

CLEANSTONE

Recupero e valorizzazione degli scarti di lavorazione lapidea per la
sostenibilità ambientale

Rückgewinnung und Aufwertung von Steinaufbereitungsabfällen für
ökologische Nachhaltigkeit

SUMMARY OF UNIUD ACTIVITIES

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Università degli Studi di Udine



WP3 Development of innovative protocols for assessing & reducing the environmental impact of stone processing



Objectives:

- Characterize the extraction and cutting process
- Analyse Italian legislation for quarry's waste disposal
- Give added value to secondary raw material from the cutting process
- Define best practices as technical and organizational guidelines for process optimization and enhanced reuse/recycle policies



CUTTING PROCESS ANALYSIS

Assessment of the productive process of the different quarries (PIETRA PISENTINA & VALPANTENA VR) and comparison

FINAL PRODUCT = STONE IN – LIME – SOLID WASTE

PROCESS EFFICIENCY = 65-70%

CRUCIAL FACTORS



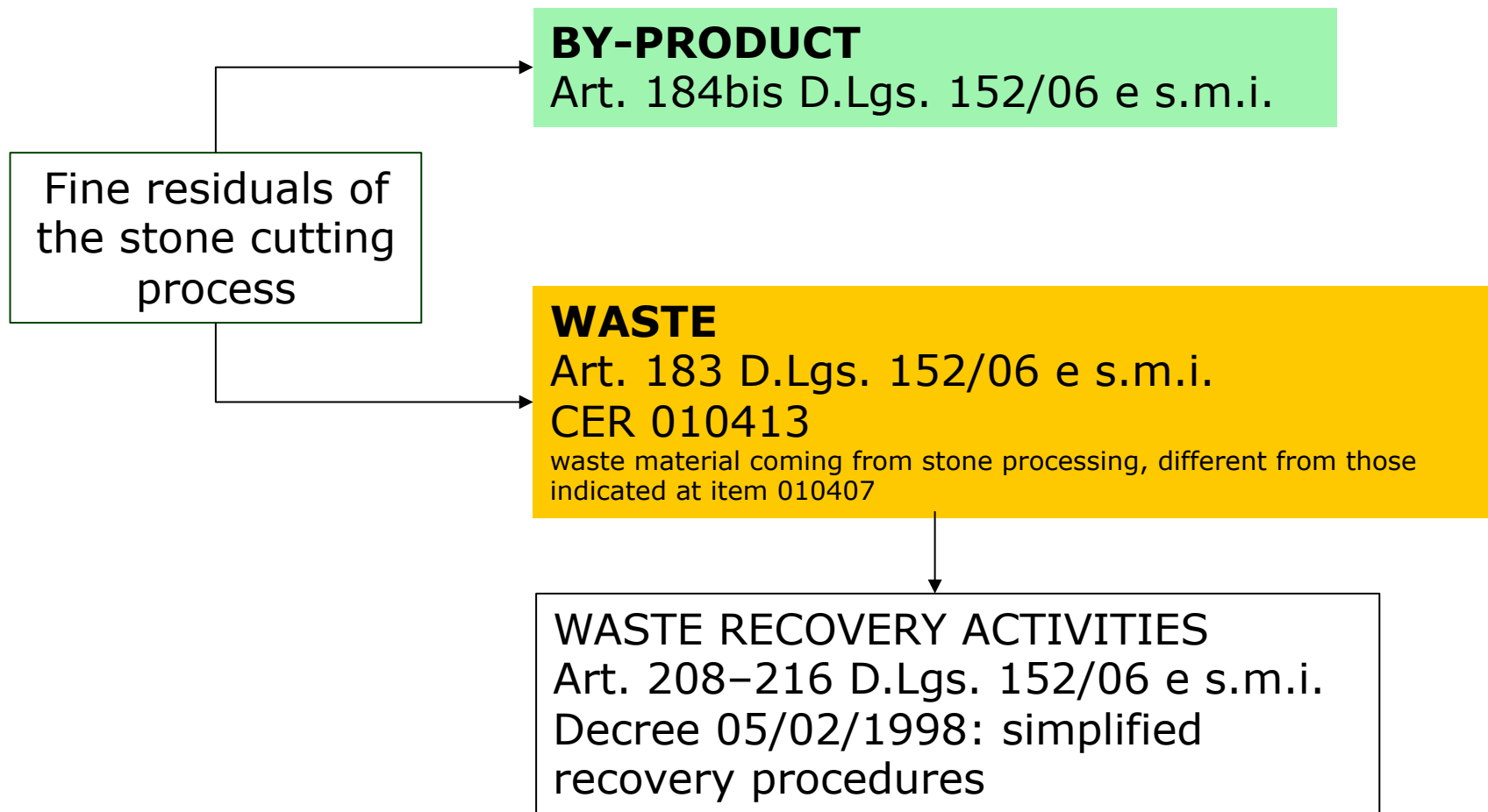
SELECTION OF INPUT MATERIAL

CUTTING OPERATION / TIPE

WATER /LIME SEPARATION



ANALYSIS OF CURRENT LEGISLATION IN ITALY





ANALYSIS OF CURRENT LEGISLATION IN ITALY



BY-PRODUCT

... any material/substance or object that meets **ALL** of the following conditions*:

- a) Originated from a productive process of which it is an integral part and the primary aim of which is not the production of that material/substance or object
- b) Use is certain and direct (no additional treatment)
- c) Satisfies the product requirements and will not have negative effects on humans and environment

* Final communication from the Commission to the Council and the European parliament (Brussels, 21.2.2007 COM(2007) 59)

D.M. n. 264 del 13/10/2016: Provides indicative criteria to facilitate the verification of the criteria that must be met by the “residual” of the productive process in order to be classified as by-product.

Circolare esplicativa del Ministero Ambiente n. 7619 del 30/05/2017 per l'applicazione del D.M. 264/16.



BY-PRODUCT vs WASTE

BY-PRODUCT

Articulated legislation that requires competences and objective verification of ALL requirements

Use of flocculants makes it difficult to meet the product's environmental requirements (specific characterization tests required)

Final use easier to demonstrate for companies that own the quarry where the by-product will end up to.

WASTE

Legislation is very clear and consolidated

Private parties distrust the use of products originated from recovery activities

In the public sector, CAM (Criteri Ambientali Minimi, minimal environmental criteria) defined to favour the reuse of waste products



NEXT STEPS IN WP3



- Valorization of process products and by-products
- Definition of best management practices and technical and organizational procedures to favour the classification of lime as by-product
- Valorization of waste products' quality



WP4: Identification/development of new best practices for the recovery of waste as secondary raw material



Objectives:

- Physico/chemical characterization of waste material
- Study the environmental impact of the extraction and processing of the materials
- Identification of testing protocols
- Identification of recycling options



WP4: Identification/development of new best practices for the recovery of waste as secondary raw material



Objectives:

- Physico/chemical characterization of waste material
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- Identification of testing protocols
- Identification of recycling options



METHODOLOGY



Investigations performed (by the Ceramics and Construction Materials group- Prof. Maschio, dott. Furlani):

- Compressive and flexural strength tests;
- Water absorption measurements;
- X-Ray diffraction;
- Particles size distribution of the powders derived from the slurries;
- Water content of the slurries;
- Optical Microscope investigation;
- SEM investigation



MATERIALS EXAMINED



Stone samples from Cava Vicenza:

- Fine-grain stone: cubic (100x100x100 mm) and parallelepipedal (40x40x100 mm) samples; slurry of waste wet powders
- Coarse-grain stone: cubic (100x100x100 mm) and parallelepipedal (40x40x100 mm) samples; slurry of waste wet powders



MATERIALS EXAMINED (SLURRIES)



Water content: 12.5 %



SOME RESULTS FROM THE ANALYSES



Compressive strength tests:

- Fine-grain samples: average value 24 Mpa
- Coarse-grain samples: average value 22 MPa
- Values << than Piasentina Stone (150 - 170 Mpa)

Flexural strength tests:

(Equation used: $\sigma_f = 3PL/2bd^2$)

σ_f = Flexural strength
P = Failure load
L = Length of sample
b = Width of sample
d = Depth of sample

- Fine-grain samples: avg value 0.8 Mpa
- Coarse-grain samples: avg value 0.5 Mpa
- Values << than Piasentina Stone (25 - 35 Mpa)



SOME RESULTS FROM THE ANALYSES



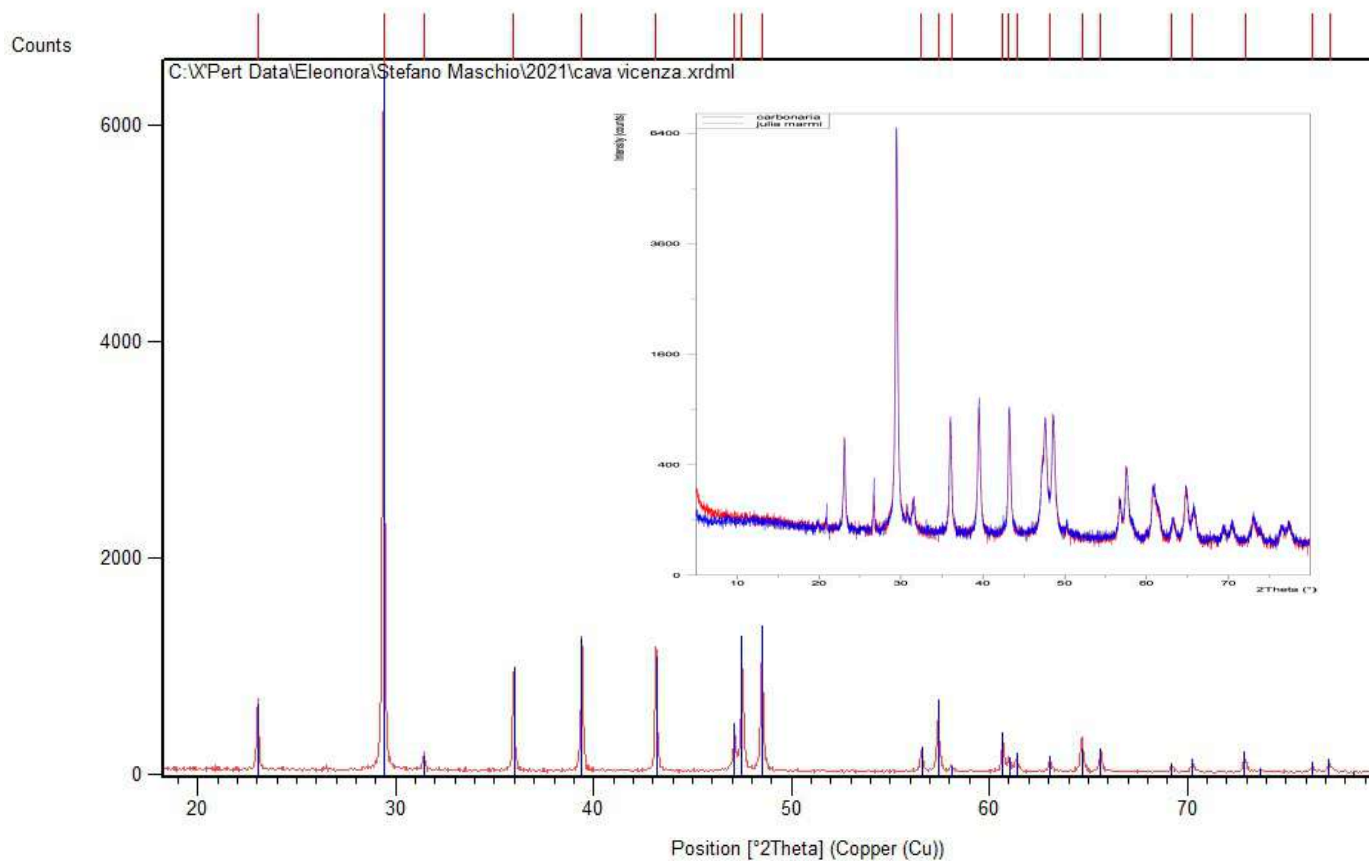
Water absorption (% H₂O):

- Fine-grain samples: 12%
- Coarse-grain samples: 13%
- Values >> than Piasentina Stone: 0.02 – 0.03



SOME RESULTS FROM THE ANALYSES

X-Ray diffraction analysis:



Phase identified:

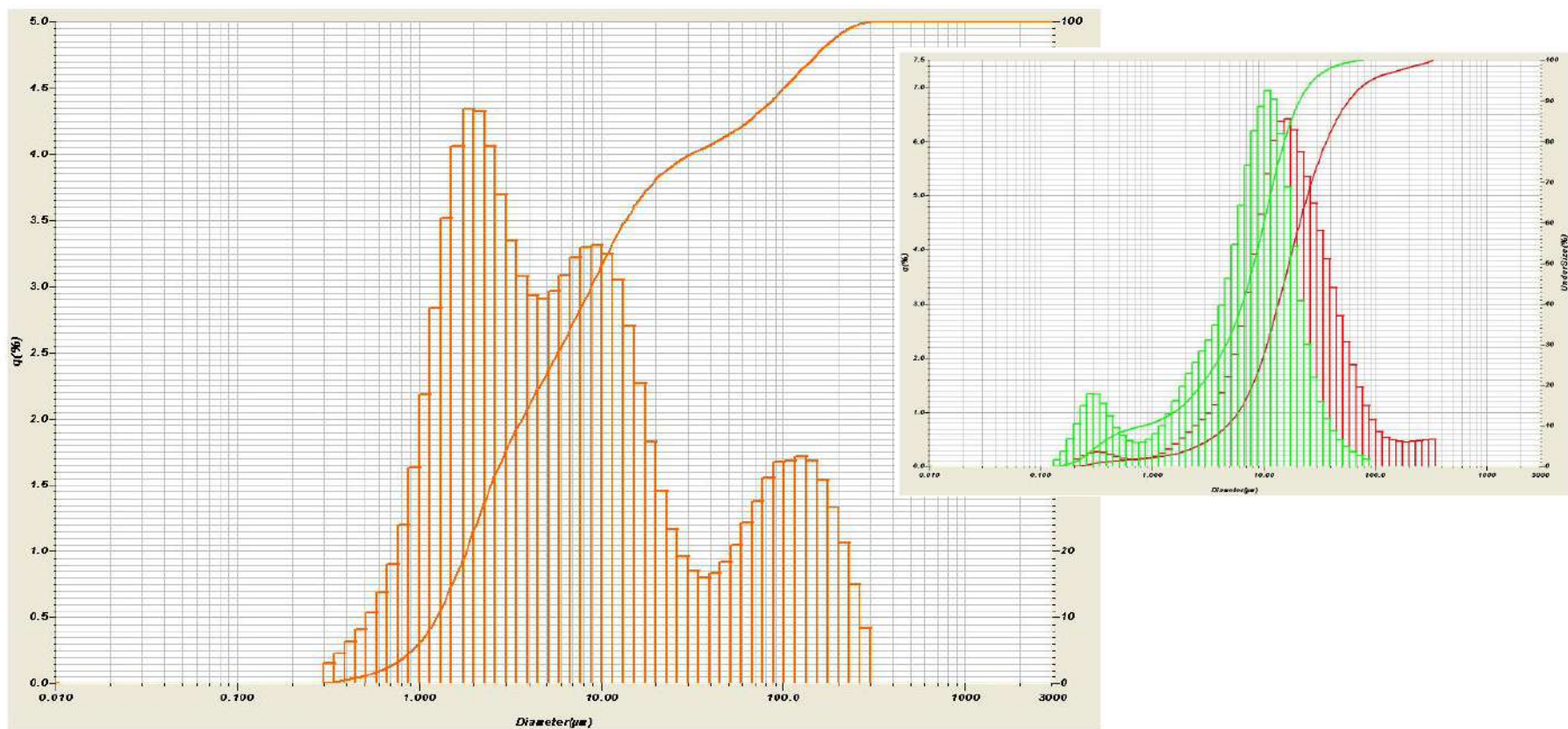
Calcite 99.0%



SOME RESULTS FROM THE ANALYSES



Particle size distribution of the powders obtained from the slurries:

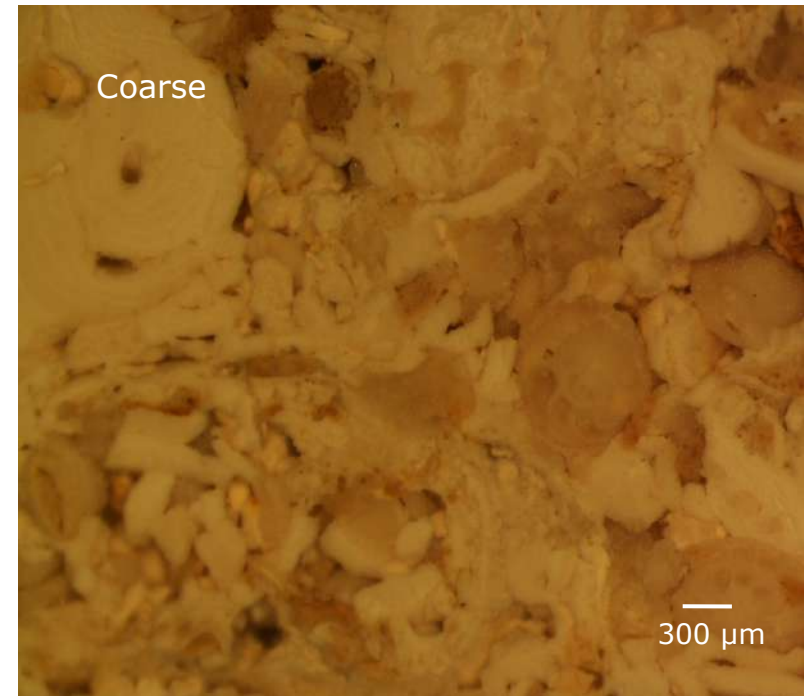
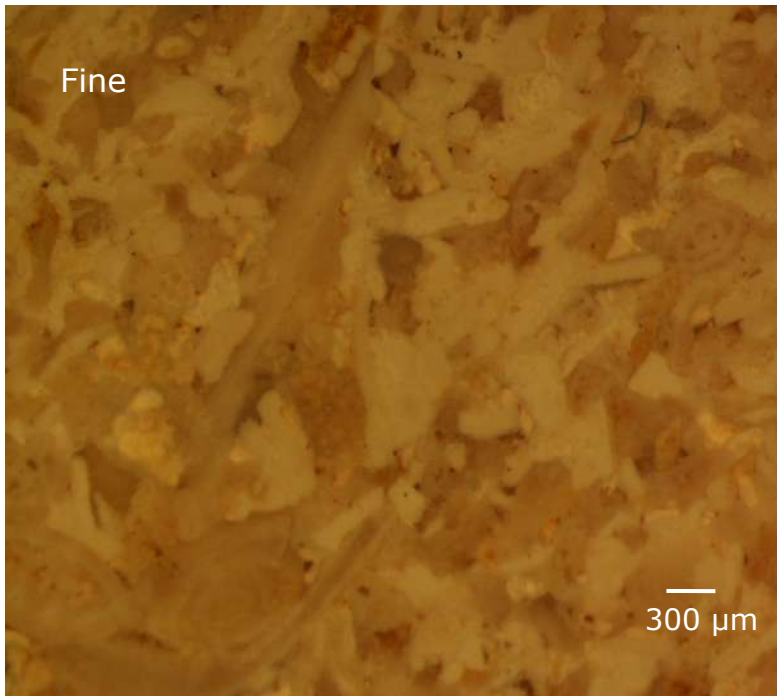




SOME RESULTS FROM THE ANALYSES



Stereoscopic optical microscope images:



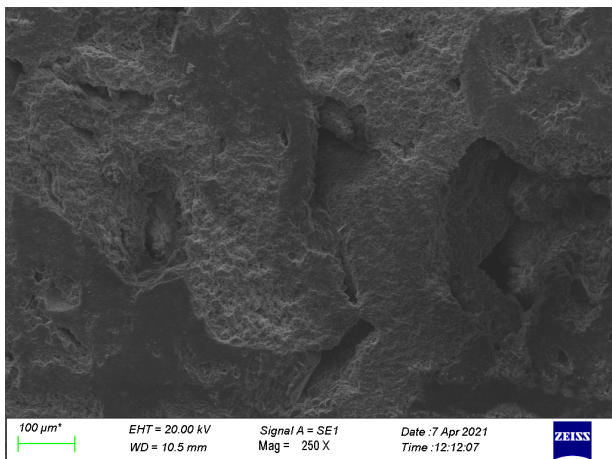


SOME RESULTS FROM THE ANALYSES

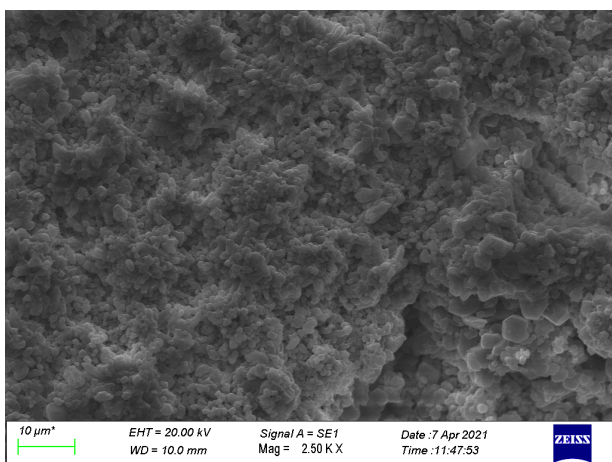
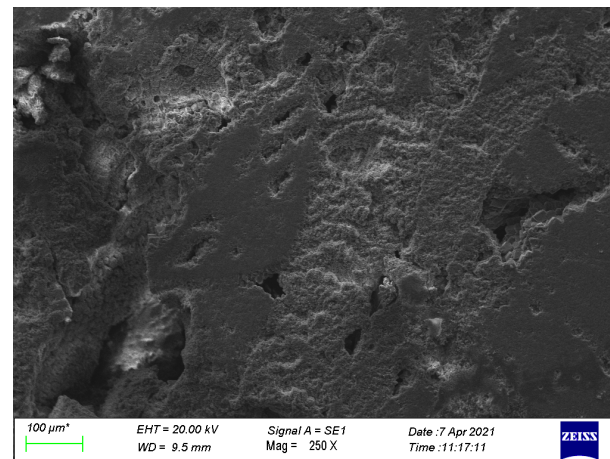
Fine

SEM investigation:

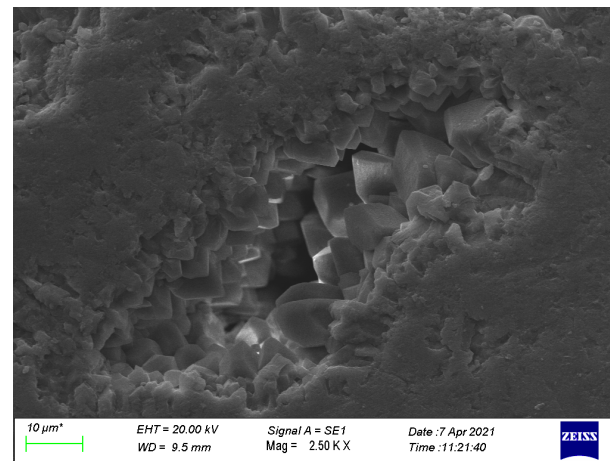
Coarse



250X



2500X





WP4: Identification/development of new best practices for the recovery of waste as secondary raw material

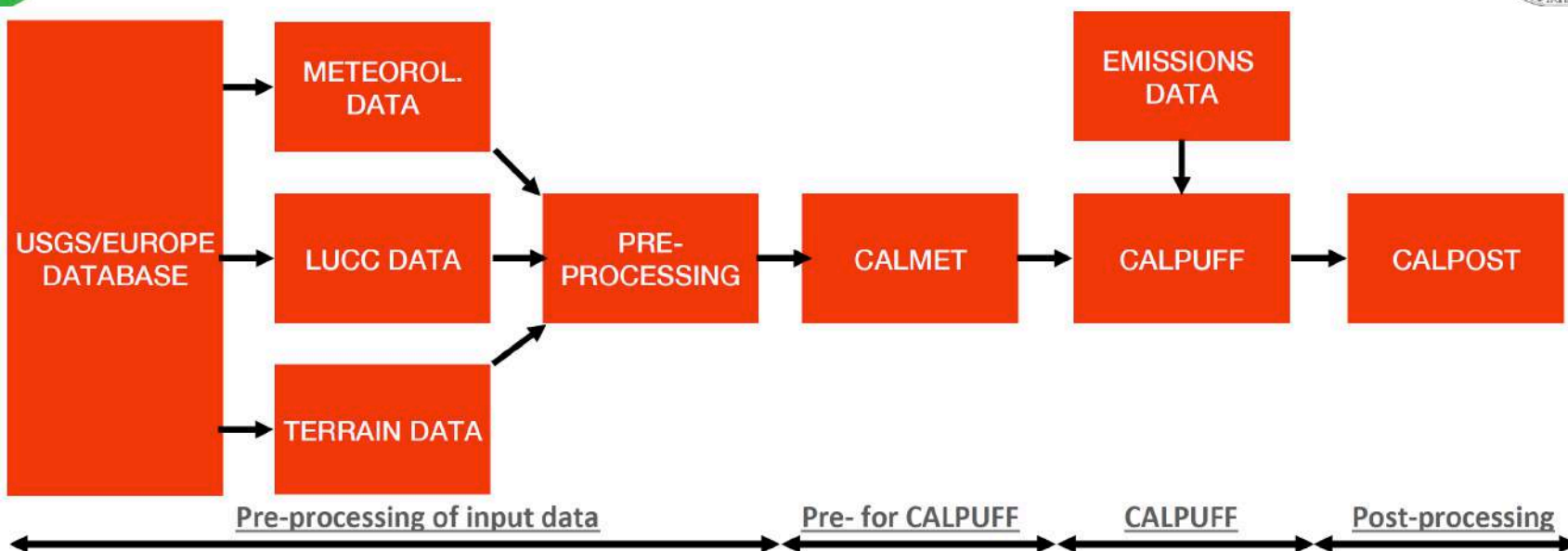


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CALPUFF software suite



Main workflow

Pre-processing of input data: input of terrain elevation data, land use and cover change data, meteorological data

Pre-processing for CALPUFF: data processed at the previous step are read by CALMET and the respective input file for CALPUFF is generated

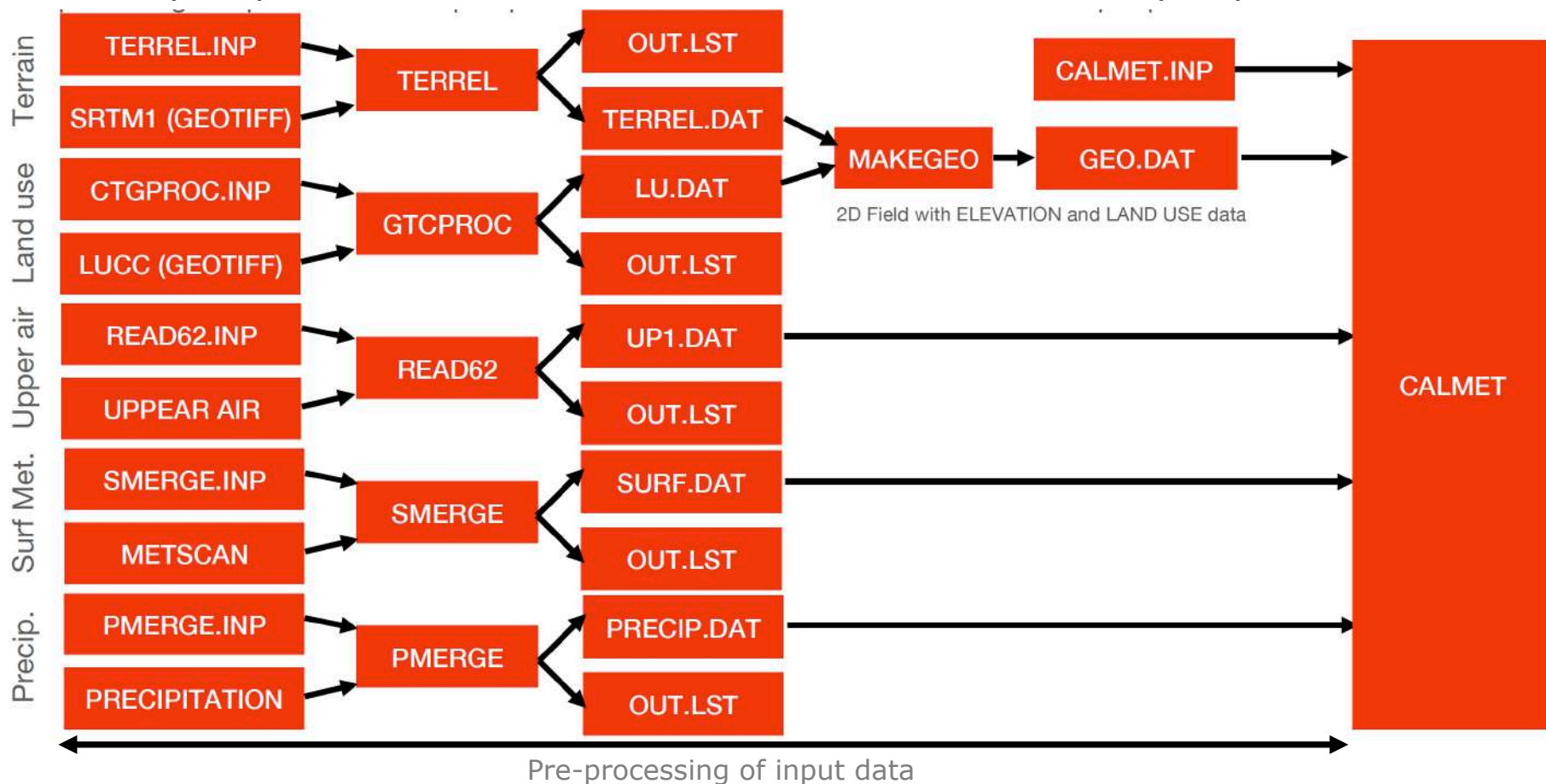
Main simulation (CALPUFF): CALMET input files and emissions data are read by CALPUFF and the main simulation is run

Post-processing (CALPOST): Dispersion and pollutant deposition



Pre-processing of input data

This step requires the use of different database and different pre-processor tools





Pre-processing of input data

Pre-processing of input data:

Location of the production sites (ITALY):

Time zone: 33

- Cava Pietra Piasentina - “Noglar”

46.14038777000248 N, 13.456136579839253 E

(46° 8' 25.396" N, 13° 27' 22.091" E)

- Cava Tarpezzo

46.1373722 N, 13.50398888888889 E

(46° 8' 14.54" N, 13°30' 14.36 E)

- Cava Clastra

46.1306083 N, 13.511447222222221 E

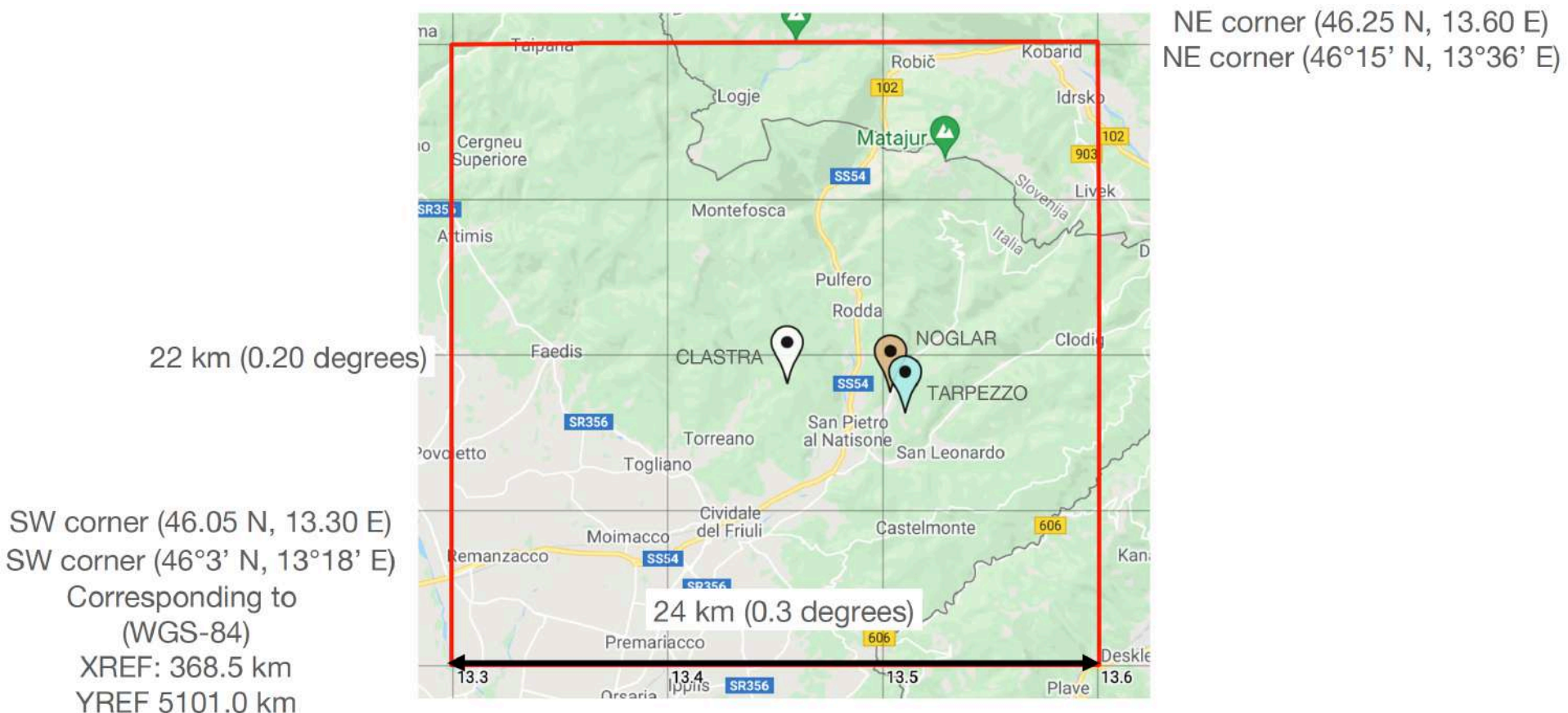
(46° 7' 50.19 N, 13°30' 41.21 E)

All production sites are located between 46°N - 47°N
and 13°E and 14°E.





Definition of computational domain





Terrain elevation data pre-processing workflow



Terrain database (provided and maintained by USGS):

- GTOPO30 (Global digital elevation model)
- SRTM (Shuttle Radar Topography mission)

The following files can be downloaded from earthexplorer.usgs.gov/:

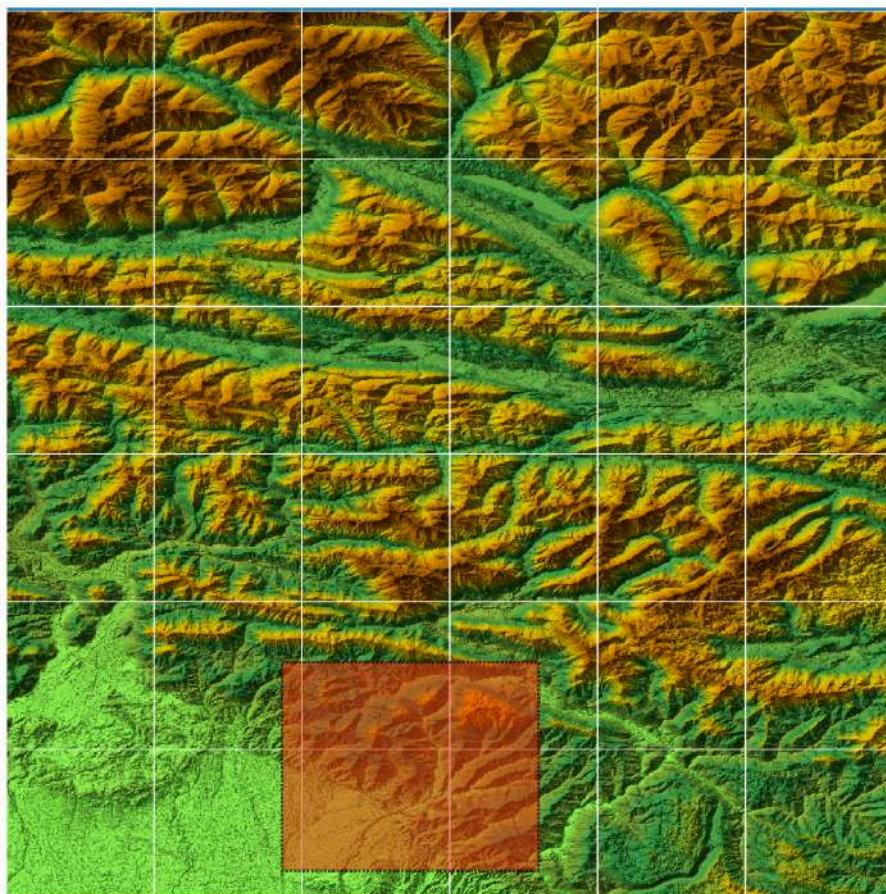
- GTOPO30 (GeoTiff format, 30 arc-second = 1km resolution)
- SRTM3 (GeoTiff format, 3 arc-second = 90 m resolution)
- SRTM1 (GeoTiff format, 1 arc-second = 30 m resolution)
- SRTM1 (oil format, 1 arc-second = 30 m resolution)

and from <http://viewfinderpanoramas.org/dem3.html>

- SRTM1 (hgt format, 1 arc-second = 30 m resolution)



Use of SRTM1 files



We use the SRTM1 files (1 arc-second resolution = 30 m resolution)

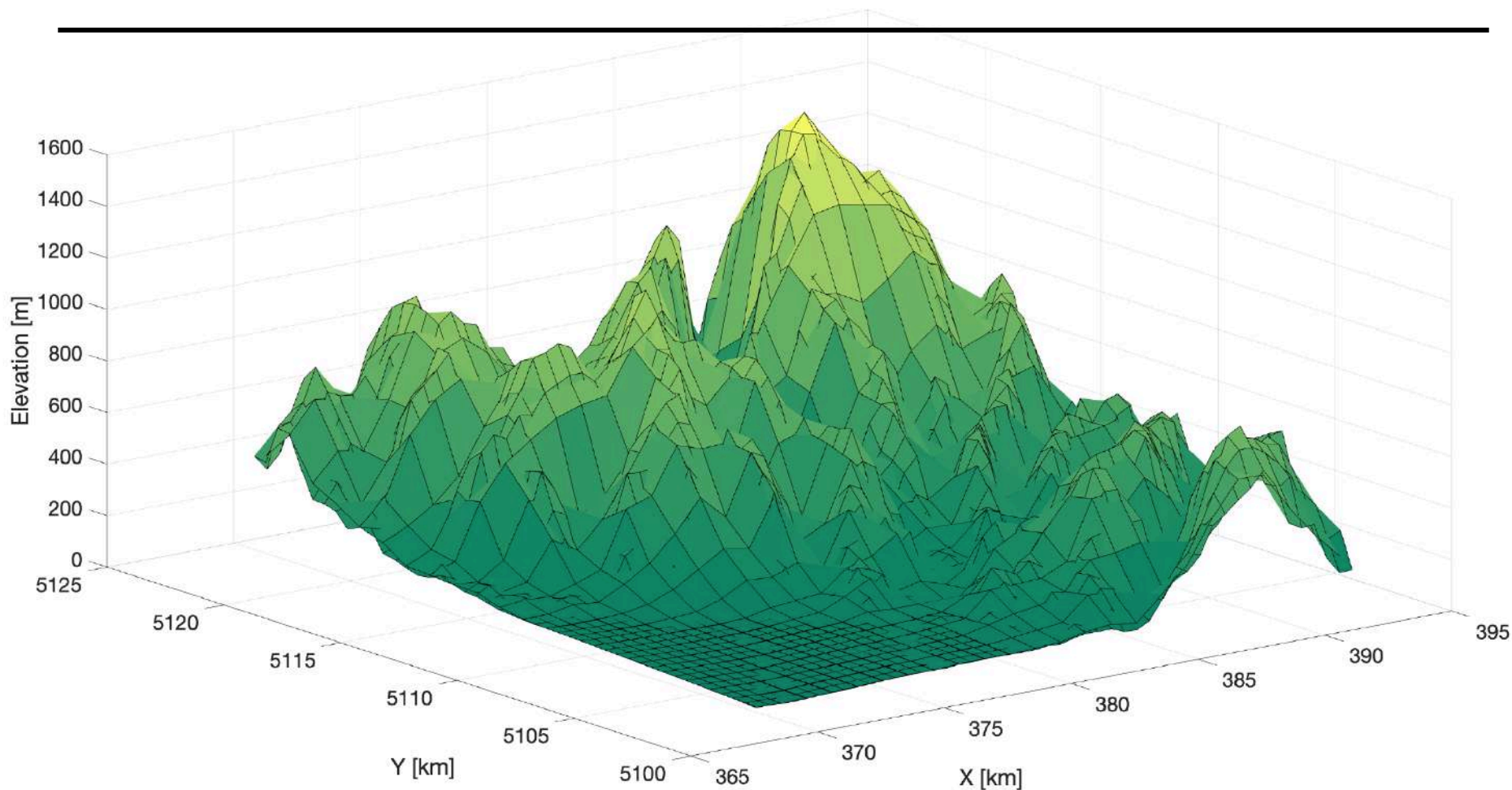
File: 46NE13 (GeoTIFF or hgt)
from 46N,13E (SW) to 47N,14E (NE)

Same computational domain
(28km x 28 km) and we consider
3 different grid resolution:

- 1 kilometer
- 500 meters
- 250 meters

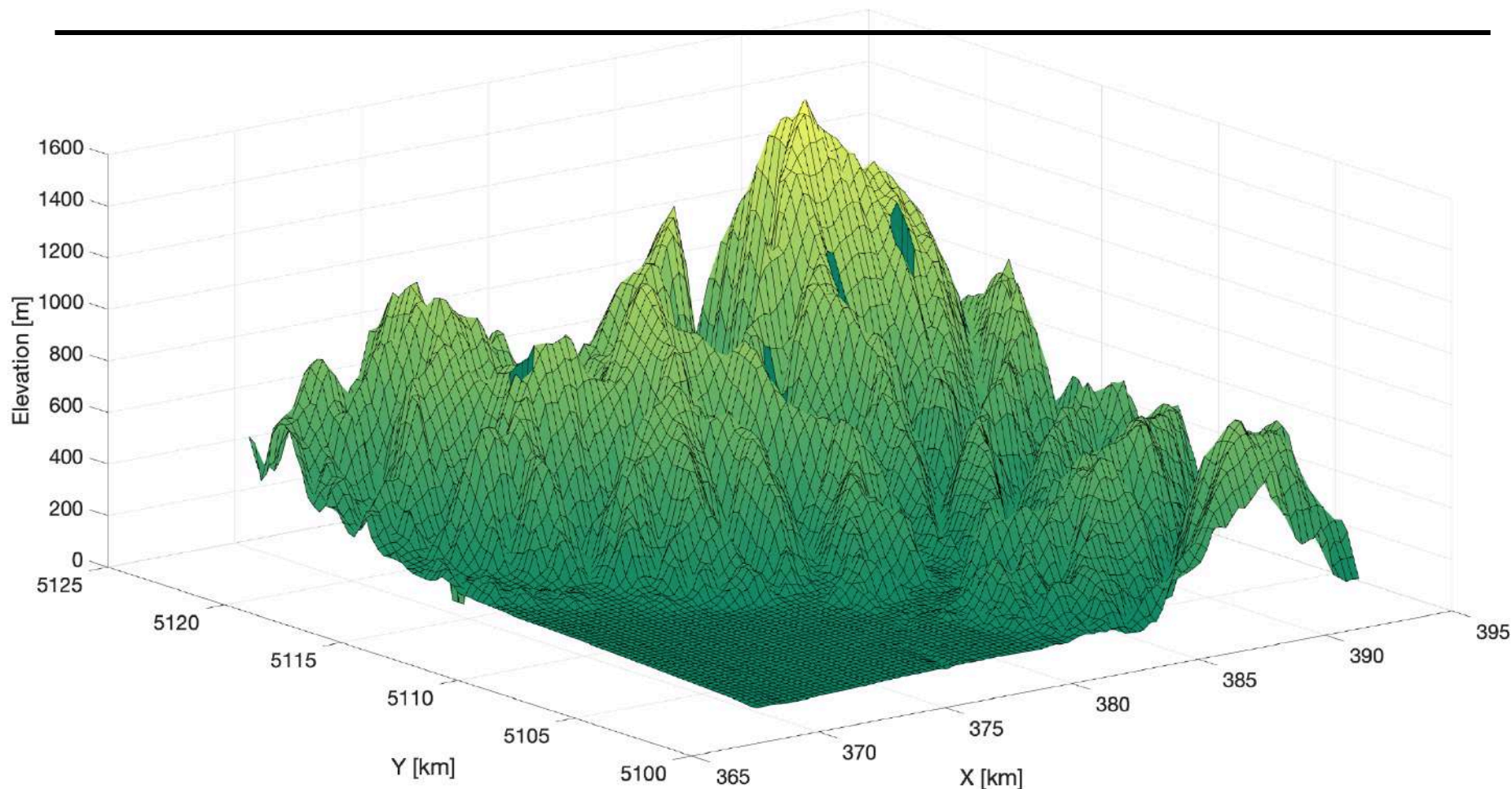


Resulting elevation files (TERREL.DAT) 500 m resolution (NX x NY = 48 x 44)





Resulting elevation files (TERREL.DAT) 250 m resolution (NX x NY = 96 x 88)





Land use and cover change data pre-processing workflow



Land use and cover change database:

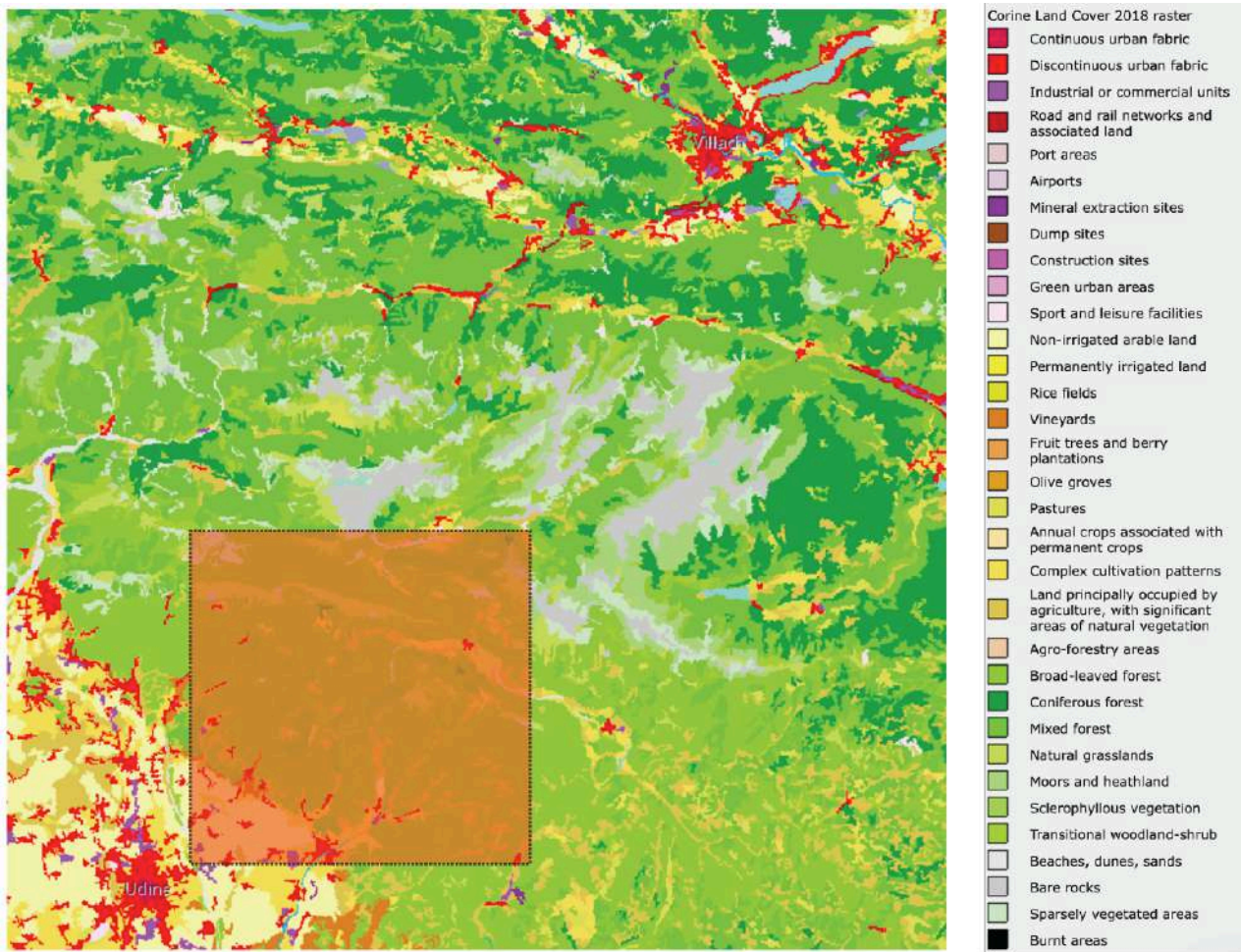
- LUCC (Provided/maintained by USGS, 1km resolution for Europe)
- CORINE Database (Provided and maintained by European Environment agency, 100m and 30m resolutions)

The following files can be downloaded from earthexplorer.usgs.gov/:

- USGS Global (GlazaEU format, 1km res)
- and <https://land.copernicus.eu/pan-european/corine-land-cover>
- CORINE (GeoTiff format, 100 m res.)
 - CORINE (GeoTiff format, 30 m res.)



Example of Corine database



CALPUFF and CORINE use different classifications and different file formats



NEXT STEPS IN WP4

- Reading of the CORINE database files in Matlab and assignment of the USGS categories
- Generation of the LU.DAT file to be used by MAKEGEO in Matlab
- Source-code (Fortran-77) of CTGPROC cannot be modified since the program is compiled with a commercial compiler with non-standard directives (cannot be compiled with PGI and/or gfortran)
- Propose options for resale/recycle (e.g. as fluxing agents in iron or steel slag forming)