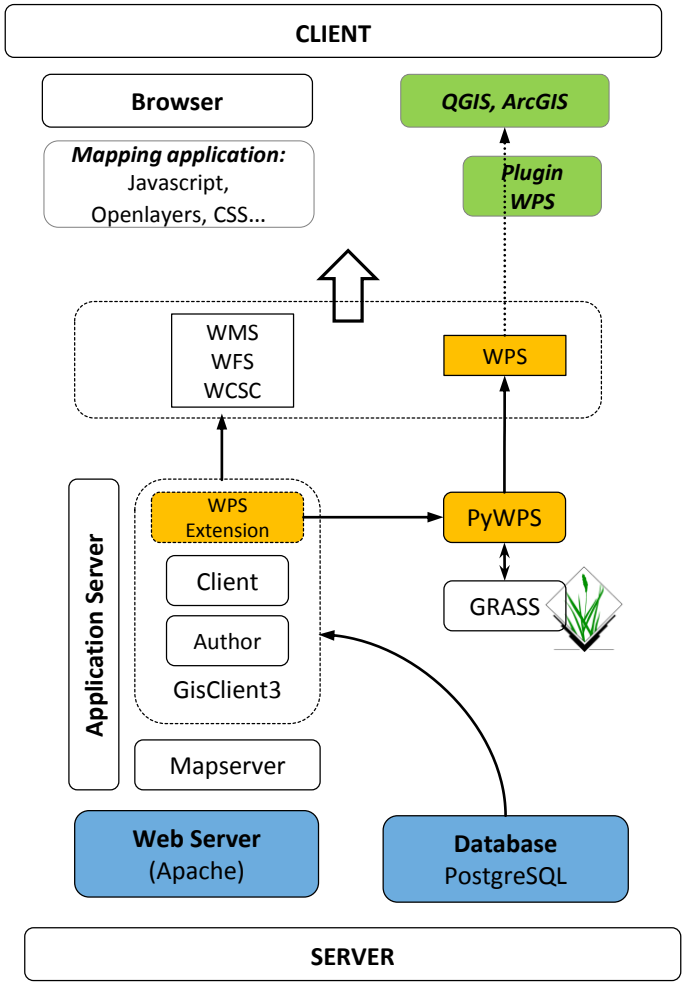
A WPS (Web Processing Service) is one of the OGC specifications to provide access to GIS data or functionality over the internet in a standardized way.

OGC Standard services:

- *WMS* - Web Map Service
- *WFS* - Web Feature Service
- *WCS* - Web Coverage Service
- *WPS* - Web Processing Service



The platform developed



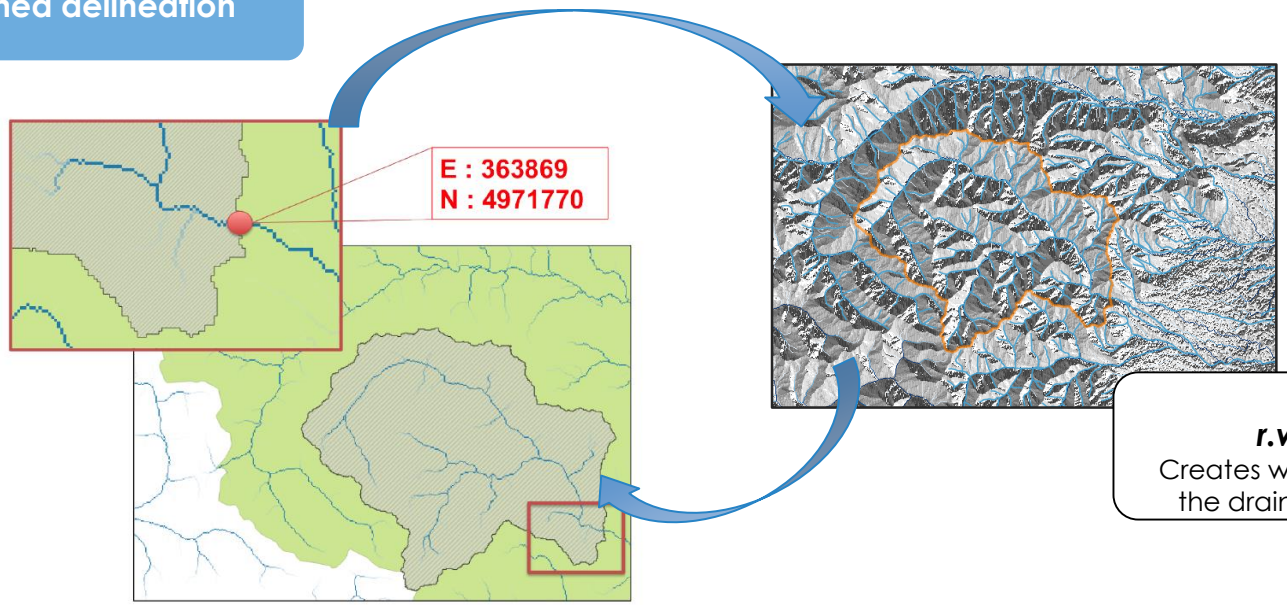
PyWPS enables integration, publishing and execution of Python processes via the WPS standard.

The WPS services proposed

Two WPS procedures are developed:

- Basin boundary delineation
- Extraction of basin descriptors and estimation of regional FDC curve

Watershed delineation

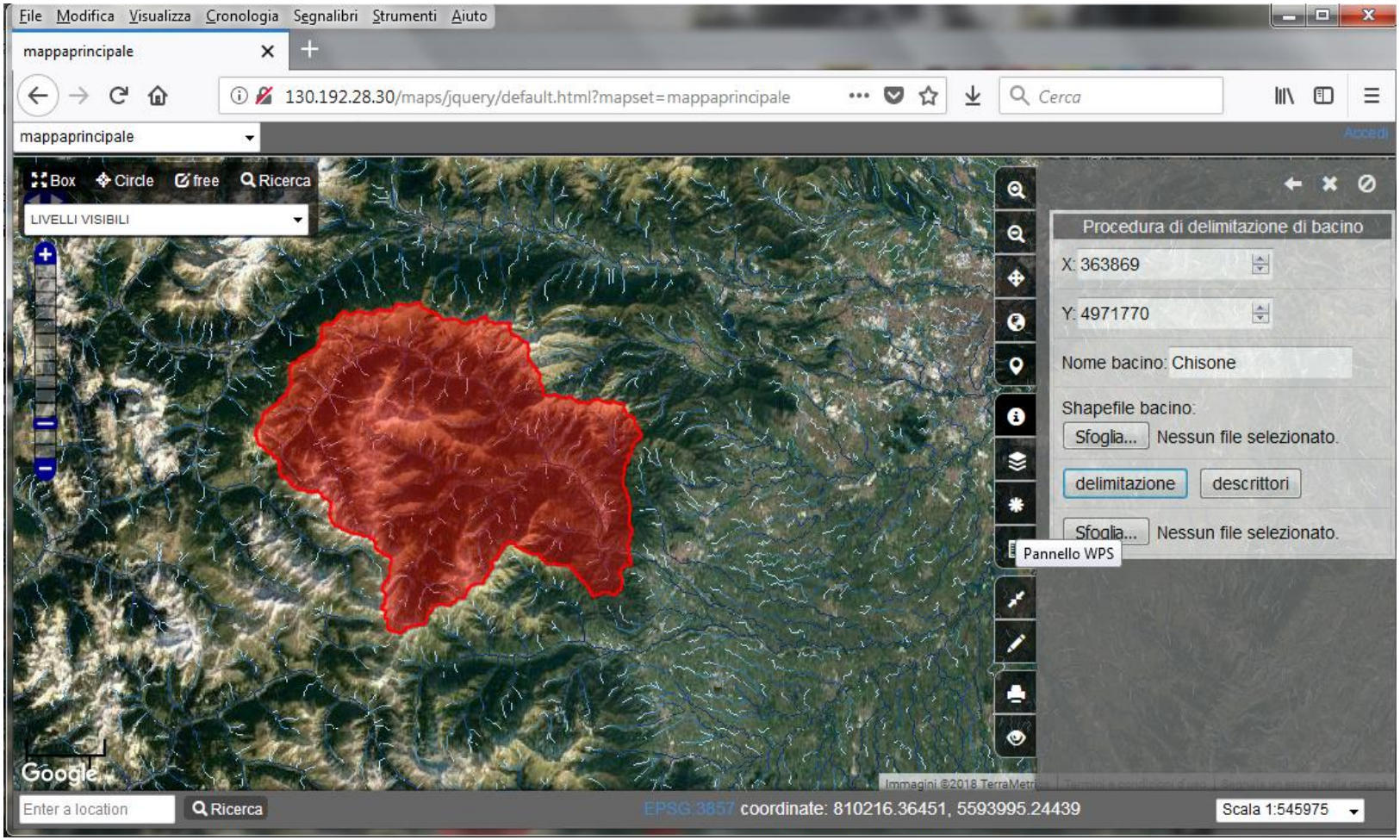


GRASS

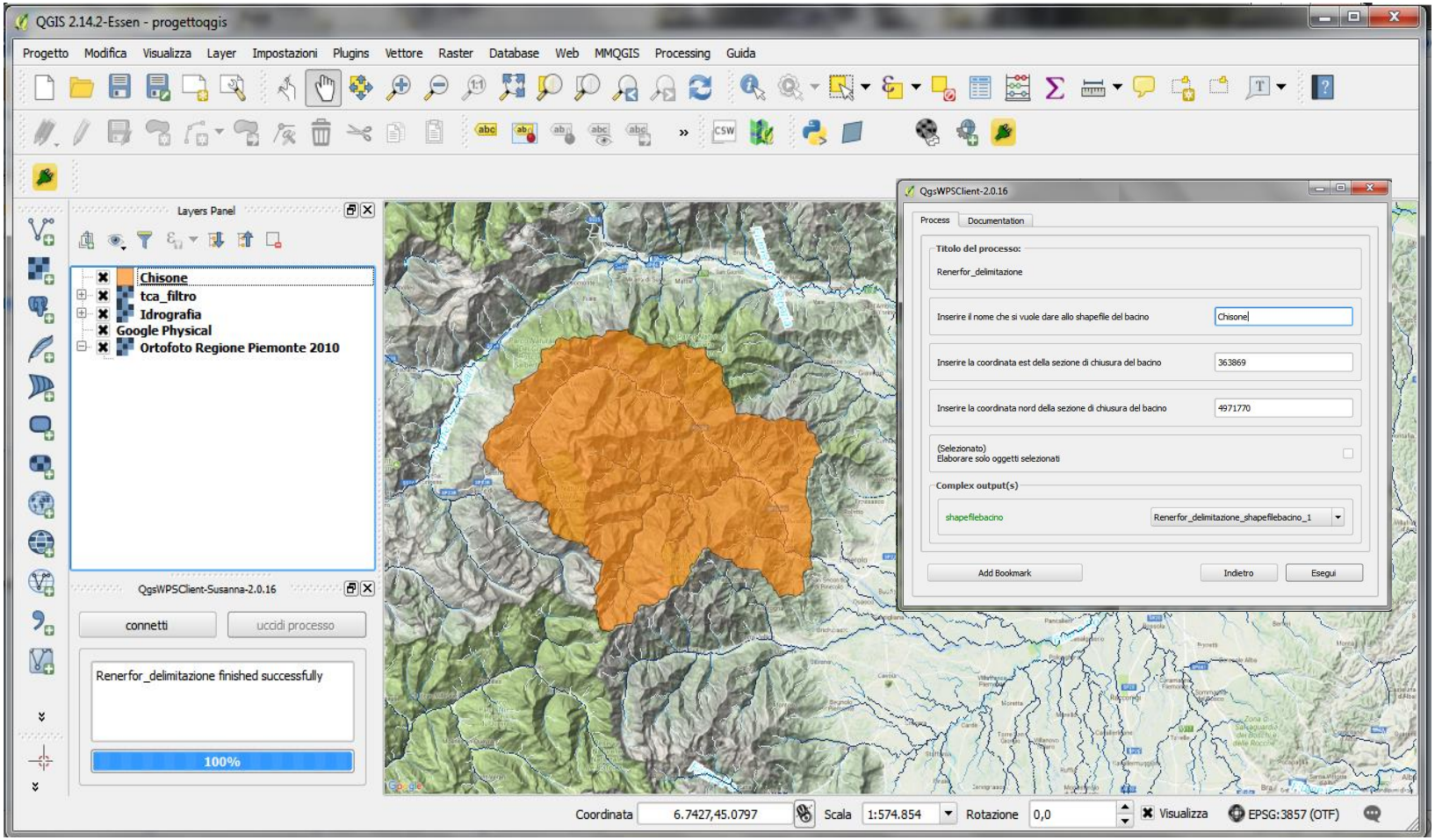
r.water.outlet

Creates watershed basins from the drainage direction map

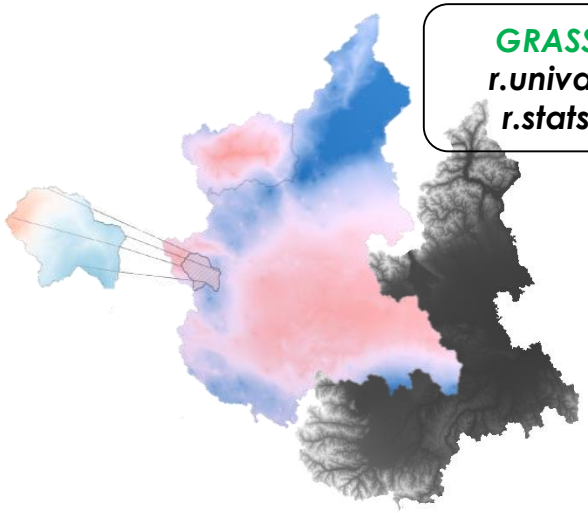
BASIN BOUNDARY DELINEATION



BASIN DESCRIPTORS EXTRACTION



ESTIMATION OF REGIONAL FDC CURVE



GRASS
r.univar
r.stats

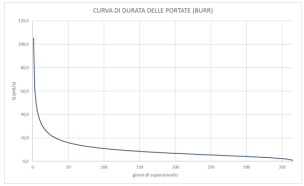
Python
Estimate regional L-moments

openpyxl

computedistributi on parameters

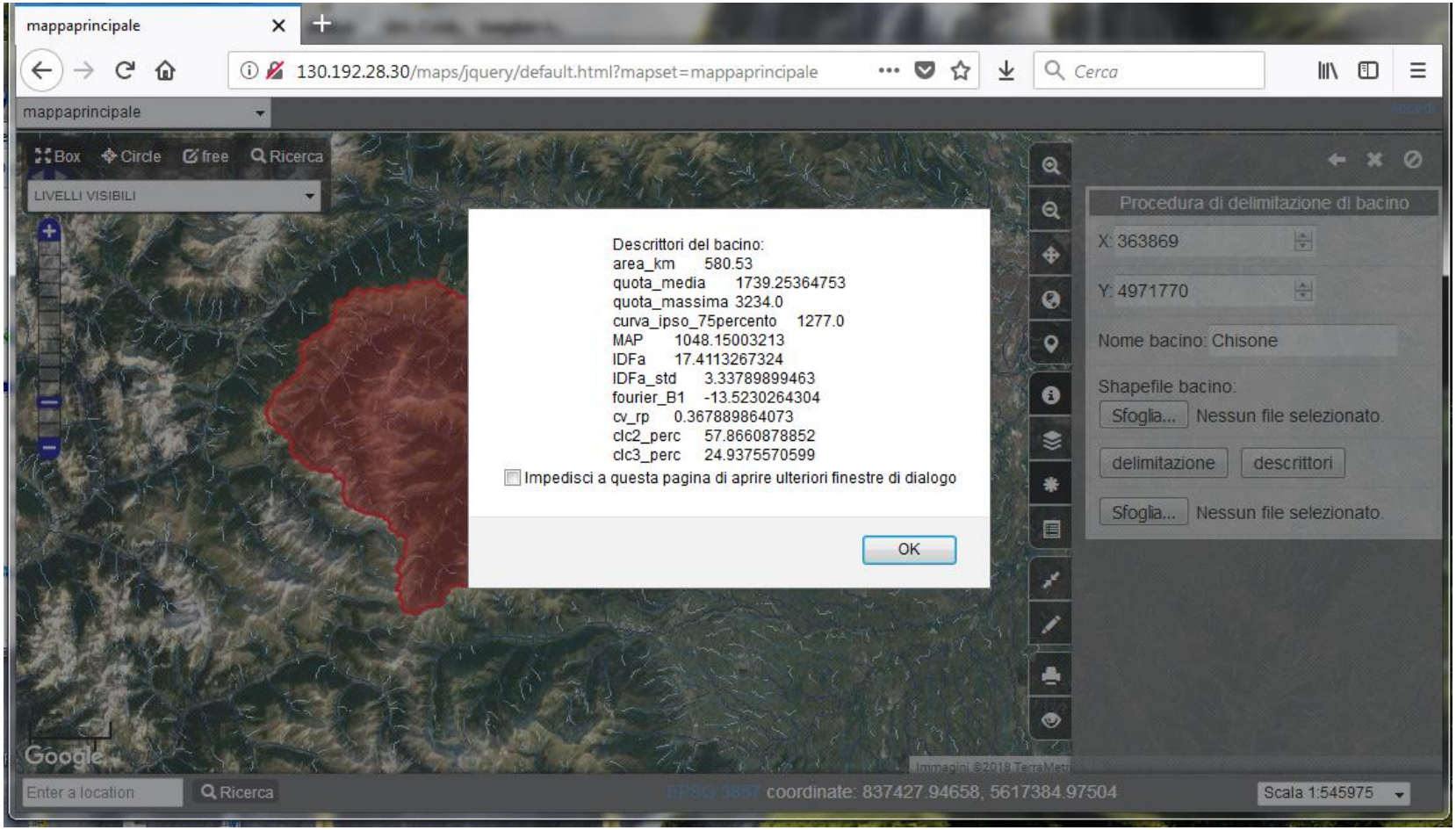
Matplotlib

Plotting FDC curve

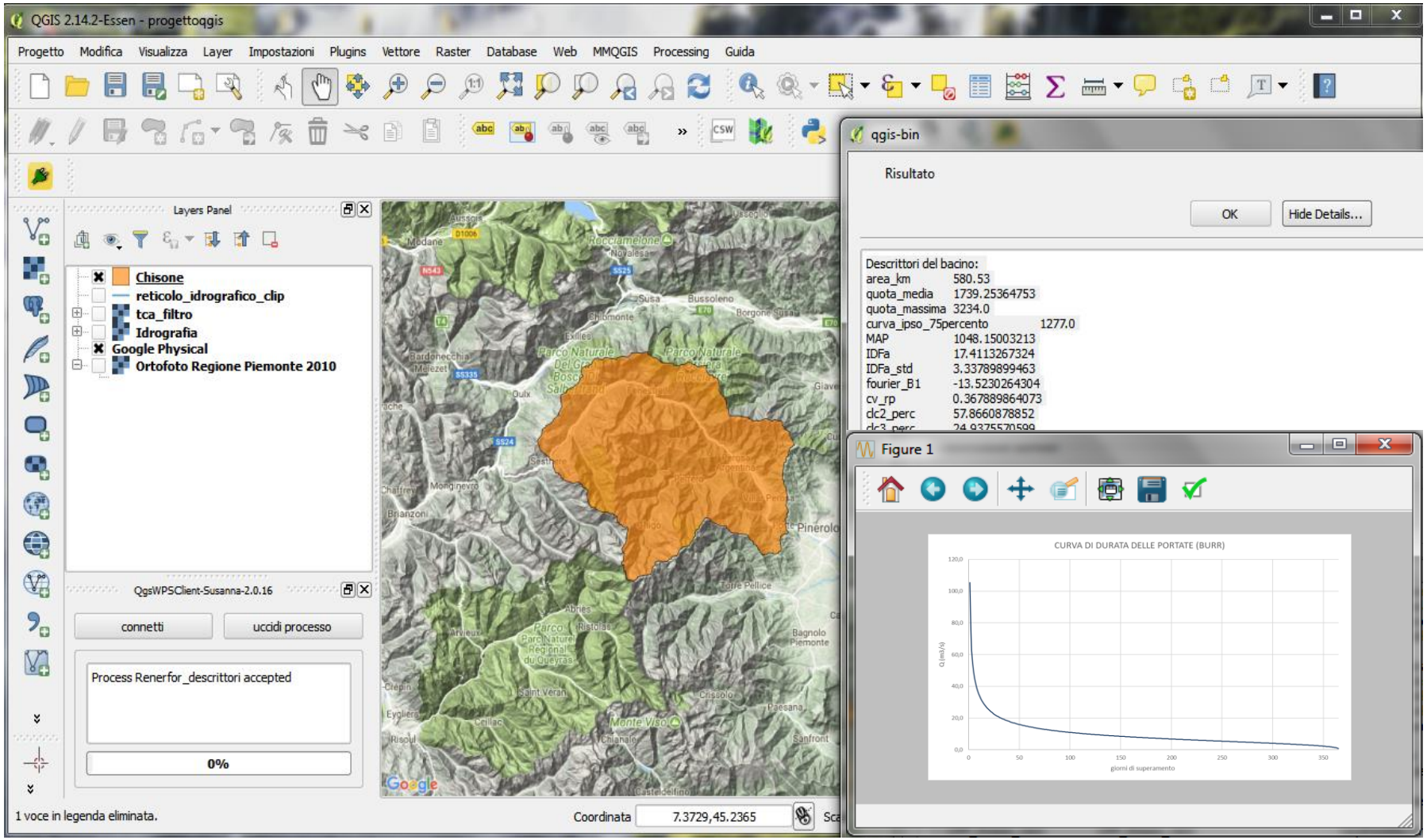


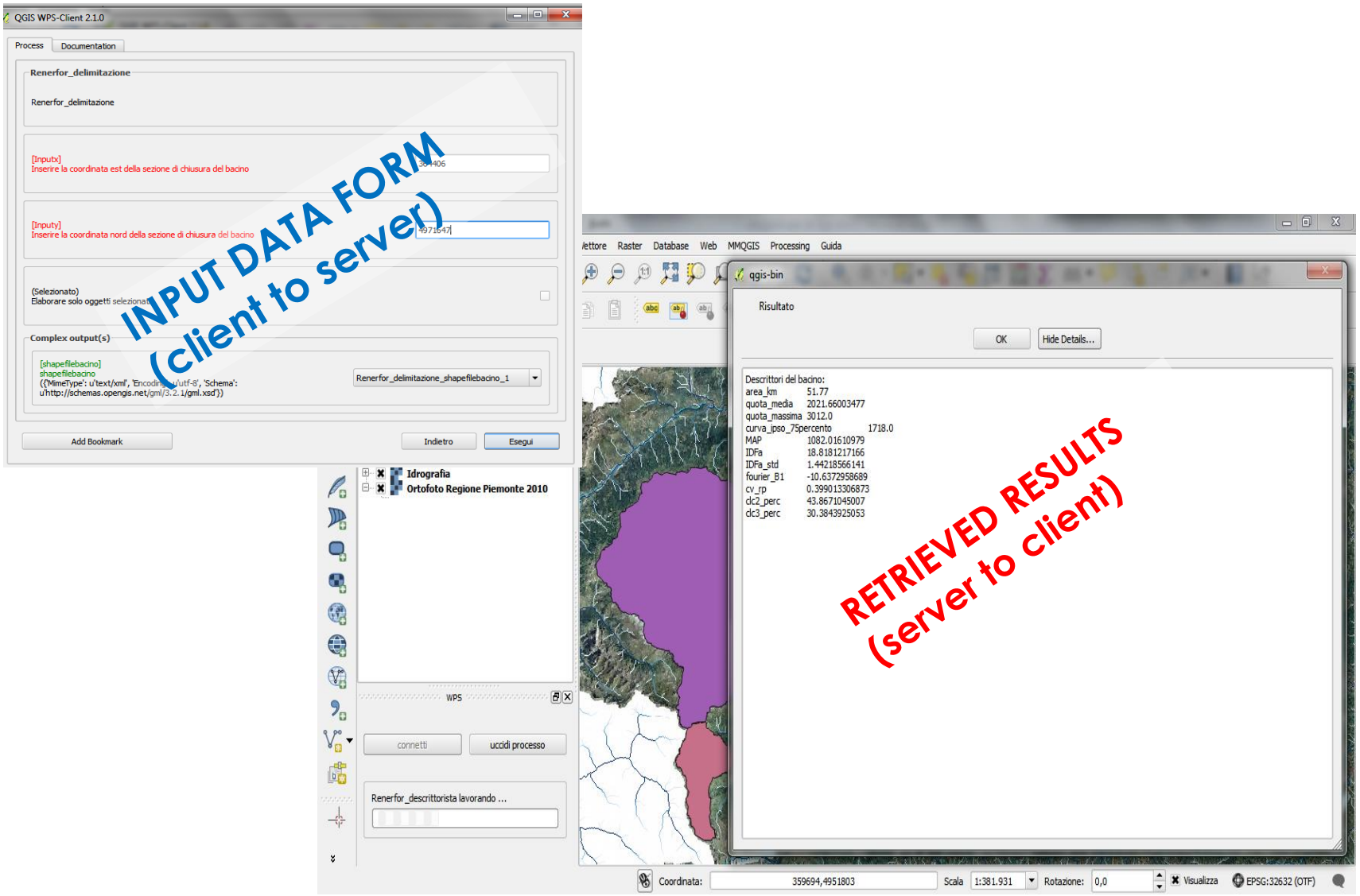
area_km	583.12
quota_media	1734.07
quota_massima	3234.0
curva_ipso_75%	1268.0
MAP	1048.45
IDFa	17.44
IDFa_std	3.37
fourier_B1	-13.635
cv_rp	0.368
clc2_perc	57.86
clc3_perc	25.01

ESTIMATION OF REGIONAL FDC CURVE



ESTIMATION OF REGIONAL FDC CURVE




QGIS WPS-Client 2.1.0
Process
Documentation
Renerfor_delimitazione
Renerfor_delimitazione
[Inputx]
Inserire la coordinata est della sezione di chiusura del bacino
[Inputy]
Inserire la coordinata nord della sezione di chiusura del bacino
(Selezionato)
Elaborare solo oggetti selezionati
Complex output(s)
[shapefilebacino]
shapefilebacino
Renerfor_delimitazione_shapefilebacino_1
Add Bookmark
Indietro
Esegui
INPUT DATA FORM
(client to server)
Idrografia
Ortofoto Regione Piemonte 2010
WPS
connetti
uccidi processo
Renerfor_descrittorista lavorando ...
qgis-bin
Risultato
OK
Hide Details...
Descrittori del bacino:
area_km 51.77
quota_media 2021.66003477
quota_massima 3012.0
curva_ipso_75percento 1718.0
MAP 1082.01610979
IDFa 18.8181217166
IDFa_std 1.44218566141
fourier_B1 -10.6372958689
cv_rp 0.399013306873
dc2_perc 43.8671045007
dc3_perc 30.3843925053
RETRIEVED RESULTS
(server to client)
Coordinata:
359694,4951803
Scala
1:381.931
Rotazione:
0,0
Visualizza
EPSG:32632 (OTF)

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Thank you for your attention

3rd International Electronic Conference on Water Sciences (ECWS-3), 15-30 November 2018

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References

Contact:
susanna.grasso@gmail.com

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