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COLLEGE OF ENGINEERING | School of Nuclear Science and Engineering

Radiation Risk - Managing & Interpreting

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What Has to Happen to Have Adverse Consequences (Risk)?

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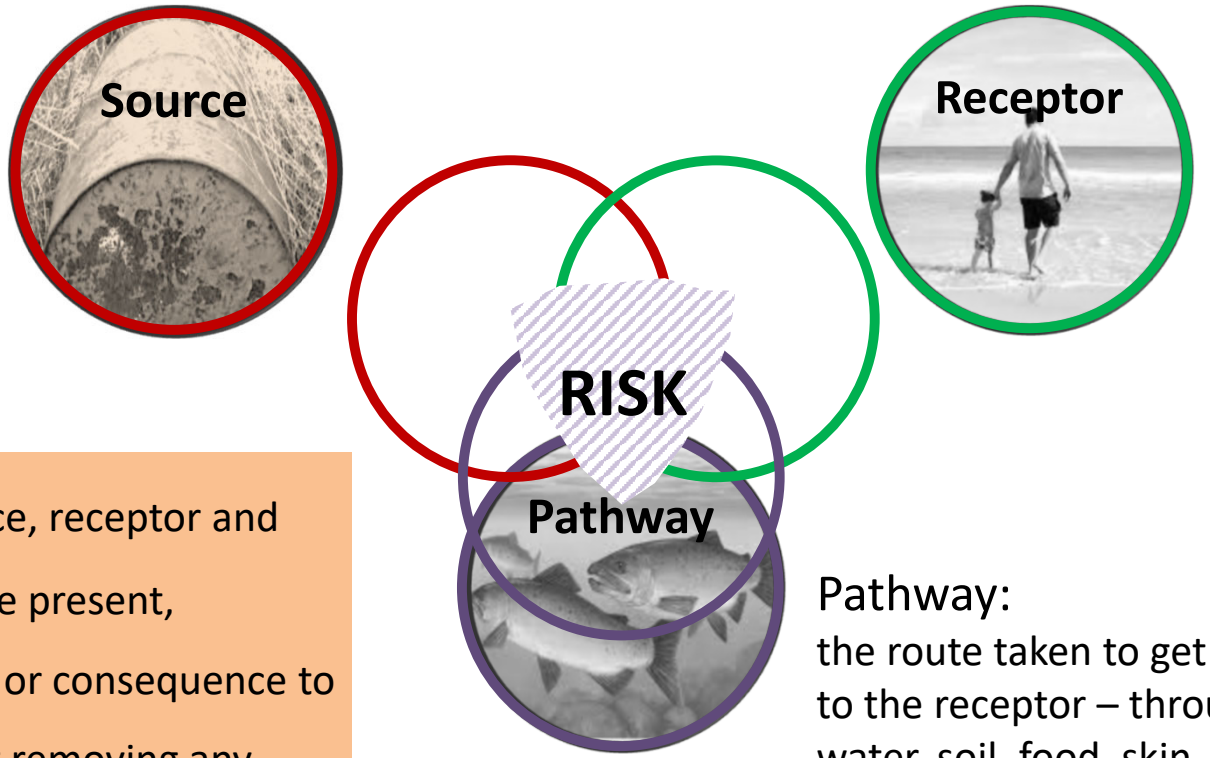
Source:
something hazardous, toxic, carcinogenic, …



Receptor:
someone or something that can be impacted

Pathway:
the route taken to get the source to the receptor – through air, water, soil, food, skin….

All three - source, receptor and pathway - must be present, together, for risk, or consequence to occur. Blocking or removing any removes the risk.

Managing Risks

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- Typical Approach
  - Characterize source quantity
  - Determine and evaluate pathways of exposure
  - Estimate exposure of receptor from the pathways (ingestion, inhalation, direct contact, …) by calculation or measurement
  - Use exposure estimate to guide action: accept or modify circumstances of source, pathways, receptor
- Pros
  - Very standardized approach
- Cons
  - Generally used for groups of people, not used to quantify single individual's circumstances

Managing Risks

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- Alternative approach
  - Measure contaminants of concern (COCs) in individuals (***biomonitoring***)
  - Use COC concentrations to inform actions
- Pros
  - Gives insight into individuals circumstances
- Cons
  - Gives no indication of exposure pathways *or source of exposure*

Limitations of Biomonitoring

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- The National Academies of Science (NAS) recommends:
  - These studies *also* collect detailed information on cofactors (for example, socioeconomic status and lifestyle factors) to help interpret the data
- NAS also noted:
  - The ability to detect has outpaced the ability to interpret health risks… at the individual, community, and population levels. *In other words, be cautious about drawing conclusions*

How to Eliminate/Reduce Risk

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Source:
Remove or Reduce

Receptor:
Remove or Reduce

Pathway:
Block, Reduce, or Remove

Hunters Point Naval Shipyard

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- Radiological cleanup standards challenging
  - ~ 3 mrem above background
  - Highly remodeled site (infill)
  - Contaminants of concern include naturally occurring and fallout nuclides
  - How to tease these apart?

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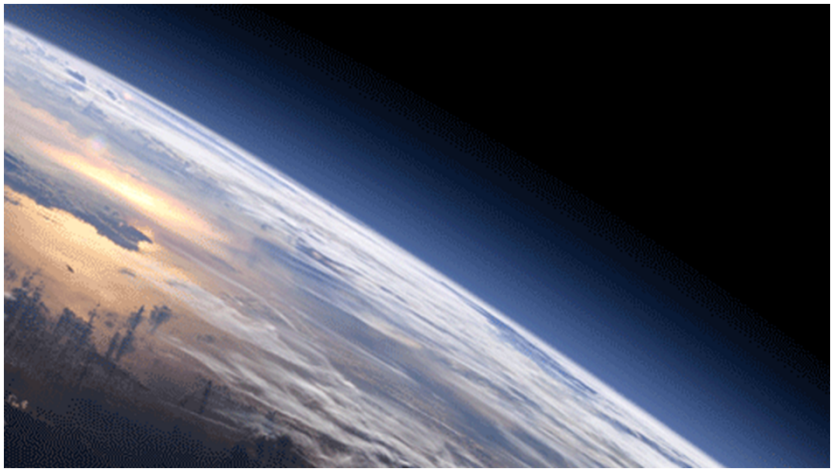
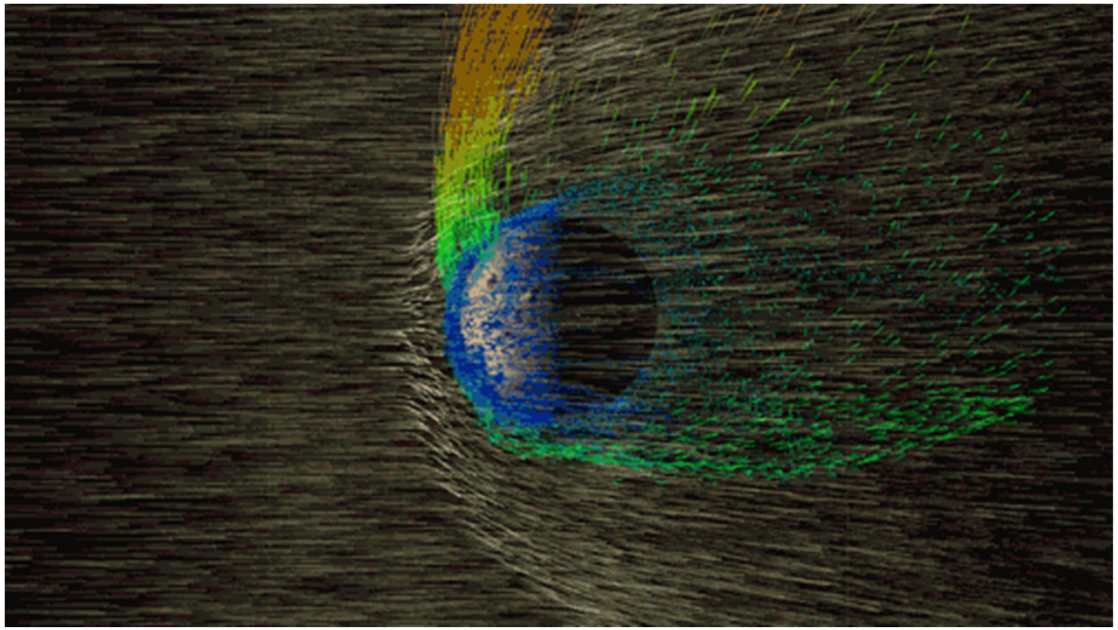
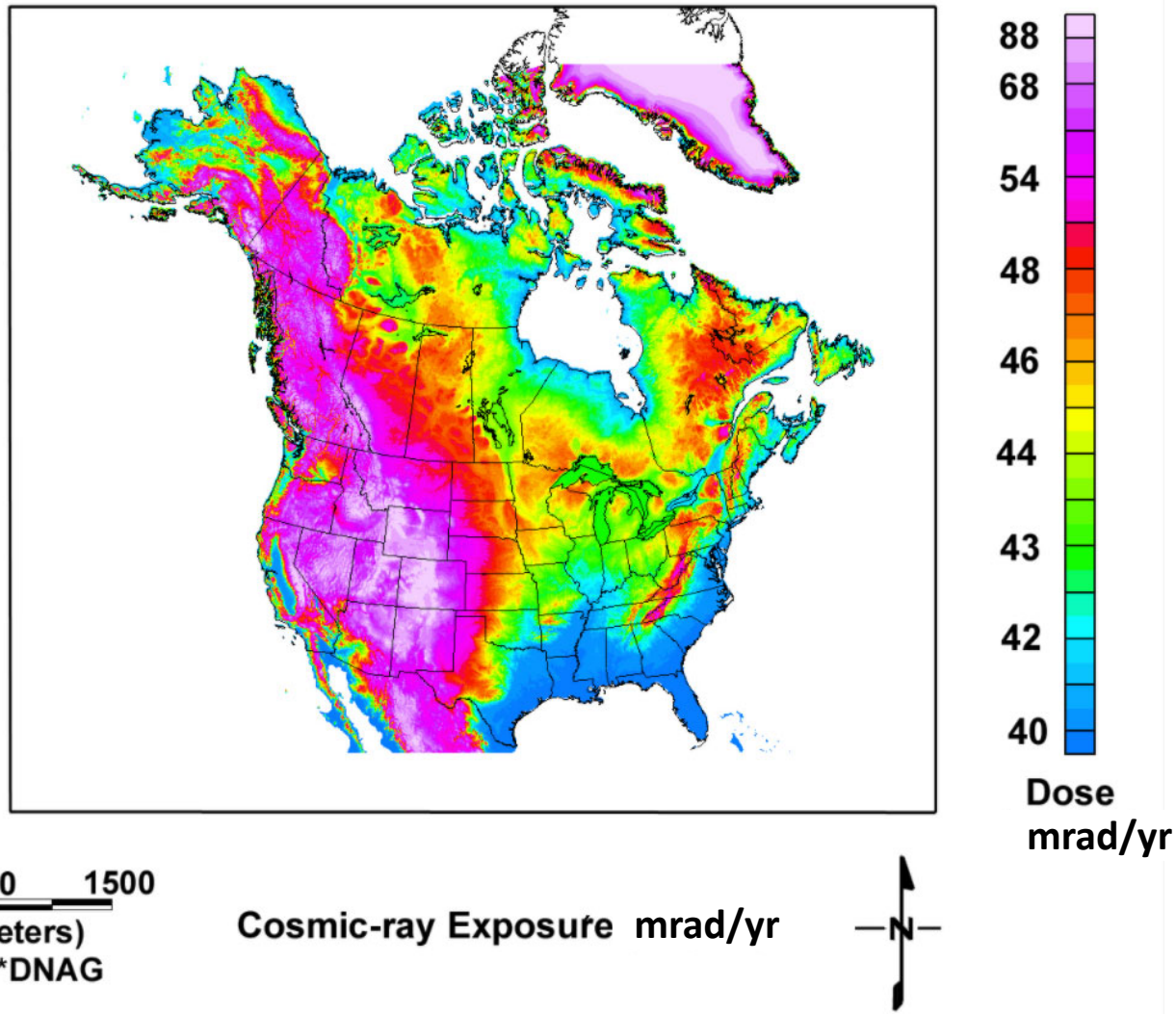




https://svs.gsfc.nasa.gov/12045


88
68
54
48
46
44
43
42
40
Dose
mrad/yr
500 0 500 1500
(kilometers)
NAD27/*DNAG
Cosmic-ray Exposure mrad/yr
N

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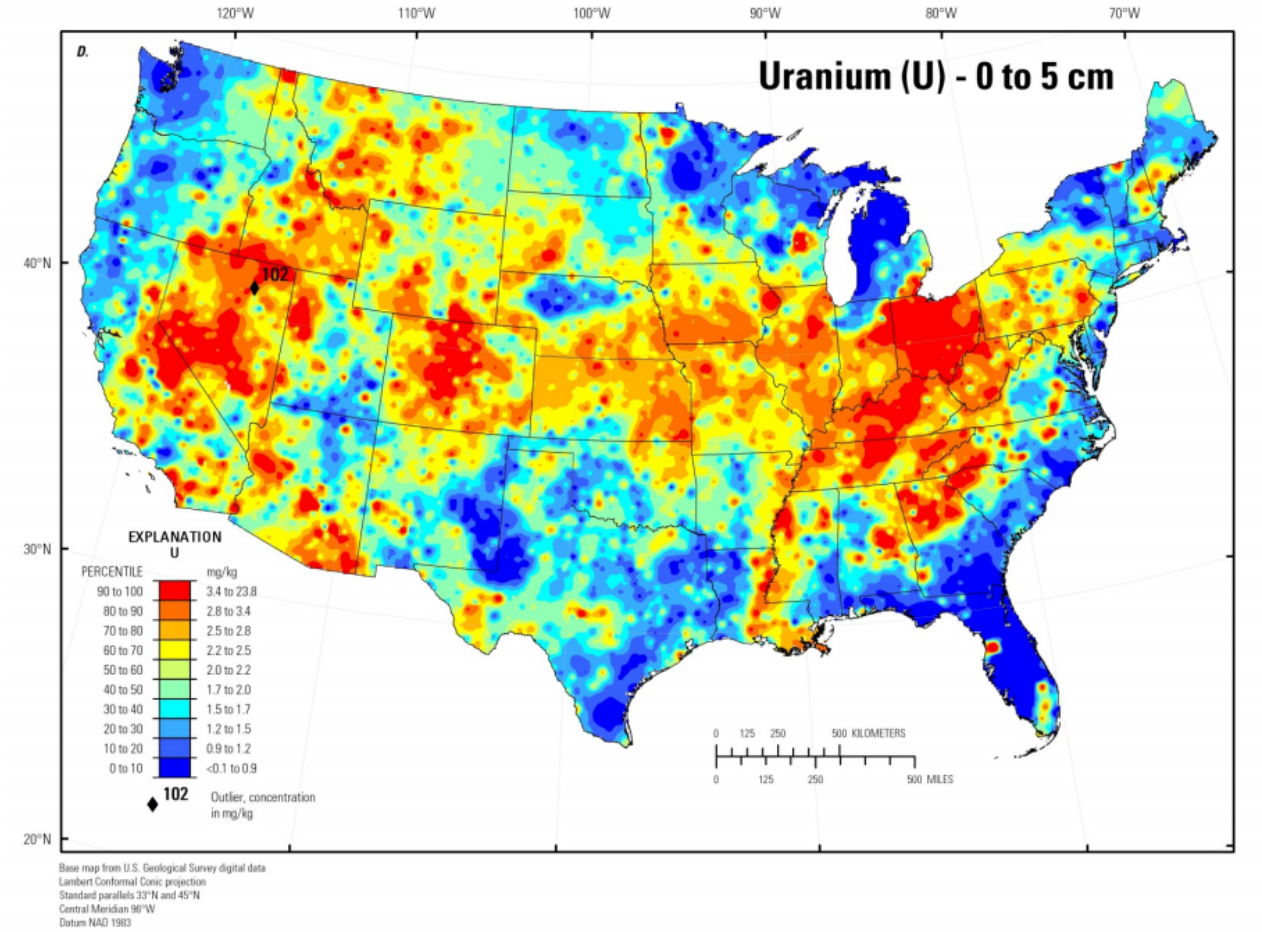

https://pubs.usgs.gov/sir/2017/5118/elements/Uranium/OFR-2014-1082-U.pdf

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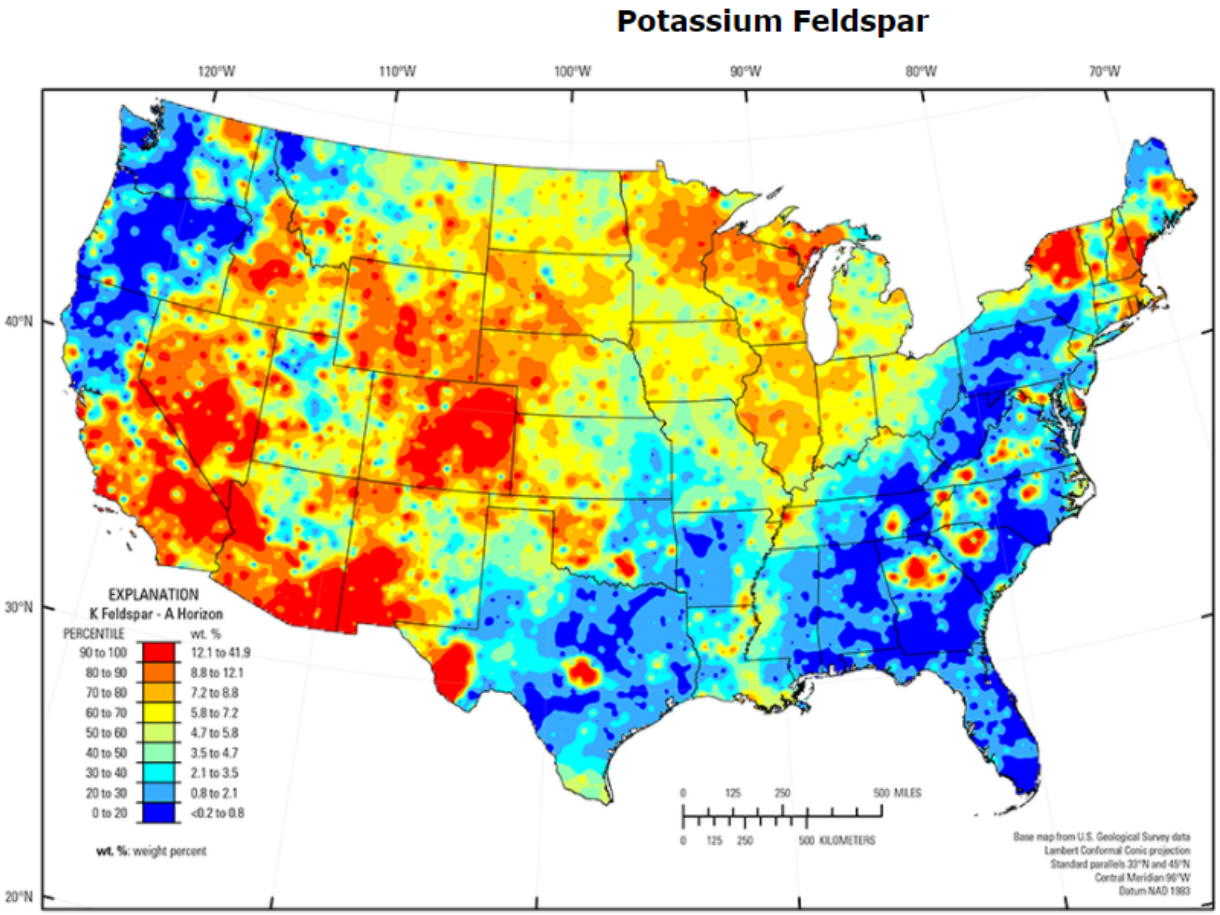
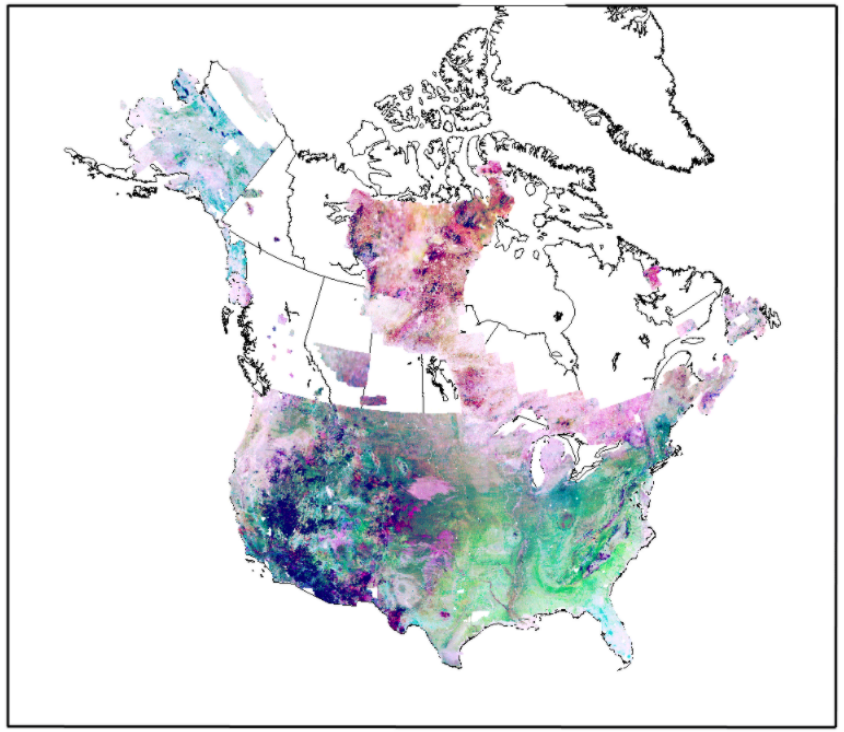


https://pubs.usgs.gov/sir/2017/5118/sir20175118_element.php?el=903

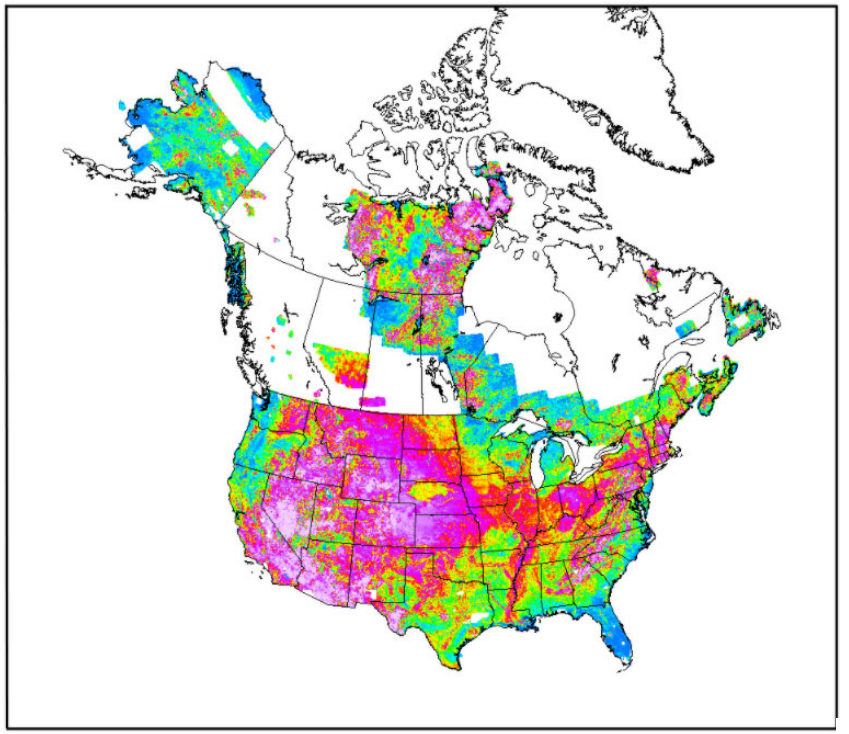
https://pubs.usgs.gov/of/2005/1413/ccmcmyfull.htm



500 0 500 1500
(kilometers)
NAD27/*DNAG

Gamma-ray Ternary Map
(eU=cyan, K=magenta, eTh=yellow)

https://pubs.usgs.gov/of/2005/1413/expmapfull.htm



Gamma-ray Absorbed Dose mrad/yr

Radiation Uses in Medical Practice Has Been Around for More Than 100 Years

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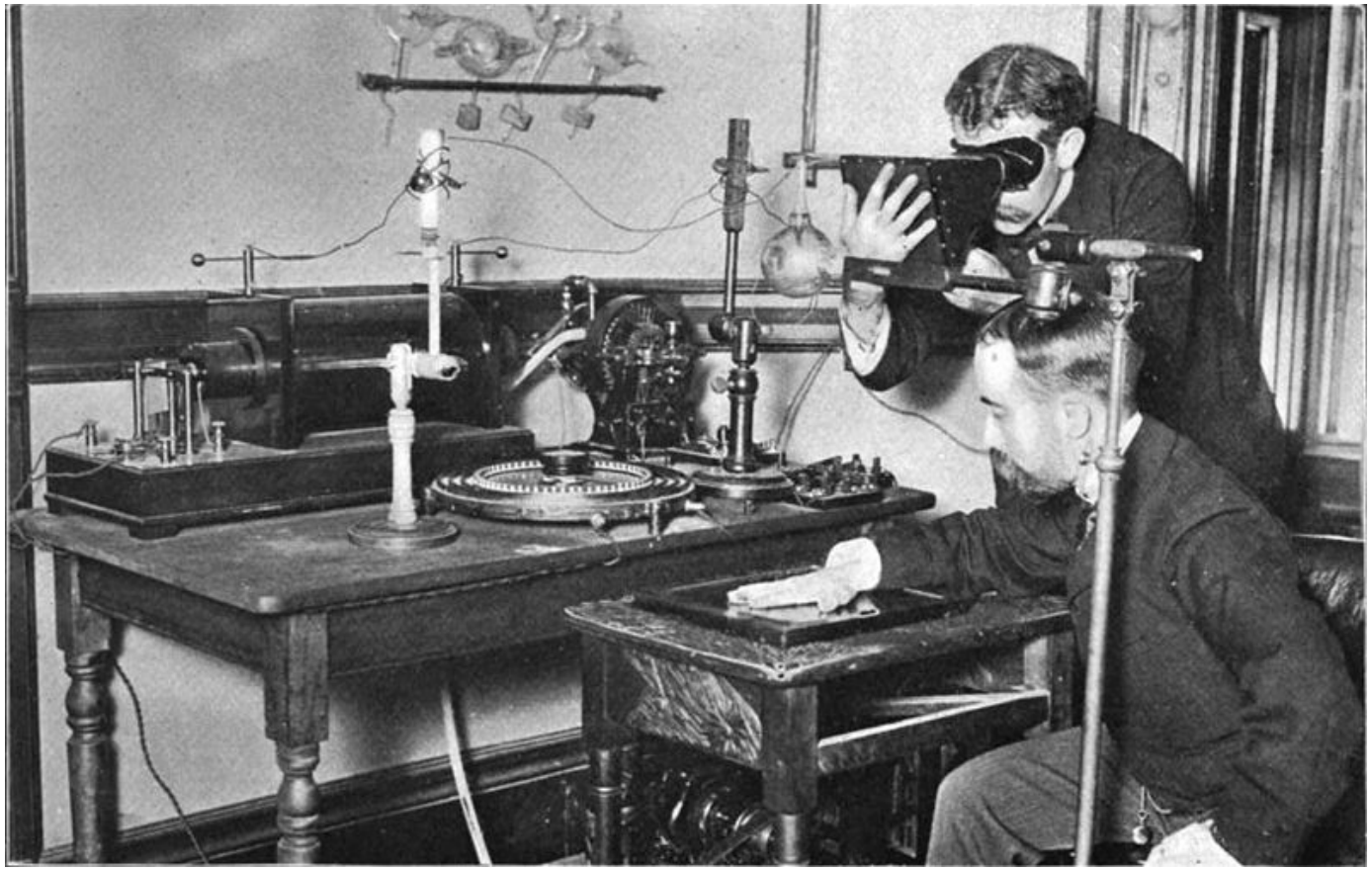

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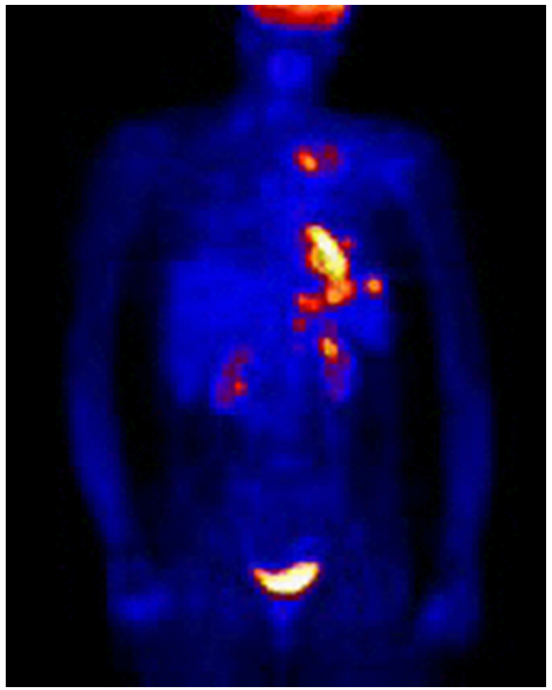

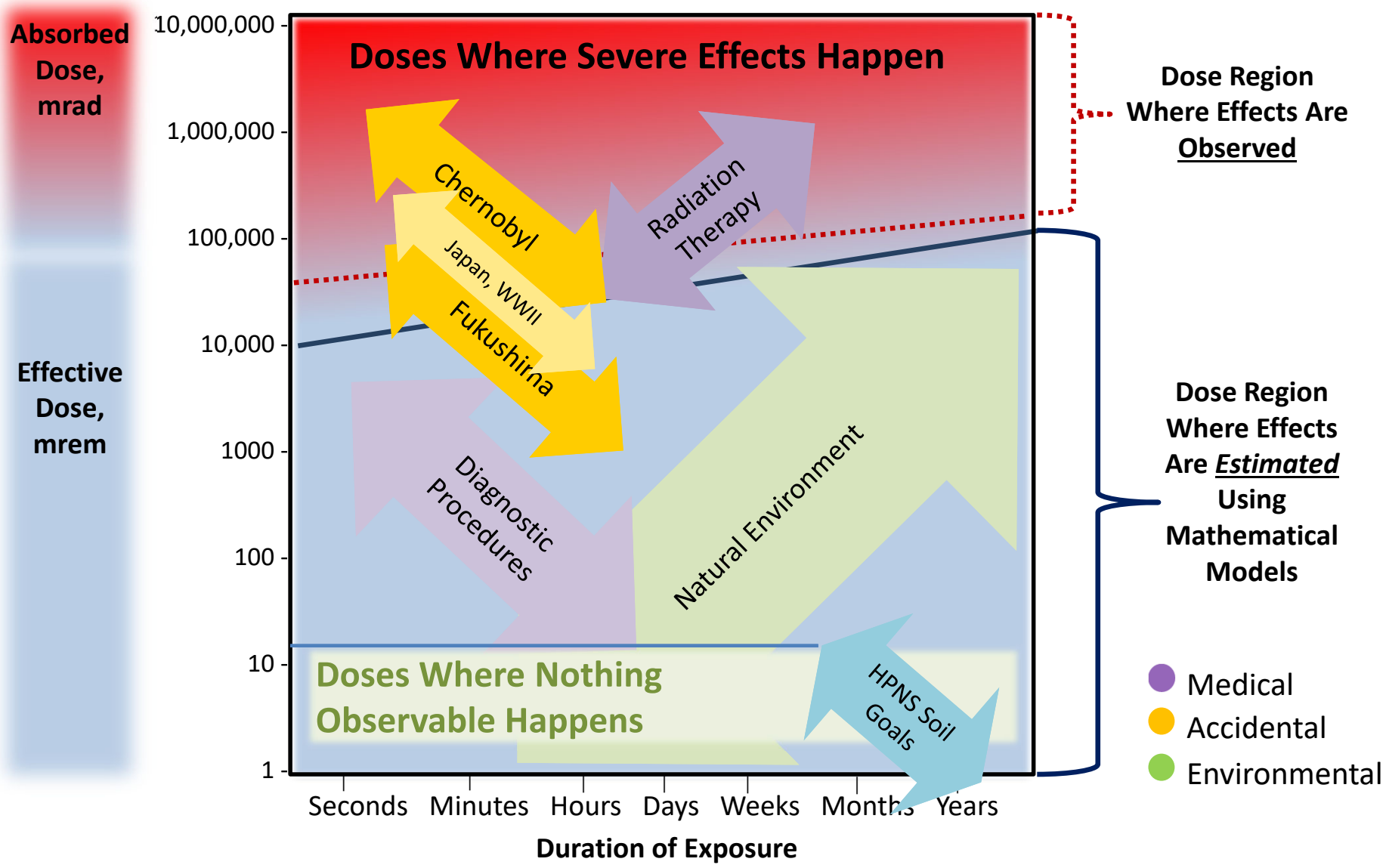
Absorbed Dose, mrad
Effective Dose, mrem
10,000,000
1,000,000
100,000
10,000
1000
100
10
1
Doses Where Severe Effects Happen
Chernobyl
Japan, WWII
Fukushima
Radiation Therapy
Diagnostic Procedures
Natural Environment
Doses Where Nothing Observable Happens
HPNS Soil Goals
Seconds
Minutes
Hours
Days
Weeks
Months
Years
Duration of Exposure
Dose Region Where Effects Are Observed
Dose Region Where Effects Are Estimated Using Mathematical Models
Medical
Accidental
Environmental

Managing and Interpreting Risk

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- Risk can be reduced or eliminated by controlling the source, pathways and receptors

- Interpreting risk requires understanding the factors that contribute to it

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Thank you