BIOCLIM

Modelling sequential BIOsphere systems under CLIMate change for radioactive waste disposal

Conclusions

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BIOCLIM : Objectives (reminder !!!)

To provide a scientific basis and practical methodology

for assessing

the potential impacts of long-term climate change

on Biosphere characteristics

in the context of radiological Performance Assessments (PAs)

⇨ For 5 regions of interest in Europe

⇨ Over the next 1 million years

⇨ Quantitative scenarios of climate changes numerically produced

↓

⇨ Narrative descriptions of future Biosphere changes (states + transitions)

Numerical Experiments

Completed, more likely situations – not extreme

Transient sequences of future climate & vegetation patterns (WP3)

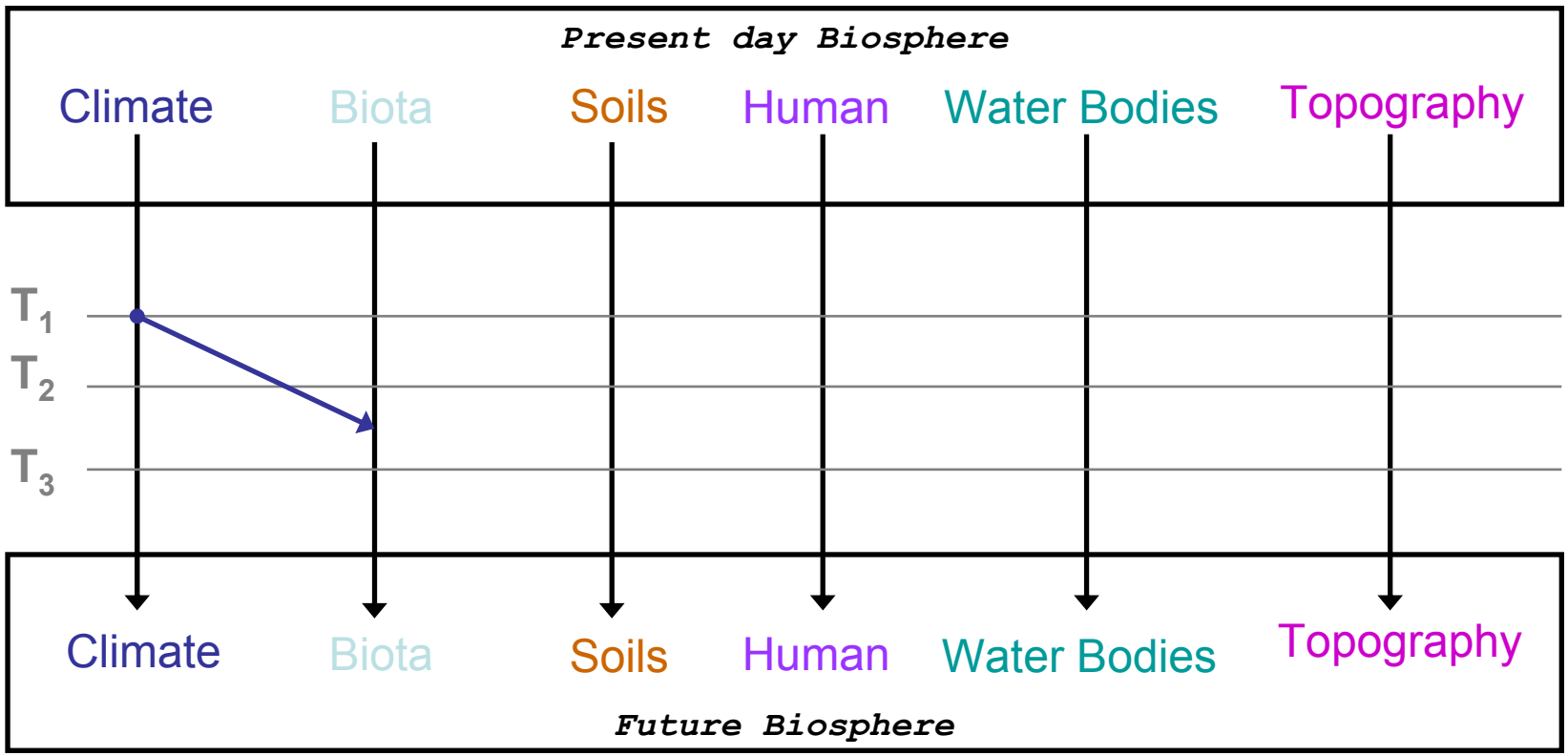
The next 1000kyr (with zoom on +200kyr) under 3 different CO_2 scenarios :

- Scenario 1 : natural CO_2 variations only (A4)
- Scenarios 2 & 3 : natural CO_2 variations + Fossil Fuel Contribution (B3, B4)

Snapshots of future climate & vegetation patterns (WP2)

- A very near future : high atmospheric [CO_2] with or without ice sheets
- A super interglacial (67ky AP) : high insolation, high atmospheric [CO_2], no ice sheets
- A glacial maximum (178ky AP) : low [CO_2] , large ice sheets

Developed Representation of Biosphere Systems Changes: States and Transitions



Conclusions – Climate Modelling (1)

- BIOCLIM has delivered a comprehensive methodology for incorporating climate-driven environmental change into the biosphere component of performance assessments.
- BIOCLIM has provided a substantial body of climatic modelling results for Europe – these represent an important resource for national organisations wanting to include future climate change in performance assessments.
- The climate modelling has included innovative new developments in Earth Models of Intermediate Complexity (EMICs).
- There would be advantages in exploring uncertainties using a larger ensemble of models.
- When deploying models, both long-term simulations with EMICs and snapshot simulations with GCMs have important roles to play.

Conclusions – Climate Modelling (2)

- Establishing communications between the climatological and performance assessment communities was quite difficult. This was not only a matter of jargon; the climatologists tend to deliver precise, quantitative information, whereas the assessment people are more interested in the broad picture.

- Multiple models and various downscaling methods can provide a robust picture of potential climate changes for the purposes of scenario development. A key issue is the robustness of scenarios for greenhouse-gas emissions and the subsequent long-term enhancement of atmospheric concentrations of those gases.

- It is unclear whether embedding of regional models in GCMs will give any substantial advantages. Resource requirements are high and we may be able to get all we need from statistical techniques, e.g. through the use of continentality, altitude and aspect related regressions.

Conclusions - Narrative Descriptions

- Narratives are an essential element of the methodology to transform climate change scenarios into environmental change scenarios. These narratives are dependent on the broad pattern of climate modelling results rather than the detailed quantitative results.

- However, consistent quantitative climatic data would be an important input to mathematical models used to represent states and transitions from those scenarios.

- A combination of long-term climate modelling using EMICs in combination with snapshot modelling using GCMs and regional models provided a good basis for narrative development.

- Several climate-change scenarios can be combined to give a limited but sufficient number of states and transitions for analysis.

Conclusions – Implication for Repository Performance Assessment (1)

- States and transitions provide an appropriate framework for developing structured descriptions of environmental change.
- The BIOMASS methodology was found to be appropriate for characterising biosphere states, but some minor changes in terminology were introduced.
- There is no assumed requirement for a one-to-one match between climate states and environmental states or transitions.
- Interaction matrices are a useful way of characterising transitions.
- Transition diagrams provide a convenient way of visualising temporal relationships between biosphere components and are a useful complement to interaction matrices.

Conclusions – Implication for Repository Performance Assessment (2)

- Descriptions of environmental states can be transformed into conceptual and mathematical models as previously demonstrated in BIOMASS, e.g. Example Reference Biosphere 2B, and in BioMoSA.

- National organisations may need to complement the climate modelling studies undertaken in BIOCLIM with their own studies, to reflect national policies, local downscaling considerations and the rapid pace of developments in climatological modelling.

- In particular, it would be useful to explore the diversity of results produced from an ensemble of different models, as has been done with GCMs in palaeoenvironmental reconstructions, and for various forcing scenarios.

- Nevertheless, it seems likely that the associated diversity of climate projections could be mapped to a limited number of states and transitions of interest at any particular site.

Conclusions – Implication for Repository Performance Assessment (3)

- Greenhouse-gas warmed scenarios should be included in PA, but natural evolution scenarios should also be given an appropriate weight for confidence building, as the environmental conditions described can be more closely related to palaeoenvironmental data.

- We need to evaluate the radiological significance of the states and transitions that we have characterised through a further phase of conceptual and mathematical model development, but none of the processes identified would appear to pose major problems in modelling beyond those associated with the comprehensive modelling of individual biosphere states.

Conclusions – Next Step (1)

- This framework has been applied only to the biosphere – it would be equally applicable to the geosphere.
- More work remains to identify key aspects of transitions for performance assessment purposes and show how they can be captured in conceptual and mathematical models.
- It would be useful to extend the methodology to include other human and Earth system processes that give rise to environmental change. Some aspects are being studied in the BIOPROTA Project

Conclusions – Next Step (2)

- It would also be useful to explore more fully the implications of full glacial episodes in the more northern parts of Europe. However, there is a substantial body of modelling to indicate that full glacial conditions are unlikely to be experienced in the next 150 ka.

- The requirement for a broad picture implies that we should give more emphasis in the future to EMIC type modelling, providing that we can be confident that we can relate EMIC results to regional/local conditions in a moderately quantitative (as in rule-based downscaling) way. Availability of a wider range of EMICs would be helpful.
- The limitations of current scientific understanding of the climate system need to be clearly stated when the results of climate modelling are used in support of PA. However, PAs should be constructed so that they are robust relative to the details of the climate modelling undertaken and the scenarios developed through application of that modelling.

And Finally

- Thank you to:
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