REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

L. Hill and J. Pernetta:

Natural resource data bank for the South Pacific

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PREFACE

Sixteen years ago the United Nations Conference on the Human Environment (Stockholm 5-16 June 1972) adopted the Action Plan for the Human Environment, including the General Principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" [General Assembly resolution 2997(XXVII) of 15 December 1972]. The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organizations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "oceans" as one of the priority areas in which it would focus efforts to fulfill its catalytic and co-ordinating role.

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes ten regions[1/] and has over 130 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities[2/].

The idea for a regional South Pacific Environment Management Programme came from the South Pacific Commission (SPC) in 1974. Consultations between SPC and UNEP led, in 1975, to the suggestion of organizing a South Pacific Conference on the Human Environment. The South Pacific Bureau for Economic Co-operation (SPEC) and the Economic and Social Commission for Asia and the Pacific (ESCAP) soon joined SPC's initiative and UNEP supported the development of what became known as the South Pacific Regional Environment Programme (SPREP) as part of its Regional Seas Programme.

1/ Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South Pacific, Red Sea and Gulf of Aden, Eastern Africa and South Asian Seas.

2/ UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1, UNEP, 1982.

The Conference on the Human Environment in the South Pacific was convened in Rarotonga, from 8 to 11 March 1982. It adopted: the South Pacific Declaration on Natural Resources and Environment. the Action Plan for Managing the Natural Resources and the Environment in the South Pacific Region; and agreed on the administrative and financial arrangements needed to support the implementation of the Action Plan and on the workplan for the next phase of SPREP[3/].

The legal framework of the Action Plan was developed through several meetings of legal and technical experts from the South Pacific Region. It was adopted by the Plenipotentiary meeting of the High Level Conference on the Protection of the Natural Resources and Environment of the South Pacific Region convened by the Secretary-General of SPC in Noumea, New Caledonia, from 17 to 25 November 1986.

The legal framework adopted by the Conference consists of the following instruments[4/]:

Convention for the Protection of the Natural Resources and Environment of the South Pacific Region;

Protocol Concerning Co-operation in Combating Pollution Emergencies in the South Pacific Region;

Protocol for the Prevention of Pollution of the South Pacific Region by Dumping.

The convention is a comprehensive umbrella agreement for the protection, management and development of the marine and coastal environment of the South Pacific Region. It lists the sources of pollution which require control: pollution from ships, dumping, land-based sources, seabed exploration and exploitation, atmospheric discharges, storage of toxic and hazardous wastes, testing of nuclear devices, mining and coastal erosion. It also identifies environmental management issues requiring regional co-operation: specially protected areas, pollution in cases of emergency, environmental impact assessment, scientific and technical co-operation, technical assistance, and liability and compensation for damage resulting from pollution.

Considerable support to the implementation of the Action Plan is received from a number of South Pacific research and training institutions. Periodic consultative meetings of these institutions are convened to discuss the environmental problems of the region which may be mitigated or solved through the Action Plan and to identify activities which may contribute toward the goal of SPREP. The present report was commissioned by UNEP as such a contribution. The report has been prepared by Mr. Lance Hill and Mr. John Pernetta of the University of Papua New Guinea and the sponsors of the study would like to express their gratitude to the authors of the report and to their institutions.

3/ SPC/SPEC/ESCAP/UNEP: Action Plan for managing the natural resources and environment in the South Pacific Region. UNEP Regional Seas Reports and Studies No. 29, UNEP, 1983.

4/ Convention for the protection of the natural resources and environment of the South Pacific Region and related protocols, UNEP 1987.

EXECUTIVE SUMMARY

Recognising the problems of information management and the use of data as a resource many countries of the SPC region have expressed the desire for some form of integrated network to handle information and data relating to the resources and environment of the Region. Accordingly SPREP commissioned this review of the current situaiton with regard to handling, storage and evaluation of such data in the countries of the region.

This review encompasses perceived needs and capabilities concerning the acquisition of environmental and resource data and its incorporation into the planning of sustainable development within the region. It includes reviews of systems for data management which might be considered relevant to the region together with a critical evaluation of current capabilities and developments as they relate to this concept.

Given the very rapid growth of information technology coupled with increased computing power at reduced costs it is suggested that SPREP adopt the concept of a Pacific Regional Environment Databank System (PREDS), for implementation. Accordingly the report recommends that:

1. The concept of a decentralised, integrated natural resource and environment information and data base system be accepted for implementation.

2. The SPREP Secretariat circulate this report widely to all member country focal points for consideration and comment.

Specific recommendations cover the further planning of this project and the adoption of two pilot projects; one in Tuvalu, a small, atoll-based state and one in the Solomon Islands, a high island state in Melanesia.

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1. INTRODUCTION

1.1 BACKGROUND

The Action Plan for the South Pacific Regional Environment Programme sets down the mandate for the programme and is based upon country reports by eighteen island Governments. It is intended to provide a framework for environmentally sound planning and management; to help the countries of the South Pacific maintain and improve their shared environment and to enhance their capacity to manage their resource base to support the needs and maintain the quality of life of the people. A necessary pre-requiste for sound environmental management is the capacity to collect, analyse, store and integrate data sources relating to environmental parameters and resource distribution and abundance. .

The exponential growth in scientific and environmental data, together with the enormous geographic area cover by the SPREP region; the enormous diversity in resource availability and distribution on both the macro-geographic and national levels and the requirement for integration of diverse data sources dictate the need for some form of computerised capability to handle and process data if this is to be made rapidly available, in a suitable form to planners and decision makers. Most of the country reports stress the need for improved access to information, much of which is currently not easily accessible in the countries of the region. Accordingly UPNG was charged with responsibility for investigating and reporting on regional needs and possible responses which might be implemented by SPREP.

1.2. FIRST CONSULTATIVE MEETING

At the first meeting in Fiji in April 1983 it was recommended that the Science Faculty of UPNG prepare a report concerning a possible Regional Natural Resource Data Bank, which:

(a) discusses the application of the proposal to the region,
(b) describes the type of information and potential sources which would be included in the data bank; and,
(c) surveys existing regional capabilities including data bases and equipment, and the problems of compatibilities and information access.

The choice of UPNG as lead Institution was based on the existence of a proposal which at that time was before both the PNG Government and UNEP for funding such a data bank in Papua New Guinea. The intention was therefore, that UPNG should expand this concept and examine its applicability at a regional level.

1.3. TORTELL PROPOSAL: RESOURCE ATLAS:

At the time of the first meeting a proposal was put to the co-ordinating group from the New Zealand Mapping Bureau for the preparation of a regional resource atlas

comparable to that prepared for New Zealand. This project was not funded by the co-ordinating group although the group reaffirmed its belief in the value of resource maps.

This decision was taken because of the magnitude of the task and the financial commitment required. Concerns were also raised regarding the applicability of overlay techniques and the efficiency of a system dependent upon working groups in individual countries. However it should be noted that there is a clear indication from most SPREP member countries that they are in favour of the publication of an atlas of South Pacific Resources. It could be argued that production of such an atlas would be a logical result of the establishment of a regional resource data base.

1.4. SECOND CONSULTATIVE MEETING:

The second consultative meeting held in January 1984 at UPNG received a preliminary report on the Resource Data Bank Project which provided an outline of the sources of data currently available both within and outside the region; outlined the problems of accessing and collating these data sources; and provided some preliminary ideas concerning the framework within which a Resource Data Bank could be constructed on a regional basis. Preliminary considerations had indicated the need for a decentralised framework based on both manual and computerised methods.

Participants at the meeting felt that there existed a need to identify potential users such that the nature of the data required could be properly assessed. A reticence was expressed by some participants concerning the introduction of costly computerised systems.

At this time the proposal for the PNG National Natural Resource Data Bank had progressed little compared with its status 10 months previously. Preliminary agreement had been reached about the need for a more detailed incountry examination of the entire UNEP package, only part of which was the National Data Bank System. As part of this review a team of UNEP experts visited PNG in 1984 and examined the component parts of the programme, including the Data Bank Proposal. Their report which was made available in early 1986 supports the proposal for the introduction of a computerised system for handling Environmental and Resource Data within the country.

1.5. PNG NATIONAL RESOURCES AND ENVIRONMENT DATABANK:

The full details of this proposed project are included as Appendix 1 to this report. In summary the recommendations of the UNEP expert team, in consultation with the appropriate incountry experts were: that such a databank should be established; that initially five data bases should be included, (meteorological, water resources, flora and fauna, land use capability and marine resources), with a geological data base being considered later; that UPNG be recommended as the agency responsible for the co-ordination and development of the NRED with specific responsibility for the flora and fauna database. Other recommendations concerned the establishment

of the necessary infrastructure and training programmes for national officers.

1.6. ENVIRONMENTAL STATISTICS PROJECT:

The United Nations Statistical Office proposed a conceptual framework for the organisation of environmental statistics. A pilot project, complementary to that in other parts of the world was formulated at a Pacific Workshop on environmental statistics in late 1980. Fiji was selected as the host country for the field test. The project was carried out by the Department of Urban and Regional Planning of the University of Hawaii.

Initially the scope of the UNSO framework was tested against articulated Pacific environmental problems; this resulted in some modifications to the proposed format, which was subsequently used in Fiji. Thirty eight Government departments and statutory bodies were surveyed and data quality, gaps and needs, itemised tables and computer applications of the project examined.

The project showed that data could be collected along the lines of the framework, that its characteristics are useful for statistical analysis, that its format could facilitate modelling of environmental problems and processes and that the table can be easily generated using a word processor and a computer (Minerbi et. al., 1983). Appendix 2 which is taken from this report is the adaptation fo the proposed scope of environmental statistics as applied to Pacific environmental problems; the Fiji survey form and a sample table generated from the data collection are also included.

2. NATURAL RESOURCES FOR DEVELOPMENT:

2.1. RESOURCE BASE: SCOPE & PROBLEMS:

For Pacific Island states development means 5, the exploitation of natural resources to provide an economic capability for the improvement of basic services, such as health care, education and their infrastructures and the expansion of cash generating opportunities. The resource base may be non-renewable such as minerals; or renewable, including forests, fisheries, agriculture (based on the soil resource) and energy forms such as solar and hydropower.

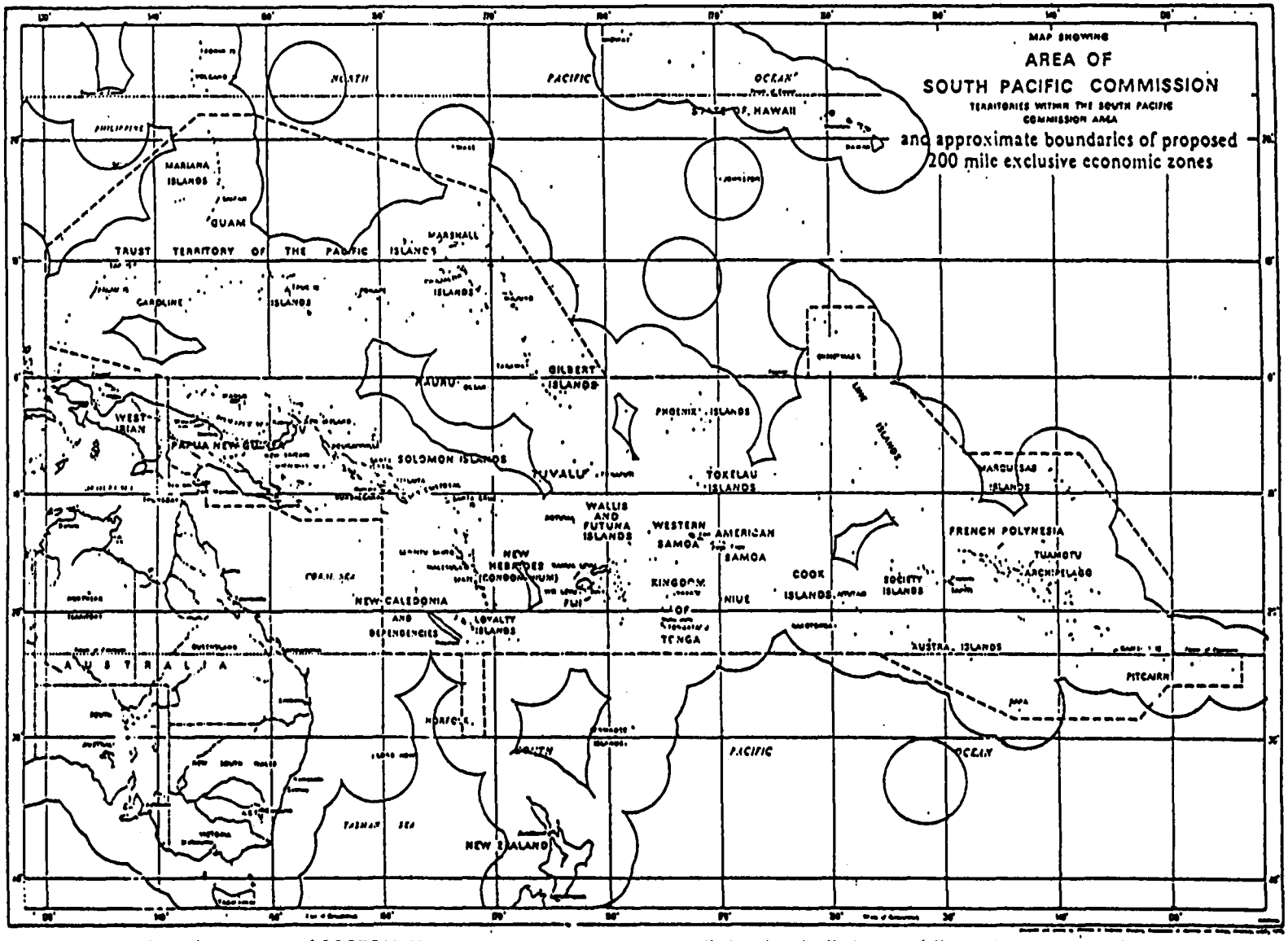
The region (Figure 1) encompasses 22 island countries or territories having jurisdiction over approximately 552,000 km^2 of land scattered through some 90,000,000 km^2 of ocean. Population size varies from as few as 70 on Pitcairn Island, and 1,600 in Tokelau to over 3,000,000 in Papua New Guinea, Table 1. The constraints facing development therefore vary greatly from country to country; a number are more general, operating in the majority of states within the SPREP region:

Geographic - The tyranny of distance is such that most states are faced with communication and transport problems which dominate their economy and that of the region.

Resource constraints - the nature of the resource base for most states dictates the involvement of high-energy, high-tech and hence high-capital development inputs. These characteristics, coupled with a shortage of local expertise result in continued dependence on international agencies and multi-national companies for development opportunities.

Such agencies and companies have their own plans, priorities and modes of operation which often conflict with the needs of small island states. Even where conflict is not inherent the separate goals of the multinational developer impinge on the priorities of the host nation.

For most small island states in the Pacific the resource base is marine; development of such resources often poses particular problems since the resource itself may not recognise the national boundaries. Jurisdiction over migratory fish populations such as tuna may be vested in several countries; over-exploitation by any one country, not necessarily Pacific based, may therefore affect the resource base of another.



Estimated boundaries by courtesy of ORSTOM, Noumea

Estimation des limites due à l'aimable concours de l'ORSTOM, Nouméa

Figure 1. Area of the South Pacific Commission

Table 1. Countries of the South Pacific Commission area; political status, land & sea area, population. (Sources: Australian Foreign Affairs Record, 1983; NPEP, 1983).

Name	Status	Land area Km²	Sea area '000,	Popn. Km²
Western Samoa	Independent	2,935	120	156,400
Nauru	Independent	21	320	7,300
Fiji	Independent	18,272	1,290	634,100
Tonga	Independent	699	700	97,400
Papua New Guinea	Independent	463,840	3,120	3,010,727
Solomon Islands	Independent	27,556	1,340	225,200
Tuvalu	Independent	26	900	7,500
Kiribati	Independent	690	3,550	58,600
Vanuatu	Independent	11,880	680	117,500
Cook Island	Self-Gov.	240	1,830	17,900
Niue	Self-Gov.	259	390	3,400
Tokelau	NZ Dependency	10	290	1,600
Pitcairn	UK Dependency	5	800	70
Marshall Islands	USA Trust Terr.	171	970	31,000
Palau	USA Trust Terr.	495	-	14,800
Fed. States of Micronesia	USA Trust Terr.	727	-	76,050
Northern Mariannas	USA Trust Terr.	471	-	16,900
American Samoa	Unincorp. Terr.	197	390	32,400
Guam	US unincorp. Terr.	549	-	106,000
New Caledonia	Overseas Terr. Fr.	19,103	1,740	139,400
Wallis & Futuna	Overseas Terr. Fr.	255	300	10,800
French Polynesia	Overseas Terr. Fr.	3,265	5,030	148,100

Population - With the exception of PNG most Pacific Island states are too small to support an independent, nationally based training for scientists and technologists. It has been suggested that a population of 5,000,000 is necessary to develop indigenous science, although New Zealand with a population comparable to PNG of around 3,000,000 disproves this assertion. It remains obvious that smaller Pacific countries are unlikely to become scientifically self-supporting in the foreseeable future. Nineteen of the 22 countries have populations of less than a quarter of a million and only Fiji and PNG have populations greater than 500,000. Certainly the critical mass of scientists in most countries will be too small to respond internally to the full range of scientific problems posed by environmental and resource management.

Educational - the relatively short history of formal education and the diversity of colonial and recent historical experiences have created educational barriers to regional cooperation; these include language barriers and a diversity of curricula and educational standards and opportunities.

Economic - As stated above the primary purpose of resource development is to improve basic services; however the lack of economic development impinges directly on a number of the other constraints, including education. The full potential of the population of small island states remains unrealised since the economic base is inadequate to provide sufficient educational opportunities for all who might benefit from them. Given the expense of scientific and technological training at all levels this problem becomes particularly acute in the scientific and technological development of resources.

Taken together the above factors dictate a need for regional co-operation not merely in the education and training of skilled personel within the region but in the sharing of expertise and experience.

Regional approaches to such problems will require novel solutions rather than transference of unsuitable models from elsewhere. The development of novel solutions to regional problems demands a more integrated data base covering such unique fields as local knowledge of resources and their use. Given that many of the environmental management problems of the region result from imported materials, novel answers to problems of pollution, re-use, and recycling become imperative. Without an adequate data base, and well developed regional cooperation, scientific and technological developments within the region will follow a fragmented pattern in which mistakes will be replicated in different countries at large cost to national and regional development.

The starting point in any development, environmental plan or, project assessment is a comprehensive inventory of available data on the natural resources and traditional knowledge available for a particular region, area or project. This is necessary in order to identify gaps, problems and issues of concern. Where gaps are identified in the knowledge base it becomes necessary to undertake primary data collection.

The primary collection and interpretation of resource and environmental data is both expensive and time consuming. Having collected such data once there exists the need to make it immediately available; to provide for multiple use; and to store it in such a manner that it remains available for later re-use. Without the latter provision costly repetition or duplication of primary data collection results.

Within the Pacific a considerable volume of research and information collection has been undertaken; data exist in many government departments and agencies; much has been published; some exists overseas; whilst most information is scattered between diverse depositories which are often unaware of each others existence. Lack of incountry knowledge concerning the existence of such data sets may not simply result in costly duplication of the collection process but more frequently, and perhaps worse still, planning and decision making in the absence of data, due to financial or manpower constraints which preclude collection and/or collation of data.

The increasingly important need for access to integrated resource and environmental information is due to a number of factors currently operating in the Pacific region. Such factors include;

. decentralisation within the island governments;
. increased pressure on the resource base of the region;
. the desire of the population to actively participate in the cash economy;
. increased mobility;

pressure for increased social services.

In addition many governments are implementing legislation which requires assessment of the impacts of development projects on the environment and resource base. Coupled with this, is the desire of the public for a greater involvement in the planning and decision making process, particularly as this *affects* traditionally owned land and resources.

2.2. RESOURCE INFORMATION & COLLECTION:

Whilst the issues outlined above may impinge directly upon environmental management and resource development it should be noted that many other constraints may operate less directly upon sustained resource use and development. Such constraints may include administrative, institutional, political and social factors peculiar to individual countries. Two more broadly based constraints operating at a regional level include information and manpower. Thus a recent UNESCO mission (Wilson, et. al., 1986) reviewing issues related to the management of science and technology for development in the Pacific, noted; "decision makers perceived a clear need for information resources" and they concluded that "the development of appropriate technological information systems to assist decision makers" was an issue of key importance to the region.

As with the distribution of the resource base itself, information concerning that base is both incomplete and uneven. For some areas data may be lacking or only partial in coverage; in other instances it may exist, but be inaccessible or unusable. Data published in scientific journals may not be available within the region or may be compiled in a form unsuitable for use by planners or administrators. In many cases physical material is domiciled overseas and hence knowledge concerning such material only becomes available for local use quite slowly.

The perceptions of scientists from outside the region can affect both the mode of data collection; the nature of the data collected; and the view of priorities in research. The role of visiting scientists is frequently the subject of emotional discussion and controversy. A number of island states have imposed restrictions, including the imposition of quite high fees on visiting researchers.

Planners and politicians are often quite uncertain themselves about the relevance of research, and the sectoral nature of much research effort means that an holistic picture of resources and their inter-relationships is missed. This may be particularly true for smaller states without a resident scientific capability to assist the planners and politicians in "interpreting" science and technology. Such problems frequently result in a "mismatch" between perceived research needs and appropriate research in relation to development objectives. As a consequence, much of the so-called applied research is in fact innappropriate to the stated aims and objectives.

A primary task of SPREP is thus, the collection and organisation of natural resource and environmental information in such a way as to render it usable and available to those formulating policies; to those involved in project identification; and to those working on the formulation, evaluation or undertaking of environmental assessments.

Availability at the time of critical policy or planning decision making is of paramount importance. Whilst ready access to data can improve efficiency and effectiveness of planning activities at all levels - local, provincial, national and regional it cannot guarantee its use and/or effectiveness. Inadequate legislative, institutional, structural or financial conditions may preclude its availability at the time the decision is processed. An integrated approach at all levels of decision making is seen as the sole means for expediting and increasing the cost-effective implementation and consideration of primary resource data inputs to the solution of development problems, in the region. Any system developed for accessing data must be capable of providing such data promptly; in the correct format and, via the correct channels where such exist.

Technical aspects of compatability, conformity and uniformity with respect to the data itself, together with the methodology employed in its collection; the terminology used in its description; the criteria used in its evaluation, and the classification of the data are important in both a regional and end-user context. A fixed approach to such problems is however not advocated; equally important is a flexible approach which makes due allowance for problems of scale; local diversity; local manpower constraints and the different approaches to resource exploitation currently adopted by the countries of the region.

In this regard the global conceptual framework outlined by the United Nations Statistical Office (Figure 2) provides one basis for the collection of natural resource and environmental data and information, is such a manner as to render it useful for:

. policy definition and/or evaluation,
. project definition and/or evaluation,
. continued monitoring or environmental and/or project parameters,
. identification of knowledge gaps,
. evaluation of relationships, processes and impacts in an environmental and national context.

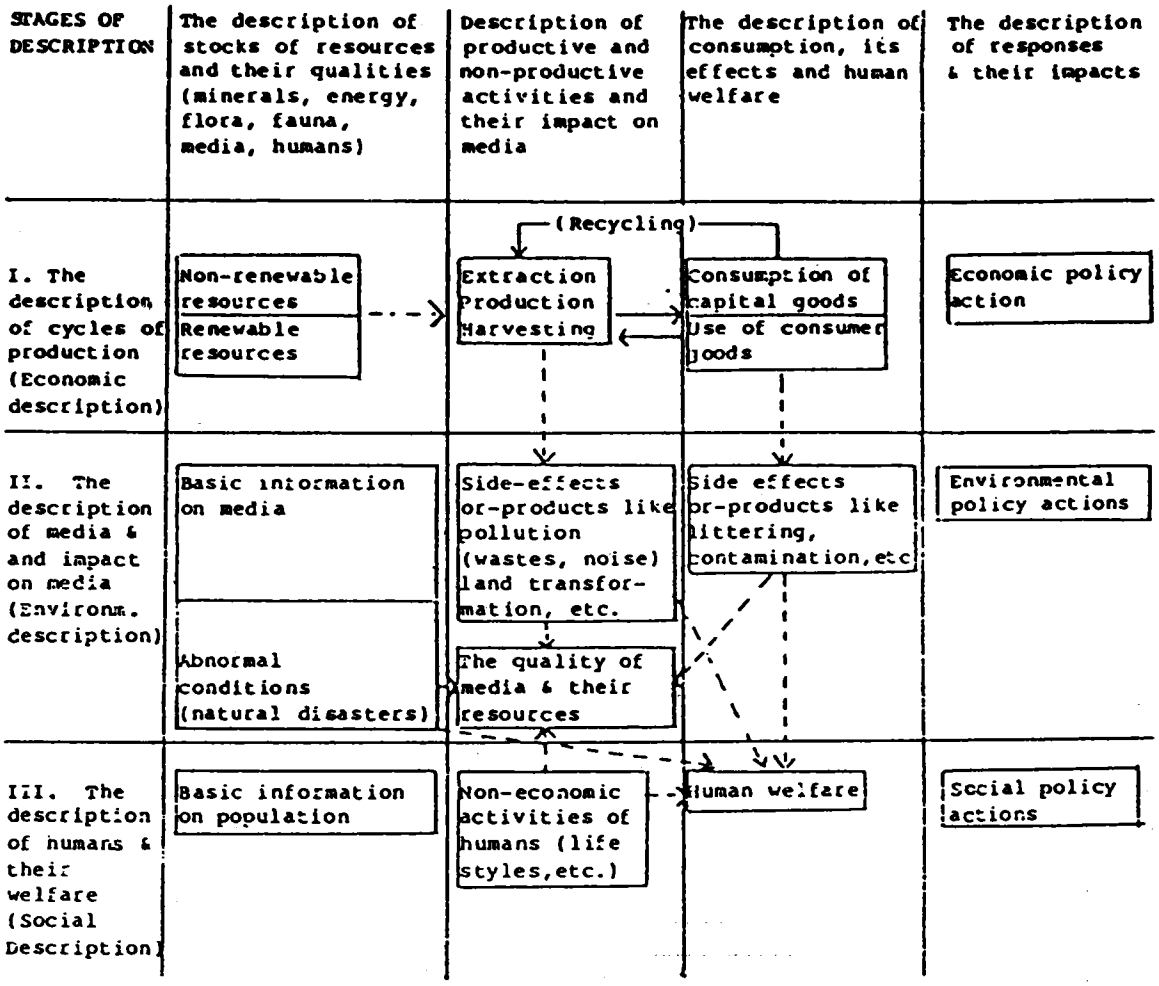
The model has applicability for local level planning in that it recognises three major input sectors; economic, environmental and social/institutional. More importantly perhpas the data can be described at various stages; standing stocks, rate and type of exploiitation/change, side effects (such as polllution or environmental degradation), responses in terms of policy, legislative or other necessary administrative changes. The implications of these points for databank design are considered later.

2.3. USERS:

The following users of natural resource and environmental data can be identified at present:

. Provincial & National Government Staff including policy makers, programme managers, enforcement and research officers;
. Personel involved in regional & International agencies;
. Private sector and industrial personel;

Figure 2. A simplified analytical model for environmental statistics



Source: UNSO Towards Co-Ordination of Environmental Data: A Draft Conceptual Framework for the Development and Organization of Environmental Statistics Second Draft Restricted September 1980, New York.

. Consultants and commercial sector personnel;
. Academic Researchers;
. Students & Teachers at all educational levels;
. Individuals/groups involved with curriculum & other educational materials;
. The general public.

2.4. INFORMATION NEEDS:

The types of information required and the initial capabilities of the databank can be defined as follows:

. Locate results of previous & current research;
. Locate information on successes and failures of projects, policies and programmes;
. Locate information on previous approaches used to solve specific problems;
. Locate historical data for comparative and/or monitoring purposes;
. Identify persons, agencies or Institutions working in particular fields or with specific unpublished data sets;
. Locate information on a geographical basis.

Where possible the capability to provide specific information should also be included, although it is recognised that this capability will be developed following successful compilation of directory style data bases covering the above fields.

2.5. BENEFITS OF INTEGRATION:

The collation of natural resource and environmental data and its integration could result in important benefits as follows:

. Reduced duplication of research effort;
. Better integration of research results for use in solving practical development problems;
. Identification of existing knowledge gaps & hence stimulating appropriate research inputs;
. Greater interaction between policy planners, administrators and researchers;
. Heightened awareness of current research and developments, both nationally and regionally;
. Heightened awareness of centres of expertise/experience.
. Greater awareness of data sources/depositories
. Stimulation of a more integrated approach to research problems and data collection.

3. INFORMATION SOURCES

3.1 BACKGROUND

As indicated above the starting point for sound environmental planning, assessment and development is a comprehensive inventory of existing data and information. This is also a necessary pre-requisite to the identification and sharing of appropriate regional experience and expertise.

Data currently exist in a wide variety of sources including:

. published & unpublished reports;
. bibliographies;
. on-going research inventories;
. data systems, at local, regional and international levels;
. museums and herbaria;
. traditional knowledge repositories.

In addition data are continuously generated by on-going research, environmental, and resource surveys.

3.2. PUBLISHED/UNPUBLISHED REPORTS:

Published information can be accessed through primary journal publications, secondary summaries, abstracting journals, bibliographies and personal contact with professional colleagues.

In the latter instance, countries which have a history of organised research and the application of such findings to project planning normally possess facilities/organisations which provide inventories of research projects, institutions and scientists working in particular fields.

The role of Professional societies in such a facilitation of information flow is of paramount importance. The existence of such societies is itself based on a large pool of professionals operating within a well-defined geographic area or scientific sphere. Most Pacific countries lack a sufficiently large pool of scientific professionals to support the existence of such bodies within the individual countries of the region. The history of such professional associations as the Scientific Societies in Fiji and Papua New Guinea, demonstrates the "stop-start" phenomenon resulting from small size.

The Pacific Science Association Bulletin provides such services on a regional basis; however it fails to reach many national scientists and administrators. The recent re-establishment of the PSA Science Communication and Education Committee may hopefully alleviate this problem, however the fact remains that for many of the smaller countries of the region the administrative capability to articulate with such larger and more extensive professional bodies is frequently lacking. Contact is maintained by individual professionals who are affiliated to such bodies. Continuity of contact is thus dependent upon individuals rather than incountry organisations.

Many scientists in the Pacific Rim countries undertake research in the Pacific Basin; they maintain contact with one another via the PSA. However they are frequently unaware of colleagues within the basin countries whose research is more restricted or

local in its publication. Such visiting scientists are frequently required to provide reports to the host country following completion of their field research and are often required to send copies of their publications back to that country.

Even where this is a requirement the administrative mechanism for ensuring that such publications become available or are directed to the appropriate incountry personel is frequently lacking. The reports/scientific papers go to the Departments of Foreign Affairs or visa issuing agency and even when redirected to the correct body frequently end up in the personal reprint collection of a scientist who is himself only temporarily resident in the country concerned. Such administrative problems are not confined to reports and papers generated by external personel, it is often the case that consultant reports resulting from incountry requests or activites fail to be deposited in a manner which allows easy access or retrieval.

The limited financial resources of smaller Pacific countries without tertiary educational institutions or large research establishments result in limited acquisition of scientific journals. In addition the high cost of abstracting services and their limited retrieval of relevant material results in limited and infrequent use of published literature by scientific administrators. This problem is further compounded by limited training in the use of abstrating journals, bibliographic facilities and even reprint request facilities. The result is frequent underuse of the existing published information base.

3.3. BIBLIOGRAPHIES:

Selected bibliographies listing papers on specific topics or covering specific fields represent a useful source of information for research workers in a particular field. A compilation or directory of such bibliographies would provide an important resource to "field" identification, whilst the bibliography itself remains more specific and detailed. The bibliography itself is often less useful for a resource planner or environmental manager than is a directory in combination with the bibliography. Judicious use of both, identifies likely fields, and gives the planner an indication of what material is likely to be available concerning a particular resource or geographic area. Often the "fields" which are needed to be covered by a resource manager are more extensive than the "fields" covered by specific bibliographies.

In this regard, geographically based bibliographies are often of more value. The needs of the resource planner have been recognised and a wide variety of bibliographies relating to particular countries have appeared in recent years. In combination with the subject specific bibliographies these form an extensive "set", the range is indicated in Table 2. Access to citations in bibliographies depends however on library facilities and/or document delivery services which are available.

Table 2. Selected Bibliographies on the Pacific Area

A. GENERAL:

Leeson, I. 1954. A Bibliography of Bibliographies of the South Pacific. Oxford University Press, U.K.

Cammack, F.M. and Saito, S., 1962. Pacific Island Bibliography. Scarecrow Press Inc., USA.

Taylor, C.R.H. 1965. A Pacific Bibliography: printed matter relating to the native peoples of Polynesia, Melanesia and Micronesia. Clarendon Press, U.K.

Dickson, D. and Dosser, C. 1970. World Catalogue of Theses on the Pacific. ANU Press, Australia.

Copell, W.G. and Stratigos, S. 1983. A Bibliography of Pacific Island Theses and Dissertations. Univ. Hawaii Press, USA.

PIC. 1980-. South Pacific Bibliography/South Pacific Periodicals Index. PIC/USP Library, Fiji.

B. ISLAND BIBLIOGRAPHIES

O'Reilly, P. 1955. Bibliographie de la Nouvelle-Caledonie. Public. de la Societe des Oceanestes No. 4. France.

O'Reilly, P. 1958. Bibliographie des Nouvelles-Hebrides. Public. de la Societe des Oceanistes, No. 8. France.

Snow, P.A. 1969. A Bibliography of Fiji, Tonga and Rotuma. ANU Press, Australia.

Quinn, S.S. 1978. The Northern Mariana islands: An Annotated Bibliography. Bureau of Education, Saipan.

Jinna, K. 1979. Fiji National Bibliography. Library Service, Fiji.

Holmes, L.D. 1984. Samoan Island bibliography. Poly Concepts Publishing Co., USA.

Overy, R. 1981. Kiribati National Collection: A List of Holdings. National Library and Archieves, Kiribati.

UPNG Library. 1967-. New Guinea Bibliography/Ne Guinea Periodical Index. UPNG Library, Papua New Guinea.

Butler, A. 1985. A New Guinea Bibliography. UPNG Press, Papua New Guinea.

C. SUBJECT BIBLIOGRAPHIES

Posnett, N.W. and Reilly, P.M., 1973-1975. Land Resource Bibliographies on the Solomons, Fiji, New Hebrides and New Caledonia. Land Resources Division, Ministry of Overseas Development, U.K.

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The enormous accumulation of scientific literature worldwide has lead to the development of a diverse range of bibliographic and related data banks. Wiliams & Rouse in their "Computer readable bibliographic data bases: a directory and data source book" list over five hundred such publicly available services. They contain over 70,000,000 citations which span a wide variety of subject areas. A listing of some of the more appropriate banks is given in Table 3.

Table 3. International Bibliographic Information Bases.

AGRICOLA	World agriculture
ASFA	World fisheries and aquaculture
BIOSIS	Worldwide life sicences
Enviroline	Environmental sciences
Environmental Bibliography	Environmental sciences
Oceanic Abstracts	World marine
Pollution Abstracts	Environmental science
SCISEARCH	World science and technology

In accessing these systems a number of problems are encountered; systems differ hence searches must frequently be undertaken by a "search analyst". Table 4 illustrates a further problem; this lists the results of a number of searches by country from various abstracting services via DIALOG. Environmental and resource publications on the Pacific are poorly covered in these data bases which also take no account of Government publications and reports or environmental impact statements; time coverage is also limited since most data bases extend backwards only ten to fifteen years. Hence the results of such searches are diffuse and patchy, furthermore access to DIALOG within the Pacific is also extremely limited.

Table 4. Country related citations found via searching various databases in DIALOG. (Search term is the name of the island).

	DATABASE				
	Oceanic Abstracts	Enviro-line	Pollution Abstracts	ASFA	Environ Biblio-graphy
COVERAGE	'64-'85	'70-'86	'70-'86	'78-86	'74-'86
COUNTRY					
Cook Islands	27	2	0	20	3
Tonga	67	5	2	119	6
Tuvalu	2	0	0	14	2
Kiribati	5	0	1	24	2
Vanuatu	14	2	0	57	0
Niue	4	0	0	9	3
Solomon Islands	9	0	0	9	3
Papua New Guinea	149	61	8	417	149

The perception of problems related to the development of national and regional biobliographies were canvassed at a meeting in Suva in 1978 (Holdsworth, 1979) which made recommendations concerning standardised formats and the need for policy on national information systems. Little in the way of concrete action appears to have taken place although a number of more recent developments have addressed the two-fold problem of unpublished and published information, ie:

. locating what is available,
. obtaining copies (accessing identified sources),

The most important of these developments are:

3.3.1. Pacific Islands Ecosystem Data Base

A comprehensive, multidisciplinary, machine-readable file or references to the literature on the Pacific Islands under the jurisdiction of the USA. It covers biological, ecological, physical and socio-economic aspects of the coastal ecosystems of the Pacific Islands and the impact of human activity on the environment of the region. The geographical area is defined as the Hawaiian Islands; American Samoa; and the micronesian islands under US jurisdiction.

It covers published and unpublished materials, including journals, serials, monographs, technical reports, theses, unpublished reports and environmental impact statements. Some 20,000 references dating back to 1927 are included. It is updated annually. Searchable files include accession number, title, author, organisation source, publication year and index terms. No restrictions are placed on access. It is operated by the US Fish and Wildlife Service.

3.3.2. Pacific Information Centre (PIC)

Formerly the Regional Bibliographic service run by the University of the South Pacific Library, this operation has recently received funding from the International Development Research Council (IDRC) to establish a multi-disciplinary bibliographic information and document delivery service. Hard copy documents include the South Pacific Bibliography and specialised subject bibliographies and inventories of research workers.

3.3.3. PNG Information Network

This is a computer based system running on the University of Papua New Guinea's Prime 750 minicomputer using ADLIB software. It contains a number of relevant information and databases covering:

- New Guinea Bibliographic Index - containing bibliographic details of some 40,000 publications (monographs and Journal articles) dealing with the island of New Guinea. It is accessed using author, title, keywords, subject, date of publication, publisher and Province. A microfiche catalogue is produced twice yearly and a hard copy New Guinea Bibliography in five volumes will be complete by 1987.

- Archives Index - covering the archival material held by the UPNG New Guinea Collection. It can be accessed in the same manner as the main bibliographic Index.

- PNG Photographic Index - This will contain records describing some 14,000 photographs currently held in the New Guinea Collection; it also indexes illustrations in books and journals in this collection. Subject to agreement, materials in other photographic collections within the country will be included.

- Melanesian Research Index - Compiled from records of Research in Melanesia and Science in New Guinea this will describe research, past and current; dealing with the New Guinea Region. It will be accessed by researcher name, geographical area, subject, ethnic group, date, and affiliated Institution.

- Natural Sciences Data Bank - funding has been sought to develop an initial

data base covering the major vertebrate collections held within the country and in overseas museums. Experience with ADLIB indicates that this is an adaptable and acceptable programme for this purpose. The user can set up his own data base, with appropriate VDU screens for inputting and can output data in whatever form and/or order is considered appropriate.

At this juncture it should be noted that PNG has a number of overlapping systems. These are usually single disciplinary bibliographic systems. Thus the Division of Fisheries for example has developed a micro-computer based, independent, fisheries bibliography. Lack of standardisation in citation format and software results in limits on information exchange. There exists an urgent need for the formulation of national and regional policy which would foster a joint, co-operative approach among the institutions of the country. Such co-operation and policy definition is also needed at a regional level.

3.4. RESEARCH INVENTORIES:

Direct contact with active research workers in a particular field or geographic area can provide Government decision makers with information not yet in print; furthermore it provides an opportunity for researchers to answer specific questions which may, or may not have been directly addressed when the research was undertaken or prepared for publication. For many administrators in the Pacific the difficulty lies in identifying who is doing what in particular areas. To assist this problem many journals and newsletters maintain inventories of research workers and ongoing research topics, (a number have been mentioned above) however the problem of making administrators and decision makers aware of such inventories remains.

The recently published directory of marine environmental centres in the South Pacific (UNEP/FAO) provides a useful listing of Institutions and their capabilities, while compilations of research workers have been undertaken by the various committees of the Pacific Science Association (eg Coral reef researchers; botanists). Some countries and/or Institutions have periodically compiled and issued inventories of research in progress, as for example the Solomon Islands Research Register and the register of New Zealand Research in the Pacific.

Within the Pacific, many countries have instituted procedures and conditions for the affiliation of foreign researchers. Such procedures are designed to keep individual Governments informed of the research being undertaken under their jurisdiction. As discussed above this does not necessarily lead to better internal information flow between different government agencies. If Governments were to define more cohesive research policies and priorities it is possible that a better match of available research expertise and needs could be made.

The great number and variety of people, institutions and agencies involved world-wide in research on national resources and in environmental monitoring has lead to the development of international information retrieval systems. A listing of relevant systems is given in Table 5.

Table 5. Inventories of Research-in-progress

Current Agricultural Research Information Data System (CARIS)	Agricultural science including nutrition and rural development. In cludes broad range of elements: project title, investigators, objectives, descriptors etc.
Current Research Information on Science and Technology Policies (TRUSP)	Multidisciplinary research on science and technology policies and R&D management data elements similar to CARIS
Index of Current Tropical Ecology Research	Environmental sciences and ecology of the tropics; item coverage similar to CARIS
International Environmental Education Network	Environmental education; similar item coverage to CARIS
MAB (Man and the Biosphere) InformationSystem	Environmental Sciences; similar item coverage to CARIS
Research Strengths of Universities in Developing Commonwealth Countries	Broad coverage; base covers research strengths description indicates keyword description, number of research workers, equipment available etc.
South Pacific Register of Research and Investigations (SPRRI)	Research in progress within the Pacific; item coverage similar to CARIS

3.5. MUSEUMS & HERBARIA:

In addition to the bibliographic resource data a further, important source of primary data is associated with the catalogued collections of biological material held by museums and herbaria within countries of the Pacific or in metropolitan institutions. Collections in Papua New Guinea include:

. National Museum - mammals, birds, reptiles, amphibians and some invertebrate groups; Port Moresby,
. Department of Primary Industry - national insect collection. National fish collection; Port Moresby,
. Wau Ecology Institute - insects and some vertebrates,
. UPNG Natural Sciences Resource Centre - insects, vertebrates, herbaria &

geological collection; Port Moresby,
Office of Forests - national herbarium, Lae.

The Bishop Museum in Hawaii and the Australian Museum in Sydney also hold extensive collections from the Pacific region as do some 50 other metropolitan museums and herbaria in Europe and America.

Computerisation of these data is, in a number of instances already in hand, however access to a computerised record of these holdings based on the region, rather than the Institution would provide planners and in-country scientists with access to the location of reference specimens and unpublished data on the distribution of resource species.

The extensive work undertaken for the Australian biotaxonomic information system, as part of the Australian Biological Resources programme, provides a relevant model for the Pacific. Institutions holding biotaxonomic information in Australia employ computer data management systems in labelling, cataloguing and cross-referencing new accessions. Retrieval and manipulation of data on distributions and other paratmeters is also possible. A common information system with the capacity to interchange machine readable data has been developed, yet each institution remains responsible for the management and control of information relating to its own collections.

3.6 TRADITIONAL KNOWLEDGE:

Johannes (1981) prepared a topic review on making better use of traditional knowledge in managing Pacific Island reef and lagoon resources. His work and that of various others such as Dahl (1985) for New Caledonia and Morauta et al, (1982) for Papua New Guinea have demonstrated that a substantial, largely untapped reservoir of resource and environmental information is to be found in the traditional knowledge of Pacific Island populations.

A systematic exploration of one aspect of the traditional knowledge base was attempted at the conference "Traditional Conservation in Papua New Guinea: implications for today" which was held in Port Moresby in 1981. The value to scientists and administrators of tapping the traditional knowledge base was made abundantly clear. The value of this knowledge base has been further demonstrated by the use made of local informants by Pernetta in the Ok Tedi Environmental Impact assessment where substantial data were collected in a short time frame. Similarly Pernetta & Hide in a longer study of land use in the Simbu Province made extensive use of local informants. In both cases local people provided quite detailed and explicit information concerning the distribution, habits and ecology of various species occuring within their own areas.

At a time when the rate of change is accelerating within the Pacific it is increasingly apparent that if the scientific knowledge base is to keep pace with the change to the environments and resources of the region the rate of knowledge acquisition must be greatly increased. One way to achieve this would be through a more systematic and concerntrated approach to the utilisation of the traditional knowledge base. More importantly the rapid pace of educational change within the region, has and continues to result in loss and erosion of traditional knowledge. If the scientific community is to provide the necessary data for resource management without "rediscovering" information which is already known by local people then a concerted effort must be made to record and make available traditional knowledge.

3.7 DATA BANKS:

In addition to computer based biliographic and inventory systems, systems providing numeric data are now becoming more commonplace. A recent development, 'Knowledge Bases', which contain an analysis and/or synthesis of published data sets in a given field, are also beginning to appear.

The magnitude of the task involved in developing a data system for all natural resource and environmental fields has meant that International efforts have been largely directed towards closely defined areas. The development of these, is itself contingent upon standards being developed for sampling, measuring, intercalibration and other aspects of standarisation.

Table 6. Regional and International sources of natural resource and environmental data.

SOURCE	COMMENT
Commonwealth Regional Renewable Energy Resource Information System (CRRERIS)	facilitating interchange of information on renewable energy sources; initially bibliographic and document delivery; later develop of data files
ORSTOM Service Hydrologique	Water stages; discharge measurements; sediment transport
Marine Pollution Information Centre	Environmental effects; contaminants; marine pollution; pesticides
Committee on Data for Science and Technology (CODATA)	provision of data in the sciences
Global Environment Monitoring Service (GEMS)	systematic collection, analysis and evaluation of environmental and pollution data
Industrial and Technological	provision of limited, analysed and annotated information on

Information Bank (INTIB)	technological alternatives.
INFOTERRA	International exchange of environmental information, by referral to data sources and registered expertise
International Register of Potentially Toxic Chemicals (IRPTC)	collection and dissemination of data and information on substances toxic to man and the environment
International Seismological Centre (ISC)	collection of seismic data
International Tsunami Information Centre (ITIC)	collection of tsunami information
Marine Environmental Data Information Referral System (MEDI)	Referral centre for information on the location and characteristics of marine environmental data
TECHNONET	technical information on small and medium-scale industries
World Weather Watch (WWW)	meteorological and other environmental information

The world data centre for Oceangraphic data for example, contains information recorded from oceanographic and bathymetric stations, geological samples, geophysical measurements and surface and sub-surface currents. The activities of the world centres are co-ordinated between regional and national agencies. Thus the Japan Oceanographic Data Centre, has agreed to act as the co-ordinating centre for the WESTPAC region.

Another relevant example of an international data base system is the NIH-EPA Chemical Information System. It is a publicly accessible computer system for chemical information, developed jointly by a number of US Government agencies. The system contains spectroscopic, crystallographic, toxicological and regulatory data on more than 200,000 chemicals (see Milne et al., 1982). Other examples of such systems are listed in Table 6.

Numerous data systems exist for single resources; the Guam Environmental Protection Agency for example uses the US water quality data base called STORET. Guam EPA submits over 21,000 data values annually in eight complexes which consist of 13 reef flat, 37 marine and 31 river stations. The data sets cover a wide range of water quality parameters. The system also contains various statistical, data presentation and water quality index programmes which operate on the data base (Rowley, pers. comm.). Within PNG, a number of single resource data systems have been developed or are currently in the development stage. These cover

metereological, river-flow, land use and some wildlife information.

3.8 COMPUTERS AND COMPUTER USAGE IN THE PACIFIC:

The falling cost and increased capacity of microcomputers has resulted in a rapid increase in their use throughout the Pacific over the last few years. The South Pacific Commission surveyed computer usage by statistical offices throughout the region in early 1985 (Janssens, 1985). A summary of various aspects of the survey results are shown in Table 7. It can be seen that practically all statistical offices use some type of computer.

Whilst NCR and IBM are the more common 'large' computers a significant diversity of brands and models of microcomputors are also in current use. Most are recently purchased indicating the rapid acquisition of this technology in recent years. Usage is mainly concentrated on statistical analyses of census and other data, financial projections, survey processing and national accounts. Smaller units are used for a variety of activities as indicated in the table. In some countries the capacity to develop software and applications "in-house" exists but all make extensive use of purchased packages. Many offices indicated that they anticipated significant expansion of their usage of (especially) microcomputers in the immediate future.

It should be noted that the Janssen survey only covered the computing capacity in statistical offices. In some cases, Nauru and the Solomons for example, the large computers exist within a central government computer centre. In others the survey is indicative of the capacity of statistical offices and not usage elsewhere in the government. Thus, a survey by Sacault (1983) in French Polynesia indicated a total of 242 micros (IBM, TRS, Apple & Sord), 56 minis (IBM & NCP) and 5 mainframes (IBM). Similarly it is known (Salter-Duke, 1984) that the total computing capacity in PNG is considerably larger than indicated in Janssens survey.

One can conclude that computer use in the Pacific is here to stay; that the current uses are likely to diversify as people develop confidence and awareness of the range of applications which are possible. Except in a few cases little use has been made to date of computers for the compilation, storage, manipulation and retrieval of natural resource and environmental information and data. In those cases where this is going on, it is usually sector restricted. Thus, Vanuatu, is implementing a microcomputer project with the introduction of 20 micro-computers into a range of government departments, (circular letter, Janssens, 1985). Agriculture is using them for budgeting, accounting, word processing, inventory, research and data analysis; Fisheries for fisheries statistics, foreign vessel licensing and budgetary control; Planning for economic data base management of development projects and the meteorological office intends to use them for the storage, quality control and processing of climatic data.

Table 7. A summary of computer usuage by Statistical Offices in the South Pacific (after Jannsens, 1985)

COUNTRY	LARGE	MICRO	APPLICATIONS
American Samoa	-	Morrow, Zenith	?
Cook Island	-	Altos	Survey census, migration
Fed States Micronesia	-	-	-
Fiji	NCR	Sord, Commodore	word processing, graphics, surveys, statistics,cpi, national accounts
French Polynesia	IBM	Apple	wp,graphs,census trade stats, projection,cpi, vital stats, national account
Guam	Molecular	IBM,Apple	ditto
Kiribati	-	IBM	graphics,census
Marshall Island	-	Apple	wp,stat.analysis
Nauru	IBM	-	survey,census, national accounts
New Caledonia	IBM	Sord, Apple	wp,graphs,survey, census, stats. analysis, trade stats, cpi, projections, labour migration, vital stats, national accounts
Niue	-	Sanyo	Labour stats
Nth Mariana Islands	-	Wang	Labour stats
Palau	Wang	Apple	wp,graphs, survey, stat. analysis, trade labour, migration stats
PNG	Honey	-	full range of applications
Solomon Island	NCR	Apple	wp,graphs, survey, stat analysis,trade labour, migration stats
Tokelau	?	?	
Tonga	-	A.E.D.	wp,stat. analysis, trade stats
Tuvalu	-	Corona	cpi,national accounts
Vanuatu	NCR, Spectrum	Apricot Apple,Xerox	full range of applications
Wallis and Futuna	-	Sord	?
Western Samoa	IBM	IBM	wp,surveys, census, cpi, trade,migration stats

A number of activities relevant to the concept of an integrated natural resource and environment data bank are taking place in PNG.

An integrated population and socio-economic data system for PNG has been developed by the National Statistical Office, called the "PNG Provincial Data System". It provides a computor based inventory of population, its demographic characteristics and the services located within any census division. The former data are largely derived from the National Census and its periodic, partial updates, whilst the latter are derived from surveys of health, education, transport, public utilities, administrative faciltiies and commercial activities. Manipulation of the data permits the derivation of various social indices and the output can be presented as tables, and maps, an example from the Rural Community Register is shown in Appendix 3.

Mapped presentations of these data and community access features have been shown to be a powerful tool in planning and budgeting sessions. The National Statistical Office is currently in the process of decentralising the system; over the next five years each Provincial Government will acquire a Honeywell DPS6/22 computer with the provincial data set for local use. Considerable effort has been invested in training and use of the data and several provinces have already acquired computers with their own funds. As a result, rapid development in the collection, verification, inputting and analysis of data for local needs is already occuring.

Another development is the PNG Resource Information System, containing land resource information for the whole of the country. This system draws heavily on the data collected by the CSIRO Land Use Surveys and the work of the Department of Primary Industry. Whilst the initial aim of the project is to assess the agricultural development of the country for village based food and cash crop production, its potential application is far wider.

This system is established as a microcomputer data base (8 or 16 bit running under CP/M operating systems) using an FMS-80 software package. It contains information relating to physical and socio-economic characteristics stored on discs within a series of separate files; these are entities composed of a collection of records, each of which contains a number of fields; each field contains information on individual attributes. The system can be accessed directly or indirectly via a query system. Information in the various files has been integrated into a land resources file containing the information relating to "Resource Mapping Units"; bounded areas in terms of the land resource attributes (eg. landform and climate). Resource information relating to each RMU has been recorded within a single record (see sample printout in Appendix 3).

A further development drawing on the above mentioned systems is the New Ireland Natural Resource and Environmental Statistics Data Base. This is a pilot project for the UNEP National Natural Resource Data Bank mentioned in Chapter 1. The data base consists of four separate but inter-related components; bibliographic, research in progress, data sources and data subfiles. These are arranged by subject category: General - legislation, policy, planning documents, maps, aerial and other imagery-; climate; geology; hydrology; lands and soils; vegetation; fauna; coastal and marine resources; culture and sociology; conservation; health and nutrition; demography; hazards and special resource issues.

The first three files have been formatted using the ADLIB programme on the UPNG Prime 750 minicomputer. Searching by subject category, locality and various other descriptors will be possible and printouts will be available for manual searching. Primary data have been compiled from diverse sources and where appropriate this has been tabulated and/or plotted using a 1:250,000 NATMAP as the base with acetate

overlays for us in Provincial Planning. Integration with the above mentioned Provincial Data System and the resource Information System is envisaged in the near future. Discussion has commenced with the UNEP-GRID Processor Facility and the developer of a software package for geographic data management programmes. Additionally work has commenced on the definition of standards and formats for the development of the database files for particular aggregated data subsets. An example for vertebrate distribution is shown in Appendix 3. This project is being carried out in conjunction with the Department of Environment, Vertebrate Recording Scheme and extends this system slightly to provide further information for Provincial Use.

4. MEETING THE NEEDS: A DECENTRALISED PACIFIC RESOURCE & ENVIRONMENT DATA SYSTEM - (PREDS):

4.1 DISCUSSION:

The different colonial and post-colonial experiences of Pacific Island states have resulted in a variety of bureaucratic structures and planning mechanisms (see Larmour and Qalo, 1985). Despite this, decentralisation in one form or another has been a recurrent theme in administrative restructuring in the last ten years. An equally important trend has been the move towards integrated approaches to planning which recognise the inter-dependence of economic, technical, social, and environmental factors in development. Hence attention has been increasingly focussed on the need for and the utility of, data as a resource; this finds expression in the desire of many countries to create or acquire systems designed for the organisation, management and timely provision of data for planning purposes.

Chapters 2 and 3 outlined potential information and data sources and emphasised that such data are both numeric (alpha and aggregated) and textual (bibliographic, inventories and source directories). We noted the difficulties currently facing island states in terms of the compartmentalisation and lack of co-ordination in both information systems and data sets; inequalities in regard to access, both in-country, regionally and internationally; the lack of trained indigenous personel for the collection, interpretation, validation and analysis of environmental and other data; the diverse and often conflicting needs of different users which are of paramount importance in the design and operation of an appropriate system.

The following considerations thus need to be addressed in the design of any regionally co-operative system:

- The need for an institutionalised, but co-ordinated national approach to the collection, organisation and handling of data which can probably best be done through collaboration between existing agencies currently responsible for data collection and processing (Statistical offices; Computer centre; & survey organisations, where these exist) and those agencies (Planning Offices, Secretariats and others) involved in information use and national planning. Since the collection, analysis, evaluation and verification of data are essentially subject oriented the need for close co-operation between "specialists" and "users" of the data is a fundamental requirement for any operational system.

- The need for ensuring compatability between data sets will require agreement on the definition and classification of data groupings, geo-coding schemes and the like.

- The need for a mix of manual and computerised approaches appropriate to the scale, needs and functions of the diverse island states will determine the nature of the database components, hardware and software considerations.

- The manner of dissemination needs to be carefully considered so as to ensure ready access by all users to the data in a form appropriate to their needs. At the same time user education will be required and the system should incorporate a feed-back evaluation system to ensure improvement and development of data services.

- The need for specific training policies and programmes (institutionalised, in-service and on-job) to develop the skills of system operators, data collectors and users.

- The limited financial, manpower and institutional resources of most Pacific countries which mean that priorities and compromises between the requirements for depth and detail in the data bank as opposed to breadth will need to be made as appropriate.

4.2 A PROPOSED SYSTEM STRUCTURE:

Existing information and data systems vary from highly centralised to decentralised, both approaches having advantages and disadvantages. With the rapid developments taking place in mini and micro-computer technology together with advances in networking, resource sharing and communication technology a combination of centralised and decentralised approaches to the present proposal seems appropriate. Local data ownership and timely access in a decentralised system will help encourage local commitment as well as enhancing local, and hence regional capabilities. In contrast a degree of centralisation will improve access to regional and international sources of information and resource sharing with avoidance of unnecessary duplication of effort, both financial and manpower.

At a country level it is vital that each country performs its own data collection, processing and management to achieve: optimal efficiency; avoid duplication; satisfy real time access requirements and ensure efficent utilisation of the data at a planning level.

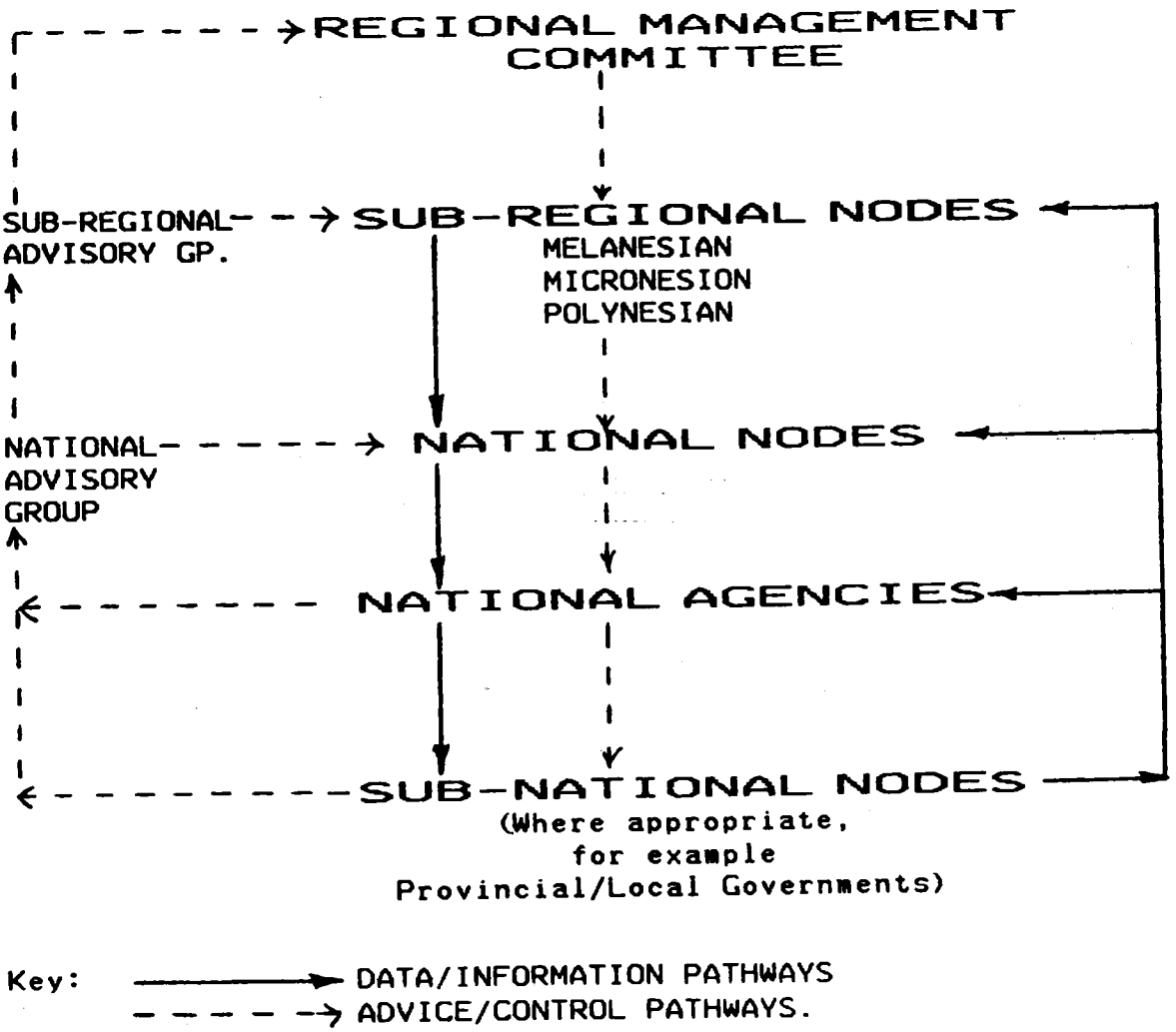
For larger island states such as Papua New Guinea or Fiji, sub-national nodes based on Provincial or local governments may be necessary to achieve the same ends. The experience of the former country suggests that at a national level various specialised, sectoral agencies have already established data bases dedicated to the collection, collation, verification, storage and management of specific data fields. Experience further suggests that mechanisms do not exist for the adequate integration of such data sets and their interpolation into the national planning process, hence the failure of planners to fully utilise them. In such cases a need exists for a national node to establish communication between the agencies and the planning sectors of government. Communication between national agencies and the national node could be via physical transfer of input forms, or computer readable media. Compatibility may present problems due to a current lack of standardisation in developments to date.

In smaller countries a single centralised node may be all that is necessary. Each member country would need to be self-sufficient in its ability to handle local data.

International assistance for the acquisition of the necessary hardware and the creation and implementation of an information system would be vital. In all cases and at all levels however, the concept of participatory management should be practised. This may necessitate the creation of National co-ordinating or advisory committees to achieve optimal interaction between contributing agencies and the users of the data.

Aggregation of data, sharing of regional experience and expertise, and accessing information held in regional or international information systems, databanks and databases could be best brought about through network linkages from individual countries to sub-regional nodes. Logistics, experience and capacity suggest that a minimum of three sub-regional nodes encompassing the melanesian, micronesian and polynesian regions respectively would be necessary; alternative models and structures exist. Communication between national and sub-regional nodes could be via a telecommunication link or again physical transfer of printouts or machine readable media. The possible structure is outlined in Figure 3.

Figure 3. Diagramatic representation of information flow and data pathways between collection and advisory levels in a centrally co-ordinated, decentralised, resource and environment databank system.



Standards in hardware, software, database structure and forms of data transmission will need to be formulated to serve as the basis for detailed system design at the sub-regional and national levels. The network organisation should be structured to suit the varied nature of administration and planning systems in different island states; it is suggested that this could best be achieved by the formation of a regional management committee with participating country membership. This committee should then establish specialised working or advisory groups from among its members to assist in the development of system standards and protocols.

4.3 FILE COMPONENTS:

The discussion on information sources (Chpt. 3) suggests that the file components should initially encompass the following: bibliographic; research in progress; resource and environmental information sources; and for the longer term, data sets. The latter fields could be organised around the data coverage outlined in Table 8.

4.4 BIBLIOGRAPHIC FILE:

The suggested data fields for the bibliographic file are shown in Table 9. In order to serve a broad clientele the file should contain information on a wide range of items including teaching materials, maps, photographs, films, theses, environmental assessment reports, unpublished reports as well as the more usual bibliographic items. Confidential publications and reports should be excluded. The inclusion of a short abstract in laymans language, whilst time consuming to prepare, greatly facilitates later use. Searching of the file would be by classification code, media type, author, date, locality, biosystematic reference and keywords. The manner of recording map reference and locality would need to be determined by the management committee; either standard map grid or latitude and longitude are possibilities with programmes being written to machine change one to the other.

4.5 RESEARCH IN PROGRESS FILE:

A suggested format and coverage for this file is outlined in Table 10.

4.6 DATA SOURCE FILE:

This file covers sources of tabulated data over the range of subject areas. These data may be held at the Provincial, National, Regional or International level. Island states would probably find it useful to have sources for information on technology options such as those listed in Table 6 included here. The suggested scope and format for this file is shown in Table 11.

Table 8. Data coverage.

The various subfiles in the system are subdivided into the following broad sub-categories; the coverage within each sub-category is indicated in brackets. Additional sub-categories can be added if it is desired to expand the system eg to cover education, infrastructure, macro- and micro-economics, infrastructure etc.

1. General (generalia, atlases, bibliographies, policy statements, legislation, planning documents, maps, aerial

photographs, satellite imagery, photographs, audio-visual material)

2. Climate (temperature, inversion heights, humidity, evaporation, solar radiation, wind, cloudiness, rainfall)

3. Geology (exploration, areal geology, stratigraphy, historical geology, palaeontology, geomorphology, quaternary geology, sediments and soils, sedimentary rocks, igneous rocks, metamorphic rocks, mineralogy, economic geology, structural geology, volcanology, seismology, solid earth geophysics, geochronology)

4. Hydrology (watershed characteristics, surface water resources, streamflow, groundwater resources, water quality, water use)

5. Land and Soils (geography, physical subregions, topography, land surface conditions, soil profile description/classification, land types, land units, land use potential, agriculture)

6. Vegatation (flora, forest types, habitat diversity, ecozoning, unique, threatened and endangered species, forest use, conservation, ecology)

7. Fauna (species, distribution, status, ecology, threatened, endangered, uniquespecies, conservation, habitat requirements)

8. Coastal and Marine Resource (physical oceanography, chemical oceanography, marine meteorology, biological oceanography, fish species, fisheries, significant ecosystems (mangroves, sago, seagrass, turtle nesting areas etc), pollution)

9. Culture/ Sociology (ethnobiology, archeology, physical anthropology, linguistics, cultural anthropology, historic and cultural sites)

10. Conservation (archeological sites, historic sites, cultural sites, caves, endangered, unique and threatened species, conservation zones, beaches, waterfalls)

11. Health and Nutrition (morbidity, mortality, nutrition, sanitation, disease patterns, birth and death rates)

12. Demography (population size, age and sex structure, spatial distribution, migration, migration patterns, birth rates, death rates, age specific mortality, growth rates)

13. Hazards (landslide prone areas, flood areas, erosion prone areas, seismic areas, geologic faults, tsumamis, volcanoes,

fire, pests, introduced species, oil spills, hazardous chemicals, droughts fish poisonings)

14. Special Resource Issues (energy, solid waste etc

Table 9. Input Data Fields for Bibliographic Subfile

Item Number
: uniquely identifies a particular record in the data base; standardised form B/XX/YYYY/ZZZZZZ where B identifies bibliographic subfile; XX identifies province; YYYY identifies year; ZZZZZZ is a unique identifier for record

Classification Code
: indicates general subject area of item as per database coverage listing

Media Type
: indicates form of item being indexed: cartigraphic (C), graphic (G), machine readable file (H), manuscript (M), microform (F), multimedia (K), sound recording (S), report (R), conference papers and proceedings (P), journal article (J), monograph (B), directory and yearbook (Y), chapter in book (T), thesis (D), pamphlet (A). Note that a maximum of two codes may apply to an individual item.

Author
: author of item being indexed

Date
: date of publication

Title
: title of item being indexed including english translation where the title is in a foreign language

Source
: title of item from which item is being indexed (eg journal, book)

Publisher, place
: publication details of item being indexed (eg journal, book)

Identifying number
: records identifying number associated with the item being indexed eg ISBN number

Scale
: scale of cartigraphic materials

Map reference and locality
: to 1:1000000 amd 1:250000 NATMAPS

Biosystematic reference
: to taxonomic codes taken from BIOSIS biosystematic code list

Abstract

Keywords

Location

where item can be obtained

Table 10. Input Data Fields for Research-in-progress Subfile.

Item Number
uniquely identifies a particular record in the data base; standardise form R/XX/YYYY/ZZZZZZ where R indentifies research-in-progress subfile; XX identifies province; YYYY identifies year; and ZZZZZZ is a unique identifier for record

Classification Code
indicates general subject area of item as per database coverage listing

Investigator
name of project investigator

Start Date

Finish Date

Project Title

Objectives

Methodology

References
publications relating to the project that give an overview of the project or progress or final compilation of results

Sponsorship and funding
external sponsors of the project and fund made available to the project

Map reference and locality
to 1:000000 and 1:250000 NATMAPS

Biosystematic reference
to taxonomic codes taken from BIOSIS biosystematic code list

Keywords

Contact officer
first point of contact for anyone enquiring about the project

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Table 11. Input Data Fields for Data Sources Subfile

Item Number
: uniquely identifies a particular dat source in the data base; standardised form D/XX/YYYY/ZZZZZZ where D identifies data source subfile; XX identifies province; YYY identifies year; and ZZZZZZ is a unique identifier for the particular source.

Classification Code
: indicates general subject area of data base as per database coverage listing

Data Description
: description in free text format of parameters or items in data source

Method of Collection
: measurement (M); registration (R); inspection (I); report (P); solicitation (S); random survey (N); stratified survey (T); partial census (C); full census (L)

Periodicity of Collection
: daily (D); weekly (W); monthly (M); quarterly (Q); semiannual (S); annual (A); biannual (B); five years (F); decade (E); or occassional (O)

Collection Locations
: grid referenced to 1:1000000 and 1:250000 NATMAPS

Coverage
: nation (N); province (P); district (D); urban/town (U); peri-urban (R); census unit (C)

Date Collected

Quality State of Data
: unprocessed (U); not collated (L); collated (C); tabulated (T); disaggregated (D); aggregated (A)

Biosystematic Code
: to taxonomic codes taken from BIOSIS biosystematic code list

Availability
: user access - published report (R); open circulation (O); limited circulation (L); restricted (S); out-or-ptint (N); on file (F)

Descriptors
: (keywords)

4.7 DATA BASE FILE:

The development of data files would take a longer period of time and will necessitate discussion and agreement on format and content. On the basis of the work undertaken by Minerbi with the Environmental Statistics Project discussed earlier it would seem useful to include categories for: basic information; activities; effects, both harmful and beneficial; and responses. Thus a climate data file for example might look like this:

. Basic information:
  Temperature - mean, maximum, minimum, range - Rainfall - daily, mean, maximum, minimum, number of days -
  Humidity - relative, maximum, minimum, dewpoint
  Solar - rediation - hours of sunshine, intensity -
  Wind - speed, direction, gustiness, turbulence -

. Activities
  Emissions - sources, quantities -

. Effects
  To environment - harmful, beneficial - To humans - harmful, beneficial -

. Responses
  Legislation
  Control activities
  Standards
  Investments
  Research & Monitoring.

4.8 HARDWARE SPECIFICATIONS:

The range of computer types currently in use in various island states is wide (Chapter 3); however for the development of an integrated approach to natural resource and environmental data banking it would be imperative to adopt some standardised systems. IBM and IBM compatibles appear to be the most sensible in the light of current systems operating within the Pacific.

4.9 SOFTWARE SPECIFICATIONS:

Theoretically many software packages are available for information processing. Choice however, is restricted by the types of hardware, the cost of the packages and the need for expertise to select, install and operate such programmes. Two useful attempts to develop suitable software packages are:

. The UNESCO developed and promoted CDS-ISIS and CANSDI software developed for IBM computers.

. The IDRC developed and promoted software MINISIS devised for the Hewlett Packard 3000 computer series. Both of these are available from the developers free of charge.

Other possibilities include: ADLIB implementable on all Prime computer models: CAIRS implementable on Prime, PDP-11 series, TI-series and Perkin-Elmer 32 series. Details of the packages are given in Appendix 4.

Software available for micro-computers includes CARDBOX, a rapid free text information retrieval package for IBM micros and LIBRARIAN implementable on Apple micros; the SCI-MATE software system, which has recently become available and which allows access to external databases with facility for searching, manuscript editing, and downloading.

Rapid developments are taking place in software packages which take advantage of the significantly increased capacity and wider availability of microcomputers which has occurred in the past two to three years.

UNEP's Global Environmental Monitoring System has recently commenced a new project called GRID (A Global Resource Information System); this uses the ARC-INFO geographic data management software and a more recently developed package developed by ERDAS Inc. implementable on IBM-PC systems. Details on GRID provided by the Facility Director, are given in Appendix 4. It would appear that this system has considerable potential for application within the framework of a decentralised natural resource and environmental data base system within the Pacific region and would provide an opportunity for the testing of a global model on both a local and regional basis.

5. RECOMMENDATIONS

GENERAL RECOMMENDATIONS

The SPREP Consultative Meeting recommends to the Coordinating Group that:

1. The concept of a decentralised, integrated natural resource and environment information and data base system be accepted for implimentation.

2. The report on the Natural Resource Data Bank proposal be circulated to all member country focal points for consideration and comment.

SPECIFIC RECOMMENDATIONS

The SPREP Consultative Meeting recommends that:

3. The SPREP Secretariat establish appropriate advisory groups to develop and recommend standards for each of the sub-components and data files of the system.

4. The SPREP Secretariat, as the Interim Management Committee, adopt two pilot projects, one in Tuvalu and the other in the Solomon Islands; these pilot projects are to specifically:

. establish an integrated natural resource and environmental information and data base system with manual and computer coverage of bibliographic, research-in-progress and data source files for these two countries;

. test GRID and similar geogrpahic referenced data-base systems for appropriateness and applicability in small island states

. develop 'in house' and other appropriate training programmes

. ensure that the experience in shared widely through SPREP member countries in a phased extension of the project.

5. The SPREP Secretariat function as a regional node to access information and data held in international information bases and data banks.

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APPENDIX 1

PNG NATURAL RESOURCES AND ENVIRONMNET DATA BANK

Project 3 - A National Analytical and Environmental Monitoring Service, (NAEMS).

Project 4 - A National Remote Sensing Programme (NRSP)

PAPUA NEW GUINEA ENVIRONMENTAL AND NATURAL RESOURCES SURVEY

PROJECT 2

2. Establishment of a Natural Resources and Environmental Databank: (NRED).

2.1. Introduction:

Papua New Guinea has a stated Constitutional policy and legislative commitment to environmental protection and the desire to integrate environmental and social considerations into its economic development planning. The broad sweep of environmental 'problems' currently facing the country emphasise that anticipatory, rather than curative, policies and administrative procedures are required to effectively reconcile sustainable economic development with social and environmental concerns.

A starting point in any development planning, environmental plan or assessment is an integrated set of available data on natural resources available for a particular region, area or project site. This is necessary in order to identify issues, problems and gaps in knowledge and ultimately to avoid costly repetition or duplication of information gathering.

The collection and interpretation of natural resources and environmental data is expensive and time consuming. There is an urgent need to make data available for later re-use. Within Papua New Guinea much work has been undertaken, especially over the past twenty-five years. Data exist in many Government Departments and agencies, see **Appendix 4** [Volume 3]. However, lack of knowledge of particular data prevents its timely availability or inaccessibility, often means duplication of effort and costly expense in recollecting it. Worse still, planning is done without the data because of money or expertise constraints. Also, much information is domiciled overseas because it has been collected by foreign researchers or companies and hence may also not be readily available.

There is a need for an adequate national natural resource and environmental data system to help meet planning needs at both the national and provincial level.

Much background work has been accomplished already. The Provincial Data System - designed to collect information for every village and rural non-village in Papua New Guinea - together with other surveys provides a base of comprehensive social data; the CSIRO Land-Use Survey teams have collected much physical resource data some of which is available in both map and computer format; water resources data has been collected and various comprehensive bibliographies of previous research publications have been completed. The challenge now is to develop a coherent Databank system in the country, through a National approach. This is an urgent matter.

Such a Natural Resources and Environment Databank would enable PNG to develop comprehensive anticipatory policies and administrative procedures to avoid environmental problems in the future. Furthermore, it would provide a useful model for other South Pacific countries as part of the Papua New Guinea and UNEP

contribution to the South Pacific Regional Environmental Programme. (SPREP).

Planning Principles for the establishment of NRED:

This project aims to develop such a national capacity over a period of time. It is planned to develop NRED as a set of individual but related modules which are immediately useful from their earliest days to the potential major users of such data.

From an Information Processing viewpoint, three matters can be clearly identified for which general policy decisions or actions much be taken if any benefit is to be derived from expenditure to establish a Natural Resources and Environment Databank (NRED).

In brief, these three matters are:

a) A policy decision must be taken, not to invest the databank in any one agency (existing or new), but rather to allocate component parts to those agenices which have functional responsibilities to administer the data sub-set.

b) There is glaring need to enhance the nation's information processing resources in the area of scientific/technical computing facilities and services. The existing two major resources - the National Computing Centre and distributed micro/mini computers - are each lacking in essential capabilities needed to establish a NRED.

c) An 'all embracing' plan must not be attempted. Rather a strategy of incremental additions to the database must be adopted. Each addition must be rigorous in its implementation. This can eventually lead to a national integrated Natural Resource and Environment Database, but this need not be achieved for some years.

The following discussion amplifies these matters.

2.2. DATA SUB-SET DISTRIBUTION:

The task of compiling a database of any description, is not simple. Data collection is usually costly and certainly requires skilled management to control validity. To ensure end-user needs are met, invariably the data needs to be converted into a machine readable form - a process also requiring skills, along with hardware and softeware resources, and support. Raw data rarely is useful without subsequent processing - again requiring resources - and then skilled interpretation needs to be applied. As the data volume grows, maintenance needs arise. Finally, information retrieval and presentation services must be provided to the users for whom the entire endeavour has been mounted.

Experience in other countries has shown that the onerous task described above have the best chance of being undertaken successfully by the people who understand the data and who themselves have a continuous need for it. This is the prime reason why it is recommended that data sub-sets be allocated to agencies with functional interest in that data.

Clear guidelines must be established for an agency which is invested with the responsibility of supporting a NRED sub-set. Consequently, adequate funding must be provided to enable the agency to meet the guidelines, and appropriate monitoring

put in place to ensure the agency conforms. The latter is best done by surveying end-user satisfaction.

Key components of the guidelines for agencies are that:

a) They can assemble an effective data collection capability (eg the PNG National Weather Service has some 200 monitoring stations - a university could never approach that coverage).

b) Data processing (if deemed necessary) is accepted as a required function and on-going arrangements are put in place accordingly. Such processing may take many forms - map production, computer data entry etc. The function need not be performed by the agency itself as it could be performed by a sub-contracting arrangement. The important point is that the agency establishes and manages an effective process.

c) It possesses the required interpretative skills. In some cases, such skills may only be in a particular institution (e.g. a university). That being so, it may be appropriate to build the framework of the other components of the guidelines around the institution, given that shortage of skills is recognised major PNG problem in PNG.

d) it accepts that end-user services must be provided. This important point cannot be over-emphasised. It must be remembered that the NRED is to serve a national goal and many organisations and individuals work towards that goal. An agency has the responsibility to meet the reasonable needs for access to the data which has been invested in it. Services must include adequate data retrieval capability and promotion of the existence and availability of the data.

This recommendation acknowledges that duplication of data collections cannot be avoided. However it can be minimised by agencies adhering to the guidelines.

In addition, some processing and aggregation of data is needed. Provincial governments in particular, will need such data to enable them to plan the use of their Natural Resources and Environment effectively. At the moment considerable data collection, particularly relating to economic and social indices is going on at provincial government level. It will be necessary to design the NRED system so that environmental and natural resource data in a processed or aggregated form is also avaiable to provincial governments and national government organisations operating at the provincial level.

2.3 ENHANCING THE NATION'S INFORMATION PROCESSING RESOURCES:

Currently, PNG's information processing resources available for scientific and technical applications are:

a) The National Computing Centre (NCC) -

This centre is under-staffed and committed to conventional government data processing functions such as payroll, financial systems and the like. Although it has a ceiling of 33 expatriates, in July 1985 only 17 positions were filled. It suffers from the high staff mobility generally being experienced in the data processing industry in all nations. Environmental systems applications have very low priority in terms of

allocation of staff resources and would suffer a similar fate when machine resources become consumed. Furthermore, the NCC has a single-supplier mainframe (ICL), which is unlikely to have suitable software products available for it.

b) Local micro/mini computers -

Many government agencies have acquired micro or mini computers on which they perform data processing, largely using off-the-shelf software. No doubt there are some successful implementations of systems and some not so successful. Unquestionably the micro/mini computer has a place in this context, however in fulfilling the requirements of the NRED, it has some serious shortcomings. Firstly, software to meet the needs of all data sub-sets is not commercially available for the range of equipment supportable in PNG. Secondly, access to such equipment is usually restrictive, thus limiting the ability of the agency to supply an adequate service to end-users of the data sub-set. Thirdly, the vast range of ancilliary data processing services and specialized equipment is not made available by restricting activity to the micro/mini range.

Another resource therefore needs to be provided. Three options appear to be open:

a) Establish such a resource within a government department or institution.

b) Use private enterprise in PNG. This is unlikely to be successful as the volume of work would not ensure commercial viability.

c) Use off-shore resources and provide communications access to them from PNG. This option is worthy of further investigation. Because so much data collection in the past 25 years has been conducted by the CSIRO in Australia, and because that organisation has a number of divisions active in the environmental database field having close links with other Australian institutions also working in the field, a connection to the CSIRO computer network would open up a vast array of facilities and services to PNG.

Appendix 5 (Volume 3) contains an initial enquiry made to that organisation, and its response.

The adoption of computer network technology in developing a Natural Resources and Environmental Databank may very well provide a vehicle by which the country can embrace that technology for the benefit of other applications. The geography and terrain of Papua New Guinea makes physical transportation difficult and yet does not inhibit the use of communication technology. Developing well trained and experienced people in the various aspects of its use, maintenance and support could be a national goal, which if adopted could lead to national advances, achievable with other strategies only at significantly higher costs, less reliability and greater delays.

2.4. INCREMENTAL ADDITIONS TO THE DATABANK:

Establishment of a Natural Resources and Environmental Databank is a long term goal. Grand concepts such as 'full integration' become meaningless. As an immediate first task, small data 'sub-sets' need to be identified and implemented as the need and resources dictate. A framework in which this process can take place needs to be developed. Key components of the framework are:

a) An 'end-user' need must be declared. Collecting data for the sake of collecting

data must not occur.

b) The 'agency' which is to support the data sub-set must be deliberately chosen, and if none is suitable and the data set is of appropriate importance, then a new agency needs to be established - this should be regarded as a last resort.

c) In choosing the agency to support the new data set, close attention must be paid to the guidelines suggested in 3.2. In particular, additional resources may be needed.

d) Adequate monitoring of agency performance by a 'coordinator' authority needs to be put in place.

2.5 THE COORDINATOR:

Duplication of data sets is a waste of resources. Prime reason why this occurs are:

a) the user makes little or no attempt to discover if a suitable data set already exists;

b) the existence of a data set is not adequately advertised;

c) the data set is poor in scope or validity, or retrieval facilities for it are inadequate, or access to it is difficult or unwelcoming;

It is recommended that a co-ordinator be established, and probably located within the University of Papua New Guinea but with linkages to the Department of Environment and Conservation. In discussions with the project team, the Vice Chancellor of the University of PNG indicated that the establishment of NRED was a top priority of the University. Given this fact, the fact that much information particularly of PNG's biological resources resides in the University, and the fact that the University is committed to only developing programmes for which there is a major national need and to keeping them relevant to the needs, it is recommended that the University be given this responsibility. It is proposed that the brief of the coordinator is to:-

a) identify end-user needs for NRED sub-sets and encourage the preparation of specification defining such needs;

b) make recommendations to government on priorities of sub-sets formation and recommend suitable supporting agencies;

c) provide supporting information for agencies in their request for resources to establish the database;

d) advertise the existence of the database and promote its use;
e) monitor the performance of the NRED.

2.6 COMPONENTS OF THE NRED:

It is not the intention of this report to produce a definitive list of components of the National Resources and Environmental Databank. In fact, if the recommendation of section 2.4 is adopted, the components will be developed over time and in response to

demand. Rather, what is described below is a recommendation for consideration by an NRED Consultancy Group section 2.16 and is included also as an illustration, and a basis on which budgets may be framed.

The components following, are included because a need for their inclusion became evident during the UNEP team's visit to PNG or because experience in developing such databanks in other circumstances have shown them desirable or necessary. As a consequence, the list is not regarded as complete, nor is it arranged in any order of prioirty.

2.7 DIRECTORY OF EXISTING DATABASE:

A directory of databases in existence would form a basis for co-ordination of an implementation plan. The word 'directory' is emphasised - it is not intended to be an 'inventory' which would contain considerable detail. Rather the directory could be formed quite speedily and be useful for obtaining an overall grasp of the current situation. It is assumed that the information for the directory could be obtained by questionnaire, surveying the public and private sectors, and those foreign institutions known to have been engaged in research in the country in the past.

This task could be assigned to the NRED co-ordinator as an initial task, and it would then become that officer's responsibility to provide maintenance for the directory.

2.8 RECORDING RESEARCH IN PROGRESS:

It is believed that a considerable amount of information on the country has been assembled by foreign researchers over many years. Gaining access to this information now is a considerable task, perhaps impossible in entirety. However, future foreign researchers should be required to provide information on their activities with some obligation place on them to furnish their research results. This activity could be controlled through the Department of Foreign Affairs and Trade, who would use PNG agencies as 'sponsors' and 'point of contact' for the researchers. It is proposed that the programme be coordinated by the NRED Coordinator in a similar manner to the programme relating to the collection of cultural data by foreign researchers, which is administered by the Institute of Papua New Guinea Studies. It is not recommended that the 'full weight' of bureaucracy be applied - most researchers will co-operate if the mechanisms are provided. Recording research by indigenous organisations cannot be achieved in this way. It is expected that most projects will be recorded through the knowledge of their existence which is generated by their funding requirements. This programme can be implemented through the National Public Expenditure Plan (NPEP) and other programmes.

Again, the NRED co-ordinator should have the responsibility for maintaining the records.

It is proposed that initially the NRED be based on the development of five sub-sets, namely, those concerned with the Meteorological Data, Water Resources (terrestrial), Flora and Fauna, Land Use and capability, and marine resources (both physical and biological).

2.9 METEOROLOGICAL DATABASE:

The PNG National Weather Service (NWS) grew out of the Australian Bureau of Meteorology (ABM) when the country gained independence. Until that time, the country's meteorological data was captured in PNG, and entered into machine readable form by the ABM which managed the resultant processing and storage. This function ceased in 1975. As a consequence of the NWS not having access to computer-based information processing resources, meteorological records gathered since 1973 remain only in manual form. The pre-1973 database however, exists in the ABM and the CSIRO in Australia, and as magnetic tape in PNG.

The establishment of the meteorological component of the NRED requires:

(a) equipping the NWS with sufficient facilities to convert meteorological observations to machine readable form, and to perform sufficient local data reduction as required before the data can be archived.

(b) training of NSW staff to carry out this function.

(c) providing the NSW with access to offshore large scale data processing resources as required, to enable them to perform their full range of responsibilities.

(d) equipping the NWS with necessary output devices, such as graphical displays, printers etc. to enable them to interpret and use offshore processed data.

(e) sub-contracting the database design and development.

This recommendation therefore envisages the NWS having an adequate powered 'workstation' with networked connections to overseas large scale data processing resources. This workstation could be the first 'node' in a PNG technical and scientific information processing resource recommended in section 2.3.

2.10 WATER RESOURCES DATABASE:

The Bureau of Water Resources (BWR) of the Department of Environment and Conservation already has the equipment and expertise to assemble a 'Water Resources' database and should be the agency so charged. The National Analytical and Environmental Monitoring Service discussed elsewhere in this report, should supply the water quality raw data to the BWR who would manage the storing, processing, interpreting and service users requiring information retrievals.

The BWR would require additional staff to meet this responsibility, particularly a hydrologist who would need the support of two data entry staff.

It is questionable whether a suitably capable software person could be recruited and retained. As a consequence, it is recommended that 'off-the-shelf software packages be used to assemble the database, supported as needed by external consultants.

2.11 FLORA AND FAUNA DATABASE:

The professional expertise required to interpret and record flora and fauna information, attend to taxonomy and nomenclature, range descriptions, define habitat

requirements etc. lead to the recommendation that the development of this database be centred on the University of Papua New Guinea Guinea. That institution already has, or is in the process of acquiring the necessary facilities (computer equipment, buildings to house collections) and the required expertise. The University should act as the prime agency, co-ordinating the activities of other institutions including:-

. the Division of Botany, Department of Forests, Lae;
  - Division of Botany, National Herbarium and Botanic Garden
. the National Museum of PNG.
. the PNG University of Technology, Lae;
  - Department of Forestry
  - Department of Agriculture
. the Department of Primary Industry, Konedobu;
  - Entomological collection;
  - Plant Pathology collection
. the Department of Forests, Bulolo;
  - Forest Pathology collection
  - Forest Insects collection
. the University of Papua New Guinea; Waigani
  - Natural Resource Centre

A person at 'director of research' level is required, assisted by two 'data entry' staff.

As has been pointed out, Papua New Guinea has a very rich flora and fauna, one of the richest in the world. The problem of collecting, curating, and studying this rich flora and fauna is a huge task and is beyond the country's resources. The flora collection at the national Herbarium in Lae is a major resource and needs special attention. A description of the biological collections of PNG is given in Volume 2 [at 10.5(2)].

Additional resources need to be utilised to assist in the development of flora and fauna collections. It is recommended that $100,000 per year be allocated for five years for this purpose. Without an increased effort in improving biological collections, the creation of a flora and fauna database will be significantly retarded. It is recommended that this assistance be administered by the Department of Environment and Conservation and not be the proposed NRED Consultancy Group.

The recommendation regarding software support and consulting made in section 2.10 on the Water Quality Database, applies also to this component.

2.12 LAND USE AND CAPABILITY DATABASE:

The PNG Agricultural Land Use Project is now of some years standing. It is a co-operative development between the PNG Department of Primary Industry and the Australian CSIRO Division of Water and Land Resources. The project's aim is to assess the agricultural development potential for subsistence food and cash crop production. As a consequence, a comprehensive inventory of the country's resources applicable to the project's goals has been produced. The information base probably is the most complete and comprehensive produced in its area of application, and would be fundamental in the NRED. Its adoption and enhancement to service a wider range of applications is therefore recommended.

The database is micro-computer base, being developed under an industry standard software system. Its conversion to more powerful equipment would not be difficult and would open up its application as well as allowing more extended processing of the information to be carried out. If continued support from the CSIRO could be negotiated then the project would fit very well into the networked strategy discussed in section 2.2.

A preliminary approach has been made to the CSIRO in Australia. The letter and its response being copied as Appendix 6 [Volume 3].

2.13 MARINE DATABASE:

Any database collection, involves problems of demarcation and overlap. A database relating to the water quality of Marine resources could be combined with the terrestrial water quality database. However, on balance, it is proposed that a separate marine database be established to consist of data relating to both the biological and physical resources of the marine ecosystem. This is probably the most desirable arrangement for PNG, particularly because of very significant coral reefs occurring in the country. This database could include the excellent Fisheries Collection in the Division of Fisheries, in the Department of Primary Industry, at Kaundi. A new facility to house this collection would almost certainly have to be considered. However, it is recommended that this matter, along with the design of other databases be left to the proposed NRED Consultancy Group (2.16) and be further developed as part of the NRED programme.

2.14 GEOLOGICAL DATABASE:

The inclusion of the database of the PNG Geological Survey could also be considered. The value of this should be established by the NRED Consultancy Group in conjunction with other interested parties. This could be assessed during the implementation of the project.

2.15 IMPLEMENTATION OF THE NRED:

Appointment of a 'Coordinator' for the NRED:

This is seen as a single person with both environmental and administrative capabilities. This person would be the advocate and catalyst for the development of the NRED. As such he/she must have a strong commitment to the concept. This person should be provided by the donor country for 2 years with a counterpart officer provided by the PNG government. A PNG National could probably do the work part time while helping to manage the flora and fauna database at the University of PNG. The person would be employed by the University of Papua New Guinea or whatever agency is finally chosen as NRED Coordinator. For the first year it is expected that the NRED responsibilities would would occupy half the person's time (establishing the directory of existing databases, involvement with the working party, etc.). After the programme is underway, it is expected that this work would decrease, with more time being taken up with co-ordination, advising of the existence of the databank, and monitoring agency performance. This person would act as executive officer to the NRED consultancy group and be responsible for the management of the programme.

2.16 ESTABLISHMENT OF A NRED CONSULTANCY GROUP:

This working party would be advisory in nature:
. to government, to aid in forming priorities
. to agencies, to set requirements of performance and database coverage;
. to oversight the development of the NRED.

Therefore it should have representatives of "information users" - those people working in the field of data collection and interpretation rather than administrators. Its composition should change with time as needs arise.

2.17 CHOICE OF INITIAL COMPONENTS AND AGENCIES FOR THE NRED:

With the components listed in sections 2.9 to 2.14 being taken as a starting point, the working party should oversee the detailed development of NRED, including the choice of priority targets.

2.18 ENHANCING THE INFORMATION PROCESSING RESOURCES:

A programme of investigation and planning aimed at enhancing the information processing resources available to the country, should be commenced. This can only be done by involving government at the highest level, and with the cooperation of such organisations as the Post and Telecommunication Corporation, and industry who may utilise any facilities made available as a consequence.

(7) That Database development and the training of PNG officers be contracted out.
(8) That arrangements to develop certain parts of the Database offshore - be seriously investigated (2.12).

2.21 BUDGET:

(US$ thousands) - (Both External and Internal Components)

	Yr.1 Ext.Int.	Yr.2 Ext.Int.	Yr.3 Ext.Int.	Yr.4 Ext.Int.	Yr.5 Ext.Int.	Total
NRED Co-ordinator: Salary (P3) Support:	36 12; 20	36 12;- 20	14;-	14;-	14-	146
NRED Working Group Within Existing Budget of Departments						
Enhancing information Processing Resource:						
Consulting During Planning	25-;	25-;	-	-	-	50
Equipment:	100.10;	50 10;	50 10; -	10;-	19;	250
Software:	25	-; 25	-; -	-; -	-;	50
Training PNG Nationals	25 40;	25 40;-	40;-	40;	40	250
Contracting to external expertise, over 5 yrs. at $100,000 per yr.	100-;	100-;	100-;	100-;	100-;	500
Training PNG Nationals in database management, computer useage, network management - 10 people per yr. @ 1,000 per persons for 5 yrs.	100.50;	100 50;	100 50;	100 50;	100 50;	750
Professional staff to head agencies responsible for major components (flora, fauna, fauna water resources etc.)	100-;	100-;	100;-	100-;	100-;	500
Use of external facilities in the development:						

processing costs, special software useage, communications over 5 yrs.	100-;	100-;	100-;	100-;	100-;	500
Assistance to biological (flora and fauna) collection	100-;	100-;	100-;	100-;	100-;	500
TOTAL	731,112;	681,112;	550,114;	500,114;	500,114	3528

External Aid Total 2,962,000
Internal Contribution 566,000

APPENDIX 2

ENVIRONMENTAL STATISTICS PROJECT

Attachment 2.1 UNSO proposed scope for environmental statistics attachment 2.2. Fiji Environment statistical study.

Attachment 2.1:

Adaptation of the Framework revised UNSO proposed scope of environmental statistics Pacific Islands problems

(a) Natural Environment

(1) Air:

i. Microclimatic deterioration due to lack of urban design principles in the setting and clustering of buildings, lack of trees and shade, and decrease of tradewinds due to tall building structure;

ii. Aerodynamics, turbulence, orographic circulation (monsoons, hurricanes, equatorial air currents);

(2) Water:

a. Watersheds:

i. Depletion of fresh water resources;
ii. Water usage in power generation;
iii. Destruction of swamps and mangrove;
iv. Encroachment into water recharge areas;
v. Sewage and waste;

b. Oceanic and Coastal Waters:

i. Coastal zone (stresses in beaches and estuaries);
ii. Pollution (oil, waste, chemicals, sedimentation);
iii. Discharges (tanker ballast);
iv. Degradation (siltation, mining);
v. Fishing (depletion);
vi. Aquaculture and mariculture;

c. Groundwater and drinking-water:
i. Water supply;
ii. Pollution (contamination);

d. Basic information (depletion, runoff, seepage, degradation);

(iii) Land/soil

a. Land use:

i. Agricultural development (slash and burn techniques);
ii. Enroachment into agricultural lands (unplanned land conversion);
iii. Loss of open space, scervci areas;
iv. Conflicting land uses;
v. Soil productivity;
vi. Definition of land suitability, potential;

vii. Inappropriate land use;
viii. Economic transformation affecting traditional land use systems;
ix. On-shore land fills;
x. Competition for land use from real easte, tourism;
xi. Recreation;
xii. Land tenure systems;

b. Green areas:

i. Depletion of forests for fuel woods;
ii. Deforestation;
iii. Destruction of forest areas especially on slopes;
iv. Clearing or vegetation;

c. Critical and vulnerable areas:

d. Plants, trees (protected, endangered species):

i. Decline of native plants and species (exotic plants);
ii. Rainforest biome, vegetration, revegetation;
iii. Nutrient depletion of biosphere (forests);
iv. Development and conservation of forest resources and effects on microflora;

e. Agriculture:

i. Nutrient leaching due to frequent use of agricultural machinery;
ii. Changing forms of agriculture (from traditional to cash cropping);

f. Degradation of soil:

i. Leaching of soils on high and low islands;
ii. Soil erosion;
iii. Soil fertility;
iv. Increase in degraded unproductive soil;
v. Land use and soil productivity;
vi. Desertification;

g. Mining:

i. Mining of natural resources;
ii. Non-renewable resource depletion;
iii. Transition from traditional forms to cash economy;

h. Pollution:

Dumping or leaking of substances (petro-chemical, enzymes, etc.);

(iv) Ecosystems:

a. Marine environment:

i. Stress on marine ecosystems;
ii. Depletion, degradation, and/or destruction of coral reefs, fish habitats, wetland habitats, wildlife, endemic fauna and flora;

(vi) Wildlife;

(c) Living conditions associated with the environment:

(i) Health and nutrition:

a. Sanitation drinking water (sanitation, contamination);
b. Human waste disposal dangerous for healthy conditions;
c. General (disposal and recycling of waste, vector control, food hygiene, medical care);
d. Ciguatera fish poisoning;

(ii) Working conditions;
(iii) Housing conditions;
(iv) Human settlement patterns:

a. Congestion in town;
b. Urbanization;
c. Degradation of rural intermediate towns'

d. Overcrowding;

(v) Recreational and cultural;
(vi) Subjective evaluation;
(vii) Infrastructure;

(d) Background information:

(i) Background factors directly affecting the environment:

a. Population (growth, migration, urbanization);
b. Economic Production (impacts of large-scale projects, cash croping and tourism);
c. Transportation, infrastructure;

(ii) Indirect, institutional, technological and ideological factors affecting the environmental:

(e) Means to improve environmental conditions:

(i) Legislation and regulation:

a. *Zoning* of islands and continental shelves;
b. High seas pollution: need for legislation on merchant shipping, offshore wells and drilling, etc.;
c. Lack of regulation of hazardous materials;
d. Lack of appropriate principles and design standards for small communities planning;
e. Lack of regulation of pollutants;
f. Fragmented regulations;
g. International standards of environmental quality;

(ii) Offences and prosecution:

a. Coastal zone protection;

b. Enforcability;

(iii) Environmental damage and abatement:

a. Appropriate technology;
b. Need for coastal zone and resource management;
c. Need to develop criteria for standards and control of toxic and hazardous substances on developed islands, especially for drinking water;
d. Need for disaster protection;
e. Conservation principles and practice, goals of development and quality of life;
f. Establishment of conservation areas or reserves for specific flora and fauna and for agriculture;
g. Environmental planning and social planning;

(iv) Research and development:

a. Hydrography profile;
b. Community dynamics and social impact assessments;
c. Identification of carrying capacity;
d. Lack of proper statistical and other records on effects of nuclear waste disposal;
e. Identification of natural resources by type, location, quality, and values;
f. Lack of demographic statistics.

Attachment 2.2.:

United nations statistical office Fiji environmental statistical study

UNSO SCOPE	OBJECT OF MEASUREMENT	PERIODICITY TIME COLL	PUB	DATE COLL	AVAIL-COVERAGE PUB	ABIL- ITY	POL. UNIT H	L	QUALITY STATE OF DATA	METHOD OF COL LEC- TION	SOURCE REPORT- UNIT	FILE MINI- STRY RECORD
Harvesting	Scuid	0	A	30	30	OP	N		A	RS	11	AEGM 05
Harvesting	Commercial Tuna	0	A	30	30	OP	N		T	RQ	11	AEGM C3
Harvesting	Eels	0	A	30	50	OP	N		A	RS	11	AEGM C3
Harvesting	Pech-De-Nee	0	A	30	30	OP	N	OV	D	RG	QR	AEGM 01
STOCKS												
Background Information												
Observation	Fish	0		78		ON	N		A		11	AEGM 13
Impact Depletion (Derfis Poison)	Fish	0		78		ON	N		A		11	AEGM 13
Depletion (Dynamiting)	Fish	0		78		ON	N		A		11	AEGM 13
Research (Harvesting)	Fish	0		78		ON	N		A		11	AEGM 13
SERVICES												
Impact Depletion	Fish Species	M	M	30	30	ON	N	!	Q	RS	09	AEGM 17
POLLUTION QUALITY												
Responses												
Honitoring	Mineral in Suspension	0	0			ON	N		T	I	25	PS 15

C.LAND & SOIL												
AGRICULTURE												
Processes	Sugar cane											
Irrigation	Lands	A	A	30	31		N	DS	A	RQ	25	DID 01
CROPS												
BACKGROUND INFORMATION												
Observation	DALO	D	D	78	51		OV		T	P	13	EPS 15
Processes												
Cultivation	Coconut	D	D	78	51		DV	P	A	P	13	EPS 11
Cultivation	Maize	D	D	77	31		N	M	A	P	13	EPS C1
Cultivation	Tropical Crops	D	D	78	31		DV	P	A	P	13	EPS 13
Cultivation	Fulses, Nuts, Oil Seeds	D	D	78	51		DV		T	P	13	EPS 15
Cultivation	Rice Farms	D	D	75	51		DV	P	A	P	13	EPS 09
Cultivation	Sugar	D	D	78	51		N	P	D	P	13	EPS 33
Cultivation	Casava	D	D	78	31		DV	P	A	P	13	EPS 16
Cultivation	Cocoa	Q	A	80	31	ON	DV	DS	A	I	25	EX 17
Cultivation	Tropical Veget-ables	D	D	75	31		DV	P	A	F	13	SPS C6
Cultivation	Fruits & Veget-ables	A	A	50	50		DV		T	S	13	EX 02
Harvesting	Dalo	A	A	77	31		DV	M	A	P	13	EPS 03
Harvesting	Cocoa	A	A	30	31	CP	DV		A	S	13	EX 09
Harvesting	Treecrops	D	D	78	31		DV	M	D	P	13	EPS 05
Production	Copra	A	A	30	31	OP	DV	P	T	S	13	EX 08
Production	Sugarcane	A	A	30	31	OP	DV		A	S	13	EX 09
Production	Dalo	D	D	75	31		N	P	A	P	13	EPS 15
Production	Rice	A	A	30	31		N	DS	A	RS	25	DID 01
Production	Rain fed Crops	A	A	30	31		N	DS	A	PQ	25	DID 01

3.2.2.1.3.5.: Agriculture (including livestock)

Agriculture is an economic activity and the row I of the analytical model (cycle of production) is a natural starting point for statistical description. Possible harmful effects associated with agricultural production and consumption on the environment and on human welfare are also treated.

BASIC INFORMATION

-Number, size of farms

(AGFM/EPS 10. D.F. Number of farms, farming households, farm population and comparisons with population census. E.g. of classification)
(AGFM/EPS 14. O.M. Area measurement of farms and fields)
(AGFM/EPS 25. O.M. Number of farms by number of farming households on (farm)
(AGFM/EPS 26. O.F. Number of farms, farming households & population by age, sex and working status)
(AGFM/EPS 29. O.M. Number of sample farms)

-Distribution & type of cultivated area

(AGFM/RD 6. D.F. Land use Viti Levu)
(AGFM/EPS 3. O.M. Dalo area yield and production example of root crop)
(AGFM/EPS 4. O.M. Reported acreage and production of crops grown for sale. Selected rootcrops and all treecrops in field)
(AGFM/EPS 6. O.M. Area under cultivation of tropical vegetables [Ha.])
(AGFM/EPS 7. O.M. All rice area and production by irrigated/rainfed season, 1978. E.g. of cereal crop)
(AGFM/EPS 9. O.M. Area and number of farms cultivating main season rice, 1978. E.g. cereal crops)
(AGFM/EPS 11. O.M. Area under cultivation of coconut, 1978. Example of treecrop)
(AGFM/EPS 13. O.M. Area under cultivation of principal crops by division [hectares])
(AGFM/EPS 15. O.M. Rootcrops, cereals, pulses, nuts of oil seeds, vegetables and other vegetables [describes all crops] - part A)
(AGFM/EPS 15. O.M. Rootcrops, cereals, pulses, nuts of oil seeds, vegetables and other vegetables [indicates land tenure] - part B)
(AGFM/EPS 16. O.M. Cassava estimated area and standard error)
(AGFM/EPS 31. O.M. Area under cultivation of sugar cane [ha.])
(AGFM/EPS 32. O.M. Area under cultivation: dalo, e.g. of rootcrops)
(AGFM/EPS 35. O.M. Root crops, cereals, treecrops, pulses nuts & oil seeds, vegetables and other vegetables)
(AGFM/EX 8. O.M. Sugar cane, copra, rice, beef, goat, production value to producers, by product, in million dollars)
(AGFM/EX 9. O.M. Production of coconuts, cocoa, citrus fruits)

APPENDIX 3

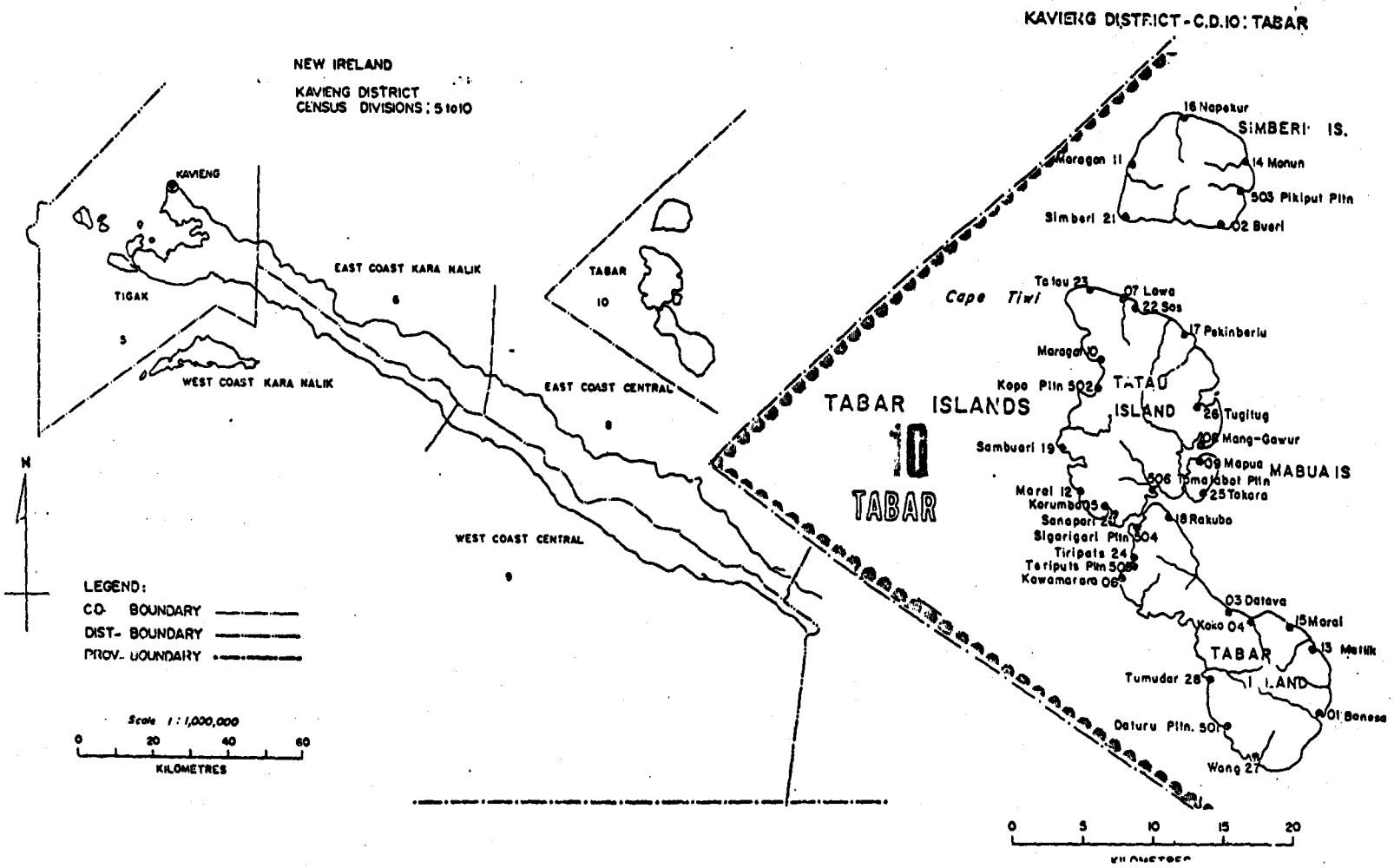
CURRENT ACTIVITIES RELEVANT TO THE CONCEPT OF AN INTEGRATED NATURAL RESOURCE AND ENVIORNMENT DATABANK

ATTACHMENT 3.1. SAMPLES FROM THE RURAL COMMUNITY REGISTRAR

ATTACHMENT 3.2 THE PNG RESOURCE INFORMATION SYSTEM

ATTACHMENT 3.3. VERTEBRATE DISTRIBUTION DATA RECORDING SCHEME

Attachment 3.1. : Samples from the Rural Community Register



Province : 17 New Ireland
District : 2 Kavieng
Census Division :10 Tabar

1979

Provincial Data system rural listing:25/03/83

No	Census unit name	Population Res	Total	Services		
001	Banesa	109	116	Aid Post		
002	Bueri	54	68			
003	Datavà	87	97			
004	Koko	91	100	Comm Sch		
005	Korumbo	18	22			
006	Kowamarara	26	26			
007	Lawa	135	176			
008	Mang-Gawur	40	52			
009	Mapua	64	69	Miss Health C/S Miss Sch Sub Dist of	Aid Post Pt Of call	CHNS Clinic Mission
010	Maragat	31	36			
011	Maragon	112	121	Aid post		
012	Marai	42	43	Mission		
013	Matlik	117	121			
014	Monun	31	36			
015	Morai	57	63			
016	Napekur	118	166	Mission		
017	Pekinberiu	118	123			
018	Rakubo	64	70	Aid post		
019	Sambuari	67	69			
020	Sanapari	90	108			
021	Simberi	126	151	Comm Sch		
022	Sos	55	67			
023	Tatau	147	176	Aid post	Comm sch	Chns clinic
024	Tiripats	22	24			
025	Tokara	93	99			
026	Tugitug	46	51			
027	Wang	96	133	Mnr Comm sch	Mission	
028	Tumudar	47	48			
VILLAGE TOTAL		2103	2401			

501	Dataru pltn	22	22
502	Kopo pltn	NS	NS
503	Pikiput pltn	5	5
504	Sigarigari pltn	NS	NS
505	Teriputs pltn	1	1
506	Tomalabot pltn	1	1

LARGE RURAL NON-VILLAGE

CENSUS DIVISION TOTAL 2132 2430

*** VILLAGE CENSUS INFORMATION ***

PROVINCE NEW IRELAND PROVINCE CODE: 17 COLLECTION YEAR - 1979
DISTRICT KAVIENG DISTRICT CODE: 2
CENSUS DIVISION TABAR CD CODE: 10

APPROXIMATE LAND AREA: 290 SQUARE KILOMETRES RESIDENT DENSITY: 7.3 PER SQUARE KILOMETRE

AGE GROUP	VILLAGE BOOK TOTAL (% IS % OF BOOK TOTAL) MALES NUMBER	%	FEMALES NUMBER	%	ABSENTEES AWAY 6 MONTHS OR MORE (% IS % OF BOOK TOTAL) MALES NUMBER	%	FEMALES NUMBER	%	RESIDENTS (% IS % OF RESIDENTS ONLY) MALES NUMBER	%	FEMALES NUMBER	%
0 -5 YEARS	180	7.5	182	7.6	7	0.3	4	0.2	173	8.2	178	8.5
6 - 17 YEARS	363	15.1	355	14.8	73	3.0	43	1.8	290	13.8	312	14.8
18 - 45 YEARS	485	20.2	362	15.1	103	4.3	49	2.0	382	18.2	313	14.9
46 YEARS OR MORE	271	11.3	203	8.5	11	0.5	8	0.3	260	12.4	195	9.3
TOTALS	1299	54.1	1102	45.9	194	8.1	104	4.3	1105	52.5	998	47.5
TOTAL PERSONS:	VILLAGE BOOK	2401	100%	ABSENTEES	298	12.4%	RESIDENTS	2103	100%			

TOTAL SEX RATIO (VILLAGE BOOK TOTAL)
117 MALES : 100 FEMALES

RESIDENT SEX RATIO (RESIDENT TOTAL)
110 MALES : 100 FEMALES

PERCENTAGE OF ADULT MALES ABSENT 15.1%

PERCENTAGE OF RESIDENTS UNDER 18 YEARS OF AGE 45.3%

NB THIS TABLE DOES NOT INCLUDE RURAL NON-VILLAGES.

Attachment 3.2: Example from the resource mapping unit file of the PNG resource information system.

Province 17 New Ireland	RMU No.	132
District 3 Namatanai	Lat.	3 deg 52 min S
	Long.	152 deg 48 min E
	Area	100 sq km

RESOURCE DESCRIPTORS

Land form raised coral reefs and associated back reef plans

Rock type limestone

Slope (2 degrees	Altitude	0-600 m
	Max Temp	32-29 degC
Relief Negligible	<10 m Min temp	27-32 degC

Rainfall	3000-3500 mm
Regime	Moderate range, heavy to intermediate
Soil water	Infrequent periods of slight moisture depletion

Inundation no flooding or inundation Extent Nil

Soil	Tropudalfs Moderately weathered soils with finer textured subsoils
Vegetation	Grassland Crops and garden regrowth

Population

Total = 2629	Males = 1412	Females = 1217

Attachment 3.3: The vertebrate distribution data recording sheets.

IDENTIFICATION
- Suprageneric .....
- Genus .....
- Species .....
- Infra-specific .....

LOCATION
- Province .....
- Latitude/Longitude .....
- Geocode .....
- Altitude/Depth .....
- Location .....

BASIS OF RECORD Specimen/Observation/Literature Record

IDENTIFIER

COLLECTION
- Date of collection .....
- Collector's name .....
- Field Number .....
- Institution .....
- Institution Number .....
- Material held .....
  .....
  .....

NOTES
- Status .....
  .....
- Microhabitat .....
  .....
- Diet .....
  .....
- Reproduction .....
  .....
- Other .....
  .....
  .....
  .....
  .....
  .....
  .....

REFERENCES .....
.....
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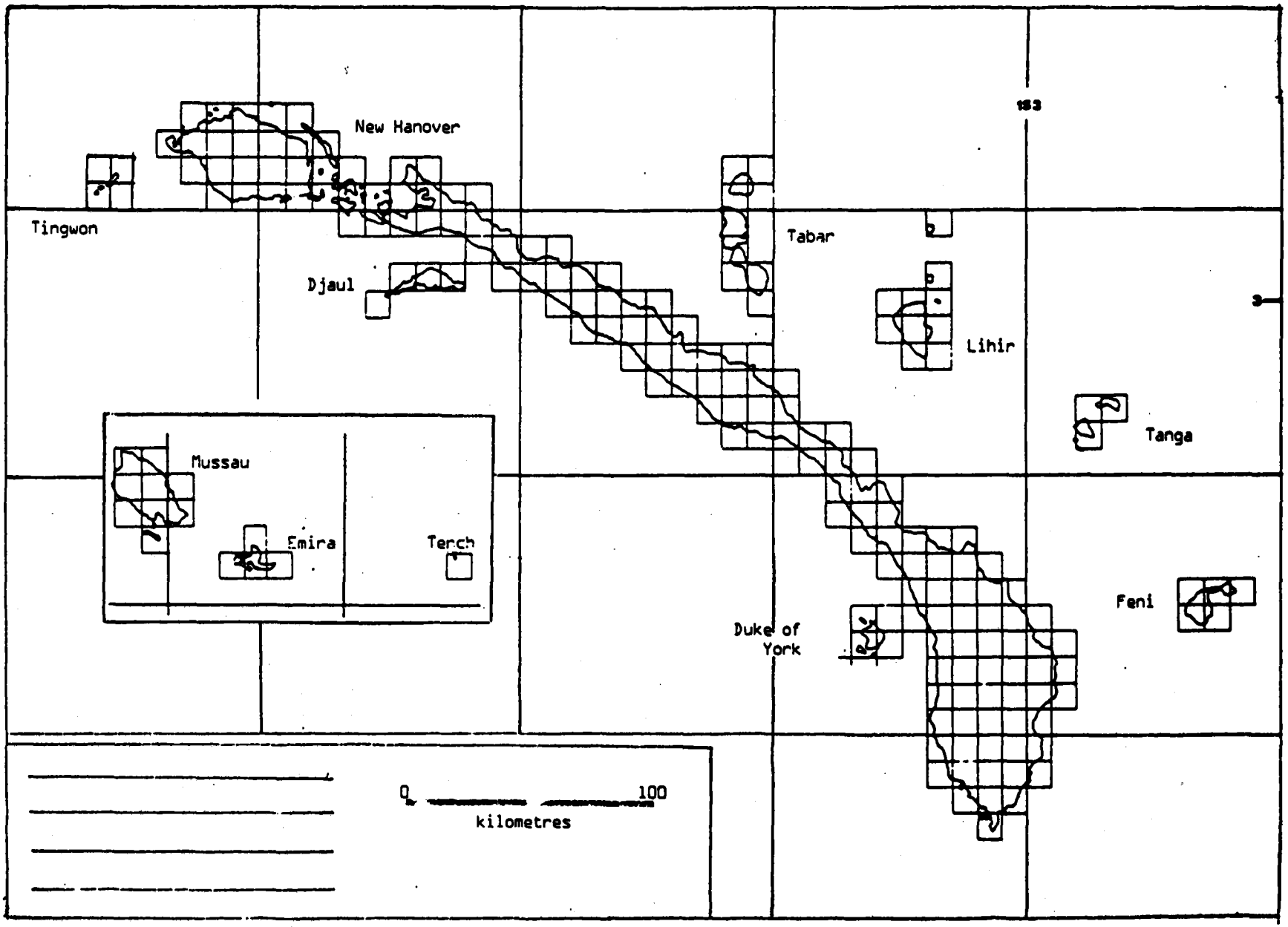
.....


New Hanover
Tingwon
Djaul
Tabar
Lihir
Tanga
Feni
Duke of York
Mussau
Emira
Terch
0
100
kilometres

APPENDIX 4

SOFTWARE FOR POSSIBLE USE IN PREDS ATTACHMENT 4.1. BIBLIOGRAPHIC SOFTWARE ATTACHMENT 4.2. A GLOBAL RESOURCE INFORMATION DATABASE (GRID).

Attachment 4.1. Bibliographic Software.

I. GENERAL FEATURES

System name adaptive library management system
Acronym: ADLIB
Version: 2.6 Release date: May 82

BACKGROUND AND PRIMARY OBJECTIVES:

First implementation was completed 1976 to meet a single user's requirements. Second implementation removed restrictions and integrated all library management functions within a single data base. The re-issued system has been installed in a range of different environments from early 1981. The objectives were originally to meet special library needs but have been extended to satisfy large academic and lending requirements. An overiding objective is to provide flexibility combined with ease of use.

GENERAL DESCRIPTION, MAIN FEATURES:

The system is built around a data base which is defined using data dictionary methods. The data base can contain multiple logical files which can be extended after the system is live. The query language is interactive and provides output displays in page mode at a VDU or any selected print format or tabulation. The functional modules are indicated below, but the utilities provided with the system enable additional modules to be set up quickly and often without any need for technical personnel to be involved.

PRODUCER:

Name: LMR Computer Services, Lipman Management Resources Limited

Address: 54-70 Moorbridge Road, Maidenhead, Berkshire SL6 8 BN, UNITED KINGDOM.
Telephone: Maidenhead 37123
Telex: 847112 LMR G

For additional information contact:

Name: Mrs. Janet Fowler
Title: Marketing Administrator
Firm/Institution: LMR Computer Services, Lipman Management Resources Limited
Address: 54-70 Moorbridge Road, Maidenhead, Berkshire SL6 8BN, UNITED KINGDOM.
Telephone: Maidenhead 37123
Telex: 847112 LMR G

II. HARDWARE REQUIREMENTS

The software package is implementable on a mini computer.
Configuration: Prime Computer, PRIME, All models.

Memory size: 512K - 8MB
Disk drives: 32MB 1 Unit - 2400MB 4 Units per controller
Tape drives: Max. 4
Terminals: 1 - 128
Printers: 1 - 128.

Other peripheral equipment: Bar Code Readers, Branch Satellite Systems.

III. SOFTWARE - OPERATING SYSTEM

Name: PRIMOS
Record Management System (RMS): Index sequential, Relative direct access
Others: ADMIN
Utilities: Sort, File Conversion Utility to import data from existing or external systems.

IV. SOFTWARE APPLICATION SYSTEM

Type of data: alphanumeric, numeric
Record length: variable
Maximum record length: 32K
Maximum number of records: 100,000,000
Maximum number of fields/record: Limited only by record size
The system's command language is: English, French, Dutch or any other language by use of the task utility program which permits each task and the corresponding dialog texts to be held in a file selected by user identity.
Thesaurus maintenance.
Batch operations.
Online operations; Number of terminals: 128 on single processor system, multiple systems may be linked using PRIMENT.
Type of system capability: multiple file, simultaneous file search.
Data entry and revision functions: Insert new text, Data validation, Change text, Delete text, find text, save old text, full screen edit, insert text from external files, move text, copy text.
Features of query language: Boolean operaotors, Numberical search, adjacency of search terms, theasurus, field-based search, full-text search, full text inversion.
Search functions: Display dictionary, show results on screen, print results, refine results of previous seletion, 'Pick' task.
Print generator: Sort, decode, KWIC-KWOC, statistics, indexing, forms, editing a format, word processing, twin track (merging of 2 typefaces) and multi-column.
Acquisition functions: Preliminary search, Document creation, displaying the document, multiple copies, budget control.
Catalog functions: Create, remove, print catalogs, correct, add, multiple copies.
Circulation functions: Borrower master file, charging an item, returning and recharging an item, control of overdue items, circulation statistics, reserving an item, interlibrary loan, multiple copies.
Documentation: Available in english; systems manual, utilities manual, operations manual, user guide.
Special applications: Museums, and collections of non-book material.
User can add application programs.
System is available without geographic limitations.

Warranty: Combined with maintenance.
System updata and/or maintenance is available.

V. COST, INSTALLATION

Price range of software:
*Source Code: $50,001 - $100,000 *Object Code: $10,001 - $50,00
Price range of hardware: More than $100,000.
*Locations: Greater London Council, Science Museum, London, University libre de Bruxelles, National Bank of Belgium, etc.

I. GENERAL FEATURES

SYSTEM NAME: Computer assisted information retrieval system
Acronym: CAIRS
Version: MK II Release date: Jan. 80

BACKGROUND and PRIMARY OBJECTIVES:

System has been under continuous development for the past 10 years. Designed to provide a computerized facility for all of the regular functions in an ifnormation unit: i.e., rapid retrieval, SDI, printed indexes, bulletins, record manipulations, etc.

GENERAL DESCRIPTION, MAIN FEATURES:

Designed for full on-line entry, editing, searching and manipulation of data. The main application to date has been bibliographic information retrieval, but use for membership records, personnel, project control, legislation, etc. is now active.

PRODUCER:

Name: Leatherhead Food Research Association
Address: Randalls Road, Leatherhead, Surrey,

UNITED KINGDOM.

Telephone: L. 376761.
For additional information contact:
Name: Mr. G.N. Cline
Firm/Institution: Leatherhead Food Research Association
Address: Randalls Road, Leatherhead, Surrey,

UNITED KINGDOM.

Telephone: L. 376761.

II. HARDWARE REQUIREMENTS

COMPUTERS: The system operates on: TI 990/10, TI 990/12, series TI 980 and TI 990, PDP-11 series, VAX II series, Prime mini-computer and Perkin-Elmer 32 series. The software package is implementable also on a mainframe computer.
The software package is implementable on a mini computer.

Configuration: Texas Instruments Inc., TI 990/10, TI 990/12.
Memory size: 64KB - 480KB
Disk drives: 10MB 1 unit - 250MB 16 units
Tape drives: Max. 4
Terminals: 1 - 30
Printers: Unlimited

III. SOFTWARE - OPERATING SYSTEM

Name: DX10, RSX-11M, RSTS, VMS, PRIMOS, PERKIN ELMER 0S32, CPM86.
Compilers: Assembler, RTL2
Record Management System (RMS): Relative direct access utilities: Sort.

IV. SOFTWARE APPLICATION SYSTEM

Type of data: alphanumeric, numeric
Record length: variable
Maximum record length: 2.8MB
Maximum number of records: 1 Million/System
Maximum number of fields/record: 90
The system's command language is: CAIRS own command language, Task names are user specific
Thesaurus maintenance.
Batch operations.
Online operations; Number of terminals: Depends upon computer.
Type of system capability: multiple file, simultaneous file search.
Data entry and revision functions: Insert new text, data validation, change text, delete text, find text, full screen edit, insert text from external files.
Features of query language: Boolean operators, Numerical search, search-term truncation, Thesaurus, field-based search, full-text search, nesting of instructions, alternative query languages.
Search functions: Display dictionary, postings, show results on screen, print results, save query, rivese query, return query.
Print generator: Sort, decode, KWIC-KWOC, indexing, forms, editing a format, word processing.
Acquistion functions: Preliminary search, document creation, skip (in create prompt mode), displaying the document, multiple copies.
Catalog functions: create, skip (in create prompt mode), remove, print catalogs, correct, add, multiple copies.
Circulation functions: Returning and recharging an item, control of overdue items, circulation statistics, circulation field codes, reserving an item, interlibrary loan, multiple copies, stock ordering.
Documentation: Available in English; operations manual, user guide, training manual.
User can add application programs.
System is available without geographic limitations.
Warranty: 3 months
System update and/or maintenance is available.

V. COST, INSTALLATION

Price range of software:
*Object Code: $10,001 - $50,000
Price range of hardware: More than $100,000

Number of installations: 30
*Locations: British Aerospace, Bristol; B.P. Chemicals, Barry, S.Wales; CPC Europe, Brussels, Belgium; Unilever, Balman, Australia, etc.

I. GENERAL FEATURES

SYSTEM NAME: Computerized documentation system/integrated set of information systems.
Acronmy: CDS/ISIS
Version: 4.0 Release date: Nov. 82

BACKGROUND and PRIAMRY OBJECTIVES:

ISIS is a generalized information storage retrieval system designed to operate non-numerical data base. The system provides for manipulation of varying data bases' contents without the need to re-program to suit the needs of the data base. Modularity is used throughout the system to minimize the cost of changes. Batch or online entry is available.

I. GENERAL FEATURES

SYSTEM NAME: Compterized Documentation System /Integrated Set of Information Systems.
Acronym: CDS/ISIS
Version: 4.0 Release data: Nov. 82

BACKGROUND and PRIMARY OBJECTIVES:

ISIS is a generalized information storage and retrieval system designed to operate non-numerical data bases. The system provides for manipulation of varying data bases' contents without the need to re-program to suit the needs of the data base. Modularity is used throughout the system to minimize the cost of changes. Batch or online entry is available.

GENERAL DESCRIPTION, MAIN FEATURES:

CDC/ISIS features online or batch data entry and retrieval, editing facilities, multifile search, access to master records via inverted files, indexes built from controlled or uncontrolled fields, print formatting language, tabular control of the composition of each master file, generalized logical record structure for master records, code look-up, standarized communications format interface.

PRODUCER:

Name: UNESCO, Div. of Library, Archives and Documentation Services
Address: 7, Place de Fontenoy, 75007 Paris,

FRANCE

Telephone: 1-577-16-10
Telex: 204461 Paris
Cable: Unesco Paris
For additional information contact:
Name: Giampaolo del Bigio

Title: Deputy Chief
Firm/Institution: Division of the UNESCO Library, Archives and Documentation Services
Address: 7, Place de Fontenoy, 75700 Paris,

FRANCE

Telephone: 1-577-1610
Telex: 204461 Paris
Cable: Unesco Paris

II. HARDWARE REQUIREMENTS

COMPUTERS: The system operates on: IBM all models and any IBM 360/370 compatible computer, such as RYAD, Ahmdal, Itel.
The software package is implementable on a mainframe computer.
Configuration: IBM, All models.

III. SOFTWARE - OPERATING SYSTEM

Name: IBM's Operating System (OS/MFT, MVT, VS1, MVS)
Compilers: Assembler, PL1, CICS required for conversational programs
Others: VSAM (key sequence)
Utilities: Sort.

IV. SOFTWARE APPLICATION SYSTEM

Type of data: alphanumeric
Record length: variable
Maximum record length: 32000 characters
Maximum number of records: 16,000,000 records
Maximum number of fields/record: Unlimited within max record size (system generation parameter)
The system's command language is: English, Other languages possible in HELP message file
Thesaurus maintenance.
Batch operations.
Online operations; Number of terminals: Limited only by CICS environment defined at CICS system generation.
Type of system capability: multiple file, single file search, networks and communication.
Data entry and revision functions: Insert new text, Data validation, Change text, delete text, full screen edit, cancel latest revisions, insert text from external files, static and dynamic definition of field contents.
Features of query language: Boolean operators, Search-term truncation, Adjacency of search terms, Thesaurus, Field-based search, Full-text search.
Search functions: Display dictionary, Postings, Show results on screen, Print results.
Print generator: Sort, Decode, KWIC-KWOC, Statistics, Indexing, Forms.
Acquisition functions: Preliminary search, document creation,

I. GENERAL FEATURES

SYSTEM NAME: Canadian Service for the Selective Dissemination of Information
Acronym: CAN/SDI
release date: 69

BACKGROUND and PRIMARY OBJECTIVES:

CAN/SDI has been a national information retrieval system for Canadian researchers, technologists and managers in industry, university and government since 1969. CAN/SDI is a current awareness service which keeps you informed of the most recent publications (journal articles, conference papers, technical reports and patents) in your field of interest, by using an "interest profile" based on your information needs. This profile consists of keywords, phrases, author and organization names describing your personal or group requirements. Once a week, every two weeks or once a month, depending on the database selected, a list of references retrieved by your profile will be mailed to you. Twenty (20) data bases are currently available.

GENERAL DESCRIPTION, MAIN FEATURES:

"Batch" information retrieval system. Tape suppliers data is manipulated into an internal processing format (MARC-like) and matched against the user interest profiles. Output is in the form of printed citations satisfying the user's area(s) of interest.

PRODUCER:

Name: Canada Institute for Scientific and Technical Information
Address: National Research Council of Canada, Ottawa, Ontario K1A 0S2, CANADA
Telephone: 613-99-1210
Telex: 053-3115

VENDOR:

Name: UNESCO, Div. of Library, Archives and Documentation Services
Address: 7, Place de Fontenoy, 75700 Paris,

FRANCE

Telephone: +331-577-1610
Telex: 204461 Paris
For additional information contact:
Name: Giampaolo del Bigio
Title: Deputy Chief
Firm/Institution: Division of the UNESCO Library, Archives and Documentation Services
Address: 7, Place de Fontenoy, 75700 Paris,

FRANCE

Telephone: +331-577-1610
Telex: 204461 Paris

II. HARDWARE REQUIREMENTS

The software package is implementable on a maniframe computer.
Configuration: IBM, IBM 360, IBM 370, IBM 30XX.
Memory size: 8MB
Disk drives: 200MB 2 units
Tape drives: 2-1600 16250BPI
Printers: 1
Other peripheral equipment: Card reader.

III. SOFTWARE - OPERATING SYSTEM

Name: IBM OS
Record Management System (RMS): Index sequential
Utilities: Sort, Tape dump, Tape copy.

IV. SOFTWARE APPLICATION SYSTEM

Type of data: alphanumeric
Record length: variable
Maximum record length: 6204 Bytes (VSAM Record); 400 bytes VISAM
Maximum number of records: N/A
Maximum number of fields/record: 60
The system's command language is: English, French
Batch operations
Type of system capability: single file search.
Features of query language: Boolean operators, Search-term truncation, Adjacency of search terms, Full-text search, nesting of instructions.
Search functions: Postings, Print results.
Print generator: Statistics, Forms.
Circulation functions: Up to 2 copies.
Documentation: Available in English; systems manual, operations manual, training manual, CAN/SDI Profile design manual available in English and French.
User can add application programs.
System is available without geographic limitations.
System update and/or maintenance is available.

V. COST, INSTALLATION

Price range of software:
*Source Code: No charge *Object Code: No charge
Price range of hardware: More than $100,000
*Locations: Located in Australia, Thailand and India.
Skip (in create prompt mode), Displaying the document, multiple copies.
Catalog functions: Create, Skip (in create prompt mode), remove, print catalogs, correct, add, multiple copies.
Documentation: Available in English; Systems manual, reference manual, operations manual, user guide, photocomposition manual, system installation manual.

User can add application programs.
System is available without geographic limitations.
System update and/or maintenance is available.

VI. COST, INSTALLTION

Prince range of software: source and object code provided free of charge to non-profit institutions in Unesco Member States, having the required hardware and manufacturer software.
Number of installations: 70
*Locations: Algeria, Argentina, Barbados, Brazil, Bulgaria, Cameroun, Canada, Chile, Colombia, Finland, France, Hong Kong, Hungary, India, Italy, Malaysia, Mexico, Peru, Philippines, Poland, Portugal, Senegal, Singapore, Sweden, Thailand, Ukraine, United Kingdom, USA, USSR, Yugoslavia. For more information refer to producer.

I. GENERAL FEATURES
SYSTEM NAME: MINISIS

Acronym: MINISIS

Version: E.02 Release date: Dec. 82

BACKGROUND and PRIMARY OBJECTIVES:

MINISIS was developed by IDRC as part of its international development research program in information sciences. In 1976, IDRC began work on a low-cost minicomputer-based online data entry and interactive retrieval package that could be used for its own in-house needs, could also be made available to developing country institutions. MINISIS became operational in 1978 and has since proved both cost-effective and adaptable. It is now an established member of the ISIS compatible family.

GENERAL DESCRIPTION, MAIN FEATURES:

MINISIS is a generalized information management system developed primarily for use in bibliographic information systems but is flexible enough for use in many types of application. It combines data base creation and management facilities and information retrieval in one "user-friendly", easy to learn package. MINISIS includes a set of programs to support library management and information retrieval in small - to medium-size libraries. There are processors for entering, modifying, and retrieving data, for performing arithmetic computations, and for defining and producing reports. Its search processor has powerful retrieval capabilities and supports the use of an online thesaurus, multilingual recognition of thesaurus terms, and Boolean and arithmetic operations. MINISIS can easily produce annotated bibliographies, library catalogues, and different types of indexes on various media including computer output microfiche. The system handles true multilingual dialogue and can support up to 16 different character sets within one data base. There are a full range of utilities to assist the data base administrator in creating and maintaining data bases. The exchange of data bases is facilitated by accepting and producing magnetic tapes in the ISO 2709 exchange format.

MINISIS provides a general set of application programs. Generally no programming is required but users with specific requirements can write specialized application programs using the MINISIS intrinsics to supplement the generalized processors provided with the system.

PRODUCER:

Name: International Developmetn Research Centre
Address: P.O.B. 8500, Ottawa, Ontario K1G 3H9,

CANADA

Telephone: 613-996-2321
Telex: 053-3753
Cable: RECENTRE
For additional information contact:
Name: MINISIS Outreach
Firm/Institution: IDRC
Address: P.O.B. 8500, Ottawa, Ontario K1G 3H9,

CANADA

Telephone: 613-996-2321
Telex: 053-3753
Cable: RECENTRE

II. HARDWARE REQURIEMENTS

The software package is implementable on a mini computer.
Configuration: Hewlett-Packard, HP 3000.
Merory size: 265KB - 8MB
Disk drives: 27MB (1 unit) - 404MB (8 units)
Tape drives: 800, 1600, 6250 bpi
Terminals: 1 - 64 lines with multipoint
Printers: variety of dot matrix, impact and laser printers available.

III. SOFTWARE - OPERATING SYSTEM

Name: MPE IV (Multiprogramming Executive)
Compilers: SPL
Others: Standard MPE fundamental operating system and software
Utilities: Sort, Standard MPE utilities.

IV. SOFTWARE APPLICATION SYSTEM

Type of data: alphanumeric, numeric
Record length: fixed & variable
Maximum record length: 4096 characters
Maximum number of records: > 10 million
Maximum number of fields/record: 256 characters
The system's command language is: Any language in which character set can be represented in 265 characters
Thesaurus maintenance.
Batch operations.
Online operations; number of terminals: As many terminals as supported

by hardware configuration.
Type of system capability: multiple file, simultaneous file search, single file search.
Data entry and revision functions: Insert new text, Data validation, change text, delete text, cancel latest revisions, move data from one field to another.
Features of query language: Boolean operators, Numberical search, Search-term truncation, Thesaurus, Field-based search, Full-text search, Nesting of instructions, Alternative query languages.
Search functions: Display dictionary, Postings, Show results on screen, Print results, Save query, Save hit file, Recall query.
Print generator: Sort, Decode, KWIC-KWOC, Indexing, Forms, Editing a format.
Acquisition functions:, Applications are user defined, duplicate checking, orders and claims, statistics, limited financial functions.
Catalog functions: Create, Applications are user defined, modify, delete, query, print exchange tapes, authority files.
Documentation: Available in English, French; Utilities manual, Introduction, data base managers guide, Programmers guide, user processors manuals, Error manual.
Special applications: Some typical applications of MINISIS include bibliographic, project information, mailing list, registry of correspondence, personnel records.
User can add application programs.
System is available without geographic limitations.
System update and/or maintenance is available.

V. COST, INSTALLATION

Price range of software:
*Object Code: $10,001 - $50,000
Price range of hardware: More than $ 100,000
Special terms for developing countries: MINISIS software made available free of charge to non-profit and governmental organizations in developing countries.
Number of installations: 76

Attachment 4.2. A global resource information database (Grid)

BY D. WAYNE MOONEYHAN
Director, Project GRID-Geneva Global Environmental Monitoring System (GEMS)
United Nations Environment Programme (UNEP) 6, rue de la Gabelle, 1227
Carouge, Geneva.

ABSTRACT

Project GRID is a UNEP/GEMS effort designed to develop methodologies and procedures for handling and analyzing environmental data on local, regional and global scales and to demonstrate the concept of effectively using geographic information system and distributed digital database technology for the application of global environmental assessments. GRID is supported by several nations with hardware, software, services and personnel. The pilot database network will consist of three nodes, in Nairobi, Geneva and the NASA/Earth Resources Laboratory in Mississippi, USA. They will be linked initially by commercial telephone/satellite data system and later by satellite communication earth stations.

The pilot program hardware and software systems will be discussed. The hardware consist primarily of two Perkin-Elmer computer and 2 Prime computers. The software consist of two data analysis/geographic information systems. One of the systems, ELAS, was developed by NASA and the other, ARC-INFO, was developed commercially.

Data analysis capability of the system will be presented using several sources of satellite data. The geographic information system will be illustrated by examples of local, regional and continental database parameters. Applications of the database will also be discussed, and preliminary examples will be presented.

I. GRID

The Global Resource Information Database (GRID) is a new project with the objective of providing information to people making decisions that affect the well being of our planet. As part of the United Nations, GRID will provide data and information to scientist, planners and decision makers in their job of managing and assessing the impacts on critical environmental issues.

Traditional access to environmental data, in shelves of reports and proceedings, fast ageing maps and charts, no longer meet the demands of planners faced with a world where the nature of environmental change is infinitely complex. With the development of computers that can handle large quantities of data, a global database is now possible.

GRID is designed to make environmental data available to a large user community. Each decision relative to the use of resources and the environment must be made with concern for the future, and concern for the generations who will inherit the legacy of today's environmental planning.

The users may be scientists trying to understand the functioning and behaviour of the global environment, or planners making important management decisions about resources in regions under their jurisdiction.

It is intended that GRID will enhance the relationship that already exists within the

United Nations by effectively giving a wider audience access to datasets that are being built up within UNEP/GEMS, other UN agencies and other international and national organizations. It iwll be a dispersed system, with facilities linked by telecommunications, eventually sending data to, and receiving data from, nodes throughout the world. This will help to build a useful picture of the state of the global environment and at the same time enable planners to make better environmental decisions and to manage resources more effectively.

During the pilot phase, three main functions have been identified for GRID. Bringing together existing environement datasets [analysing existing information in order to pinpoint areas of environmental concern] and training people from both developing and developed countries in the use of the technologies involved in the use of geographically based information systems.

II. THE DATA

The data for the GRID database are collected through numerous organizations both national and international. United Nations Organization such as UNEP, UNESCO, UN Statistics office, FAO, WHO, WMO, etc., collect data on a global scale for major environmental parameters. These parameters include soils, tropical forest, rainfall, temperature, hydrology, background air pollution, urban air pollution, water quality, worldwide glacier inventory, human population statistics, agricultural produciton, economic statistics, and many others. Other international organizations and regional organizations also provide important information. The IUCN maintains records on endangered species, both plant and animals, on a global basis, and ILCA (International Linestock and Cattle Association) maintains statistics on domestic animals in North East Africa. National organizations collect and maintain national environmental data and some national organizations such as NOAA (National Oceanic and Atmospheric Administration) in the United States collect and analyze satellite data of the entire world.

All environmental assessments need baseline datasets. First is a base map of the world, a framework for georeferencing. To this base map information on elements such as soils, vegetation, plant and animal species, climate and human settlements will be registered geographically. Initially, data will flow in from international datasets to which the United Nations Environment Programme already has access, for example, the five programme areas of GEMS. Using these datasets in the pilot phase, GRID managers will be able to establish priorities for collecting new data to expand the database. Sometime in the future, sufficient data will be available to allow a response to many questions about the environment. Answers will lead to new questions and improve the process of upgrading datasets. The attention of managers will be drawn to gaps in the database and action taken to fill them. Upgrading is a process that will be part of the day-to-day working of GRID, leading to decisions based on increasingly reliable and comprehensive data.

III. THE SYSTEM

The GRID system is planned to be a distributed networks of database nodes around the globe. Two nodes have been established within UNEP for the pilot phase. One of the centres is located in the GEMS/PAC offices at UNEP headquarters in Nairobi, Kenya. This center, GRID Control, serves the overall policy and priority fixing functions as well as the principle center for Africa. The second center, GRID-Processor, located in Geneva, Switzerland, is the centre processing facility and, in addition, will serve the areas of Asia and Latin America until operational nodes are established in these regions. (ANASA center, the Earth Resources Laboratory,

located at the National Space Technology Laboratory in Mississippi, USA, is participating in the pilot phase and providing both technical support and expertise under the NASA Earth Science and Application Program).

A. The hardware

1. The Nairobi center is equiped with one Perkin Elmer computer system and one Prime computer system. The Perkin Elmer is a model 3220 mini computer with one megabyte of memory, 170 megabytes of disc storage, interactive image analysis station, tape drives, printer ploter, color copy camera and an X-Y digitizer. The Prime system is a model 2250 with 2 megabytes of memory, 158 megabytes of disc storage, tape drive, printer and a graphics system. A third micro-processor system by ERDAS Inc., which utilizes an IBM AT will be added to the Nairobi center in 1986 and will be used as the primary system for training participating scientists and managers.

2. The Geneva center is equiped with one Perkin Elmer computer system and one Prime computer system. The Perkin Elmer is a model 3241 with 4 megabytes of memory (capable of 8 MB), 1200 megabytes of disc storage, tape drives, printer, electrostacter printer plotter, interactive image analysis system, XY digitizer, and color copy camera. A second interactive image analysis will be added in 1986. The Prime is a model 750 with 6 megabytes of memory, 1350 megabytes of disc storage, tape drives, printer and an interactive image display. A graphic system and XY digitizer will be added in 1986. A micro-processor system by ERDAS Inc. will also be added in 1986 and will be used for training of participating scientists and managers.

A. The software

1. The Perkin Elmer computers in Nairobi and in Geneva employ the Elas software system. ELAS was designed and developed by NASA at the Earth Resources Laboratory located at National Space Technology Laboratory in Mississippi, USA. It is both an image analysis system and a geographic information system. Data input can be accomodated from tapes, disc, terminal and XY digitizer. It is capable of handling all types of digital image data as well as line, point and polygon data from any geographically referenced source. Data are stored in the database in the most efficient form, grid or polygon, and are manipulated in grid format within the GIS models. ELAS presently contains more than 200 executable models and overlay programs, and is written in Fortran for ease of transfer to various computers. (For detailed information on ELAS, contact Ms. Trish Penton, NASA/ERL, NSTL, MS 39529, USA).

2. The Prime computer in both Nairobi and Geneva employ the ARC/INFO software system. ARC/INFO was developed by Environmental Systems Research Institute (ESRI) in Redlands, California, USA. (INFO was designed and developed by HENCO Software Inc. in Waltham, Massachuetts, USA). ESRI is a commercial firm which sells and services the software systems. ARC/INFO brings together geographic analysis and modeling capability with a complete interactive system for entry, management and display of spatial data. It is a geographic information system and a database management system. Data input can be accomodated from tape, disc, terminal, XY digitizer or graphics terminal. It is capable of handling all tapes of digital data from any geographically referenced source. The relational database management system is interactive with spatial and attribute query, tabular

analysis and report generation. (For detailed information on ARC/INFO contact ESRI Inc., 380 New York Street, Redlands, Ca. 92373, USA).

IV. DATA ANALYSIS

Like most computer-based geographical information systems, GRId has a number of basic features. Data capture, storage and retrieval, analysis, output and display.

Data capture involves putting information into the computer and organizing it in memory. Data in GRId are geo-referenced. The software recognizes every piece of information in terms of its position on the surface of the earth, and all data entering the system have that in common.

Data are store as geo-referenced points. The points, however, are arranged by the software to represent either points, lines or areas. Thus, rain gauges and houses are points, lines such as roads and rivers are stored and recognized as a series of points, while areas have points defining their perimeters (polygons). The software can deal with areas of any shape or size. Data storage also involves registering characteristcs. Every point, line and area is actually described, be it a rain gauge, road or lake. Any description is possible and any point (or line, or area) may be described over and over again and given new and revised attributes.

Retrieval is recovering ordered data from the computer's memory, or from mass storage discs or magnetic tapes, so that they can be analysed. Retrieval involves asking the computer to search and query both by location and attribute. For example, all the lakes in Gambia, all the man-made lakes or reservoirs, all of the same that are within 10 Kilometres of a major road, those that contain a certain species of fish, or those that suffer from high acidity.

The main feature of GRID is its capacity to analyse and display information. This involves the retrieval of data files or parts of them in any combination and their analysis together or separately to generate tables, graphs, maps, or charts that will help analysts examine, manipulate and understand the problem they are investigating. GRID will be able to handle almsot any question couched in geographical terms. Its ability to answer will be a reflection of data availability, not analytical flexibility. The three basic techniques of data analysis are modeling, overlay, and the use of statistics for any particular area, any datasets held in the system can be overlaid, with different information for the same area. For example, in a study of soil erosion the computer will be able to compare the degree of erosion with soil quality, water runoff, temperature, human settlements or domestic animal distribution by overlaying them one by one (or all together).

The software's capacity to display analysed data will ultimately determine the way in which they will be used. Perhaps the most common ouptut will be the map, but many others will be possible/ graphs, charts, tables and displays on color monitors.

V. APPLICATIONS

The applications of the GRID system will determine it's wroth. The number of possible applications is only limited by the data availability and the imagination of the users. The system can be used at any scale from the global level (for general assessment statements about worldwide trends in deforestation and desertification) and at the local level for analyzing problems within countries (an environmental impact of reservoir construction). The applications fall into three generic categories.

- inventory (for status)
- monitoring (for change analysis)
- modelling (for cause/effect analysis)

An example of inventory and monitoring can be illustrated by Figures 1, 2 and 3, Fig. 1 is the extent of tropical forest in Costa Rica in 1940 as determined by areal survey. Fig. 2 is the same phenomena in 1977 as determined from Landsat satellite data. Fig. 3 is the amount of change that occured between the two dates.

An example of modelling results is shown in Fig. 4 which is the final product of applying the Universal Soil Loss model to a watershed in Iowa, USA. Fig. 5, a soils map for Africa, is an example of a continental scale dataset. This dataset, along with datasets of rainfall, number of wet days, wind speed, temperature, land use, vegetation and climate zones was used in a model to produce the desertification hazard map shown in Fig. 6.

SUMMARY

The first GRID computer was placed in service on September 27, 1985 in Geneva. The second system in Geneval will be placed in service in February 1986 and both Nairobi computer systems will be in service in February 1986. Thus, the process has started and its success will depend on many factors. In the beginning, the most important activity is collecting the appropriate data and constructing the geographic datasets. This will require much cooperation between GRID and the international, regional and national organizations that hold the needed datasets and several years of careful work in their construction. In the end, its success will be judged by the applications and users of the database.