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CHALLENGES AND SOLUTIONS
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The unified approach to assessment of environmental impact caused by releases from NORM industry

Boguslaw Michalik

Silesian Centre for Environmental Radioactivity,
Central Mining Institute (GIG), Plac Gwarków 1
Katowice, Poland

GŁÓWNY INSTYTUT GÓRNICTWA

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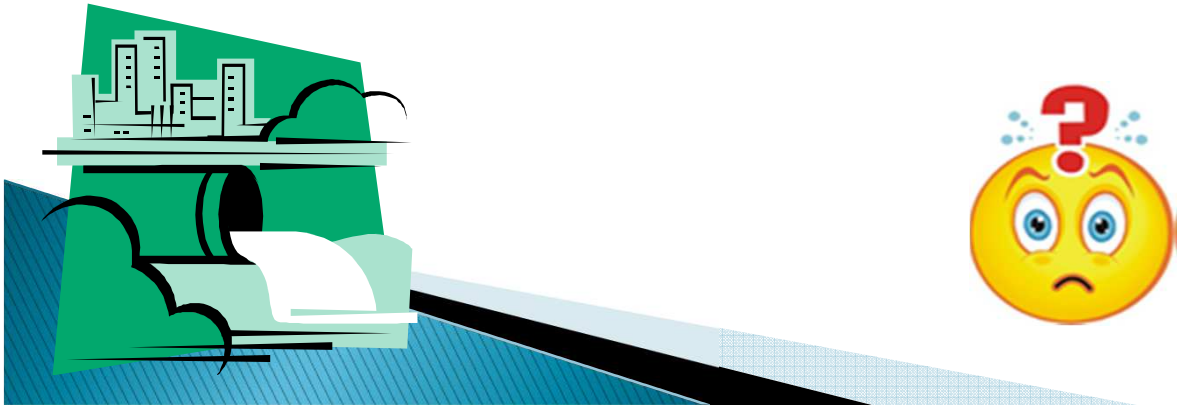
PROBLEM ARSISNG

- ICRP have pointed out the necessity to consider radiation risk to non-human biota independently from the risk to humans (ICRP, 2007).
- This demand was reflected in the new International Basic Safety Standards (2014) as well as the European counterpart (2013).
- Simultaneously, both of these documents have underlined the importance of radiation risk caused by NORM.
- NORM usually gives rise to enhanced occupational exposure, **however, given the fact, that NORM can occur in huge amounts and its disposal sites often are in direct contact with precincts in managing the residues and waste in NORM industries, radiation protection of the public and environment need to be addressed.**

EU BSS Article 65

Operational protection of members of the public

In addition, these discharge authorizations shall take into account, where appropriate, the results **of a generic screening assessment** based on internationally recognised scientific guidance, where such an assessment has been required by the Member State, **to demonstrate that environmental criteria for long-term human health protection are met.**



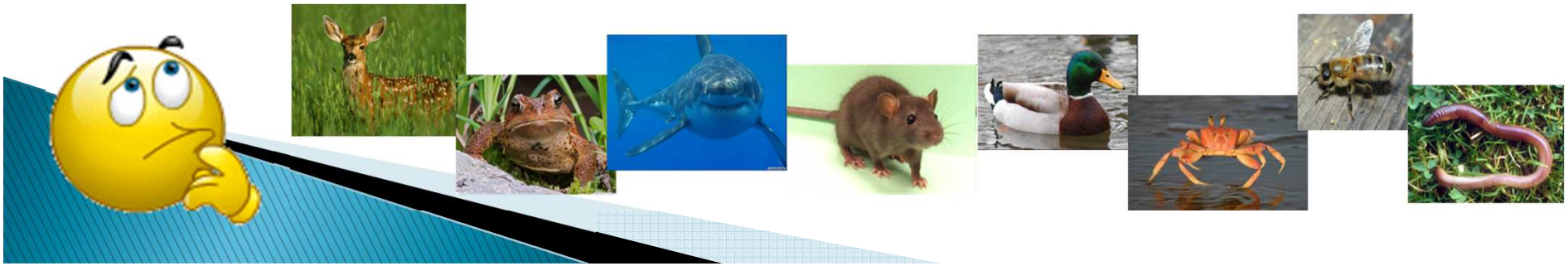
CHALLENGES

- NORM activities cover broad industrial sectors of much diversified characteristics, therefore many site and practice specific risk assessment methods seems to be needed.
- This includes discharge control, decommissioning and remediation of relevant sites and control of disposal of waste in a landfill.
- Taking into account that many industries of concern have not been regulated in term of radiation safety up till now, misgivings exist that already developed methods and concept applied in radiation protection are inadequate to NORM and may lead to discrepant results.

However, it is clear that not all of the NORM related scenarios can affect the environment.

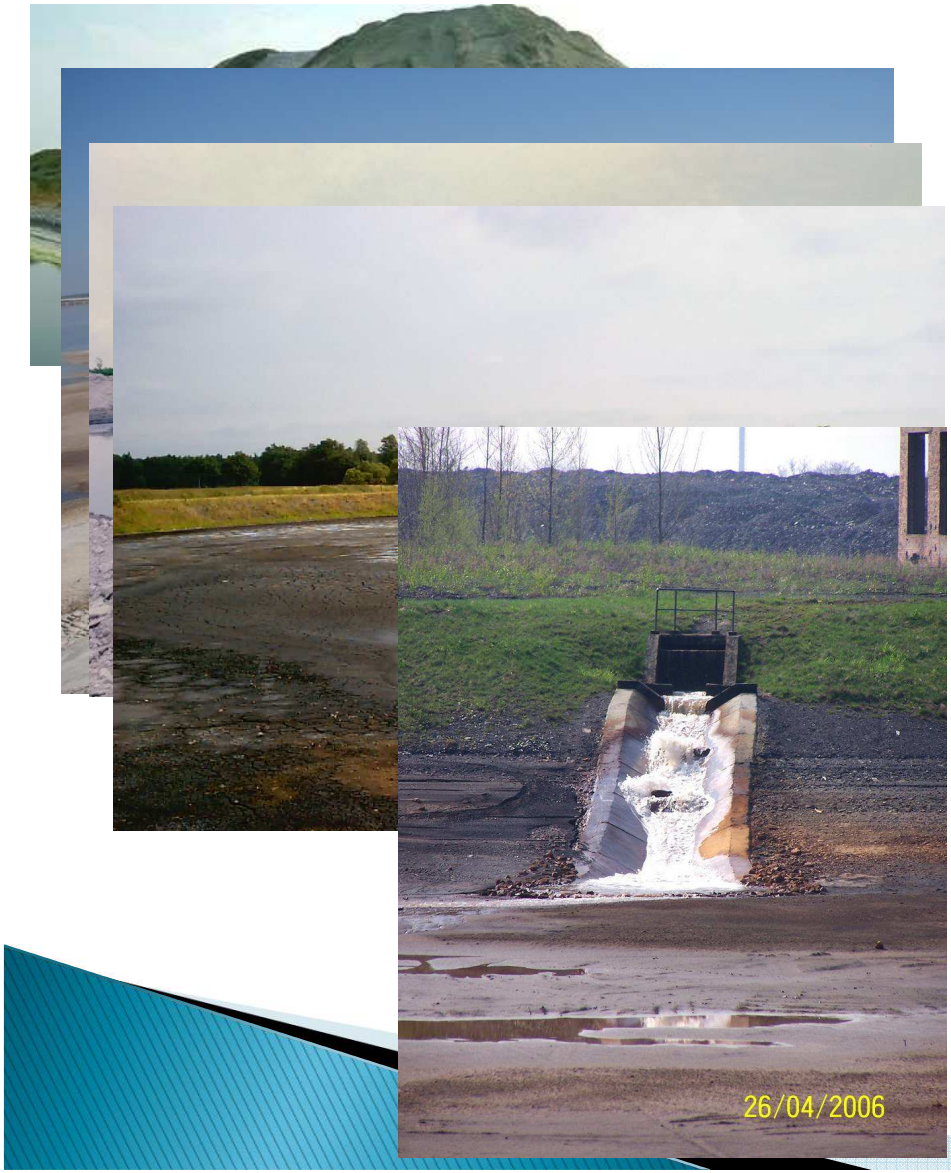
Moreover it is quite easy to identify the *sine qua non* condition when NORM influences the environment seriously, namely:

- **existence of enormous amounts of material deposited directly into the environment,**
- **release of contaminated water,**
- **release of contaminated air/dust.**



Features of environmental impact of NORM residues:

physical appearance



source geometry, location and possible dispersion models: typical NORM repositories have the appearance of common waste dumps and tend to have more in common with industrial waste than with spent nuclear fuel or dispensable radioactive sources;

total amount: NORM residues are usually bulk materials, e.g. phosphogypsum, slag, sediments, sometimes water;

ambient conditions: residues are usually in direct contact with environment, it means that they are exposed to meteorological conditions (water and wind erosion) and unlimited access by biota;

Frequently they are associated with other pollutants as heavy metals, sulphates, hydrocarbons.

SOLUTION

to reduce complex phenomena to the interactions of their parts…

In order to predict human and wildlife exposure in a robust way it is necessary to identify exposure scenario and sequences of key processes that influence radionuclides fractionation, speciation, migration, transfers and accumulation…..

a reductionistic approach:

a complex system is nothing but the sum of its parts

Features of environmental impact of NORM residues:

exposure scenario: a landfill site

- Looks like radioactive waste repository …
- Exposure pathways:
  - ~~Direct exposure,~~
  - Migration: erosion, Dust resuspension,
  - Rainwater seepage,
  - Ground water contamination.

Total contaminated area is not too big …..

Exposed ecosytem ?

Endagered species?

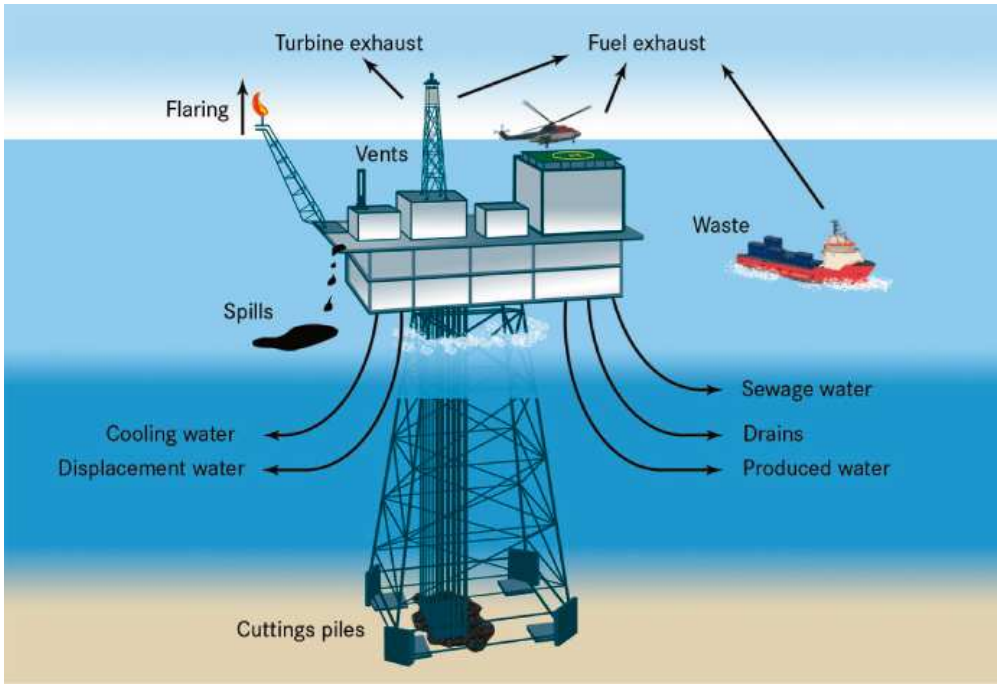
Features of environmental impact of NORM residues:

exposure scenario: water discharged into inland water

- Point source discharging contaminated water :
- Exposure pathways:
  - ~~Direct exposure~~
  - Direct transfer into pelagic fish, zooplankton, phytoplankton,
  - Precipitation and accumulation in bottoms,
  - Transfer into benthic organism,
  - Entering food chain.

Features of environmental impact of NORM residues:

exposure scenario: water discharged to sea



- Point source discharging contaminated water
- Exposure pathways:
  - ~~Direct exposure~~
  - Direct transfer into pelagic fish, zooplankton, phytoplankton ,
  - Precipitation and accumulation in bottoms,
  - Transfer into benthic organism,
  - Entering food chain,

- Exposure to marine ecosystem.

Features of environmental impact of NORM residues:

exposure scenario: stack emission

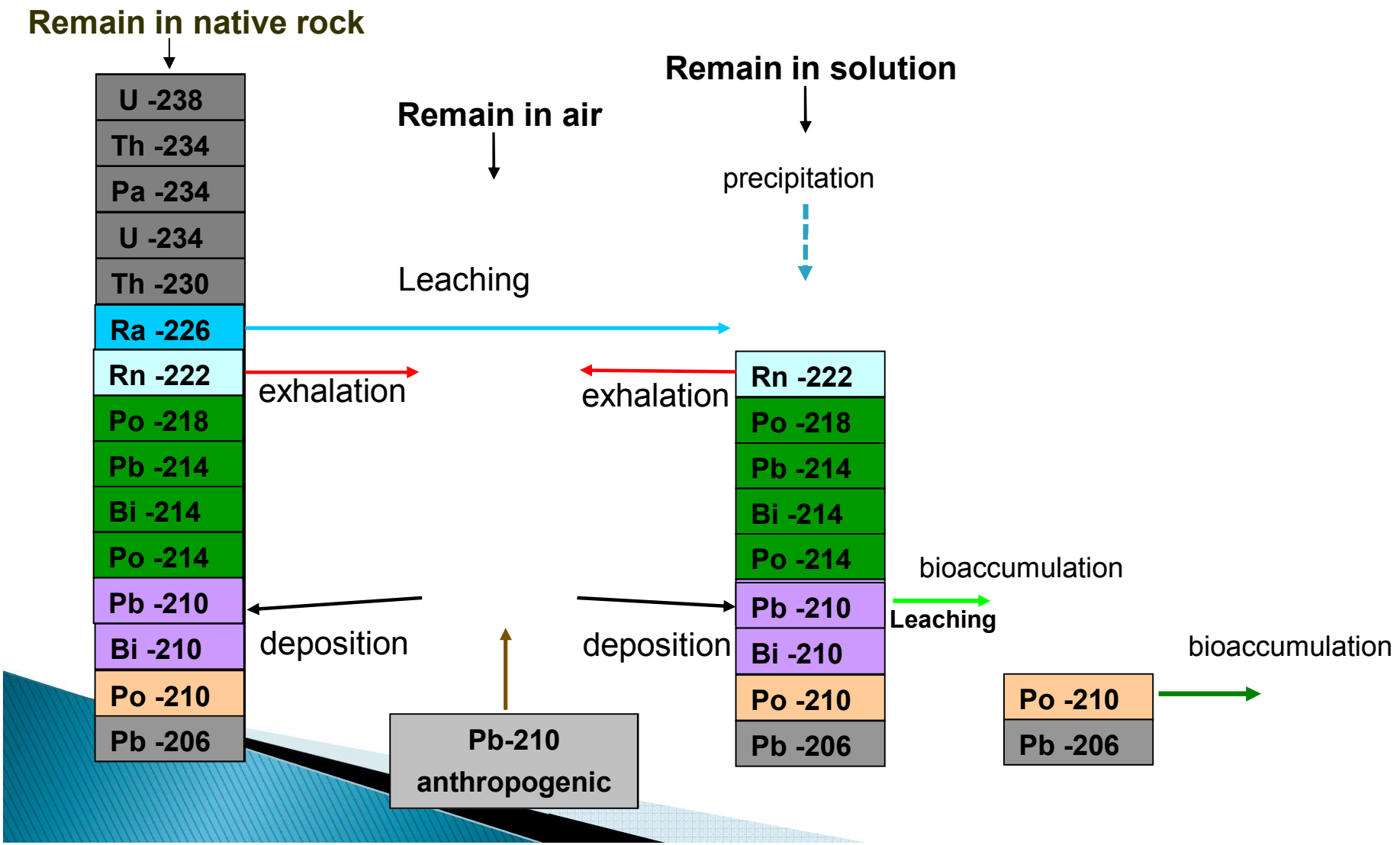
Volatile radionuclides ^{210}Pb , ^{210}Po

- Point source discharging fumes and particulates (PM)
  - effect similar to fallout but affected areas are smaller
- Exposure pathways:
  - direct exposure to external radiation
  - migration to biota (interception)
  - inhalation
  - contamination of food chain

Features of environmental impact of NORM residues:

Complex radionuclides suite and radionuclides fractionation

^{238}U decay chain



Conclusion

- All identified scenarios and related processes let one to carry out qualitative and quantitative analysis of natural radionuclides migration (and accumulation) in an exposed ecosystem.
- Obtained results are sufficient to apply recommended graded approach in regulatory oversight of NORM activities based on the concepts of **exemption and clearance.**
- However, considering that natural radioactivity is ubiquitous in environment and clearance levels set does not cover or possible media (e.g. liquids or biota) the understanding on consequence NORM management requires other criteria.

Radionuclides occurrence ≠ **effect**

From pragmatic point of view a model that allows one to predict an effect (defined as a biological/molecular endpoint) based on activity concentration released into environment are the most useful and strongly expected.

Radioactivity released into environment ….

Based on reference organism approach …..

- early mortality ?
- morbidity ?
- reduced reproductive success ?

or … observing effects at molecular level ?
(cyto and genotoxicity)

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Thank you for the attention…