# Radioecology in 2012
# Current research directions and trends for the future

# What is Radioecology

**A multidisciplinary scientific discipline:**

**biology, chemistry, physiology, ecology, biogeochemistry, geophysics, ecotoxicology, mathematics (models, statistics), metrology, …**

- **centered on the environment,**
- **aimed at describing, understanding and predicting**

  - **the fate of radioactivity in environmental systems,**

    **(artificial and natural)**

  - **its impact on man (via the environment) and on the environment itself (biota, ecosystems)**

    **(human and ecological risk assessment)**

  - **biogeochemical processes by means of tracer studies**

- Main research directions of radioecology
- On-going move from anthropocentric to ecocentric
- Conclusion: challenges from Fukushima

# The main research directions of Radioecology

## Axis 1: Source term

- Speciation, mobility (in the various environmental media)

## Axis 2: Transfers

- In abiotic compartments, within the human food chain
- In abiotic compartments, within the biota trophic network

## Axis 3: Effects

- (On man)
- On biota, populations, ecosystems

## Axis 4: Risk assessment

- Human risk assessment
- Ecological risk assessment (organism-based/ecosystem-centred approach)

## Axis 5: Tracer studies

- Biogeochemical cycles, ocean streams, run-off

AXIS 2

**Transfers**

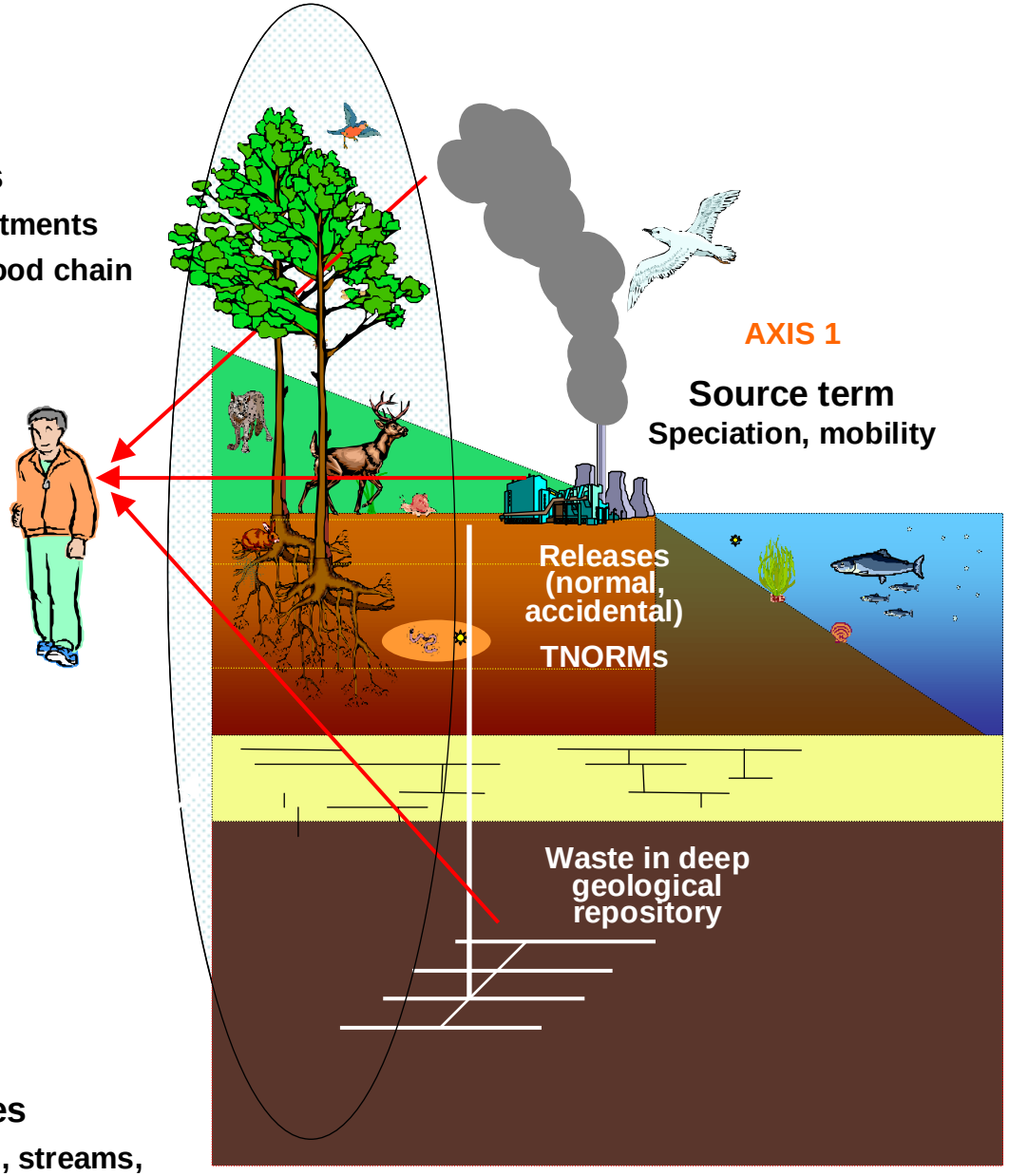
**In abiotic compartments**

**Within the human food chain**

AXIS 3

**Effects**

**(On man)**




AXIS 1

**Source term**

**Speciation, mobility**

ATMOPHERE

BIOSPHERE

GEOSPHERE

AXIS 4

**Risk assessment**

**Human risk assessment**

AXIS 5

**Tracer studies**

**Biogeochemical cycles, streams, run-off…**

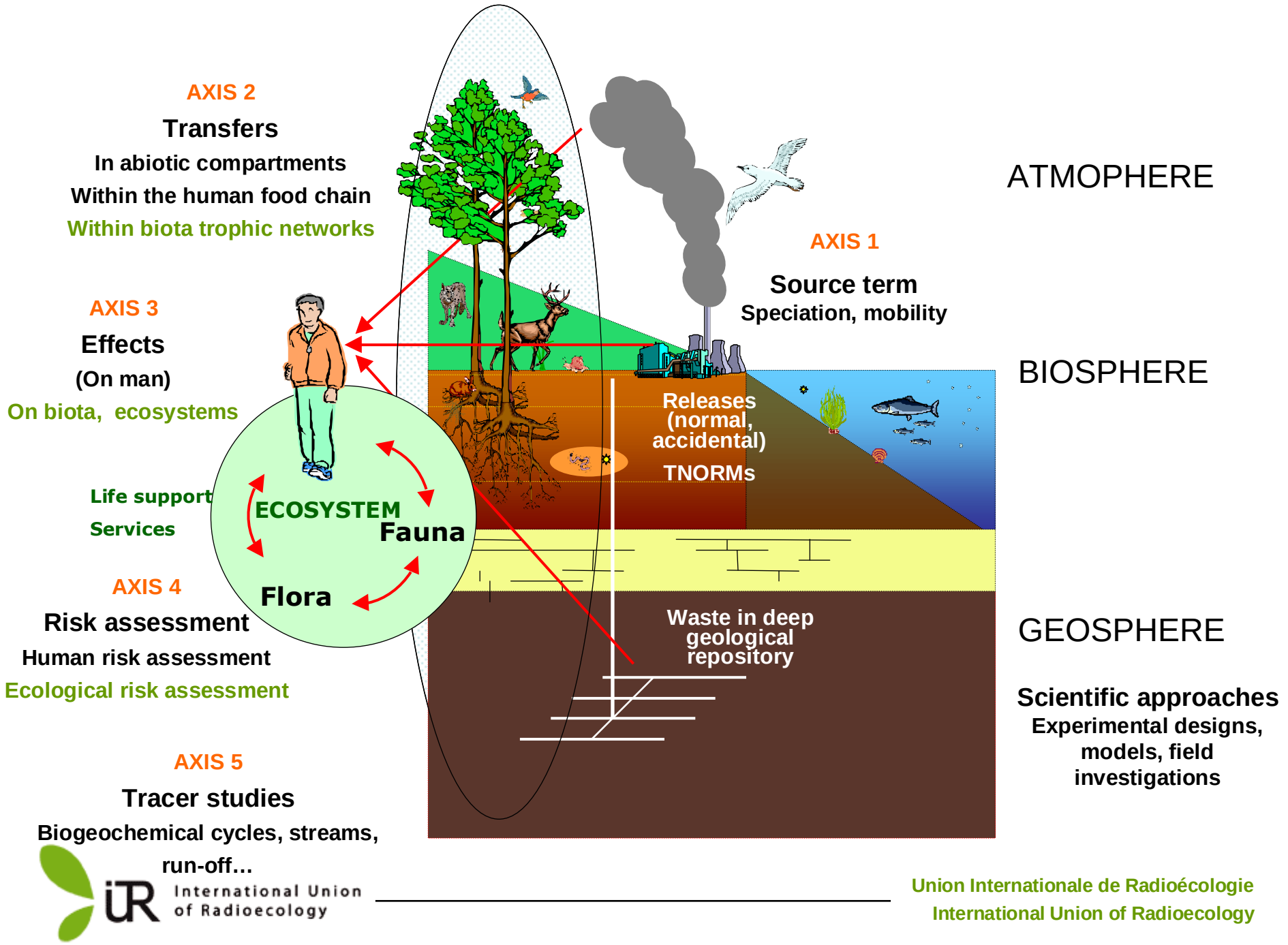
**Scientific designs**

**Experimental approaches, models, field investigations**

International Union of Radioecology

Union Internationale de Radioécologie

International Union of Radioecology


AXIS 2
Transfers
In abiotic compartments
Within the human food chain
Within biota trophic networks
AXIS 3
Effects
(On man)
On biota, ecosystems
Life support
Services
AXIS 4
Risk assessment
Human risk assessment
Ecological risk assessment
AXIS 5
Tracer studies
Biogeochemical cycles, streams, run-off…
ECOSYSTEM
Fauna
Flora
AXIS 1
Source term
Speciation, mobility
Releases (normal, accidental)
TNORMs
Waste in deep geological repository
ATMOPHERE
BIOSPHERE
GEOSPHERE
Scientific approaches
Experimental designs, models, field investigations
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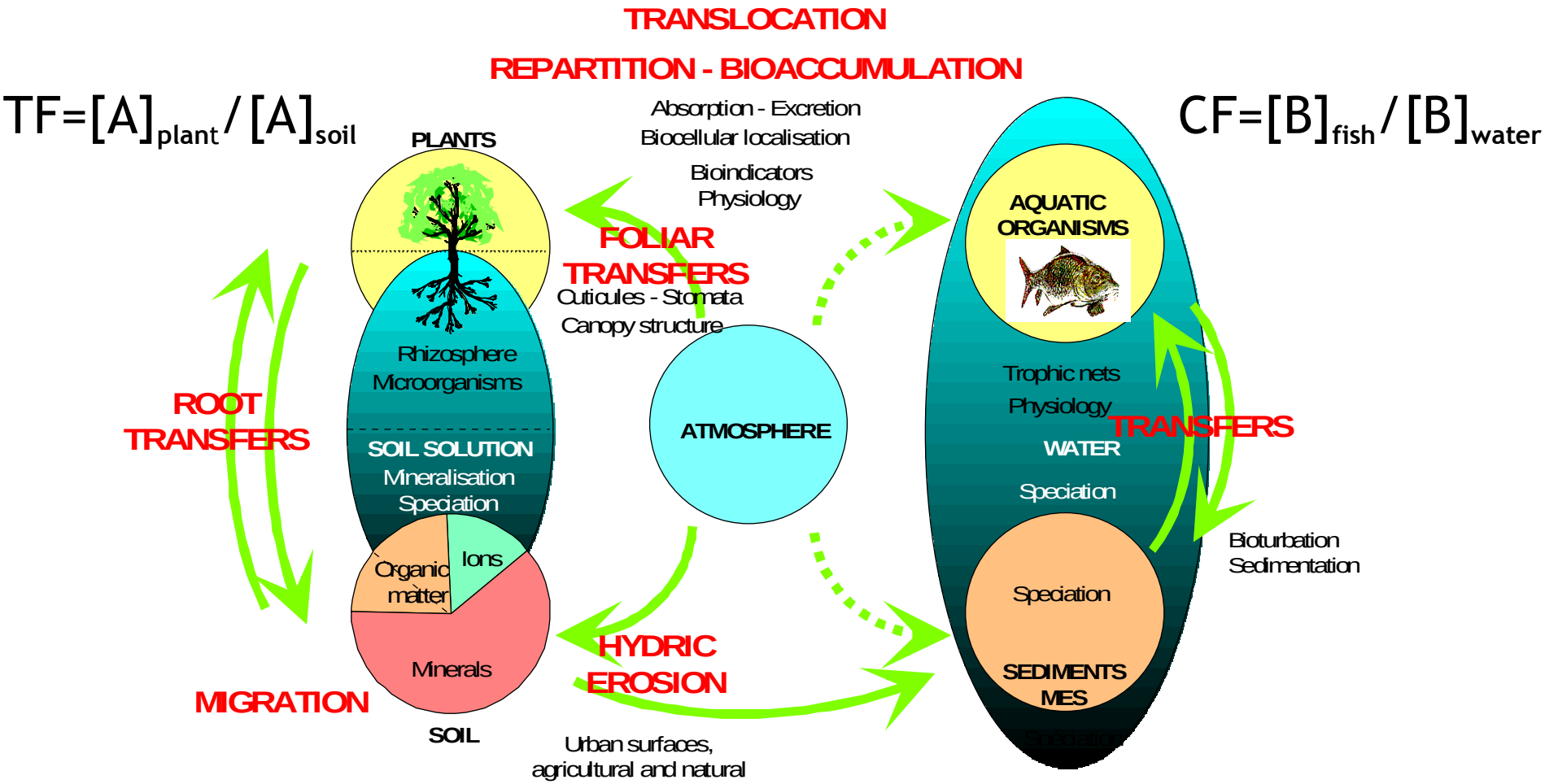
# Radionuclides transfers

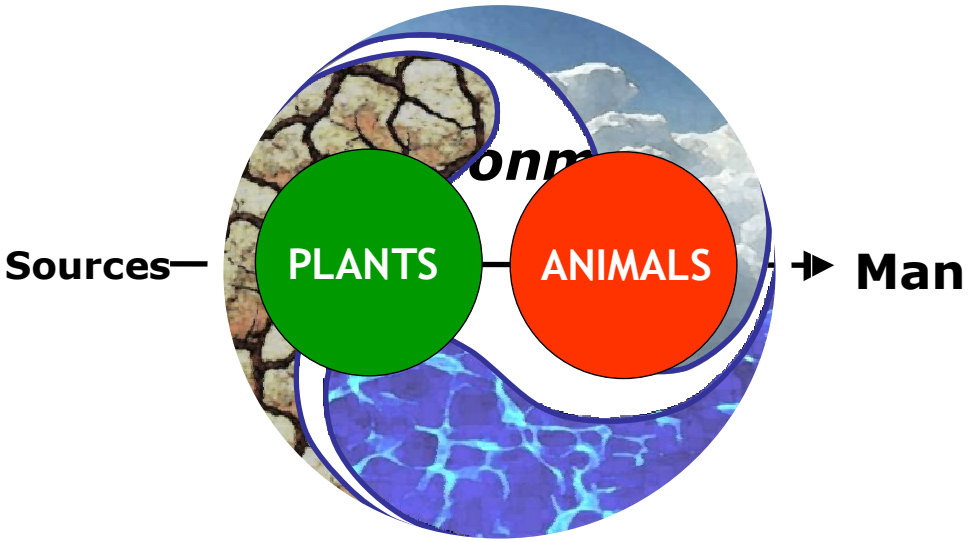


# Radiation effects on wildlife: missing knowledge

**Research priorities** →

- Long-term (trans-generational)
- Low doses and dose rates
- Internal contamination
- Observations at population, community and ecosystem level
- More species (biodiversity)

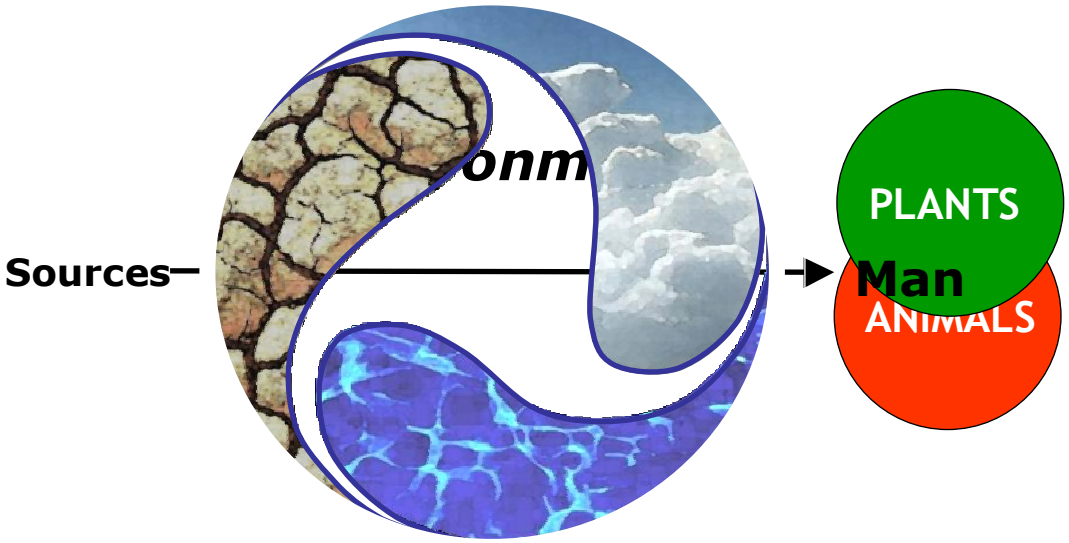
# Historical anthropocentric approach




**Linear Transfers**

- External (to man) medium (exploitation of abiotic resources)
- Animals and plants, but only for agricultural purposes (produce human food)
- Animals and plants as vectors of contamination to humans, not as targets
- Man was considered out of the environment, and as the exclusive target of concern

# From anthopocentric to biocentric … today




***Environment***

- Pristine nature (the wilderness and its biota, fauna and flora)
- Radioactivity effects on wild animals and plants
- Animals and plants as targets

**Linear Transfers to biota**

**Effects**

# Effects under chronic exposure

10 µGy.h$^{-1}$

Screening

1 mGy.d$^{-1}$

10 mGy.d$^{-1}$

## Recent literature compilation (ERICA EC project)

| Dose rate µGy.h$^{-1}$ (mGy.d$^{-1}$) | < $10^2$ (< 2.5) | $10^2$-$10^3$ (2.5-25) | $10^3$-5.$10^3$ (25-125) | 5.$10^3$-$10^4$ (125-250) | $10^4$-2.$10^4$ (250-500) | > 2.$10^4$ (>500) | > $10^5$ (>5000) | > $10^6$ (>50000) |
|---|---|---|---|---|---|---|---|---|
| Plants | | Growth red.<br>Morphologic al alt.<br>Populations alt.. | Canop. ind. modification<br>Growwth reduction<br>Photosynth. reduction | Coniferous mortality | Leaves growth reduct. & mortal.<br>Reduction of seeds | Reduction of reproductive potential<br>Grass mortality<br>Herbacées M | Mortality of all plants | Reduction of biodiversity |
| Fishes | Reprod. anomalies | Germ cells alteration.<br>Reduced fecundity | Par. Nuptial<br>Reduced fertility<br>Increased sterility | Reduced spermato-genesis | Larvaes mortality<br>Severe sterilit<br>Vertebrae growth reduction | | | |
| Mammals | Alt. Germ cells<br>Reduced fecundity<br>Chromosome aberrations | Brain cells mortality<br>Germ cells alteration<br>Increased sterility<br>Reduced survival | Weight reduction<br>Ovaries malfunction<br>Sterility | | Mortality of embryos | | | |

**Effect endpoints focused on individual organisms:**

- **Mortality**
- **Morbidity**
- **Reproductive success**
- **Chromosome damage**

Ecosystemic approach

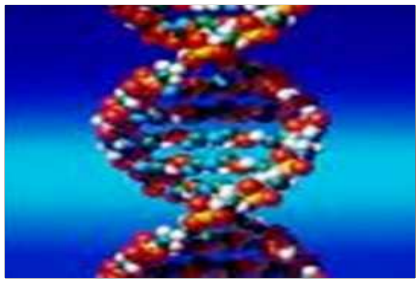
Toxicological approach

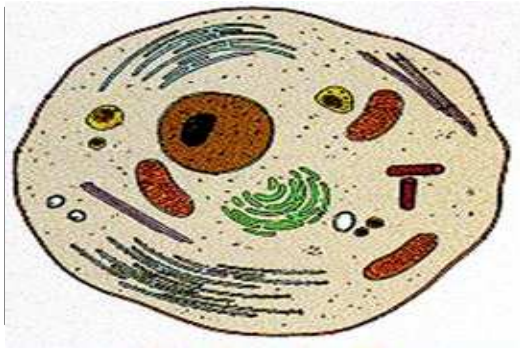
DNA-RNA
Membrane receptors
Key enzymes
Biochemical integrity

Xenobiotic introduction

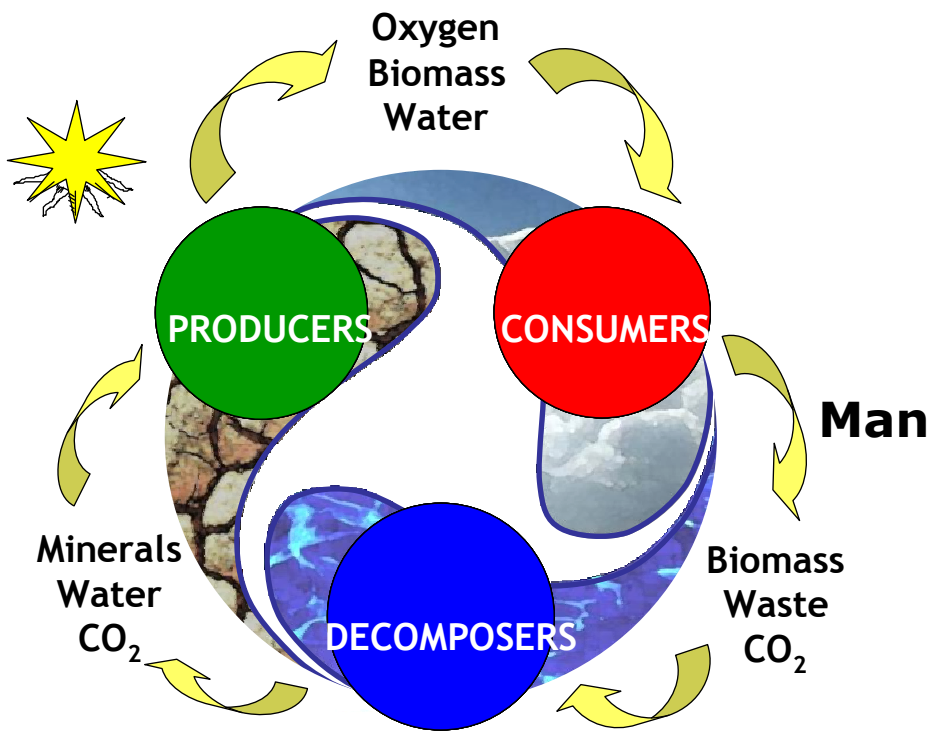
Site of action

**Ecosystem effects**





# Tomorrow: moving to an ecocentric view with the ecosystem approach




***Environment including man***

- **Ecosystem** = biotope + biocenose

- **Services** (waste recycling, provision of ressources, …)

- **Life support** (water recycling, air bioregeneration, biomass production, …)

# Conclusion: How is radioecology challenged by Fukushima?

**Remediation, mitigation, decontamination techniques (terrestrial)**

- Speciation,

**Impacts on the marine ecosystem**

- In-sediment accumulation ?
- Long-term distribution and impact on the local marine trophic network

**Better understanding of the multiple stressors context**

- Tsunami physical reshaping of the coastal area
- Radioactive releases to the environment (terrestrial and marine)
- Integrated Ecological risk assessment

**Tracer studies**

- Ocean streams, run-off