Radioecological Observatories – A Promising Concept With Obstacles

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www.star-radioecology.org
www.radioecology-exchange.org

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Overview

- Concept and potential benefits
- STAR's activities
- Lessons learned
- Suggested way forward

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Concept

- What is a "Radioecological Observatory"?
  - Radioactively (and chemically) contaminated field site that is **jointly used** for **coordinated**, **long-term** field work by several research groups.
  - Innovative approach to maximize the efficacy of radioecological field investigations and to promote integration of the organizations involved.

Concept

- OECD/NEA clearly expressed the need:

"…environmental data collected over the last half century by the nuclear industry for surveillance purposes has not been utilised in an efficient, co-ordinated manner…. Therefore it is proposed that a useful development would be an international network that allowed researchers to coordinate and understand research in relevant fields. This "observatory" would be grounded on past and ongoing observations in the real environment and allow them to be linked with laboratory and theoretical developments."

Benefits

- Efficient approach that will create **synergistic effects**:
  - Coordinated efforts of several participating research groups.
  - Sharing of expertise, ideas, data and resources.
- Strong **integrating component** for all research groups involved.
- Provides excellent **training and education sites**.

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Selection process

- STAR selected the Radioecological Observatories in a structured, progressive approach that is transparent, consistent and objective.
- STAR combined three components:
  - A formal approach (multi-criteria decision analysis, MCDA).
  - Group discussions.
  - Recommendations provided by invited external experts.
- Why is a combination of these three approaches useful for group decision making?

Selection process

- Multi-criteria decision analysis (MCDA):
  - Pro: Tool to formalise and address the problem of competing decision objectives.
  - Con: Decision makers usually hesitate to accept the results of a purely formal approach.
- Group discussions:
  - Pro: Help to reach a consensus.
  - Con: Group thinking may lead to a **consensual** decision, not to the **optimum** decision.
- Guidance from external experts:
  - Pro: Helps to broaden the group members' view and to take into account aspects that the group is not aware of.

Coal mining area in Upper Silesia

- Key information:
  - The Upper Silesian Coal Basin (USCB) is a post-industrial landscape that has been and still is heavily affected by coal production.
  - Fifty underground hard coal mines are still in operation.
  - The daily discharge of mine water into surface reservoirs exceeds 600,000 m^3.
  - Currently, there are 25 settling ponds in use which contain in total 5,000,000 m^3 of sediment with enhanced levels of radium isotopes.
  - All Polish Observatory sites are located at distances of 60 km or less from Katowice (50°16'15.22" N; 19°1'35.47' E).

Coal mining area in Upper Silesia

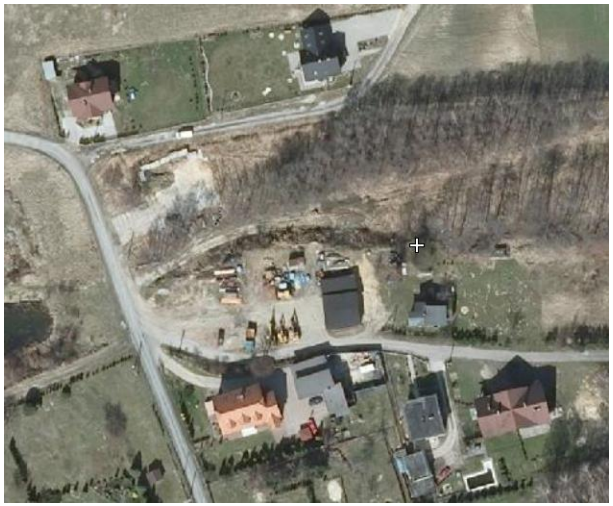
- Site #1:
  Upper Vistula basin, a natural river affected by discharges of mine brines with high levels of radium.
- Site #2:
  Former mine settling pond Rontok Wielki (surface area 32 ha), a natural pond that was adapted in the past as settling and retention pond for mine waters but is currently excluded from technological processes and filled with fresh water.

Coal mining area in Upper Silesia

- Site #3:
  Mine settling pond Kaniów (surface area 4.5 ha), a semi-artificial pond that is currently used for clearing mine water from suspended matter and discharging saline waters into inland water in a controlled way.
- Site #4:
  Former mine settling pond Bojszowy (surface area 16 ha). After technical land reclamation bottom sediments were covered with a layer of waste rock.

Coal mining area in Upper Silesia

- Site #5:
  County borough Świerklany, a residential area, arable land and wasteland contaminated due to the discharge of mine brines.



USCB: Radioactive pollutants

- Radium isotopes dominate.
- Example: Former mine settling pond Rontok Wielki
  - Radium levels of sediment:
    - up to 49,200 Bq kg^{-1} ^{226}Ra
    - up to 6,400 Bq kg^{-1} ^{228}Ra
  - Dose rates to non-human biota:
    - up to 22 µGy h^{-1} for vertebrates living on the soil surface
    - up to 67 µGy h^{-1} for burrowing vertebrates
    - Screening value for generic ecosystems: 10 µGy h^{-1} (EC-funded project ERICA)

USCB: Non-radioactive pollutants

- **Heavy metals** represent the dominant non-radioactive pollutants.
- Example: Heavy metals in sediment
  - Ba: up to 122,000 ppm
  - Pb: up to 830 ppm
  - Zn: up to 760 ppm
  - Cu: up to 270 ppm
- Additional contamination with **hydrocarbons** (engine oil, lubricants), since brines are often used as process water.

Chernobyl Exclusion Zone (CEZ)

- The CEZ is one of the most radioactively contaminated sites in the world.
- Established shortly after the accident in 1986, the CEZ was initially the area within the 30-km radius around the Chernobyl Nuclear Power Plant.
- The predominantly rural woodland and marshland of the CEZ covers now an area of approximately 2,600 km^2 in Ukraine and 2,160 km^2 in Belarus.

CEZ: Radioactive pollutants

- The most important radionuclides include long-lived ^{137}Cs, ^{90}Sr, plutonium isotopes, ^{241}Am and uranium isotopes.
- A key characteristic of the CEZ is the extremely heterogeneous contamination pattern that offers **contamination gradients with high maximum dose rates**.
- Appreciable amounts of non-radioactive pollutants are absent.

CEZ: Ecosystems and biota

- Diversity of ecosystems:
  - The Ukrainian portion contains forests, abandoned farmlands, wetlands, flowing waters, standing waters, deserted villages and urban areas.
  - The Belarusian portion is a land of swamps, marshes and peat-bogs. Areas not covered with forest (about one half of the territory) are mostly former reclaimed agricultural lands and meadows.

Photo credit: Jean-Marc Bonzom, IRSN

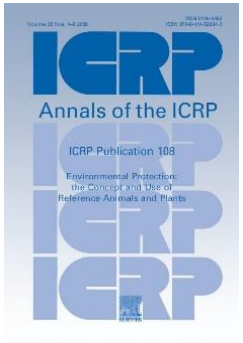
CEZ: Ecosystems and biota

- Diversity of biota:
  - More than 400 species of vertebrate animals, including 67 ichthyoids, 11 amphibians, 7 reptilians, 251 birds and 73 mammals inhabit the vicinity of the CEZ.

Photo credit: Jean-Marc Bonzom, IRSN

CEZ: Dose rates to biota

- Estimated weighted absorbed whole-body dose rates to terrestrial reference organisms as calculated using the ERICA Tool exceed
  - 400 µGy h^{-1} for large mammals (deer) and
  - 1,400 µGy h^{-1} for reptiles.
- EC-funded project ERICA: Predicted-No-Effect-Dose-Rate for generic ecosystems:
  - 10 µGy h^{-1}
- ICRP 108: Derived Consideration Reference Levels for deer:
  - 1 – 10 mGy d^{-1} (42 – 420 µGy h^{-1})
- The CEZ is expected to provide the opportunity to study long-term effects of ionising radiation on populations of wildlife.



STAR's further activities

- Drafting of **Memorandums of Understanding** for accessing the Polish Observatory sites (with the indispensable support of the Central Mining Institute, GIG).
- **Field visit** to the Polish Observatory sites in August 2014:
  - To verify and/or complement the information that has been collected through an extensive literature review.
  - To collect soil and plant samples from locations with an elevated ambient dose rate for hypothesis-based investigations.

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Lessons learned – selection process

- Formal approach:
  - Effective way of supporting the decision making process.
  - Group members prefer formal approaches with which they are familiar.
  - Suitability and efficacy of an approach often play only a minor role.
- Selection criteria:
  - Reaching consensus on a complete list of clearly defined criteria is one of the most important and most difficult parts of the group decision making process.
  - It is virtually impossible to specify evaluation criteria without ambiguity.

Lessons learned – selection process

- Discussions (within the group):
  - Reaching consensus exclusively through discussions might be difficult for a heterogeneous group.
  - There is also a risk that trying to reach consensus results in the **most acceptable** decision, not necessarily in the **optimum** decision.
- External experts (who are neither directly involved in the decision making process nor benefit from a specific decision):
  - Help to broaden the view and to identify aspects that the group members are not aware of.
  - Should be involved early in the decision making process.

Lessons learned – access to the site(s)

- Obtaining permissions might be difficult and time-consuming.
- Site owners' attitudes towards research in general, their individual interests and their economic situation might play an important role.
- Public opinion, especially reservations against radioactivity, might create severe problems.
- Cooperation with a local research institute or communication with the site owners via a local organization might be helpful. In the case of the Polish Observatory sites, the Central Mining Institute (Główny Instytut Górnictwa, GIG) acts as the local contact point (http://www.gig.eu/en).

GIG

Lessons learned – availability of data

- Easy access to and scientific exploitability of information and data is a key factor for synergistic effects:
  - Central online repository
  - Easy (online) access for all interested research groups
  - Suitable standardized online formats

Lessons learned – NORM sites

- Identifying large-scale terrestrial sites in Europe with high levels of naturally occurring radionuclides is extremely difficult (if possible at all).

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Suggested way forward

- Within the EC-funded (FP7) Network of Excellence **STAR** (Strategy for Allied Radioecology, www.star-radioecology.org) initial steps for Radioecological Observatories have been taken.
- Mechanisms to use these sites will be established under the EC-funded project **COMET** (Coordination and Implementation of a Pan-European Instrument for Radioecology, www.comet-radioecology.org).
- Research at the Radioecological Observatories will primarily focus on radioecological topics outlined in the **Strategic Research Agenda** (SRA) which presents the major challenges for radioecology over the next 20 years (www.radioecology-exchange.org).

Suggested way forward

- Polish Observatory sites:
  - Provide the opportunity to investigate a variety of very specific research questions, e.g. different temporal stages of mine settling ponds (in operation, post-operational phase, after remediation measures).
  - Provide opportunities for education and training (e.g. Course on Naturally Occurring Radioactive Material (NORM) in the Environment, 7 – 10 September 2015).
  - Do **not** provide large-scale terrestrial Observatories with high levels of naturally occurring radionuclides.

Suggested way forward

- Alternative NORM Observatory sites:
  - Efforts to identify alternative terrestrial ecosystems that are contaminated with high levels of naturally occurring radionuclides not yet successful.
  - Major problems are missing long-term perspectives and access restrictions.
  - ALLIANCE Secretary will encourage all ALLIANCE members to suggest terrestrial NORM sites that might be suitable.

Suggested way forward

- Chernobyl Exclusion Zone:
  - Next step will be to define smaller areas that are suitable to address the research lines prioritized in the SRA and the implementation plan currently being developed under COMET.
  - Selection process will also take into account the experience that several STAR partners gained through collaborations with local research institutes in the CEZ.
- Fukushima area:
  - The marine ecosystems around the Fukushima Daiichi Nuclear Power Station could complement the range of ecosystems that can be used for hypothesis-based field investigations.

Thank you very much for your attention!

Observatory sites will be further developed under COMET. The COMET consortium is happy to support groups who are interested in starting research projects at the Observatory sites.

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