The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

Radon outdoor and radon flux in maps for radiation protection issues –WP4

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Scientific Workshop, EMPIR 19ENV01 traceRadon

20 October 2020

AIMS

The aim of WP4 is to provide:

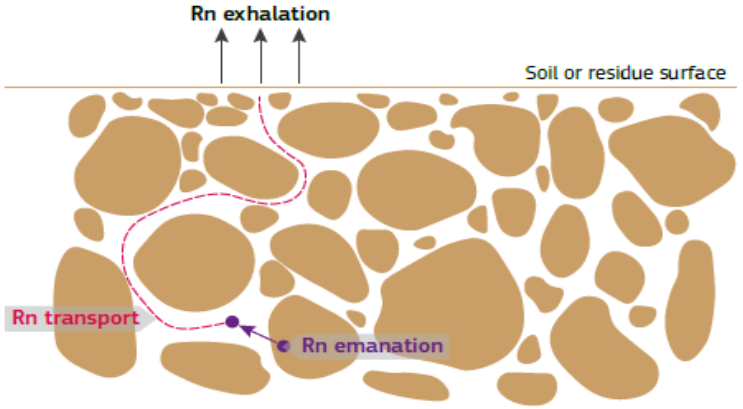
an easy to use dynamic **radon concentration and radon flux map** for

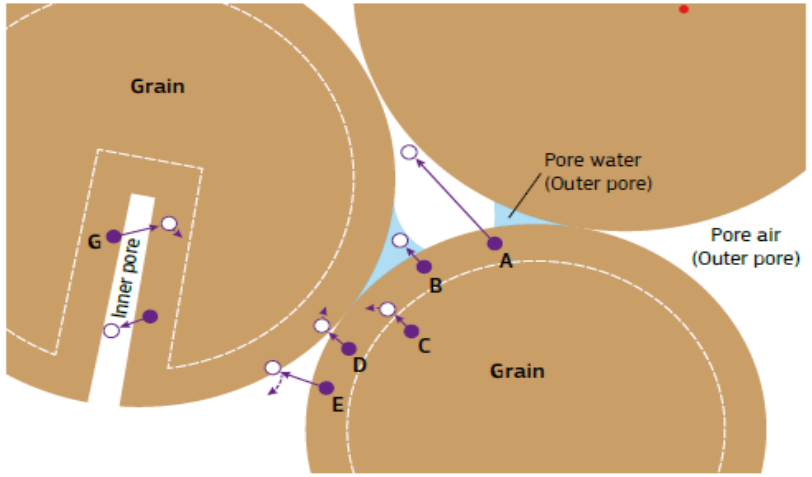
climate change research

radiation protection in line with Council Directive 2013/59/EURATOM

Framework

- Radon (^{222}Rn) concentration in the atmosphere is directly related to the exhalation rate of radon from soil.
- Once radon is in the outdoor air, its dilution/dispersion depends on atmospheric diffusion conditions related to meteorology and topography.
- Typical outdoor radon concentrations are on the order of 10 Bq/m^3(Unscear, 1993)
- Radon concentration in outdoor air-atmosphere is known to have **no major impact on health** (WHO, 2009).





Why did we mention radiation protection?

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Radon outdoor and exhalation rate useful in radiation protection

WP4 tasks:

1) **Identify Radon Prone Areas (RPAs) –task 4.1**
2) **Identify the radon wash-out peaks in the Ambient Dose Equivalent rate measurement – task 4.2**
3) **Data Accessibility and public engagement – task 4.3**

What is a Radon Priority Area - RPA?

According to Article 103(3) of the Directive*, Member States are obliged to *identify areas where the radon concentration (as an annual average) in a significant number of buildings is expected to exceed the relevant national reference level*.

The delineation of geographical or administrative areas where radon concentrations in buildings are more likely to exceed the national reference level will allow to plan and to prioritize measures within the national action plan. These areas are often called "**radon priority areas**" **

*Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation…Official Journal of the European Union OJ L13, 17.1.2014, p. 1 – 73

**Radiation Protection n.193, Radon in workplaces, Implementing the requirements in Council Directive 2013/59/Euratom

.

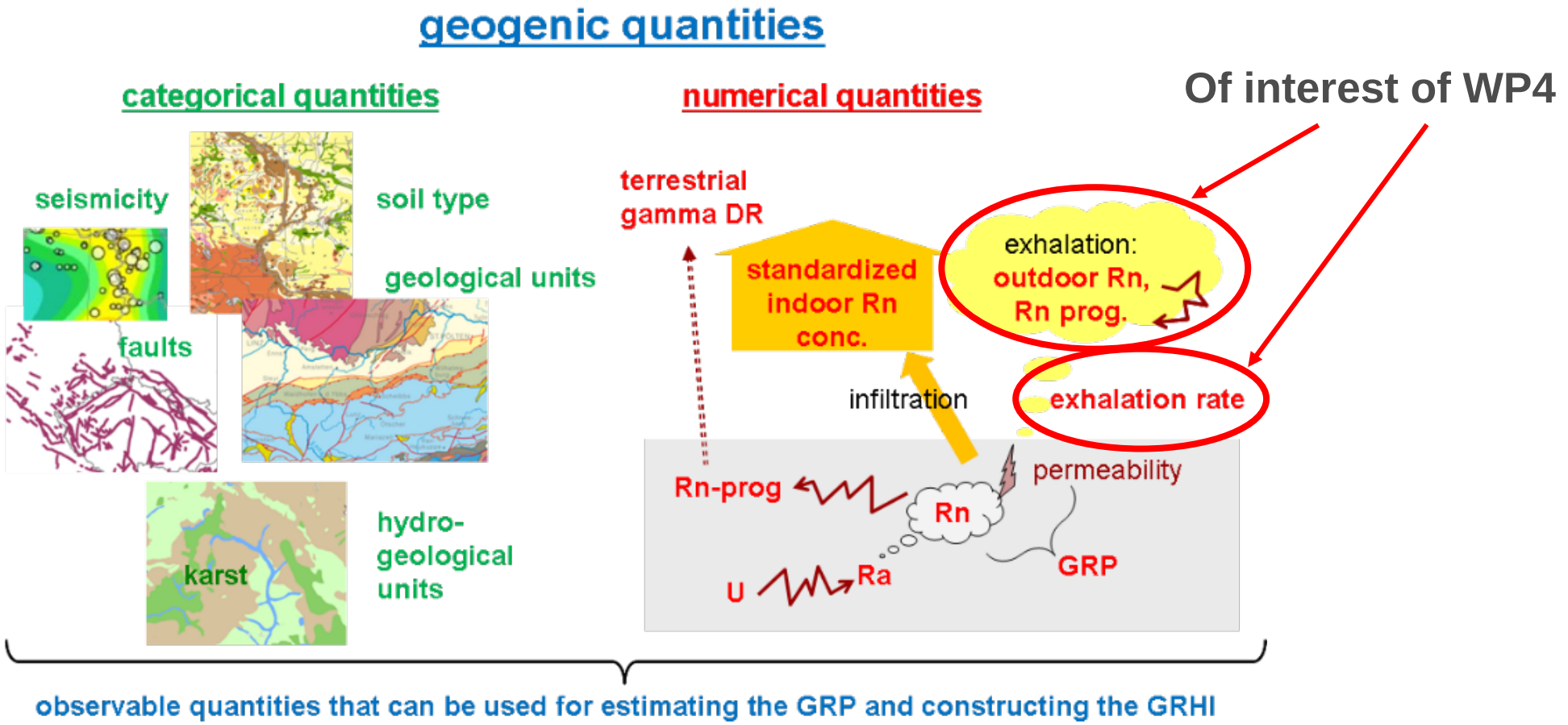
RPA: radon in buildings – radon indoor

Indoor Rn is controlled by both natural and anthropogenic factors.

- Natural factors, defined as **geogenic factors**, are related to radon generation and transport in the ground, whereas

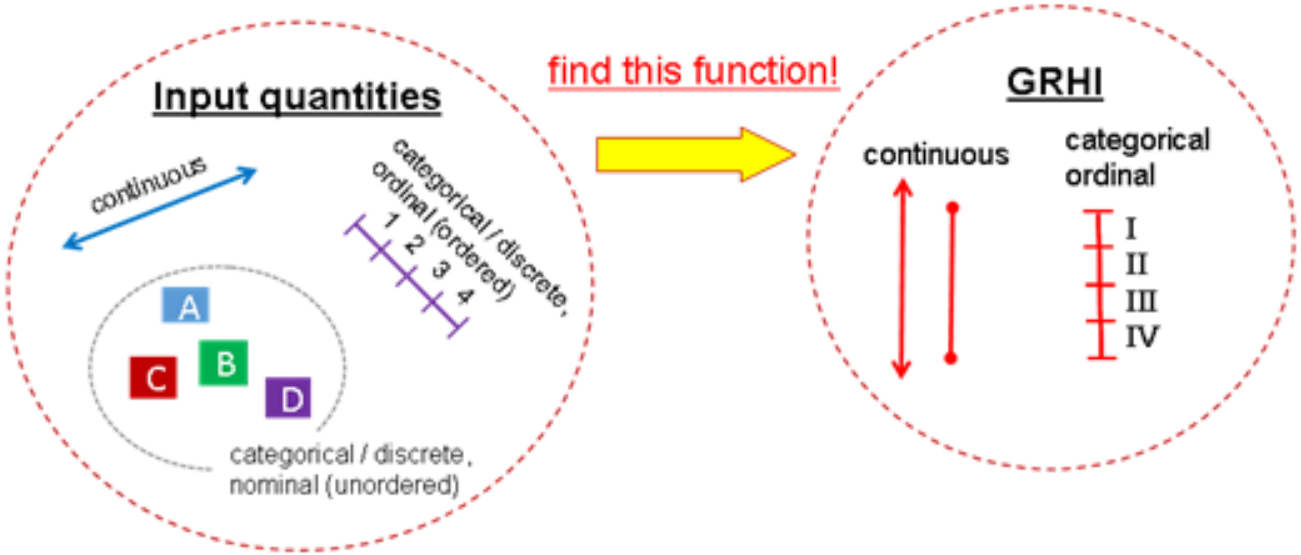
- **Anthropogenic factors** relate to construction characteristics of a building, including building materials and usage patterns.

RPA: Geogenic factors



Publication:
Bossew, P., Cinelli, G., Ciotoli, G., Crowley, Q.G., De Cort, M., Elio Medina, J., Gruber, V., Petermann, E., Tollefsen, T., 2020:
Development of a Geogenic Radon Hazard Index – concept, history, experiences, IJERPH 2020, *17*(11), 4134 (2020), https://doi.org/10.3390/ijerph17114134

RPA and Geogenic Radon Hazard Index (GRHI)



- Quantify the hazard originating from geogenic radon using the geogenic quantities regionally available.
- The challenge is to ensure consistency between the GRHI estimates in neighbouring regions if estimated from different predictors

MetroRadon project- WP4

Publication:

Bossew, P., Cinelli, G., Ciotoli, G., Crowley, Q.G., De Cort, M., Elio Medina, J., Gruber, V., Petermann, E., Tollefsen, T., 2020: Development of a Geogenic Radon Hazard Index – concept, history, experiences, IJERPH 2020, *17*(11), 4134 (2020), https://doi.org/10.3390/ijerph17114134

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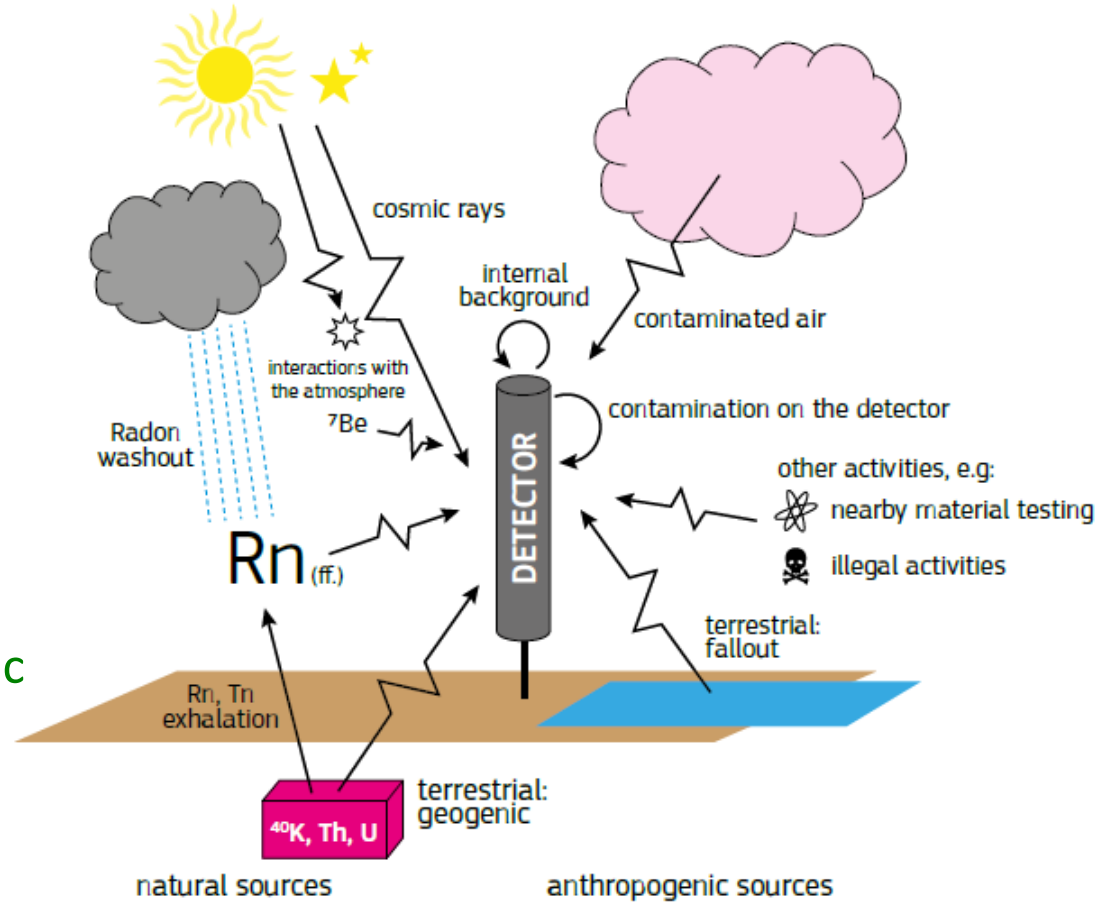
Task 4.2- Ambient Dose Equivalent Rate

Constant:

- internal background or self effect of the probe
- cosmic radiation (mainly muons)
- antropogenic radionuclides (in case of radiological event or accident)
- terrestrial gamma radionuclides (U and Th series, ^{40}K)_TGDR

Variable:

- Natural airborne (Rn, Tn and progenies, cosmogenic radionuclides)
- Fluctuation of TGDR due to different soil humidity
- Anthropogenic: Radiological release
- **Wet deposition of Rn progenies *(Radon wash-out peak)***



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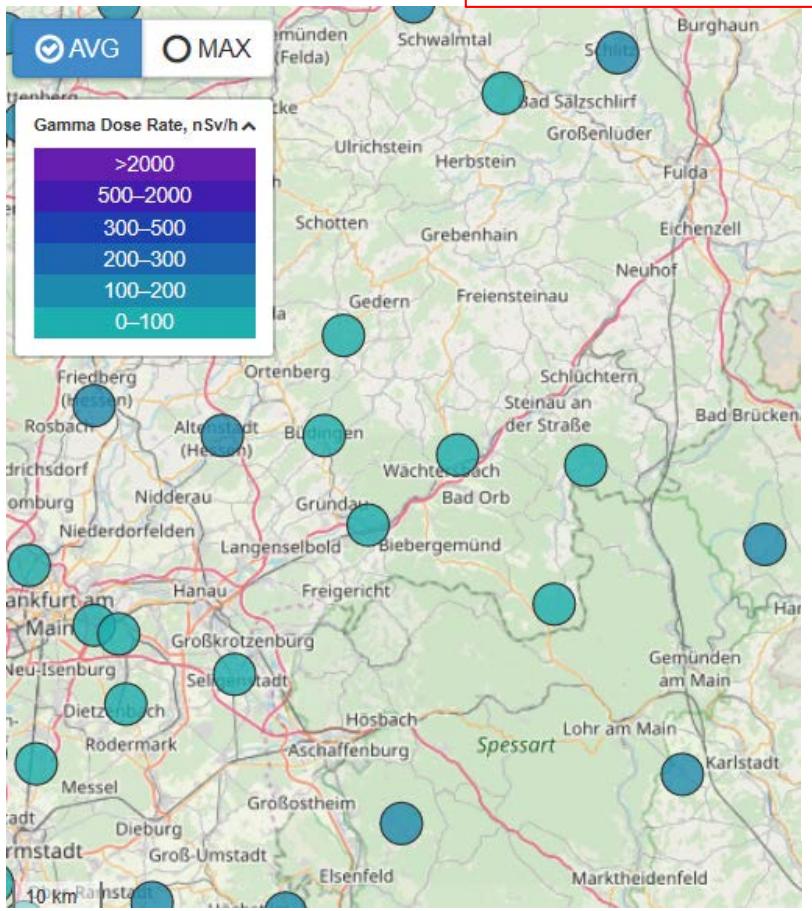
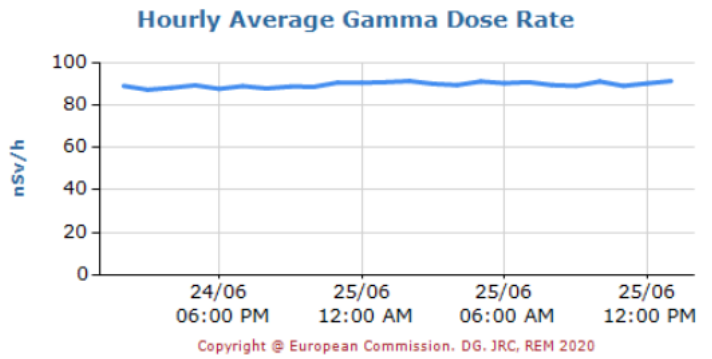
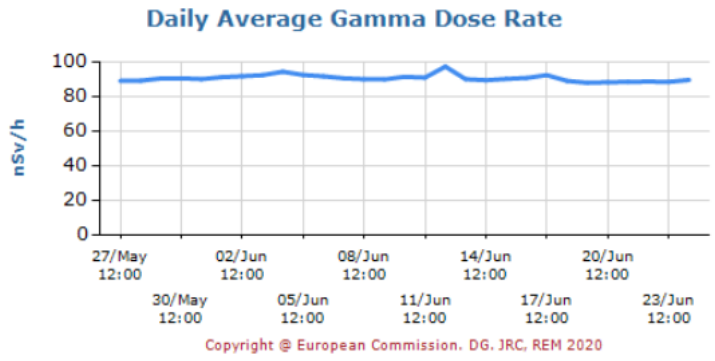
Task 4.1: EURDEP – public page

EUropean Radiological Data Exchange Platform (EURDEP) network for the exchange of radiological monitoring data between participating countries almost in REAL TIME. Monitoring information are collected from automatic surveillance systems in 39 countries. These data reflect essentially the natural radiation background, if NO radiological events occur.

Early warning in radiological emergencies







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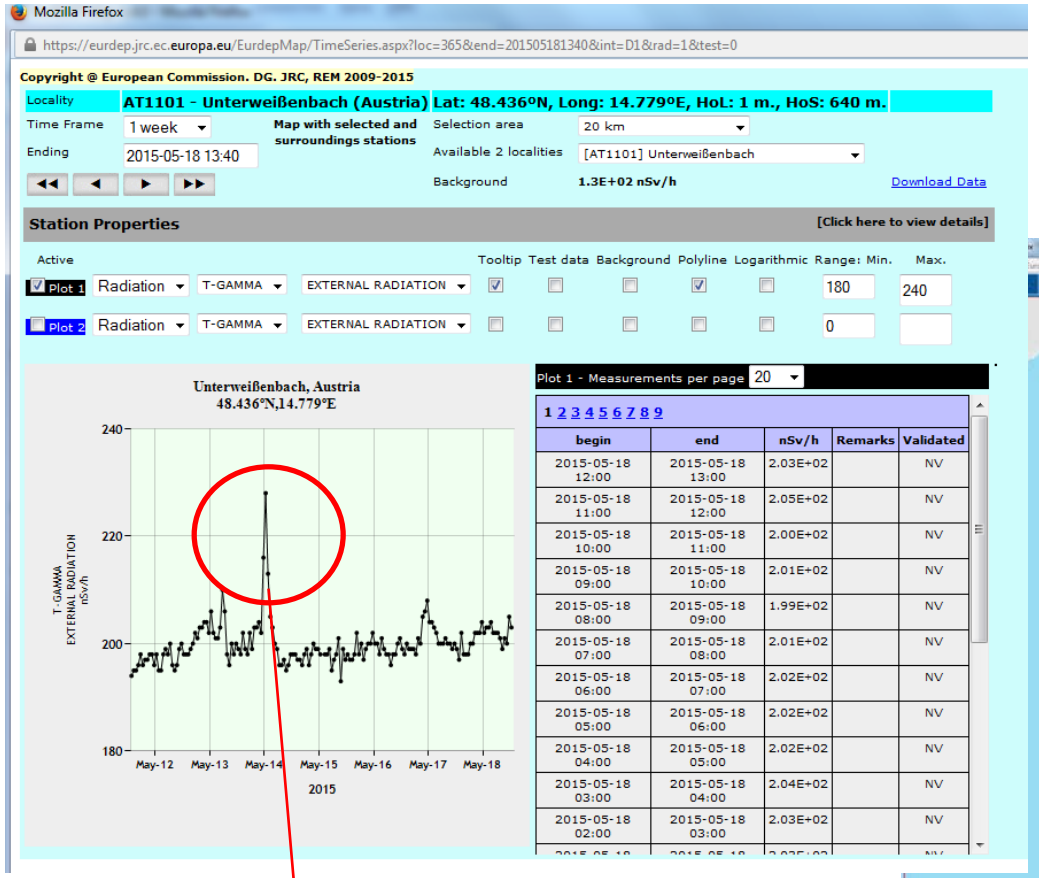
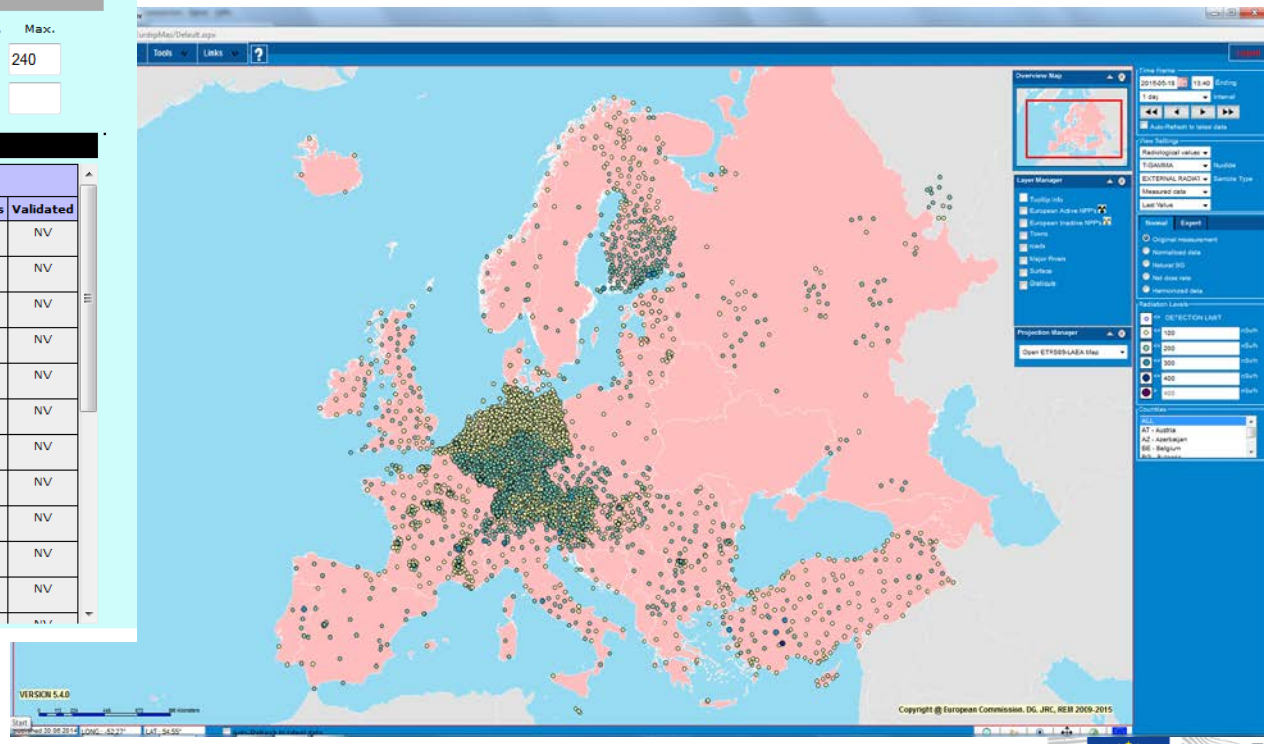
Task 4.2: Methodology - EURDEP – expert page





Radon wash out peak

Benefits (i.e. in EURDEP)

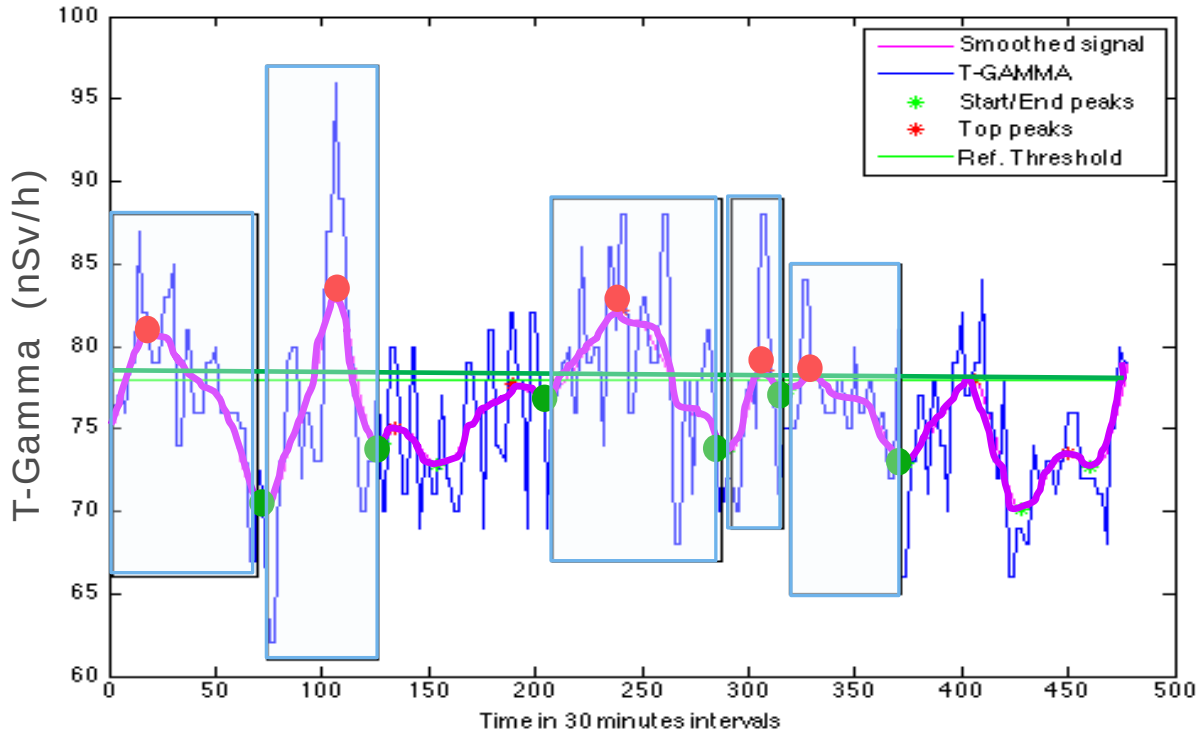
- **Signal detection**: Limit the risks of 1. and 2. kind errors (false alarms and false non-alarms) in the identification of false-positive or false-negative peaks;

- **Signal interpretation:** Avoid public misunderstanding about peaks due to natural causes, i.e. meteorological events

Task 4.2: Methodology - Objective

Study the influence/relationship of meteorological parameters and radon concentration on ADER peaks

Characterization of ADER peaks → intensity, season, duration



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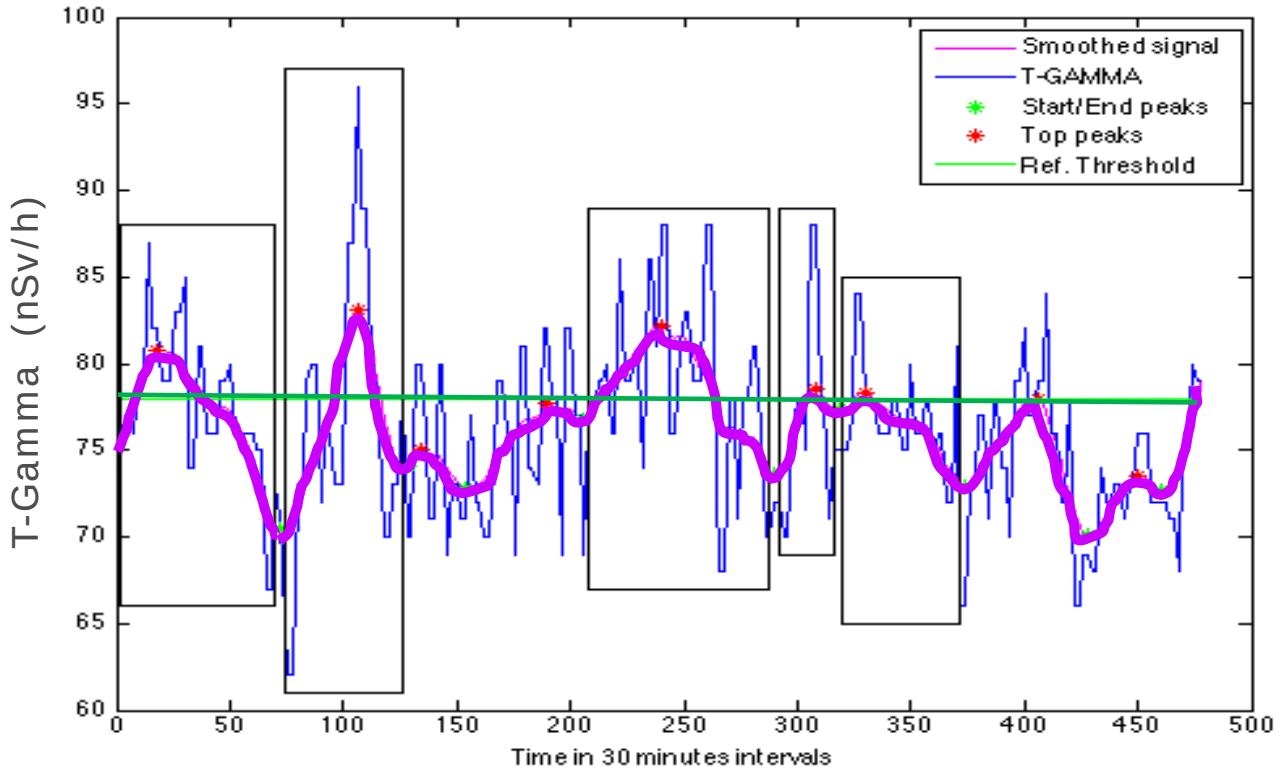
Task 4.2: Methodology 1 - proposal

Objective: Identification of ADER peaks

(Previous use: Estimate the Terrestrial gamma dose rate*)

1. Smoothing (moving average filter – 8 values) of Total-Gamma to remove the short-term variations in the data whilst preserving the medium-term trend (pink line)
2. Calculate the yearly 75th percentile as minimum threshold (green line)



* Bossew, et al, 2017. Estimating the terrestrial gamma dose rate by decomposition of the ambient dose equivalent rate. Journal of Environmental Radioactivity, Volume 166 Part 2, 296-308 http://dx.doi.org/10.1016/j.jenvrad.2016.02.013

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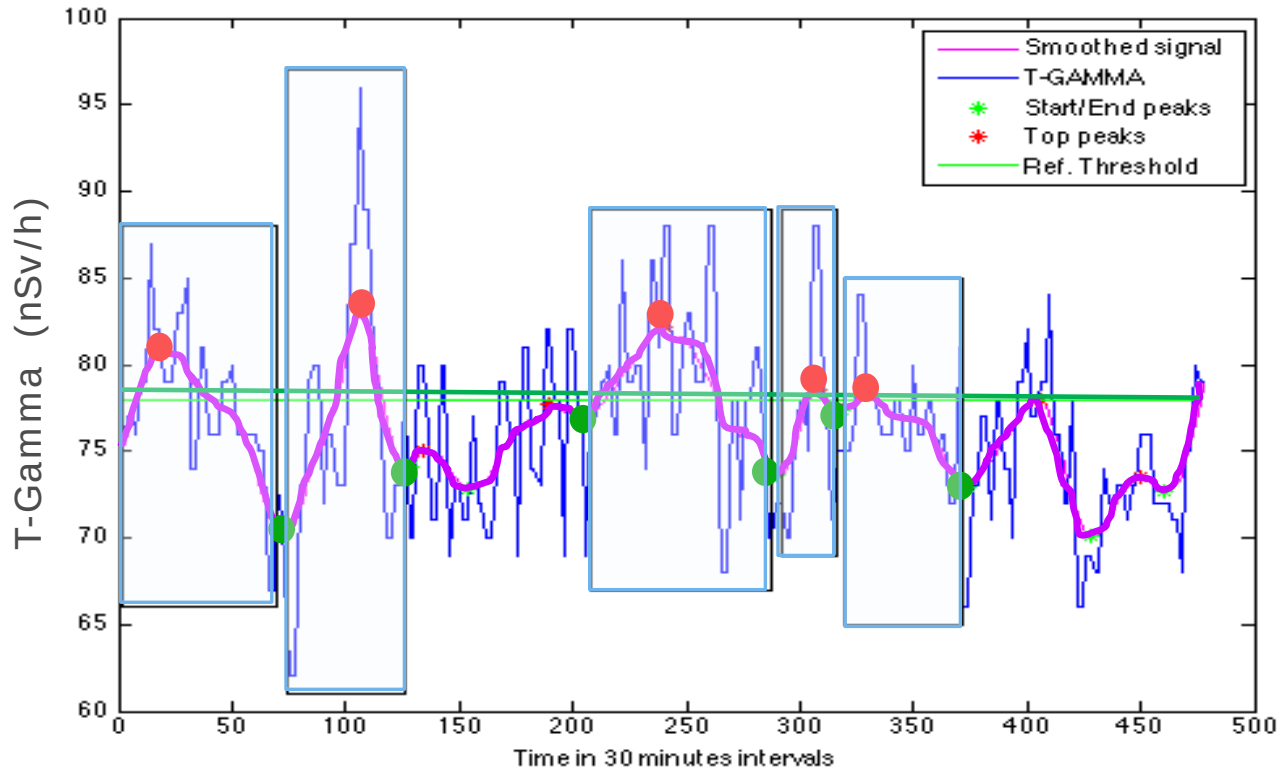
Task 4.2: Methodology 1 - proposal

3. Identification of peak values (red points)

4. Identification of peak interval → Valley value (green points) + peak value



Task 4.2: Methodology 1 - proposal

Objective: Characterization of ADER peaks

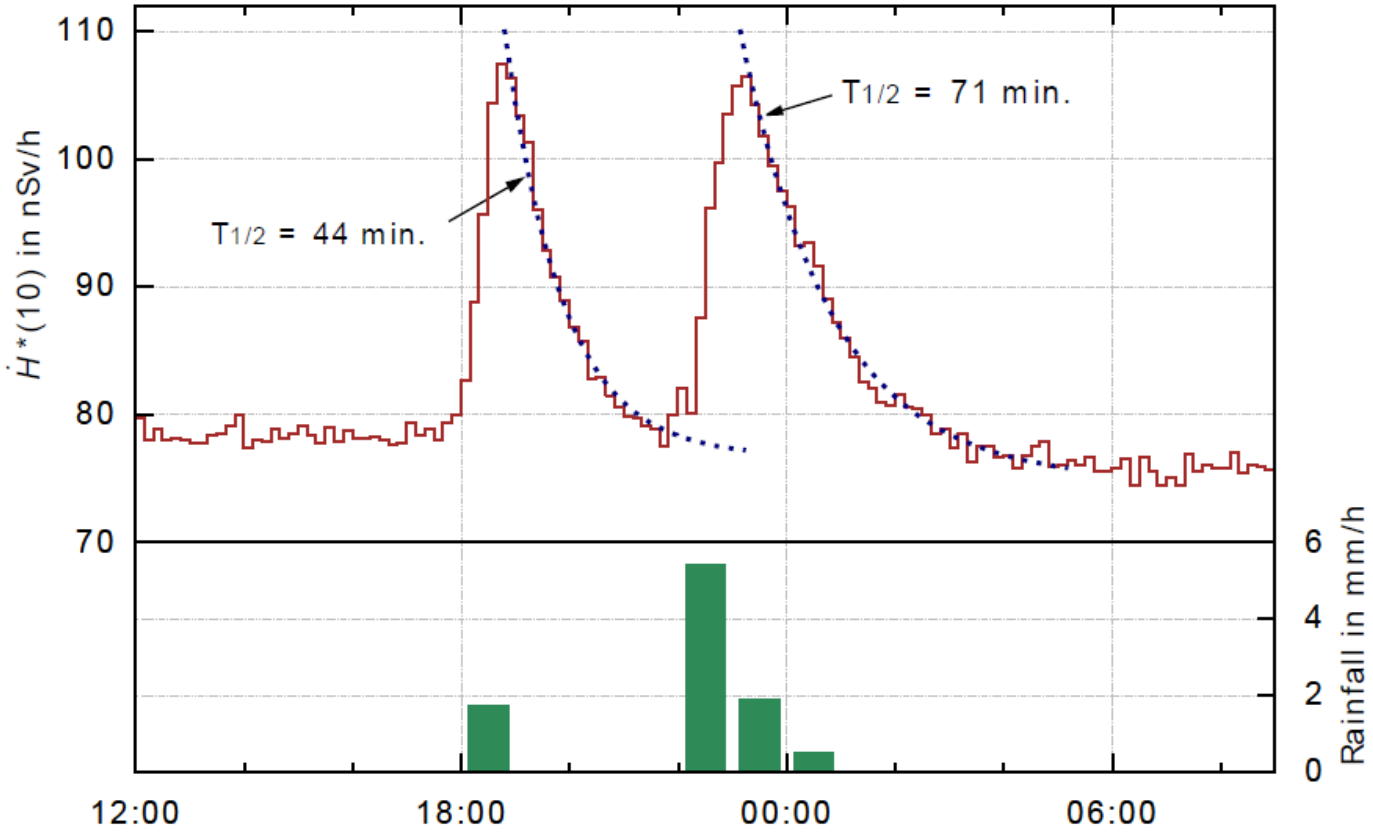
Metereological parameters

Rn concentration

	Duration of the peak	Rainfall	Relative Humidity (RH)	Temperature (T)	Wind speed (WS)	Rn average during the whole period	Average of radon during ADER Peaks
ADER peak values							

ADER peaks = β f(Duration of peak) + α f(Temperature) + μ f(rainfall) + θ f(wind speed) + η f(relative humidity) + ε f(radon) + ν f(antropogenic radioduclides).....

Task 4.2: Methodology 2 – Decay time



Calculate the decay time of the ADER peak to check if it is a "radon" peak

Rafał Dąbrowski, H. Dombrowski, P. Kessler, A. Röttger, S. Neumaier, EURADOS WG3-S1, Ljubljana 2017

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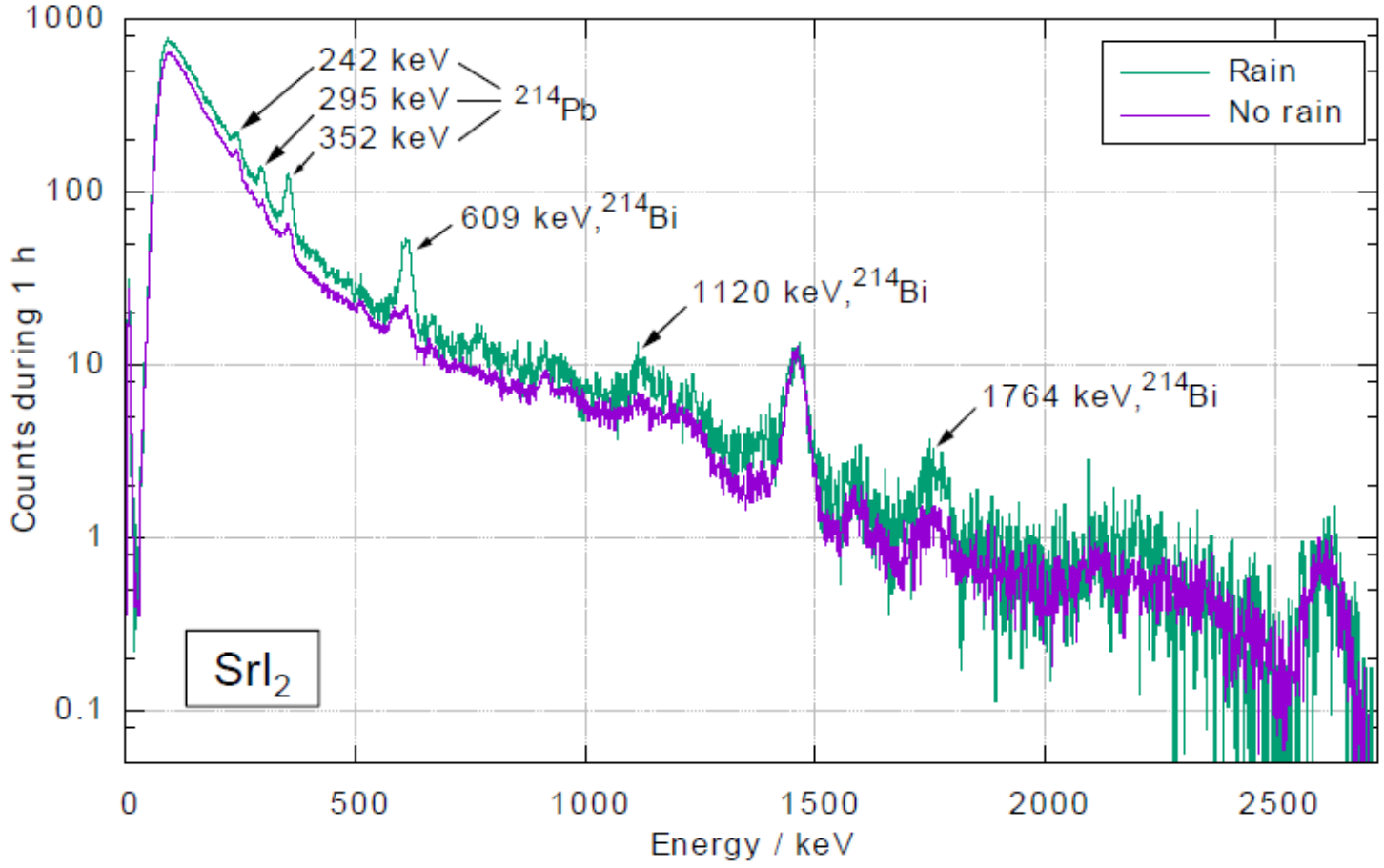
Task 4.2: Methodology 3 - proposal



Use gamma spectra to identify radon washout-peaks

Spectrometric detectors needed

Rafał Dąbrowski, H. Dombrowski, P. Kessler, A. Röttger, S. Neumaier, EURADOS WG3-S1, Ljubljana 2017

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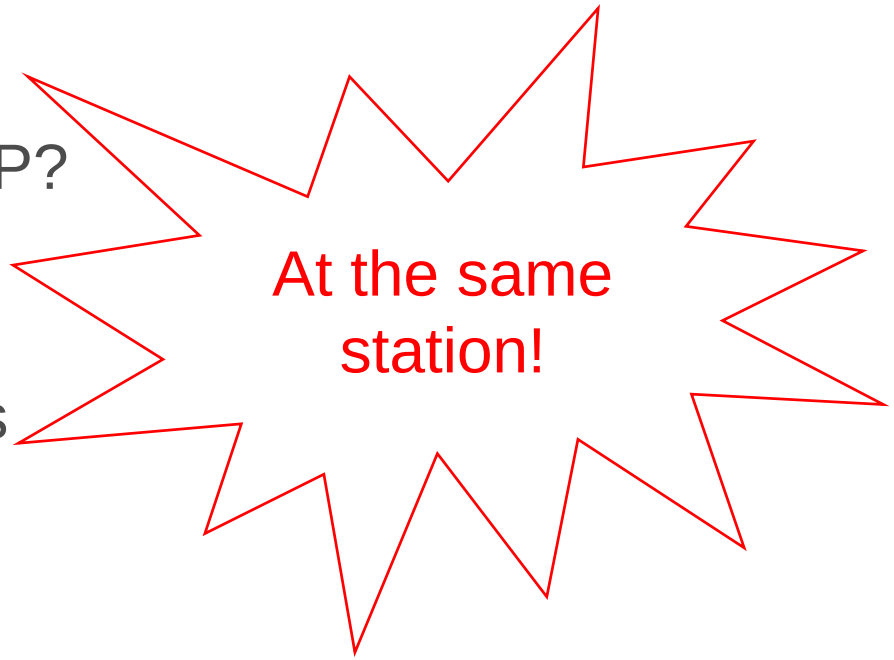
Needs!

- ✓ Good Ambient Equivalent Dose Rate –EURDEP?
- ✓ Good radon outdoor and exhalation data series **(WP2, WP3, EURDEP and various)**
- ✓ Good meteorological data



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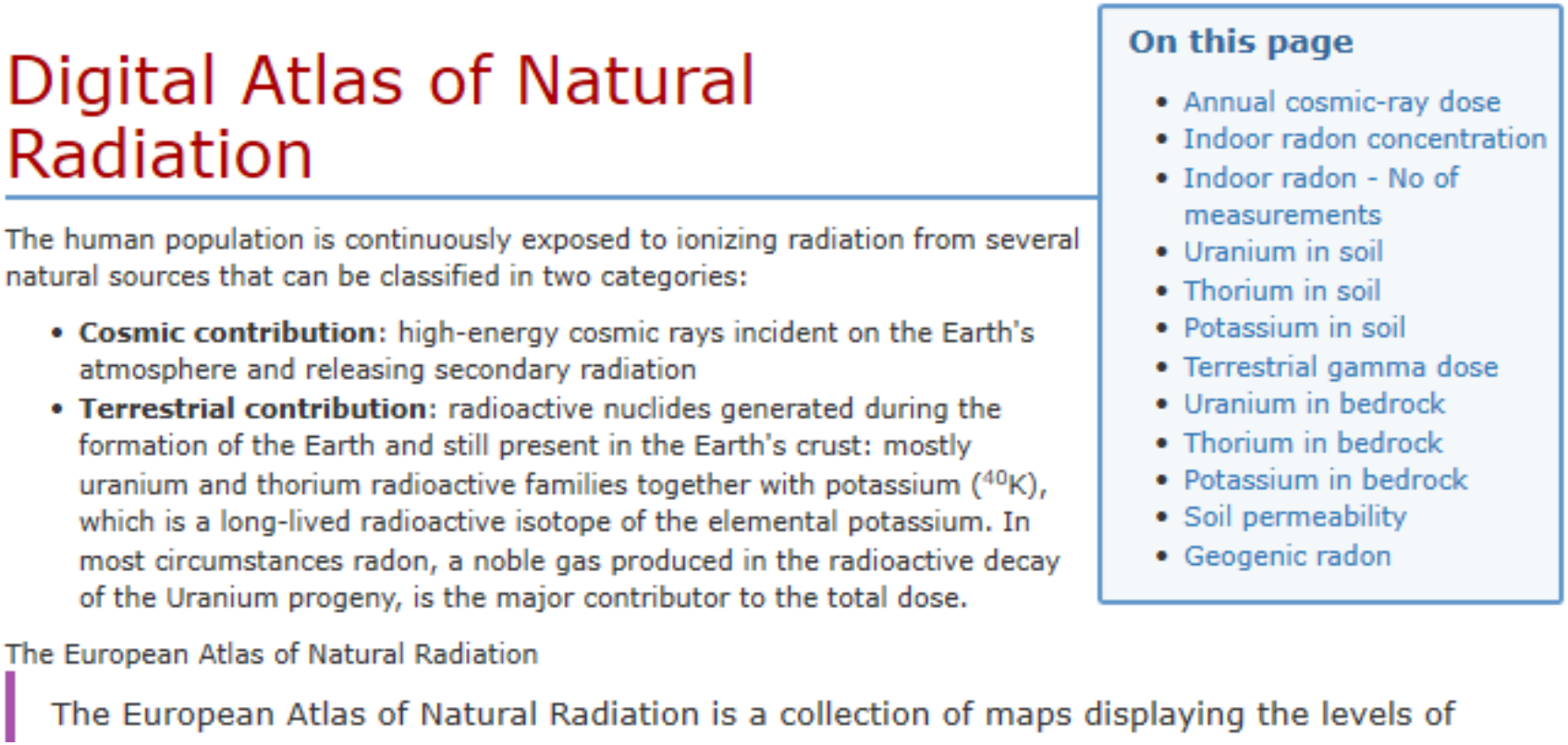
Task:4.3 Data Accessibility and public engagement

To provide **online radon activity concentration and radon flux maps - Task 4.3**.

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



Digital 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 potassium (^{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

- Annual cosmic-ray dose
- Indoor radon concentration
- Indoor radon - No of measurements
- Uranium in soil
- Thorium in soil
- Potassium in soil
- Terrestrial gamma dose
- Uranium in bedrock
- Thorium in bedrock
- Potassium in bedrock
- Soil permeability
- Geogenic radon

The European Atlas of Natural Radiation

> The European Atlas of Natural Radiation is a collection of maps displaying the levels of

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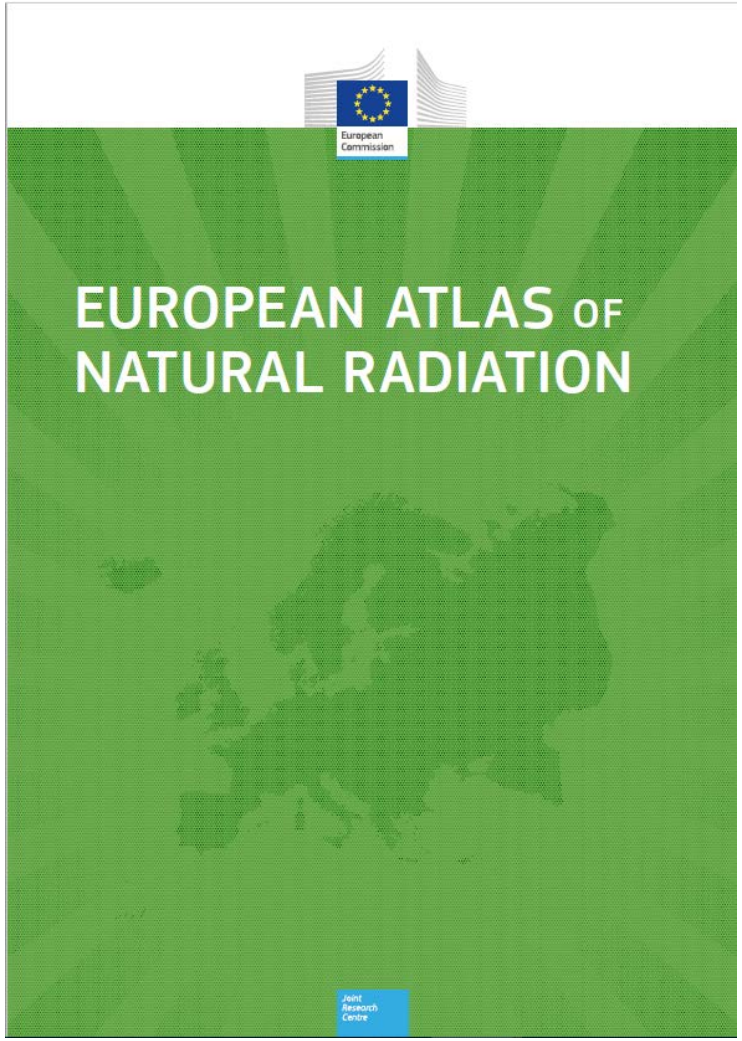
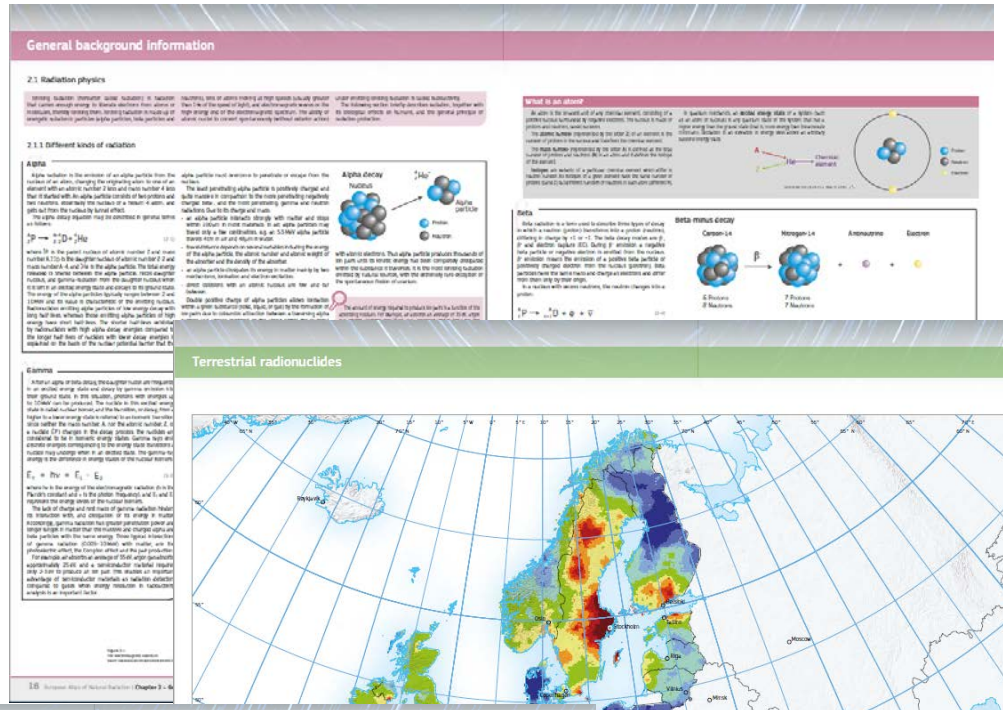
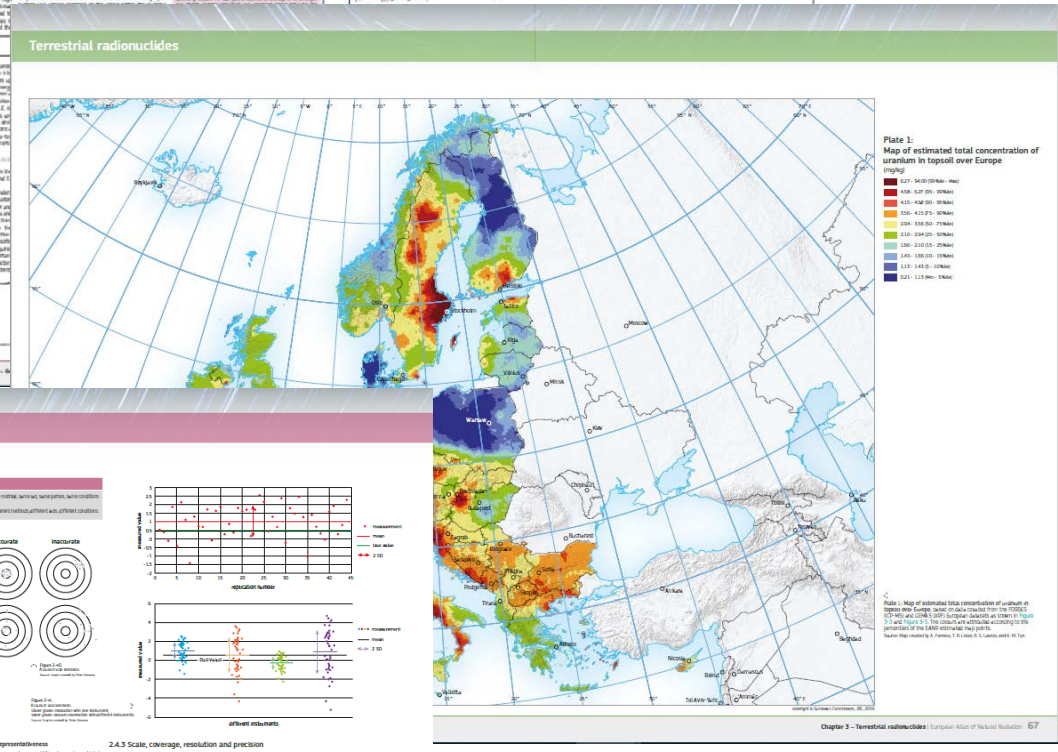
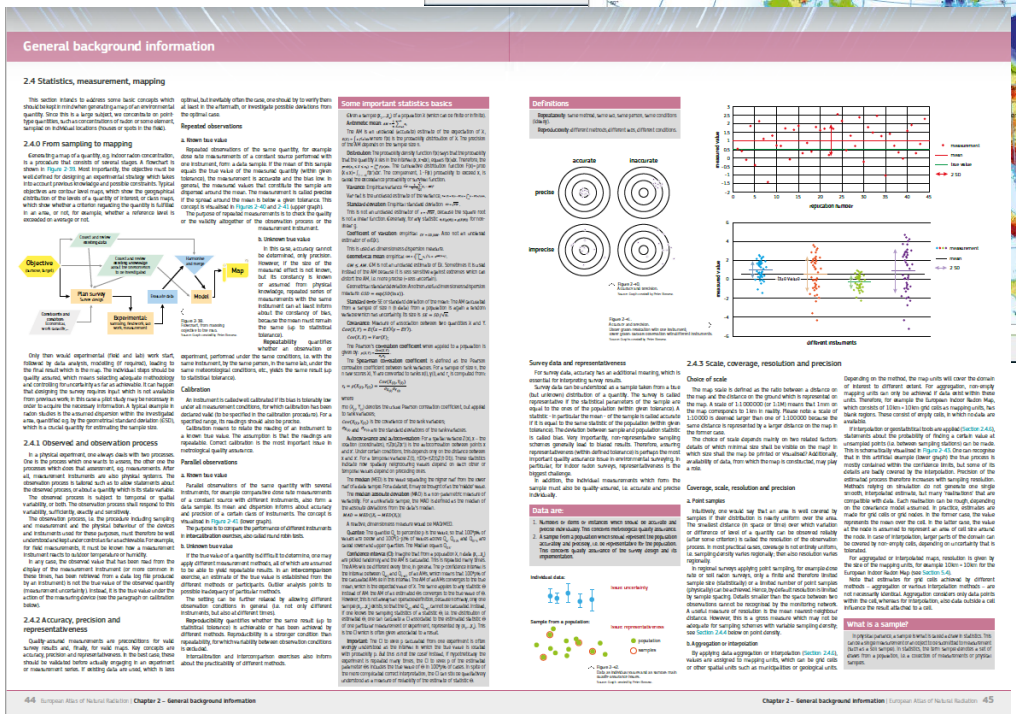
Atlas Publication



- A3 format
- 190 pp
- Digital and paper







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Partners involved in WP4

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CLOR, Centralne Laboratorium Ochrony Radiologicznej (PL)

INESC TEC, Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência (PT)

JRC, Joint Research Centre - European Commission (IT)_**WP leader**

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PTB, Physikalisch-Technische Bundesanstalt (DE)

UC, Universidad de Cantabria (ES)

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VINS, Institut Za Nuklearne Nauke Vinca (RS)

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