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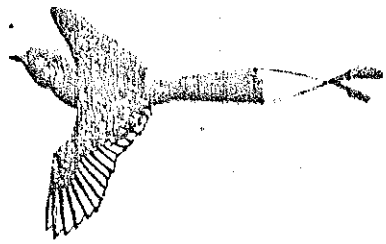

# Scientific Programme for the Nilgiri Biosphere Reserve: Proposal for an Action Plan

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## Scientific Research Programme in the Nilgiri Biosphere Reserve

### 1 An Overview

The objectives of research in the Biosphere Reserves are to

a) understand and sustain the diversity and productivity of natural ecosystems,

b) to monitor and critically assess the process of man-environment interactions, and

c) to formulate and test sustainable alternative strategies and techniques for the harmonious survival of humankind as an integral part of the biosphere.

In actual practice, this is to be achieved through identifying intact representative benchmark areas for all the possible varieties of ecosystems for detailed study. These core areas will have concentric insulating zones of modified and managed ecosystems, designated as buffer areas, wherein the principal management strategy would be to study the ongoing ecosystem manipulations or wherein the main effort would be to restore the destroyed productivity. The management of the buffer areas, based upon an ecosystem approach, is expected to gradually improve the insulating capacity of the peripheral zones so that the viability of the core areas is assured, and the total natural resource base is sustainably used for human welfare.

All scientific studies undertaken in the Biosphere Reserve area must have a basic common orientation - the Biosphere Reserve approach outlined above.

The extremely wide range of conceivable scientific studies could be broadly divided into three inter-linked groups:

1) Long term monitoring;

2) Action research, specifically tackling resource use problems; and

3) Developing an in-depth understanding of the biological diversity and the processes that maintain this diversity.

The whole field of scientific research in the Biosphere Reserve is not to be centrally institutionalised, i.e. a single agency need not be set up to handle it. Rather, within a generally agreed and clearly drawn up programme with spatial and temporal priorities, independent studies are to be carried out by a variety of survey organizations, institutions, laboratories, University departments and non-governmental agencies and individuals. But there will be need for co-ordination and assessment of the research and at least one central data pool where it can be compiled, integrated, and the information flow maintained.

2 Research Infrastructure/Support facilities

A considerable amount of the research work in the Nilgiri Biosphere Reserve would be field studies, and there is at present no field laboratory in the Biosphere Reserve area. Studies are envisaged or would be necessary in different areas which, at present, lack any facilities. Although a few tourism/forest administration facilities exist, such as at Mudumalai, Bandipur, Nagarhole, etc., there is a need to plan out, in detail, locations and facilities in other areas also. This has to tie up with the management/protection plans also. Besides buildings with water and power supply, accessibility, communication facilities, other ground support such as the requirement of manpower (e.g. field guides) must be worked out for each specific location and overall research plan. To avoid duplication of expenditure, a composite

complex can house the field monitoring station, can accommodate the wireless station, protection staff, picket etc. simultaneously. This will also enhance human efficiency under such difficult conditions. Planning, allocation of money, and construction of these stations have to be completed during the first phase if research is to start properly.

Intensive study locations in each habitat type must be identified, demarcated and mapped. The many preservation plots laid out by the Forest Department, for example, are often suitable locations for long-term ecosystem monitoring. These have to be listed, located on maps and on the ground, and all previous data collected from them compiled and made available. (Some of the detailed study locations are indicated on the map).

These locations are:

Main/central field stations:

1. H.D.kote
2. Ooty/Gudalur
3. Nilambur

Field monitoring stations (to be set up within 6 months):

Karnataka

1. Nagarahole
2. Bandipur
3. Moolehole

Tamil Nadu

1. Kargudi
2. Masinagudi
3. Hasanur

4. Tengumarada/Bhavanisagar

5. Pillur

6. Avalanche

7. Upper Bhavani/Bangitappal

8. Kotagiri

Kerala

1. Nedungayam

2. Silent valley - old dam site

3. Muthikulam

4. Agali

5. Mukkali

6. Munderi

Field monitoring stations to be set up in due course depending on necessity for researchers

Karnataka

1. Titimati

2. Murkal

3. Sunkadakatte

4. Kalkere

5. Nugu dam/Sargur

6. Begur

Tamil Nadu

1. Kakanhalla

2. Anaikatti (Sigur)

3. Kodanad

4. Talamalai

5. Talavadi
6. Cherambadi
7. Mukurti
8. Korakundah
9. Siruvani hills (Bolampatty)
10. Sispara

Kerala

1. Vazhikadavu
2. Meenmutti
3. Kunjali colony
4. Kalikavu
5. Aruvampara
6. Melathodukki
7. Yedavani
8. Tolpetti
9. Vandaikadavu
10. Rampur
11. Muthanga

3 Research tie-up with management

Research input in actual management of the Biosphere Reserve is a critical issue. The very survival of the concept as well as the biological diversity of the area depends on adopting correct management strategies. In fact, the very identification of the area and determination of its boundaries is a scientific task. Delineation of the different zonal boundaries, which ensures the actual survival of the benchmark core areas, requires, besides ground ecological knowledge, awareness of the cultural, historical, current economic and political

scenario of the area.

The first requirement of research oriented to management is 1) a detailed reconnaissance report of the entire tract. Priority areas for corrective management should be identified and overall procedures laid down; 2) all enclosures within the core as well as buffer areas must be mapped; and 3) precise ecological boundaries between the zones must be verified in the field.

To illustrate the relevance of the points mentioned above, the Kerala part of the Nilgiri Biosphere Reserve is discussed. Here, the core areas are: a) Nilambur Kovilakam forests; b) part of New Amarambalam-Silent Valley complex. The current forest boundary is not known. It needs ground verification. Core a) has no buffer area along the north-east or south. A viable bufffer belt, not including intact vegetation, needs to be identified. The condition of habitat between core a) and b) needs to be checked to evolve management procedures to re-establish a corridor linking the two.

In the case of New Amarambalam in the second core area the boundaries of the part that is included is the protection working circle, i.e. only area above 1300 m. elevation covering 6930 hectares out of the 61,619 hectare New Amarambalam Reserve. The actual boundaries of the natural forest cover in this reserve need to be fi ld checked and brought within the core.

The Reserved Forest boundary of Silent Valley Reserved Forest includes parts of the areas considerably damaged by fire where restoration efforts are needed, i.e., along the west of the Kundi River, while intact vegetation continues east beyond this Reserved Forest

boundary into the adjoining Attappadi Reserved Forest. The core area needs to be correctly demarcated similarly in between New Amarambalam and Silent Valley. There is an approximately 1000-acre enclosure causing considerable damage to the core. The feasibility of relocation of this settlement should be explored.

To cite another example, the 740 sq. km. Attappadi area needs ecorestoration effort on a massive scale, but the procedure will have to be worked out in detail. An entire range of measures, including soil conservation, watershed management, grazing and fire prevention, reforestation, translocation of settlements, etc. needs to be contemplated. This would be a prolonged, time-consuming task, progressively developing spatial and methodological form.

The actual management of the Biosphere Reserve is a dynamic concept, which not only evolves and improves with experience and knowledge, but also needs constant scientific feedback and assessment. Before the Biosphere Reserve management zone boundaries are finalized, it is of utmost importance to develop a clear picture of the ground situation. This is particularly true of the difficult terrain covering the western slopes of the Ghats in Kerala where, excepting a recently prepared sketchy Forest Working Plan, no data exists for the extensive vested forest tracts. Before the action plan is finalized, before management steps are initiated, developing a total ground picture would be essential. Unless detailed vegetation maps, land capability maps, etc. are available, it would be difficult to judge the suitability of many management measures, and hence one can only have an interim management procedure. In fact, in the initial phase of the Nilgiri Biosphere Reserve establishment, more emphasis should be placed on those scientific studies that enable the consolidation of management

procedures, which in turn is possible only if there is at least an approximate concept of management requirements in the different areas. This is possible only with a clear understanding of the areas and their current status. From the very beginning, there must be a scientific research-management co-ordination group translating research data into management procedure and translating management requirements into research objectives.

## 4 Base Data Compilation

### 4.1 Surveys and Maps

An essential priority requisite for any management or research in the Biosphere Reserve area would be the availability of up-to-date topographical maps. At present, 1:250,000 and 1:50,000 scale maps are available for the entire area. The actual field survey for the mapping was done 10-20 years earlier. In many parts, the ground situation has changed radically, hence remapping is urgently required.

Remapping is needed in a larger 1:25,000 scale for the entire area, and as a priority in some areas. The priority areas are:

1) Toposheet No. 58 A/3 surveyed in 1967-68.
2) Toposheet No. 58 A/7 surveyed in 1970-71.
3) Toposheet No. 58 A/8 surveyed in 1969-70.
4) Toposheet No. 58 A/11 surveyed in 1969-70.
5) Toposheet No. 58 A/12 surveyed in 1969-70.
6) Toposheet No. 58 A/15 surveyed in 1969-70.
7) Toposheet No. 58 A/16 surveyed in 1969-70.

Intensive study locations have to be mapped on a 1:5,000 scale, or on an even larger scale. This task is to be carried out through the

Survey of India and the Department of Environment. The Government of India should take responsibility for initiating this work.

4.2 Satellite images of the area are available through the N.R.S.A. and it should be possible to regularly obtain images of the area twice a year from spot satellite or thematic mapper for any user organization. State institutions like the Remote Sensing Centre, Karnataka, could be entrusted with the task of continued satellite image mapping of the Karnataka part of the Nilgiri Biosphere Reserve. The satellite images should be investigated with concepts developed in the newly developing field of landscape ecology.

4.3 Aerial survey photographs of the entire Nilgiri Biosphere Reserve should be taken immediately, and once the entire area has been photographed, should be repeated regularly at 5-year intervals. Since the actual mapping of the western slopes of the Western Ghats in the Nilgiri Biosphere Reserve will take some time, taking aerial survey photographs of this part immediately is most essential, in particular of the western slopes in Kerala, with their difficult terrain and rapidly-changing land use patterns.

4.4 Geologic mapping

If the basic mapping of geology, geomorphology, and geophysical aspects has been carried out, and if the maps are available, they must be obtained from the Geological Survey of India, Calcutta, and if detailed mapping is needed, the Geological Survey of India should be entrusted with the task.

4.5 Vegetation mapping and Bioclimatic mapping

The vegetation maps of part of the area have been prepared by the

French Institute, along with bioclimatic maps in 1:250,000 scale. The southern portion of the Nilgiri Biosphere Reserve has yet to be mapped by the French Institute. This is a priority task since the whole area could be depicted in the same scale. After this, the entire area needs to be mapped in 1:50,000 scale.

4.6 Detailed soil maps of the entire Biosphere Reserve are needed, particularly of the intensive study locations and of the agricultural manipulation and restoration zones. Vegetation and soil maps should be generated for the entire area in at least five years' time.

4.7 Forest vegetation of the Nilgiri Biosphere Reserve could be mapped through the Forest Survey Organization, using aerial photographs, as early as possible. Similarly, a fresh, detailed, quality-class mapping of existing forest plantations is also needed, a task that forest survey organizations can undertake.

4.8 Land use and land capability mapping

Using existing base data and thematic maps it is essential to prepare a land capability map of the Biosphere Reserve area, in particular of the manipulation-restoration buffer zones. This is essential for management measures. This task will have to be given to institution(s) with proven expertise. This should also include all human settlements, including tribal settlements which periodically shift.

4.9 Revenue mapping

In many areas with a complex mosaic of land uses undergoing rapid changes, in particular extensive forest encroachments, etc., detailed revenue surveys and settlement of the boundaries of the occupied vs.

community/government lands have to be carried out. Gudalur taluk, Munderi-Nadukani part of Gudalur-Nilambur slopes, Kunjali colony area in Kottapuzha valley, and Anamuli-Kanjirapuzha-Muthikulam stretch of the Attappadi western edges are examples. This is a joint Forest Revenue land verification - ground demarcation operation.

4.10 Specialized mapping work

Apart from these basic resource mapping works there will also be a need, later, for specific surveys, e.g., ground water potential, etc. Such surveys need only be carried out later, through concerned agencies.

4.11 Resource atlas

In fact, it is necessary to have a comprehensive and detailed resource atlas for the entire Biosphere Reserve area depicting in maps, apart from the natural features and resources, the human resource and development details also. This regional resource atlas can be updated regularly, and the map unit resolution enhanced, as available data increases. This is an essential data compilation for any planning.

4.12 Anthropological and Ethnobiological Surveys

The Nilgiri Biosphere Reserve area has an exceptionally rich variety of forest inhabitants. This human micro-cultural diversity needs urgent documentation. Detailed field studies are needed to map out the current distribution of the various tribal societies and document their diverse cultural adaptations, in particular ethnobiological information.

4.13Data bank

Collection and compilation of all data including historical,

cultural, economic, administrative and scientific data must begin and continue throughout as part of the task of the nodal institute. This is needed to identify research lacunae, priority fields, etc. This has already begun at the Centre for Ecological Sciences, Indian Institute of Science, Bangalore.

4.14 State of the art report

At the earliest opportunity, an outline document giving an overview of the area has to be prepared, enabling those unfamiliar with this part of the landscape to get a bird's-eye view of it.

4.15 Reconnaissance report

This is a more detailed ground exploratory report, taking the known areas first and providing a more and more accurate picture, necessary for management or research follow-up. It is necessitated by the extensive poorly documented terrain.

4.16 Inventories

Along with survey and mapping, one of the preliminary scientific tasks is to prepare detailed inventories of the biological diversity of the Nilgiri Biosphere Reserve.

In the area, the task of collecting and cataloguing the flora and fauna has been going on for a fairly long time. The total inventory of plants and animals would take a very long time to complete, and would be a continuous task. But it is proposed that the programme be phased such that areas which have been given the least attention be treated as priority areas. This includes Nilambur-Kovilakam forests, New Amarambalam, and corridors linking Silent Valley with New Amarambalam, as well as Silent Valley-Muthikulam links. Other similar poorly-exposed

tracts need to be identified on the basis of spatial lacunae in previously published literature.

Certain key indicator groups indicated need to be studied first. This includes soil fungi, fresh-water algae, pteridophytes and flowering plants.

In the preparation of inventories, there is the initial qualitative approach, i.e. collection and identification of individual plants, and the quantitative approach of taking into consideration distribution-association aspects also. The taxonomic work poses problems in the availability of expertise in specific groups, in the logistics of actual field work and the preservation and storage of data. Using a centrally organized collection of material and other existing schools, such as at the Botanical Survey of India, taxonomic expertise should be developed in other groups currently lacking specialists. All others who carry out collection and studies should be made to deposit the relevant material and publications in a central repository.

The faunistic cataloguing is far more inadequate than that of the flora, and the indicated priorities are equally applicable here. During the initial period, faunistic surveys should focus upon the poorly surveyed as well as core areas and emphasis should be laid on the indicator groups such as soil annelids, arthropods, and vertebrates. The Zoological Survey of India, the Bombay Natural History Society, and various University Centres are carrying out systematic studies on these groups, and it may also be necessary to develop fresh expertise in some groups.

Since the flora and fauna are often to be collected on a priority

basis from the least frequented core areas, wherein the logistics of camping etc. are difficult, a method should be worked out whereby annual multidisciplinary expeditions are mounted to cover such difficult areas during the January-April period. Money should be made available to one capable institution exclusively for mounting such expeditions, i.e. setting up camps and looking after the transport and daily needs of a team of about 12-15 participants who would be invitees from various institutions involved in the Biosphere Reserve Research programme.

Participation of teams from survey organizations such as the Z.S.I. and B.S.I. should be ensured through the Dept. of Environment, and such field work included regularly in their annual field programmes. Only on the basis of such prolonged expeditions can the little-known core areas be covered and future infrastructural facilities in such locations planned.

4.17 Cultivars

Along with the flora and fauna of the region, an invaluable heritage of diversity exists in cultivated crop plants and domesticated animals. The cultivars, in particular, warrant urgent attention and cataloguing, since changes in lifestyles and the process of modernization extinguishes the diversity evolved over thousands of years to locally specific habitat situations.

Apart from the Bureau of Plant Genetic Resources and the Agricultural Universities at Bangalore, Coimbatore, and Trichur, the National Dairy Research Institute also could play a role in cataloguing the diversity of domesticated animals.

The perpetuation of cultivars is possible only through in situ

preservation of the varieties and even of the cultural practices. It would also be necessary to work out details regarding the cultural reinforcements necessary for retaining these seed varieties and domesticated races. Apart from purely specialized research, actual participatory efforts with the local people being involved need to evolve.

5 Long-term monitoring

Many environmental parameters constantly fluctuate or change in time. For a better understanding of the mechanisms of these natural processes and the impact of man on them, such select parameters have to be recorded over long spans of time. The Biosphere Reserves are the first study locations intended for this purpose. The benchmark areas in the various zones will be monitored continually. Watersheds provide the boundaries for unit areas, and, within watersheds, the different vegetation types occurring in the Nilgiri Biosphere Reserve provide subunits. Further categorizations on the basis of degree or intensity of human impact can be identified and an entire comprehensive grid of monitoring points fixed. Altogether, about 18 such microcatchment subunits are proposed, forming a representative composite network.

The long-term monitoring involves environmental parameters as well as processes. The parameters include:

1) Meteorological parameters such as rainfall, temperature, humidity, solar radiation, wind, and evapotranspiration. Air quality parameters such as carbon dioxide concentration, dust, and various chemicals such as sulphur dioxide, should be monitored in at least one or two select stations.

2) Hydrological parameters include surface runoff, percolation, soil-

water storage, stream flow, silt load in runoff, water quality, in particular pesticides and fertilizers in water, etc.

3) Natural ecological processes such as productivity, mineral cycling, population and community dynamics in ecosystems, etc. fall into this category. Human population changes also form part of this data.

6 Impact monitoring

a) Land use and human settlement changes.

Cultivation and plantation practices, livestock, forest management, water resources and soil changes are to be monitored.

Studies on the same type of land use under different environmental conditions as well as long-term monitoring of the same land use are needed. The influence of different forestry practices including clearfelling, selection felling, a wide variety of monoculture as well as polyculture tree plantations, collection of so-called minor forest products, etc. needs to be studied.

Human demands on natural products for varied uses such as food, fuel, fodder, construction material, raw material for traditional crafts and cultural requirements, industrial raw materials, etc. need to be estimated.

b) Monitoring of biological diversity also forms part of the monitoring studies.

Long-term monitoring poses three different types of problems:

1) overall research planning and co-ordination

2) logistic difficulties with regard to ground facilities

3) funding, institutional, personnel, procedural difficulties.

To avoid a dearth of data in crucial aspects as the Biosphere

Research Programme unfolds, preventing a holistic understanding, sufficient thought should be given to preparing a comprehensive research overview plan. It will also be necessary to have a continuous co-ordination of this long-term monitoring, since a wide variety of scientific expertise is called for, involving very many institutions and personnel. Co-ordination should be vested with one institution or agency. It is also essential that there be a central repository of data to which any user has access. Collating the varied data into integral comprehensive pictures should also be the responsibility of the data bank.

The second possible constraint in long-term monitoring would be the logistic base. For a comprehensive data collection grid system on a very complex and difficult terrain, there will be the need to have a whole series of well-planned field stations.

A series of transects would have to be located, for example, along the various slopes of the Nilgiris, for setting up meteorological or hydrometric stations. Accessibility to them would be difficult during the rainy seasons. Self-contained field stations must be set up which could house as well as serve as field laboratories for the scientific personnel, besides the protective or management staff of the Biosphere Reserve; i.e., function simultaneously as a wireless station/fire watch station/patrolling staff picket, etc. The location, planning and construction of these stations should be one of the first steps where scientific research planning as well as the management plan correspond. Developing communication facilities to these stations also goes hand in hand. Such locations are suggested in detail earlier.

The third anticipated difficulty is regarding funding and personnel. The long-term monitoring actually extends without a terminal date. Normally, research funds are made available for a much shorter duration. Personnel in involved institutions will change, and to maintain continuity and uniformity in the quality of data collection, safeguarding measures will have to be laid down.

A team of experts from each discipline such as meteorology, hydrology, etc. should be constituted at the earliest opportunity to finalise the parameters to be monitored and the specific procedures, instrumentation, data retrieval, etc.

It is proposed that the parameters for monitoring be finalised and actual procedures and instrumentation worked out and codified before the locations and budgetary provisions are finalized. Once this is done, the actual task of collecting the data can be contracted out to some institution, or still later, handed over to a Biosphere Reserve scientific cadre. There should be guaranteed availability of money for the much longer monitoring programme as part of the continuing Biosphere Reserve funding.

All the data collected through the field stations should also be pooled in a central data bank, accessible to any scientific institution or researcher. There should be provision for regular publication of all the data.

## 7 Studying Biological Diversity

Conserving the entire spectrum of biological diversity including that of cultivated plants and domesticated animals is, of course, an

important purpose of a Biosphere Reserve. Our scientific understanding of processes governing trends of biological diversity is very inadequate, and investigations elucidating these processes will have to form a major component of work at the Biosphere Reserves.

This programme will have two components: studies at the level of communities, and studies of populations of individual species. Our particular interest lies in how various environmental factors as well as human impacts, including fragmentation of natural habitats, affect diversity levels. It would therefore be most appropriate to site these diversity studies on plots in the eighteen microcatchments selected to represent the whole range of environmental regimes and human impacts.

The investigations will have to focus on estimating levels of ecological species packing (or alpha diversity), ecological species turnover (or beta diversity), as well as mosaicity (or mu diversity). Standard methods will have to be developed to estimate these diversity levels for different groups of organisms. We suggest that this be attempted for: fresh water algae, soil fungi, flowering plants, fresh water fishes, annelids, soil arthropods, birds and larger mammals. A number of sample plots of appropriate sizes will then have to be chosen to represent the habitat gradient in each microcatchment to carry out estimations of alpha and beta diversity with comparable, standardized methodologies. The diversity levels will have to be monitored both seasonally and year after year on an appropriate time schedule.

8 Ecodevelopment research

A singularly important field of study in the Nilgiri Biosphere Reserve is studies, often of immediate applied value, concerning sustainable ways of natural resource use by man. This is a field with

considerable scope for improvisation of methodologies, participation in actual research by local people, and considerable immediate value for society, by and large. There are three approaches to ecodevelopment research:

1) Using the least modified lifestyles and techniques of resource husbanding as models for propagation and extension. Such traditional knowledge available among tribal societies and in rural "backward" areas is subjected to impartial scientific scrutiny.

2) Subjecting known disruptive processes of resource utilization to a critical analysis, to identify corrective measures.

3) Applying modern scientific/technical understanding to develop and introduce techniques of efficient resource use, e.g. biogas and drip irrigation.

In all the approaches, the presence of human beings and societies as test objects creates a dimension different from the theoretical, scientific approach with which scientists are mostly familiar.

The ecodevelopment research, in principle, focusses on the use of land and water and natural productivity. Management of biotic productivity includes agriculture, horticulture, animal husbandry, hunting, fishing, and traditional medicine. Handicrafts and skills, including housing and traditional art, social organization and cultural patterns adapted to habitat conditions also fall within this field of study. Although rural development and voluntary social service are well established activities in our country, the ecological dimension to viewing such activities is new. Attempting to gauge the potentialities and limitations of each ecologically identifiable habitat unit and

attempting to design patterns of interaction for each village, community or physiographically distinct regions provide not only an opportunity to work out sustainable alternative, decentralized models of development, it also safeguards and enhances natural heritage and cultural diversity.

The ecodevelopment research also provides a unique opportunity for a closer link-up between scientists and ordinary people. A better realization of the needs and aspirations of the rural people in the Biosphere Reserve buffer areas, for example, would enable socially relevant studies to be initiated.

The ecodevelopment research would also enable voluntary/non-governmental groups and individuals to participate in studies and extension work. A smoothly graded two-way transfer of knowledge and action is almost necessary if knowledge is not to end up as yet another tool of exploitation or suppression.

Wide publicity is needed for the Biosphere Reserve concept and the actual programmes of ecodevelopment research if it is to become truly participatory. Unless this precondition is met, there will not be sufficient acceptance of the new concepts by the people.

Voluntary agencies should be encouraged to take up specific ecodevelopment activities such as afforestation, microwatershed management on a scientific basis, soil conservation, etc. Ecodevelopment activities should be decentralized and, as far as possible, parcelled out to local tribal co-operative societies, youth groups, etc.

In each of the [illegible]graphically and culturally distinct restoration

zones Paryavaran Vigyan Kendras should be set up and equipped to translate the scientific basis of the Biosphere Reserve programme into a commonly understood format such that it is assimilated by the people of the area and they become partners in the procedure.

9 Manpower and Funds

The common characteristic of all research programmes in the Biosphere Reserve is that they fit in within a total framework, which is, to help us have a holistic understanding of our only habitat - the spaceship Earth. Studies should integrate into a composite exploration of our standing with the rest of the natural world.

A fairly comprehensive list has been drawn up, of organizations and institutions which have the potential for carrying out monitoring and research in the various fields indicated earlier. They are:

9.1 All India Survey Organizations

1) Anthropological Survey of India (Southern Circle Office, Mysore)
2) Botanical Survey of India (Southern Regional Station, Coimbatore)
3) Forest Survey of India (Bangalore)
4) Geological Survey of India (Circle Office in each State)
5) Indian Meteorological Department
6) Natural Remote Sensing Agency.
7) Soil Survey and Land Use Bureau (Bangalore)
8) Survey of India
9) Zoological Survey of India (Southern Regional Station, Madras)
10) Zoological Survey of India (Western Ghats Station, Calicut)
11) Forest Soil and Vegetation Survey, Coimbatore

These organizations carry out systematic nationwide surveys. Their work in the Nilgiri Biosphere Reserve can be requested on a priority basis, and specialists entrusted with preparing guidelines for long-term monitoring work.

9.2 Research Institutions

In each of the States concerned, there is a wide range of scientific institutions located close to the Nilgiri Biosphere Reserve, carrying out research in many of the relevant fields. Many of these institutions are autonomous, State or Central Governmental. They include:

1) Central Water and Soil Conservation Research and Training Institute (Ooty)

2) Centre for Development Studies (Trivandrum)

3) Centre for Earth Science Studies (Trivandrum)

4) Centre for Water Resource Development and Management (Calicut)

5) Entomology Research Institute (Madras)

6) French Institute (Pondicherry)

7) Indian Institute of Tropical Meteorology (Pune)

8) Institute for Social and Economic Change (Bangalore)

9) International Institute of Ayurveda (Coimbatore)

10) Kerala Forest Research Institute, Peechi (Trichur Dt.)

11) Southern Forest Rangers' College and Forest Research Institute, Coimbatore

12) Tribal Institute of Tamil Nadu University (Ooty)

13) Tribal Training Research Institute (Calicut)

14) Tropical Botanical Garden (Trivandrum)

These institutions have wide-ranging research interests and expertise in relevant fields.

9.3 Universities

1) Anna University (Madras)

2) Bangalore University (Bangalore)

3) Bharathiyar University (Coimbatore)

4) Bharathiyar University (Tiruchirapalli)

5) Calicut University (Calicut)

6) Cochin University (Cochin)

7) Indian Institute of Science (Bangalore)

8) Indian Institute of Technology (Madras)

9) Kerala Agricultural University (Trichur)

10) Kerala University (Trivandrum)

11) Madras University (Madras)

12) Madurai Kamaraj University (Madurai)

13) Mangalore University (Mangalore)

14) Mysore University (Mysore)

15) Tamil Nadu Agricultural University (Coimbatore)

16) University of Agricultural Sciences (Bangalore)

These universities have departments such as Botany, Zoology, Anthropology, Geography, etc., many of which are dynamic centres of research and training. They must be fully involved in the Biosphere Reserve programme.

9.4 State Government Organizations

1. Research wings of the Forest Departments of Karnataka, Kerala and Tamilnadu.

2. Departments of Agriculture in Kerala, Karnataka and Tamil Nadu.
3. Irrigation Departments of Kerala, Karnataka and Tamil Nadu
4. Departments of Statistics in Kerala, Karnataka and Tamil Nadu.
5. Institute of Hydraulics and Hydrology, Poondi
6. Depatments of Geology and Mines in Kerala, Karnataka and Tamil Nadu.
7. Electricity Boards of Kerala, Karnataka and Tamil Nadu.

9.5 Voluntary organizations and societies

Besides these institutions, there are nationally known research centres like the Bombay Natural History Society (Bombay), Wildlife Institute of India (Dehra Dun), Centre for Wildlife Studies (Mysore), Nilgiris Wildlife and Environmental Association, etc., and voluntary groups such as MYRADA (Bangalore), Vivekananda Girijana Kalyana Kendra (Biligiri Rangan Hills), P.P.S.T. (Madras), Kerala Sastra Sahitya Parishat, Techsell (Ooty), a number of environmental conservation groups in the Biosphere Reserve area, etc.

It may be necessary for a small team to prepare a short audiovisual programme and brief explanatory material and visit the various Universities and Research Institutions to brief the scientists on the new concept and its scope. This team should also identify the existing potentialities of the institutions and scientists. A carefully assessed list of potential schools of research and institutions may have to be drawn up in the next few months' time and, depending on priority needs of research data in the overall Biosphere Reserve research programme, a phased schedule should be prepared.

It is necessary to enhance the manpower of the regional stations of existing survey organizations in view of the greater demands on their

resources and personnel, and enhance their financial allocation.

Apart from the physical and natural sciences studies envisaged, the Biosphere Reserve will also generate a large quantum of data on history, economics, sociology, etc. A whole array of studies could be taken up in these fields with financial aid from I.C.S.S.R., through institutions like the Centre for Development Studies, Trivandrum, which would be of as much relevance as the ecological scientific studies.

In the central laboratory of the Nilgiri Biosphere Reserve, there should be provision for fellows or scholars to work in trans-disciplinary fields, going through and interpreting data without being bound to specific project objectives.

APPENDIX I

Provisional estimate of financial requirements for scientific studies (financial input ranging from 25-60 lakhs per year).

| Head | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| Reconnaissance studies including fixing locations for field stations | 2 | 2 | 1 | 1 | 1 |
| Annual 3-month expeditions for collections and studies in difficult locations | 1.5 | 1.5 | 1.5 | 1 | 1 |
| Base mapping including aerial photography and satellite imaging, etc. | 10 | 10 | 10 | 10 | 10 |
| Detailed inventories | 1 | 1.5 | 3 | 5 | 5 |
| Diversity studies | 1 2 | 1.5 4 | 3 9 | 4 17 | 5 19 |
| Specific research projects for management feedback | 0 | 1 | 3 | 8 | 9 |
| Long-term monitoring for core group, and instrumentation | 3.5 | 10 | 10 | 10 | 10 |
| Eco-restoration research | 2 | 5 | 10 | 10 | 10 |
| Research co-ordination cell | 1 | 1 | 1 | 1 | 1 |
| Central laboratory and publication | 3 | 1.5 | 2.5 | 5 | 8 |
| Total/year | 25 | 35 | 45 | 55 | 60 |

Provisional estimate of financial requirement for scientific studies (Financial input ranging from 40-80 laks)

| Head | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| Reconnaissance studies including fixing locations for field stations | 2 | 2 | 2 | 1 | 1 |
| Annual 3-month expeditions for collections and studies in difficult locations | 3 | 2 | 2 | 2 | 2 |
| Base mapping including aerial photography and satellite imaging, etc. | 20 | 25 | 25 | 20 | 14 |
| Detailed inventories | 2 | 3 | 4 | 6 | 6 |
| Diversity studies | 2 5 | 3 9 | 6 18 | 7 22 | 10 28 |
| Specific research projects for management feed back | 1 | 3 | 8 | 9 | 12 |
| Long-term monitoring for core group, and instrumentation | 5 | 10 | 16 | 11 | 11 |
| Eco-restoration research | 2 | 5 | 10 | 15 | 15 |
| Research co-ordination cell | 1 | 2 | 2 | 2 | 2 |
| Central laboratory and publication | 2 | 5 | 5 | 7 | 7 |
| Total/year | 40 | 60 | 80 | 80 | 80 |

Provisional estimate of financial requirements for scientific studies (financial input ranging from 65-100 lakhs per year).

| Head | 1st year | 2nd year | 3rd year | 4th year | 5th year |
|---|---|---|---|---|---|
| Reconnaissance studies including fixing locations for field stations | 4 | 4 | 2 | 2 | 1 |
| Annual 3-month expeditions for collections and studies in difficult locations | 2 | 4 | 4 | 2 | 2 |
| Base mapping including aerial photography and satellite imaging, etc. | 20 | 20 | 25 | 20 | 20 |
| Detailed inventories | 4 | 5 | 5 | 5 | 5 |
| Diversity studies | 5 12 | 7 20 | 9 24 | 10 30 | 10 30 |
| Specific research projects for management feedback | 3 | 8 | 10 | 15 | 15 |
| Long-term monitoring for core group, and instrumentation | 10 | 14 | 17 | 14 | 12 |
| Eco-restoration research | 10 | 10 | 15 | 20 | 22 |
| Research coordination cell | 2 | 3 | 3 | 3 | 3 |
| Central laboratory and publication | 5 | 5 | 10 | 10 | 10 |
| Total/year | 65 | 80 | 100 | 100 | 100 |

Map Reference

Central Field Research Centre

Field monitoring stations - can be established (within 6 months)

Field monitoring stations - can be established later, depending on requirements of researchers.

The grid stations are proposed basically from the plains across the Nilgiris and also along the three faces of the Nilgiris, i.e. the western N-S face, the southern SW-NE face and the northern NE-SW face.

Topography has a crucial controlling influence on the edaphic factors which, in turn, determine the nature of natural as well as cultural landscapes.

The south-west monsoon as well as the north-east monsoon rainfall determines the element of time in the hydrological cycle. The field monitoring stations have to be located in the different rainfall regions.

Considering the accessibility, current location of basic facilities including nuclear institutional base such as agricultural field stations, dam site colonies, etc., a tentative list is prepared - practically encompassing the entire spectrum of habitats and land use.