Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

First evaluations on Hydrogeological Water Budget to identifying aquifer recharge area in the ET infrastructure site

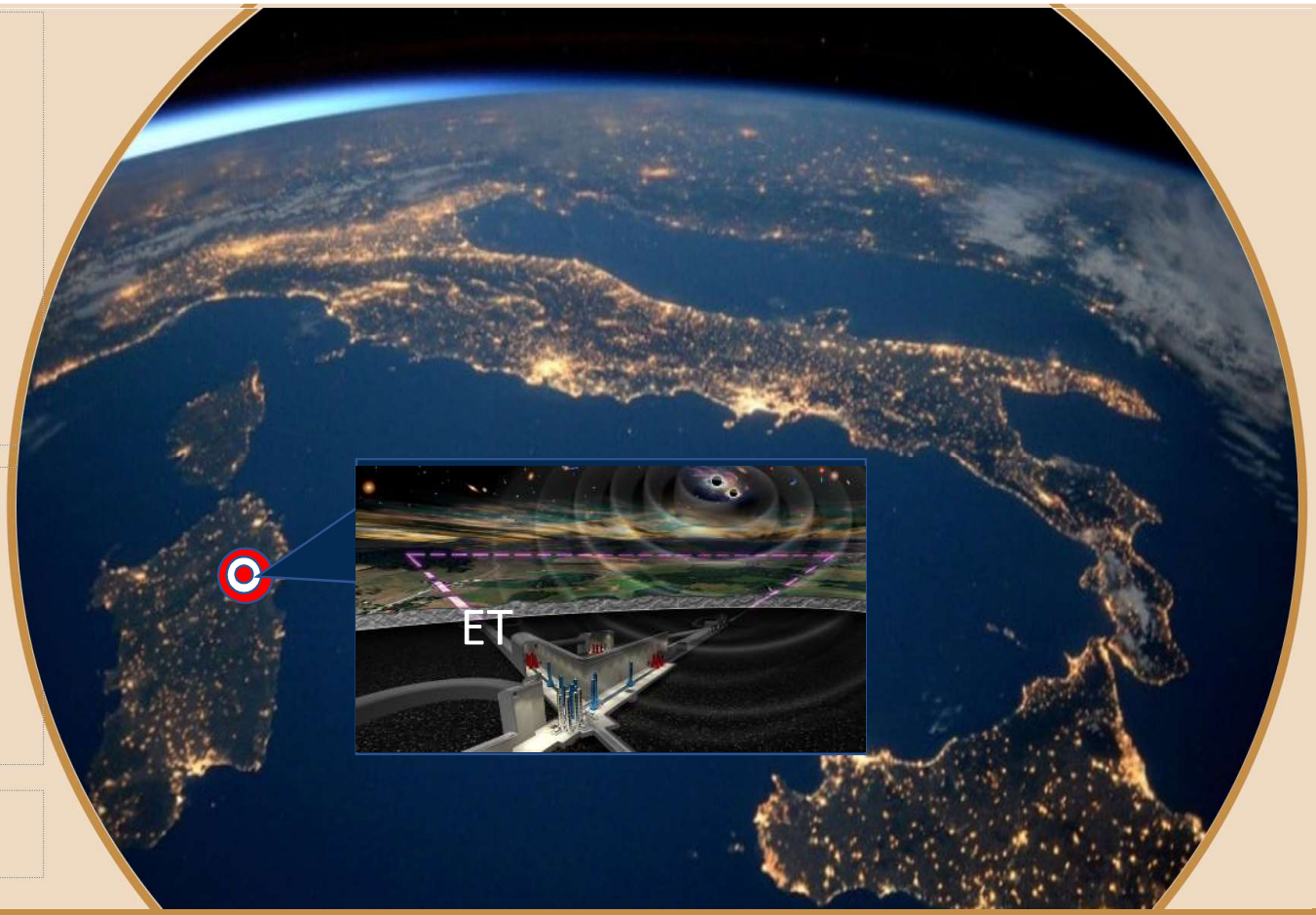
Flavia Ferranti Giuseppe Sappa

Department of Civil, Building and Environmental Engineering (DICEA)

Sapienza - University of Rome

flavia.ferranti@uniroma1.it

giuseppe.sappa@uniroma1.it



ET: Scienza e Tecnologia in Italia

Assisi 20-23 February 2024

ET ITALY Einstein Telescope

WP6.6 Hydrogeological modelling

- Hydrogeological model set up to identify:
  - shallow, suspended and deep groundwater lenses or aquifers
  - groundwater hydrogeochemical facies and rock-water interactions
  - groundwater flowpaths
- Characterization of excavation sludge
- Support for the design of hydraulic works for the disposal of groundwater
- Analysis of areas of slope instability

Future Activity Plan for the Preliminary Site Condition Assessment

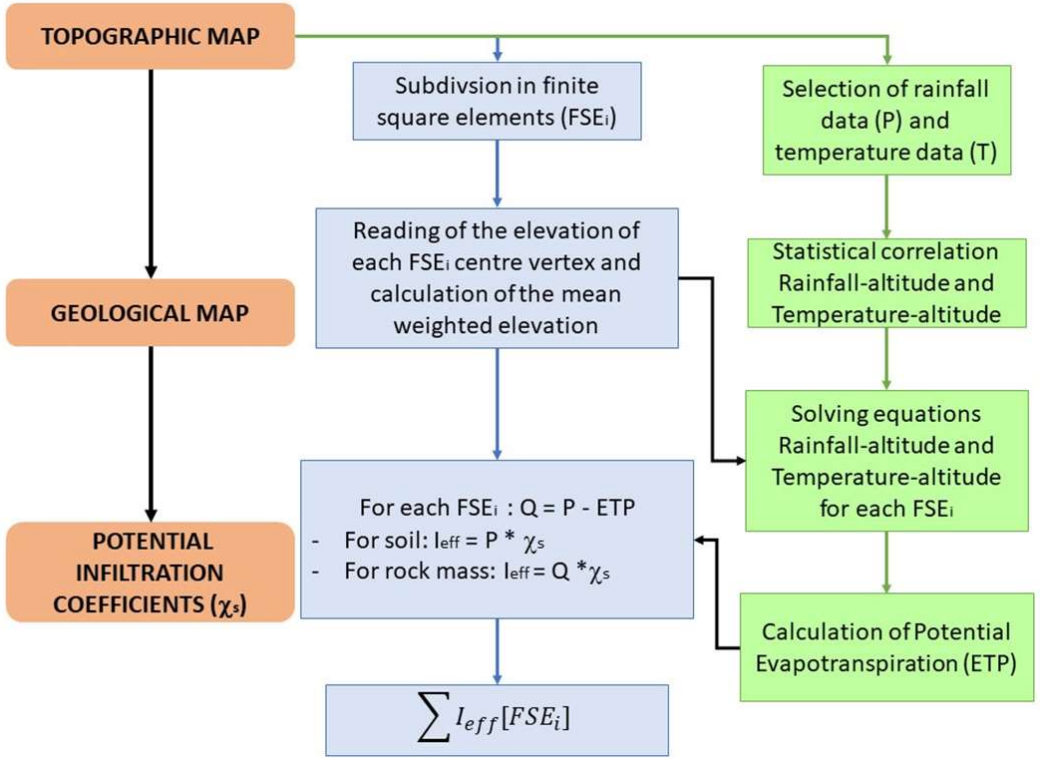
- Electromagnetics surveys for the development of a hydrogeological model
- n. 20 geognostic surveys for a development of 5000 m of drilling of which at least 3000 m performed with continuous core drilling using wireline
- installation of n.10 piezometers for a total of 2500 m of pipes installed
- n.4 Lugeon permeability tests in each survey point for a total of n. 80 tests

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

Potential Recharge Estimation of the ET site using the Inverse Hydrogeological Water Budget

The Inverse Hydrogeological Water Budget (*Sappa et al., 2023*[*]) is a distributed parameter method, which allows estimating the infiltration rate within a study area, taking into account a series of climatic parameters, such as:

- rainfall
- temperature
- elevation
- outcropping geology
- permeability characteristics of the soil



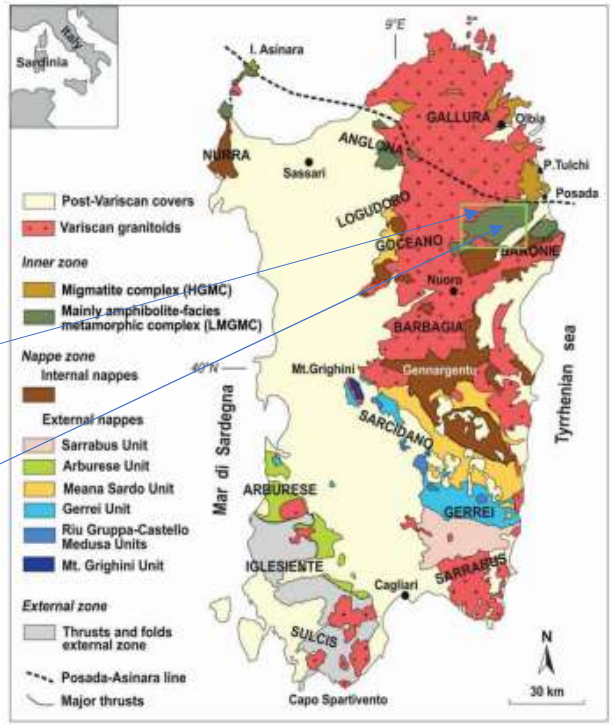
Flow-chart of the Inverse Hydrogeological Water Balance

[*]G. Sappa, S. Vitale, F. Ferranti, M. Barbieri (2023). Limpopo National Park (Mozambico): groundwater assessment as a tool for a sustainable management of the area, Environmental Earth SciencesVolume 82, Issue 20

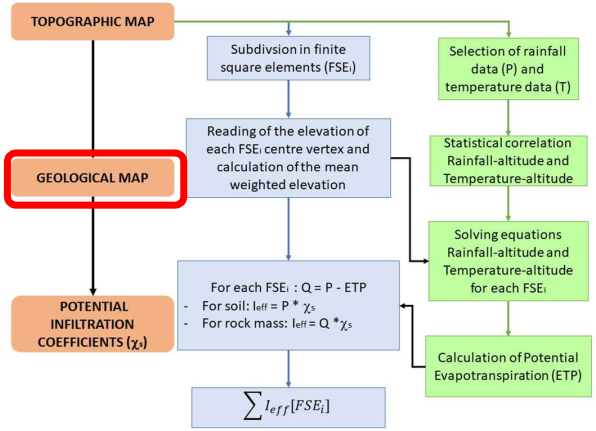
The ET site geological features

The ET site is located in the Variscan basement of Sardinia because of its geodynamic quietness, very low natural seismicity as well anthropogenic seismic noise

- **Intrusive complex**
  Granodiorite and monzogranites
- **Methamorfic basement**
  Orthogneiss
  Phyllites, micaschist and paragneiss



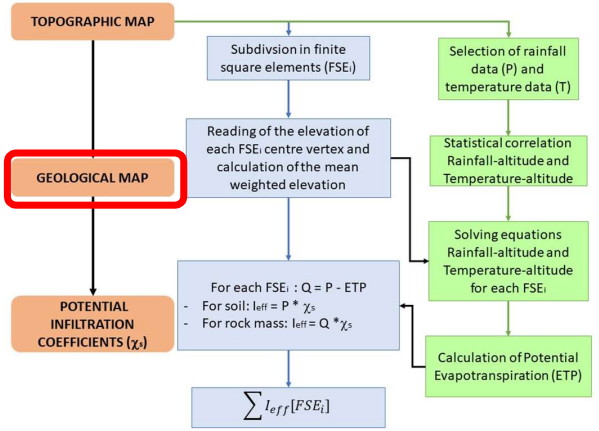
Geological map of the Sardinia region (Cardello & Oggiano, 2021)

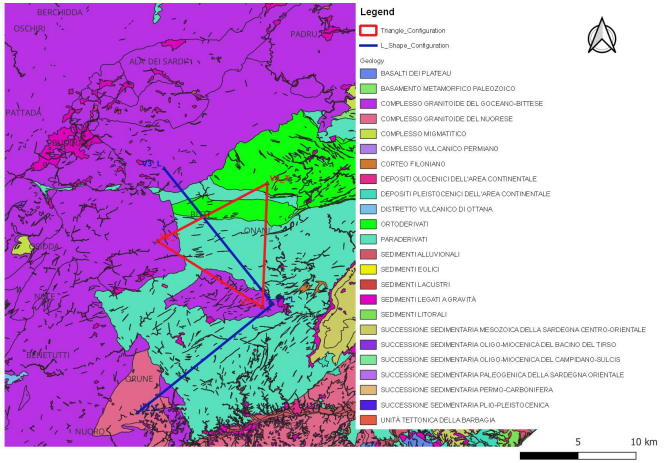


[1] Credits to L. Cardello

The ET site geological features

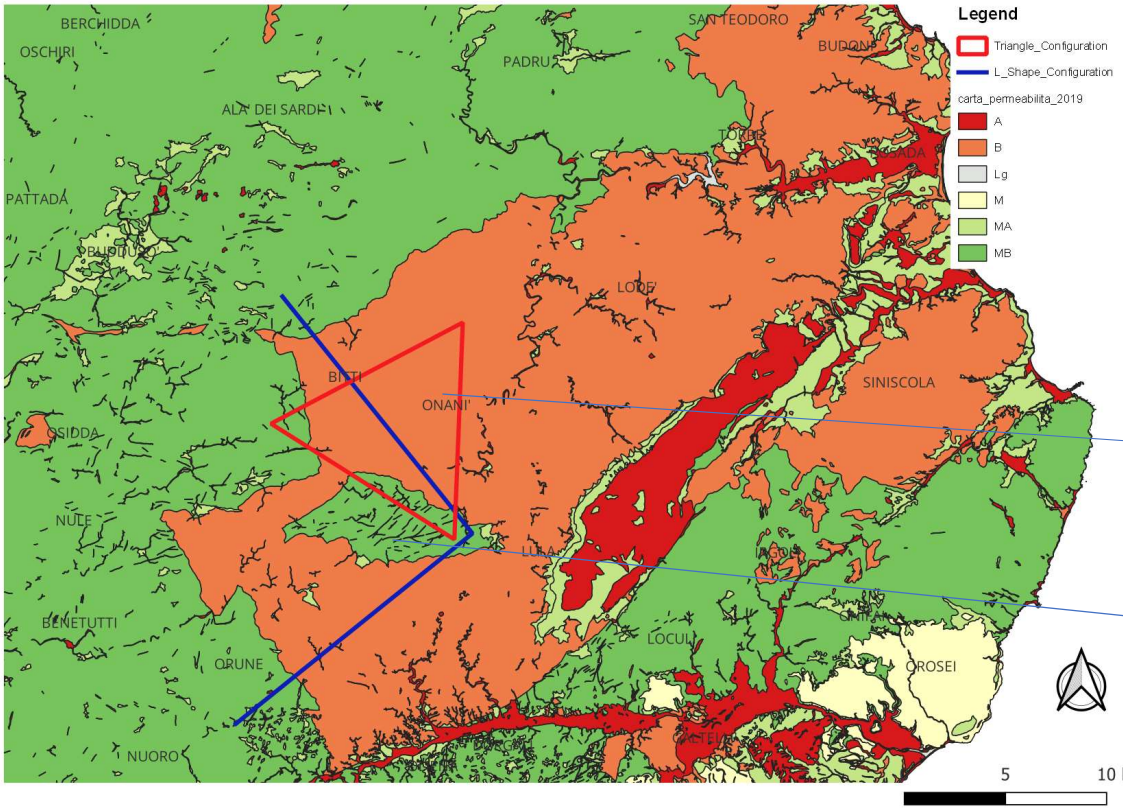
- Bitti granodiorites: granites and biotite orthogneiss (VT1-VT2-VL1-VL3)
- Nuoro granodiorites: post-ercinic granites, medium-grained biotite granites (VL2)
- Mamone orthogneiss: granodiorite orthogneiss, with gray or reddish-grey colouration, and leucocrate orthogneiss with granitic composition (VT3)

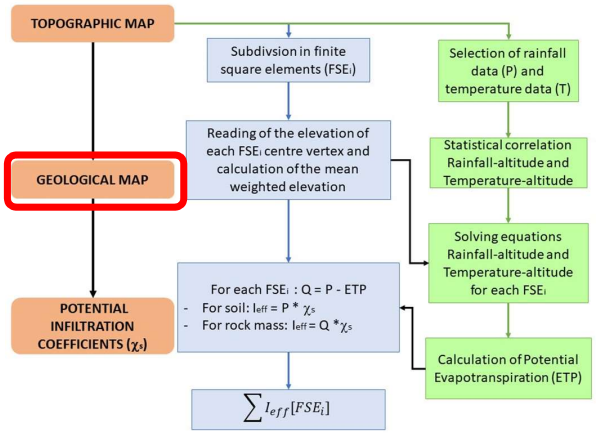




Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

The ET site permeability map*





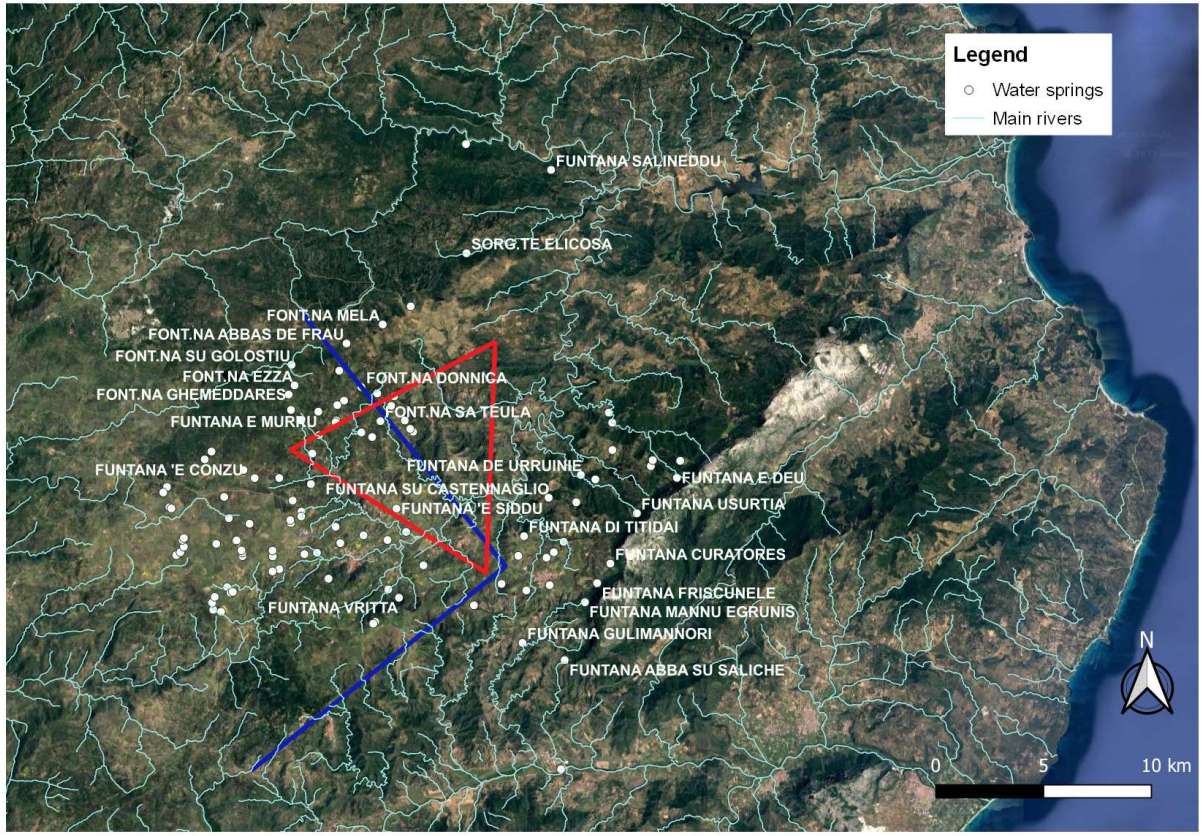
Low permeability for fracturing

Medium-Low permeability for fracturing

*SardegnaGeoportale

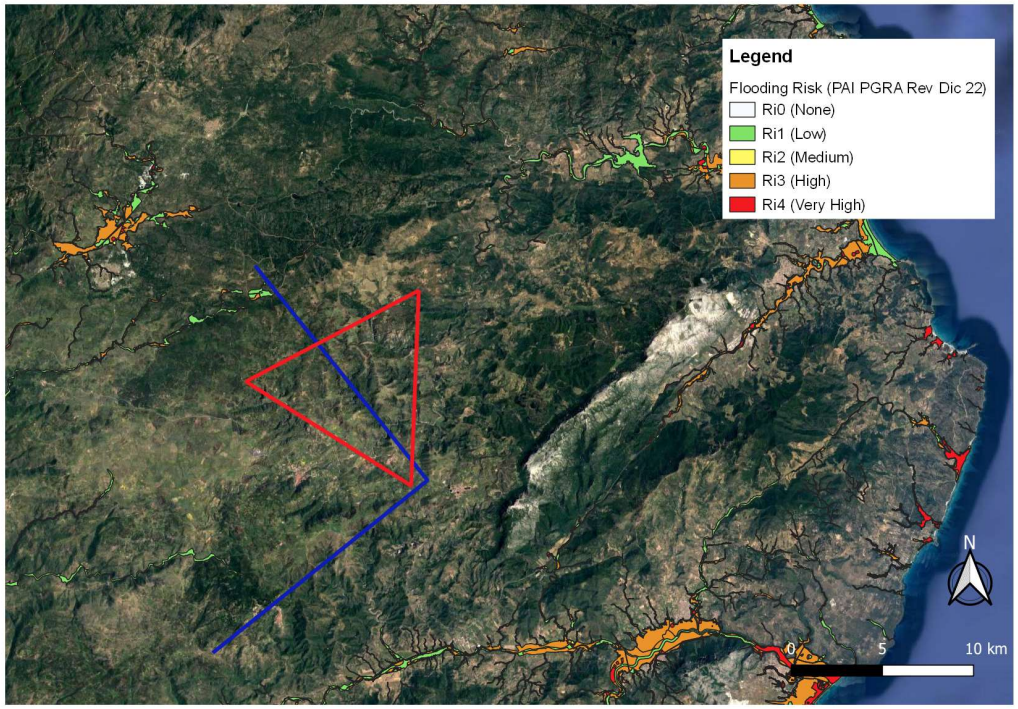
Local hydrology

- Identification and location of the main groundwater springs respect to the ET triangle and L shape configuration

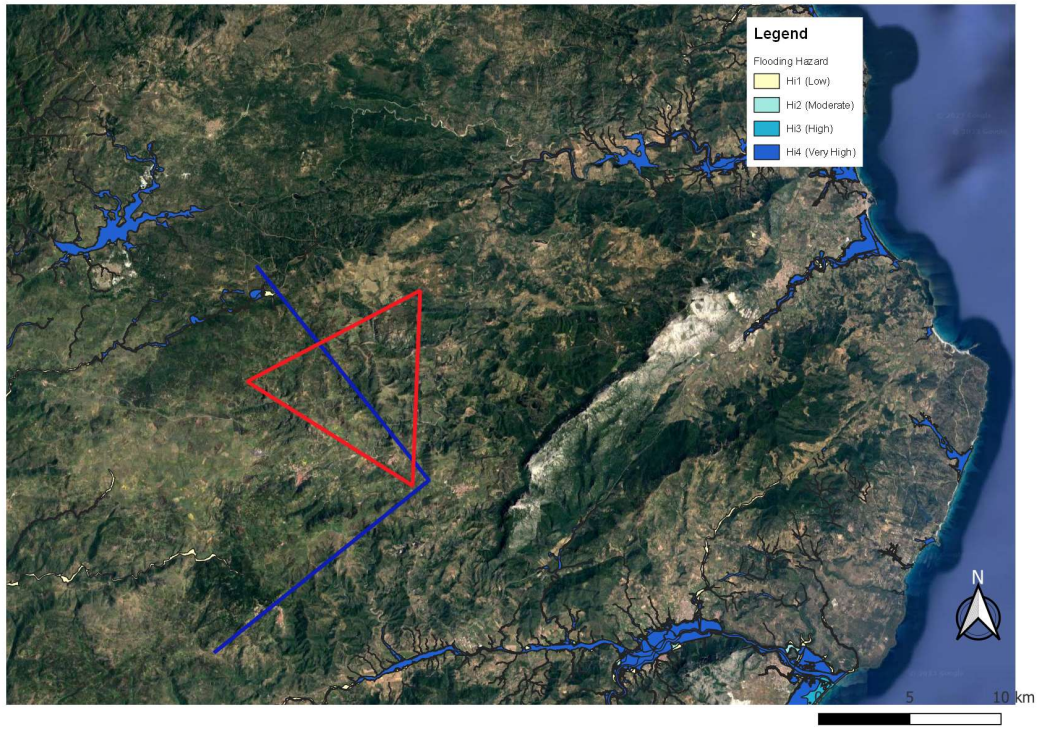


Finanziato dall'Unione europea
NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

Flooding risk



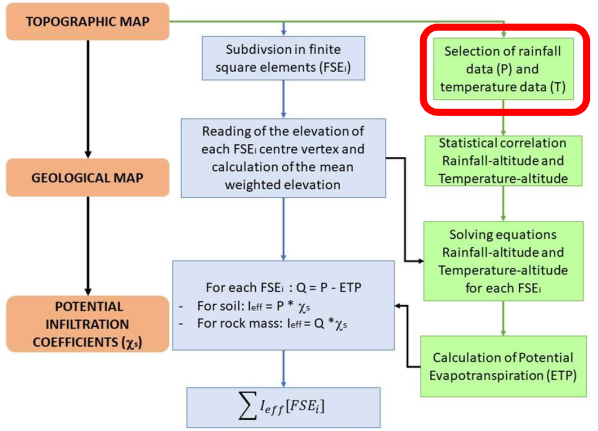
Flooding hazard



PAI - Piano Stralcio per l'Assetto Idrogeologico (P.A.I.), redatto ai sensi della legge n. 183/1989 e del decreto-legge n. 180/1998, e approvato con decreto del Presidente della Regione Sardegna n. 67 del 10/07/2006.

The Rainfall and Temperature data

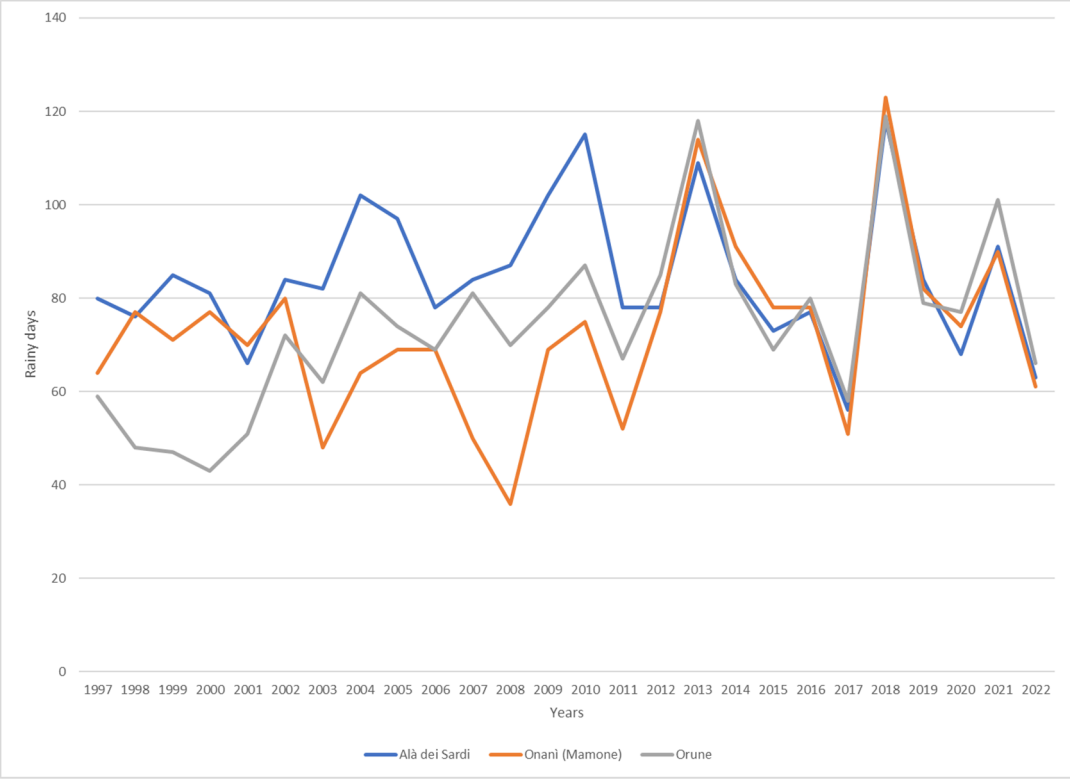
They have been considered, on the first, the existing meteorological station network in the surroundings of the study area.

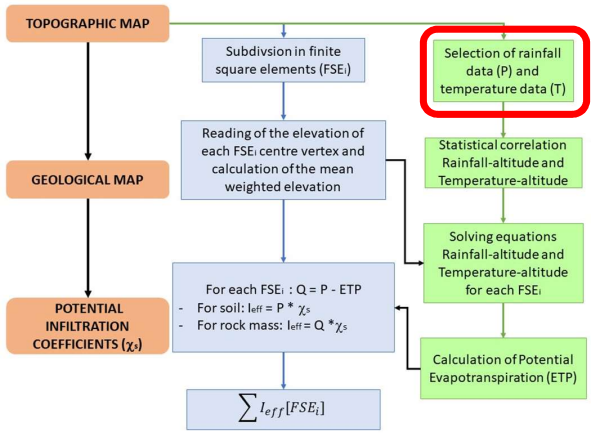


ID	Metereological staion	E	N	Altitude(m a.s.l.)	Province
1	Alà dei Sardi	527431	4499493	665	OT
2	Onanì (Mamone)	535739	4491173	868	NU
3	Orune	530002	4473540	870	NU

25-year historical series (1997-2022) of rainfall and temperature data are considered

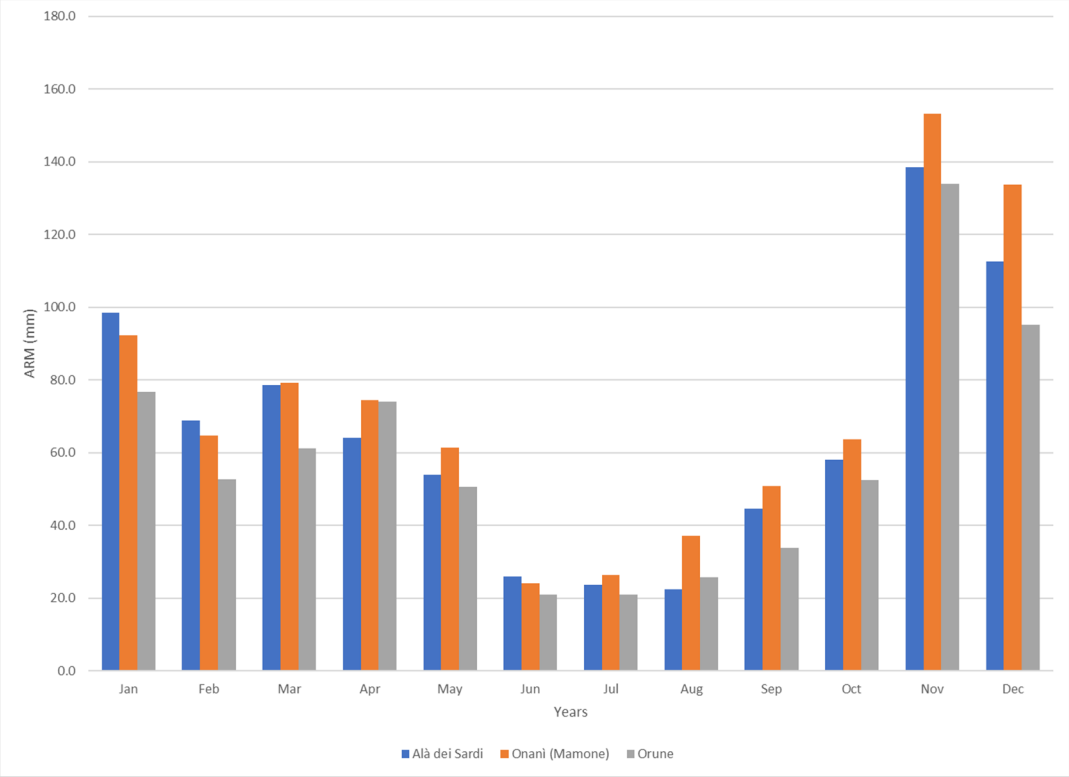
Rainfall days distribution

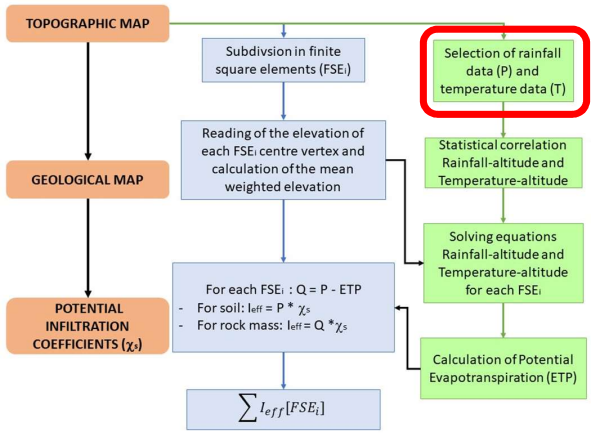




25-year historical series (1997-2022) of rainfall and temperature data are considered

Rainfall distribution

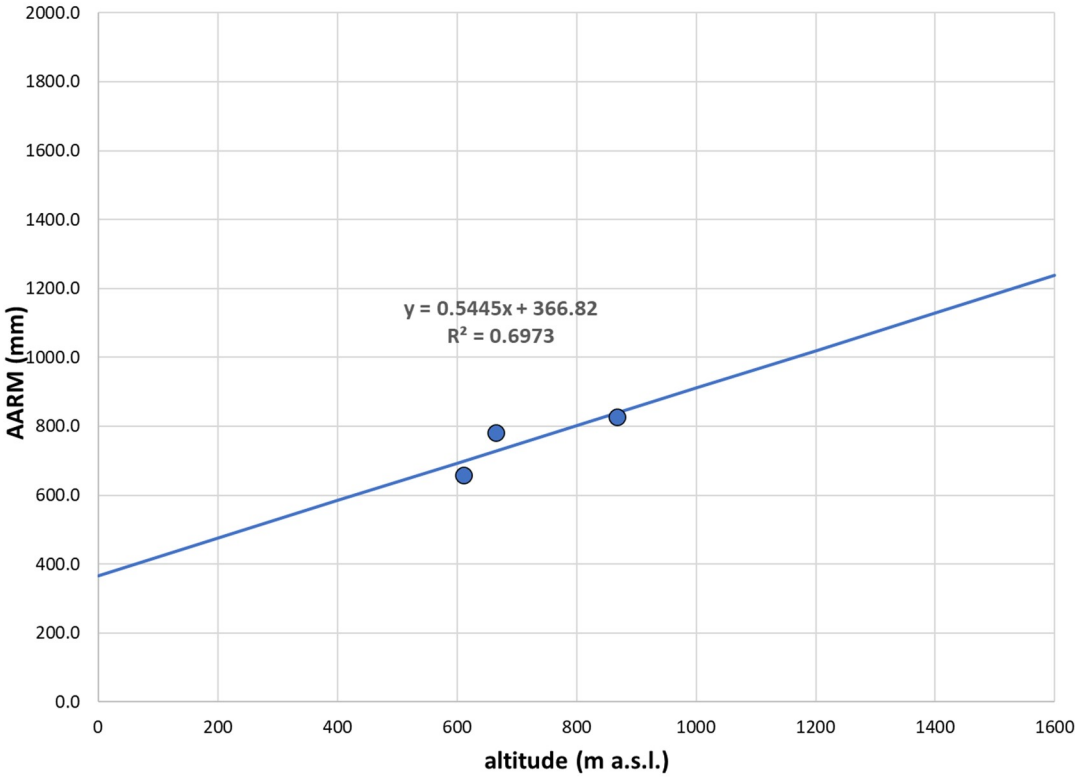


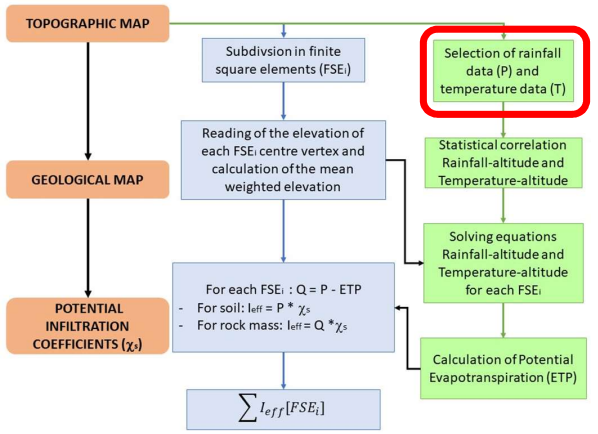


ID	Metereological staion	AARM (mm)
1	Alà dei Sardi	472.3
2	Onanì (Mamone)	512.0
3	Orune	412.0

Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN

The rainfall-altitude relationship





Rainfall = f (altitude)
→ AARM = f (altitude)

Finanziato dall'Unione europea
NextGenerationEU

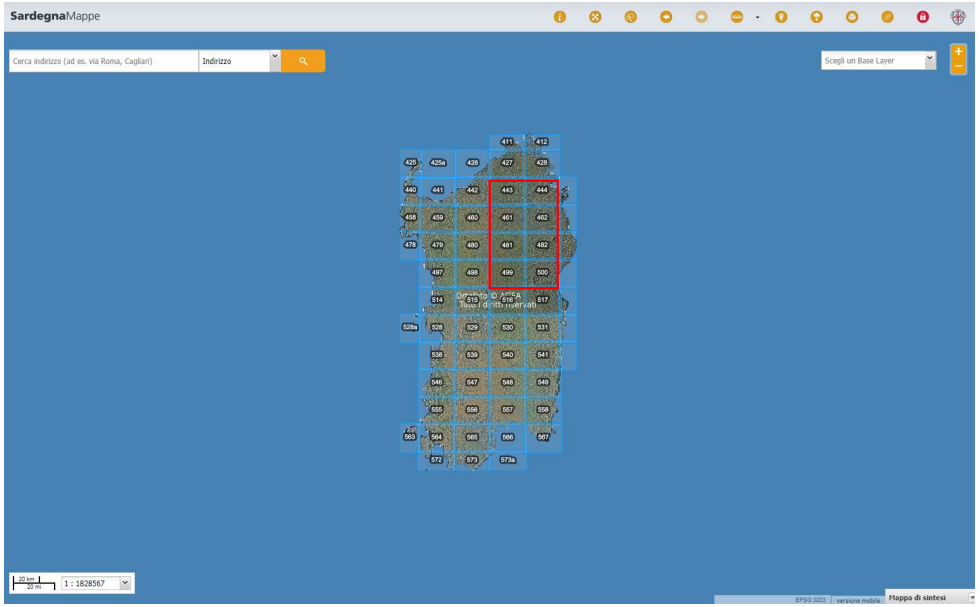
Ministero dell'Università e della Ricerca

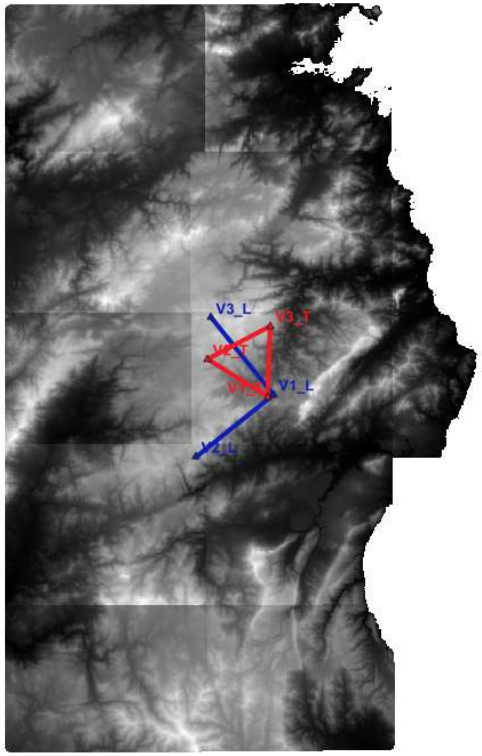
Italiadomani
PIANO NAZIONALE DI RIPRESA E RESILIENZA

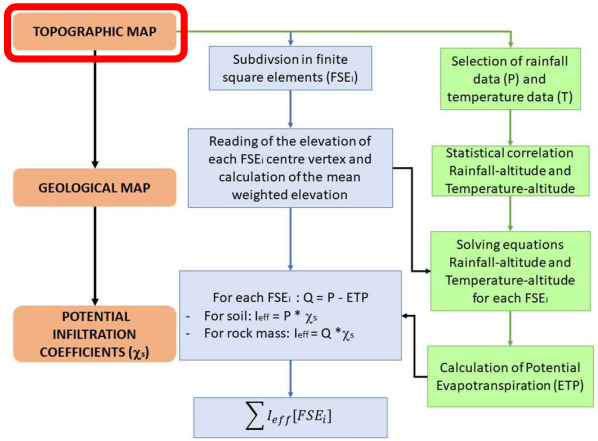
INFN

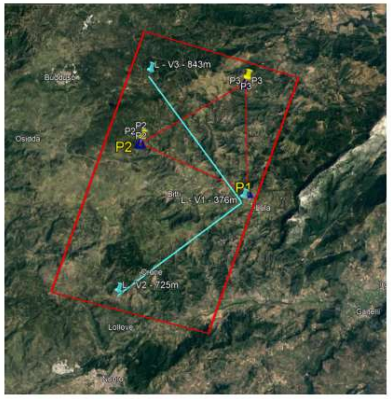
The Inverse Hydrogeological Water Budget

10 mt DTM (source: Sardegna Geoportale)







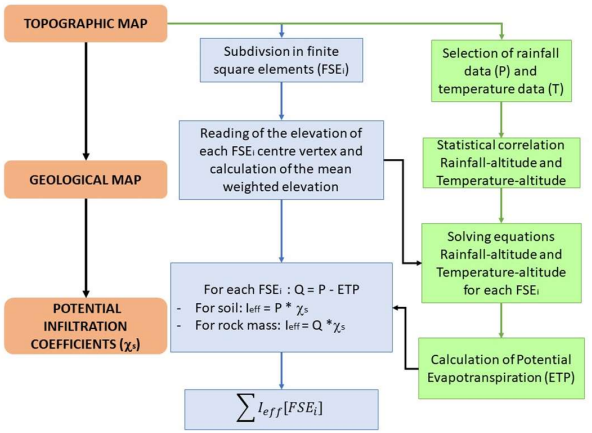


SURVEY AIRBORNE EM (15 x 25 Km)

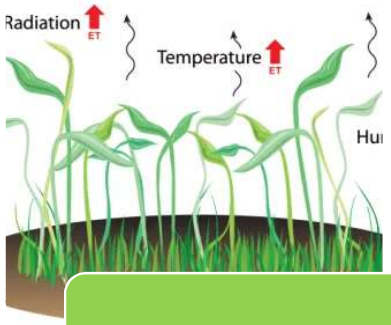
The Inverse Hydrogeological Water Budget
Next steps

Identification of the Hydrogeological basin

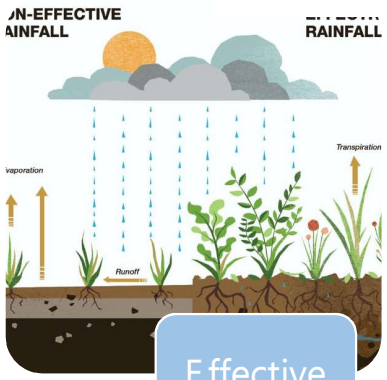
Discretization of the study area in Square Finite Elements (FSE)



Rainfall (R)



Evapotranspiration (ETP)



Effective rainfall (Q)

And then:

- Recharge