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## Strategic Research Plans for Environmental Radiation Protection Research

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# European Radioecology ALLIANCE

**Webinar - 18 April 2024**

## Strategic Research Plans for Environmental Radiation Protection Research

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# Strategic Research Plans for Environmental Radiation Protection Research

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## Webinar - 18 April 2024

1. ALLIANCE: history, members and organization
2. Our Strategic Research Agenda (SRA latest update 2019)
3. Joint Roadmap for radiation protection (JRM, Concert 2019)
4. Next steps / Way forward

# 1 Strategic Research Plans for Environmental Radiation Protection Research

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# The European Radioecology Alliance

- The **ALLIANCE** was founded in 2009 (after 6FP-FUTURAE) to develop a **vision on long-term research needs** in radioecology, to **foster cooperation** and to **assure sustainability** of radioecology .
- Objectives:
  - **Coordinate and promote research in Radioecology**
  - **Act as a Research Platform**: Definition of priorities and research programmes
  - **Promotion and Communication**
- Members of the ALLIANCE
  - 8 founding members in 2009
  - Officially established (French Law) – **August 2012**
  - 32 members

# How is the Alliance organized

- **Board of Directors**

Consists of a minimum of eight members appointed by the General Assembly, including at least fifty percent of members drawn from the Founding Members.

- **Bureau** (Chosen by the Board of directors; elected for 3 years):

- a president;
- a vice president;
- a secretary;
- a treasurer.

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President  
IRSN, France



Vice President  
DSA, Norway



Secretary  
Ciemat, Spain



Treasurer  
Cefas, UK

- **General Assemblies** (on an annual basis)

One representative of each legal entity Member (one vote).

- **Working groups:** SRA & Roadmap, E&T, Sustainability, Infrastructure

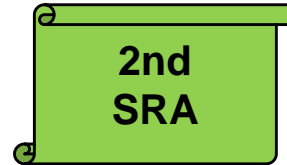
# A major tool: The Strategic Research Agenda

A SRA is vital to get sufficient **priority in scientific programming** and to **maintain visibility** of radioecology. It was developed since 2010:



(2010 – 2014) Coordinated by IRSN

[www.comet-radioecology.org](http://www.comet-radioecology.org)



(2013 – 2017) Coordinated by SCK•CEN

[www.comet-radioecology.org](http://www.comet-radioecology.org)



(2016 – 2020) Coordinated by BfS

[www.concert-h2020.eu](http://www.concert-h2020.eu)

(2022 – 2027) Coordinated by IRSN

[www.pianoforte-heu.eu](http://www.pianoforte-heu.eu)

# ALLIANCE and MEENAS



- ALLIANCE collaborates with PIANOFORTE through MEENAS

# ② Strategic Research Plans for Environmental Radiation Protection Research

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# A major tool: The Strategic Research Agenda

- Outlined a **suggested prioritisation of research** topics in radioecology
- “What topics, if critically addressed over the next 20 years, would significantly advance radioecology?”
- Updated Nov. **2019**
- Published **2021**

# ALLIANCE Strategic Research Agenda

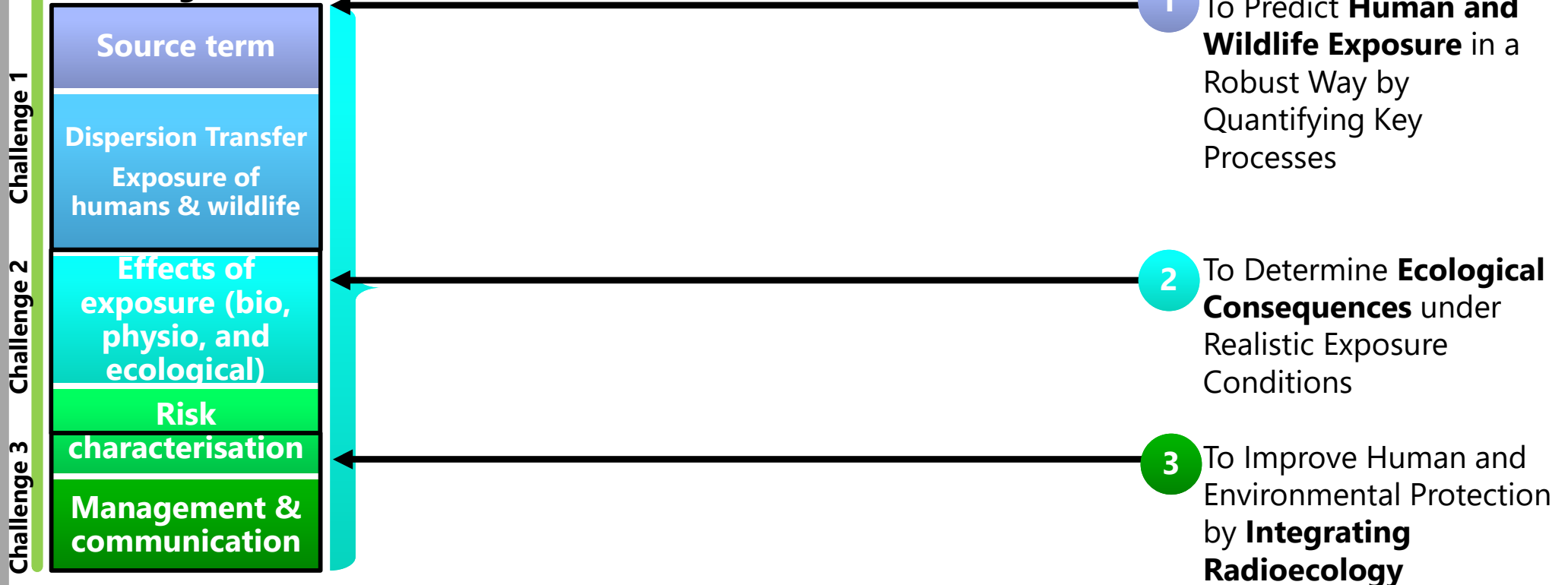
Published 2021 (J. Environ. Rad. 237:106697)

**General framework** : Environmental exposure situations (planned, existing, emergency) and associated human and ecological risk assessment and management

**Ultimate goal** : Advance on mechanistic understanding across radioecology such that we can provide fit-for-purpose human & environmental impact assessment in support of protection of man and the environment in interaction with society

## 3 main Challenges

### Challenge-related knowledge



# SRA Challenges 1 - Predict Human and Wildlife Exposure in a Robust Way

## **Challenge one: To Predict Human and Wildlife Exposure in a Robust Way by Quantifying Key Processes that Influence Radionuclide Transfers and Exposure**

### **Research Lines**

- 1. Key processes that make significant contributions to the environmental transfers of radionuclides and resultant exposures of humans and wildlife**
- 2. Parameterisation of the key processes controlling the transfer of radionuclides**
- 3. Process-based transfer and exposure models** (physical, chemical and biological interactions, kinetics)
- 4. Represent transfer and exposure at a landscape or large geographic scale** with an indication of the **associated uncertainty**

# SRA Challenges 2 - Determine Ecological Consequences under Realistic Exposure Conditions

## **Challenge two: To Determine Ecological Consequences under Realistic Exposure Conditions**

### Research Lines

1. Radiation induced effects **from molecules to individuals**
2. Intra- and inter-species **differences in radiosensitivity**
3. Interactions with other **co-stressors**
4. **Multi-generational responses** (e.g., hereditary effects, adaptive responses)
5. **Effects at higher levels of organisation** (population dynamics, trophic interactions, indirect effects at the community level, ecosystem functioning)

# SRA Challenges 3 - Determine Ecological Consequences under Realistic Exposure Conditions

## **Challenge three: To Improve Human and Environmental Protection by Integrating Radioecology**

### **Research Lines**

1. Integrate **uncertainty and variability** (transfer, exposure, effects characterization) into risk characterisation
2. Integrate **human and environmental protection** frameworks
3. Integrate **ionising radiation and chemicals**
4. **Multi-criteria** perspective including decision support systems for an optimised decision-making
5. Interaction and integration of radioecology with other disciplines, including **social sciences and humanities**

# Challenge for education and training to maintain and develop a skilled workforce

- increasing student and teacher/researcher **mobility**
- **funding early career researchers** in funded projects
- **joint EU MSc** (Erasmus, European Universities) and links with other E&T programs in nuclear and environmental sciences
- providing **courses and workshops** for students, professionals and academics
- increasing **stakeholder and employer involvement** in E&T
- development of **distance learning courses**, novel educational materials and approaches
- offering **refresher courses and seminars** at conferences
- organising **international summer schools, field training...**

# Challenge for infrastructures and capabilities to maintain and develop the infrastructures

- identify the requirements and create the **partnerships of excellence** that bring together the required infrastructures
- maintain a web-based **catalogue** of infrastructures and capabilities
- promote the visibility and **joint use of existing infrastructures**, encourage wider collaboration
- further **development of the Radioecological Observatory sites** (Chernobyl Exclusion Zone, Fukushima Exclusion Zone, NORM-impacted sites in Belgium, Poland and France)

# Challenge for infrastructures → Observatory sites

Chernobyl exclusion zone

Belgian NORM Observatory

P-industry  
CaF<sub>2</sub>-sludge heap

Fukushima exclusion zone

Upper Silesian Coal Basin

Coal mine  
Mine water release

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# From SRA to Roadmap

## *ALLIANCE specific roadmap*

- Underpinning science for an **enhanced basis for fit-for-purpose human and environmental impact assessment** by mechanistic modeling, improved parameterisation, improved databases

## *Radiation protection roadmap*

- Identify research needs and develop tools that will further optimize the existing radiation protection system and advance radiation protection, considering the societal needs and concerns, and to plan such research

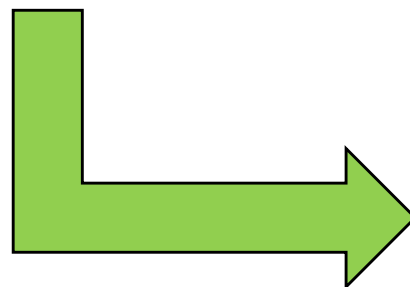
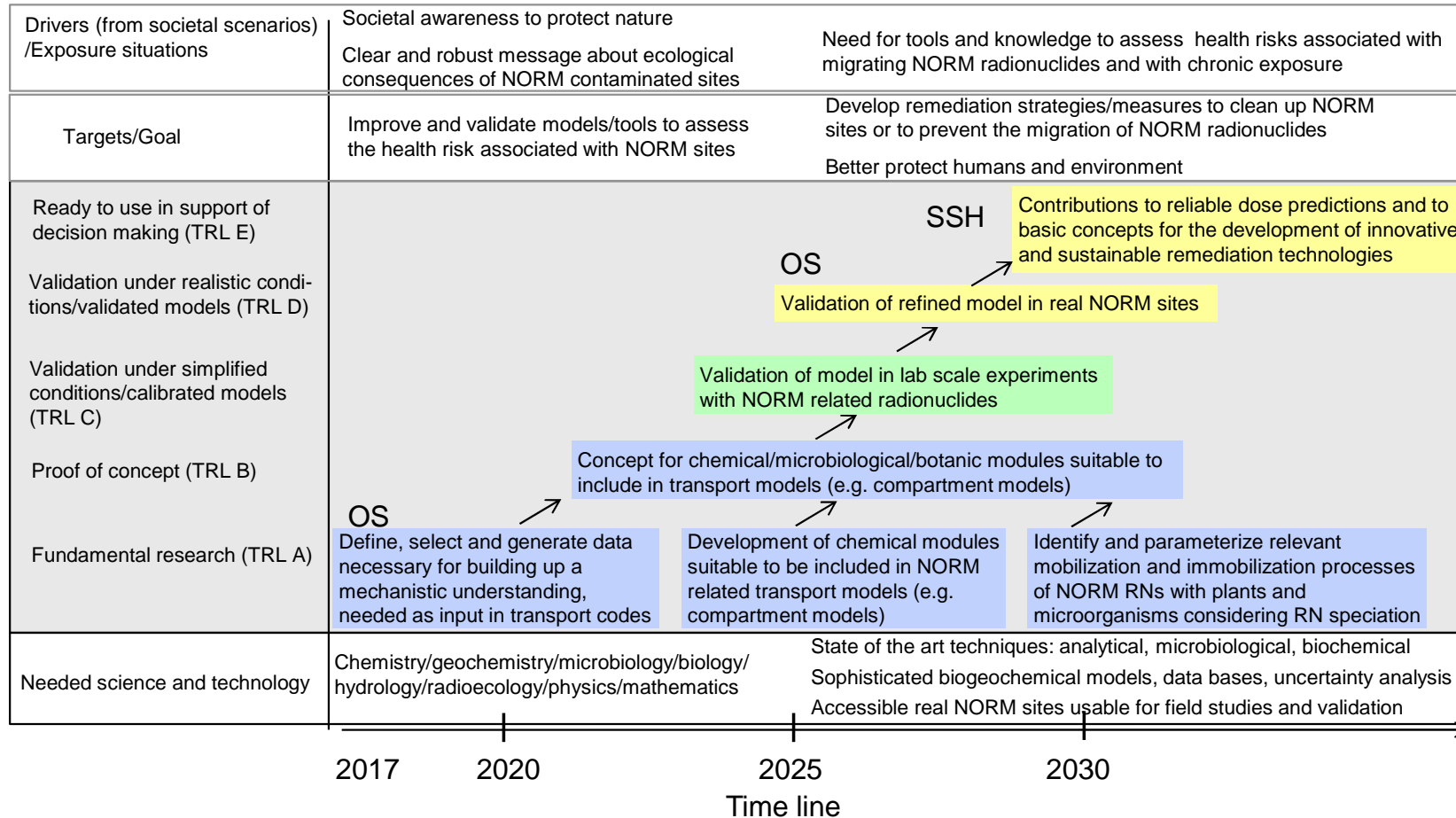
Roadmaps developed through **consultation & stakeholder involvement**

# Priority domains for Roadmap development

- **Marine radioecology** - Fukushima accident showed lack of robust marine radioecological models
- **Human food chain modelling** - Actual DSS to be adapted to other regions of Europe and radioecological models to be improved
- **Atmospheric radionuclides in transfer processes** - Fukushima accident highlighted several lacks in air transport and inhalation dose assessment, deposition stage from atmospheric releases or long-lasting secondary emissions
- **NORM radioecology** - NORM sites often close to settlements requiring follow up and appropriate remediation
- **Transgenerational effects and species sensitivity** - Major concern of long-term biological effects of low radiation doses → improve our knowledge on long term/transgenerational effects and on basis for differences of radiation sensitivity

# Example - ALLIANCE NORM Topical Working Group

## Topical Roadmap - NORM



# Joint Roadmap

- **A common and shared vision** for radiation protection research (priority areas and cooperative strategic objectives to 2030 and beyond)
- **Eight research challenges** all exposure situations, relevant for society and radiation protection
- Presents '**game changers**', defined as *research issues that, when successfully resolved, have the potential to impact substantially and strengthen the system and/or practice of radiation protection for man and/or the environment*

# ALLIANCE Research plans link with the Joint Roadmap research challenges and Game Changers

- A. Understanding and quantifying the health effects of radiation exposure
- B. Improving the concepts of dose quantities
- C. Understanding radiation-related effects on non-human biota and ecosystems**
- D. Optimising medical use of radiation
- E. *Improving radiation protection of workers*
- F. An integrated approach to environmental exposure and risk assessment from IR**
- G. Optimise emergency and recovery preparedness and response
- H. Radiation protection in society

During CONCERT

→ MELODI, NERIS, SHARE, EURADOS

→ EURAMED : Rocc-n-Roll

# C. Understanding radiation-related effects on non-human biota and ecosystems

EURADOS →



# C. Understanding radiation-related effects on non-human biota and ecosystems

## Why ?

- **Resolving the controversy with regard to the effects on wildlife reported in the Chernobyl and Fukushima exclusion zones**

*Impact: confidence in and credibility of the radiation protection of the environment (e.g., robustness of 'no-effect' benchmark dose rates) (and humans?).*

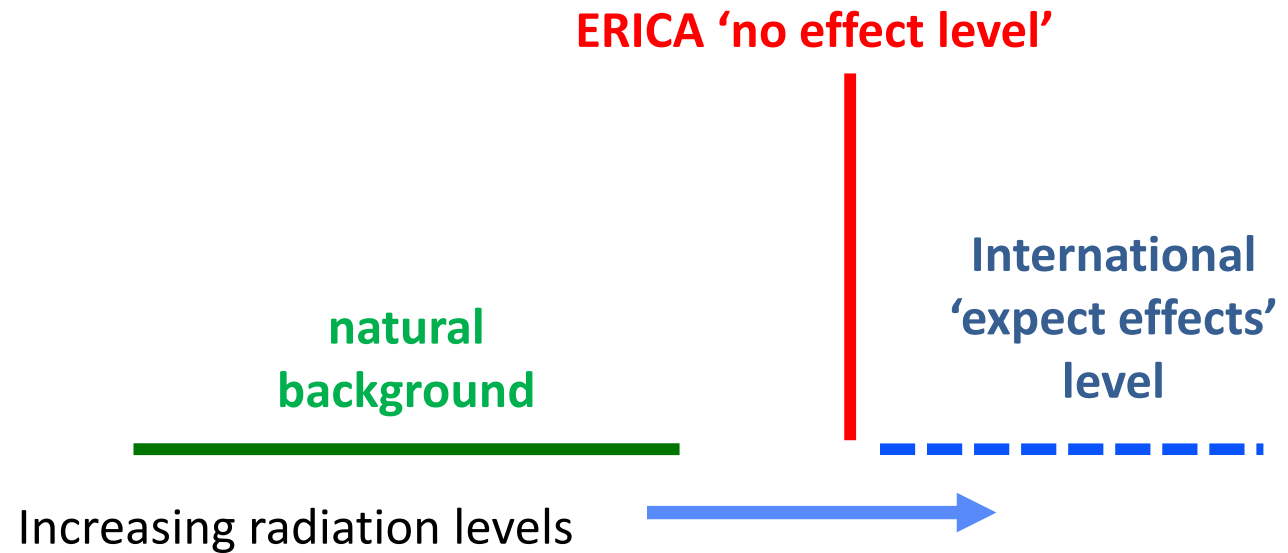
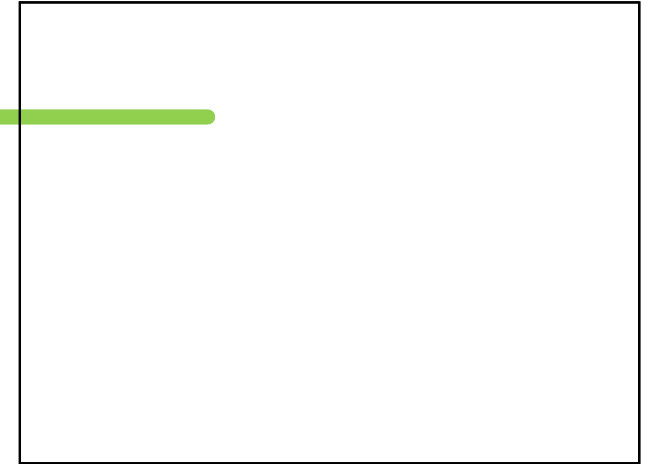
→ **policy protecting the environment**  
*environmental criteria based on internationally recognised scientific data (EC, ICRP, UNSCEAR, IAEA)*

# C. Understanding radiation-related effects on non-human biota and ecosystems

## Conflicting science



# Example – Challenge C



## C. Understanding radiation-related effects on non-human biota and ecosystems

- Some effects observed, all at dose rates above generic ('ERICA') screening value but **also below the ICRP benchmark**
- **No evidence of effects** expected from authorised releases, including 'New Build' and Geological Waste Repository
- Only considered a few species - **need to keep testing hypotheses of ecological damages**

### **Topical Working group evolution (dec. 2023):**

→ **from TESS\* to EFFECTS** of radiation and radiological contamination at multiple levels: from molecules to ecosystems

\* *Transgenerational effects and species sensitivity*

# F. An integrated approach to environmental exposure and risk assessment from IR

- Robust **prediction of radiological contamination in the human food chain**  
→ *Impact: resultant models applicable in any situation and optimised post-emergency management*  
*Include future changes in European agricultural practices (**terrestrial food-chain**), NPPs built on the coast and on floating vessels (**marine dispersion & biota transfer models**)*
- Identifying and quantifying the **key processes** that influence radionuclide behaviour in **existing environmental contamination situations** (*relevant as proxy for spent fuel management and decommissioning – e.g. U, Se, I*)
- **Integrating risk assessment and management** (consistent exposure assessments for **humans and wildlife**; risk integration for **radiation and other stressors**)  
→ *Impact: more efficient and cost effective (proportionate) risk assessment*



# Example – Challenge F

## Guidance to select level of complexity

(TERRITORIES D 9.61)

- Mechanistic **fit-for-purpose knowledge** for diagnosis and prognosis of the environmental behaviour of the radionuclides
- **Test assessment models** in a set of well-characterised long-term contaminated sites
- Quantify the **improvement of 'advanced' models compared to 'simple' models**
- Handbook on **uncertainty analysis** for radioecological risk assessments

### 10 radioecological models (forests and seas)

- 5 **"existing/widely applied" models** (e.g. tools, such as CROM, Mora *et al.*, 2015; Kaasik *et al.*, 2020)
- 5 **"more advanced" models** (research)

soil

wood

needles

Simple (IAEA-SRS19)

Advanced(TREE4)

Simple (TREE4)

### Focus on Fukushima forests ecosystems

Gonze *et al.* STOTEN, 2021) :-

- FORESTCROM (simple IAEA-SRS19)
- TREE4-simple (IRSN-SYMBIOSE)
- TREE4-advanced (IRSN-SYMBIOSE)

# D. Optimising medical use of radiation



- BT 7 - Quality, safety, and legislation for medical application of IR in Europe: **ensure the safety of workers and the public** (e.g. Calculation of the Impact of Radioactive Spills in Wastewaters Networks)

## Impact of medical radionuclide discharges on people and the environment



applied to  $^{18}\text{F}$ ,  $^{123}\text{I}$ ,  $^{131}\text{I}$ ,  $^{153}\text{Sm}$ ,  $^{99\text{m}}\text{Tc}$  and  $^{201}\text{Tl}$ .

doses to WTP workers, to farmers from agricultural practices, to Flora&Fauna

→ **predicted impacts are very low**

→ **data gaps and uncertainty** in the assessment of radiopharmaceutical effluents impact

- **environmental monitoring** (as the nuclear industry does): source term characterization
- **specific radionuclides and speciation** (chemical forms), with specific biokinetics
- **mode of operation of WTPs** (retention/separation efficiencies (water and sludge), basic working pattern (occupancy fractions))
- **retention** of radionuclides in wastewater at the treatment plant & riverbank sediment
- **transit times** of the different effluents (relevant radionuclide decay factors)

# H. Radiation protection in society



- **Tools for the mediation** between radioecology research and stakeholders covering the space between the scientists, the public and other stakeholders; stimulating a broader stakeholder engagement in radiological protection and radioecology
- **Improve credibility** with stakeholders  
acceptable level of uncertainty for stakeholder, how/what we can be attained through research
- Help in **research prioritization**  
identify the main drivers for research prioritization with stakeholders (Knowledge uncertainties and their management (eg. tiered approaches); Societal needs, relevance for the public,...)
- **Integrate human and environmental protection** frameworks  
Methodologies not fully complementary, cause difficulties for operators, stakeholders, regulators. Need for better integration of radiation protection systems (underlying philosophy, practical application)
- Integrate risk assessment frameworks for **ionising radiation and chemicals**  
Facilitate stakeholders' understanding of risk from various sources & mutual understanding between assessors
- **Multi-criteria analysis** in support of decision-making  
research/tools for risk communication, evaluation and consideration of social acceptance, risk perception, economical aspects and radioecology (ecosystem services, ecosystem approaches...)
- **Bring scrutiny into our research and assessment** methodologies  
help in the debate by focusing on scientifically established understanding, factorising risk perceptions, human valuation of the environment (eg. socio-historical approaches)

# 5 Strategic Research Plans for Environmental Radiation Protection Research

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# Conclusion

## Success

- SRAs and joint roadmap **evidence of increased integration**
- **Projects** follow from collaboration
- **PhDs**
- Strong pillar of **MEENAS**
- **Growing membership**

## Societal responsibility

- **response to stakeholders concerns** regarding presence of RNs in environment
- **responsible RD&I for improved radiation protection** of human health and wildlife populations

## Coordination of research, infrastructures availability and E&T

- build **common goals and share resources** among radioecology and with European radiation protection community (Joint Roadmap, PIANOFORTE)
- promote **hypothesis-driven research** for the acquisition of new scientific knowledge, and model and tools optimization

# Way forward

## ICRP RP System adaptation for the Next Generation (in progress)

- IR effects on the **Structure and Function of ecosystems**
- **Resilience and adaptation** capacities of non-human biota and shifts between levels of organization (organisms and life stages, populations)
- IR effects with **Other stressors** (chemicals, **climatic change**...)

## New contexts & societal perspectives

- **War situations** (Ukraine) or natural disasters
- **Novel nuclear technologies** (SMRs, AMRs, fusion) and specific sitings (marine, urban, arctic, tropical...)
- **Specific radionuclides** of interest (e.g. medical applications)
- **Waste** and Spent Fuel Management and **Decommissioning**

## Incorporation of Advanced Technologies

- **Artificial Intelligence, Data science, Computational modelling** (e.g. Inverse environmental modelling)
- **AOP** approach to provide further insight in the effects of low doses(rates)
- High-throughput screening methods in Ecology (**environmental DNA**), **remote sensing** metrology...

# Next steps

- Continued integration of environmental protection (**environmental health, exposome**)
  - Links with larger considerations: UN Sustainable Development Goals (**SDGs**), preservation of **biodiversity** and **ecosystem services**
  - **Balanced approach** against radiological impacts (social, environmental, economic)
- **Update of the Joint Roadmap** (PIANOFORTE WP2.2)
- **Engagement with stakeholders and the public**
  - Objectives: To update the first edition of the Joint Roadmap for radiation protection research published in 2020, taking into account scientific progress and evolution of societal needs

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**Webinar - 18 April 2024**

**Thanks for your attention**  
**Questions?**

The ALLIANCE warmly welcomes new members [application@er-alliance.org](mailto:application@er-alliance.org)

More information

[www.er-alliance.org](http://www.er-alliance.org)

Modest Membership fee

500 – 1 000 €/year (2024)

Alliance invites Ukrainian colleagues to join the Alliance  
free of paying the fee for the next three years