

Implementation of the Integrated Approach in Different Types of Exposure Scenarios

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ICRP Committee 4
Chair of Task Group 105

Overview

- **Applying the system of radiological protection in**
 - Planned exposure situations
 - Existing exposure situations
 - Emergency exposure situations
- **Highlighting examples, practices and plans to produce advice and guidance**

This presentation has neither been approved nor endorsed by the Main Commission of ICRP

ICRP Publication 103

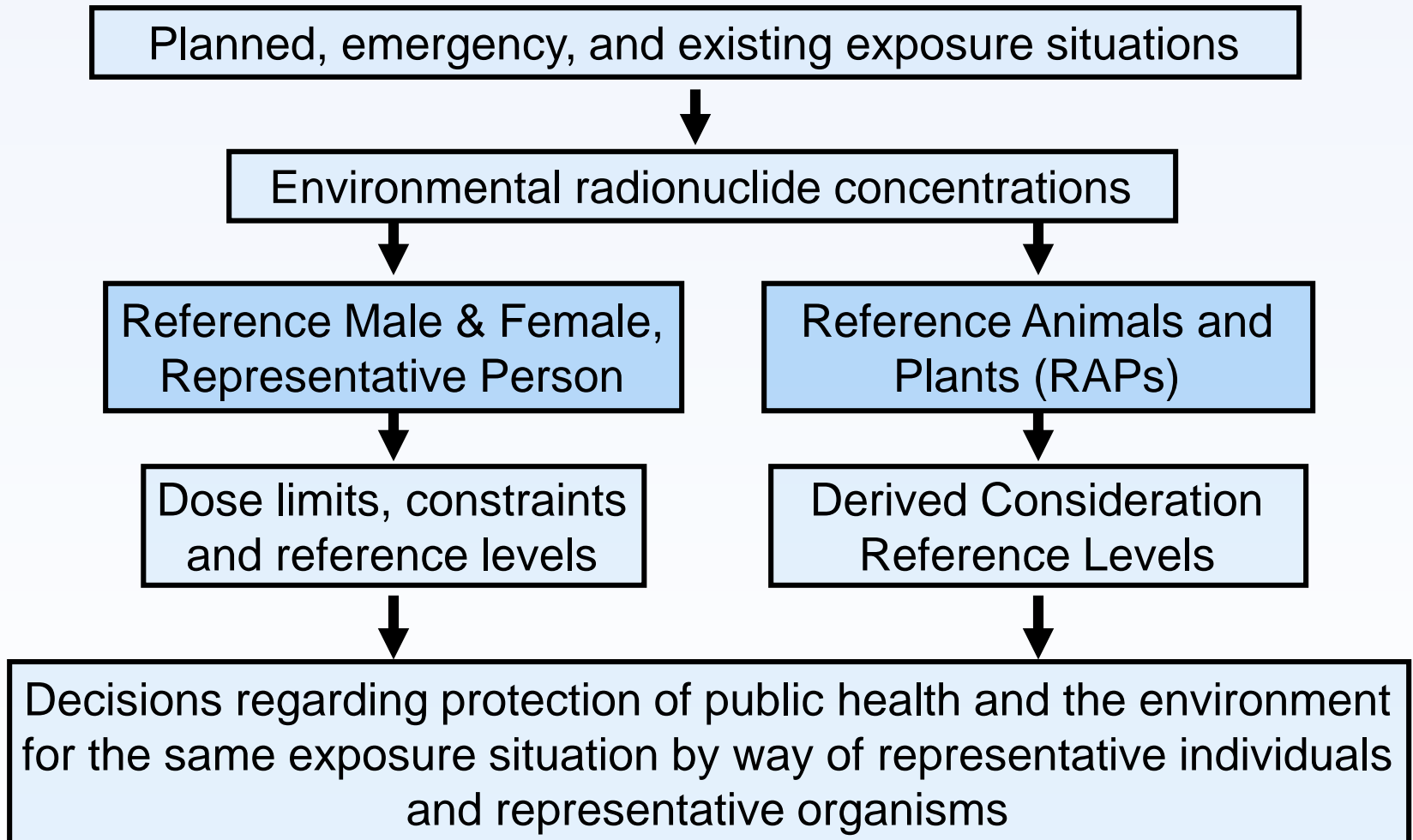
2. THE AIMS AND SCOPE OF THE RECOMMENDATIONS

2.1. The aims of the Recommendations

(26) The primary aim of the Commission's Recommendations is to contribute to an appropriate level of protection for people and the environment against the detrimental effects of radiation exposure without unduly limiting the desirable human actions that may be associated with such exposure.

(27) This aim cannot be achieved solely on the basis of scientific knowledge on

The Protection System



Derived Consideration Reference Levels (DCRLs) – a reminder

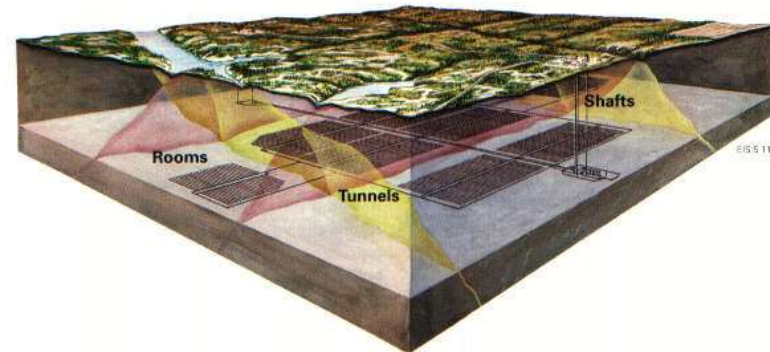
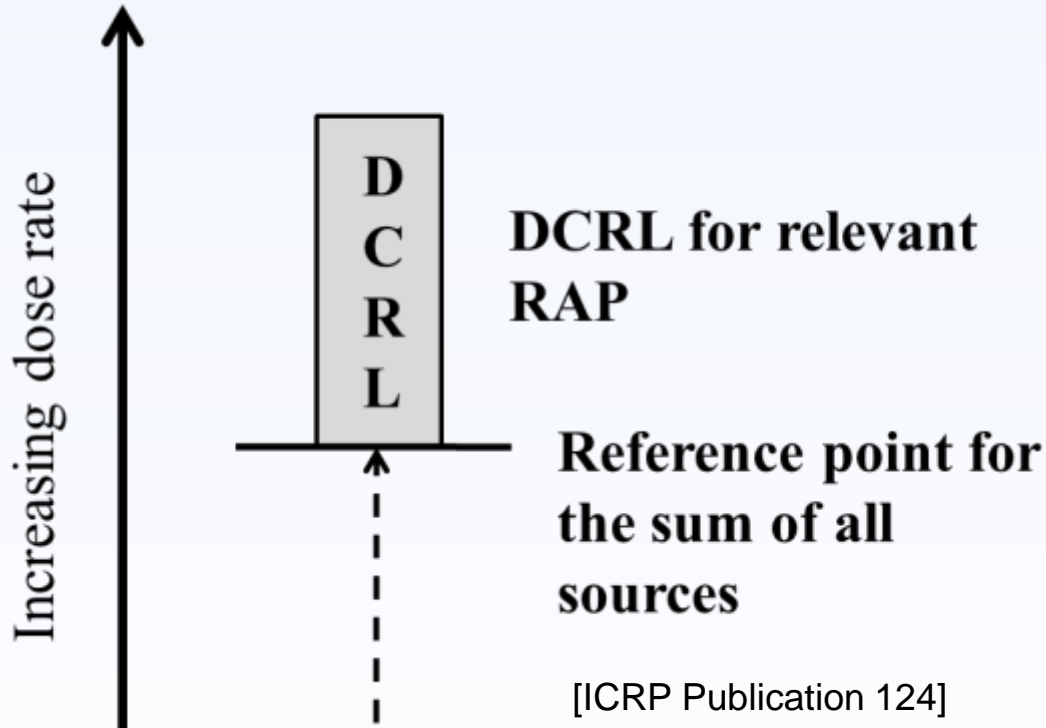
- ICRP Publication 108:
- *“A DCRL can therefore be considered as a band of dose rate within which there is likely to be some chance of deleterious effects of ionising radiation occurring to individuals of that type of Reference Animal or Plant, derived from a knowledge of defined expected biological effects for that type of organism that, when considered together with other relevant information, can be used as a point of reference to optimise the level of effort expended on environmental protection, dependent upon the overall management objectives and the exposure situation.”*

RAPs and DCRLs - a reminder

Wildlife group	Ecosystem ¹	RAP	DCRL, mGy d ⁻¹ (shaded)		
			0.1-1	1-10	10-100
Large terrestrial mammals	T	Deer			
Small terrestrial mammals	T	Rat			
Aquatic birds	F, M	Duck			
Large terrestrial plants	T	Pine tree			
Amphibians	F, T	Frog			
Pelagic fish	F, M	Trout			
Benthic fish	F, M	Flatfish			
Small terrestrial plant	T	Grass			
Seaweeds	M	Brown seaweed			
Terrestrial insects	T	Bee			
Crustacean	F, M	Crab			
Terrestrial annelids	T	Earthworm			

¹T, terrestrial; F, freshwater; M, marine

Application in Planned Exposure Situations

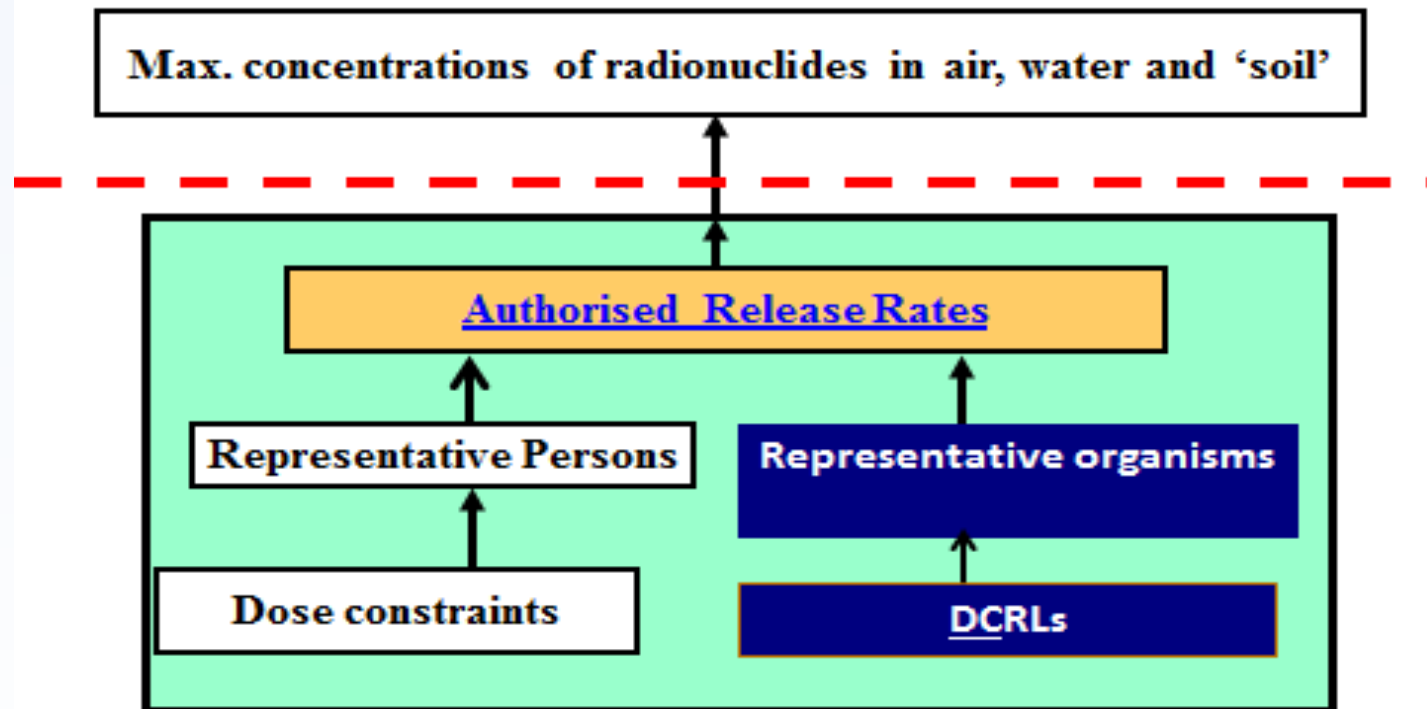


ARTIST'S VIEW OF A DISPOSAL VAULT IN RELATION TO THE ROCK STRUCTURE

Dose limits and constraints for humans

Application

Planned situations



This approach has been used already...



**OSPAR
COMMISSION**

*Protecting and conserving the
North-East Atlantic and its resources*

Agreement on a Methodology for Deriving Environmental Assessment Criteria and their application

(OSPAR Agreement: 2016-07) ¹

Introduction

1. This agreement sets out the methodology for deriving criteria for the radiological environmental assessment of concentrations of radioactive substances in the marine environment of the OSPAR maritime area by OSPAR Contracting Parties. The agreement also describes how the criteria should be applied.
2. The practical aspects of the methodology should be reviewed and updated where necessary by 2020.

Methodology

3. The methodology developed by the International Atomic Energy Agency (IAEA) for deriving the environmental assessment criteria (EAC) is set out in Reference 1 ("the IAEA Methodology") and attached at Annex 1. The principles of the IAEA Methodology were agreed by the OSPAR Radioactive Substances Committee in 2013 subject to further testing and demonstration (see 'Application' below).
4. The scheme used in the IAEA Methodology to assess the radiological impact on humans and non-humans in an integrated manner is summarised in Figure 1.

IAEA TECDOC SERIES

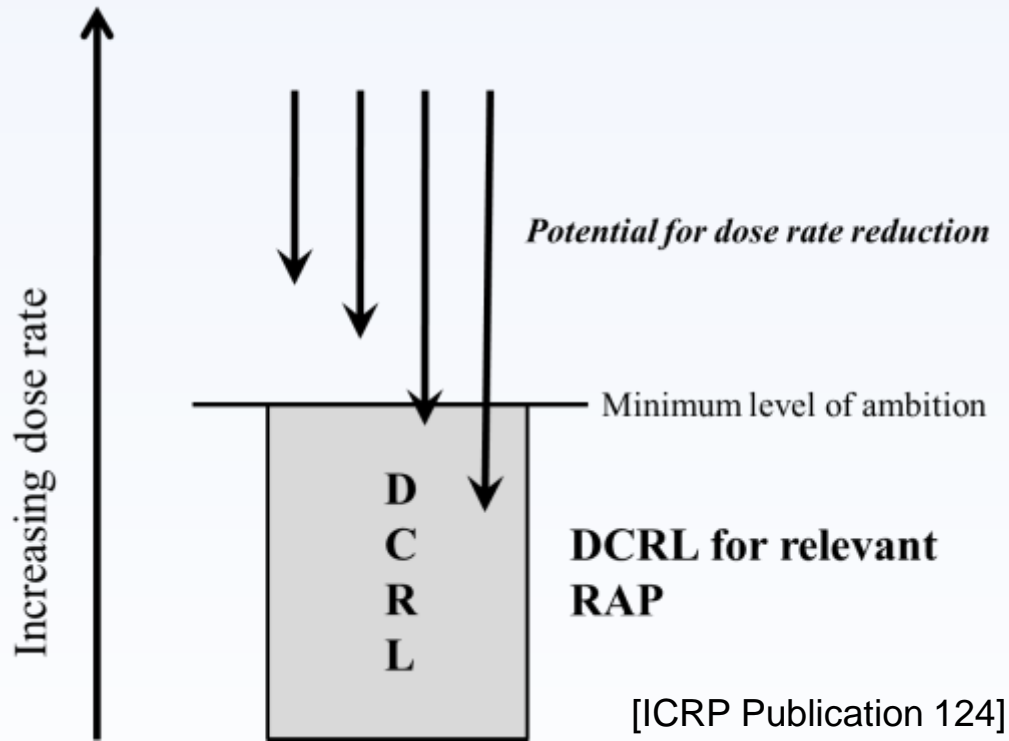
IAEA-TECDOC-1759

Determining the Suitability of Materials for Disposal at Sea under the London Convention 1972 and London Protocol 1996: A Radiological Assessment Procedure

Scenarios to be investigated

- **Hospital discharges**
- **Nuclear power plant discharges**
 - And so on.
- **Plan is that this will be a joint activity with IAEA who are developing scenarios within the update to SRS-19**

Application in Existing Exposure Situations

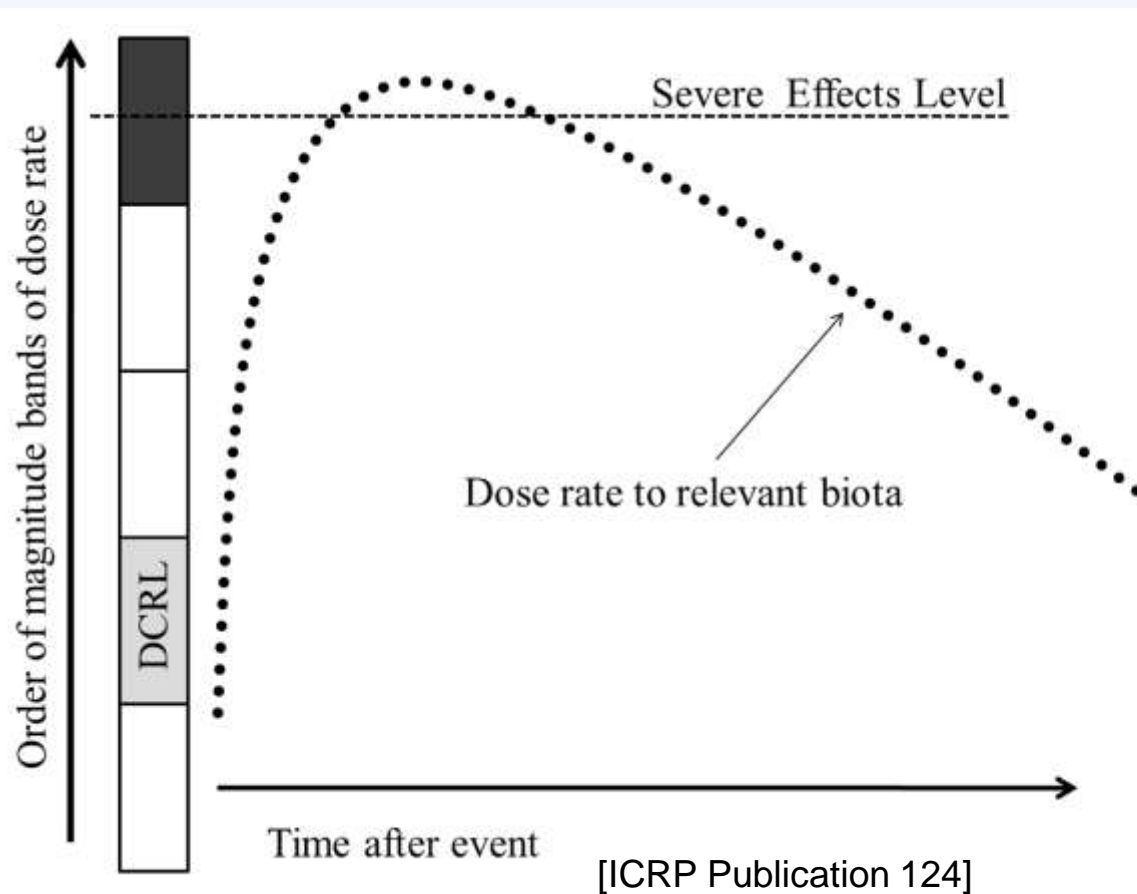


Dose limits and reference levels
for humans



Dose rate (mGy d ⁻¹)	Reference Pine tree	Reference Wild grass	Reference Brown seaweed
>1000	Mortality [5 to 16 Gy LD ₅₀].	Mortality [16 to 22 Gy LD ₅₀].	Deleterious effects expected at very high dose rates. No LD ₅₀ data.
100 - 1000	Mortality of pine trees after prolonged exposure.	Reduced reproductive capacity.	Effects on growth rate.
10 - 100	Mortality of pine trees after very long exposure. Growth defects. Reduced reproductive success.	Reduced reproductive capacity.	Potential effects on growth and reproductive success.
1 - 10	Morbidity assessed through anatomical and morphological damage. Prolonged exposure leads to reduced reproductive success.	No information.	Potential effects on growth.
0.1 - 1	No information.	No information.	No information.
0.01 - 0.1	No information.	No information.	No information.
< 0.01	Natural background.	Natural background.	Natural background.

Application in Emergency Exposure Situations



Reference levels for humans

Dose rate (mGy d ⁻¹)	Reference Pine tree	Reference Wild grass	Reference Brown seaweed
>1000	Mortality [5 to 16 Gy LD ₅₀].	Mortality [16 to 22 Gy LD ₅₀].	Deleterious effects expected at very high dose rates. No LD ₅₀ data.

Emergency



100 - 1000	Mortality of some trees after prolonged exposure.	Reduced reproductive capacity.	Effects on growth rate.
10 - 100	Mortality of some trees after very long exposure. Growth defects. Reduced reproductive success.	Reduced reproductive capacity.	Potential effects on growth rate and reproductive success.
1 - 10	Morbidity as expressed through anatomical and morphological damage. Prolonged exposure leads to reduced reproductive success.	No information.	Potential effects on growth rate.
0.1 - 1	No information.	No information.	No information.
0.01 - 0.1	No information.	No information.	No information.

After time



< 0.01	Natural background.	Natural background.	Natural background.
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So how are we going to do this?

Case studies – what can we learn?

- **Not an exhaustive list:**
 - Andreeva Bay
 - Belgian radium site*
 - Gunnar Uranium Mine and Mill Site*
 - Little Forest
 - Maralinga*
 - Marshall Islands
 - Mayak
 - Midwest Uranium Mine and Mill site*
 - Montebello Islands*
 - **Others?**

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- **Others?**

Environmental considerations and consequences of recommended recovery approaches?

Status at two Australian nuclear test legacy sites:

Maralinga:

- Former British nuclear weapons test site
- **Assessed 1980s-90s for radiation risk to humans**
- Assumed continuous habitation of traditional aboriginal lifestyle
- Major clean-up (c. 2000) to criteria of 5 mSv reference level
- Periodic reassessment by Australian government confirms clean-up
- Potential impact on **wildlife not formally** considered. Formal environmental dose assessment has yet to be performed
- Recent studies on wildlife uptake (Johansen et al. 2014; Johansen et al. 2016)



Status at two Australian nuclear test legacy sites:

Montebello Islands:

- Testing included the first British test (Hurricane in the ship HMS Plym), and the largest detonation in Australia (Mosaic G2)
- Has been assessed for human exposure only transient island visitors (Cooper et al. 1990)
- Minimal clean-up performed
- Recent investigations have begun on wildlife (Johansen et al. 2017). A formal environmental dose assessment has yet to be performed
- Threatened and endangered species use the contaminated islands

Rufus Hare-wallaby



Status at planned uranium mining site:

Midwest Uranium Mine and Mill site:

- The planned facility is located in northern Saskatchewan in Canada.
- Human health risk assessment, ecological risk assessment and socio-economic assessment were carried out, as part of the environmental assessment process.
- In doing so, characterization of habitat, a species inventory, baseline contaminant concentrations, and baseline impacts of stressors were conducted.



Ribbon-leaf pondweed



Woodland caribou



Northern leopard frog

Status at planned uranium mining site:

Midwest Uranium Mine and Mill site:

- Key contaminants and stressors of potential concern anticipated from the project were identified (including radionuclides).
- Loss of fish habitat was a potentially significant impact and it was necessary to develop a fish habitat compensation plan to ensure no net loss of fish habitat.
- Plans were established to ensure no significant net effect from potential project-related contaminants or stressors.



Northern leopard frog

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Status at abandoned legacy uranium mining site:

Gunnar Uranium Mine and Mill Site:

- The site is located near Uranium City in northern Saskatchewan, Canada and was operated from 1953-1964 after which it was abandoned and left essentially “as is”
- Due to imminent risk to public safety, in the short-term, authorization was given by the regulatory body to dismantle buildings and structures outside of the environmental assessment process
- To address long-term impacts, human health risk assessment, ecological risk assessment and socio-economic assessment were carried out
- Assessment outcomes: potentially feasible remedial options were identified, and a systematic process was undertaken to justify and optimize potential options



Status at abandoned legacy uranium mining site:

Gunnar Uranium Mine and Mill Site:

- Due to the lack of monitoring data and historic records, it was necessary to develop an innovative decision-tree approach
- Identification of a relatively large number of remedial options (instead of the typical 1 “preferred” and 1 “alternative” option)
- Regulatory hold-points were then established, pending further monitoring data, and at each hold-point remedial options were selected and proposed for authorization
- After >50 years since being abandoned, the Gunnar Site is now under regulatory control

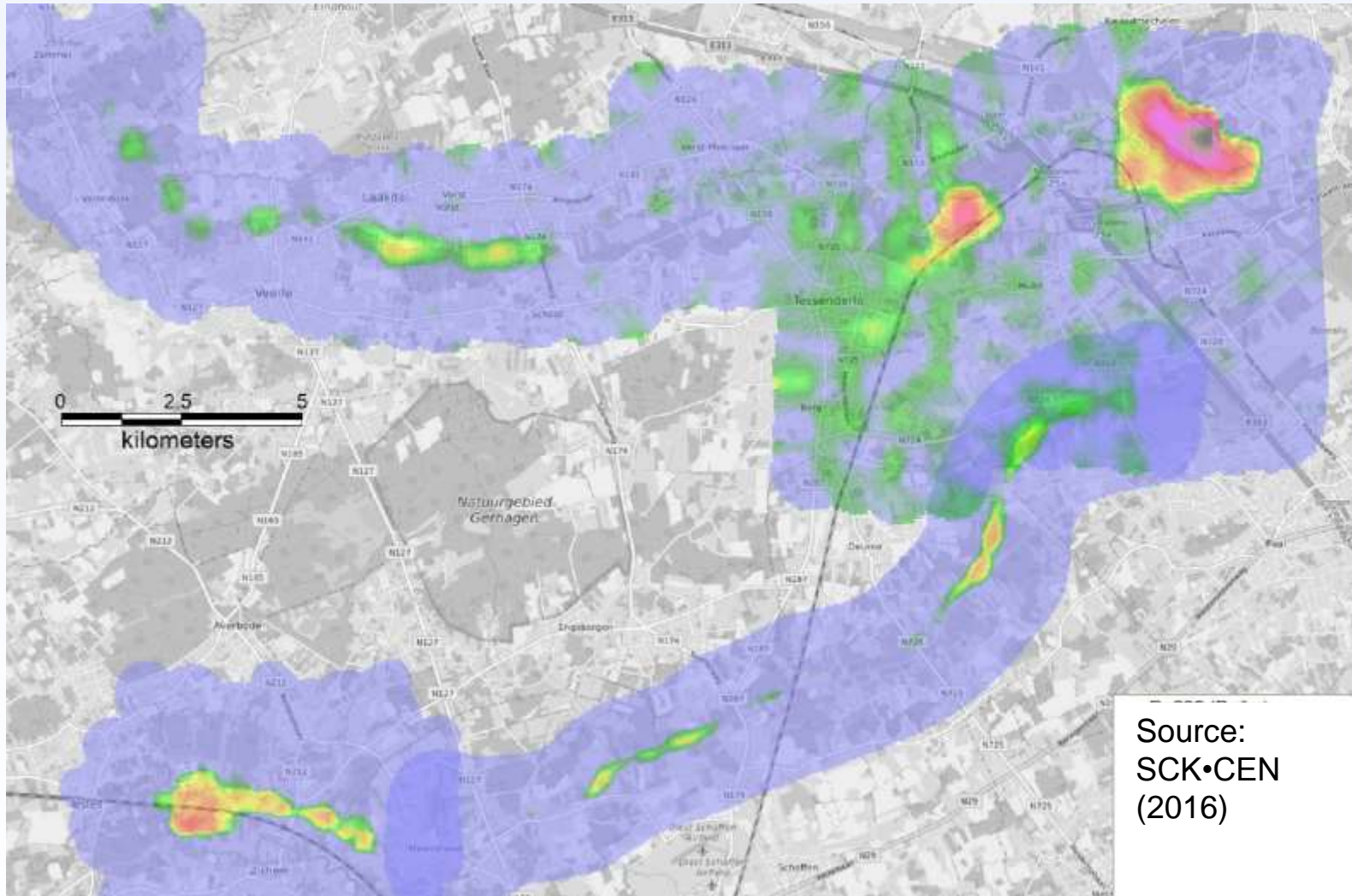


Radium contaminated site at Winterbeek

- Old phosphate industry activities



AGS Overview of the contamination at Winterbeek



Source:
SCK•CEN
(2016)

Winterbeek Risk Evaluation

- **Average: 1330 Bq/kg**
- **Range: 8-8600 Bq/kg**
- **Average riverside: 3800 Bq/kg**
- **Average border study area: 150 Bq/kg**
- **Dose assessment** using different exposure pathways (external-, internal by ingestion and inhalation) under **current use**:
 - **dose < 1 mSv/year** → **No intervention needed**
- For **future use** of contaminated areas : construction of buildings should be avoided (**indoor radon risk**)
- **Local workers** (rat catchers) were dosimetrically followed up, results were all below DL (theoretically < 0,3 mSv/y)
- SCK•CEN study about impact to biota → JER 141 pp14-23 (2015).
 - but what about **'regular' pollutants?** (heavy metals)

Winterbeek Risk Evaluation

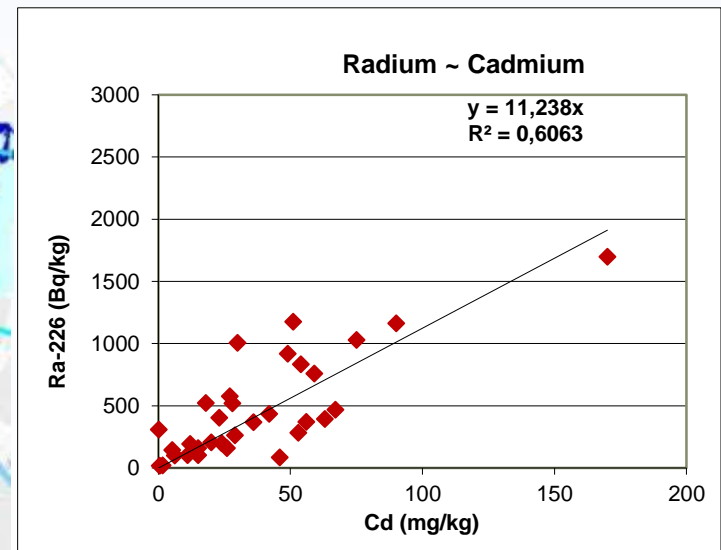
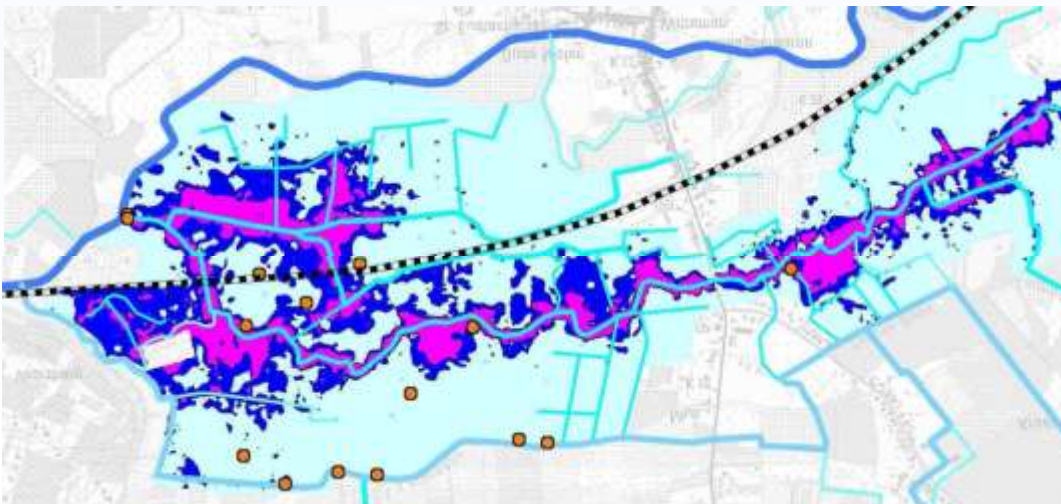
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Winterbeek Risk Evaluation

- Cadmium is the main pollutant: levels up to **160 mg/kg**
- Zones with **DR > 150 nSv/h** contain 90% of samples with **Cd > 6 mg/kg**
⇒ 6 mg/kg Cd ~ 150 nSv/h ...
- DR can be used as tool to **find metal contamination** as well as **operational tool** during remediation
- **Exceeds soil remediation levels + non-negligible impact to biota**
→ INTERVENTION



Case studies – what do we hope to do/learn?

- Generation of advice and recommendations for decision making in terms of both humans and environment
- Application of fundamental ethical principle of “do more good than harm”
- How to handle radiological and non-radiological impacts?
- Answers to “What if” questions
- What to do if the assessment indicates impacts above the DCRL for wildlife, but where there is no significant human impact?

Case studies – what do we hope to do/learn?

- What to do in **complex situations** e.g. where emergencies turn into existing situations or where urgent protective action needed?
- Advice for how to **better integrate** environment into the system of radiological protection
 - E.g. Inclusion of environment in ALARA
- How to **communicate** issues and considerations for different exposure situations

Challenges

- **Level of complexity?**
- **Stakeholder interests in the sites**
- **Ensuring pragmatic and fit-for-purpose approaches**
- **Addressing where management action may lead to environmental harm**
- **Provision of practical advice e.g.:**
 - area or zone (km²) to consider
 - the time period to consider
 - the type of managerial interest, such as fisheries management, agriculture, nature conservation, habitat protection, etc.
 - the degree of precaution to be considered
 - Communication approaches.... Etc.

Summary

- **Task Group 105 is to:**
 - Describe the approach to considering humans and biota in an integrated manner
 - Provide guidance on how to handle decisions on what needs to be done where humans are considered protected but biota may not be
 - Embed the ethical principle of “do more good than harm”

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