RadoNorm

Managing risks from radon and NORM

Towards effective radiation protection based on improved scientific evidence and social considerations – focus on radon and NORM

Research and Innovation Action (RIA)

EURATOM Nuclear Fission and Radiation Protection Research

CALL: NFRP-2019-2020-12

Further integrating Radiation Protection research in the EU

Grant Agreement Number: 9 0 0 0 0 9

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The main goal of RadoNORM is reduction uncertainties in the field of scientific, technical and societal knowledge with regard to Radon and NORM by:

- initiating and performing research and technical development
- stimulating and integrating education and training activities in all research and development activities
- disseminating project outcomes to the public, stakeholders and regulators

Consortium

56 Partners, 20 Member States plus Norway and Switzerland

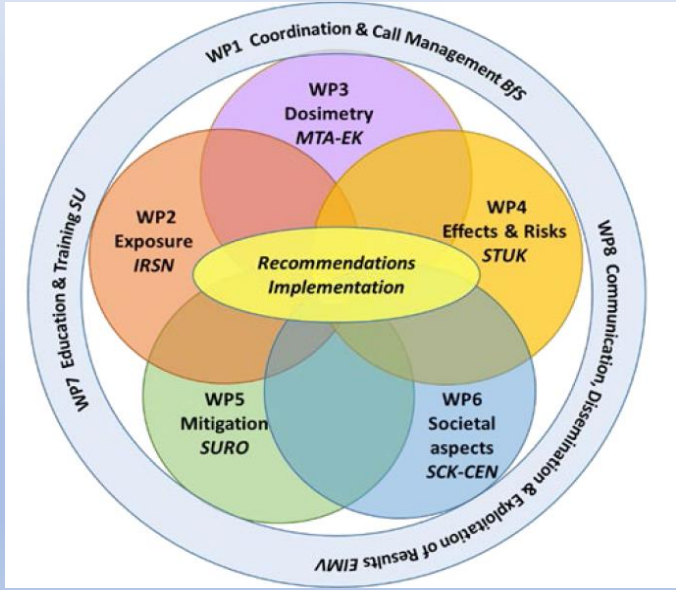
Starting date 1st September 2020,
End date 31thAugust 2025 (60 months)

This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 900009.

Projekt organisation

The overarching concept of RadoNorm **is to forge a bridge from** the scientific bases of radiation protection to targeted regulations **with justifiable dose limits** and the implementation of **effective measures** to improve the radiological situation where **feasible and reasonable.**

- **Exposure** - measuring and/or modelling human exposure,
- **Dosimetry** – exposure to dose conversion
- **Effects and risks -** assessment of radiation-induced biological effect as well as risks to humans and the environment,
- Innovative **mitigation** techniques and strategies aiming at dose reduction and exposure optimisation,
- **Societal and economic** aspects including communication,
- **Dissemination** of information and re-use of knowledge,
- **Education and training**.



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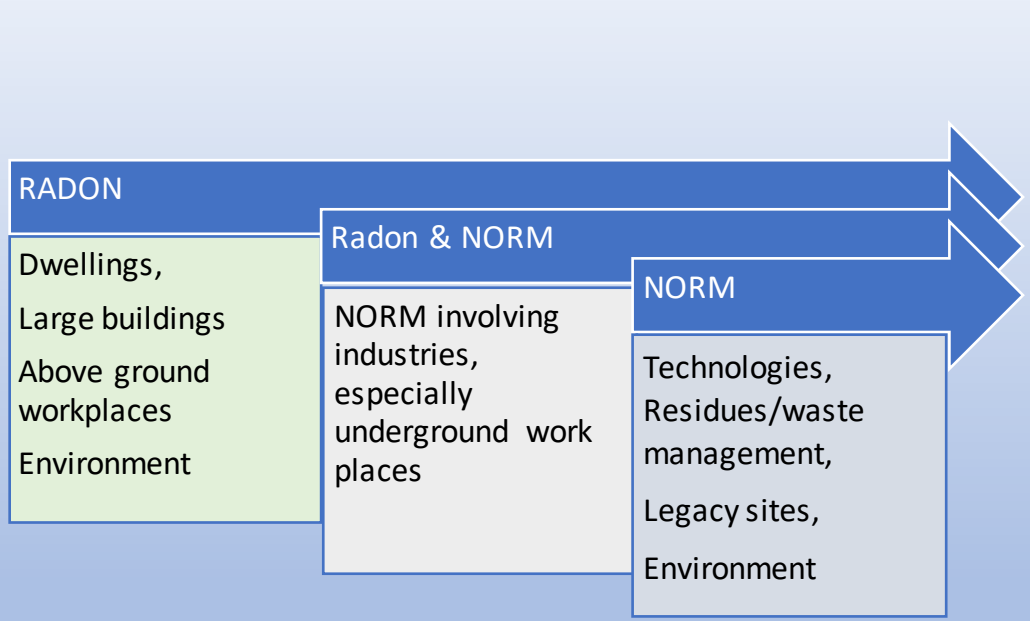
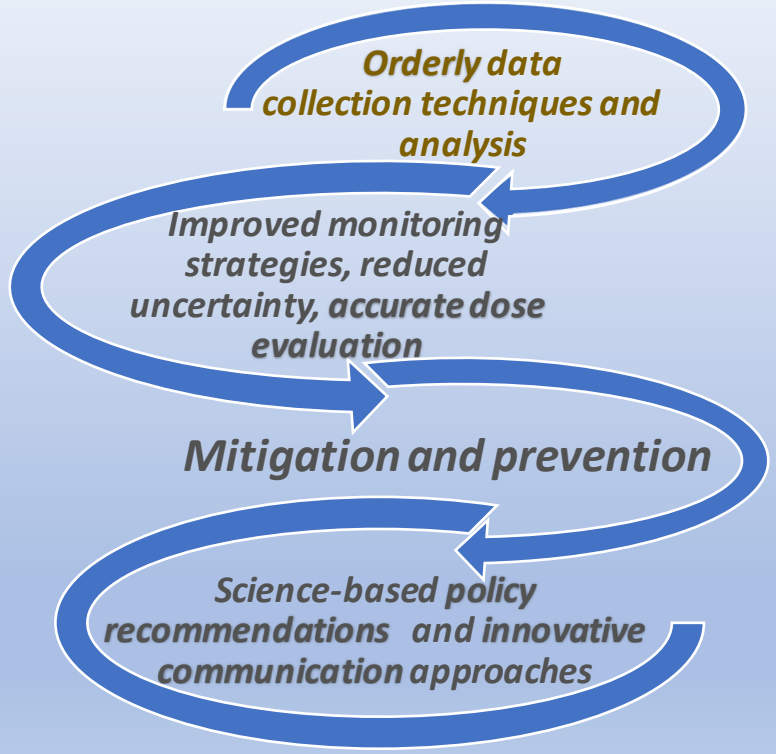
Research subjects and expected outcomes structure





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EXPOSURE: Radon/thoron risk

Important issues underlined:

- *Radon **activity concentration** in air is easy to be measured, however overall exposure evaluation results strongly depend on measurement protocol and measurement methods applied (e.g. temporal and spatial distribution of integrating devices)*
- ***Not radon** but **radon progeny** are direct source of exposure, that is extremely important at workplaces with active ventilation system e.g. **large modern buildings** or **underground mines***
- *In mines exposure to radon mainly **depends on exploitation system not on excavated material** – hence radon risk should be considered **in each underground mine** (workplaces)*

Identification of existing needs and improvement of radon measurement methods and development of **radon progeny monitoring protocols** and measurement techniques.

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EXPOSURE: Orderly data collection techniques and analysis

1. Methodology and tools for information collection **about NORM exposure sites** based on:
   - ❑ *natural resources and mining activities registers,*
   - ❑ *European and National European Pollutant Release and Transfer Register (PRTRs)*
   - ❑ *European Waste Catalogue*

2. **Selection criteria for NORM exposure scenarios** - *data sheet templates for systematic typical scenarios characterisation*

3. **Joint NORM survey dedicated for regulators, industry and waste disposal facilities operators**: *launched in January 2022*

   https://www.radonorm.eu/norm-e-survey/

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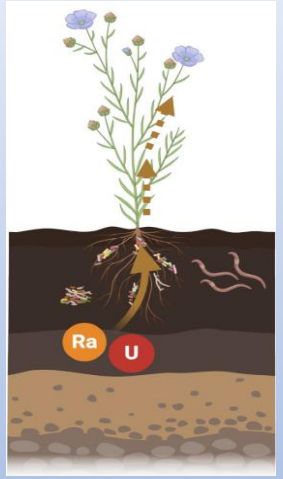
EXPOSURE: environmental aspects

- Identification of **geochemical and biological processes** controlling NORM mobility in soils for more robust or site specific K_d values
- Understanding the impact of **soil biocenosis** (*bacteria, fungi and earthworms*) on NOR migration from abiotic environment to biota - **refine transfer factors (TF)**
- Critical review of exposure pathways considered in **radioecological models applicable** for dose assessments for members of public and non-human-biota at NORM involving industrial / legacy sites



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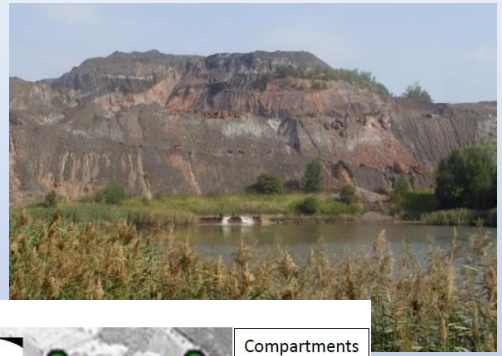
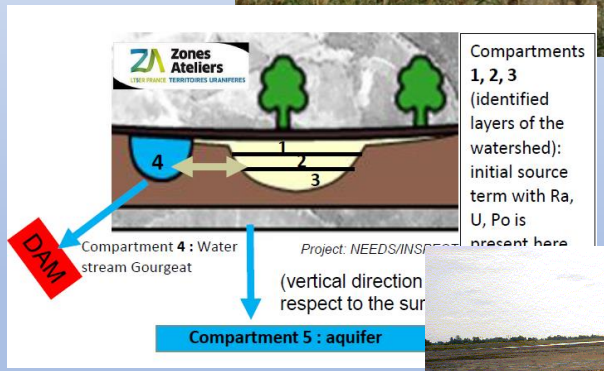
EXPOSURE: Updating approaches for modelling long-term prediction of NOR transfer in the environment



Application of the most suitable models to selected NORM sites by accounting for improved understanding of biological and geochemical processes:

- Management of NORM residues in the context of **conventional waste disposal**;
- Study of **water transport processes** by means of water flow and solute transport models and geochemical speciation;
- **Sludge from sewer depuration** systems of liquids effluents used as fertilizer in agriculture. Relevance of contamination pathway and guidance to dose-assessment;



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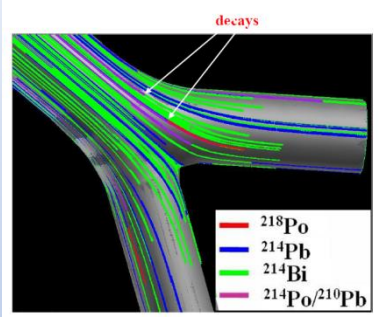
Dosimetry

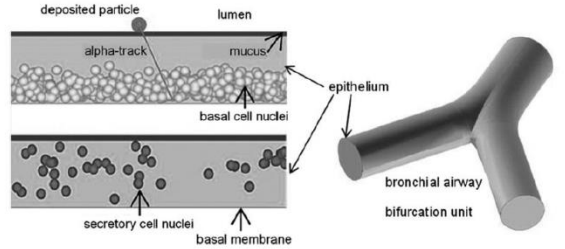
Important aspects underlined:

- Current radiation protection is based on the risks associated **with doses, not exposure.**
- Considering radon and NORM, most **work, living or natural environments** are characterized by **exposure parameters** (e.g. radon in air concentration, other NOR activity concentration in solids and liquids).
- **Numerical modelling** is a useful tool for **converting** exposure into doses, e.g. simulation with numerical lung particle deposition models, like the *Human Respiratory Tract Model* or the *Stochastic Lung Model* offer a unique way to describe the deposited amount of radon progenies in the airways.

Simultaneous deposition, clearance and decay



α – cell interaction, hits



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Dosimetry

Specific aims

- to provide data for epidemiological studies on absorbed doses and their uncertainties,
- to provide data for biological experiments on doses at different levels of biological organization (dosimetry and microdosimetry),
- to quantify doses in specific groups with potentially higher sensitivity or higher public concern,
- to generate new knowledge related to the role of spatial dose distribution in radiation risk,
- to explore how intra-organ dose distribution can be considered in the system of radiation protection

Expected outcomes:

- Assessment of uncertainties affecting dosimetric calculations for the intake of radon and NORM
- Identification the most sensitive parameters to dose calculations, crucial for guiding future epidemiological studies.
- The reliability of assessed doses and indications to sensitive parameters for a better fit of the models to monitoring data
- Improvement of the ICRP HRTM regional box model considering the individual characteristics of the subject on the local radiation burden what determines the probability of DNA damage.

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Effects and Risks

General Objectives:

- To generate new knowledge related to biological effects and responses after exposure to radon and NORM that have implications for risk assessment and radiation protection of humans and the environment
- To reduce the existing uncertainties in risk assessment

Methods Used:

- Epidemiological studies and simulations based on epidemiological datasets
- Risk modelling
- Molecular epidemiology
- Experimental studies on combined effects carried out in realistic co-exposure conditions
  - Human cell systems (radon, nanoparticles / tobacco smoke)
  - Biota (particles, NORM, chemicals, UV)
- Determining of adverse outcome pathways linking the mechanisms and effects after co-exposures

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Mitigation & prevention

- **Radon reducing and control technologies applied in:**
  - large scale buildings,
  - underground workplaces (mining industry; public access caves and mines; civil protection facilities etc.).
- **Radon control technologies focused on mitigation of radon exhalation from building materials.**
- **Development of measurement protocol of radon progeny attached and unattached fraction, radioactive aerosols size distribution for the purpose of radon mitigation systems efficiency evaluation (work conditions optimisation).**
- **Application of personal dosimeters application and workplace continuous and integral monitoring for exposure optimisation.**

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Mitigation & prevention

as radon/radon progeny ratio depend on ventilation system properties modification of it may be considered as effective mitigation

Ventgraph – a software for predicting radon hazard in facilities with forced ventilation

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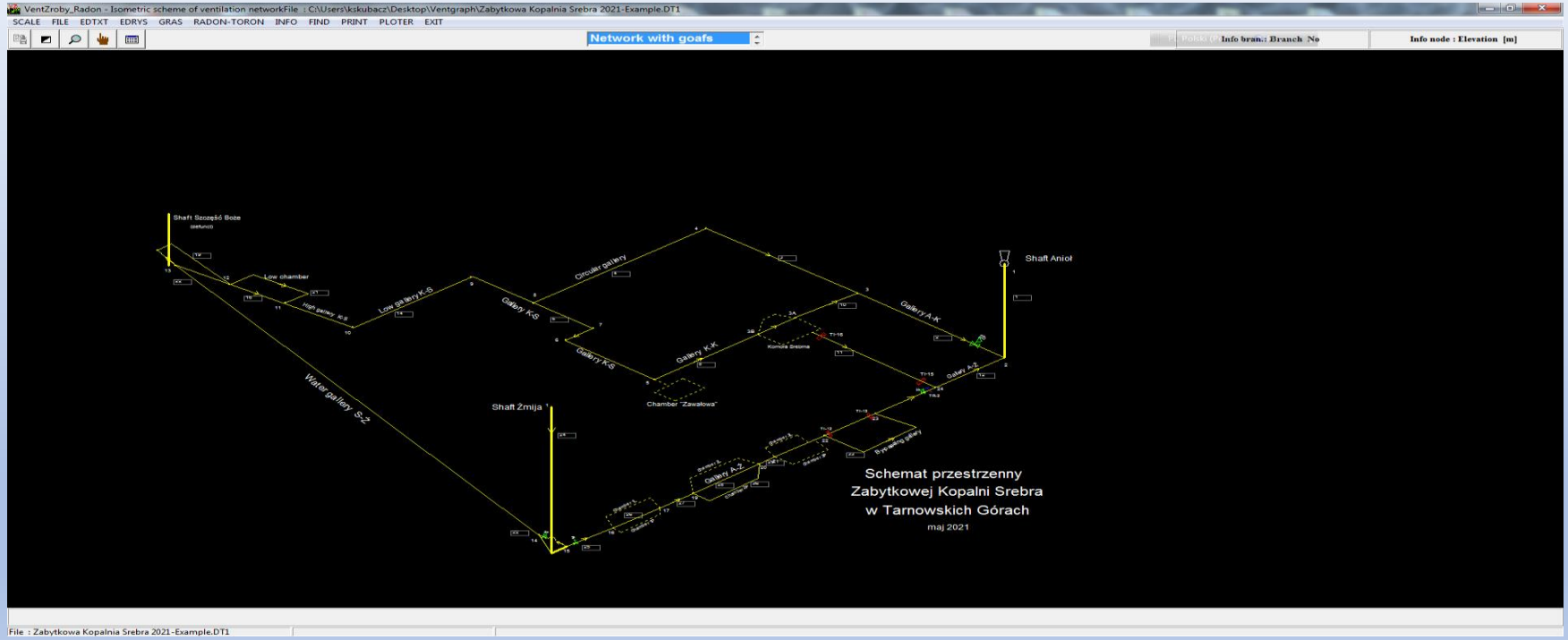
Ventgraph - Ventilation scheme



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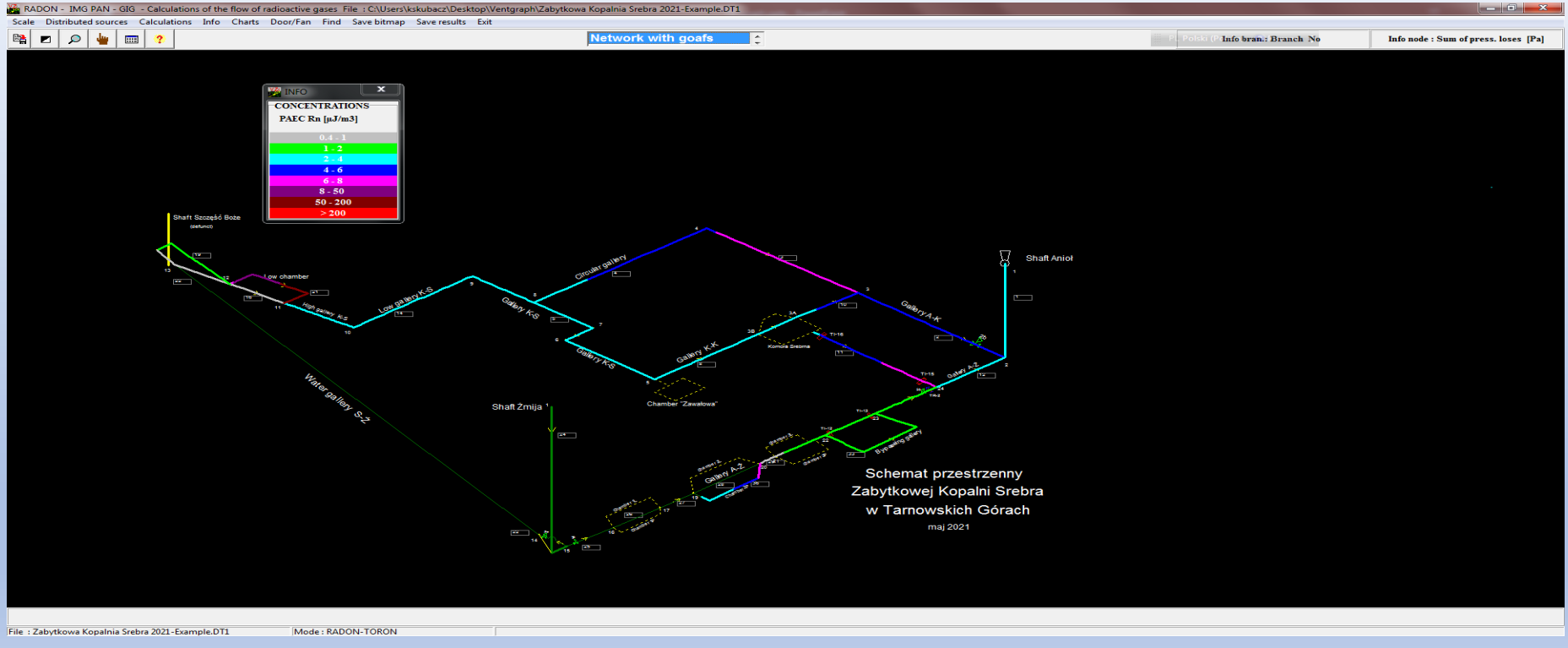
Ventgraph - Displaying results



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Mitigation & prevention

Radiation risk mitigation measures applied in NORM involving industries and remediation of legacy sites – general aspects considered:

- *Work environment conditions - common base (source of data) for evaluation of occupational exposure as well as environmental one.*
- *Overall work conditions improvement – interaction with general OHS rules.*
- *Work organisation - efficient tool for exposure limitation.*
- *A case needs special attention:* ***prevention and mitigation of radiation risk caused by formation water (and other liquid NORM).***

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Mitigation & prevention

- ***NORM vs. conventional waste -*** *main differences and similarities at the level of regulation and practice****.***
- ***Treatment option considered***
  - ***disposal***
  - ***recovery***
  - ***recycling***
  - ***reuse***
- ***Critical raw materials recovery –*** *promising option for some NORM*

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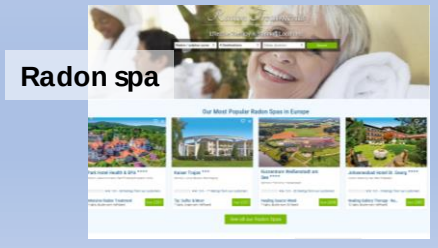
Research on Societal aspects

- Development and improvement of **systematic** and **methodological** approaches
- Addressing a **value-action gap by innovative communication approaches**

- **Citizen science** in order to help the work of scientists
- Exploring **perception** of specific exposure situations - **controversy to exposure**

- Development of **science-based policy recommendations**



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Education and training

Yearly organised training courses on different aspects related to radon and NORM – 5 series planned.

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NORM X 2022

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Thank you for the attention

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