Assessing potential exposures to people in the post-closure period of a waste disposal facility

II. From present to future conditions

Gerhard Proehl

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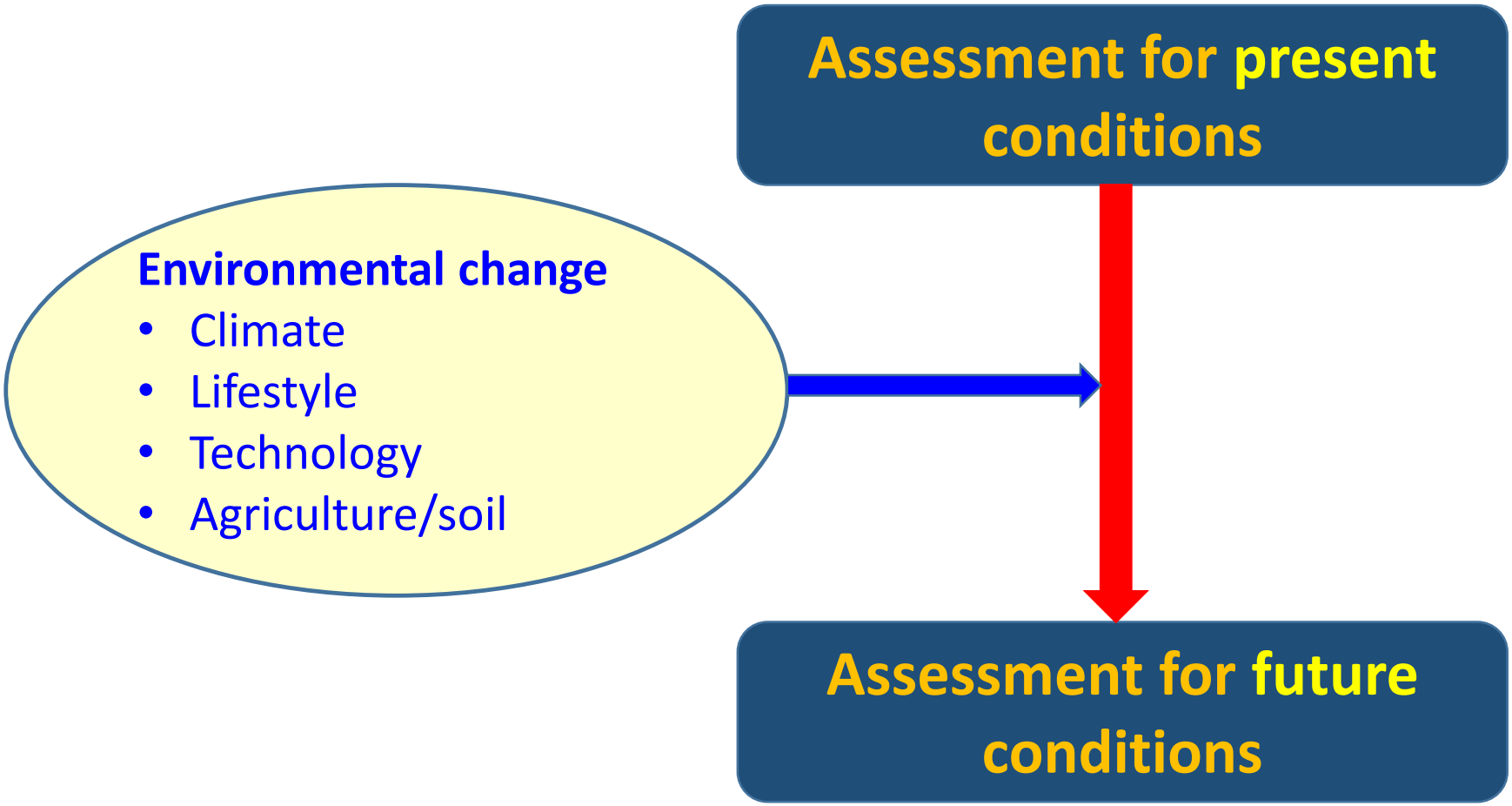
From present to future conditions



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Can exposure be assessed for long time frames?

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What will people do in 10000 years ?

- We don't know!
- But:
  - They will breathe.
  - They will drink.
  - They will eat.
  - They will stay outdoors or indoors.

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How much will people eat, drink, breathe, in 10000 years ?

- **We don't know!**
- **But:**
  - **They need similar amounts of**
    - Energy
    - Protein
    - Fat
    - Minerals
  - **They need similar amounts of drinking water**
  - **They will breathe similar volumes of air**

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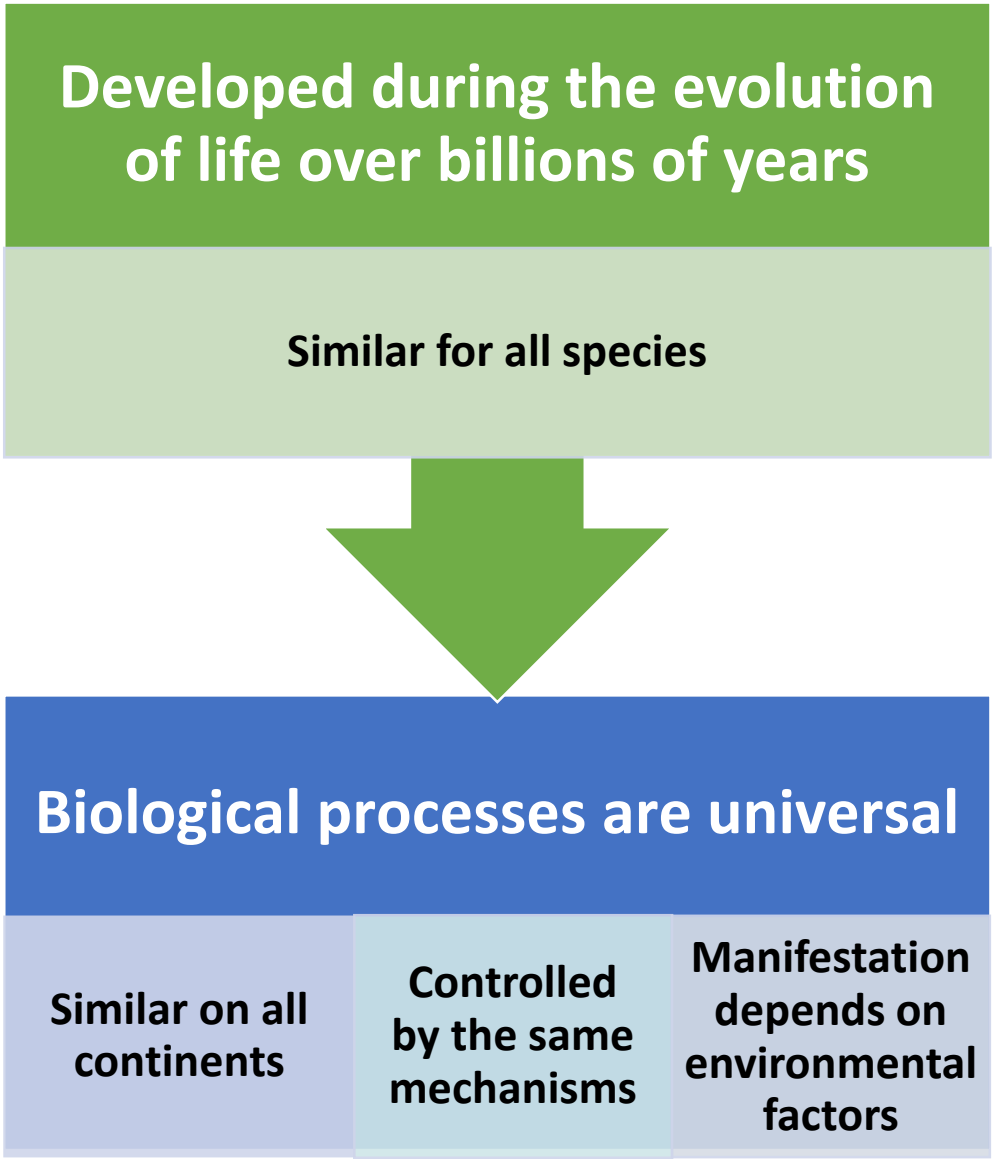
Physiological and biological process



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Assumptions related to radiation protection criteria

- **Radiation Protection criteria**
  - Derived for present day's populations based on current knowledge on radiation risks.

- **Future progress in medicine may**
  - Modify the radio-sensitivity of people
  - Modify the biokinetics of radionuclides in humans
  - Improve the success of treatment or radiation-related diseases

= > Such changes are not anticipated in the assessment

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Basic exposure scenarios

- **Subsistence farming**
  - **All food** consumed is produced on the area with the highest impact of radionuclides released from the disposal facility
  - This is a very conservative assumption:
    Any other assumptions regarding food supply will cause lower exposures via intake of food

- **Agricultural practise**
  - Spectrum of crops and domestic to comply with the site characteristics
    - Soil properties should allow the cultivation of crops
    - Use of fertilizer to ensure long-term fertility

- **Sustainability of land use**
  - The scenario should allow a long-term land-use
    - Salinity of irrigation and drinking water
    - Availability of water

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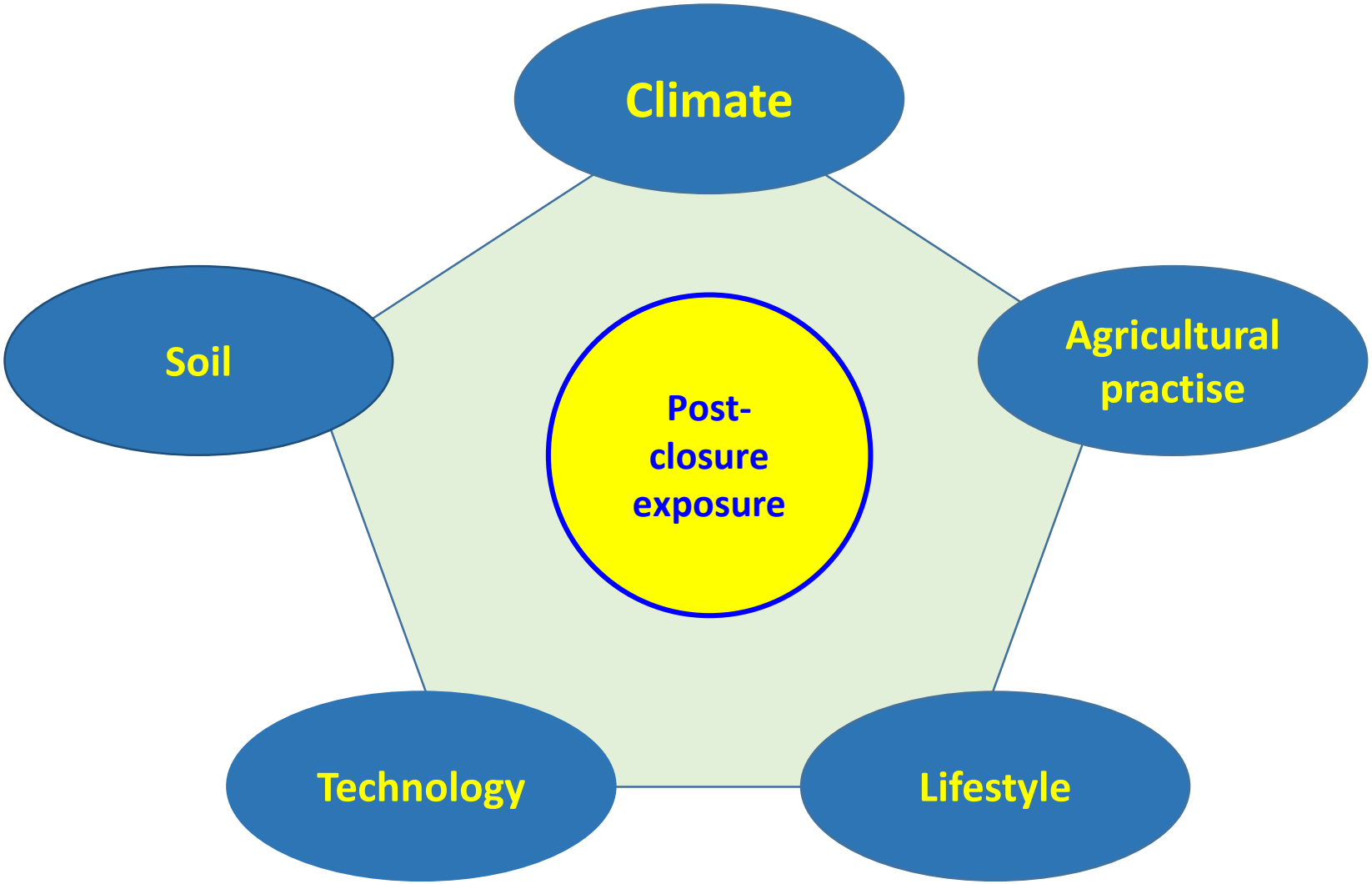
How to address environmental changes when assessing exposures for the far future ?

Impact on post-closure assessment



What may change –

Life-style

- ***Food supply***
  - The basic scenario assumes **complete self-supply**, i.e 100% of the food consumed is produced locally
  - This is **a pessimistic assumption**, the degree of self-supply cannot be higher
  - Lower degrees of self-supply imply lower exposures to people

- ***Food intake***
  - Demand for energy, fat and protein will remain constant
    (physiological constraint)
  - Impact of different diets to be explored by sensitivity analyses

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What may change –

Agricultural practise/ soil

Sustainability

- The basic scenario assumes **sustainability of agriculture**
  - Extreme conditions allowing agricultural use of land only for a short period of time are not considered
  - Soil cultivation will try to achieve favourable conditions for plant growth
    - pH-value: 5.0-7.5, depending on the crop
    - Porosity for exchange of air and drainage of water

Consistency with site-specific conditions

- The practices assumed should be consistent with the site-conditions
  - No irrigation on sites with sufficient precipitation
  - E.g. Husbandry of sheep in arid climates

What may change –

Technology

- Changes in technology are not explicitly taken into consideration
- Agricultural activities will ensure sustainability of land
  - This is a universal requirement
- Crops will be grown on soil, not in nutrient solutions

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Climate change, a key element of long-term safety assessment

Climate

- Temperature
  - Seasonal and daily variation, days of frost, etc
- Precipitation
  - Seasonal and daily variation

Impact on plant growth

- Length of the vegetation period
- Crops grown
- Yield of crops
- Demand for irrigation
- Animal husbandry

Impact on the earth's surface

- Hydrology and hydrogeology
- Weathering of rocks
- Development of soils
- Wind and water erosion

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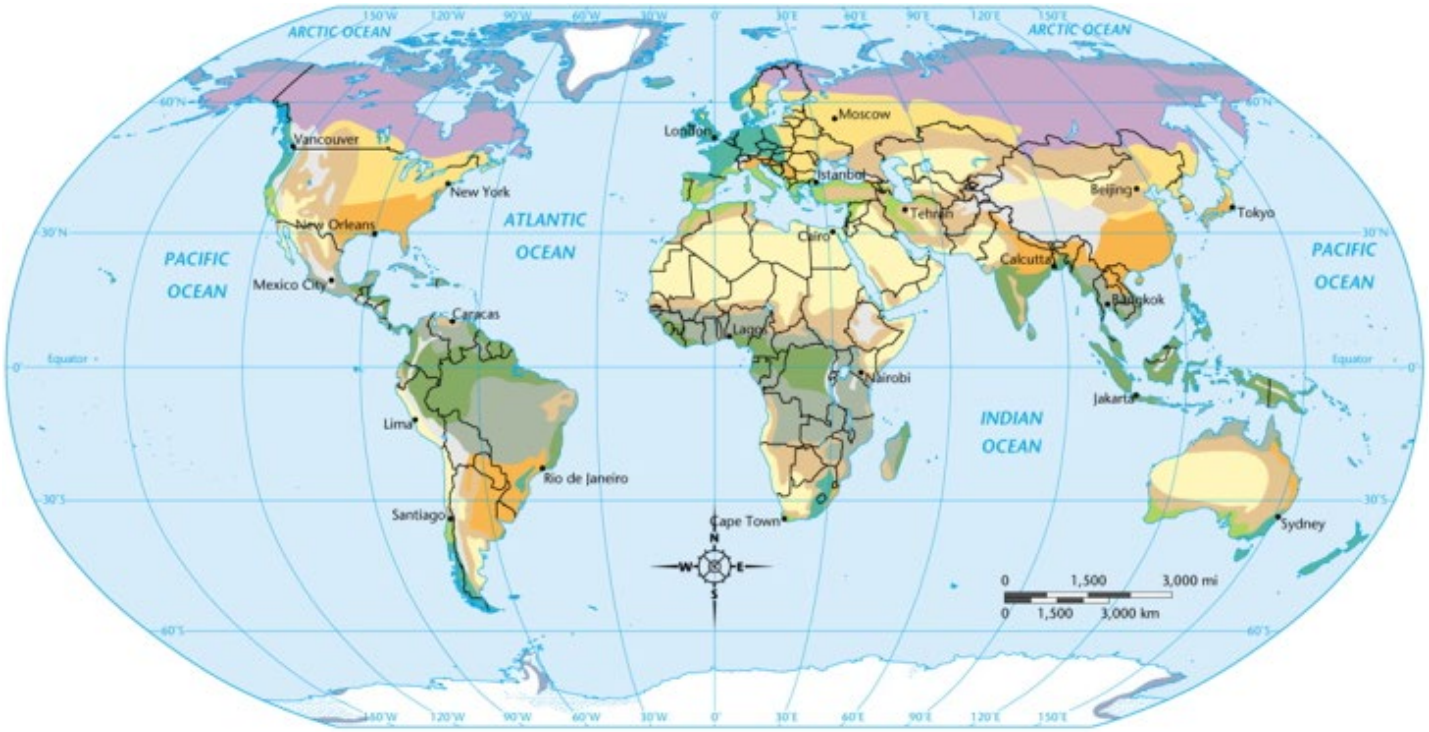
How to address climate?



Tropical
- Tropical wet
- Tropical wet and dry

Dry
- Semiarid
- Arid

Moderate
- Mediterranean
- Humid subtropical
- Marine west coast

Continental
- Humid continental
- Subarctic

Polar
- Tundra
- Ice cap
- Highlands

Non-permanent ice

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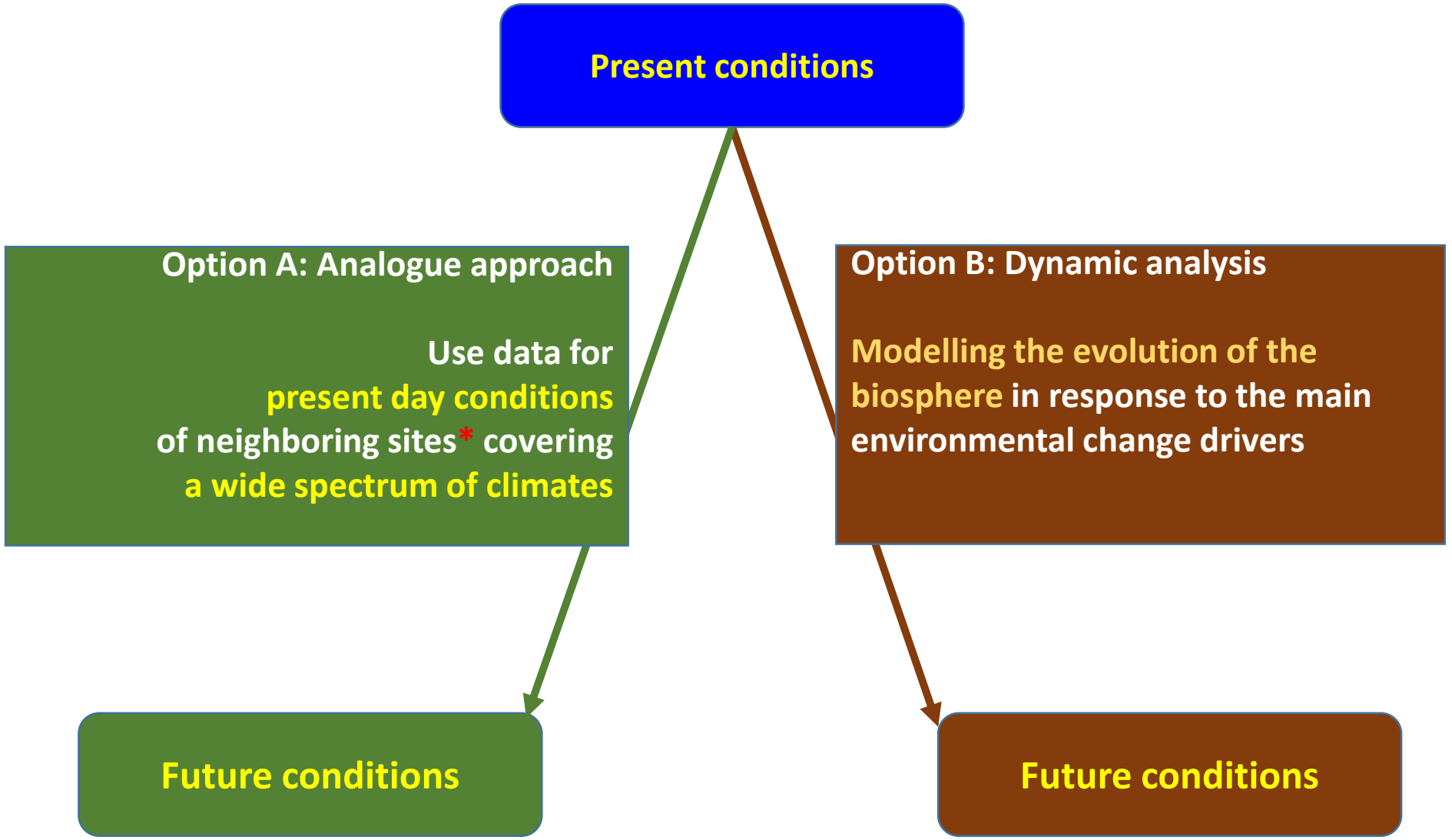
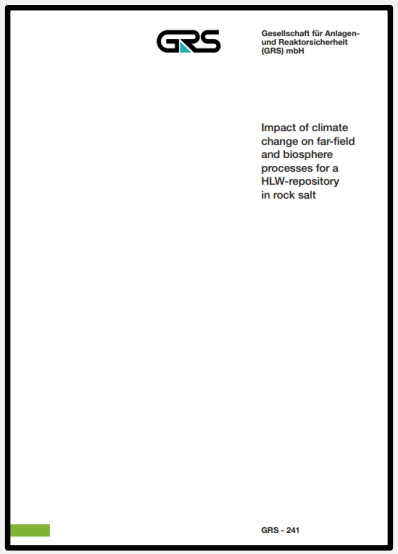
Options to reflect future developments



*Neighbouring sites: Selected from a radius of about 3000 km

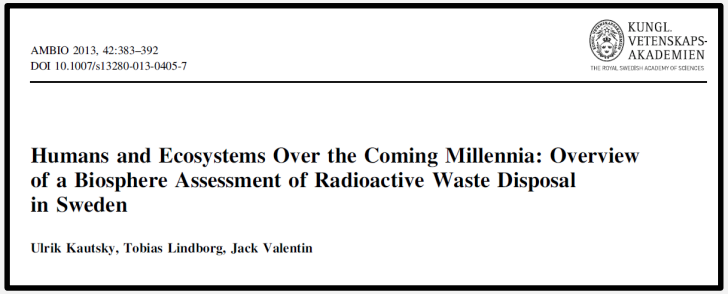
Option A:

Analogue approach



- **Use of data for present day conditions at a range of different sites with different climate and other characteristics**
  - Sites are considered as suitable analogues for future development
- **It is assumed that**
  - this set of analogous biosphere systems adequately captures the relevant range of future systems
  - => Envelope for future developments

Option B: Dynamic analysis of future biosphere systems



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Humans and Ecosystems Over the Coming Millennia: Overview of a Biosphere Assessment of Radioactive Waste Disposal in Sweden

Ulrik Kautsky, Tobias Lindborg, Jack Valentin

- **Modelling the evolution of the biosphere in response to the main environmental change drivers**
  - Climate change
  - Geomorphological changes associated with sea-level change at coastal sites
  - Erosion in areas of geological uplift.
- **Modelling of the interaction of**
  - Climate
  - Hydrology
  - Landform
  - Radionuclide release from the geosphere
  - Radionuclide migration and accumulation
  - Land-use

SUMMARY

- **Safety assessments need to consider future developments**
  - Principally, there is an inherent uncertainty to predict future conditions
  - However:
    Biological processes are universal, following the same dependencies now and in the future

- **Climate**
  - Climate is a key driver for environmental changes with impact on
    - Agricultural practise
    - Soil development
    - Life style

- **Addressing future conditions**
  - Option A: Using current data from a wide range of environmental conditions to elaborate an envelope for future conditions
  - Option B: Dynamic modelling of climate and landscape

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