

BIOPROTA

**Key Issues in Biosphere Aspects of Assessment of the Long-term
Impact of Contaminant Releases Associated with Radioactive
Waste Management**

Report of the Eighth Workshop

Oxford, 16-18 May 2006

Hosted by UK Nirex Ltd

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Preface

The report is presented as working material for information. The content may not be taken to represent the official position of the organisations involved.

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1. INTRODUCTION

1.1 Objectives of the Eighth BIOPROTA Workshop

The objective of the workshop was to update interested parties on the progress throughout 2005 on the various tasks supported through BIOPROTA and to provide a Forum for discussion on additional topics. It was intended that discussions would highlight continuing areas of common interest upon which future BIOPROTA tasks could be built. The meeting therefore focused on progress to date and implementation of a future work plan.

The workshop opened with an introduction by the 2006/07 BIOPROTA Chairman, Ales Laciok (Nuclear Research Institute (NRI), Czech Republic). This was followed by agreement of the draft agenda for the workshop and introductions by participants with a particular focus on their areas of interest in relation to the Forum.

1.2 Report structure

The remainder of this report provides:

- ◆ An overview of the progress made in 2005/06;
- ◆ A summary of presentations made by participants on their national biosphere programmes;
- ◆ An introduction to potential new tasks that were discussed; and,
- ◆ An overview of discussions of new tasks and agreement of way forward in 2006/07.

1.3 Participation

There were 30 participants from 10 countries, representing a range of operators, regulatory bodies, and technical support organisations. Point of contact are list in Appendix A.

2. PROGRESS TO DATE

Five tasks were ongoing in 2005/06 and progress on each of these was presented by the project co-ordinator (or representative). Summaries of these presentations are given below. In addition, a brief overview of progress on the publication of Theme 2 reports was presented. Each of these reports is available for download from the BIOPROTA website (www.bioprota.com) and three have been made available to Forum members and contributing authors as published reports. The final three are currently in print and shall be distributed to the Forum members and contributing authors shortly.

2.1 The Specialised Database

Adrian Punt (Enviros) presented the work undertaken by Enviros and Quintessa in 2005 on the population of the Specialised Database project. The aim of this project was to undertake a review of scientific literature pertinent to the behaviour of key radionuclides within the biosphere. The process involved the identification of literature to review on the basis of the existing databook structure, the collation and formatting of the data, and input into the BIOPROTA databook with the aim of providing a data resource for Forum members.

The BIOPROTA databook is an existing standalone software tool that was provided for Forum use by Nirex. It is based on an MS Access system, which stores data in pre-defined data entry tables. It is a system for storing, rather than manipulating data and is hence a databook, not a database.

The project focussed on ten predefined radionuclides of anticipated importance in relation to biosphere processes (Cl-36, Se-79, Tc-99, I-129, Np-237, and U-238 and its daughters Th-230, Ra-226, Pb-210 and Po-210). The biosphere aspects of interest were biological uptake plus some geochemical factors with a particular focus on agricultural systems. An additional focus of the project was the collection of supporting information that would enable a more informed decision to be made regarding the usefulness of data under site-specific environmental conditions (e.g. soil conditions, climate conditions etc).

Various search engines used to identify pertinent literature in addition to the use of the PRISM references held by Quintessa. In addition, Forum members were invited to provide relevant data for inclusion in the databook.

The screening process initially identified in excess of 2,000 references that were subsequently reduced to around 600 by review of abstracts. Primary literature was the focus of the project, but robust reviews were also included. A total of 300 references for review were short listed by prioritising those that were most recent and those that included multiple radionuclides of interest.

Following the review and collation of data, efforts were made to restructure and populate the BIOPROTA databook. However, shortcomings associated with the databook were identified at this stage and issues arose in the input of data. As a result, an alternative presentation/delivery of data was agreed with the project coordinator. The data have therefore been provided in a series of MS Excel spreadsheets. These comprise different worksheets for different parameters and radionuclides to allow easy navigation between data of relevance. Where applicable, the mean, range, and uncertainty plus supporting notes and reference details have

been provided. These have undergone review by Steve Sheppard (ECOMATTERS) and Mike Thorne (MTA).

Finally, it was noted that although progress has been made on providing the required data, the vast number of combinations of required data mean that there are still a large number of data gaps that could be addressed in a subsequent task should Forum members require.

Mike Thorne then provided some clarification on the status of the databook software. It is understood that the software issues that arose during the population task are believed to have been resolved and therefore Mike offered to take the datasheets and enter them into the databook, which will then be distributed to the Forum members. Again it was noted that the databook, as its name suggests, is a means of storing data rather than a tool for manipulating or searching for those data.

Following the presentation, Paul Degnan (Nirex) explained that sponsoring organisations will shortly be provided with the project deliverables, including spreadsheets and report from Enviros, and a populated databook, from Mike Thorne. Once the deliverable has been received, sponsoring organisations are requested to decide whether they feel that the databook is the correct tool for their needs or whether an alternative structure (such as a database) is required. The deliverable could be made more widely available, but this will be dependent upon project sponsors views.

There is a responsibility on the data user not to use the information provided without considering the context of their assessment – references to the original sources have been provided and these may need to be consulted. By providing the supporting data, it is anticipated that assessors will be able to identify relevant data on the basis of knowledge gained during the site characterisation process. Paul also explained that there is a need to progressively populate the database so it will be an ongoing project. There is still therefore a requirement on Forum members to provide additional information that can be used to populate the databook. It has the potential to be a useful tool for members, but the onus (responsibility) is on the additional information being provided by members and the need for a broader decision on the format and functionality of such a system (i.e. a databook or database). It was however noted that development of new software tools was outside the remit of BIOPROTA.

Achim Albrecht (Andra) suggested that both would be of benefit. A databook would be used to identify relevant data and a database could then be used for direct input to assessment models. However, it was recognised that model codes are not identical so their database requirements could differ. It would therefore be difficult to develop a database applicable to all models. Achim therefore felt that a databook would be of most relevance to the Forum as a whole from within which the most relevant information could be sourced. The possibility of providing a web-based database from which models could select data was raised.

Ulrik Kautsky (SKB) raised the important point that the databook should not only identify relevant literature, but should also screen out bad literature to prevent duplication of effort.

Finally, Mike Thorne explained that, to date, the critical evaluation has focused on the quality of the literature, but there is still the need for critical evaluation and comparison of the collated data to provide a more focused data resource that could be used for an assessment.

2.2 Iodine in Peat Bogs

Elisabeth Leclerc-Cessac (Andra) provided an overview of the work conducted to date on a research project investigating the behaviour (including long term sorption) of iodine onto organic matter, which has received funding by Andra, Posiva, SKB and Nirex.

The focus of the study is on *in situ* field behaviour of iodine in a Canadian peat bog that received an input of stable iodine in 1987. Peat is used as an analogue for possible future cold biospheres to be considered by various European waste disposal agencies. The bog is vegetated by various plant species, including sedges (*Carex* species) that are known to accumulate iodine.

There are three main foci of the study:

- ◆ The biogeochemical cycle of iodine in the peat bog including:
 - the transfer of iodine along the carbon cycle in the peat bog; and,
 - the influence of the redox potential on the migration and the speciation of iodine in the peat bog.
- ◆ The effects of aging of the organic matter on the interaction with iodine (e.g. desorption and re-sorption of iodine onto the peat).
- ◆ The relation between the chemical structure of organic matter and the sorption of iodine, through thermal maturation of the peat. Work on thermally matured peat aims to identify whether the retention capacity is related to the chemical structure of organic matter. Batch experiments are being conducted to see what compounds within peat are responsible for iodine retention.

Observations to date are that:

- ◆ Sedges accumulate iodine to high concentrations with most being retained in the older immersed leaves. The peat composition is known, and results show that senescent leaves retain more iodine than the peat.
- ◆ Iodine seems to be incorporated into the peat once the organic materials are degraded and they come into contact with the iodinated water.
- ◆ In peat, iodine may be associated with polyphenolic substances, which were also found in the sedges (*Carex*)

Ongoing experiments include:

- ◆ *In situ* redox potential monitoring related to the seasonal retention of iodine in bogs.
- ◆ Sorption and desorption capacities of iodine in the bog.
- ◆ Batch equilibrations with pyrolysis products.

The project is due to complete at the end of 2006, with the intention that scientific papers will be published.

Ulrik Kautsky started discussions by raising the question as to whether iodine accumulated in leaves that were old prior to the addition of iodine and therefore accumulated more iodine or whether they had just had a longer contact time with iodine during growth. Elisabeth responded that there are various possibilities, but that the most likely explanation is that the leaves are older so have higher contact time with iodine resulting in greater accumulation compared with younger leaves. Experiments are planned to demonstrate this.

Mike Thorne raised the question as to whether the ultra-distribution in senescent leaves could be studied as this could be a potentially interesting investigation. It was also noted (Achim Albrecht) that, since iodine is redox sensitive, as soon as there is a change in Eh, the partitioning of iodine to organic matter will be enhanced under oxidising conditions. There is therefore a need to be certain of the redox state to understand the form of iodine that is being studied in experiments. Also, Adrian Punt mentioned that Enviros had observed significant uptake of iodine to biosolids under aerated sewage treatment processes and that these results were consistent with other observations.

2.3 Comparison on Surface Hydrosphere and Biosphere Contaminant Transfer Modelling Codes

Progress on the comparison of surface hydrosphere and biosphere contaminant transfer modelling codes was presented by Achim Albrecht.

A meeting on this subject was held in September 2005 at Andra in France where there was an exchange of information on modelling codes. The meeting was attended by around 20 participants. The workshop report is available from the BIOPROTA website (www.bioprotacom.com) and the majority of workshop presentations can be accessed from the bioprotacom workspace within business collaborator.

A similar workshop was held in the USA in 2000, which aimed to develop a collaborative platform, which was achieved within the 'Frames' system. Frames is a platform that is open source to all Federal Government developers and is free to all users. Version 2 of Frames has been released recently. A US goal would be to develop a web-based database that is jointly managed and accessible directly by the different codes from affiliated members.

The first part of the September workshop at Andra identified the various codes in use by participants and aimed to evaluate what these specific codes do, and whether templates for each code could be produced that could be made available on the web so that interested parties could identify the codes of most relevance to them. Codes discussed included the mathematical modelling tool Matlab. This is used by SKB; Facilia has developed easy to use specific modules for Matlab. This approach is successful since Matlab is commonly used. Independent tools used by other participants include AMBER, SimEr, GoldSim and MoM. These are highly flexible compartmental modelling codes that allow the user to create a large variety of models without the need to develop their own source code. Other codes do not have an intrinsic model building capacity. In general, the more powerful and flexible the codes are, the more difficult they can be to use. There is however a sufficient diversity of codes available for people to choose from.

The second part of the Andra workshop considered data handling and the use of databases. For example, in Spain the approach is to use VALORA, which is a database communication interface tool that allows for data searches. NUMO/JGC

intends to built a biosphere assessment database system to allow storage of all data relevant for past, present and future risk assessments. Most codes have inbuilt databases that can read MS Access or Excel files. The structure of the database is not so critical for model developers, so long as it creates output files accessible to their codes. One idea arising from the workshop was that a joint web-based database for biosphere related parameter values could be created rather than data being distributed in separate Excel/Access forms. Such a database should be restricted to the most relevant parameters used in PA.

The possibility of conducting a joint exercise on modelling a complex, evolving biosphere system to test a variety of codes and hence compare the impact of simplifications inherent in each modelling approach was raised. Such an activity could for instance be linked to a GBIZ initiative.

Since this workshop, not much further progress has been made. Financial support would be required to enable participants (mostly consultants and modellers) to take part in joint exercises.

David Brazier (Environment Agency of England and Wales) agreed that there is perhaps a need for convergence on the best models since only limited money is available for model development and to ensure that a consistent approach is taken. However, he noted that too much reliance should not be placed on just one model as there is a need for comparison with other models that have been constructed independently for validation purposes. For example, an ensemble of models with different structures and parameterisation should be used to scope uncertainty when issues of major concern, such as climate change, are being evaluated. The use of an ensemble of models allows issues relating to conceptual uncertainty to be recognised and quantified.

Finally, Paul Degnan noted that no matter how model calculations are done, there is a fundamental need to understanding the environmental processes occurring which underpin the modelling assumptions.

2.4 Geosphere-Biosphere Interface Zone (GBIZ)

Progress on the GBIZ was presented by Graham Smith (Enviros). A workshop held in Barcelona in September 2005 was attended by 18 participants and aimed to discuss various aspects of the GBIZ. The workshop report is available from the BIOPROTA website (www.bioprota.com).

The workshop concluded that:

- ◆ There is a need for further review of GBIZ FEPS and for the development of new conceptual models that take account of time dependency;
- ◆ It is important to evaluate whether models work well on a site-specific basis (current generic models may need to be assessed on a site-specific basis to determine their applicability to site-specific conditions); and,
- ◆ A comparison of current PA approaches could be conducted to identify weaknesses and to help identify the need for better generic data or better site-specific characterisation.

As a result of the GBIZ workshop, a proposal was submitted for an invited EC funded project. This was rejected based significantly on the basis that IAEA and NEA activities already cover similar topics, though both of these organisations have confirmed that they do not have projects on the GBIZ. In addition, the proposal apparently followed the terms of the invitation, but did not apparently add value. Consequently, there was disappointment in the submitting team.

Discussions however indicated a continued interest in a GBIZ task within BIOPROTA for both shallow and deep sites, and both inland and coastal sites.

2.5 Site Characterisation and Data Protocols

An update of Theme 3 (Site Characterisation and Data Protocols) was presented by Graham Smith on behalf of Elisabeth Leclerc-Cessac. Theme 3 is now largely finalised following input from Elisabeth, Enviro and Mike Thorne. A draft report has been produced and will be distributed shortly following minor modifications.

The aim of Theme 3 is to provide information about what kind of characterisation may be required for the biosphere part of a system that will help in the understanding of post-closure performance, i.e. what do we really need to know to better inform assessments and what would be the protocols to carry out the required research and site-characterisation activities? This is not for environmental impact assessment (EIA), but more for the purpose of long term performance assessments (PA) with respect to radiological impacts. However, it is noted that EIA and post-closure assessment may have over-lapping data requirements.

The three BIOPROTA themes are all inter-related. Theme 1 (the specialised database) addresses questions regarding the quality and availability of data for assessment biospheres. Theme 2 identifies the sensitivity of biosphere parameters for the impact estimation, and hence, with Theme 1 output, allows identification if key data that may not be available. Finally, Theme 3 aims to identify the best methods for characterising key biosphere parameters which are relevant to derivation of those missing key data.

The current Theme 3 document focuses on the stage before site selection, but it is noted that the iterative nature of PA suggests that there is continuing relevance up to the point at which the site is de-licensed. Mike Thorne (MTA) interjected that the report is now more balanced between pre- and post-site selection since it now contains more information from both Nirex and SKB programmes.

One of the important factors to take into account in site characterisation is that the environmental characteristics of a site will change over time. The timescales for the PA are such that the biosphere conditions that result in the potential maximum exposures may be different from those at present, i.e. when the site investigation is being conducted. This has relevance for the scenarios considered. There is therefore a need to prioritise resources for site characterisation on the basis of a sound understanding of the key parameters that determine long-term environmental impact.

The next step in Theme 3 is for the current draft to be sent to participants for comments and agreement to publish. It is requested that Forum members respond to the draft within 1 month of receipt.

A future step identified for a further site characterisation task within BIOPROTA was a consideration of the specific details relating to soil conditions that may affect the accumulation of problematic radionuclides.

3. CONTINUING CHALLENGES

In Session 2 of the workshop, participants were invited to provide an overview of their national biosphere programmes and to identify any issues arising within these programmes. An overview of the presentations and discussions is provided below.

3.1 Overview of SKB programme

Tobias Lindborg (SKB) began the presentation on the SKB programme. Site investigations began in 2002 at three sites, but only two are undergoing ongoing active site investigation (Forsmark and Laxemar, with Simpevarp currently on hold).

A conceptual model is being developed that takes account of various possible geosphere to biosphere exit points within the systems which are linked together by surface hydrology. The environmental changes occurring over time are also taken into account. It was noted that a surface system characterisation report (ref SKB R-06-11) is to be made available within the next few weeks that may be of interest to participants. The report will be accessible via the SKB website (www.skb.se).

Two types of models are being employed – descriptive and ecosystem models.

- ◆ Descriptive models are divided into both biotic and abiotic types. Chemical data are currently available for the Laxemar site (e.g. soil, water data) abiotic model. However, no biota data are yet available.
- ◆ Ecosystem models are available as both individual and integrated models. The latter is fed by the single ecosystem models plus the descriptive models. Ecosystem models range from simple 1D models to those based on specific site data. The first full terrestrial ecosystem model is due to be completed by the end of the year and will be based on site specific data. Once completed, the individual ecosystem models will be linked to provide an overall system model.

Following the description of progress with biosphere modelling, Ulrik Kautsky continued by describing the safety assessment for high level waste (SRCan). The focus of the safety assessment is on canister performance and is based on early site data. The safety assessment will be reported in October 2006. In March 2007 the full site assessment will begin and is due to complete in 2009.

Discharge points from the geosphere to the biosphere have been identified and the biosphere is being characterised to provide data on which models can be based. The modelling approach for the biosphere remains based on concentration factors in the interim, but these do not take full account of the potential behaviour of radionuclides, there is also a large degree of variation and it is unknown what factors could lead to this variability.

Land uplift will greatly affect the landscape into the future. The Baltic Sea is likely to evolve into a multiple lake ecosystem primarily through land up-lift that will more than off-set potential sea level rise through climatic change. These future modelling scenarios need to consider hydrology (water turnover), chemical and biological characteristics of the lake system that are likely to develop and how long they will exist and whether areas could be suitable for agricultural use (potentially through subsequent draining). Seabed topographic mapping is currently being used to develop an idea of whether areas could be used for agriculture in the future.

Carbon balances are also being used to predict the number of people that could be supported on areas of such land. This approach takes account of the type of land and the extent of agricultural crops that could be produced. No assumptions are made as to what people eat – if something could be eaten then it is taken into the account. Predictions of sustainable populations are then produced and are taken into account in defining landscape dose conversion factors.

Precise assessment of maximum individual dose is difficult since it is highly dependent upon the assumptions of land use. Landscape dose conversion factors (LDF) that take into account changes over time and doses to different population groups associated with various biosphere objects are applied.

3.2 Finnish Biosphere Programme

Ari Ikonen (Posiva) presented an update on the Finnish biosphere programme, which is based on a safety case portfolio. The portfolio consists of a series of scientific and technical reports plus the assessment itself. Overall there are 10 main components/levels, each of which contains numerous folders. The scientific level comprises of three areas: processes; evolution of site and repository; and biosphere. Penetrating issues are GBIZ, future human activities and the knowledge for a quality assessment (overall consistency and confidence assessment). Current work is focused on supporting the data requirements of the safety case.

The Regulatory requirements for the safety case have been defined:

- ◆ The biosphere timeframe is several thousand years (up to the beginning of the next glaciation).
- ◆ The assessment is to be based on current ecosystems taking account of land uplift and the emerging of new land areas.
- ◆ The standard exposure pathways are to be considered, but less obvious ones are also required to be considered.
- ◆ There is an implicit requirement for the impact on non-human biota to be assessed (including rare and domestic animals etc).

The Posiva strategy comprises:

- ◆ description of the site and processes (realistic);
- ◆ description of the evolution of the site (as realistic as possible);
- ◆ radionuclide transport (semi-conservative assumptions to simplify models);
- ◆ effects analysis; and,
- ◆ assessment (conservative and regulated).

The later stages involve more detailed assumptions for the longer term associated with possible environmental change; hence the adoption of an increasingly conservative approach, albeit, with such conservatisms being explicitly recognised and explained, so that a less conservative approach can be justified given new information, say, from later stages of site investigation.

Shoreline displacement modelling has been conducted to determine future land area. Six thousand years from now, the minimum distance of the site from the shore will be > 21,000 m. On the basis of this modelling, and in association with both sounding data and sediment maps, the future terrain has been predicted (e.g. lake and river formations, vegetation types). The results have indicated that the future land coverage would be very similar to present with regard to vegetation types and therefore terrestrial species are also likely to be similar to those present today.

With regard to landscape modelling, it is possible that forests could act as a 'plug' where radionuclides are continually cycled rather than moving between systems. The key factor in this is the regional water balance. One of the main problems associated with landscape modelling is acquiring and handling the parameters, since thousands of parameters are required.

Posiva is currently updating the safety case plan. The biosphere description is being compiled this year and the overall terrain and ecosystem model development is ongoing. A process report on forests is planned for this year as are continuing landscape modelling exercises, particularly of human activities.

The method for the biosphere assessment is due to be published as an interim report by the end of 2006. This will be followed by an 'Exercises' interim report, which is due in 2009. The final assessment is due in 2012.

To manage uncertainty and knowledge quality there will be a quantitative uncertainty and sensitivity analyses, plus a consistency and confidence assessment. This will include information on what data has and hasn't been used (and why), uncertainties and potential for alternative interpretations/models etc plus a pedigree analysis.

The main challenge faced – getting the work done!

3.3 Developments in Landscape Modelling for Nirex

Mike Thorne presented information on landscape modelling developments on behalf of UK Nirex. In the UK, no site for radioactive waste disposal has been selected so models have therefore focused on generic inland catchments.

There is a need when modelling landscapes to take account of direct impacts on the landscape as a result of human activities in addition to those impacts resulting from climate change. The Nirex models therefore take into account climate, topography, soils and lithology, water bodies, biota, human communities and potentially exposed groups (PEGs).

Future climate landscape scenarios are developed on the basis of sequential changes to the current landscape and therefore current site descriptions are important on which to base predictions. Three climate scenarios have been considered in the Nirex landscape model:

- ◆ natural variations in CO₂;
- ◆ moderate greenhouse warming; and,
- ◆ extreme greenhouse warming.

The following processes giving rise to landscape change were considered: chemical weathering and dissolution, mechanical erosion and transport, sedimentation, isostasy and other mechanisms of land-level change, human actions and disruptive events such as fires, landslides and lake bursts.

Two human community types are considered – present day and primitive (e.g. hunter-gatherer), which assumes minimal disturbance of the landscape in all types of environment. Both community types have been compared to assess the difference in doses received. Human habits have been based on various sources of information including national survey data. From the national statistics, general rules can be surmised, particularly that those foods consumed at low individual consumption rates tend also to be only consumed by a few individuals, whereas those consumed at high individual tend to be consumed by many people.

Various landscape change scenarios have also been considered and from this it is evident that, in the case of the UK, a wide range of future environmental evolutions can be addressed through consideration of only 12 landscape evolution scenarios. Under full periglacial conditions, doses to hunter/gatherer groups would be much lower than those arising in the pre-existing boreal conditions due to the large resource area required to support a periglacial community.

Further consideration needs to be given to modelling the rapid warming during interglacial conditions following a glacial episode, as surface materials are likely to be substantially spatially redistributed over such an interval. Such surface material movements may disturb and release radionuclide accumulations in the GBIZ.

3.4 Application of Regulatory Performance Assessment Approach for Comparison with the Proponents Calculations

Ryk Klos presented on behalf of SSI, the competent authority concerning radiation protection in Sweden.

The CLIMB project aims to develop an independent modelling capability that will enable SSI to evaluate the radionuclide release and resultant dose/risk calculations performed by SKB during their safety assessment. CLIMB is therefore a PA modelling system that takes into account biosphere models, radionuclide transport across the GBIZ, geosphere transport models and near field models.

Using these models in association with knowledge of the distribution of drainage areas and topographic data etc, the entry points for radionuclides in the biosphere can be predicted. Possible release points include the sea, lakes, and forest ecosystems with release points more or less coinciding with surface drainage.

A case study comparing predictions performed by SKB with those of SSI for the release of I-129 to the biosphere was presented. It was concluded that it is important for regulators to have an independent modelling capacity and that analyses of mathematical dispersion should be performed when small numbers of compartments are used to predict the transport of radionuclides within an ecosystem. It is also important to assess whether all FEPs relevant to the evolution of the disposal system are handled in the models used to support the safety assessment, with site characterisation being key to refining system understanding.

3.5 Update on the ANDRA Programme

Achim Albrecht provided a brief overview of the situation in France in relation to radioactive waste management and biosphere radionuclide transfer assessment. Andra presented in December 2006 the final version of a report on the feasibility of a repository for high-level and long-lived radioactive waste in a deep geological formation. This feasibility-assessment report on clay formations, based notably on the work conducted on the site of the Meuse/Haute-Marne Underground Laboratory gives the sum of the last 15 years of investigations

To verify the robustness of the solutions proposed, Andra has simulated the repository evolution in the very long term through a phenomenological analysis of repository situations and then tested the limits of validity of this representation via a safety analysis. This safety analysis defines the simplified history of a repository evolution (normal evolution scenario). It covers the full range of possible situations through very cautious choices. Andra has also examined scenarios entailing highly unlikely events (intrusion, failure of safety functions). According to the methodological guide published by the Nuclear Safety Authority (Basic Safety Rule RFS.III.2.f), the impact of the repository on man and the environment must amount to less than 0.25 mSv in normal situations (i.e., 1/4 the dose due to non-natural exposure currently admitted for the public and approximately 1/10 the annual dose due to natural radioactivity). This impact has been subsequently calculated based on models. Andra has extended its calculations to one million years, in accordance with IAEA guidance on timeframes for assessment.

The analysis shows that for all the situations considered, normal or altered, the proposed system ensures the required level of safety without excessively depending on any of its individual components. Each component contributes to the overall safety of the system in a significant but non-preponderant manner. The Callovo-Oxfordian formation plays a major role in immobilising the radionuclides and in delaying and limiting their migration into the environment in all situations. The repository performance meets the dose objectives recommended by Basic safety rule III.2.f in all the scenarios considered, whether accidental or altered, and with significant margins. The repository represents therefore a robust disposal concept, including in rather unlikely situations with concurrent penalizing circumstances.

Biosphere dose conversion factors have been assessed according to the prescriptions of the International Commission on Radiological Protection (ICRP) and the recommendations of basic safety rule RFS III.2.f. Radiological impact is measured based on the individual dose calculation for the critical group. It is defined based on a study of the living habits of populations around the site considered. This leads to the definition of one or more 'reference' groups. However, the mere knowledge of the quantity of radioactivity present in the environment does not immediately yield a dose value. It is necessary to formulate hypotheses regarding the manner in which the radionuclides present may lead to the exposure of humans, particularly through the food chain.

Such an assessment presents specific difficulties when conducted over a period of approximately one million years. Over that time scale, it is not reasonable to expect to obtain an accurate assessment of living habits in the area considered. The definition of the reference group, referred to as the 'critical group' in such a context, is therefore based on simple and very pessimistic hypotheses, assuming that small groups of humans live near the repository and derive most of their subsistence from local production (vegetables, domestic animals, water). The critical group is therefore conventional, but the practices attributed to it guarantee an extremely cautious

measurement of the dose to which that group will be exposed. It is assumed that the water pumped from geosphere outlets (see discussion of GBIZ) is used to water a vegetable garden or as drinking water.

The model takes into account the transfer of radionuclides through the biosphere (via plants and animals) up to a member of a critical group, basically village-dwelling farmers obtaining most of their subsistence from their crops. A group living in complete autarky has also been considered. Within the scope of the IAEA BIOMASS international programme, four reference biospheres have been identified as possibly occurring in the Meuse / Haute-Marne region during the next million years: temperate biosphere (similar to the current one), warm (possibly accruing during the first 100 000 years as a consequence of global warming), boreal biosphere and tundra. Each of these biospheres is associated with agricultural practices adapted to climate conditions. For each of the climates considered, it is demonstrated that the 'village-dwelling farmers' group is associated with the largest number of transfer paths and therefore constitutes the critical group. The biosphere that seems most penalising has been considered.

An English version of the feasibility report will be made available on the Andra website (www.andra.fr) shortly. A new law is due in June/July 2006 that will define the future of Andra and the nuclear waste programme. It is anticipated that by 2040 the fourth generation nuclear reactors may be available. A retrievable waste option is favoured in France and a "demande d'autorisation de construction" (request for construction authorisation) for a high level waste deep geological storage site will be made in 2015, with a possible beginning of waste storage in 2025.

For future evaluations (research plan 2006-2010) Andra has indicated in particular phenomenological and modelling work on Iodine and Chlorine behaviour in the biosphere, the assessment of future biospheres and issues related to the geosphere – biosphere interface zone.

3.6 Nexia view of Bioprotected Issues

Mark Willans (Nexia Solutions) provided an update of work on the Drigg LLW disposal facility. Previous biosphere work for Drigg was carried out systematically with the Drigg site being split into near field, far field and biosphere, and processes within these were looked at in detail. Future scenarios relating to climate change were considered. However, it is a requirement that the best available modelling techniques are used to assess performance and therefore the assessment will require updating in the future.

Conceptual model uncertainties have been identified and ranked. Highest ranking was biosphere system change. Second was the GBIZ. These are therefore the two main areas of interest in relation to Drigg. Nexia has since focused on climate and landscape change at NDA (Nuclear Decommissioning Authority) sites within the UK taking account of both global and local climate change. This is aimed at identifying which sites may be vulnerable to both climate and land changes with most vulnerable sites being coastal. Nexia has also been involved in the development of a tier 1 assessment tool for contaminated land.

3.7 Czech Republic

The radioactive waste programme in the Czech Republic was summarised by Ales Laciok (NRI). There are three main organisations involved – RAWRA (state

implementing organisation), SONS (regulator) and NRI Rez (the main research and development organisation). The strategy for radioactive waste management is to select a granitic host rock for deep geological disposal. The siting process has been interrupted, but it is planned that two potential sites (out of 5 to 7 with suitable geology) will be identified by 2015 with final selection being confirmed in 2025.

A biosphere research project began in the Czech Republic in 2005. This has involved the development of various conceptual models based on general characteristics that could be applied to the selected site. A performance assessment project is likely to take place from 2006/7.

The Czech Republic currently has three near-surface repositories in operation. A new safety assessment is required that will take into account new site data for each of these.

NRI Rez is also involved in projects on the remediation of uranium mining and milling waste - it is estimated that around 7100 tonnes of uranium are in the environment as a result of milling and mining activities.

3.8 Progress on the Estimation of Dilution volume by the Near-Surface Groundwater System in Japan

Hideji Yoshida described work conducted by JAEA in Japan. Japan is currently in the process of selecting a candidate site for a geological repository. Once selected, a three phase work programme will begin that will comprise of an initial literature survey followed by a preliminary survey (e.g. a small number of boreholes) and finally a detailed survey phase (i.e. construction of an URL).

Recent work by JAEA has aimed to try and characterise the GBIZ using a non-candidate site in which estimates of dilution volume have been attempted. The main uncertainty in the estimates is associated with the permeability of the structure. Uncertainty was reduced by use of borehole data. Near-surface characterisation is therefore important in order to reduce uncertainty associated with understanding the amount of dilution that is available at a site.

3.9 Yucca Mountain Project

An overview of the current state of play at the Yucca Mountain Project (YMP) was presented by Maryla Wasiolek. It is expected that the US regulatory agencies will soon add an additional standard for the period of geological stability since the courts have decided that the standards used in the initial PA were not appropriate to ensure the protection of people and the environment. If a new standard is introduced, an additional PA will be required. Work on the YMP is therefore focusing on the calculation of peak dose performance and the land use scenario is being amended, taking account of the way that land may be irrigated.

The current plan is to submit a license application in 2008 for the building of the facility. Licence evaluation will then follow and it is anticipated that there will be a lot of legal activity as a result. It had been planned that the repository would be opened by 2012, but this is questionable due to the anticipated legal activity. In particular, hearings concerning the Licence Application are expected to last three to four years.

3.10 Update on progress in Switzerland

Frits van Dorp (Nagra) briefly explained that, in Switzerland, the government is currently deciding whether the current repository feasibility study is complete. It is not known when the next assessment will be.

4. NEW TASKS

Following the presentations by participants on their national programmes, a number of possible future tasks were outlined that may be of interest to the Forum and participants were requested to consider whether they/their organisation would be interested in funding/participating in each. Each of the tasks is detailed below.

4.1 Selection and modelling of exposure pathways

Frits van Dorp suggested a possible task on the selection and modelling of exposure pathways. An understanding of exposure pathways is critical to the assessment of human doses/risks from waste repositories. Exposure pathways that have been considered in the past include fishing gear exposure, swimming, consumption of agricultural produce etc, but more recently new items have been added to some exposure pathways lists including wild/cultivated mushrooms, game, wood and ashes. The criteria for selection of pathways involve consideration of their contribution to the total dose for an identified critical group. Once pathways are known, the process of contamination needs consideration (e.g. soil contamination, soil plant transfer etc) and items in the diet should be selected and categorised. Having these things categorised on an international basis could prove useful and this was therefore proposed as a BIOPROTA task for 2006. The task would involve documenting what is known (measured doses, behaviour of the element) and document what has been evaluated in assessments. Further studies could then include experiment and/or model calculations.

In response to the presentation, Mike Thorne noted that the UK National Dose Assessment Working Group has a list of unusual pathways that is a living document and is available on their website. It was also noted that the remit of the Working Group may extend to solid waste disposal and this could therefore build a useful bridge between the Forum and the Working Group. Mike also noted that both the FSA and EA may be interested in this as a task.

Finally, Maryla Wasiolek raised the issue of recreational drugs (for example, leafy plants whose that can be inhaled rather than ingested) where habits data are not known due to legal restrictions on cultivation and use, but the use could be important when considering dose.

4.2 Carbon-14

Two presentations were given on recent work on the modelling of Carbon-14. Frits van Dorp described a conceptual model has been developed based on the Nagra Opaliunus Clay (OPA) assessment from 2002 which considers long-term (steady state) and the main pathway of groundwater-soil-plant. Input into soil is inorganic C-14. Adaptations made to the model were described (e.g. plants and roots added plus soil gas and air in the canopy). Water is from either groundwater transport through soil or as a result of irrigation. Organic matter production is an input parameter, with a few percent of the carbon assimilated by photosynthesis being derived from inorganic carbon in the soil solution.

The concentration ratio, as a function of various parameters, has been calculated on the basis of the revised model. The parameters determining the specific activity of C-14 in plants are the carbon cycle (yield) plus the exchange between the general atmosphere and atmosphere-in-canopy. Open issues includes the consideration that

temporal variability might be important, but this cannot be addressed in a steady state model.

Based on this model, a preliminary suggestion of an apparent concentration ratio (CR) for C-14 is between 30 and 300 (dry wt) mainly as a function of the plant production rate (low production leads to a high apparent CR). Previous Nagra data had suggested the CR would be between 5 and 35.

Mike Thorne then detailed work he has conducted on the modelling of C-14 and other matters relating to the gas pathway for UK Nirex.

During transport and storage the main gas likely to be released from waste is $^{14}\text{CO}_2$. As a result of transport and storage, occupational annual effective doses to members of the public are unlikely to exceed 1 μSv . However, based on a highly cautious assessment approach, routine discharges from a repository during the operational phase could give annual effective doses to members of the public from $^{14}\text{CO}_2$ of up to 0.25 mSv.

In the post closure phase, peak bulk production rates of methane could be a few thousand cubic metres per year. Some microbial metabolism of C-14 gases could occur in the geosphere, but complete metabolism of methane in the soil zone is unlikely to occur. For realistic release scenarios, annual effective doses from $^{14}\text{CH}_4$ could be in excess of 1 mSv, with the majority of dose being associated with foodchain pathways rather than inhalation. Such doses are a threat to the viability of the repository concept and are the focus of significant on-going research. However, currently, no account is taken of geology with all gas generated in the repository being assumed to be discharged instantaneously to the land surface.

Two models have been compared, RIMERS and a FSA model (which was a predecessor to the H-3 module in PRISM), which showed good agreement when the key parameters of the models were tuned to match each other. The results of a sensitivity analysis indicated limited sensitivity to the above-canopy atmosphere exchange rate, greater sensitivity was found to the exchange rates between the below-canopy atmosphere and the above-canopy atmosphere. The analysis also concluded that concentrations of C-14 in vegetation for chronic exposure are unlikely to be more than a factor of five lower than in the reference calculation and could be up to about a factor of ten higher. In extreme cases they could be up to a factor of about 100 higher.

4.3 GBIZ

Various presentations/discussions took place on the issue of the GBIZ. Juan Merino (Enviros Spain) began presentations by providing a short review of how GBIZ processes have been treated in Performance Assessments based on a preliminary comparison of four case studies. This comparison considered the radionuclides of interest, source term, understanding of transport processes (based on FEPs) and the consistency between conceptual/ mathematical models. Consideration of environmental change was made for each of these cases.

The comparison concluded that the source term from the geosphere to biosphere is often an artefact of modelling the two subsystems in a non-integrated manner. The key mechanisms are better understood and dealt with in site-specific assessments. In general, a specific FEP analysis of the GBIZ is lacking.

Recommendations included that:

- ◆ toxic chemicals should be included in PA;
- ◆ the radionuclide selection process should not be too restrictive or too crude and should be based on identified assessment needs;
- ◆ an uncertainty analysis should be carried out to assess the degree to which limitations in the confidence in the PA relate to uncertainties in the GBIZ.

Further work identified as a result of the review is as follows:

- ◆ A more comprehensive study on how the relevant FEPs have been treated in several PA exercises could be conducted.
- ◆ A generic reference GBIZ could be defined in analogy with reference biospheres based on an in-depth analysis of FEPs.
- ◆ A study into how natural and/or man-made changes can affect the identified GBIZ processes could be undertaken.
- ◆ A site-specific GBIZ could then be developed further with specific data, at a level of detail available as it exists today. Several examples could be done and the results used to justify further generic and site (or site-type) specific characterisation requirements, and/or research requirements.

Subsequent to Juan's presentation, Sten Berglund (SKB) provided an overview of how SKB represent the GBIZ in models, which are built on the basis of site data, and identified issues relating to the soil-rock interface.

The main questions of importance to the representation of the GBIZ are:

- ◆ What are the most important discharge areas of flow paths from depth as these will define the type of areas that require characterisation and modelling?
- ◆ Where do the detailed flow/transport paths in the surface system go and what properties do they have?
- ◆ What do the available site data say about the conditions for radionuclide retention at the site and is there a need for additional data?

Radionuclide transport in surface systems is governed by surface water movements and is strongly linked to the production, transport, accumulation and degradation of organic matter with carbon being a key element.

Various models are employed including hydrogeological, surface hydrology, and GIS models that overlap. Investigations are ongoing and will provide more detailed data for coupling the surface and deep rock in flow and transport models.

The Andra approach to the modelling of the GBIZ was then presented by Achim Albrecht. Over the period of one million years adopted for the safety assessment, the environmental conditions are subject to variations (particularly climate conditions). Current studies allow for predicting the main characteristics, at least in the form of general hypotheses. This leads to the representation of a combined morphological and hydrological situation for the present state and for a possible state after one million

years. These two situations allow definition of the impact assessment outlets, i.e., locations where radioactivity may reach the environment. Since the main radioactivity transport vector is water, these outlets may consist of rivers, aquifers or water wells. In order to identify these outlets, the evolution of the geological medium and the radioactivity transfer paths from the repository must be represented. The development of water circulation models at sector scale for the current and the 1 My situation allows for the identification of the various possible outlets. The safety analysis must then select those that are most penalising with regard to committed doses. The selection of outlet locations within each hydrogeological model is based on the following principles:

- ◆ natural outlets are given less importance. Despite being by far the most probable, they do not produce the highest doses (due to dilution); and,
- ◆ water wells are considered in the porous horizons of the surrounding formations, with a member of the critical group collecting the radionuclide-contaminated water for drinking purposes or agricultural use. Although less probable, these outlets are more penalising, since the contamination is less diluted. They are assumed to be located as close as possible to the conventional repository site in zones with low water flows, and in most cases at depths of approximately 50 to 100 metres. This pessimistic choice significantly increases the calculated impact. This approach is more penalising than the recommendations of basic safety rule RFS III.2.f, which specifies that "the outlets shall consist of rivers and shallow water wells".

Among the outlets considered, a water well drilled in the Saulx valley appears to be the most penalising. It consists of pumping water at the first possible location in the immediate vicinity of the repository, selecting a zone with maximum radionuclide concentration levels. This outlet is therefore placed upstream of all the natural outlets possibly encountered by radionuclides during their migration through the surrounding formations. It is located near the site but outside the transposition zone, in a zone where the hydrogeological model provides for diffuse fracturing (today purely hypothetical) parallel to the Marne faults.

Mark Willans then introduced an idea for a GBIZ proposal. This would comprise a model inter-comparison study of a simple system that can be modelled at differing levels of complexity, e.g. an inland river site with different GBIZ conceptualisations and the usual radionuclides.

The objectives would be to compare results from the different approaches taken by participants such as the application of time-invariant biosphere models for each state or time-variant biosphere models. The project would investigate various ecosystem evolution scenarios (no system change, abrupt system change, evolving system change) and would assess any human activities superimposed on the models. The system could be modelled simplistically using four compartments (site soil, overbank soil, river (plus suspended sediment) and bank and bottom sediments) and would involve two climate scenarios, the first being present-day climate, the later assuming a warmer climate with resultant lower river flow and drier soils and the potential use of a well for irrigation. In the initial climate scenario, radionuclide input into the river would most likely dominate dose pathways. System change and the GBIZ would be inherent in the proposal.

In response, Mike Thorne suggested that a very well-defined concept would be required that could be modelled at different levels of complexity to ensure that the results of a comparison would be useful. Graham Smith suggested the use of real data from a field site in such a project.

Graham Smith then went on to suggest further ideas for the next steps in relation to GBIZ. There is a need not only to understand the science of the GBIZ, but also a need to understand how it should be included in the overall PA. These are linked, but could be considered separately in a further GBIZ task.

Understanding science. A further review GBIZ FEPs should be conducted and conceptual models developed. During the review, consideration should be given to whether models can only be usefully developed on a site-specific basis or are there more generic aspects. By applying the models to a site, we could identify the important issues and key weaknesses. Adrian Bath (IntelliSci) suggested in response that such a study should start by looking at a well-characterised environment before moving to more relevant environments to ensure that conceptual models are as accurate as possible.

Assessment. A more comprehensive study could be conducted to determine how relevant FEPs have been treated in several PA exercises.

Mike Thorne and Tobias Lindborg both noted that proposals would need to be well defined in relation to the GBIZ, since this zone is an artefact of the models used.

4.4 Chlorine-36

Elisabeth Leclerc-Cessac is responsible for Cl-36 in Techdoc 364 and raised the idea of launching an international Forum on this radionuclide to exchange information on models and processes of relevance to Cl-36.

In response, Paul Degnan noted that Imperial College soil experimental data has now all been collated into a single monograph that will be published by Imperial College Press. Much of this work has focused on radionuclides such as Cl-36. Paul offered to provide a copy to each Forum member organisation once published and requested that Elisabeth send out an email to the Forum detailing the objectives for a Cl-36 Forum for people to sign up to. Mike Thorne added to this that the book will cover experimentation and modelling, justification for root uptake parameters and effects of different water stress regimes etc. Graham Smith would like to see the experimental data being used in a safety case demonstration that could then feed back into the Forum to help identify where there are still data gaps.

4.5 Uranium Series Modelling

Mike Thorne introduced an idea for a task on Uranium Series modelling. In assessments for Nirex, U-238 series radionuclides are important for periods over 10,000 years. It is often assumed that shorter-lived radionuclides in this series decay at their point of production. It is also often assumed that these radionuclides are in secular equilibrium with their ancestors in the biosphere, but in reality they have very different chemical characteristics and radionuclide half lives. The assumption of secular equilibrium is not necessarily cautious and the kinetics of the chain may be important.

It was therefore proposed that there should be a specific task to develop conceptual and mathematical models for the transport of U-238 series radionuclides in terrestrial and aquatic ecosystems. The aim would be to permit the degree and radiological significance of disequilibrium between the various members of the decay series to be explored.

Two subgroups are proposed to develop models for terrestrial and aquatic systems although, if resources do not permit, the scope could be restricted to the terrestrial system with a single contractor responsible for the development of a mathematical model (not full software development). The model should represent a multilayer soil model that specifically considers Rn-222 diffusion. Root uptake should be considered as a function of depth and Rn-222 loss from plants needs to be considered explicitly as should be loss of Rn-222 by exhalation in animals. Partitioning between flowing waters and bottom sediments should also be considered on a kinetic basis. If an aquatic model is developed, the uptake by aquatic organisms may be either by sorption to surfaces or by internal accumulation (these routes give very different possibilities for both differential uptake between chain members and subsequent in-growth).

4.6 Data: Next steps in the SDB

Following the project conducted in 2005 to populate the BIOPROTA specialised database (SDB), Graham Smith proposed a way forward to further populate the SDB. To date, a broad spectrum of data has been reviewed for 10 radionuclides for a range of parameter values and related conditions. Mike Thorne has agreed to take the collated information and input into the BIOPROTA databook. From discussions following the presentation by Adrian Punt on the work conducted in 2005, it is evident that there is interest in a 'book' type tool that allows the user to select the value they want to use in their assessment from a wide range on the basis of specific system description information or, if this is lacking, it will help to guide the site characterisation process. There is also interest in a database type tool that allows information to be processed and/or directly linked to software. It was however suggested that this is perhaps not a task for BIOPROTA and therefore a book-type tool would be best for all participants.

The work on the SDB focused on parameters associated with agriculture and so different systems (for instance coastal environments) could be beneficial. If more work on the SDB is done it is important to define whether the radionuclides included to date are still those of interest to participants or whether additional radionuclides are required. Participants were also requested to consider whether they would want data relevant to non-human biota assessments to be collated. It was suggested that any new task should focus on nuclide-pathway parameter combinations that are critical to building confidence in assessment results and to use the EMRAS output and previous compilations for non-critical data.

The way forward suggested was for the current report and datasheets to be distributed to the Forum members and, once the stability of the databook software has been confirmed and data entered, this too will be distributed. It was proposed that a questionnaire could accompany the datasheets/databook that would ask Forum members to identify whether the databook is the correct tool, whether there is a need to extend the databook, which radionuclides (if any) should be added to those already considered, whether more data on same radionuclides is required and, if so, which processes are of importance (i.e. are there problem issues with any radionuclides) and what ecosystems should be considered. If further work on the SDB is required, Forum members would also be asked to consider how they would prefer to support the further work. For example, would funding be provided to support a small team/individual to further populate the SDB or would Forum members provide data themselves. Mike Thorne also raised the question of how much data interpretation would Forum members require within the SDB.

In response to the question of whether the SDB is the correct tool, Aldmudena Aguera (CIEMAT) suggested that the Valora database tool used by CIEMAT could be useful and could be made available to the Forum. Valora is easy to use and has a large capacity. Functionality can be modified and/or added to and documents can be linked to it. Maryla Wasiolek raised the issue of potential copyright infringement through the distribution of documents linked to a database. In response, Mike Thorne suggested that, rather than documents themselves being added, an evaluation of the reference could be added which would avoid the copyright issues.

4.7 Theme 2 Model Review

Graham Smith put forward the suggestion that Theme 2 model reports should be reviewed. These reports document and compare dose models for the contamination of the foodchain by irrigation, accumulation of radionuclides in soil and inhalation exposure pathways. External irradiation hasn't been covered, but this is simple to calculate when accumulation in soil has been considered. As a result of these comparisons, it is suggested that we can be confident in model structures and have gained knowledge of the sensitive assumptions. We also have an idea of the significance of regional differences. However, there are still significant radionuclide and other data uncertainties that could/might be reduced with site-specific analyses. The GBIZ dilution and distribution of radionuclide discharges has not been included in comparisons (although this could be addressed through the GBIZ proposals detailed in section 4.3). Temporal evolution of the system and marine model comparisons have also not been included/assessed. Three tasks were therefore proposed:

1. Review existing Theme 2 outputs and draw conclusions about commonalities.
2. On the basis of this review, consult the assessment community as to what their latest key uncertainties are (this could be combined with the SDB questionnaire).
3. Once problems/uncertainties have been identified, the issues should be classified according to how they could be resolved, for example:
 - i. addition of further existing data to the SDB;
 - ii. clarification of assessment contexts;
 - iii. development of a new conceptual models, leading potentially to new data requirements;
 - iv. further site characterisation work and/or new experiments leading to new data, which could be added to the SDB.

4.8 Site Characterisation

As noted previously, a draft of the BIOPROTA Theme 3 report will be distributed to Forum members shortly for comment and agreement for the report to be published under BIOPROTA.

Graham Smith suggested that there is scope for the document to be extended to include further consideration of specific sites and taking more account of the output of site investigation experience and the conclusions from the other tasks.

Sten Berglund noted that site characterisation programmes of the different participants are all at different stages, so it would need to be clear what input people should provide.

4.9 Historic Discharge Analogues

A task on the review of historic discharge analogues was also raised following discussions outwith the workshop. This task would involve a review of what the analogues are. (Mike Thorne noted that historical information from US DoE sites is available and may be relevant for such a task). The task would look at specific analogues so would be country specific; however, the information derived in the review could be used as analogues for future climate scenarios.

5. FUTURE WORK PROGRAMME

5.1 Continuing work programme

All proposed tasks for 2006 were met with enthusiasm from the majority of participants and, therefore, it was proposed that proposals be developed on the topics raised that will be circulated to all Forum members and other interested participants. Agreements made on the way forward and the lead person identified for each of the proposed tasks is detailed below. In drawing together proposals, it is requested that project plans be included so that anyone interested in participation can sign up to specific aspects as appropriate.

GBIZ. A proposal for a 2006 task on the scientific evaluation of GBIZ FEPs will be developed over the next couple of months by Juan Merino (Enviros Spain). A proposal on GBIZ assessments will be produced by Mark Willans (Nexia Solutions). In addition, although the EC rejected the GBIZ proposal submitted in 2005, submission of a further proposal has been encouraged. The ideas developed for a BIOPROTA task may therefore be combined and resubmitted to the EC under FP7 (Adrian Bath noted that FP7 will contain a geological disposal category that may be very relevant for such a proposal).

U-238 series modelling. Mike Thorne (MTA) will produce a proposal for circulation to participants via the secretariat.

C-14 modelling – As a first step, it was agreed that Mike Thorne (MTA) would conduct a comparison of models of C-14 for a soil-plant system that will be used to identify requirements for additional work. The results of this comparison will be circulated.

BIOPROTA SDB. It was agreed that any decisions on a future SDB task was premature since participants had not yet seen the output of the 2005 project. Paul Degnan (Nirex) offered to manage any future task on the SDB if required.

CI-36 Forum. Elisabeth Leclerc-Cessac (Andra) was nominated as champion.

Site Characterisation. It was agreed that the onus was on all Forum members to highlight how Theme 3 on site characterisation should be extended following the distribution of the draft report.

Criteria for selecting pathways. Frits van Dorp (Nagra) will draft a proposal for distribution.

Historic discharge analogues. Adrian Punt (Enviros) is to produce a proposal with input from Mike Thorne. Brief suggestions on analogue sites for inclusion should be sent to Adrian (Adrian.punt@enviros.com) as soon as practical

Iodine. Ales Laciok noted that a natural analogue site being investigated in Czech Republic in relation to iodine in association with organic matter. Ales therefore proposed to collect information from the site on iodine where there is organic matter input and this would allow comparison with I-bog project. Ales will therefore check site data and perhaps perform some additional measurements. Ales and Elisabeth Leclerc-Cessac will then discuss and, if relevant, distribute. Finally, Paul Degnan noted that there can be issues in moving from laboratory studies to the field and there might therefore be a driver for a project to investigate scaling issues.

5.2 2007 Forum meeting

The next BIOPROTA meeting (BIOPROTA IX) is provisionally to be hosted by Ales Laciok and the NRI in the Czech Republic in May 2007. The exact location (Rez/Prague) and date are to be confirmed.

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