The IAEA methodology for radiological protection of the environment, including human and non-human biota.

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International Atomic Energy Agency

Outline

- Introduction.
- International milestones on radiation protection of the environment.
- Key international consensus.
- International safety standards and recommendations.
- Highlights of IAEA methodology recently incorporated in a Safety Guide (DS427).

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Introduction

- The paradigm for environmental radiation protection, based in the assumption that 'protection of humans provide protection to other species in the human environment', was challenged by society in the late 90's, acknowledged in the 2000's by the radiation protection community, the ICRP and other international and national organizations and, resulted in changes in the 2010's.
- The IAEA followed closely this process and contributed within its role, to coordinate international efforts, foster information exchange and develop international safety standards and guidance.

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International milestones on radiation protection of the environment

- The IAEA considered explicitly protection of species where human is not present since the late 70's and 80's in relation to dumping of radioactive material into the oceans (i.e. IAEA TSR-172, TSR-190, TRS-288).
- 1996 UNSCEAR report address protection of environment and effects on plants and animals explicitly (same in 2008).
- 2003 International Conference on the Protection of the Environment from the Effects of Ionizing Radiation recognized the need to demonstrate explicitly protection of biota (IAEA, UNSCEAR, IUR, EC, Member States).
- 2005 IAEA Plan of Activities on the Radiation Protection of the Environment fostered information exchange and consensus on regulatory approaches (IAEA, UNSCEAR, UNEP, ICRP, IUR, OECD/NEA, EC, WNA, Member States).

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Key international consensus

- Integrating environment and sustainable development in decision making (Rio Declaration 1992).
- The system of radiation protection extended to address protection of the environment more explicitly.
- Need of a methodological approach:
  - practical and simple,
  - avoiding unnecessary burden (graded approach based on actual risk),
  - allow for harmonization with ICRP system for radiation protection.
- Need of an international agreed regulatory approach for protection of biota.
- Consideration of radiological environmental impacts for managerial purposes where feasible (planned exposure situations) and as part of the optimization process together with societal and economic factors (for existing exposure situations).

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International safety standards and recommendations

- 2006 IAEA Fundamental Safety Principles (SF-1: IAEA, ILO, IMO, WHO, UNEP, PAHO, FAO, EURATOM, OECD/NEA)
- 2007 ICRP Recommendations (Pub. 103).
- 2008 ICRP Reference Animals and Plants (Pub. 108).
- 2011/14 IAEA Basic Safety Standards (GSR Part 3; IAEA, ILO, WHO, OECD/NEA, UNEP, PAHO, FAO, EC).
- 2014 ICRP Environmental Protection under different exposures situations (Pub. 124).

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Key aspects of IAEA standards on protection of the environment

- Address radiological protection of humans and the environment in an integrated manner.
- Protection for non-human species was set at a high organization level:
  - conservation of species,
  - maintain biodiversity
  - Address populations, communities and ecosystems, rather than individuals (as it is for humans).
- Assessment and control based on exposures to reference animals and plants and reference levels (similarly to reference person, limits and reference levels).
- Relation with managerial options different for planned, existing and emergency exposure situations.

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Highlights of IAEA approach in the safety guidance

- Use of ICRP reference approach for humans and flora and fauna.
- Integration of human and flora and fauna protection (linkage through the exposure scenario).
- Use of a reference area for assessments for planned exposures situation, combining the scenario of exposure to humans and flora and fauna.

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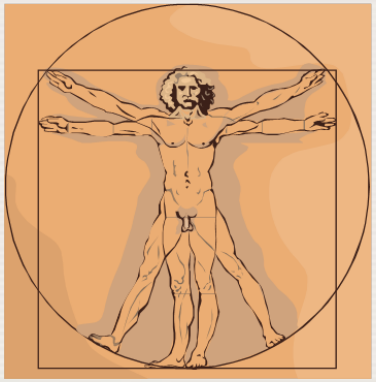
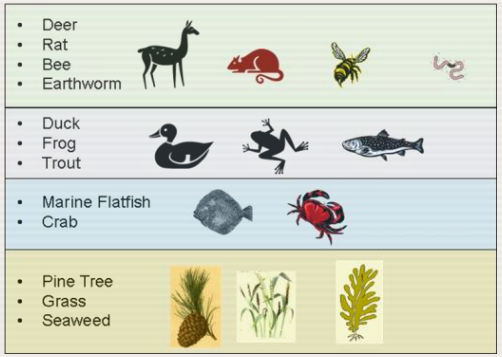
ICRP Reference approach for protection of humans and flora and fauna

Objects of protection	Assessment reference	Estimation of radiation dose	Criteria
 Individuals	 Reference person	**Source/transfer** + **Exposure pathways**	Limits, Reference levels, risk on individuals.
 Populations, communities	 Reference animals and plants	+ **Dosimetric models**	Reference levels on individuals having impact on the structure of populations.

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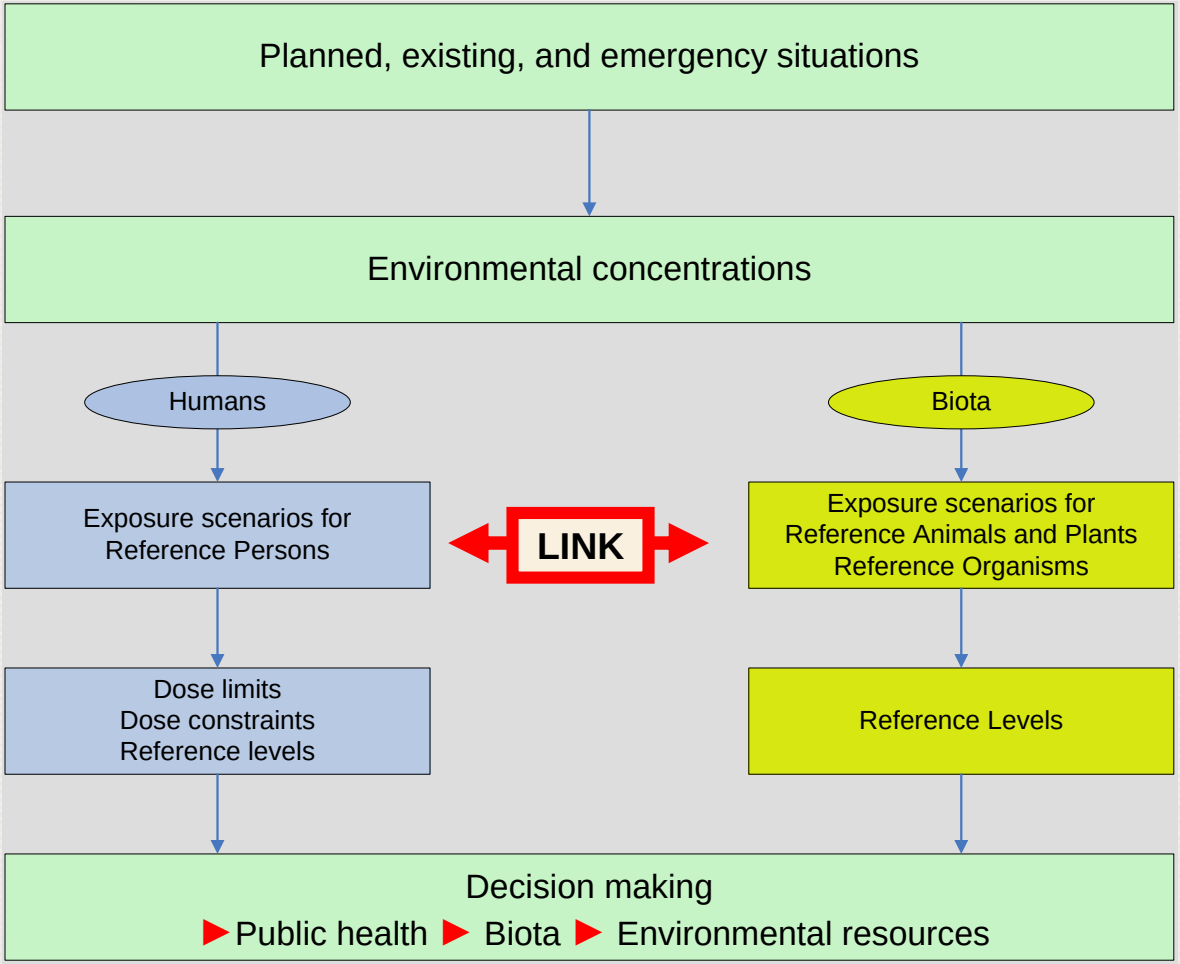
IAEA proposal for integration of human and environmental protection

Representative person
(based on individual's characteristics)



Representative organism
(based on group's characteristic)

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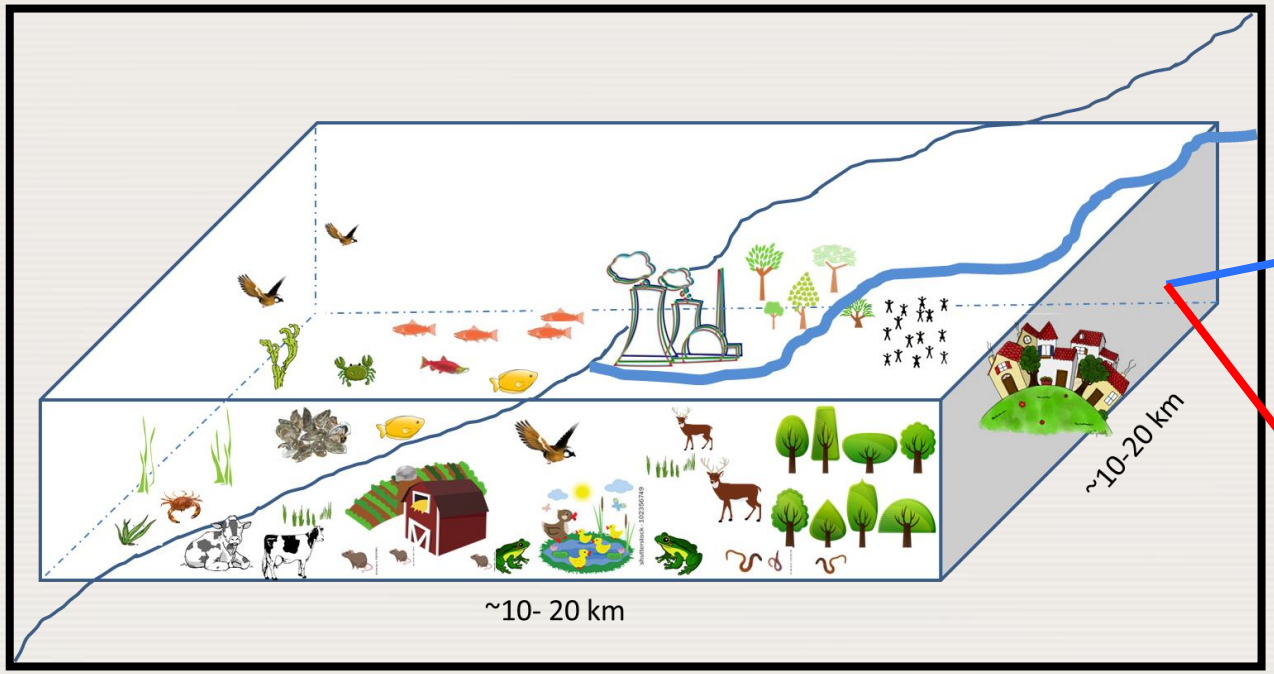
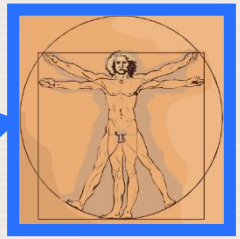
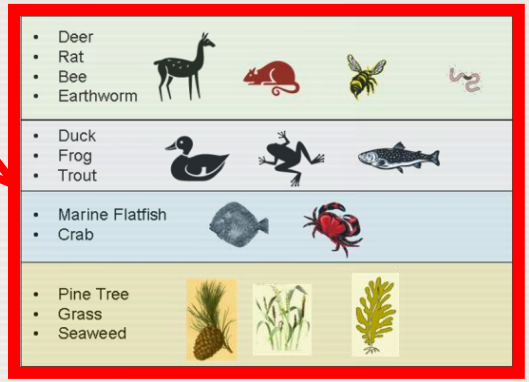
IAEA reference area for assessment of environmental impact



Representatives of **more highly exposed individuals** / **more highly exposed groups of animals and plants**





- Humans and flora and fauna assumed to share the same exposure scenario.
- Dose is estimated to the representative person and most highly exposed group of reference plants and animals (using the averaged dose rates) in a reference area of ~100-400 km^2 around the source, where the highest activity concentrations generally occur.

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IAEA approach for planned exposure situation (DS427)

- **Public**
  - Exposure to representative person (an individual 'more highly exposed', with particular location and habit data); it must be controlled/managed.
  - Dose limit, 1 mSv/a.
  - Optimization of the protection (starting from dose constraints < 1mSv/a).
- **Other species**
  - Exposure to representative organisms (a group of reference animals and plants (RAP) 'more highly exposed'); it can be controlled/managed.
  - No dose limit: ICRP bands of Derived Consideration Reference Levels (DCRL);
  - Lower boundary of the DCRL band to be used as reference point.
    - Exposures to RAP
      - Below lower boundary of DCRL
        - Appropriate level of protection of flora and fauna
      - Above lower boundary of DCRL
        - Maybe acceptable but further actions to be considered.
      - Above upper boundary of DCRL
        - Stronger needs for further protection efforts

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DS427 Methodology

Table I-1: Types of animals and plants for three major ecosystems to be used in generic assessments of radiological impact on flora and fauna and relevant derived consideration reference levels

Ecosystem of interest	Type of animal or plant	ICRP reference animals and plants	Derived consideration reference level, mGy/d
Terrestrial	Large plant	Reference pine tree	0.1–1
	Small plant	Reference wild grass	1–10
	Insect	Reference bee	10–100
	Annelid	Reference earthworm	10-100
	Large mammal	Reference deer	0.1–1
	Small mammal	Reference rat	0.1–1
Freshwater	Aquatic bird	Reference duck	0.1–1
	Amphibian	Reference frog	1–10
	Fish	Reference trout	1–10
Marine	Seaweed	Reference brown seaweed	1–10
	Crustacean	Reference crab	10–100
	Fish	Reference flatfish	1–10

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DCRL versus typical exposures to biota in planned exposure situations (control based on humans only)

Ecosystem of interest	Types of animals and plants	ICRP reference animals and plants	DCRL, mGy/d
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	Insect	Reference bee	**10–100**
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Source	Involved radionuclides	Biota type	Exposure, mGy/d	
Nuclear Industry	^{3}H, ^{99}Tc, ^{137}Cs, $^{238/239}Pu$	Macroalgae, crustaceans, vertebrates	**0.0000024 – 0.0024**	[1]
Nuclear Power Plant	^{3}H, ^{14}C, ^{131}I, $^{134/137}Cs$	Various plants and animals	**0.000012 (max)**	[2]
Reprocessing	^{3}H, ^{14}C, ^{60}Co, ^{90}Sr, ^{106}Ru, ^{129}I, $^{134/137}Cs$, Pu, ^{241}Am	Fish, molluscs, plankton	**0.0012**	[3]
Oil and gas	$^{226/228}Ra$, ^{210}Pb, ^{210}Po	Fish, molluscs, plankton	**0.00168 (max)**	

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[1] OSPAR (2008); [2] Beresford (2005); [3] Chambers (2005) ;

Conclusion

- The radiological protection of the environment is currently seen as a integrated aspect together with human protection.
- Methods which have international consensus where developed by IAEA to assess and inform control/manage when feasible (i.e. in planned exposure situations) the radiological impact to flora and fauna.
- Generally, the exposures resulting to biota due to normal operation of installations of different type, when the discharges are limited on the basis of human protection only, are orders of magnitude below the reference levels to biota.
- The historical assumption that 'protecting humans imply other species are protected' can and should now be tested (confirmed) explicitly (particularly for planned exposures situations) by mean of simple methods, given reassurance that the use of the environment can be done in a sustainable manner from the radiological perspective.

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THANK YOU FOR YOUR ATTENTION!

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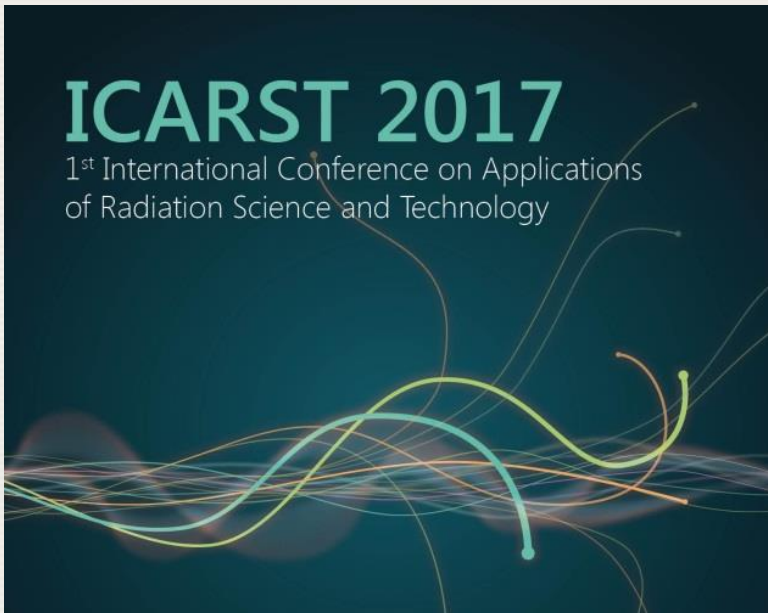

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