BRIM/SM/2
10 August 2001
English only

SPECIAL MEETING ON

BIOSPHERE RESERVE INTEGRATED MONITORING (BRIM)

GTOS Office, FAO, Rome, 4-6 September 2001

Note by the Secretary of the Man and Biosphere Programme

The present document is intended to provide the participants in the Special Meeting on Biosphere Reserve Integrated Monitoring (BRIM) with a basis for their work and deliberations.

The document contains:

- *background information on BRIM, including the need for the Special Meeting and the meeting's objectives;*
- *a brief description of the biosphere reserve concept and the functions performed by the World Network of Biosphere Reserves, with particular reference to monitoring;*
- *information on current and planned monitoring programmes and initiatives that are relevant to, and could benefit from, BRIM;*
- *preliminary considerations on some of the main issues in relation to socio-economic aspects of monitoring; and*
- *some ideas and options for the future development of BRIM.*

I. INTRODUCTION

A. Genesis and evolution of BRIM

1. The Biosphere Reserve Integrated Monitoring Programme (BRIM) is implemented as part of UNESCO's Man and Biosphere (MAB) programme. BRIM originated in 1991 from an initiative of MAB's regional network for Europe and North America - EuroMAB, which had stressed the importance of standardized biological inventory measures as a management and decision-making tool, identified the need for integrating multiple databases for inter-biosphere reserve cooperation in monitoring global change and changes in intraregional biodiversity, and also recognized the need to survey key scientific research and the monitoring potential of biosphere reserves.

2. While the original objective being pursued by EuroMAB was essentially to identify elements for a programme to promote inter-biosphere reserve communication, soon the goals of BRIM expanded to include provision of possibilities for the interdisciplinary monitoring of biosphere reserve, to provide scientific, administrative and policy-making communities with access to all kinds of information available in biosphere reserves, and to provide means for systematic exchange of scientific information. These goals, naturally, went beyond the regional scope of discussions held by EuroMAB on BRIM, thus making the latter of relevance to the whole MAB programme.

3. The main steps in the genesis and evolution of BRIM, including in MAB regional networks, are summarized in the box in the next page, and it is worth noticing that, throughout its evolution, BRIM's original goals were not questioned but rather reinforced.

4. However, recent decisions of MAB's governing body - the International Co-ordinating Council of the MAB programme (hereinafter referred to as 'ICC') - were that current work on BRIM should be reoriented to reflect the specificity of biosphere reserves on people and their environment; that BRIM should be provided with an integrated monitoring dimension by incorporating social sciences, including social and economic indicators; and that it should build on existing relevant monitoring initiatives such as the Global Terrestrial Observing System (GTOS). These recommendations have formed the basis for the Special Meeting on BRIM, which the GTOS Office located in the headquarters of the Food and Agriculture Organization in Rome graciously offered to host.

MAIN STEPS IN THE GENESIS AND EVOLUTION OF BRIM
(in a reverse chronological order)

2000

- At its 16th session (Paris, November 2000), the ICC considered the recommendations on BRIM by the 'Seville + 5'[1] International Expert Meeting (Pamplona, October 2000). The ICC recommended that the implementation of the BRIM programme be accelerated, including explicit recognition of the need to integrate social sciences in its activities, and endorsed EuroMAB's recommendation for a special meeting on BRIM. The main goal of the special meeting will be to expand BRIM into a truly integrated monitoring programme by incorporating social and economic indicators, including indicators of sustainable development. The ICC decided that BRIM should build on existing relevant monitoring initiatives.
- At the First AfriMAB Technical Workshop for Anglophone and Lusophone Countries (Nairobi, September 2000), BRIM was identified as one of the research priorities for AfriMAB Anglophone countries and National Committees.
- On the occasion of the First Joint EuroMAB Conference for Biosphere Reserve Coordinators and MAB National Committees (Cambridge, April 2000), a call was made to reorient current work on BRIM to reflect the specificity of biosphere reserves on people and their environment. The Conference recommended that a special meeting on BRIM be held, which would serve as a mechanism for the further design and planning of the programme. These recommendations were fed into the 'Seville + 5' International Expert Meeting in Pamplona.

1999

- ArabMAB decided to establish a biodiversity database at the level of each biosphere reserve in the Arab region, based on the use of common standards and protocols. These databases will be linked to form an Arab biodiversity database.
- At the First AfriMAB Technical Workshop for Francophone African Countries (Dakar, September-October 1999), it was recognized that biosphere reserves needed to be equipped with a monitoring and evaluation system. The workshop recommended that this should partly be addressed through efforts aimed at strengthening research ties between relevant networks operating in the region, such as Bionet, Wafrinet, the African Ethnobotany Network, Centre Pilote Régional de la Biodiversité in Benin and the Botanical Garden Project in Burundi.

1993-1998

- At its 15th session (Paris, December 1998), the ICC welcomed the decision by the State Department of the U.S.A. and US-MAB to transfer the management and funds of the US contribution to BRIM to the MAB Secretariat at UNESCO to strengthen its international scope and to provide it with an integrated monitoring dimension.
- The *MABFlora* and *MABFauna* databases were further developed and became a standing activity of BRIM.[2]
- *ACCESS 1996* was completed, which contained detailed information on activities carried out in permanent plots for the monitoring of flora, fauna, geology, soil, hydrology, climate and anthropogenic changes.
- In March 1995, an international conference of experts was organized by UNESCO in Seville, Spain, where the 'Seville Strategy for Biosphere Reserves' was elaborated (the Strategy recommends the action to be taken for the future development of biosphere reserves in the 21st century). The Seville Conference also helped finalize the 'Statutory Framework of the World Network of Biosphere Reserves', which set out the conditions for the functioning of the World Network. Both documents were subsequently adopted under 28 C/Resolution 2.4 of the UNESCO General Conference in November 1995, in which the General Conference agreed that *"biosphere reserves constitute ideal sites for research, long-term monitoring, training (…) while enabling local communities to become fully involved in the conservation and sustainable use of resources."*
- *BioMon* - the Biodiversity Monitoring Database - was developed, which provides a consistent data management protocol using the Smithsonian Institution/MAB methodology as published in MAB Digest 11.

1992

- France-MAB hosted the second BRIM workshop in Paris in July 1992, at which MAB national committees discussed problems encountered while implementing BRIM.
- A database of EuroMAB biosphere reserves was created, which contained 65 categories of scientific data and site infrastructures, with the idea to continuously update the database and make it publicly available through a directory named *ACCESS*, which was published in 1993. Subsequently, US-MAB undertook a re-survey of the sites to fill management and social science gaps; 8 new categories were added to the database.
- As a result of the first BRIM workshop organized by US-MAB in 1991:
    - A directory of permanent plots in biosphere reserves was agreed upon (later published as *ACCESS 1996*);
    - A number of national activities contributing to BRIM were launched, such as: the MAB programmes of the Czech Republic, Slovakia, Sweden and US started a joint initiative on the development of a standardized format to document their flora, fauna and status of biological inventories; Canada-MAB engaged in the development of a model for case studies illustrating social and demographic relationships in biosphere reserves; Russia-MAB volunteered to develop a global change project proposal that involved biosphere reserves utilizing north/south transects, the alpine and high altitude sites as proxy measures for latitudinal gradients; etc.

1991

- A survey of the EuroMAB biosphere reserves was carried out. Results included: identified key scientific research, monitoring potential for identified sites and identified elements for a programme to promote inter-biosphere reserve communication.
- A EuroMAB working group for the integration of multiple databases for inter-biosphere reserve cooperation in monitoring global change and changes in intraregional biodiversity was created.
- At the Third EuroMAB Meeting (Strasbourg, September 1991) discussions took place on standardizing biological inventory measures for monitoring biodiversity within protected areas as tools for management and decision making.

[1] See below for information on the 'Seville Strategy for Biosphere Reserves.'

B. Objectives of the Meeting

5. Based on the ICC recommendations at its 2000 meeting, the Special Meeting on BRIM will provide a mechanism for MAB to establish new, and strengthen existing, forms of cooperation with relevant monitoring programmes and initiatives. In blunt terms, the meeting aims at bringing together monitoring efforts under the MAB programme and BRIM more into a context of other research and monitoring initiatives in support of policy-making.

6. The specific objective of integrating socio-economic issues into BRIM will be discussed, using as a working basis the outcome of a two-day workshop on socio-economic aspects of monitoring that will precede the Special Meeting. As this is a concern of several of the existing global and regional monitoring programmes and initiatives, this is indeed a shared objective among the participants in the Special Meeting.

7. More importantly, the meeting aims at developing synergistic cooperative arrangements among existing monitoring programmes and initiatives in the area of integrated monitoring. It is envisaged that this particular objective be met through the development of joint pilot projects, with a strong regional focus.

II. CURRENT MONITORING IN BIOSPHERE RESERVES

A. Brief description of the biosphere reserve concept in relation to monitoring

8. Biosphere reserves are areas of terrestrial and coastal ecosystems under a particular regime (and set of approaches) known as the 'biosphere reserve model.' They are internationally recognized within the framework of the UNESCO's intergovernmental programme on Man and Biosphere (MAB), and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves are united globally into the World Network of Biosphere Reserves, and as of July 2001 there are 393 sites established in 94 countries.[3]

9. Since its inception, the network has grown on a steady basis, and in principle there is no limit to the number of sites that could join it, which makes it an 'open-ended network.' There are two basic justifications to it: the first is that rather than each biosphere reserve having to perform all the functions for which biosphere reserves are designed[4], it is for the World Network as a whole to be functional; the second is that one of the MAB programme's goals is for the biosphere reserve model to provide a tool for landscape planning and management at the regional level.

10. The World Network fosters exchanges among biosphere reserves - for example, knowledge about, or experience in resolving, specific issues - and facilitates cooperative activities, including scientific research and monitoring, environmental education and specialist training. Although biosphere reserves may and indeed are very often part of very different geographical, economic and cultural contexts, they do have a common interest in seeking concrete solutions to reconcile biodiversity conservation with sustainable use of natural resources, for the benefit of local people, based on common approaches.

11. The institutional basis for BRIM lays in the Vision from Seville for the 21st Century, which includes the following key direction in the implementation of the three basic functions of biosphere reserves: *"Reinforce scientific research, monitoring training and education in biosphere reserves since conservation and rational use of resources in these areas require a sound base in the natural and social sciences as well as the humanities."*

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[2] See section II for more information on The *MABFlora* and *MABFauna* databases.
[3] As of July 2001, more than 20 new nominations from 14 countries were received, which will be considered by the MAB Bureau at its next meeting (19-21 September 2001).
[4] (see below for a full description of the three functions of biosphere reserves)

12. Ideally, fully functioning biosphere reserves perform three main roles:

(i) conservation *in situ* of natural and semi-natural ecosystems and landscapes, as well as the diversity there within;
(ii) the establishment of demonstration areas for ecologically and socio-culturally sustainable (land and) resource use; and
(iii) the provision of logistic support for research, monitoring, education, training and information exchange related to conservation and sustainable development issues.

13. These functions are associated through a zonation system consisting of a core area with minimal human activities - except research and monitoring - aimed at protecting the landscape, ecosystems and species it contains (there may be several patchy core areas in a single biosphere reserve). The surrounding area acts as a buffer for the core and accommodates more human activities such as research, environmental education and training as well as tourism and recreation. An outer transition area, or area of cooperation, extends outwards and serves as a liaison with the larger region in which the biosphere reserve lies, and promotes in particular the development concern with activities such as applied research, traditional use or rehabilitation, human settlements, agriculture, fisheries, etc.

14. Initially, the three zones were presented schematically as a series of concentric rings. However, the zonation is usually implemented in many different ways to accommodate local geographic conditions and constraints. This flexibility allows for creativity and adaptability, and is one of the strengths of the concept. In particular, the logistic function is aimed to promote scientific research and monitoring in biosphere reserves, which in some ways serve as ‘living laboratories’ for testing out and demonstrating integrated management of land, water and biodiversity. Thus, an efficient logistic function of biosphere reserves is central to the successful implementation of BRIM.

B. Some definitions of monitoring and basic requirements for monitoring programmes

15. Monitoring in biosphere reserves is often only a small part of the overall set of monitoring/observation activities taking place in the countries participating in the MAB programme. Indeed, many countries have national monitoring plans and programmes in place, e.g. for water quality, habitat, fire, food security, early warning systems for natural hazards, etc.

16. Monitoring is about the repeated measurement of a series of defined variables. Monitoring allows for assessing changes, where a baseline is available, or to establish the latter. Monitoring is not an end in itself but should be undertaken to accomplish specific goals. It can provide scientists with biological and environmental data. It can also identify trends and discriminate between natural, anthropogenic, and climatic changes. The results can be used at local, regional and global scales and assist managers in implementing sustainable use and conservation.

17. Ultimately, monitoring should provide a basis for informed policy-making. The latter relies, for its development, on a multidisciplinary body of knowledge and data sets that can be gathered through research and monitoring, while its application to society trusts in the use of intersectoral mechanisms. In this context, undertaking research, carrying observations and producing sound knowledge and data sets are basic tasks of any integrated research and monitoring programme.

18. Definitions of monitoring may vary substantially. One explanation of the United Nations Economic Commission for Europe (UN/ECE) Working Group of Designated Experts on Flora and Fauna states that monitoring is:

"The long-term, continuous or periodic assessment of biological and other environmental variables, using a particular methodology. […] It is aimed at detecting changes in terms of deviations from a standard or norm. Thus, it is essential to establish a baseline or standard against which changes can be measured. Monitoring is a long-term activity: year-to-year changes may not be significant but longer series of data may reveal trends." [5]

19. With particular reference to monitoring of biodiversity, the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to the Convention on Biological Diversity (CBD), at its fourth meeting in June 1999, invited the Executive Secretary of the Convention to prepare a detailed proposal on scientific assessments for the Convention. As part of the preparation for this proposal, a brainstorming session (Oslo, November 1999) was convened, which identified the following requirements for any assessment process to be commissioned under the CBD:

    - engage a full spectrum of societal interest;
    - be based on scientific principles;
    - be based on existing knowledge and authoritatively unearth knowledge gaps;
    - be focused;
    - be conducted within a set of agreed procedures, rules and framework;
    - avoid duplication.

20. These requirements are also valid for monitoring of biodiversity to be carried out under BRIM, in that, scientific assessments under both the CBD and BRIM ultimately aim at addressing the same fundamental questions, i.e., as the preamble to the Seville Strategy states: *"How can we reconcile the conservation of biodiversity, the quest for economic and social development and the maintenance of associated cultural values?"*

21. The above-mentioned considerations and definitions concentrate on biological and other environmental variables, and are complemented by a very broad definition of socio-economic monitoring, according to which *"the production and provision of socially relevant information including their presentation"* (Habich/Noll 1994) are the key characteristics. The term "social" in social monitoring refers to economic, political, cultural and socio-psychological aspects of human actors and systems. Distinct from biological or other environmental monitoring, social monitoring explicitly includes a reflexive and a value-oriented component. In contrast to simple observation, monitoring refers to a long-term, more or less systematic form of observation of social states and processes, includes quantitative and qualitative information (not or not only data), and is embedded in a framework of analysis, evaluation, communication, and action. (Other aspects of socio-economic monitoring are dealt with in section IV of the document.)

22. Finally, it is important to distinguish between monitoring activities for specific purposes and 'integrated' monitoring. In the past few years efforts have been made to integrate, for example, biological and chemical monitoring, based on the fact that the findings of chemical monitoring only do not allow to assess ecosystem health, e.g. the presence of pollutants does not give any information of their possibly being taken by organisms.[6] The same applies to the need to integrate environmental and socio-economic monitoring, if one wants to identify human factors of change.

23. Integrated monitoring is the measurement of related variables in different biotic and abiotic compartments and coordinated in space and time to provide a comprehensive picture of the system under study. As argued by Munn (1988), *"[w]hen based on an interconnected picture*

[5] UN/ECE (http://www.unece.org). Cited in: CAFF - Arctic Biodiversity Monitoring (see http://www.grida.no/caff/biomon.htm).
[6] *Nature*, **411,** 28 June 2001 (989-990).

of the environment and the biosphere (through the notion of biogeochemical cycling of trace substances, for example), the monitoring system is much more likely to be responsive to detecting surprises than if it consisted of several disconnected components (an air monitoring network, a water quality network, etc.)." [7]

24. Because of the very nature of the biosphere reserve concept, BRIM should involve repeated measurements in both the natural and social science fields - which is what *"long-term ecological and socio-economic monitoring and research programme in biosphere reserves"* stands for, and in doing so should reflect the specificity of biosphere reserves on people and their environment. Ultimately, BRIM should provide the basis for the integration of knowledge arisen from specific types of monitoring in biosphere reserves and beyond.

C. Examples of different types of monitoring in biosphere reserves

25. Biosphere reserves in their role as living laboratories throughout the World Network explore a vast array of different activities in the areas of abiotic, biodiversity, socio-economic and integrated monitoring. It is the demand, capacity or interest of each individual biosphere reserve that determines what the priority monitoring themes should be. In one single biosphere reserve, many different research and monitoring activities may be carried out at the same time. Biosphere reserves also participate in major international scientific research and monitoring programmes. This section provides examples of different types of monitoring activities in biosphere reserves, while individual 'case studies' are provided in detail in Annex 1.

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[7] The UK Environmental Change Network Internet site at http://www.ecn.ac.uk/.

EXAMPLES OF DIFFERENT RESEARCH AND MONITORING ACTIVITIES IN FIVE BIOSPHERE RESERVES

Pilon-Lajas Biosphere Reserve, Bolivia

- Census of indigenous and '*campesinas*' communities
- Impact studies (systems of land-use, exploitation of forest tree species)
- Inventories of fauna
- Study on tourist activities
- GIS
- Zonation / mapping of areas of special interest

Mananara Nord Biosphere Reserve, Madagascar

- Marine and terrestrial biodiversity
- Biological inventories
- Vegetation studies including ecological succession and regeneration
- Rehabilitation of degraded areas
- Multiple resource use and land use planning
- Impact of local communities on national terrestrial and marine parks
- Socio-economic studies

Fenglin Biosphere Reserve, China

- Korean pine (*Pinus koraiensis*)
- Study on forest litter, bog forest succession
- Study on the impact of different water uses on forest productivity
- Plant diseases and insect pests
- Effects of economic crisis and population change
- Standards and indicators of sustainable development

Askaniya Nova Biosphere Reserve, Ukraine

- Climate
- Accumulation and migration of pollutants in the soil
- Phenology of the species of the steppe
- Dynamics of species composition
- Ecology
- Seed yield of dominant plant species
- Reintroduction/rehabilitation of species
- Anthropogenic influence of the natural territorial complexes
- Economic activities in the buffer and typical land-tenure zones

Dinder Biosphere Reserve, Sudan

- Habitat assessment
- Monitoring of flora and fauna
- Food habit studies
- Watershed management
- Resources utilization
- Production of maps by remote sensing techniques: drainage system and landscape ecology vegetation
- Socio-economic surveys

26. **Abiotic** or physical/chemical monitoring in biosphere reserves includes climatic parameters, pollution measurements, chemical analyses, soil quality, hydrology, etc. This type of monitoring can help screen for pollution, identify specific contaminants of concern, identify water quality trends, and reveal symptoms in climatic change. By integrating long-term abiotic data with information on species trends and land-use change collected in a given area, a more complete profile of ecosystems can be drawn, and indications of change and/or condition documented.

27. Abiotic monitoring is a common activity in biosphere reserves. About 90 sites claim undertaking studies related to climatic factors (climate change, climate monitoring, climatic parameters). Some 70 sites are carrying out research and monitoring on hydrological factors (hydrology, hydrological data, hydrogeology, hydrometeorological parameters), and about 50 on soil related issues (soil quality, soil monitoring, soil/vegetation inter-relationships, etc.).[8]

28. One example comes from the Virgin Islands Biosphere Reserve, U.S.A. where water quality monitoring protocols have been in use on a monthly basis since 1988 (temperature, salinity, dissolved oxygen, nutrients) in order to obtain baseline data on water quality. The data sets are intended to help researchers and park managers identify and better understand the changes affecting marine ecosystems.

29. Another example comes from Canada, where a project was designed to provide information on climate change, with the participation of four biosphere reserves (Niagara Escarpment, Waterton Lakes, Riding Mountain, Long Point). Annual and seasonal series were generated for temperatures as well as precipitation, rainfall and snowfall and the results were used to help local planning and management with a specific focus on adaptation strategies.

30. **Monitoring of biodiversity** is an important process for the conservation and sustainable use of landscapes, ecosystems, species and genetic variety. This type of monitoring is probably the one most frequently undertaken in biosphere reserves. More than 90 biosphere reserves carry out research and monitoring activities on different plant and animal species, of which at least 25 focus on rare/endangered species. About 80 biosphere reserves are involved in population studies (population dynamics and behavior, population ecology, population monitoring of specific species, etc.).

31. In the Lake Torne Area Biosphere Reserve, Sweden, the main objectives of the ecological projects carried out there are to study the dynamics of plant populations and to identify the controlling factors at their latitudinal and altitudinal limits.[9] The Abisko Scientific Research station is located within the biosphere reserve, and the area has been investigated since the beginning of the 20th century. In Lake Torne Area, MAB will work for a 'sustainable research', first of all trying to establish a database and GIS (Geographic Information System) application showing what, where and by whom research is done. Environmentally friendly research in the sensitive northern latitudes will be encouraged.

32. In the Torres del Paine Biosphere Reserve, Chile, monitoring using radio-tagging techniques has been carried out to study the dynamics of guanacos (*Lama guanicoe*) populations. Despite their threatened status, guanacos continue to be an important local and regional economic resource, and this is a species for which a scientifically based managed harvest could contribute to its conservation. The Chilean National Forestry and Park Service (CONAF) is currently striving to implement a guanaco management programme of sustained-yield use that is based upon sound and updated studies of population dynamics.

33. At the level of the whole World Network, an important component of BRIM are efforts focused on species inventorying, mainly in the context of the *MABFlora* and *MABFauna* databases. These efforts are based on the recognition that individual species may provide useful information on the overall ecosystems of which they are part.[10]

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[8] These statistics and the ones below are taken from the UNESCO-MAB Biosphere Reserves Directory (http://www.unesco.org/mab/bios1-2.htm). The figures are most certainly higher since not all biosphere reserves have provided the Secretariat with detailed descriptions of current research and monitoring activities.

[9] Source: http://www.ans.kiruna.se/ans.htm.

[10] Some provisions of the Convention on Biological Diversity (CBD) with regard to status and trends of the biodiversity of inland water ecosystems and options for conservation and sustainable use provide an example of this. Decision IV/4 of the Conference of the Parties to CBD affirms that suitable organisms should be identified as being particularly important in the assessment of inland water ecosystems and that, ideally, such groups should meet the following criteria: the group should contain a reasonable number of species with varied ecological requirements; the taxonomy of the group should be reasonably well understood; the species should be easy to identify; the group should be easy to sample or observe so that

THE *MABFLORA*/*MABFAUNA* DATABASES
(http://www.ice.ucdavis.edu/mabsite)

The Information Center for the Environment (ICE), in cooperation with US-MAB and UNESCO's MAB programme has produced standardized databases containing species inventories of plants and animals reported from biosphere reserves. The development of these databases has and still relies on numerous collaborators (see below).

This effort was conceived as part of BRIM in 1991, at the EuroMAB Congress in Strasbourg, France. Subsequent to the EuroMAB Congress in Strasbourg, regular updates and corrections to the databases have continued with support from several programmes within the US MAB Program, the Biological Resources Division of the USGS (formerly the National Biological Service), including the Inventory and Monitoring Program, the Gap Analysis Program, and the California Science Center. More recently, beginning in 1999, support for the further development and maintenance of the BRIM databases has been provided by UNESCO's Division of Ecological Sciences.

As the *MABFlora*/*MABFauna* databases available via the Internet have grown, both in terms of the numbers of records they contain and in the frequency with which these databases are accessed, personnel from a large number of protected areas that are not part of the World Network of Biosphere Reserves have asked to contribute data to the effort. Such offers have been gratefully received.

In order to better discriminate between the BRIM programme, whose data are derived exclusively from sites which have been recognized by UNESCO as biosphere reserves, and the larger *MABFlora*/*MABFauna* databases, whose data are derived from a wide variety of protected areas and sources, ranging from databases developed by museum specimens and professional scientists doing research in the protected areas, through guidebooks, checklists developed for visitors, existing web sources, publications, and personal knowledge of individual experts, separate links from the *MABFlora*/*MABFauna* web site have been provided: one for BRIM, for data derived from sites which have been recognized as biosphere reserves only, and the other for the *MABFlora*/*MABFauna* databases, which provide access to all data contained in the databases.

Recently, the web site has extensively been updated to provide more information about the BRIM programme and the related *MABFlora*/*MABFauna* databases. Also, the query capabilities have been enhanced to improve the performance of the query engine and to reduce the time to display the results of queries. This should provide much faster query results, especially for those site users with slow Internet access.

Results of queries may now be displayed to the screen like before, or saved as a comma separated value (CSV) file for use in a variety of software environments (e.g. spreadsheets, database management software) which utilize CSV files. CSV files are also commonly used in applications on UNIX platforms.

The databases are updated monthly, and new data are added during the monthly updates.

These databases are made possible through efforts to standardize both the structure of the databases and the names by which the species in the databases are known. Such species naming standards ("nomenclatures") are provided by collaborators, individuals and institutions, who are experts in their respective taxonomic groups.

MABFlora does not exist in one but in eight versions, with each version pertaining to the plants of a specific geographic region. This has been possible also thanks to the developers of the "master species lists" (published nomenclatures or catalogs of species names), whose support have made this effort possible.

The eight versions of *MABFlora* are those for Australia (Australian Plant Name Index (APNI)), China (Flora of China (FOC)), East Africa (List of East African Plants (the LEAP database)), Ecuador (Catalogue of the Vascular Plants of Ecuador), Europe (Flora Europaea database), North America (U.S.D.A. PLANTS checklist), Peru (Catalogue of the Flowering Plants and Gymnosperms of Peru), and Russia and adjacent States (Vascular Plants of Russia and Adjacent States).

MABFauna is published in a single version providing worldwide coverage of all five vertebrate groups. The following "master species lists" have been used: Catalog of Fishes database (fishes); Amphibian Species of the World database (amphibians); EMBL Reptile Database (reptiles); Sibley's Birds of the World, with species-level updates from the American Ornithologists' Union Checklist of North American Birds, as well as updates posted to the Zoonomen web site (birds); and Mammal Species of the World database (mammals).

34. **Socio-economic monitoring** is a more recent monitoring theme and has not been carried out extensively throughout the World Network of Biosphere Reserves, partly due to the difficulty to conduct research and monitoring related to human factors. Still, some forty biosphere reserves state that they are carrying out socio-economic studies/research, although for most of them no details are given; therefore, overall, the information is scattered and often not well described, which makes it difficult to get a good picture of current socio-

density - absolute or as indices - can be assessed, used objectively and treated statistically; the group should serve as indicators of overall ecosystem health or indicators of development of a key threat to ecosystem health.

economic activities in the World Network. Studies most commonly carried out refer to tourism (socio-economic studies on tourism, sustainable (eco) tourism, impact of tourism, etc.) and cultural (cultural anthropology, cultural site recording, cultural and traditional activities) aspects.

35. Information from the six Cuban biosphere reserves reveal the following socio-economic research and monitoring themes: impact of tourism, cost-benefit analysis in eco-tourism, influence of environmental education programmes in the conservation and management of biodiversity (Península de Guanahacabibes); home gardens for *in situ* conservation of genetic plant resources (Sierra del Rosario and Cuchillas del Toa); socio-economic studies of local communities; investigation of tourism in areas with high conservation value (Ciénaga de Zapata); composition of local human communities (Buenavista); socio-political studies (Baconao).

36. Some biosphere reserves monitor indicators of sustainability relevant to economic activities. For example, in the Monts Nimba Biosphere Reserve, Guinea, the indicators monitored are: area of surfaces under agricultural experimentation; rice cultivation; number of cultivations of dwarf palm trees (*hevea*); number of establishments with animals (cattle, fish, etc.); and access to agricultural credits.

37. The **integration** of different long-term monitoring data sets such as environmental (physical, chemical), land-use, biodiversity, water and other types from natural and/or human influenced ecosystems can provide an overview of the interactions between the abiotic, biodiversity and socio-economic components (and processes) within, and a better comprehension of, the system being studied. In the World Network, some 90 biosphere reserves state that they are active in management issues (forest management, exotic species management, genetic resource management, land-use and management, etc.), while about 50 carry out different kinds of impact studies (impacts of human activities on ecosystems, tourism impacts assessment, impact of grazing by domestic livestock, etc.).

38. One example of integrated monitoring in biosphere reserves comes from Kogelberg Biosphere Reserve, South Africa, where the monitoring and control of alien woody invasive species is an important management practice to maintain water supply from catchment areas. In the Beni Biosphere Reserve, Bolivia, the preferences of hunting for different ethnic groups have been investigated and hunted fauna monitored. The level of sustainable hunting was obtained for 10 species in the biosphere reserve, and the results indicate that some of the hunted species are over-used, with some reaching the limit of sustainability.

39. In the Montes Azules Biosphere Reserve, Mexico, a GIS has been introduced for integrating biological data with socio-economic and physical environment data for resource management and land-use decision-making in the reserve. A study in Canada has provided information on landscape changes in Canada's biosphere reserves using air photos and satellite images from as long ago as 1761 (Environment Canada published the information in 2000).

40. At the regional level, several biosphere reserves in the South-East Asian region (SeaBRNet) have ongoing research and monitoring activities, which is often self-funded. Some have developed monitoring methodologies, including in cooperation with international partners. A major technological limitation is due to the fact that SeaBRNet has virtually no access to Internet. Up to the present, SeaBRNet has not officially embarked on BRIM.

41. By the year 2000, 45 protected or other similarly managed areas in the East Asian Biosphere Reserve Network (EABRN) had been designated as biosphere reserves. Some activities have been undertaken within the scope of BRIM. *MABFlora*/*MABFauna* have been introduced to EABRN and data sets have been compiled in a number of biosphere reserves. Research on ecotourism indicators started in 2000. The countries continue their long-term scientific research and monitoring on biodiversity (for example, all biosphere reserves in Japan and most biosphere reserves in the far east of the Russian Federation, the Republic of

Korea, and some biosphere reserves in China). China has also embarked on long-term monitoring of climate change, impacts from hydroelectric power, water quality, flora and fauna. This offers a good basis for developing a new phase of MAB-BRIM. The real challenge will be to set up a scientifically sound, interdisciplinary, manageable, and cost effective monitoring programme that can generate information on the change of these managed ecosystems and support the governments to improve the related management in biosphere reserves.

42. There are over 200 biosphere reserves in more than 40 countries in the EuroMAB region, which includes Europe, Canada and U.S.A. The BRIM initiative would provide a much needed activity in common for the EuroMAB countries that at the last EuroMAB meeting (April 2001) recommended to expand BRIM by including socio-economic aspects to monitoring. It might be difficult to find a common thread for co-operative activities within BRIM, and so far most EuroMAB work is taking place through groups of countries on specific themes. Some countries have already set up systems of environmental monitoring. The challenge would be to provide an affordable system, which can give benefits at the site level and also serve the longer term interests of detecting and understanding global changes.

43. The ArabMAB network includes 13 Arab countries and one member from international organizations. There are 14 biosphere reserves established in 6 of these countries. One of the objectives of the ArabMAB network is to undertake collaborative research projects and other activities. Of relevance to BRIM is the biodiversity database that has been developed for Arab countries having established biosphere reserves. The database includes an embedded search engine that finds information by country name, biosphere name, and flora and fauna names. It is possible for responsible administrators for individual biosphere reserves to update the contents in the database online.

44. More information on current and planned monitoring activities in MAB regional networks will be available in the context of specific presentations to be given at the Special Meeting.

III. OVERVIEW OF CURRENT AND PLANNED MONITORING PROGRAMMES AND INITIATIVES OF RELEVANCE TO BRIM

45. Habitats, ecosystems, landscapes and seascapes and in certain aspects the biosphere as a whole, have changed significantly since the Industrial Revolution. There are several factors of change, they may be different depending on the issues being studies (climate, biodiversity, etc.), and some of them are not yet well understood.

46. There are several global/regional monitoring programmes and initiatives that address prevailing/driving forces of change, such as climate change, terrestrial and oceanic carbon, nitrogen and other biogeochemical cycle imbalances, land-based sources of pollution (including litter), habitat loss/fragmentation/degradation, over-harvesting of natural resources, species introductions, tourism.

47. Document BRIM/SN/INF.2 provides a brief description of the goals and activities of the monitoring programmes and initiatives that will be represented at the Special Meeting and their links with BRIM. The annex draws, whenever possible, on contributions submitted by individual participants; for those institutions for which no information was submitted to the MAB Secretariat, the latter has used the information available in those programmes' official web sites or in published documents.

48. As far as actual and potential links between BRIM and those monitoring programmes and initiatives, as well as some possible options for a better harmonization of efforts and stronger synergy, a preliminary analysis of the information gathered has shown that the potential of synergistic arrangements with BRIM is great, which will be dealt with in-depth at the meeting.

IV. MAIN ISSUES IN RELATION TO SOCIO-ECONOMIC ASPECTS OF MONITORING[11]

49. World-wide, there are many social monitoring systems on different levels of aggregation. The most widely known system is the national economic accounting system, focused upon the concepts of production and monetary valuation (e.g. as Gross Domestic Product, GDP). In the last decades there has been widespread criticism with regard to this conceptualization, as many social and cultural aspects of societies as well as their environmental performance are either not included in this system or cannot sufficiently be correlated to the performance of its main indicators. This observation has led to the development of a great array of either alternative or complementary systems of indicators, expressing different notions of social monitoring.

50. One example is the so-called ‘social indicator movement’ within the social sciences, launched in the 1960s and 1970s, which has led to an established field of (often institutionalized) social reporting systems that include ‘objective’ indicators (such as education, income, life cycle stage, gender relations, voting behavior) as well as ‘subjective’ indicators (such as well-being, values, attitudes, political orientations). An example is the “German Socio-Economic Panel” (GSOEP), a continuously carried out representative panel study at the household level, pursued in Germany since 1994 (www.diw-berlin.de/english/sop/index.html) and, more recently, at the European level. Other examples are the “Eurobarometer”, carried out since 1972 twice a year in all member countries of the European Union (europa.eu.int/comm/dg10 /epo/eb.html), or the “International Social Survey Programme” (ISSP) that involves leading academic institutions in 32 countries in an annual survey of economic and social policy issues since 1985 (www.issp.org). Another example for global social monitoring is provided by the United Nations Development Programme (UNDP) and its Human Development Report, containing an annual ranking of countries due to a so-called Human Development Index (HDI) that combines data relating to health, education, gender, or poverty (www.undp.org/hdr2001).

51. Although environmental aspects (mostly on an attitude level) have occasionally been included in those social monitoring activities, the full-fledged integration of social and environmental monitoring is still a desideratum, requiring not only data integration, but also the integration of different forms of data qualities, aggregation levels and - most of all - systemic interlinkages. It was under the head of the concept of Sustainable Development that this endeavor had started to become a main concern within the social monitoring community.

52. One of the most important initiatives in this field has been launched by the UN Commission on Sustainable Development (CSD). Based upon a broad national participation process and related to existing data sets a system of about 130 indicators has been developed, covering the four main domains of sustainability (environmental, economic, social, institutional). Another interesting approach is The Assessing Progress Toward Sustainability project which has been provided by The World Conservation Union (IUCN), supported by the International Development Research Centre (iucn.org/themes/eval/english). The approach considers sustainable development as a combination of human and ecosystem well-being. The former is measured by indicators on health & population, wealth, knowledge & culture, community and equity, the latter by indicators on land, water, air, species & populations, and resource use. Several other integrated monitoring initiatives can only be mentioned here that are of potential relevance for BRIM (such as the Ecological Footprint, the Index of Sustainable Economic Welfare (ISEW)).

[11] This section draws upon the information contained in the main working document for a two-day workshop on socio-economic aspects of monitoring that will precede the Special Meeting on BRIM. See also: Habich, R., Noll, H.-H. 1994. *Social Indicators and Social Reporting. International Experience and State of the Art*. Bern. (in German) and Kruse-Graumann, L., Hartmuth, G., Erdmann, K.H. (Eds.) 1998. *Goals, Possibilities and Problems of Social Monitoring*. MAB-Mitteilungen, No. **42**. German MAB National Committee, Bonn. (partially in German).

53. Nevertheless the above-mentioned integrated monitoring initiatives suffer from several shortcomings that have to be taken into account or improved if they are to be used in the context of BRIM:

- A generally accepted integrated monitoring system has not evolved up to now. Each of the above-mentioned approaches is debated among experts, some of them are severely criticized (e.g. by mainstream economists).
- The indicator systems under the heading of sustainable development are open to the different definitions of that term - and thus more or less consensual. But also other indicator systems require target or goal definitions that are open to debate.
- There is a clear bias between indicator construction and quantifiable data sets. Nevertheless, social monitoring in a wider sense as well as integrated monitoring (especially under the headline of sustainable development) both need the integration of qualitative information that often is more meaningful for the concrete development of a region than numbers would be. Some concepts - e.g. the Syndrome approach followed by the Potsdam Institute of Climate Impact Research (PIK) - try to integrate both sorts of information (www.pik-potsdam.de/cp/quest).
- Most monitoring systems are lacking reliable time series of data needed - thus not performing their own criterion for monitoring. Especially the lack of a global social monitoring network is more and more felt as an important issue to be tackled by social sciences, e.g. within the International Human Dimensions Programme (IHDP), where the initiative for a so-called "Geoscope" has been launched.
- There is a clear gap between data and indicators on the one hand and analysis and systems on the other. Much more research energy should be invested in linking the indicator and the systems analysis communities, e.g. in the context of integrated assessment or modeling.
- Finally, there is a clear deficit in the indicator and monitoring research field on the one hand and management and decision making on the other. Too little attention is paid to questions like "Which indicators might be influenced by politicians?" or "What monitoring systems would provide stakeholders (business, NGOs, others) with information relevant for their daily decision making?"
- With regard to BRIM it has to be realized that biospheric aspects (biodiversity, habitats, biome types, etc.) are particularly weakly represented in integrated monitoring systems - partly due to lack of pragmatic definitions and operationalizations, partly due to lack of data.

54. It would be a formidable task for an initiative like BRIM to help overcome at least some of these deficits. One important prerequisite for this would be to define at what scale in time and space social and integrated monitoring activities are necessary for biosphere reserve monitoring, and to what extend existing monitoring systems could be used to complement existing on-site monitoring activities.

V. FUTURE DEVELOPMENT OF BRIM

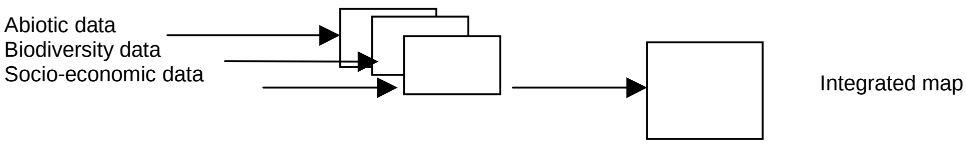
55. BRIM could provide a platform for the integration of information and data emerging from abiotic, biodiversity and socio-economic monitoring. It could contribute to a better understanding of the changes that take place in the areas being studied and not just how the changes in biosphere reserves affect the sites, but also how these same changes may reflect larger environmental changes taking place at the regional and global levels. It could also help identify the factors

triggering these changes. On this basis, BRIM would provide a tool for natural resource and biodiversity management and landscape planning - a tool in the hands of society at large.

GIS AS AN EXAMPLE OF ONE TECHNOLOGY AT THE SERVICE OF INTEGRATED MONITORING, NATURAL RESOURCE MANAGEMENT AND POLICY-MAKING

GIS (Geographic Information System) is a computer system capable of assembling, storing, manipulating, analyzing and displaying geographically referenced information, i.e. data identified according to their locations annotated by x, y and z co-ordinates of longitude, latitude and elevation. Any data which can be located spatially x, y (estimated at about 85%) can be fed into a GIS system.

A GIS creates maps from data pulled from databases. Starting with a base map at a chosen scale, different "layers" of spatially defined data (e.g. abiotic, biodiversity data, socio-economic variables) can be overlapped and displayed graphically. Spatial relationships can be emphasized and information is linked or integrated, combining mapped variables to build and analyze new variables. Data presented in the form of a map as opposed to data tables catalyses pattern recognition and helps to form connections and to draw conclusions about interacting variables.



GIS graphic display techniques essentially produce maps. With a function known as visualization a GIS can produce images, drawings, animation and other cartographic products. Changes such as differences in land use can be analyzed over time. It is also possible to create 3-D images.

Data capture is the time consuming component of GIS work. The main limiting factor for GIS is the availability of sound data and the compatibility of data format. Since 2 data sources may not be entirely compatible a GIS must be able to convert data from one structure to another. The main data structures are raster and vector. Raster data files consist of rows of uniform cells coded according to data values and are suitable for such variables as land cover classification. Raster files require a lot of computer memory. Vector files are represented as a series of point co-ordinates or shapes bounded by lines and are suitable for such variables as property boundaries. Vector files use a lot less computer memory than raster files.

Typically, a GIS comprises a client-server architecture. Ideally the server is dedicated to geographical data and computers are installed with GIS software. Typical software is the ESRI (Environmental Systems Research Institute) range of *ArcInfo* with applications for Internet publishing (*ArcIMS*).

An example of the use of a GIS system in integrated monitoring and natural resource management can be seen in the Biosphere Reserve of the Voges du Nord in France. Using aerial and satellite information, land use changes from 1962 to 1995 revealed a marked increase in the covering-over of valley floors due to forest encroachment. The number of cattle, and thus pastures, in the area had declined due to the decline in the number of farmers. A project involving the introduction of the rustic Highland cattle breed for extensive rearing used GIS to determine which valleys were suitable for this type of land use and thus ecosystem diversity was maintained. This example shows the value of the use of GIS in integrated monitoring and natural resource management.

56. For the purpose of future development of BRIM, it is important that needs for, and problems to overcome in relation to, integrated monitoring in individual biosphere reserves as well as in the World Network as a whole are clearly identified and solutions found. For example, true scientific exchanges amongst sites usually require efforts towards the standardization of methodologies being used at the individual site level, for the sake of comparability of the results.

57. In addition to an effective network of sites and standardized methodologies, normally, any integrated monitoring endeavor should rely on:

- appropriate human and infrastructure capacity for data collection;
- internationally agreed use of instruments, instrument development (as needed and feasible), and intercalibration/interlaboratory exercises;
- quality assurance and quality control (QA/QC);
- data processing, interpretation, archiving and distribution.[12]

[12] It could also be worthwhile exploring (and perhaps highly recommended, if one considers the sometimes limited infrastructure capabilities of certain biosphere reserves) the possibility that in depth activities such as thorough inventorying be accompanied by simple, inexpensive, rapid and easy to use assessments.

If BRIM does not meet the above-mentioned requirements, notwithstanding the often high quality of the results of research and monitoring activities carried out by individual biosphere reserves, the danger is that it could only represent a ‘paper’ network.

58. There also is a need to address the question whether or not the next phase of BRIM should focus on the identification and selection of indicators. If so, guidance can be drawn from relevant sources, e.g. in the field of biodiversity indicators, the Convention on Biological Diversity has developed the following criteria to be matched by a feasible and universal core set of biodiversity indicators:

- quantify information so that its significance is apparent;
- be user driven;
- be scientifically credible;
- be responsive to changes in time and/or space;
- be simple and easily understandable by the target audience;
- be based on information that can be collected within realistic capacity and time limits
- be linkable to socio-economic developments and indicators of sustainable use and response.

59. However, these are general criteria, while actual indicators to be used in the context of monitoring activities are actually so difficult to identify! However, it seems that a set of ecological indicators for BRIM could be drawn from existing monitoring programmes.

60. When it comes to societal indicators, the Seville Strategy provides a list of them, and the most appropriate should be identified and selected for the purpose of BRIM and fully integrated in its next implementation phase. These, however, are mainly implementation indicators (thus of a policy nature), and the general experience indicates that governments are not particularly interested in being evaluated in terms of the extent to which they implement provisions under a given international agreement. The question of choosing appropriate indicators of socio-economic changes, reflecting people’s influence on natural resources and biophysical processes, thus remains. (On the overall issue of socio-economic aspects of monitoring and how the socio-economic dimension of BRIM could be taken further, reference is made to the outcome and draft recommendations emerging from the two-days workshop on socio-economic aspects of monitoring that will precede the Special Meeting.)

61. Another issue of relevance to the next phase of BRIM is that of information and data requirements that are likely to emerge. These are likely to entail:

- setting up informal regional networks (e.g. South East Asia) for the collection of information and data;[13]
- identifying existing gaps in research and monitoring within the participating biosphere reserves;
- organizing the information and data e.g. in the form of databases;
- linking the activities under BRIM with relevant monitoring and assessment processes;
- producing reports in order to make the information and data available for major international processes.

62. In the above-mentioned context, *MABNet* represents an important tool in the implementation of this type of activities. Ideally, *MABNet* should be able to inform on, *inter alia*:

[13] This would imply: identifying focal points within biosphere reserves responsible for research and monitoring activities; gathering of information and data from the focal points; compiling of these information and data; facilitating communication among the focal points, including (as appropriate and depending on availability of funds) through the organization of meetings; and promoting the standardization of research and monitoring methodologies.

- which sites have adequate data format, which ‘substandard’ data format, and which no data sheets;
- which sites possess maps and in which form, and make those maps available;
- online software could be developed in order to ensure data entry by individual biosphere reserves.

63. *MABNet* would thus provide an Internet based information and data gateway, as well as a metadata[14] facility. A search engine (under development) would facilitate to seek out the information and data. The first step of this new web tool will be to enable visitors to search a database containing the information on research and monitoring activities already available on the *MABnet*. Future steps will be to collect more information on the following issues and publish this on the BRIM pages, including information on:

   - socio-economic research and monitoring activities taking place in biosphere reserves in order to develop this aspect further;
   - monitoring methodologies;
   - lessons learned within the World Network with regards to monitoring aspects, management experiences, etc.;
   - training and capacity building issues;
   - publications relevant to BRIM, with the intent to make this information searchable in the future as well.

64. BRIM pages on *MABnet* will also be a gateway for reaching other relevant monitoring initiatives that are either cooperating directly with BRIM, or that could be a useful source to link up to.

65. The concept of BRIM as a global platform for monitoring implies the integration of a GIS directly into the *MABNet* and BRIM database. The ‘data layers’ will geographically locate which biosphere reserves are carrying out which type of monitoring (abiotic, biodiversity, socio-economic and integrated monitoring) and combining it with variables such as biogeographical regions, land cover, indicators of sustainable development and other global socio-economic data. Gaps in the monitoring network could then be identified.

66. The first stage in the implementation of GIS in BRIM would involve the setting up in the MAB programme of a GIS system linked to the BRIM database. This would imply the purchase of the relevant software, and there would also be training needs. This system would not be particularly expensive. Using this technical solution, data from monitoring programmes outside the biosphere reserves could then be progressively integrated into the BRIM global GIS system giving a more complete picture on environmental monitoring. This would encourage other monitoring programmes to use BRIM as a global platform.

67. At the level of the biosphere reserves, the use of GIS as an integrated monitoring tool should be encouraged. This approach would entail the study of existing and potential GIS systems at the scale of biosphere reserves - identifying models, promotion of GIS as a tool for integrated monitoring, information exchange and capacity building.

68. To begin with, the BRIM GIS system could be linked by simple hyperlinks to the biosphere reserves that are presently using GIS and in time a completely integrated system could be developed. With the development of the MAB information and GIS system, data exchange with different levels of access could be possible, e.g. Intranet within the context of MAB and the biosphere reserves themselves, Extranet allowing data exchange with institutional partners and Internet in the context of education and public awareness. (In this context, BRIM will take into account the mission of the CBD-UNESCO global initiative on biodiversity education and public awareness when using the results emerging from research and monitoring in biosphere reserves for education and awareness purposes.)

[14] (information on where to find the information and data)

69. As data capture is the most difficult part of setting up a GIS, guidelines and specific methods should be elaborated for data collection procedures within the biosphere reserves. An inventory of freely available international data sources could be identified and communicated to relevant interested parties.

70. As it seems that no other world monitoring programme has a GIS facility for displaying where, when and what type of monitoring (in particular integrated monitoring) is taking place in the world, a BRIM GIS facility could act as a platform for other monitoring programmes to publish their activities and a centralized system could exist which would allow gaps in monitoring to become evident. The UNEP-World Conservation Monitoring Center publishes thematic GIS maps on its Internet site. The soon to be published Internet mapping service of the Ramsar site hosted by CIESIN (Center for International Earth Science Information Network) is also comprised of thematic maps. Document BRIM/SM/Inf. 3 provides a preliminary feasibility study on the possibility of implementing GIS within BRIM.

71. In terms of knowledge and experience already available within the World Network, it is important that the body of knowledge and experience accumulated therein be used appropriately. It is equally important to make full use of monitoring methods developed and applied by biosphere reserves up to the present, as well as of the training expertise, capabilities, knowledge and experience that are available within the World network.

72. Therefore, a main concern in the next phase of BRIM will be to establish a useful mechanism to gather the information and data that are available and make use of past and present experience. A first step in this direction to ensure the participation of MAB National Committees outside the EuroMAB Network in BRIM. In this regard, the establishment of special purpose networks along the REDBIOS (Réseau Est Atlantique de Réserves de Biosphère) model will be a priority.

73. But all of the issues mentioned above (information and data gathering and integration, QA/QC, appropriate methodologies, selection of suitable indicators, infrastructural aspects, surveys needed, appropriate technology, capacity building aspects, etc.) are more likely to be addressed in a successful manner through the establishment of cooperative agreements with existing global and regional monitoring programmes and initiatives that have dealt with similar issues already.

74. The issue of synergies with related global and regional research and monitoring programmes is central to BRIM's future. Objective III.2 of the Seville Strategy contains clear guidance on how monitoring activities should be improved and recommends that the World Network of Biosphere Reserves be used at all levels as priority long-term monitoring sites for international programmes focused on topics such as terrestrial and marine observing systems, global change, biodiversity, and forest health.

75. In the context of cooperative arrangements between BRIM and other programmes and initiatives in the next future implementation phase of BRIM, it is important that issues (e.g. carbon, nitrogen, biodiversity, specific social or economic issues, issues needing an integrated approach, etc.) and components (e.g. data and Information management, networking, training, etc.) of a few pilot regional programmes in biosphere reserves be identified and subsequently elaborated upon.

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ANNEX 1 - CASE STUDIES ON CURRENT MONITORING IN BIOSPHERE RESERVES

1. Water quality monitoring in Virgin Islands Biosphere Reserve, U.S.A.

Objective/Aim: The biosphere reserve is located on St. John Island, and the characteristically oligotrophic waters that surround the island provide ideal conditions for the growth of corals, seagrasses, and many other marine species. The monitoring on St. John serves the purpose of generating baseline data on water quality for researchers and park managers to use in understanding and identifying changes affecting marine ecosystems.[15]

Description: Monitoring has been carried out on a monthly basis since 1988 and focuses on abiotic factors such as temperature, salinity, dissolved oxygen, conductivity, pH, transmittance, organic nutrients etc. Recent concerns over widespread "bleaching" of reef organisms and its possible association with high water temperatures, along with more general concern over global warming have increased the interest in water temperature data from coral reef environments. The same monitoring protocols are used for the 15 sites around St. John which are being used for water sampling.

Implications: Development in the Caribbean is occurring at an alarming rate and may prove to be the single greatest pressure facing these tropical marine ecosystems. Increased development on land inevitably results in increased erosion and the delivery of sediments from runoff to the nearshore waters and coral reefs. The baseline data may help in understanding these changes and promote management practices to decrease the negative effects of development.

2. Large-scale ecosystem experiments and long-term monitoring in the Dutch Wadden Sea Area Biosphere Reserve

Objective/Aim: To illustrate the importance of enrichment and fishery for the Wadden Sea ecosystem.

Description: An example of large-scale natural or man-made interference in ecosystems is provided by two far-reaching changes that have taken place in the Dutch part of the Wadden Sea (designated as a biosphere reserve in 1986).[16] First, a drastic increase in the late 1970s of the annual rates of primary production and of chlorophyll concentrations (restricted to the western part of the Dutch Wadden Sea and probably induced by eutrophicated fresh water) and second, a sudden removal in 1990 of nearly all mussel and cockle beds by commercial fishery all over the Dutch part of the Wadden Sea.

These two large-scale events can be regarded as large-scale 'experiments', manipulating an almost natural ecosystem over a vast geographic area. The consequences could be followed by regularly executed long-term monitoring programmes of the phytoplankton and the benthic macrofauna carried out in the Dutch Wadden Sea Area. Based on abundance data covering three decades of observations (starting in 1970), researchers from The Netherlands Institute for Sea Research have been able to illustrate the importance of enrichment and fishery for the Wadden Sea ecosystem.

As a response to the substantial and rather sudden increase in their food supply around 1978, the total benthic biomass roughly doubled, though with a time lag of about two years. The response to the sudden removal in 1990 of nearly all beds of the two major bivalve species was even more dramatic: concentrations of phytoplankton were unusually high in the 1990-1991 winter, and phytoplankton blooming started unusually early in late-winter, which caused high weights and early and rapid growth in the bivalves that had remained. Mortality rates in some benthos species were extraordinarily high during the 1990 -1991 winter, probably as a consequence of birds switching from the unprecedentedly scarce mussels and cockles to other prey species.

[15] http://www.fcsc.usgs.gov/Coral_Reef_Ecology/Virgin_Islands_National_Park/virgin_islands_national_park.html
[16] Beukema, J.J.; Essink, K.; Dekker, R. 1998. How two large-scale "experiments" illustrate the importance of enrichment and fishery for the functioning of the Wadden Sea ecosystem. Senckenbergiana maritima, 29(1/6): 37-44.

Oystercatchers and eider ducks suffered high mortality and a high proportion of these birds left the Dutch Wadden Sea earlier than in other years.

From both 'experiments', the research team has concluded that the Wadden Sea is a food-limited ecosystem, both in the first and in the second link of the main food chain. Only in restricted areas with extreme environmental conditions is the fauna so scarce that competition for food cannot play a significant role. In such areas, other (stressing) factors apparently inhibit the abundance of the benthic fauna and enrichment of food supply is not effective (food, therefore, not being the limiting factor there).

Implications: Unrestricted fishery appears to be a greater threat to the normal functioning of the ecosystem of the Dutch Wadden Sea than mild eutrophication, which has important management applications.

3. Radio-tagging of guanacos at Torres del Paine Biosphere Reserve, Chile

Objective/Aim: Monitoring of guanacos, an important local and regional economic resource, for which a scientifically based managed harvest could contribute to its conservation.

Description: Radio-tagging is a technique widely used by wildlife biologists in studies on the dynamics of vertebrate populations. A study in Torres del Paine National Park and Biosphere Reserve has focused on the survival of juvenile guanacos (*Lama guanicoe*). Though protected, guanacos have declined throughout their range in the southern Andes due to poaching and agricultural practices. Despite their threatened status, however, guanacos continue to be an important local and regional economic resource for which a scientifically based managed harvest could contribute to its conservation. The Chilean National Forestry and Park Service (CONAF) is currently striving to implement a guanaco management programme of sustained-yield use that is based upon sound and updated studies of population dynamics. Within such a context, a study has been carried out investigating the survival of 409 radio-collared juvenile guanacos in Torres del Paine.[17] Mortality rates were highest during the first 14 days after birth, with most deaths occurring between birth and seven months of age. During winter the risk of mortality increased by almost 6% with every 1cm increase in snowfall.

Implications: Guanaco management programme of sustained-yield use. Among the recommendations is that adult males from male groups could be harvested without affecting population size if juvenile mortality is considered carefully.

4. Putting social and economic values on ecosystem services: alien woody invaders in the Cape Floristic Province, Kogelberg Biosphere Reserve, South Africa

Objective/Aim: To monitor and control/clear alien weed species as an important management practice to maintain water supply from catchment areas.

Description: In the Kogelberg Biosphere Reserve, in Western Cape province, South Africa, scientists have shown that invasive woody plants, such as *Acacia* spp. and *Hakea* spp. (both introduced from Australia), have important consequences in terms of water use.[18] Catchments that are invaded yield much less water than catchments under intact nature vegetation, since the invasive species use much more water than the natives do. This impact of invasive species is particularly significant in the Kogelberg area, which is an important source of the water supply to the city of Cape Town, situated some 40 km away.

[17] Sarno, R.J.; Clark, W.R.; Bank, M.S.; Prexl, W.S.; Behl, M.J.; Johnson, W.E.; Franklin, W.L. 1999. Juvenile guanaco survival: management and conservation implications. *Journal of Applied Ecology*, 36: 937-945.
[18] Le Maitre, D.C.; Van Wilgen, B.W.; Chapman, R.A. and McKelly, D.H. 1996. Invasive plants and water resources in the Western Cape Province, South Africa: modelling the consequences of a lack of management. Journal of Applied Ecology, 33: 161-172

In a study, researchers have been modeling the likely consequences of a discontinued management of invasive species on the water supply. Results suggest that if periodic clearing were discontinued, the cover of alien plants would increase from an initial estimate of 2.4% to 62.4% after 100 years. Invasion of catchment areas would result in an average decrease of $347m^3$ of water per hectare per year over 100 years, resulting in average losses of more than 30% of the water supply to the city of Cape Town. In addition, invasion of *fynbos*[19] vegetation by alien plants would cause the extinction of many plant species, increase the intensity of fires, destabilize catchment areas with resultant erosion and diminished water quality, and decrease the aesthetic appeal of mountain areas. The overall conclusion is that the control of alien weed species is necessary to avert such adverse impacts.

Implications: Based on the results of this study, the government of South Africa has funded a major national initiative called Working for Water, which aims to tackle many problems simultaneously. Key social problems are poverty, crime, lack of basic services, and health issues, while environmental issues include security of water supply, restoring the productive potential of the land and combating the loss of biological diversity resulting from massive invasions of non-native plant species.

The periodic monitoring and clearing of invasive plant species is an important management practice, co-ordinated by the National Department of Water Affairs and Forestry, with Cape Nature Conservation the implementing agent for the programme in the *fynbos* region. The savings achieved in maintaining adequate water run-off from stable catchments in the long term can justify the costs of control operations. Through the programme the invading plant species are controlled, natural vegetation restored and the water yield and quality from the mountain catchment areas are improved.

5. Reviving olive oil production in Cilento Biosphere Reserve, Italy

Objective/Aim: Monitoring of air temperature to decrease use of pesticides.

Description: As part of a WWF initiative on Conservation and Development in Sparsely Populated Areas (CADISPA)[20], activities have included rural development projects which are closely interwoven with conservation of the region's cultural and environmental heritage. The olive tree and the production of olive oil have been at the heart of rural renewal at Cilento Biosphere Reserve, in the southern Italian province of Salerno. Olive oil production in Cilento has a long tradition, dating back to the Middle Ages when Benedictine monks planted olive groves on the hillsides. Olive oil production originally brought wealth to the area but, over the past few decades, Cilento has suffered from mass emigration and competition from cheaper foreign oils. Moreover, in the past, olive oil from Cilento would be sold to Tuscany and Puglia, where it was bottled and sold bearing labels from these regions. To redress the downward spiral, the farmers of Cilento have worked towards a common goal of producing, bottling and selling their own quality product. A local olive oil co-operative, Nuovo Cilento, has now introduced organic farming techniques and produces a chemical-free extra virgin oil similar to that originally produced on these hillsides by Greek farmers, over 1,500 years ago. A teacher at a local high school, explains principles of organic farming, such as the importance of monitoring air temperature, to the co-operative's 130 members.

July is the season for olive flies, a time when most farmers spray their trees with pesticides. But Nuovo Cilento farmers now know that at temperatures over 32°C, olive flies might bore into olives but will not lay eggs. By closely monitoring the air temperature and checking the olives by hand, the co-operative's farmers spray only when necessary.

[19] This biome is characterized by evergreen sclerophyllous forests, woodlands and shrubs and only occurs on well-leached, relatively infertile soils. *Fynbos* vegetation presents a high degree of endemicity, e.g. of some 1600 plant species that are to be found in the reserve, more than 150 are endemic. Regular fires act as a main natural controlling factor in this system.
[20] Zalewski, S. (ed.) 2000. *Lessons from a Different Europe. CADISPA: Conservation and Development in Sparsely Populated Areas.* WWF Mediterranean Programme.

Implications: Reduced costs, production of chemical-free oil, promotion of a natural product.

6. Monitoring and advantages/use of the fauna in 'Estación Biológica del Beni', Beni Biosphere Reserve, Bolivia

Aim/Objective: Investigation of preferences of hunting for different ethnic groups. Monitoring of the fauna to find out if hunting is sustainable or over-used.[21]

Description: In low populated natural areas in the neotropics, hunting of wild animals, particularly mammals, is an important element for subsistence for local and indigenous people, mainly as a source of animal protein, but also for cultural practices. If these resources are going to be continuously used, the hunting cannot be higher than the reproduction of the animals. The monitoring was initiated in 1992 and included observations of the fauna and monitoring of the use of fauna. The local populations were asked to answer a survey each year on what they species they were hunting, at what time of the year etc. The guards of the park (guardaparques) were carrying out this collection of data. In total, 17 communities were "monitored."

After five years, the information was analyzed and maps of hunting patterns were produced in order to identify hunted species, which species were under pressure, which months of the year the hunting was as its maximum, what species each communities were preferring etc. To analyze the status of some animals with respect to hunting, an index was used. Maps were produced of the areas where the hunting was taking place and surface of these areas was calculated. With this information, the level of sustainable hunting was obtained for 10 species in the biosphere reserve. The results indicate that some of the hunted species are over-exploited and some reaching the limit of sustainability.

Implications: The results of this monitoring has led to the conclusion that further studies need to be carried out on relative abundance, reproductive and spatial patterns. Moreover, it was concluded that it was necessary to develop a strategy for protection of the species under pressure, particularly in the months when the hunting was at its maximum.

[21] Aguirre, L.F.; De Urioste, R.J.; Galarza, M.A.; Guayao, E.; Vaca, D. 2000. El Monitoreo de Aprovechamiento de Fauna en la "Estación Biológica del Beni" (Un Análisis Crítico) Bolivia. In: Carmen Miranda, L.; Imke Oetting, J. (eds.) 2000. Experiencas de Monitoreo Socio-Ambiental en Reservas de la Biosfera y otros Areas Protegidas en la Amazonia. 115-155. UNESCO Montevideo.