

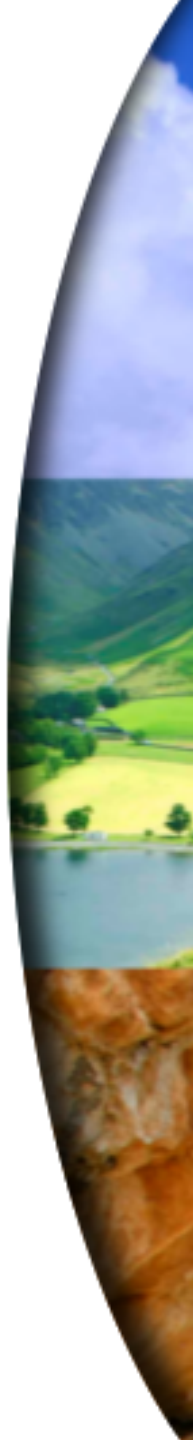
# Landscape Modelling Review

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Quintessa



# Background and Objectives

# Background

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- Landscape Modelling
  - Defines site descriptive context for biosphere assessment calculations
  - Considers geosphere-biosphere interface and implications of site evolution
- Elements
  - Understanding key influences on system change and geosphere-biosphere interface
  - Focus on potential for accumulation/release
  - Integration into wider assessment

# Objectives

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- Consider whether the landscape models used by SKB are fit for purpose
  - Taking account of Reference Biospheres (and approach) recommended by BIOMASS
  - Assess whether data collection is appropriate and sufficient
- Identify needs for complementary information and clarifications from SKB
- Identify critical issues for further examination

# Reports Reviewed

Reviewed report	Reviewed sections	Comments
TR-11-01 (Main Report)	4.10, 10.4.2, 13.2, 13.5.7, 13.6.5, 15.6.20, 15.7.5	Other relevant sections covering climate change etc.
TR-10-09 (Biosphere Analyses – Synthesis and Summary of Results)	Whole report	
TR-10-06 (Landscape Dose Conversion Factors)	Whole report	Focus on landscape modelling, rather than dose assessment
TR-10-05 (Landscape Forsmark – Data, Methodology and Results)	Whole Report	
TR-10-01, TR-10-02, TR-10-03 (Terrestrial, Marine and Limnic Ecosystems)	Various, according to follow-up of detailed issues	Principally for background
R-10-37 (Components, Processes and Interactions in the Biosphere)	Overview	Supporting/background reading

# Main Review Findings

# Depth of SKB's Analysis

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- Substantial, detailed characterisation of present-day conditions
- Interpretation of evolution up to present and beyond on c.10 000 year timescale
- Both a strength and (perhaps curiously) a weakness
  - Strong scientific investigation and analysis
  - Less visible recognition of limitations inherent in using such characterisation as basis for assessment
  - Tendency for detail (“as realistic as possible”) to obscure the identification and justification of necessary assumptions

# Basic Approach

- Reconstruction of last glacial cycle assumed to cover all relevant climate-related changes within a 120,000 year perspective
- Divides period into climate-driven process domains (including periods when site is submerged)
- Considers potential implications of transitions occurring within and between domains
- Elements broadly consistent with BIOMASS methodology

# Fundamental Assumptions

- Biosphere assessment is driven by assumptions as much as it is by site and radionuclide-specific data
- Examples of key assumptions include:
  - Shoreline displacement (combined effects of land rise and global sea level change)
  - Human behaviour (particularly use of resources) within a given landscape context
- Examination of sensitivity to such assumptions is fundamental to assurance of robustness in assessment outcomes

# Rate of Shoreline Displacement

- Related assumptions
  - Ice loading and rate of rebound (now and next glaciation)
  - Changes in global sea-level
- Why important?
  - Influence on geosphere-biosphere interface
  - Focus of release over time
  - Timescales for accumulation in terrestrial media
- Potential sensitivity
  - Reference case (6m over 1000 years, based on rebound only)
  - SR-Site acknowledges uncertainties but appears to examine only the potential for marine transgression, rather than implications of a slower 'net' rate of displacement

# Human Influences on System

- Related assumptions
  - Land use
  - Water use
- Why important?
  - Exploitation of resources influences radionuclide transfer and exposure pathways
- Potential sensitivity
  - All agriculture begins when the ground level is 2m above sea level (potential for pasture before arable farming not considered)
  - Irrigation with well water considered 'unlikely' (implications of short-term use assessed, but no consideration of potential long-term requirements in warmer/drier climate)

# More Detailed Findings

# Conceptual Models (1)

- Aquatic → Terrestrial transfer a key element of model
  - No clear explanation why ‘transfer’ from aquatic sediment is to ‘middle’ terrestrial compartment (appears to assume overlying peat layers are present instantaneously)
- Not clear how significant it might be to have ‘chains’ of landscape objects (inputs from more than one source)

# Conceptual Models (2)

- Novel 'primary productivity' approach for assessing doses via foodstuffs appears to have value (e.g. in relation to size of potentially exposed population), but implementation not transparent
  - Difficult to relate approach to standard 'reference group' diet
  - Particularly complex in relation to assessing potential impact of dietary uncertainty

# Other Concerns

- Traceability
  - Lack of assessment ‘narrative’ structure to frame the presentation of more detailed elements
  - Detail has a tendency to obscure the identification of key landscape-related FEPs and their influence on LDFs
- Geosphere-biosphere Interface
  - Fully-coupled contaminant transfer model (geosphere/biosphere) may be inappropriate, but no clear analysis is presented of consistency between the two within an evolving environment
  - E.g. assumptions relating to well capacity, potential multiple discharge locations
- Confidence-building through comparison with simpler ‘reference’ approaches

# LDF comparison with recent studies

- Simple comparison to assess potential variability
  - SKB results: Long-term release, temperate (TR-10-06 Table 4.1)
  - NDA RWMD results: Irrigation with well water, continuing release to sub-soil (QRS-1378ZM-4)
  - Nagra results: Irrigation with well water, advective release to soil (NAB 10-15) (“large area with large river”)

# Biosphere Dose Factors (Sv/Bq)

Radio-nuclide	SR-Site	NDA RWMD			Nagra	
		Temperate	Semi-arid	Warm Humid	Reference	Warmer/Drier
C-14	5.40E-12	1.20E-12	2.95E-12	6.54E-13	7.40E-16	9.60E-15
Cl-36	5.80E-13	1.48E-13	3.93E-13	1.03E-13	7.00E-15	8.50E-14
Ni-59	7.40E-14	4.00E-15	1.21E-14	3.84E-15	1.20E-16	7.00E-16
Cs-135	4.00E-14	5.77E-13	1.48E-12	3.62E-13	2.80E-14	1.20E-13
I-129	6.50E-10	3.27E-12	1.18E-11	4.53E-12	2.00E-13	1.90E-12
Ra-226	3.80E-12	5.10E-11	1.58E-10	5.52E-11	2.80E-13	1.70E-12
Th-230	1.30E-11	9.55E-11	2.25E-10	4.46E-11	3.30E-12	2.60E-11
U-238	1.90E-12	1.38E-12	5.14E-12	1.98E-12	2.40E-14	1.90E-13

# Ratio to SR-Site LDF

Radio-nuclide	SR-Site	NDA RWMD			Nagra	
		Temperate	Semi-arid	Warm Humid	Reference	Warmer/Drier
C-14	1	2.E-01	5.E-01	1.E-01	1.E-04	2.E-03
Cl-36	1	3.E-01	7.E-01	2.E-01	1.E-02	1.E-01
Ni-59	1	5.E-02	2.E-01	5.E-02	2.E-03	9.E-03
Cs-135	1	1.E+01	4.E+01	9.E+00	7.E-01	3.E+00
I-129	1	5.E-03	2.E-02	7.E-03	3.E-04	3.E-03
Ra-226	1	1.E+01	4.E+01	1.E+01	7.E-02	4.E-01
Th-230	1	7.E+00	2.E+01	3.E+00	3.E-01	2.E+00
U-238	1	7.E-01	3.E+00	1.E+00	1.E-02	1.E-01

# In Summary

# Main Points

- Assumptions are unavoidable, even for a very well-characterised site
- Key assumptions need to be identified and justified as appropriate and sufficiently robust
  - SR-Site tends to focus biosphere uncertainty/sensitivity analysis on parameters used to assess radionuclide transport within a defined biosphere system
  - Much more limited exploration of sensitivity to underlying assumptions and conceptual models relating to landscape evolution
- Potential for building confidence in site-specific analysis through comparison with 'generic' biosphere systems

# Recommendations to SSM

# Recommendations

- Technical issues – lists of questions to SKB
- Possible further review work
  - Depends on responses to questions, but considerations include:
    - Systematic identification of key landscape and climate-related parameters
    - Assessment of robustness of LDFs to alternative structural assumptions
    - More detailed examination of linkage to radionuclide transport modelling