Radioecology in 2014
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

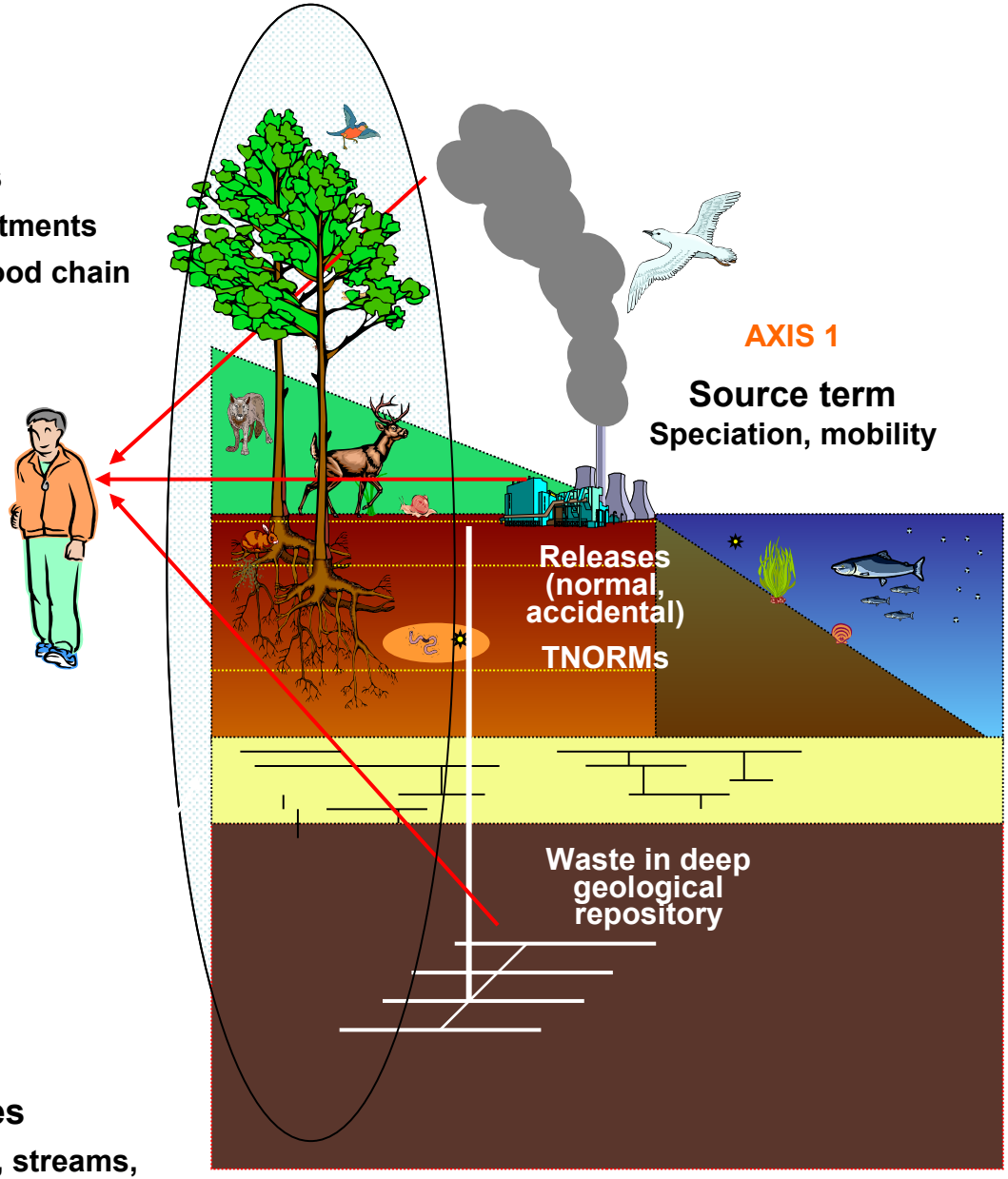
In abiotic compartments

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

Scientific designs

Experimental approaches, models, field investigations

AXIS 5

Tracer studies

Biogeochemical cycles, streams, run-off…

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

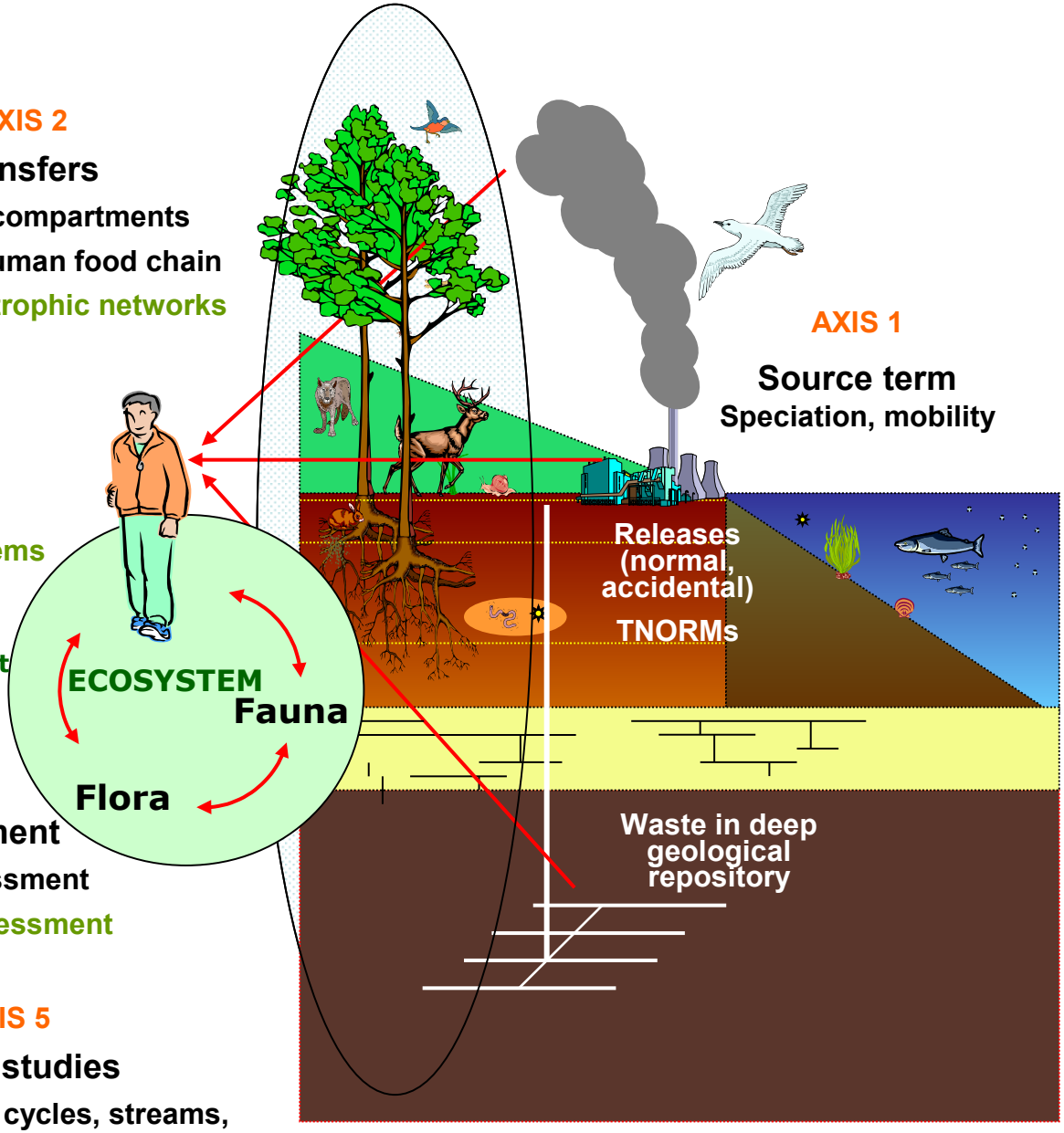
Human risk assessment

Ecological risk assessment

AXIS 5

Tracer studies

Biogeochemical cycles, streams, run-off…



AXIS 1

Source term

Speciation, mobility

ATMOPHERE

BIOSPHERE

GEOSPHERE

Scientific approaches

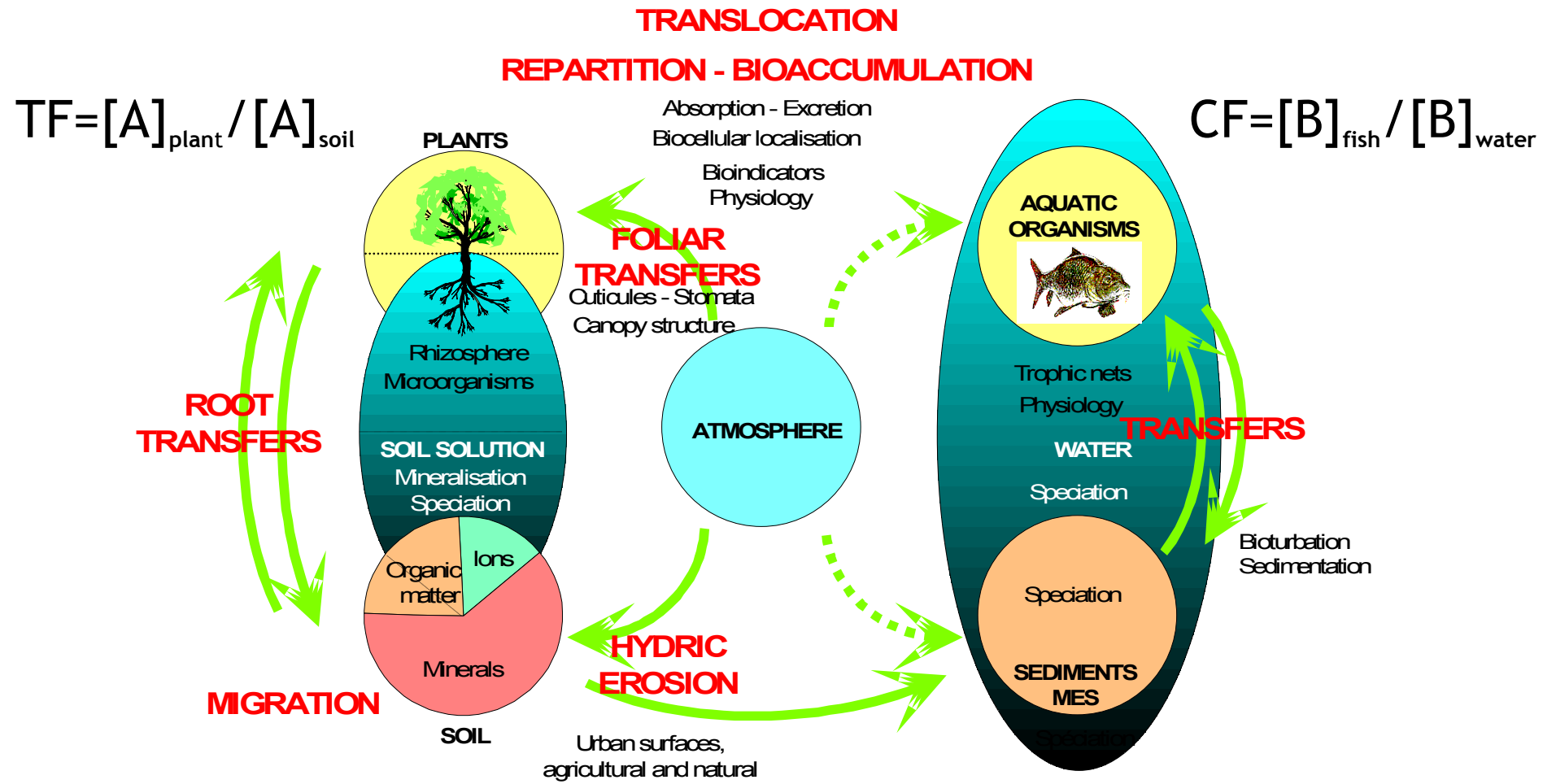
Experimental designs, models, field investigations

iUR International Union of Radioecology

Union Internationale de Radioécologie

International Union of Radioecology

Radionuclides transfers

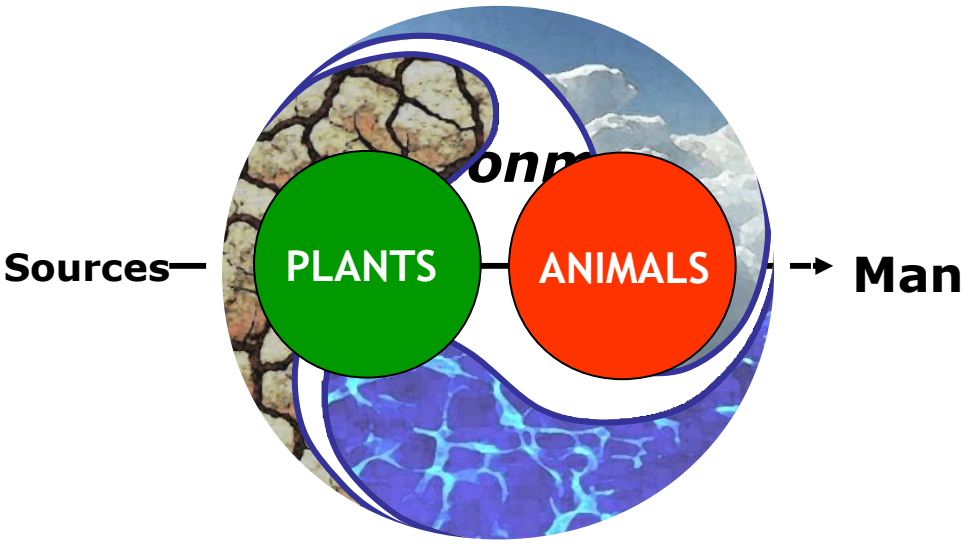


Radiation effects on wildlife: missing knowledge

Research priorities

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

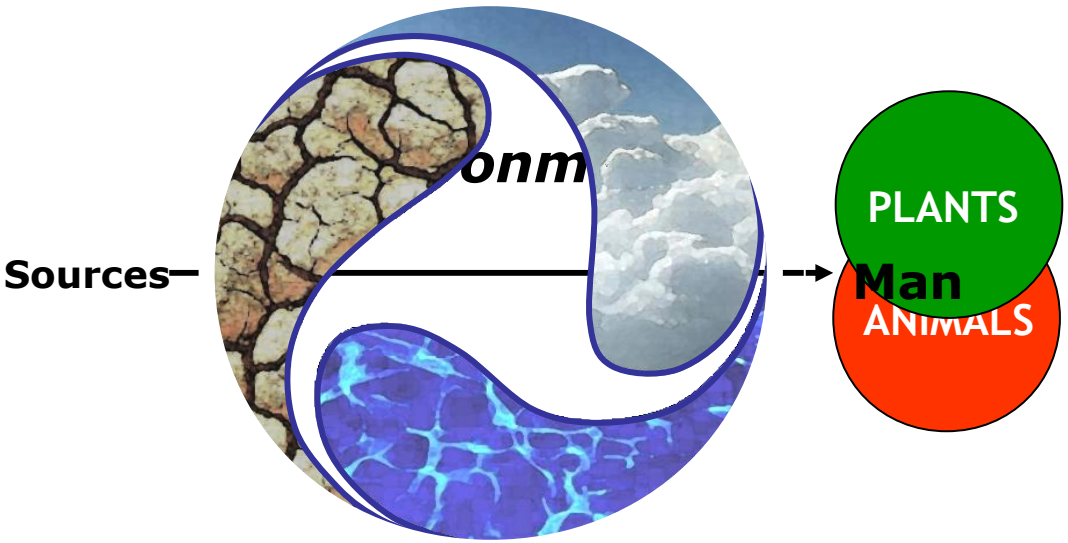
Historical anthropocentric approach



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 µ Gy.h^{-1}

Screening

1 mGy.d^{-1} *10 mGy.d^{-1}*

Recent literature compilation (ERICA EC project)

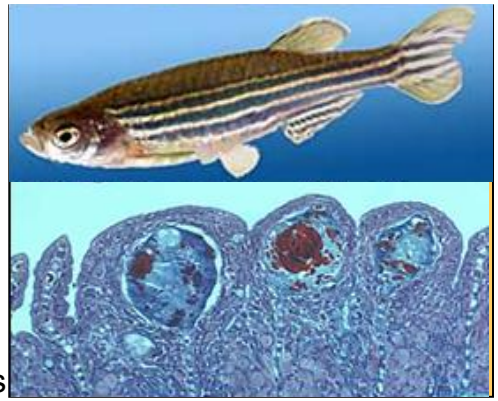
Dose rate µGy.h^{-1} *(mGy.d^{-1})*	< 10^2 *(< 2.5)*	10^2-10^3 *(2.5-25)*	10^3-5.10^3 *(25-125)*	5.10^3-10^4 *(125-250)*	10^4-2.10^4 *(250-500)*	> 2.10^4 *(>500)*	> 10^5 *(>5000)*	> 10^6 *(>50000)*
Plants		Growth red. Morphologic al alt. Populations alt..	Canop. ind. modification Growwth reduction Photosynth. reduction	Coniferous mortality	Leaves growth reduct. & mortal. Reduction of seeds	Reduction of reproductive potential Grass mortality Herbacées M	Mortality of all plants	Reduction of biodiversity
Fishes	Reprod. anomalies	Germ cells alteration. Reduced fecundity	Par. Nuptial Reduced fertility Increased sterility	Reduced spermato-genesis	Larvaes mortality Severe sterilit Vertebrae growth reduction			
Mammals	Alt. Germ cells Reduced fecundity Chromosome aberrations	Brain cells mortality Germ cells alteration Increased sterility Reduced survival	Weight reduction Ovaries malfunction Sterility		Mortality of embryos			

Effect endpoints focused on individual organisms:

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

Ecosystemic approach

Toxicological approach

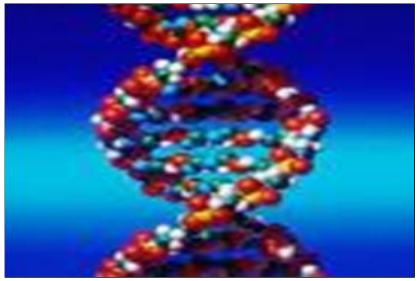


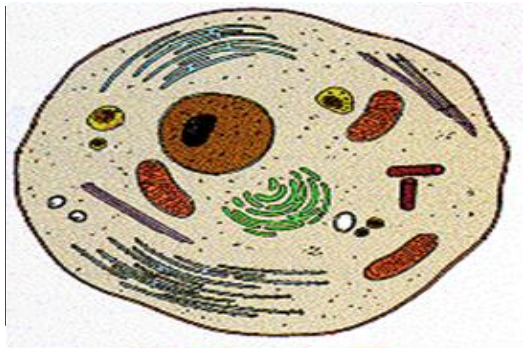
DNA-RNA
Membrane receptors
Key enzymes
Biochemical integrity

Xenobiotic introduction

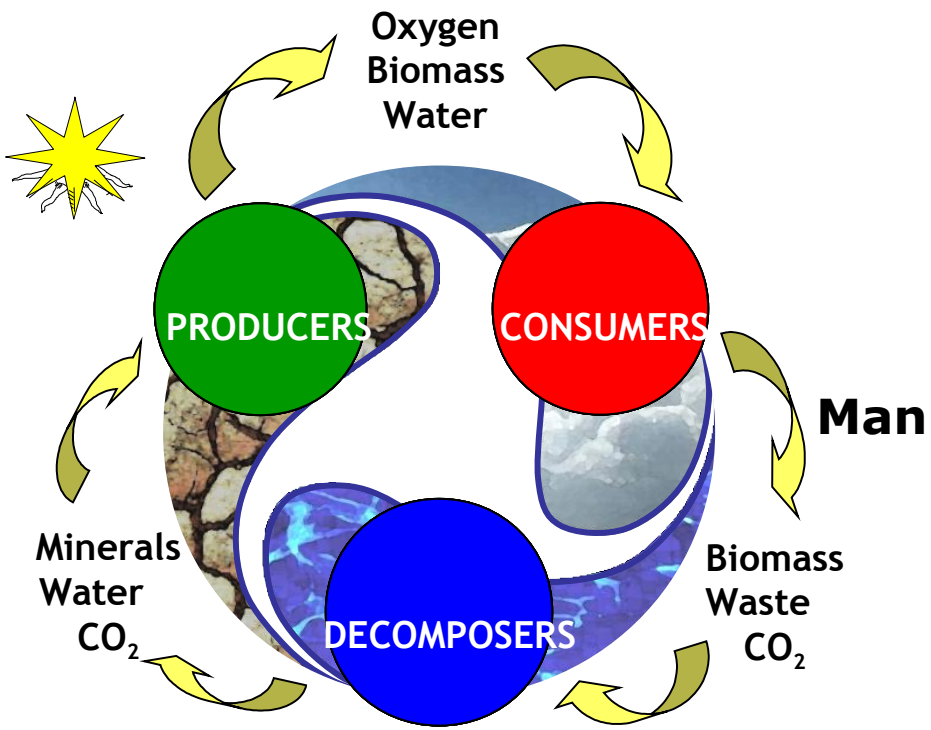
Site of action

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