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Le opportunità non hanno confini.

HELI-DEM: integrazione dei dati di altezza transfrontalieri fra Italia e Svizzera

Helidem geoportal

Prof. M. Cannata, M. Antonovic, M. Molinari
In the name of the HELI-DEM working group

www.helidem.eu

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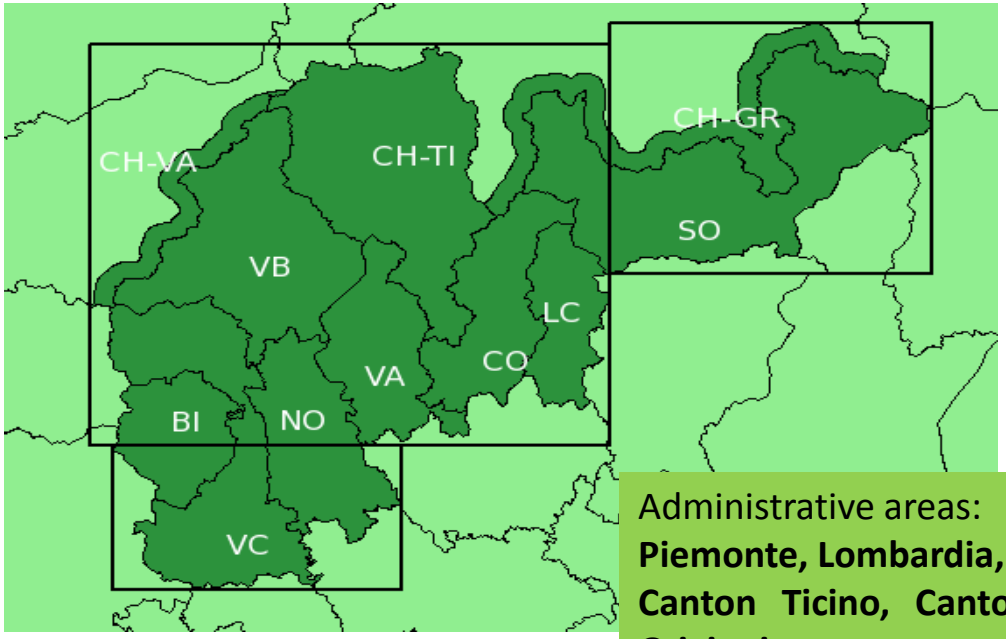
Helvetia Italy Digital Elevation Model

Capofila: Regione Lombardia

Partner: Regione Piemonte, Politecnico di Milano, Politecnico di Torino, Scuola universitaria professionale della Svizzera italiana SUPSI, Fondazione Politecnico di Milano

Project objective

Creation of a unified digital terrain model, for the Alpine and Sub-Alpine area on the border between Italy and Switzerland, correctly geo-referenced in the three dimensions



Administrative areas: **Piemonte, Lombardia, Canton Ticino, Canton Grigioni**

DTM elaboration throughout the coordination and fusion of all the available information

Project duration and WP

20 September 2010 - 19 September 2013

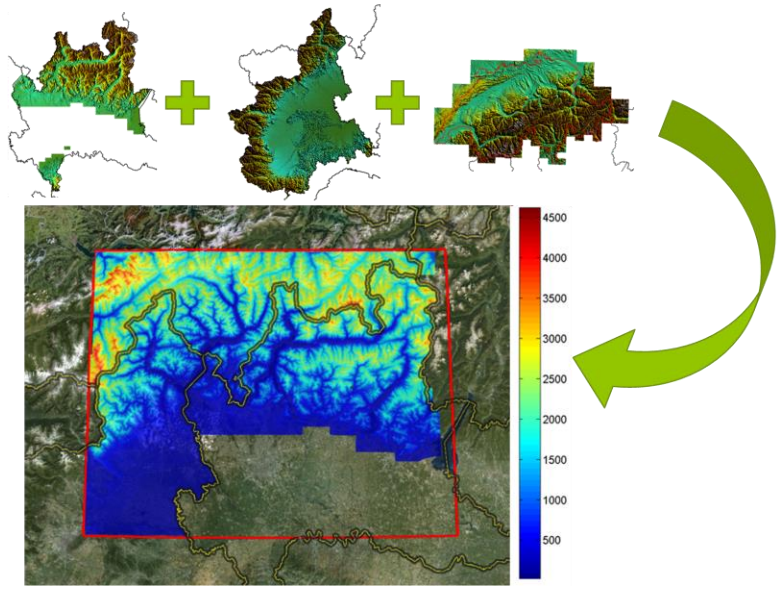
WP	Title
WP1.	Management
WP2.	Data collection and analysis of different sources (DTM & geoid)
WP3.	Verification of existing DTMs and geoids
WP4.	Experimenting cross-border GNSS networks
WP5.	Unification of height datum (geoid) between Switzerland and Italy
WP6.	External validation & geo-referencing of DEM
WP7.	Integration of validated available height data
WP8.	Experimenting of dare elaborated by the project and evaluation of the results
WP9.	Dispatch and valorisation of the research results

Data source integration

Available LR DTMs				
DTM	**Reference Frame**	**Coordinate System**	**Resolution**	**# Points**
Lombardy	Roma40 – GB	Cartographic	20 m	29'287'577
Piedmont	ETRF89 - UTM	Cartographic	5 m	607'997'593
Switzerland	ETRF89	Geographic	~25 m	19'400'361

- ✓ *Transformation* of the three DTMs to the ETRF2000 reference frame - geographic coordinates,
- ✓ Creation of the nodes of the grid for the unified DTM (φ, λ coordinates of the nodes),
- ✓ *Independent interpolation* of the three original DTMs on the unified grid nodes. Interpolation performed by *bicubic* surface:
  - parameters estimate by LS with the 32 nearest points,
  - number of points increased in case of ill conditioning,
- ✓ *Average* of the results where overlap exists,
- ✓ Correction of the DTM over the *lakes*:
  - creation of the contour of the lake,
  - to each point of the lake: a constant elevation given by the median of the original lake values.

Unified DTM				
DTM	**Reference Frame**	**Coordinate System**	**Resolution**	**# Points**
One regional LR unified DTM	ETRF2000	Geographic	$\varphi = 2*10^{-4}$°, ~22 m $\lambda = 2*10^{-4}$°, ~15 m	~ 116'000'000



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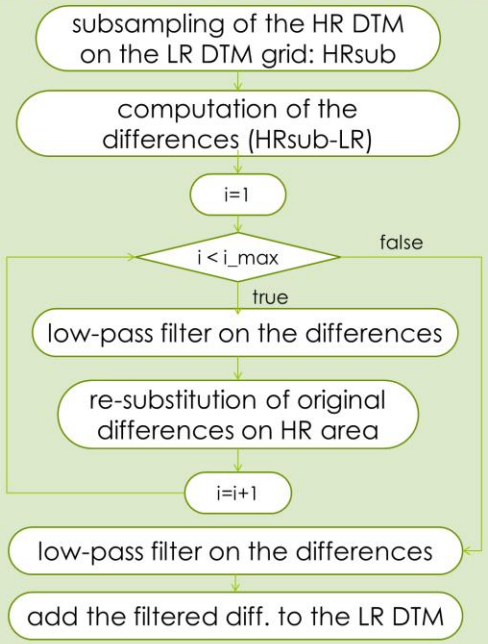
Correction of DTM with LiDAR HR DTM (Italy only)

A LiDAR HR DTM covering some hydrographic basins of Lombardy and Piedmont, with planimetric resolution of $1*10^{-5}$ ° (~1m) is available and can be used to correct the LR unified DTM.

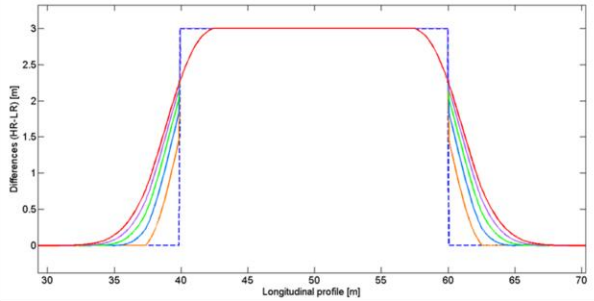
How to avoid sharp discontinuities at the HR-LR transition?

Iterative low-pass filter on the differences



Re-substitution of the original differences every step allows to work preferably on the less accurate LR DTM.

Simulated example: (Butterworth) filter on a bias

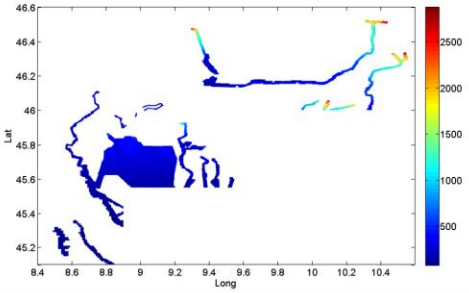


original differences (HR-LR)
(iter. 1) filter and re-substitution
(iter. 2) filter and re-substituion
(iter. 3) filter and re-substitution
(iter. 4) filter and re-substitution
(iter. 5) filter only

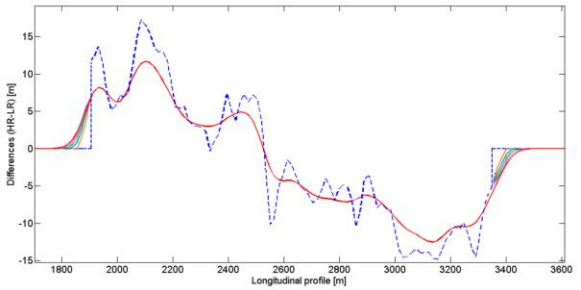
Iterative filter on re-substituted differences → best smoothing effect at the border

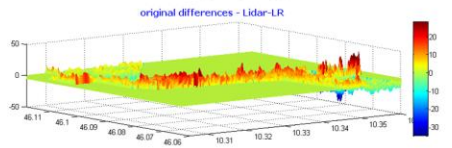
Final filter on all the differences → slight smoothing of HR data to obtain homogeneously rough DTMs

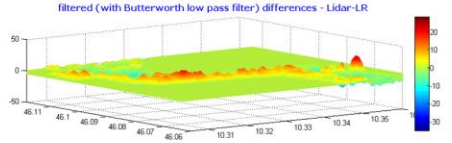
Subsampled LiDAR HR DTM



One case study: Oglio river profile







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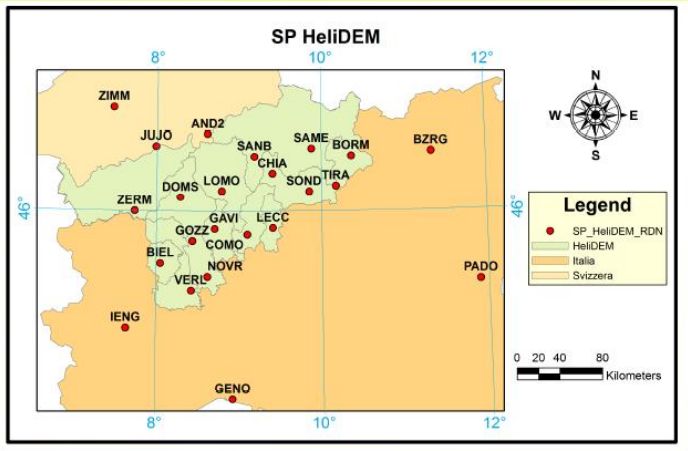
Cross-border GNSS network

1. GNSS cross-border network



Establishment of a GNSS cross-border network for:

DTM validation

Both static and NRTK survey on points that can be easily found on a DTM

Experimentation of a possible future service

NRTK positioning with fixed ambiguity phase at different heights

2. CORSs network validation (NRTK positioning)

Single epoch kinematic positioning:

- ✓Session length of about 40' with fixed ambiguity phase
- ✓Compared with static post-processed solution obtained in a multi-base mode with a commercial software

Station	Height [m]	μ_{2D}	μ_h	σ_{2D}	σ_h
Varallo	485	0.012	-0.081	0.006	0.015
Alagna	1200	0.013	-0.055	0.007	0.019
Pianalunga	2050	0.017	-0.009	0.011	0.029
Indren	3260	0.005	0.000	0.009	0.024

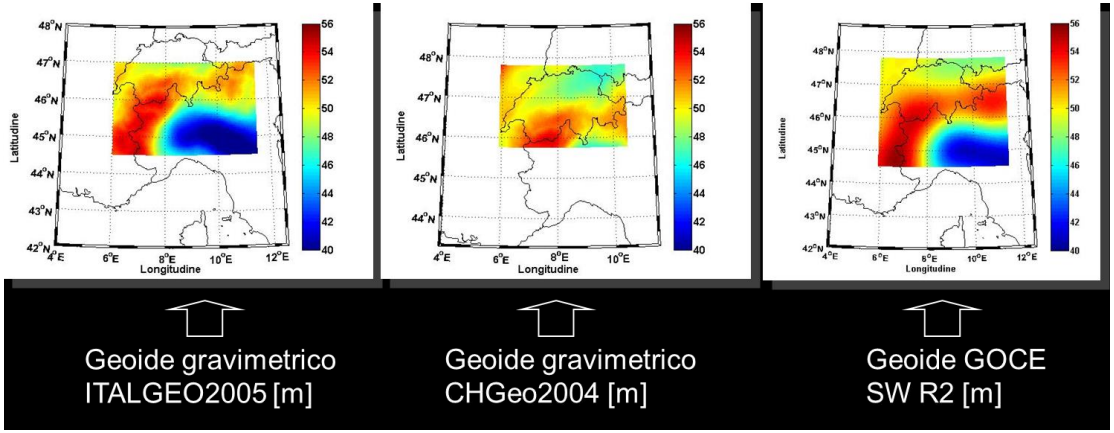
Good performances of the HELIDEM network even at high altitudes

↳ Punta Indren (3260 m)

Positioning with relatively lower quality at lower altitudes

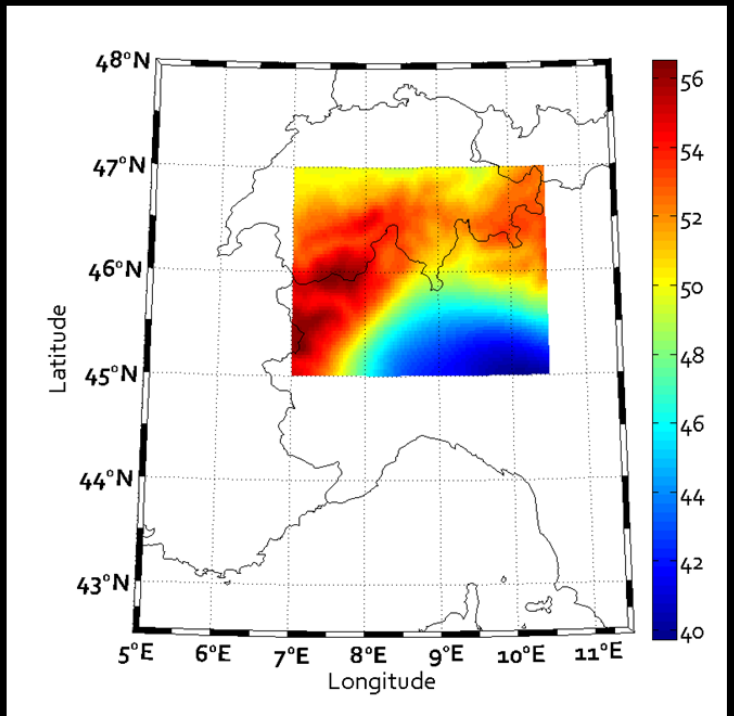
↳ Increase the density of CORSs stations in areas with extreme changes of altitude

Geoid

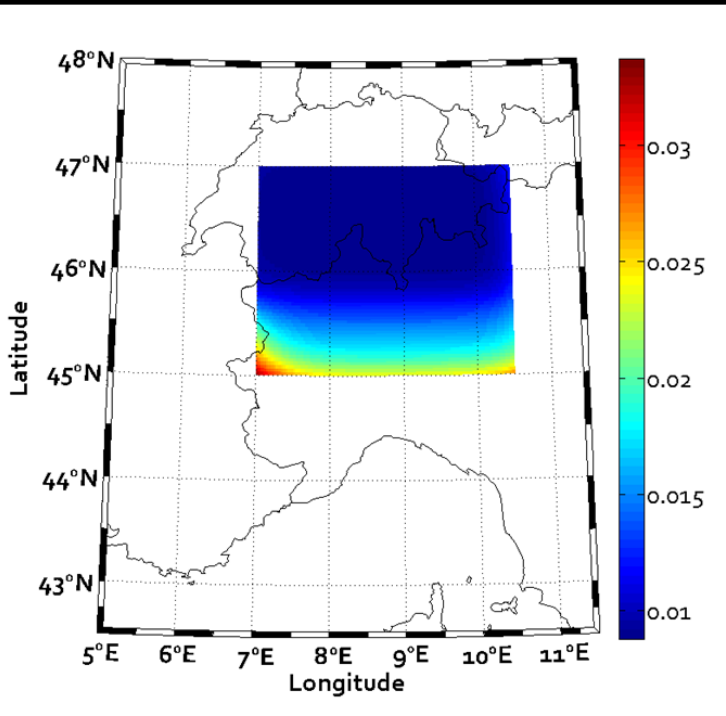


EGU: A least-squares colloCATION procedure to merge local geoids with the aid of satellite-only gravity models: the italian/swiss geoids case study

Estimated merged geoid



Estimated variance



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Istituto Scienze della Terra (Institute of Earth Science)

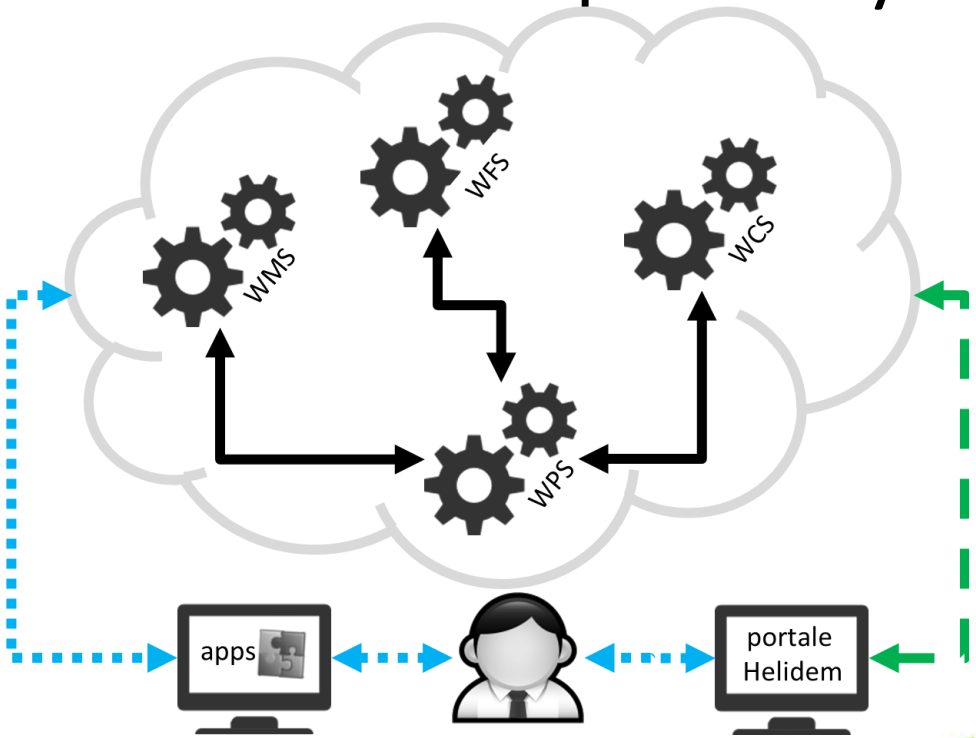
Geoportal Objective

- Disseminate the HELI-DEM results by means of a geospatial portal capable to offer some of the most common operations applied to DTMs.

Architecture

The portal implement a distributed architecture based on Web services and OGC interoperability standards.

- Web Map Service
- Web Feature Service
- Web Coverage Service
- Web Processing Service



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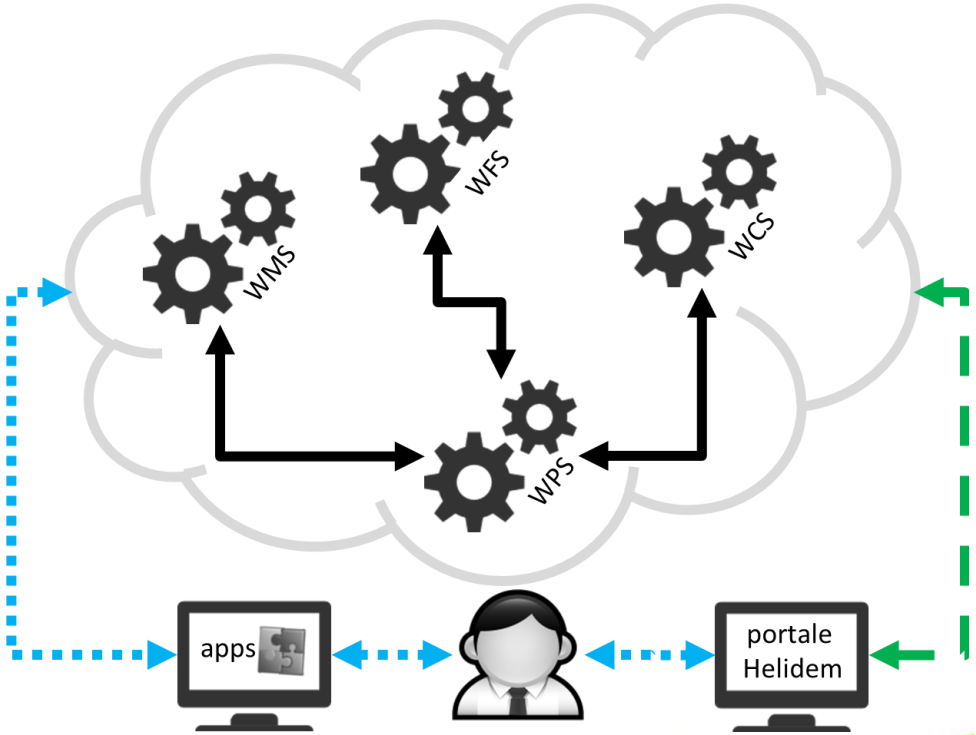
Raster data access

WCS: defines rules and logic for raster data access

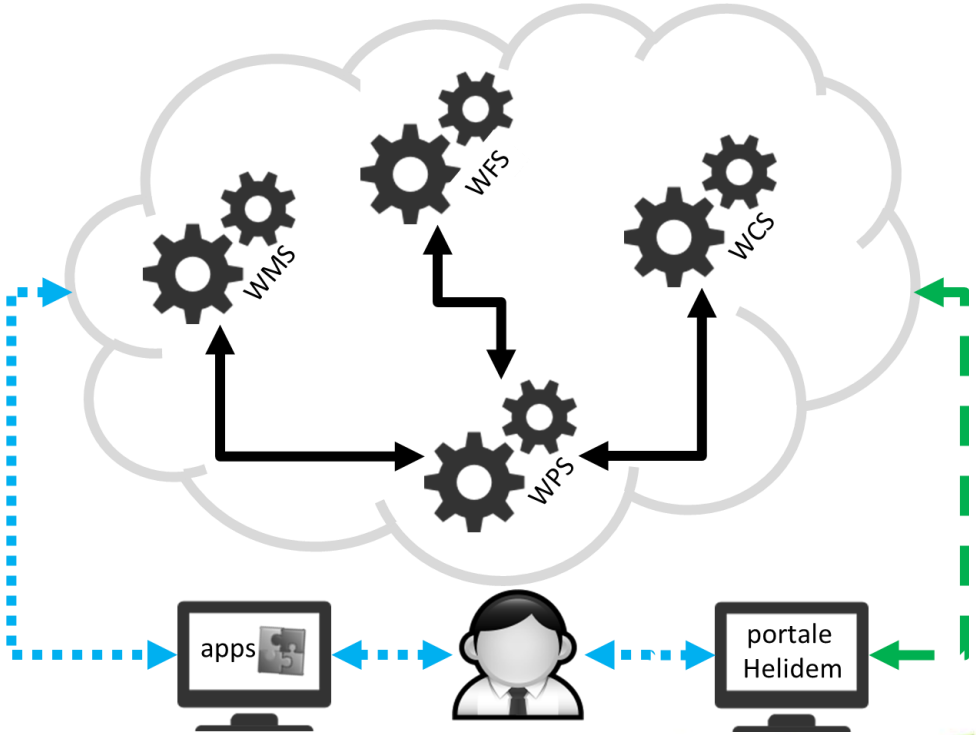
- Get Capabilities
- DescribeCoverage
- GetCoverage



Processing

WPS: defines the rules to access pre-programming elaborations and/or models that applies to geospatial data.

- Get Capabilities
- DescribeProcess
- Execute



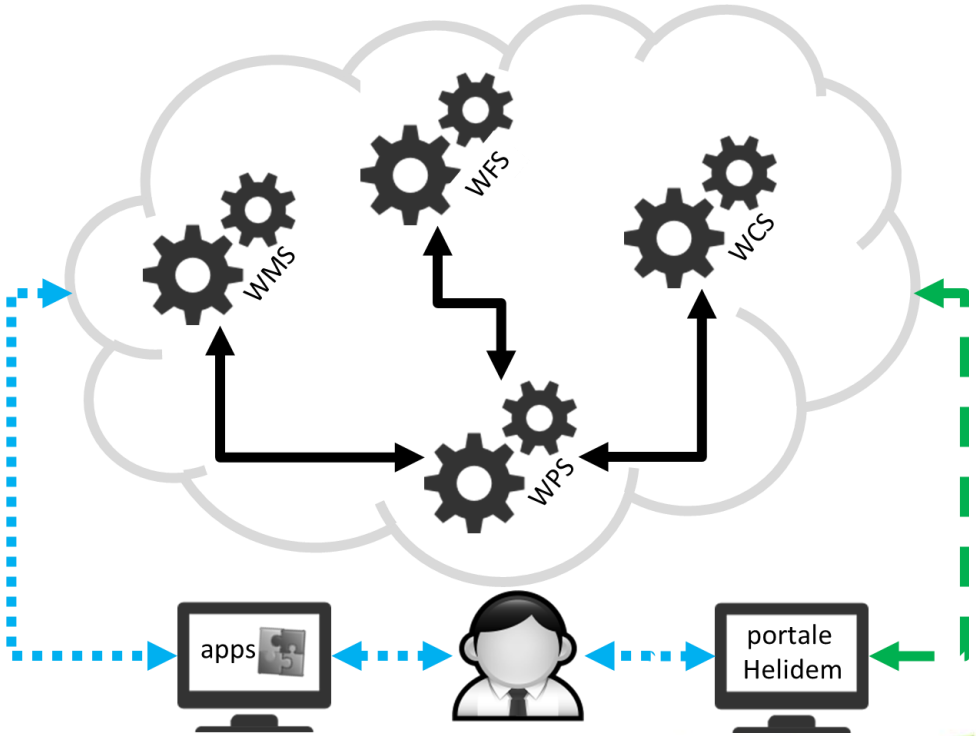
Results dissemination

WFS/WMS: define rules to access vector data and raster images

- Get Capabilities
- DescribeFeatureType
- GetFeature
- LockFeature
- Transaction

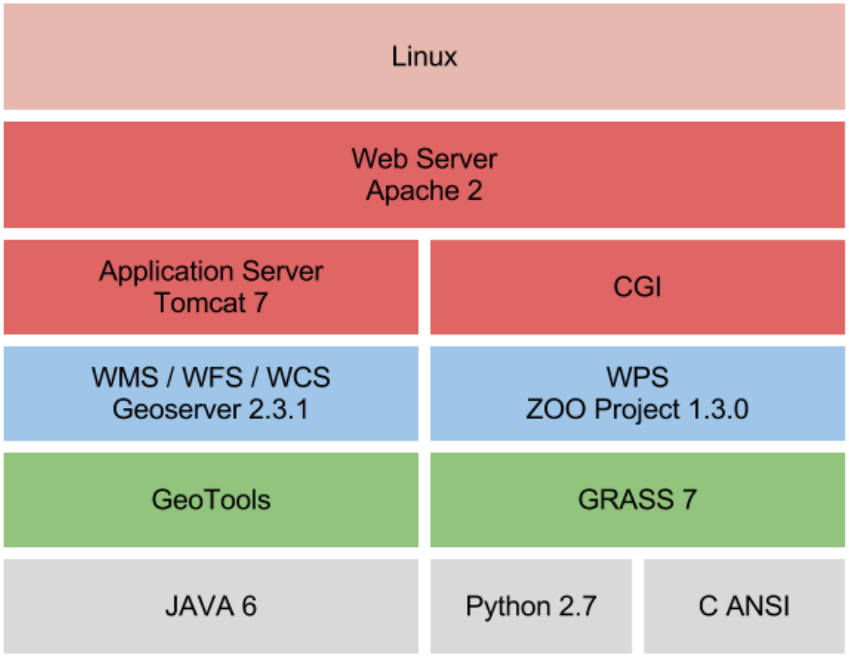
- GetPropertyValue
- GetFeatureWithLock
- CreateStoredQuery
- DropStoredQuery
- ListStoredQueries
- DescribeStoredQueries

WFS 2.0.0 only

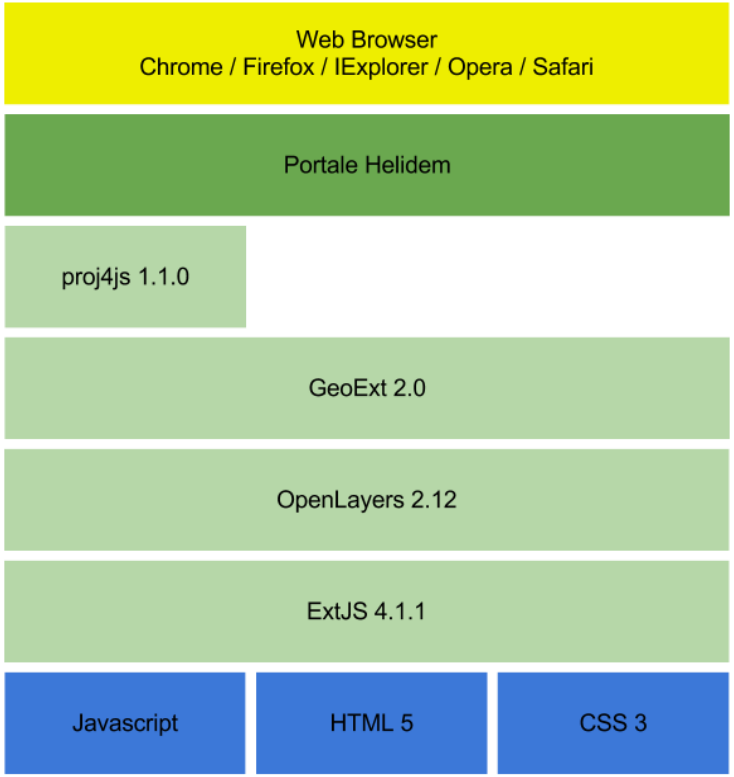


Software e languages

- Server side



- Client side



Processing capabilities

- Contours lines extraction at defined heights or interval
- Profile extraction on polyline
- Delineation and hydro-morphological characterization of basins
- Calculation of DTM derivatives (slope, aspects, curvatures, etc.)
- DTM extraction of selected area
- Coordinate conversion of features (general precisions provided by EPSG parameters)

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For further information:
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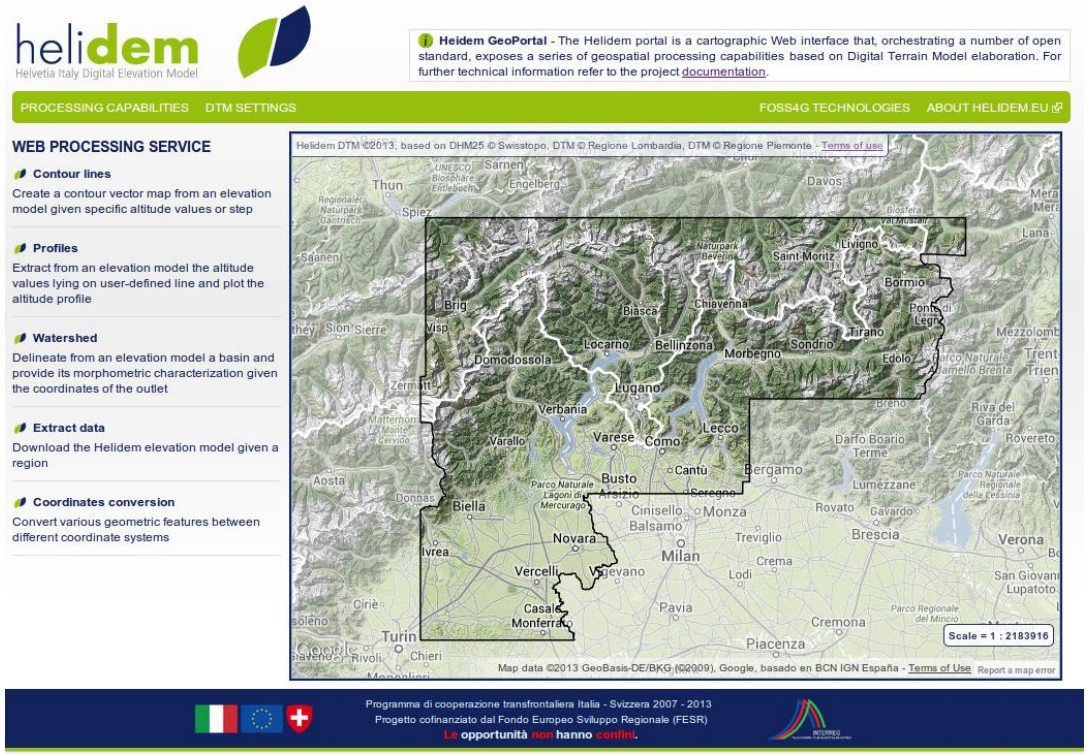

http://geoservice.ist.supsi.ch/helidem