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Analysis of the European Atlas of Natural Radiation data within geological and soil units

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European Atlas of Natural Radiation

A tool for the public to:

- ✓ familiarize itself with natural environmental radioactivity;
- ✓ be informed about the levels of natural radioactivity caused by different sources;
- ✓ have a more balanced view of the annual dose received by the world population, to which natural radioactivity is the largest contributor;
- ✓ make direct comparisons between doses from natural sources of ionising radiation and those from man-made (artificial), and hence to better understand the latter.

Digital version of the Atlas

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https://remon.jrc.ec.europa.eu

About

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European Atlas of Natural Radiation

The human population is continuously exposed to ionizing radiation from several natural sources that can be classified in two categories:

- **Cosmic contribution**: high-energy cosmic rays incident on the Earth's atmosphere and releasing secondary radiation
- **Terrestrial contribution**: radioactive nuclides generated during the formation of the Earth and still present in the Earth's crust: mostly uranium and thorium radioactive families together with ^{40}K, which is a long lived radioactive isotope of the elemental potassium. In most circumstances radon, a noble gas produced in the radioactive decay of the Uranium progeny, is the major contributor to the total dose.

On this page

> The European Atlas of Natural Radiation is a collection of maps displaying the levels of radioactivity caused by different natural sources in Europe.

The Atlas is intended to familiarise the public with the radioactive environment, to give a more balanced view of the annual dose that it may receive from natural radioactivity and to provide reference material and generate harmonised data for the scientific community. The overall goal of the Atlas is to estimate the annual dose that the public may receive from natural radioactivity, combining all the information from the different maps. Indeed, natural ionizing radiation is considered the largest contributor to the collective effective dose received by the world population.

The Atlas is developed and maintained by the Joint Research Centre of the European Commission.

Cinelli G. *et al.* 2018. *Digital version of the European Atlas of Natural Radiation*, Journal of Environmental Radioactivity. Article in press. https://doi.org/10.1016/j.jenvrad.2018.02.008

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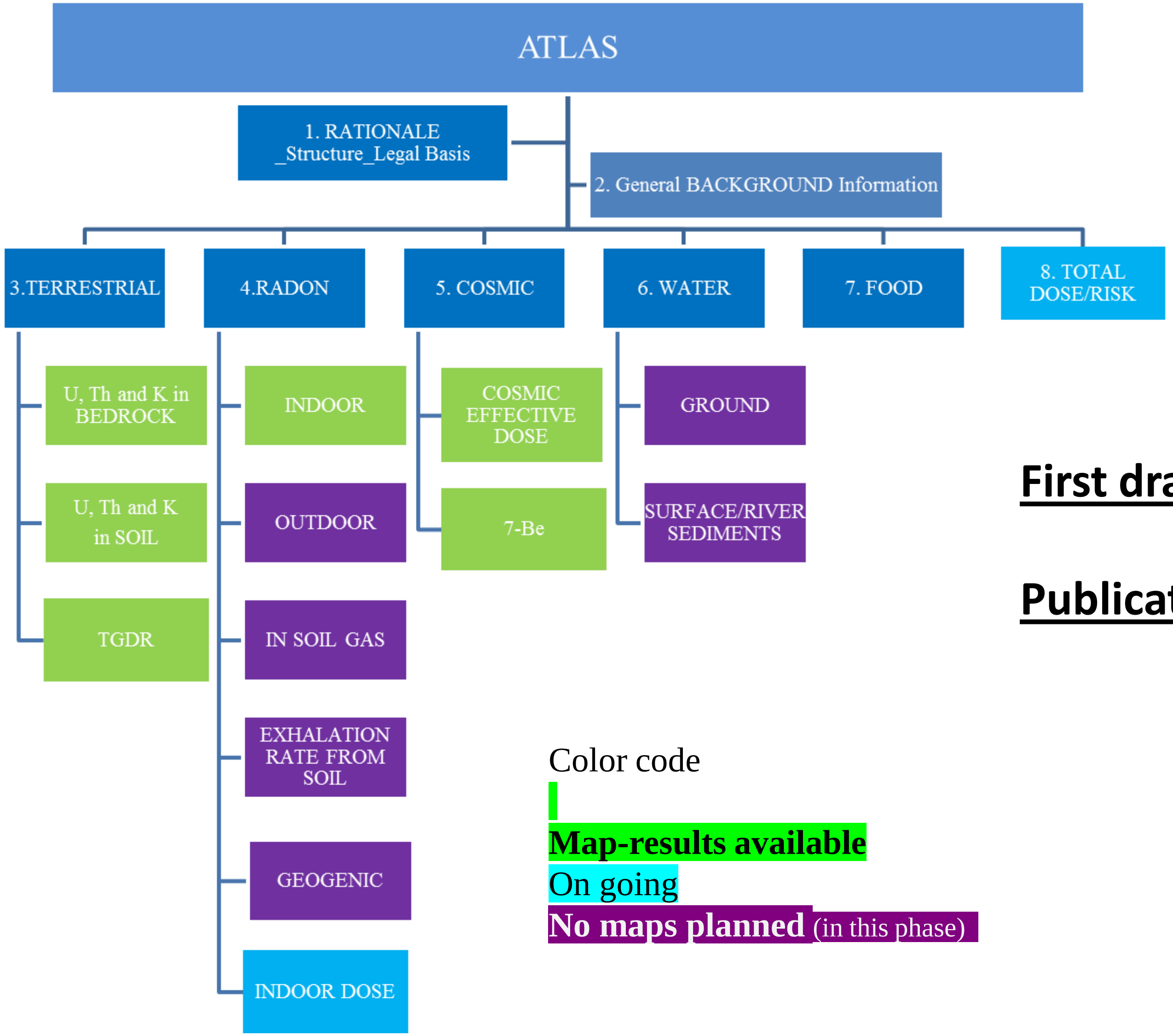
Structure of the Atlas publication



First draft: December 2018

Publication: Spring 2019

Color code

Map-results available

On going

No maps planned (in this phase)

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Objectives and Benefits

OBJECTIVES:

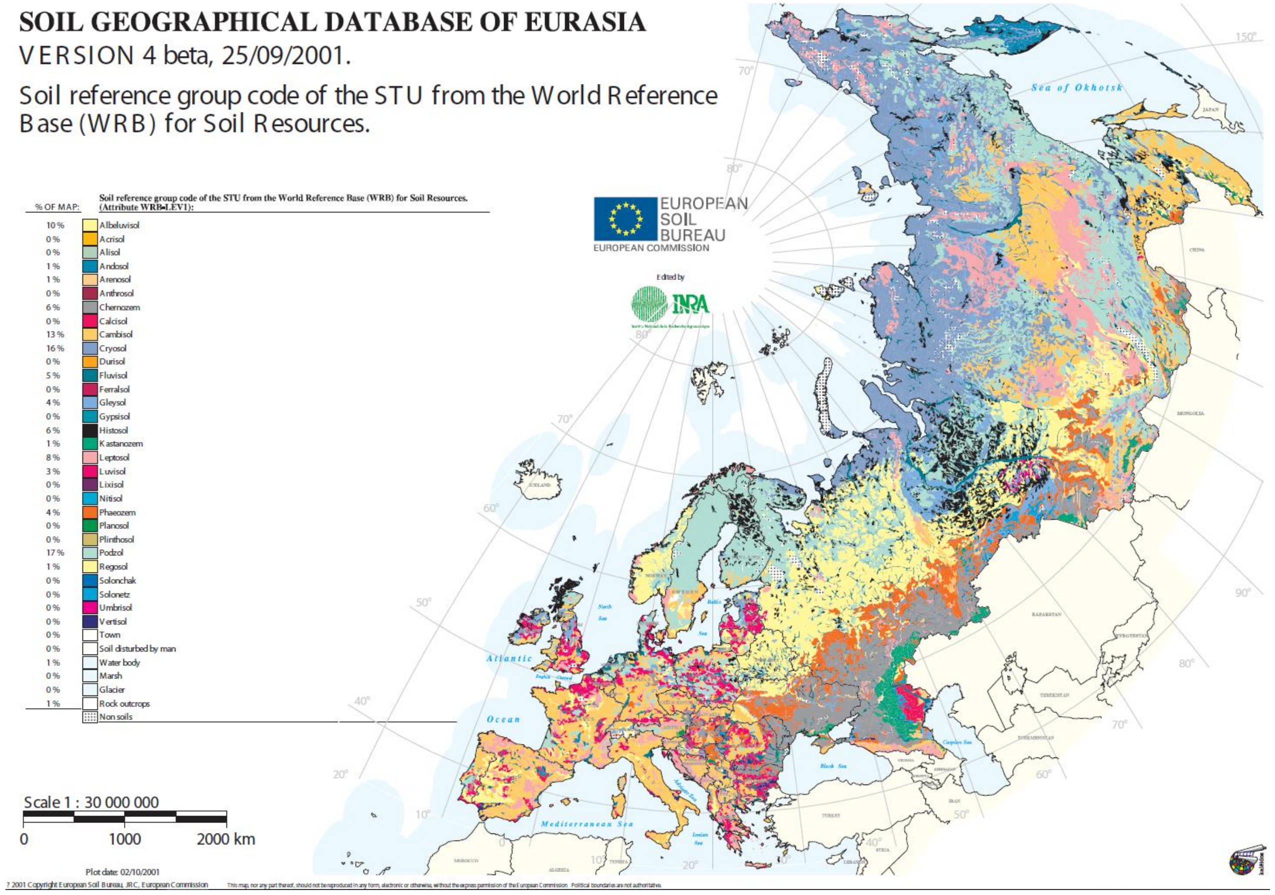
- Analyse the data of the EANR maps (related to terrestrial sources) within geological and soil groups;
- Analyse the difference between soil and geology groups

BENEFITS:

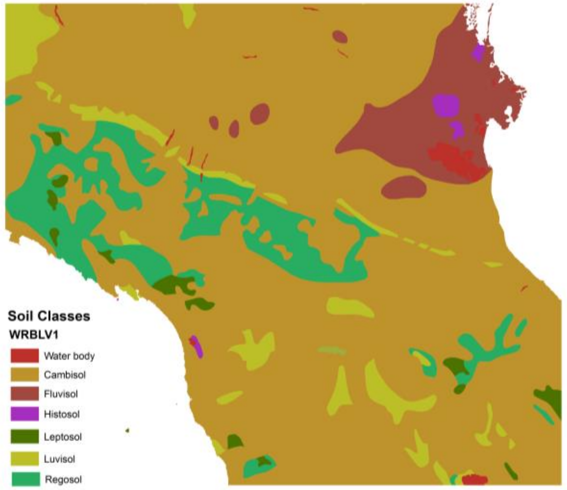
- Better understand how much natural radiation sources are linked to the geology and soil types;
- Apply methodologies to improve the maps coverage and expand the knowledge on the geogenic radon hazard index

Soil units

The European Soil Data Centre (ESDAC)
https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties



For each 10x10 km cell the dominant soil class has been identified



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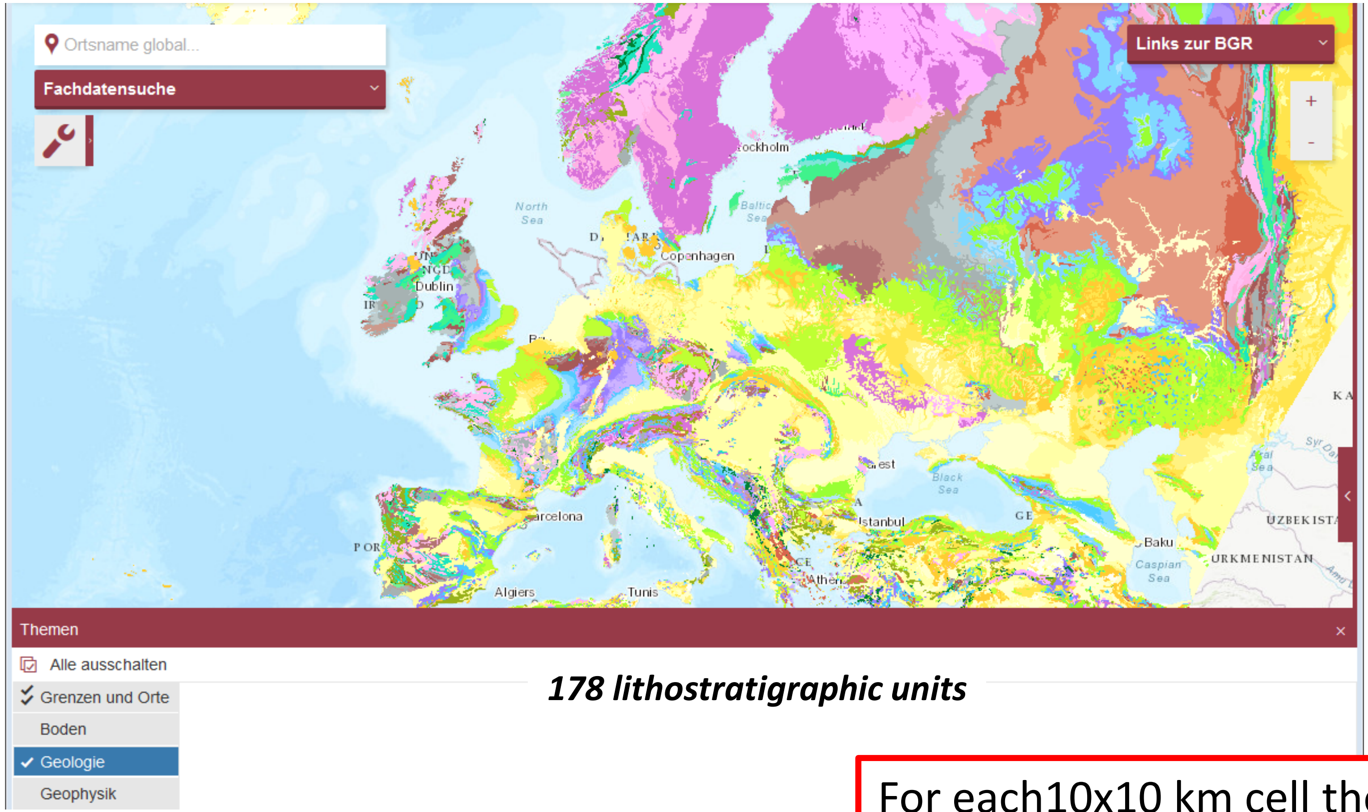
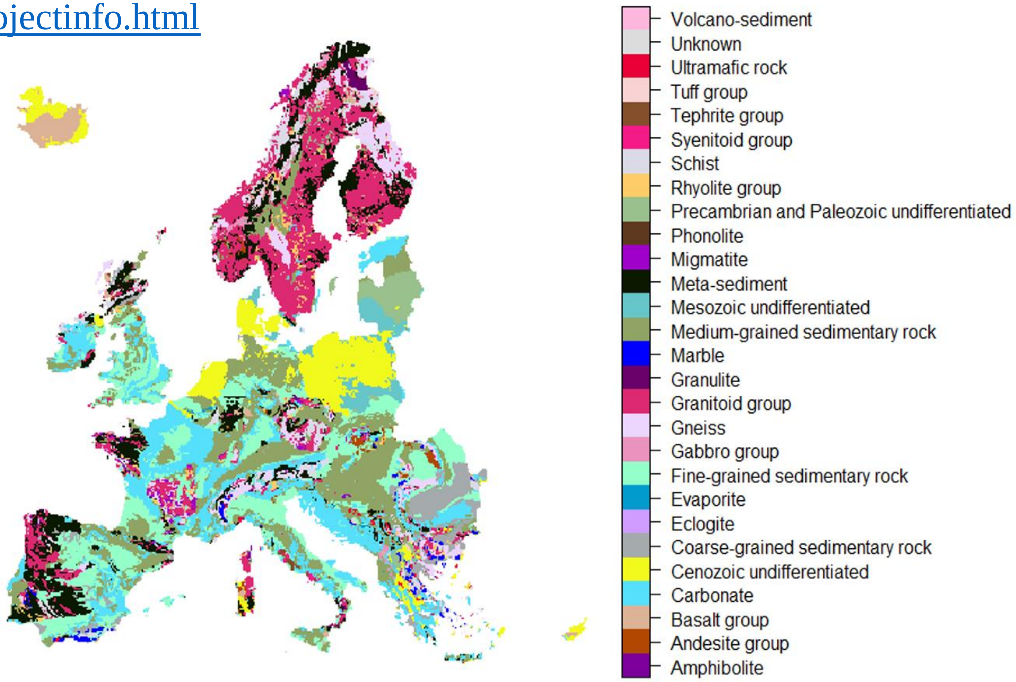
Geological units

1 : 5 Million International Geological Map of Europe and Adjacent Areas (IGME 5000)

https://www.bgr.bund.de/EN/Themen/Sammlungen-Grundlagen/GG_geol_Info/Karten/International/Europa/IGME5000/IGME_Project/IGME_Projectinfo.html



178 lithostratigraphic units



Simplified European lithological map _28 lithological units

For each10x10 km cell the dominant lithological unit class has been identified

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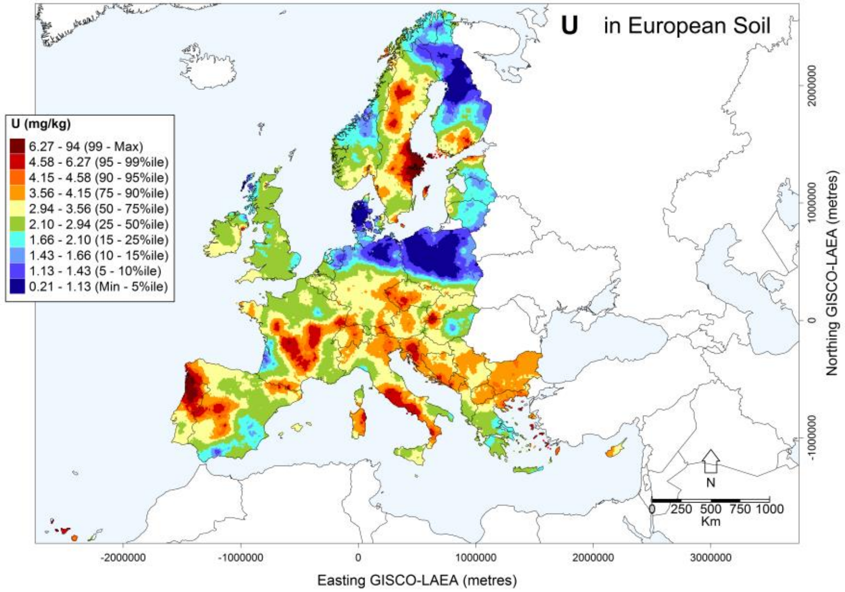
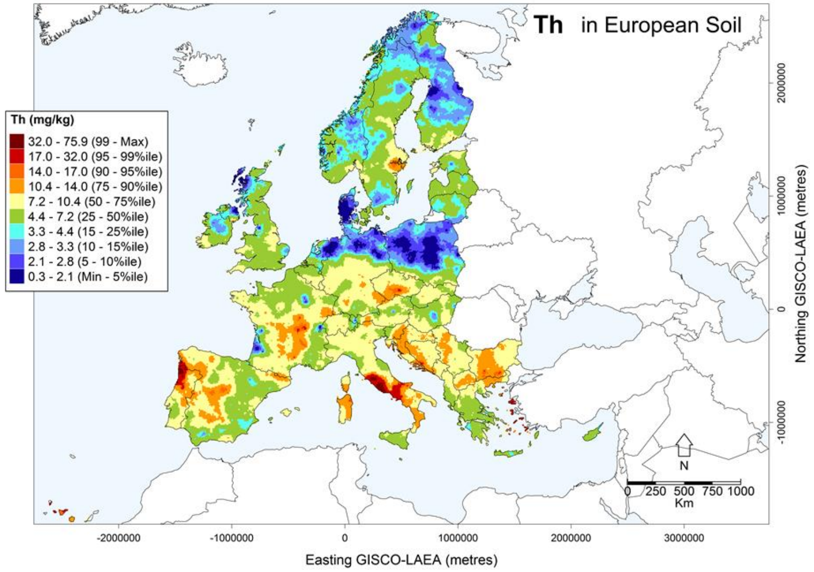
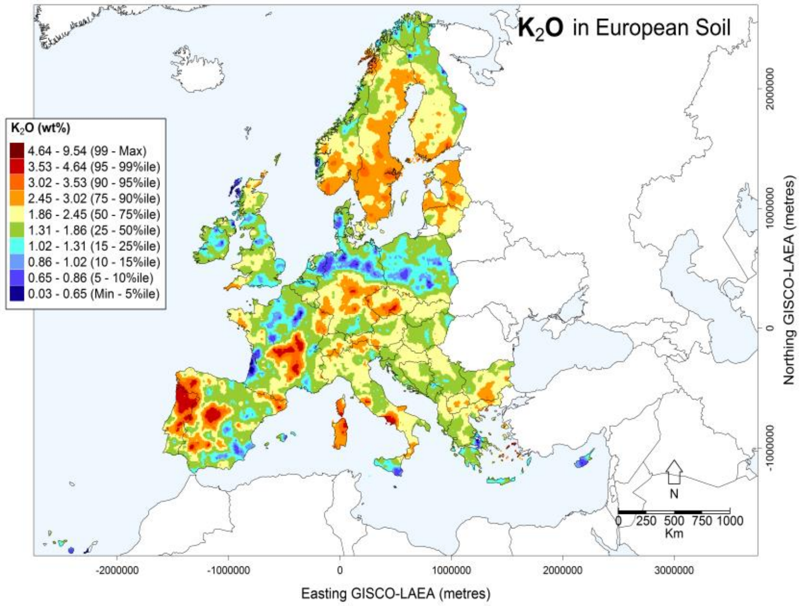
U, Th and K concentration in soil Maps







Maps of estimated U, Th and K total concentrations in topsoil over Europe, based on data collated from FOREGS (ICP-MS) and GEMAS (XRF) European datasets.

The colours are attributed according to the percentiles estimated map points.

Acknowledgment: Antonio Ferreira, Bob Lister, Andrew Tye (British Geological Survey)

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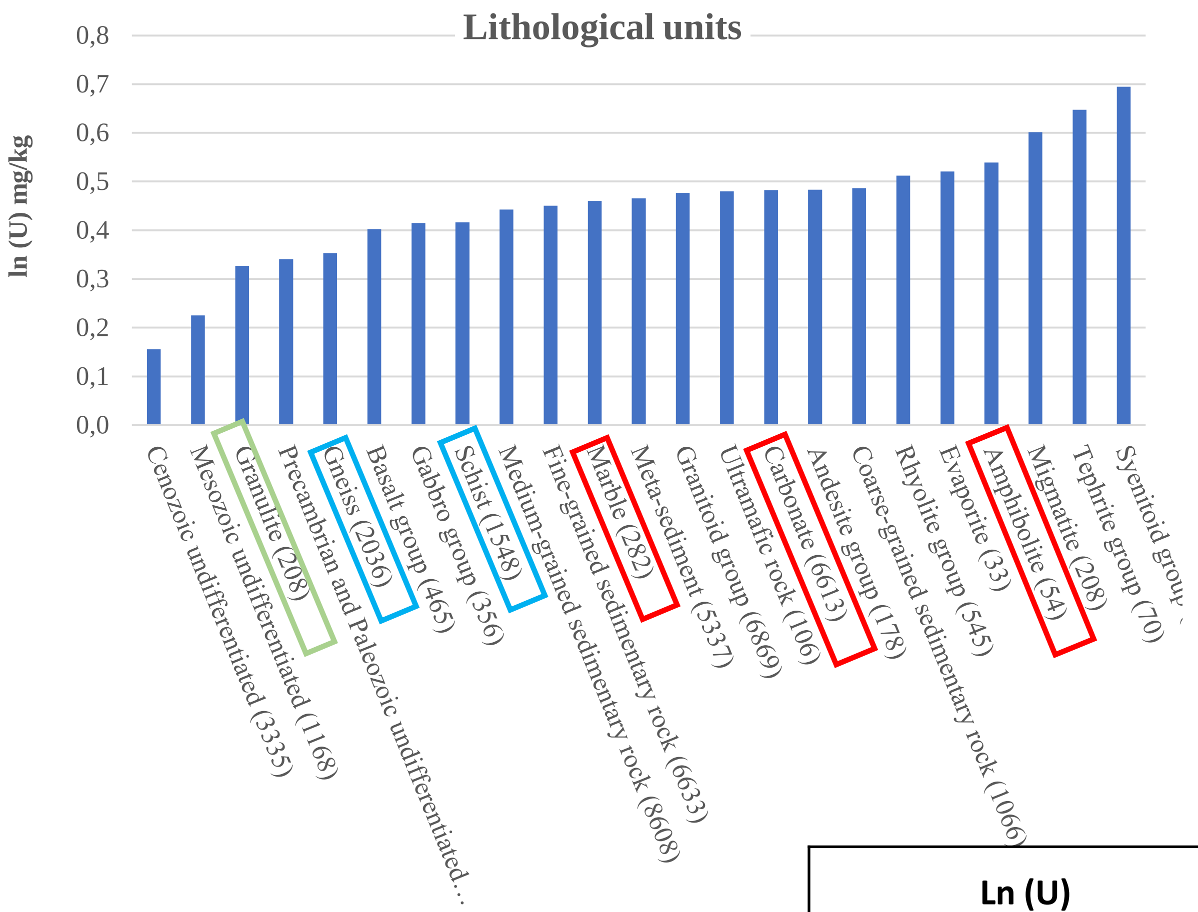
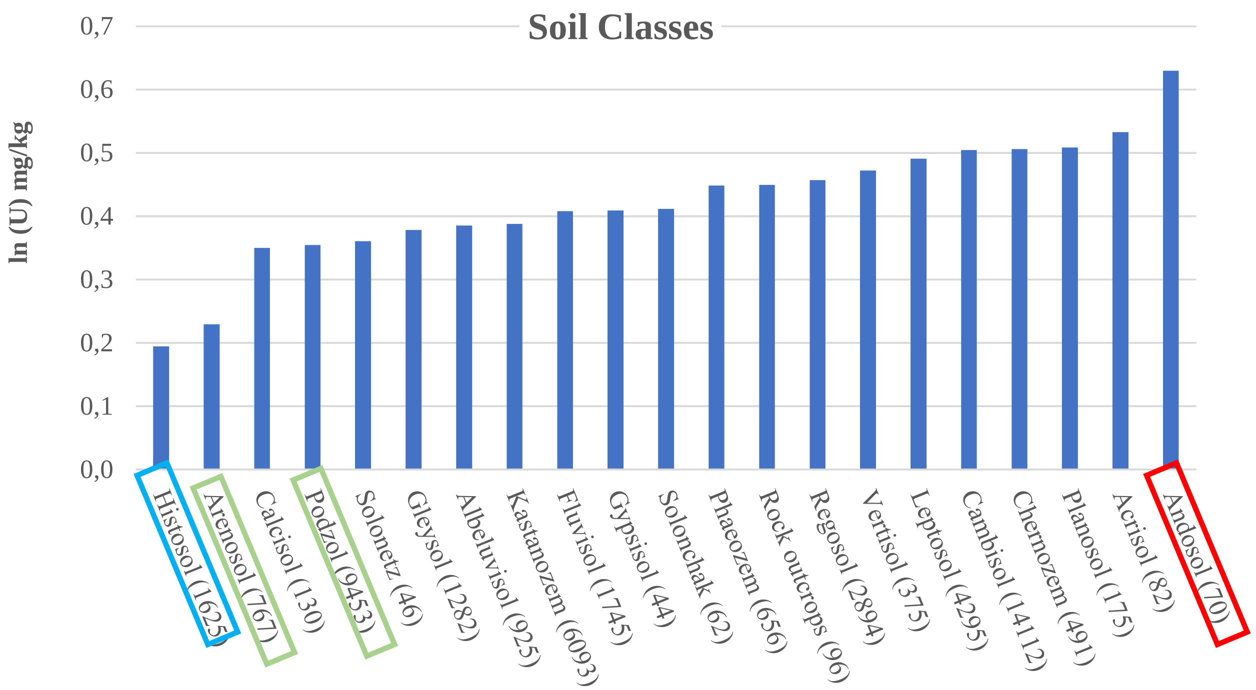
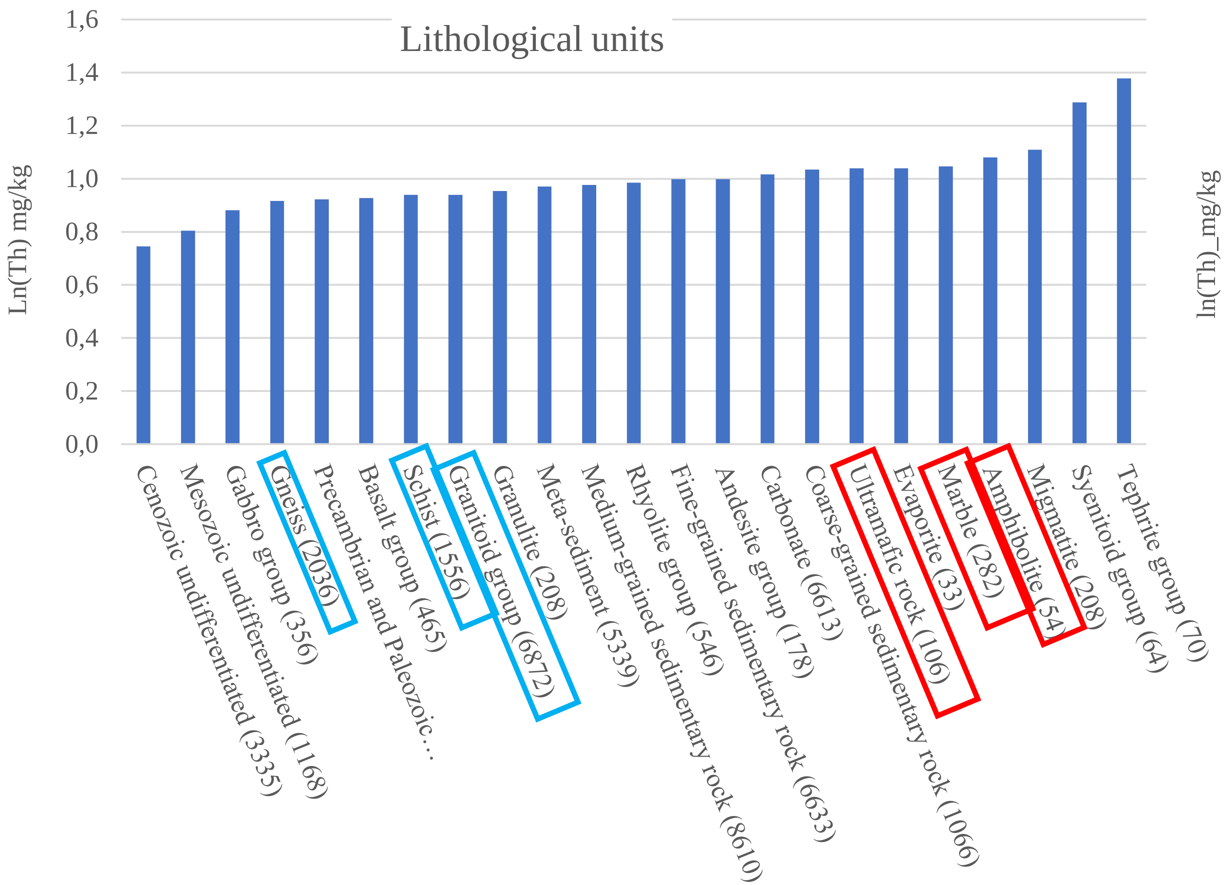
U concentration in soil: analysis

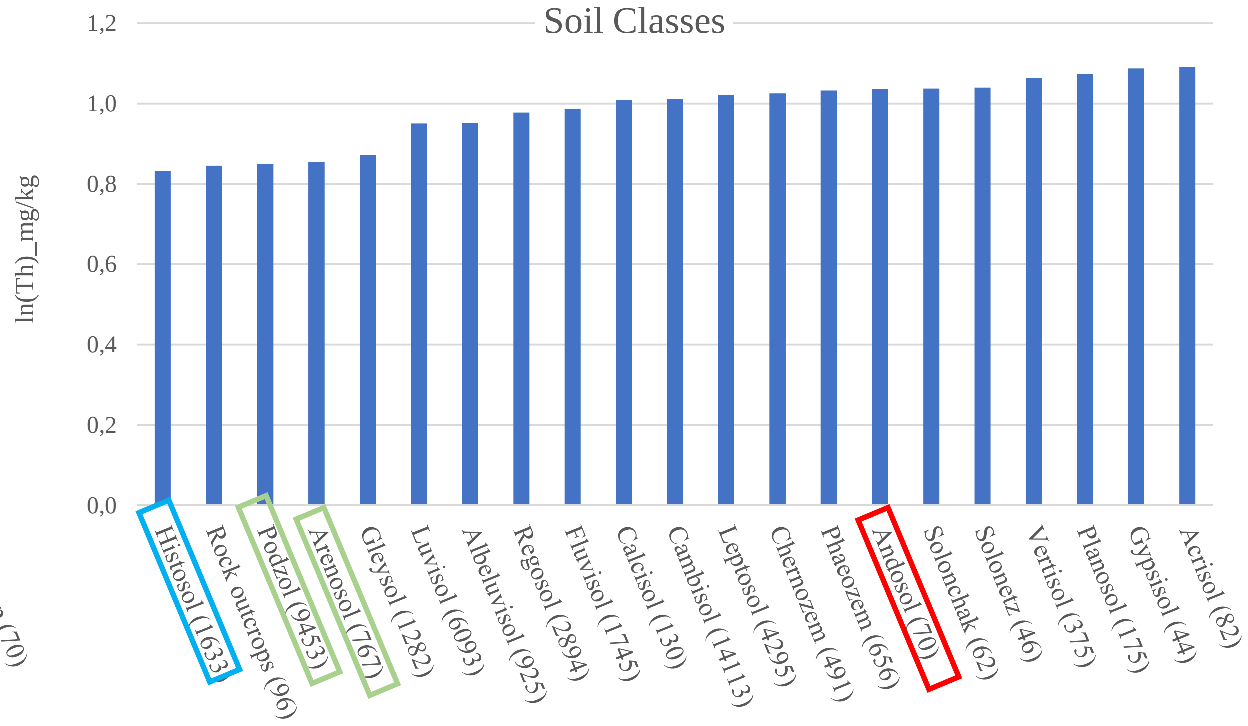




Ln (U)	Number of units	Percentage of variation (%)
IV: lithology	23	24.39
IV: Soil Classes	21	19.15

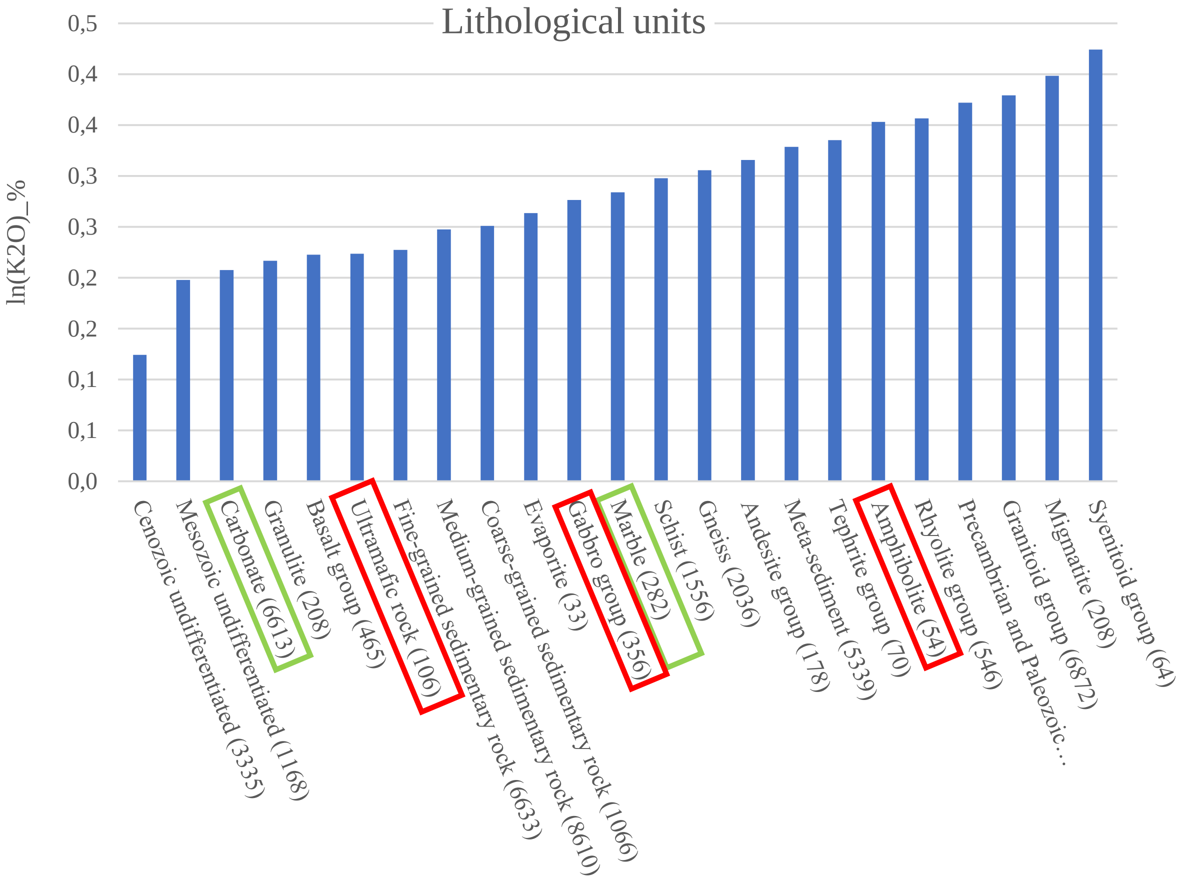
Th concentration in soil: analysis

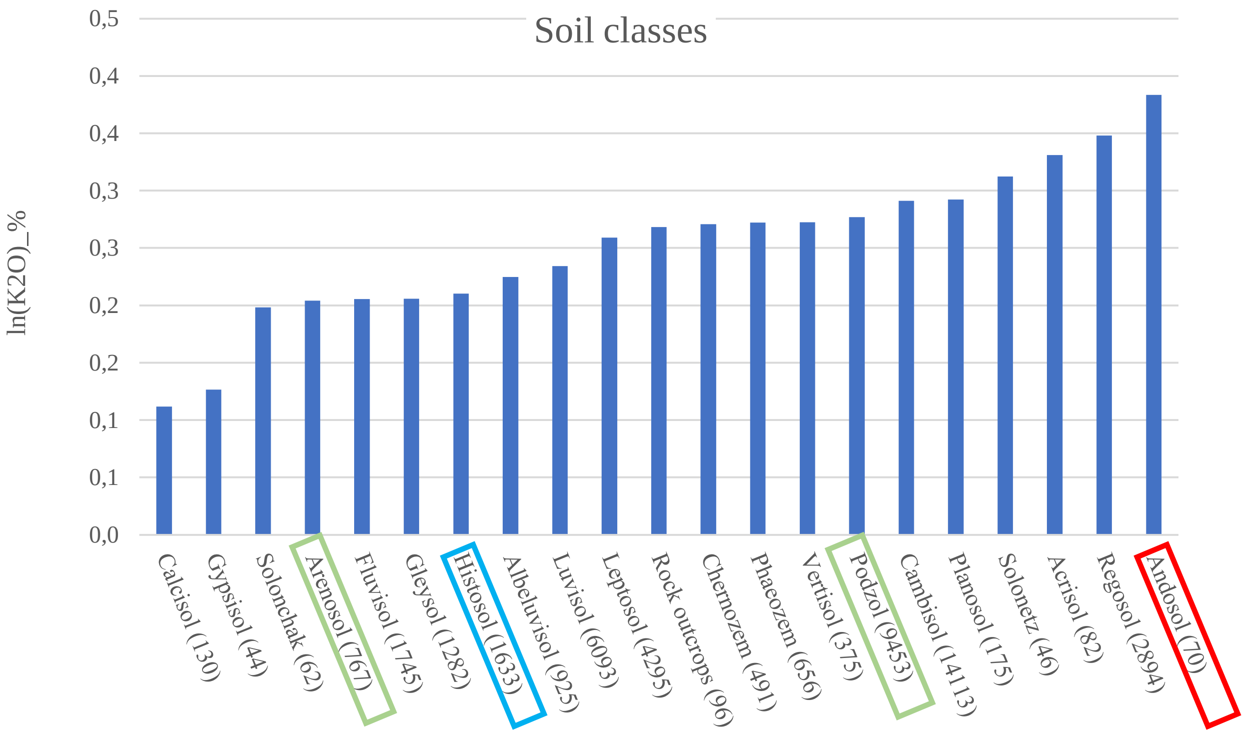




Ln(Th)	Number of units	Percentage of variation (%)
IV: lithology	23	21.10
IV: Soil Classes	21	18.90

K_2O concentration in soil: analysis





Ln(K2O)	Number of units	Percentage of variation (%)
IV: lithology	23	25.6
IV: Soil Classes	21	6.7

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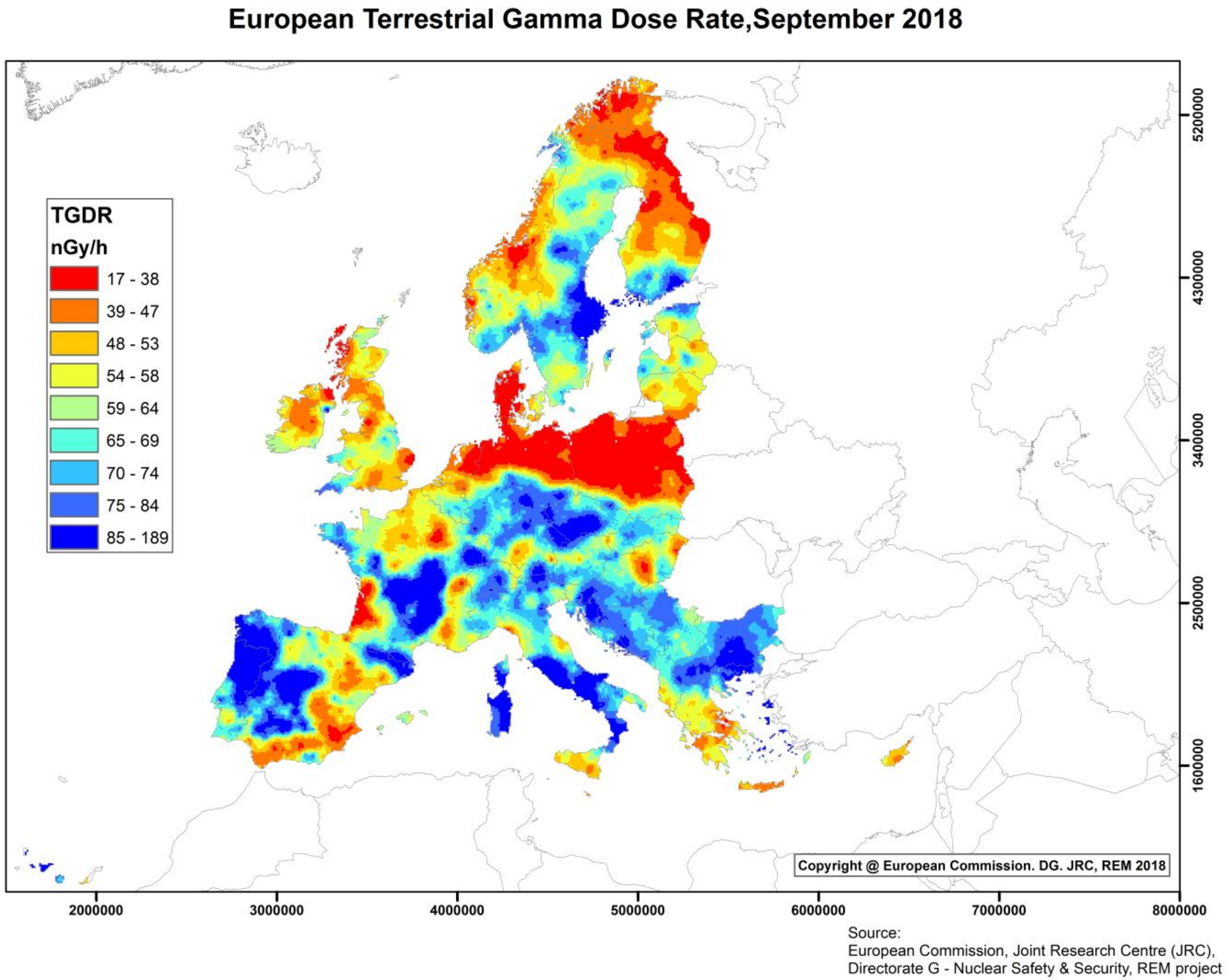
Terrestrial Gamma Dose Rate Map



Input data: U, Th and K concentration maps (above):

- 0.83 K%/K2O%
- 309.7 Bq/kg K / K%
- 12.35 Bq/kg U /ppm
- 4.072 Bq/kg Th /ppm

TGDR(nGy/h) (UNSCEAR, 2008)=
$0.0417 * C_K + 0.462 * C_U + 0.604 * C_{Th}$

Acknowledgment: Paolo Falletti, Enrico Chiaberto, Anselmo Cucchi, Mauro Magnoni (Arpa Piemonte)

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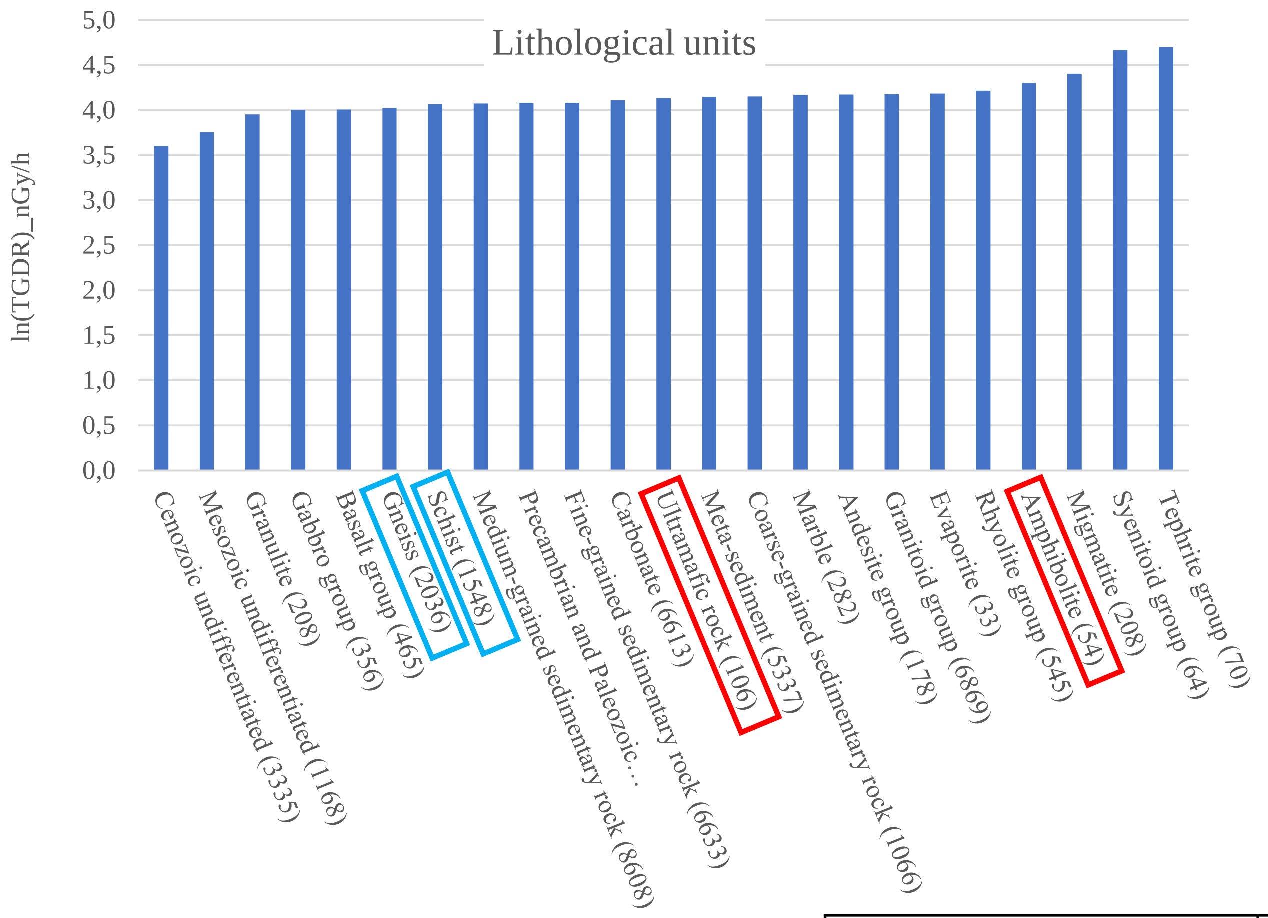
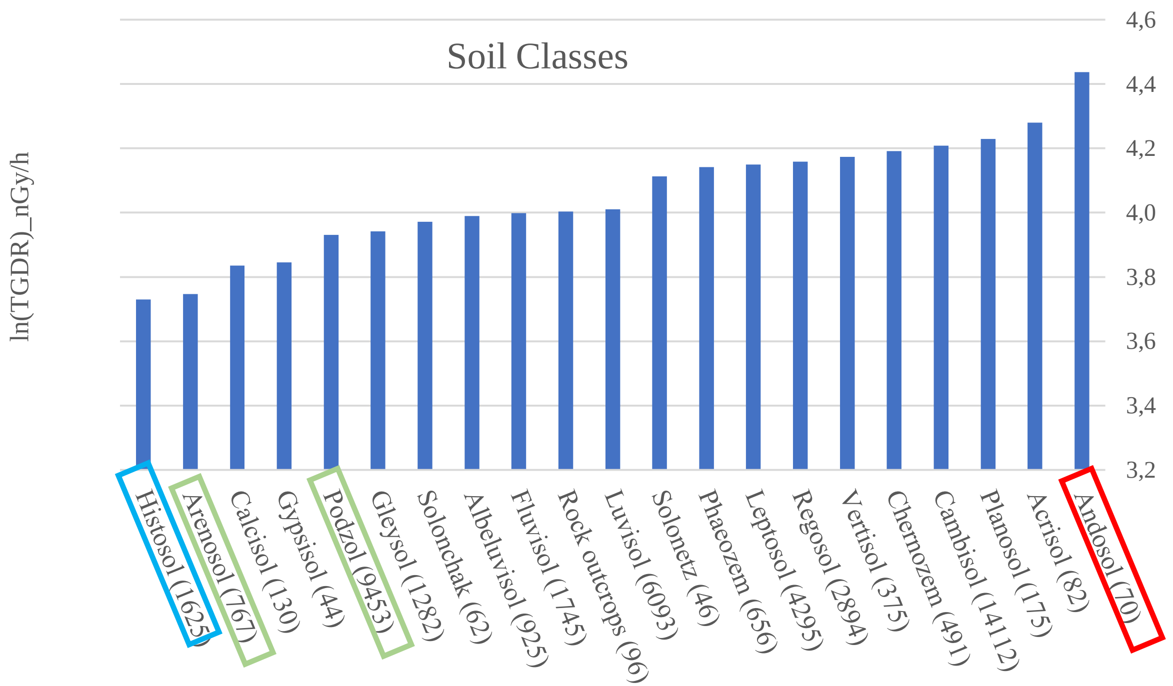
TGDR concentration in soil: analysis





Ln(TGDR)	Number of units	Percentage of variation (%)
IV: lithology	23	22.66
IV: Soil Classes	21	18.71

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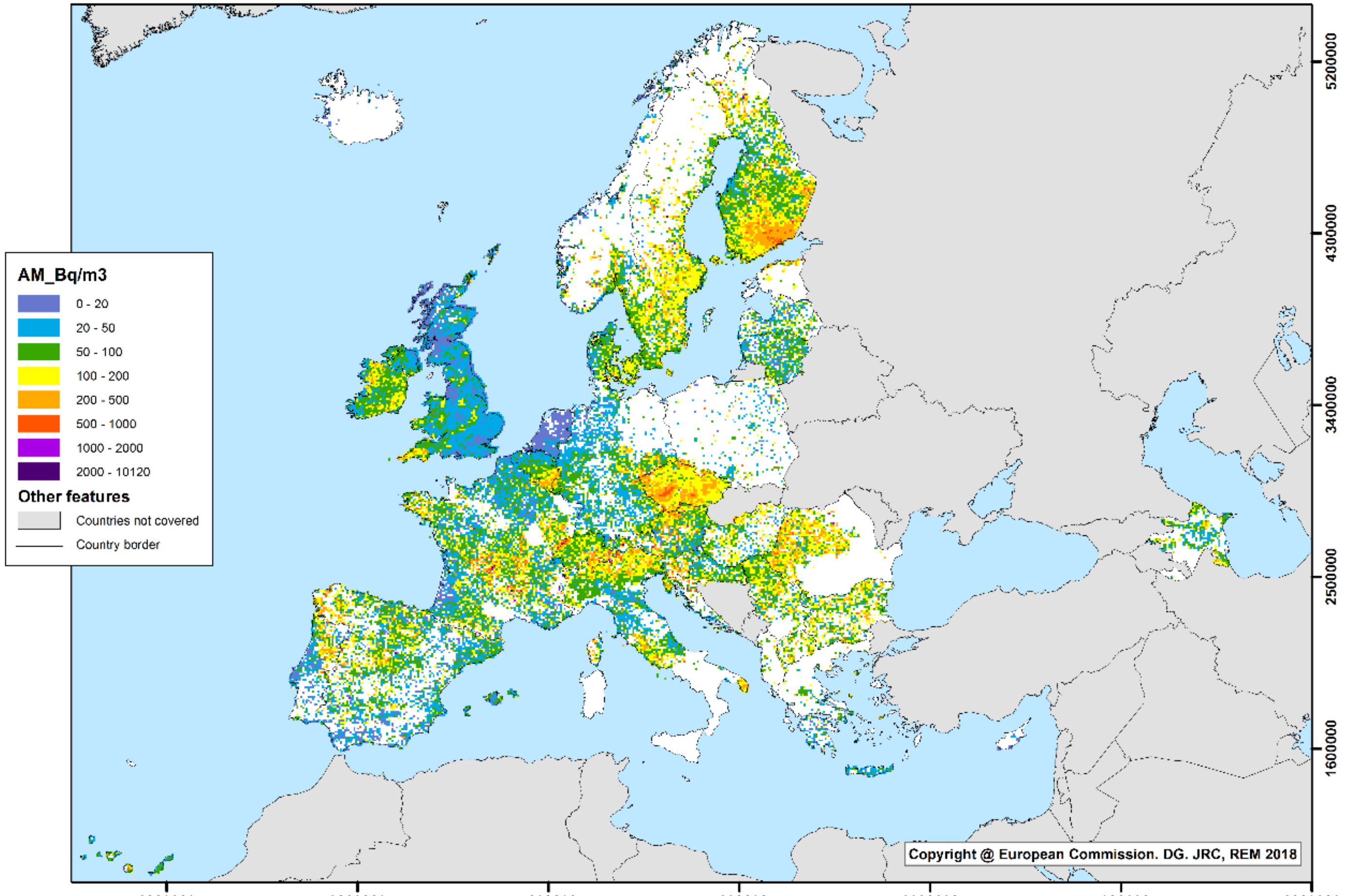
Some explanations for the unexpected classification:

- High variability inside the Lithological group
- Soil does not reflect the bedrock
- Use of fertilizers

European Indoor Radon Map: data

European Indoor Radon Map, March 2018



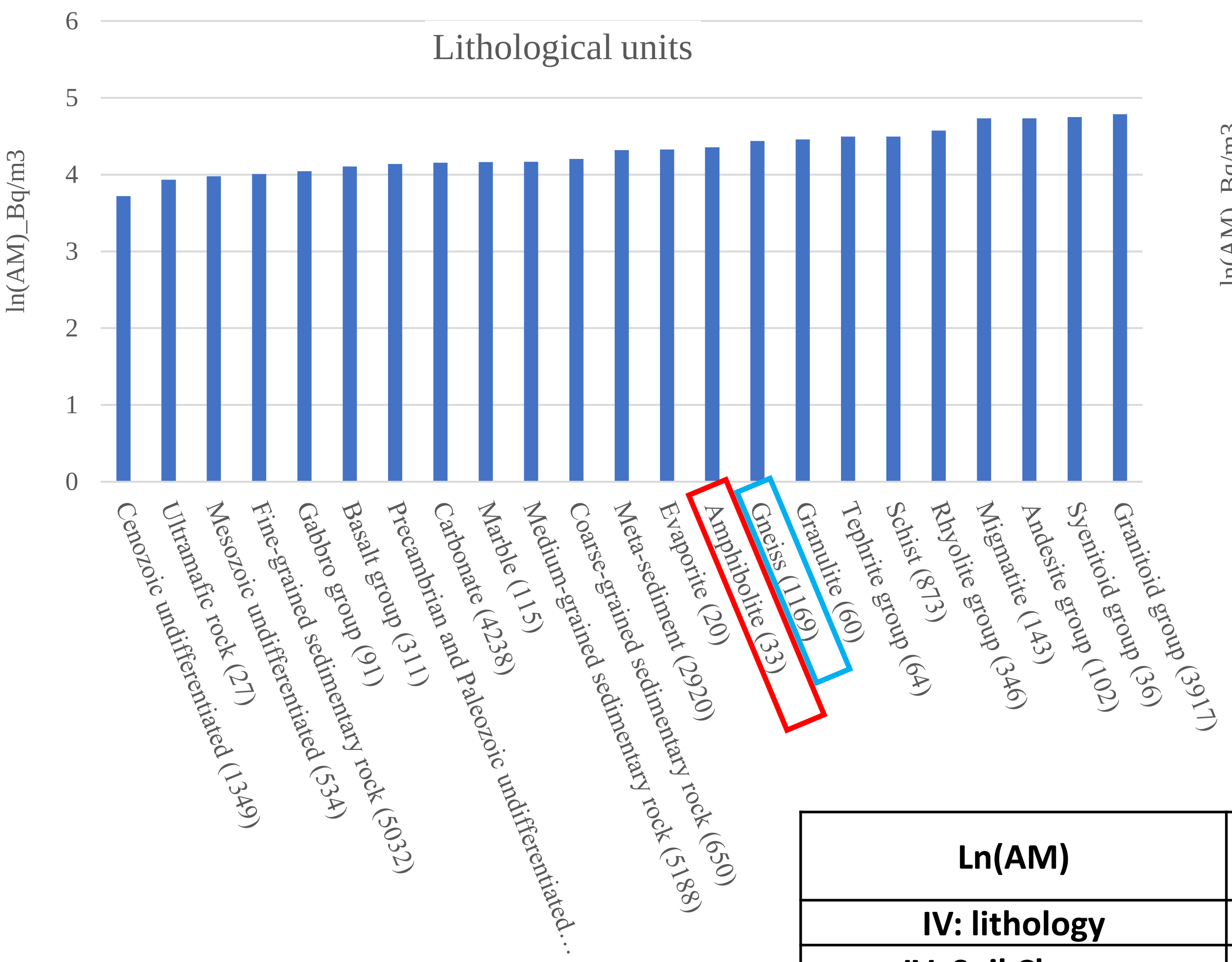
Arithmetic means over 10 km x 10 km cells of long-term radon concentration in ground-floor rooms.
(The cell mean is neither an estimate of the population exposure, nor of the risk.)

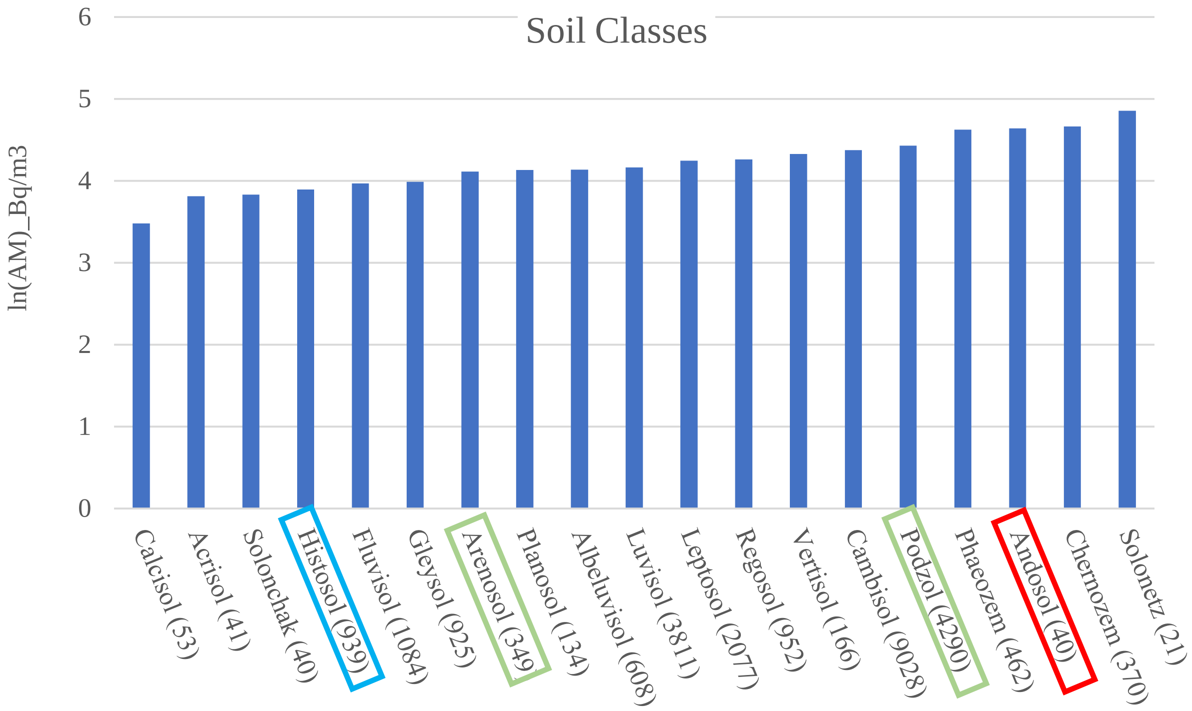
Source:
European Commission, Joint Research Centre (JRC),
Directorate G - Nuclear Safety & Security, REM project

- 10 km x 10 km grid cells
- Living rooms, ground floor
- Participants send statistics:
  - number of measurements
  - arithmetic mean (AM)
  - standard deviation (SD)
  - AM(ln data)
  - SD(ln data)
  - Median
  - minimum
  - maximum

Status (March 2018):
34 countries participate
~28,000 non-empty cells
~1,150,000 original measurements

European Indoor Radon Map: analysis





Ln(AM)	Number of units	Percentage of variation (%)
IV: lithology	23	10.08
IV: Soil Classes	19	4.0

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In summary

	IV: lithology	IV: Soil Classes
Ln (U)	24.39	19.15
Ln (Th)	21.10	18.90
Ln(K2O)	25.6	6.7
Ln(TGDR)	22.66	18.71
Ln(AM indoor Rn)	10.08	4.0

Conclusions

- Improve the analysis (foregs – gemas)_ to see the possible influence of fertilizers

- Use diffferent geological units (see poster of Nogarotto)_ find a compromise beetween reasonable number of GU and better classification

Any questions?

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