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A REPORT TO USAID/ROCAP TO SUPPORT DEVELOPMENT OF A PROJECT PAPER FOR A REGIONAL WATERSHED MANAGEMENT PROJECT FOR CENTRAL AMERICA AND PANAMA

(Data Base/Information System Component)

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Dulin (1982a) in reviewing agroforestry as a land use system in the tropics states "that no land-use system, regardless of its ratio of benefits obtained for effort expended, will succeed in the near future in the countries of the American Tropics without informed decision making by policy makers and proper legislative support". (Emphasis added by author). Informed decision making requires availability of data, i.e. collection and dissemination, and training in how to properly incorporate data into the decision making process.

The importance of an information support system for the watershed management project cannot be stressed enough. Watershed managers need to integrate large amounts of data from many different sources. Often this information is lacking, but more frequently the information, though existing, is not readily available because it is widely dispersed and not well organized.

In the World Wildlife Fund report on "Strategy for Training in Natural Resources and Environment", one of the major gaps or general themes identified was integral resource management (World Wildlife Fund 1980 a). The problem is "a general lack of consciousness of the interrelatedness and interdependence among factors of environment and development".

Training in the integral management of natural resources, demonstration areas for showing methods and practices and information to better focus on the problems and its possible solutions should be major parts of a project dealing with this identified gap.

Many of the benefits of a regional watershed management project depend on the successful transfer of information to planners, decision makers, land managers and technicians. This transfer must be timely and in a form that facilitate understanding and implementation. Efficient technology transfer is precluded by many of the standard forms of information distribution, e.g. unpublished reports or scientific publication. The former are often over-burdened with technical detail if not trivial background information, the latter are often aimed only at a small, highly trained audience or reaches only a small audience because of the style of presentation.

2. Institutions with Watershed Management Activities

All countries established governmental institutions with responsibilities for managing or organizing resources in the Public Domain by legal decree. Many of those laws created an overlapping of authority and responsibilities for watershed resources management (Dulin 1982).

Every country in the study region has very similar institutions which are directly and indirectly involved with watershed management questions. At the highest level typically exists a national planning office charged in general with all national planning needs. Normally, one key agency is explicitly or implicitly charged with questions concerning land use including watershed management. Each country has one or more institutions representing the electric power industry. These institutions are typically powerful, and as the largest users of water have the most to gain immediately from watershed management activities. In some cases, these institutions have special departments with watershed management responsibilities such as in Panama. In some countries, institutions exist in charge of water use and treatment specifically. Other institutions do play a role, but to a much lesser degree. This is not to say, that these organizations should not get involved more in watershed management questions. One example are the environmental groups which can be effective in watching over private and governmental land-use development programs.

3. Watershed Information Systems/Current Status

A good staring point for beginning a review of available inventory data on natural resources and watershed management is a paper by Dulin (1982b) in which he reviews past

and current inventory activities in Central America. The role of various institutions in the collection of data related to watershed management problems in Central America is discussed by Garcia (1982) and Dulin (1982c). Though these reports reveal that there have been and are ongoing efforts of gathering data, they also show that these data are widely dispersed, outdated and sometimes of questionable utility.

Of particulary interest for existing background is the information and documentation program in IICA known as CIDIA (Centro Interamericano de Documentacion e Informacion Agricola) and its recent activities in the collection and documentation of natural resources information in Central America including computerized bibliographic systems and thematic bibliographies. Already exists at CATIE through IICA the best regional library on natural resources related information. A CIDIA/RCCAP project known as PICIAC (Programa de Informacion Agropecuaria del Istmo Centroamericano) is producing a management information series reflecting a better organized and systematic information collection. This series contains a number of references to preliminary plans for data base management.

One of the invertory documentation methods employed is the computerized geographic information system (CRIES). This system provides a systematic framework for the storage and analysis of mapped information. Eight thematic maps including

land use, life zone ecology, population density, dry season length, annual precipitation, temperature and evapotranspiration, and political boundaries have been logged into the system for each Central American country and Panama. The system has been installed at CATIE. In Costa Rica, the Direccion General Forestal is considering its use for its AID funded natural Resources Project.

INFOPAT (Informacion y Documentacion para America Tropical) is an information and documentation service of CATIE supported by the Swiss agency for Development (DDA) and gives high priority to the distribution of publications. INFOPAT also established a small collection of reprints on agroforestry.

4. Justification for Data Base/Information System

The establishment of a regional data base/information system will provide one of the important service functions of the program. It will directly serve the countries, i.e., institutions and specific projects, by providing administrative, social, economic and technical data for regional and national planning and management operations. It will also support various functions, long and short-term, in the training programs and provide the permanent advisory team with backup data and information.

A number of specific arguments can be made in support of development of data base management systems (DBMS) especially for a complex, highly integrated subject area as watershed management:

(1) It reduces the cost of information retrieval and transfer over "traditional" systems.

(2) It makes information available on a more timely basis.

(3) It forces abstraction of important information from many sources (publications, reports, etc.) for efficient and central storage. This facilitates information transfer.

(4) It helps identify major gaps in information and helps direct data collection efforts into high priority areas.

(5) It requires systematic analysis of major problems and questions to be answered by data base.

(6) It supports the standarization of data collection efforts and data recording forms.

(7) It reduces the risk of information being lost compared with decentralized, widely dispersed information storage.

(8) It facilitates data quality control through standardized procedures including error checking programs.

(9) It supports integrated planning activities and lead to improved balance of all types of information.

(10) It helps integration of many supporting fields in watershed management.

(11) It can speed appropriate management decisions and reduce the likelihood of poor, uninformed decisions.

(12) It helps avoid duplication of research and data collection efforts.

5. Strategy for Development of Data Base/Information System

Information and data collection and the transfer of this information occurs at many different levels. For a regional watershed management project data collection must support the management of the resource. Each level of data collection must be designed for specific levels of decision making within the regional institutions, i.e., strategic planning, management control, and operational control according to Anthony (1965). Strategic planning incorporates the process of defining long-range goals for the organization. Management involves resource allocation decisions. Operational control involves methods of insuring completion of specific tasks.

The Management Information System (MIS) to be developed within the watershed management project must cover this spectrum of planning needs. It will have to consider in its design the major categories of MIS and their relation in the MIS transformation process.

transformation process is shown. The process must be defined for the whole regional structure of the watershed management project and for the subregional institutional levels with watershed management roles. The inputs are all data collected supporting watershed management activities. The technology transforms the inventory data into MIS outputs. The outputs may include summary reports, programmed decisions, or decision support. The latter are designed to assist decision processes. MIS feedback evaluates the efficiency or effectiveness of the transformation process.

In developing a strategy for the data base information systems component of the program, the background information provided by the various documents together with survey findings (CATIE, Watershed Project 1983) were very useful. It provided answers to which key groups would need specific information, to what kind of information was most needed, to the needs for training to use information and to the priority of services of a central data bank.

The general strategy that evolved involves establishing a central data base/information service for the region with the purpose:

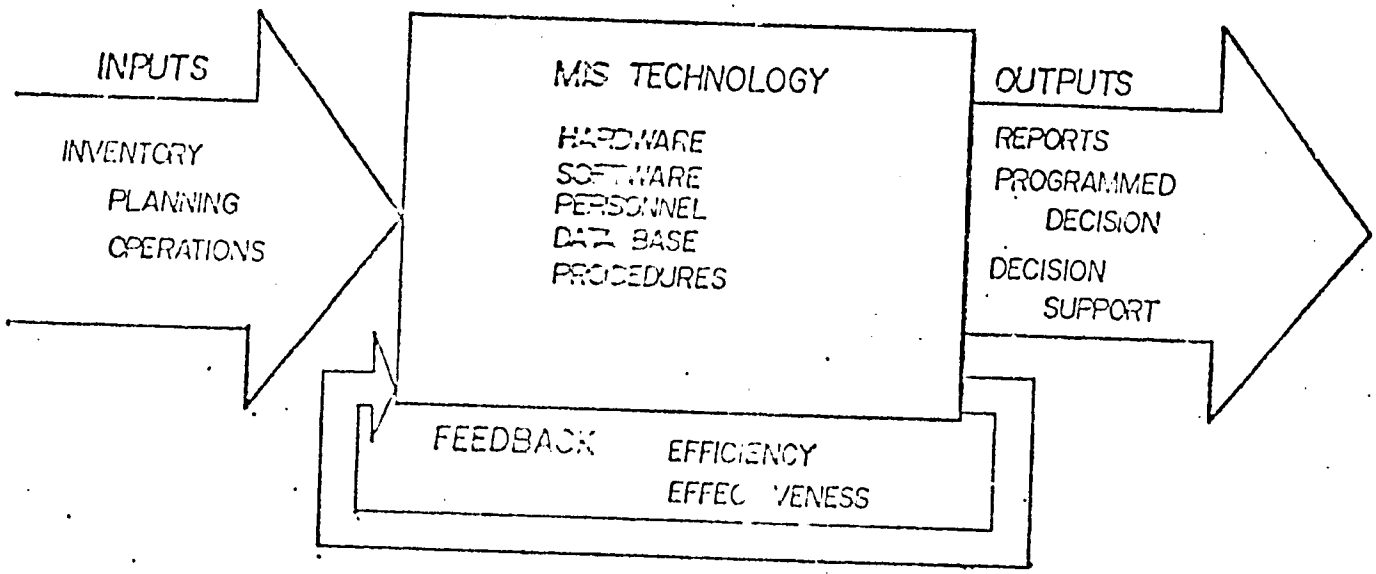

Figure 1. Information system transformation process.
(Adopted from Murphy, 1981)

To serve as a regional center for collection, storage and dissemination of information to planning offices, watershed projects and institutions involved in watershed management activities.

A number of strong arguments can be made for a centrally organized and maintained MIS. For one, data collection is an ongoing process, requiring constant updating of the data base or bases. For economic reasons and error control, a central processing unit is clearly preferable. There is no inherent reason, that the standarized data cannot reside in other locations for regional access and use, but one central unit should be responsible for updating the data base and for data entry into the base.

Central organization also facilitates meeting information requests efficiently, on a timely basis, and guarantees that the information request is being met with latest available, complete information. Maintenance of data base management systems is not cheap. A large portion of the costs are initial fixed costs or costs associated with setting up the system. The variable costs of operating the system consist in costs for loading information tapes or disks and for computer processing time. With the large fixed cost component, operation of data base often show strong economies of scale, i.e., the cost per

information retrieval decreases with the number of retrieval requests, because the fixed costs can be divided over larger and larger number of requests. This factor also favors centralization of such data retrieval systems.

The level of technical skill required from a data base manager is high. Since qualified personnel is not easy to find centralization is recommendable.

Initially, the project should assemble and organize available data relevant to watershed management. Only then can begin the process of identifying additional inventory needs, including decisions on what type of data to collect, on who is to collect these data, and on overall priorities for various types of data. To avoid duplication, the current and proposed activities of DCA funded INFORAT should be examined.

Design and execution of inventories are influenced by environmental, socio-economic, political and institutional considerations (Dulin 1982b). Extreme topography and the complexity of ecosystems in the tropics create technical problems of access and for aerial photography and other forms of remote sensing and for the design of inventories. Because of socio-economic problems in developing countries, information gathering activities receive little public and

private support. The project needs to educate decision makers on the value of information by contrasting costs and derived benefits. This job will require acquisition of comparative data. Political instability and isolationist attitudes of countries need to be considered when integrated data collection efforts are planned. The promotional efforts of a centralized data collection, storage and dissemination strategy need to be carefully designed to obtain the cooperation of the diverse governments and institutions. One of the severe problems among the latter, even within countries, is the lack of coordination of data gathering and dissemination. Personnel trained in the collection, interpretation and application of resource information is scarce. This problem needs to be addressed through training programs.

One aspect of a successful promotion of the regional information center is the early development of a number of useful products and services. Requests for these products and services should be met without delay and in easily understandable form. The request forms themselves should be easy to understand and use. Otherwise, requests are likely to be vague, incoherent or expensive to fulfill. In any case, response to requests might have to be an iterative process, at least initially.

It will not be possible for the regional information center to carry out all data collection activities. In assigning roles for data collection to individual countries and institutions, a separation of regional versus country-specific data would be useful. Regional data are data of interest to the whole region while country-specific data are relevant only to a specific country. In general, the information center at CATIE should be responsible for the former category while countries assume a responsibility for country specific data. This separation cannot be maintained totally in all cases. For example, all geograchic map information should be maintained at CATIE for use with the CRIES system. Wherever feasible, data collection should be coordinated as much as possible. Possibly, examples of each type could be developed and responsibilities be suggested by the central unit.

Opportunities exist for coordinating data collection and information transfer in several ongoing watershed projects. For example, the Natural Resources Management Project of AID in Honduras has as one of its main components natural resource data gathering and analysis. A similar component exists in the Costa Rica AIL project in natural resources.

6. Functions of Regional Data Bank

The major functions envisioned for the regional watershed management center at CATIE are:

(1) Organize regional information useful in major aspects of watershed management planning.

(2) Design central information storage and retrieval system.

(3) Respond to information requests.

(4) Advise countries on data collection needs and help coordinate collection efforts.

(5) Develop uniform data recording forms and train country personnel in use of forms and data entry.

(6) Advise in organization of data bases of research fields important to watershed management.

(7) Advise in establishment of in-country information storage and retrieval systems.

(8) Train coordinators in data collection, checking, processing and retrieval.

(9) Contribute to training of graduate students and short-course participants in use of data in decision making and planning.

7. Potential Production by Regional Data Bank

In line with a strategy of development of useful products and services of the center before asking for the cooperation of country institutions in data collection and to promote the use of the central data bank, the data base specialist should put early emphasis of the project on products considered useful by potential users.

To facilitate this rapid development of various products, advantage should be taken of existing capabilities at the computer center in terms of available computer packages for word processing, geographic information systems and data base management and of personnel.

Following are general descriptions of some of the possible products that might be produced by the regional data center. These preliminary recommendations are based on needs expressed in the survey (CATIE Watershed Project, 1983) and in various documents, e.g., Dulin (1982 b,c,d).

7.1 Computerized Reference Library

Initial review and development of a computerized reference library should be one of the first activities of the

data base specialist, but needs to be one of the many ongoing activities throughout and beyond the project. This collection would be a relatively small collection of only the most useful documents for watershed management activities especially for the high priority needs expressed in the survey (CATIE 1983), and its establishment will require major input from staff specialists. Otherwise this could become a very time-consuming activity.

Many of the documents reviewed by the team, e.g., Dulin (1982b) and Garcia (1982), are good starting points. In addition to the many references contained in the latter, there are many references to potentially useful information in the "Environmental Profiles" that have been prepared for some of the Central American countries (AID 1980 c,d,; AID 1982 World Wildlife Fund, 1980 b,c). The project should assemble all this information at CATIE for initial screening and for establishing a literature reference library designed for computerized retrieval by proven classification methods. This work will be facilitated by the availability of the UNESCO/CDS/ISIS (CDS/ISIS 1978) computerized reference system at CATIE. This system is currently being compared with another commercially available program called STAIRS (STAIRS 1981) as part of ongoing program and product evaluation by computer center staff. STAIRS/VS

(Storage and Information Retrieval System/Virtual Storage) retrieves information from documents it has stored. STAIRS/VS bases this retrieval capability on a multilevel indexing scheme that is used through queries and prompts. Either one of the two or both of these systems will be available to the data base specialist for immediate use and computer center staff can support this activity. Detailed user instructions and entry formats are being developed currently. Training in the use of these systems by the computer staff is being planned.

The establishment of a computerized reference library within CATIE by this proposed project and other existing projects does not run counter to the already existing services of organizations like IICA. For one, the system at IICA contains only documentation that is registered within libraries and, therefore, misses much of the information produced within CATIE. The system to be established will also serve the central library at CATIE which currently has no such capability. The network established by IICA is also not developed to a point where general direct access by computer or telephone into their data bank is possible. Such access is available to some large commercial banks. IICA computing capabilities in San Jose based on an outdated IBM 360 computer are also far more limited than those at CATIE. The

computerized reference library at CATIE could in the future be linked possibly with IICA and serve to strengthen and supplement their functions.

7.2 Map and Photo Collection/Geographic Data Base System

A second major output to be produced by the data base/information system is a collection of maps and photos useful in watershed management. The incorporation of the computerized geographic information system CRIES (CRIES 1982) into this process will not only facilitate this process, but will allow rapid production of maps useful for complex planning problems. CRIES provides a systematic framework for the storage and analysis of mapped information.

CRIES provides the capability to process and store digitized data from maps. The system accepts any type of mapped information maintaining a table of rows and colums. The cells of this table with minimum size of 1 km^2 can contain any information. No limitations exist with respect to the number of maps in the central bank as long as central memory is available on disk.

CRIES can retrieve all or parts of the information and display the results in the form of statistical summaries and computer printed maps of various scales for single or combined data. Data within a map can also be linked with analytical packages such as SAS (SAS 1980) for more refined analyses. Generally, the utility of the system becomes apparent when 3 or more maps need to be overlayed.

The major current limitations of the system are of a technical nature. Maps produced on a line printer allow only a very limited degree of resolution because the printing characters are of the same size independent of the map scale. For maps of a scale smaller than 1:25,000 (each character approximately covering 1 Km^2), the system needs to dispose of data to produce the map. The second problem is that currently map information needs to be coded by hand.

Codification of data by hand is a slow and costly process and increases largely the chance for errors. The needs for codification of maps are great because many maps useful for integrated watershed management purposes exist but are not part of the permanent data base.

To speed map digitization, the purchase and installation of a digitizer in the computer center is absolutely necessary. It will greatly enhance the usefulness of the CRIES system. Installation of a multi-color plotter is highly recommended for production of maps for planning purposes. Line printer created maps can convey only very limited amount of information due to poor resolution for many maps scales. Provisions for equipment maintenance are important for these items. Acceptability to IBM might need to be discussed.

Better commercial packages for geographical information system exist. Strong arguments can be made, however, for utilizing the existing system. Already exists some expertise in using this system at CATIE within the computer center and the Crop Production Project. Introduction of new systems generally requires considerable time to set up the system, to test it and to develop user guides to promote its use. The specialist coming into the project would find support and experience in the computer center staff for using CRIES. The computer center staff also is currently developing better user manuals to encourage wider use of the existing system. There will be no direct front-end cost to the project for acquiring another commercial package. With the addition of a digitizer and plotter, CRIES represents a fairly powerful analytical tool. CRIES has also been linked to a statistical analysis

package SAS (SAS 1980) at the computer center, largely enhancing its analytical capacities. Additionally, one of the strategies of the project to promote itself must be to develop useful products as soon as possible. Use of already established and tested capabilities facilitates this strategy. However, improved commercial products are coming on to the market and suggests continued study of product evolution and provision for acquiring a more flexible mapping package to deal with point data and to enable boundary adjustment. The computer center itself supports these arguments and might finance the move to another product. It would support both the old and new product and help the project to make the transition to a new program when required. The project could, therefore, concentrate on developing useful products and play a reduced role in the installation and testing of new systems for CATIE. CATIE computer staff would require additional training to facilitate a change to a new system.

There exists a backlog of useful geographical information in the forms of maps. CATIE, through its library and within the Crop Production Department, already has a large collection of maps. It must be cautioned, however, that apart from topographic maps, many of the thematic maps are based on extremely sketchy and incomplete data. In many cases, the

basis of the information on the maps is not revealed. There are some sets of maps which are worth digitizing but only a small proportion of the total available. The ability to bank a code for: (a)reliability of boundary positions, and (b) classification would be essential.

Some of the available maps are useful for watershed management purposes and should be codified as soon as possible and be made accessible through the CRIES system. This activity should include the updating of the information in already codified maps with better and newer information available for subregions of Central America and Panama from a number of specific studies, e.g., studies carried out in Guatemala by the Ministry of Agriculture dealing with agricultural classification, actual land use, hydraulic resources, climate and vegetation, and soil units and potential of soils (Guatemala, Ministerio de Agricultura, 1981). Updating of 1950's maps on a 1:50,000 scale would provide a potential tool for planning and land management.

7.3 Watershed Management Descriptive Tables

The development of data storage and retrieval systems is the third major output to be produced by the specialist. This will require selection of a commercial data base

management system (DBMS) package, design of a data base, collecting and coding of available information, and development of retrieval capabilities.

Rose (1983 a,b) reviewed existing capabilities for data base management at the CATIE computer center. The system Query-by-Example or QBE (QBE 1981) already supported by CATIE, is an example of data basing using linked or relational tables. This system was compared with hierarchial or network type data base systems such as SYSTEM 2000, (MRI. 1974) and SIR.

In a hierarchial data base design, sets of information are stored in a prearranged hierarchy and can be retrieved following the logic of the established pathways of the network. Once a hierarcy is established, retrieval can only follow predetermined patterns. Since many hierarchial designs are feasible, the design of one that best meets the varied needs of this integrated project would require considerable throught and probably would have to undergo many mayor revisions throughout and beyond the project life.

The other alternative is the development of relational tables. The procedure begins with establishing a set of tables and their specific content. A table is described by a unique name and rows and columns of information. A row is a set of

logically associated data elements. Different tables can be linked by creating tables that share identical key columns. The ability to search for and retrieve information from a complex of linked tables is, of course, the major reason for going to computerized retrieval systems.

A number of considerations enter into the selection process for a DBMS package among them support of a commercial system by the manufacturer, flexibility of data input, functions that the system can perform, e.g., statistical analysis and report writer, ease of interfacing package with user supplies routines and costs of maintaining and operating the system.

On the basis of computer efficiency (storage requirements), a hierarchial data base design is slightly preferrable. The inflexibility of these types of systems, once a data base design has been chosen, and the very high cost of acquiring for example system 2000 are arguments against their use. Systems of relational tables are more flexible and since the data base design of the watershed management program will undergo almost continuous changes and revisions, selection of that system is preferable. Supporting this recommendation is the considerable expertise in the use of these systems that already exists at

CATIE through its computer staff and the "Genetic Project" within the Department of Crop Production. The CBE system is also linked to the statistical analysis system SAS (1980) and its major shortcoming of not having a good report writer will be overcome with the arrival of SQL another IBM supported DBMS. SQL has all the features of CBE in addition to a good report writer.

7.4 Examples of Information Tables

The following are examples of tables that the data base specialist might develop. The specialist will design these tables and collect available information for storage in the desired form for at least sample cases. In many cases, the specialist will need the assistance of country institutions to check table contents, to provide additional information or to do the data collection for the tables.

7.4.1 Watershed Management Institutional Activity

This table would contain all information relevant to planners, researchers and managers of watershed projects in the initial phases of collecting information on key persons and institutions involved in watershed management activities. This

table might contain, by country, names, addresses and telephone numbers of key institutions and persons involved in watershed management activities with descriptions of their specific responsibilities, specialization and other information.

7.4.2 Index to Maps and Photos

One of the most important tools to watershed management planners is mapped information. The bigest problem facing planners is often not the lack of maps, but information on where to find them. It is recommended that the project specialist develop a data base table summarizing all relevant information on maps and aerial photographs. This table would include indexes to a collection of maps and photos already maintained by CATIE's library and the Crop Production Project (Contact: Dr. Richard Hawkins) and to be expanded as necessary, as well as information on content, scale, date of origin, vendors, purchase costs, and addresses of key contacts, i.e., intitutions and/or persons.

7.4.3 Watershed Description

The selection of priority watersheds would be an early task of the project. A tabular summary of information on key watershed should include all information relevant for the

development of watershed management plans and to help general coordinating and priority setting activities.

General Description:

- location
- size
- index to maps and photos

Physical Features:

- topography
- soils, soil capability, interpretation, potential yield
- source of water and other hydrological data
- existing structures (dam)
- roads

Climatic Features:

- precipitation
- temperature

Current Land Use:

- vegetative cover
- current yields

Social/Economic:

- land tenure
- population density
- major industries
- major water users

Administrative:

- management responsibilities (agency)
- existence of plans, programs, activities

This table can be designed centrally and be completed for sample watershed of each country. Individual countries through the country coordinator should be responsible for developing this type of information for all major watersheds.

7.4.4 Land Utilization

Land utilization classes should be developed specifically for Central America and Panama. They should reflect the potential of a unit of land to produce various agricultural and/or forestry crops and incorporate soil, topography, rainfall amount and distribution, temperature and possible other factors. The life-zone ecological land

classification developed by Holdridge (1978) could be a starting point.

7.4.5 Watershed Management Techniques

This table would be linked to the Land Utilization Table and describe technical information on watershed management procedures. This information should include references to published documents, location where techniques have been implemented, key contacts, and technical and economic data useful for planning.

7.4.6 Supporting Information

These are tables of information on specific land uses falling into the catagores of:

a) agriculture including crops and pasture

b) forestry

c) agroforestry

These tables should serve as general information bases for the planner, researcher and manager to identify types of management options, e.g., the species suitable for production on a specific land area, treatment requirement, description of

types of products and yields and references to more detailed information in the form of specific data bases, special reports and/or contact persons and institutions. These tables should contain key columns such as soil, location, land utilization to link it to other tables with more general information.

The data base specialist will not be able to handle the development of these information tables. The departments and projects at CATIE should be encouraged to develop these specific data bases for their projects in close coordination with the watershed management project. The data base specialist should help design these specific bases and supervise their integration into the larger design. A preliminary conceptual design of a data base for the fuelwood project at CATIE provides one example of how projects might organize information (Rose 1983 a,b).

8. Information Transfer

In accordance with the role of a regional data bank, mechanisms must be set up to respond to information requests by national institutions. This will require the data base specialist to:

a) Design data bases and retrieval procedures.

b) Design simple request forms for retrievable information.

c) Promote use of center's services by mailing filled sample request forms and associated information summaries retrieved from data bank to country coordinators and key institutions. It would include simple instructions for filling out requests and blank request forms.

d) Fill requests when received at center.

e) Develop a service fee structure.

Other forms of information transfer should be explored whenever appropriate. Country institutions expressing an interest in developing some of their own information retrieval capabilities should receive technical advise from the data base specialist. Certain portions of the data base could be transferred to appropriate installations including micro-computers. For example, a relational type DBMS program called CONDOR that runs a Z80 based micro computers could be acquired by a country institution for about $700.

To be able to respond to information requests on a timely basis and to reduce turn around time for preparation of documents, the project should develop word processing capabilities. This involves entry of text or data via a keyboard like typewriter into a computer for storage and easy

modification at any required time. With only minor training needs and investment by this program into a high quality printer and additional terminals, this system could become functional at CATIE.

The storage of text and data would be handled by the existing computer. The highly flexible word processing program SCRIPT (SCRIPT 1979) has just been acquired by CATIE's computer center. SCRIPT can process documents marked up with Generalized Markup Language (GLM) tags as well as those marked up with its own control words.

SCRIPT has other applications besides formatting documents. It can also be used as processor of documents that are going to be used as input to STAIRS/VS.

9. Training for Users of Data Base/Information System

In the design of the proposed watershed management graduate curriculum, a basic course in Statistics will be required from all students. The course "Principles of Data Base Management and Computer Applications" is designed for applications of statistical analysis programs and data retrieval programs. This will provide exposure to basic principles of data handling at a minium to all students in the

watershed management curriculum and generate a general awareness of the utility of organized information sources. Students will also be exposed to data base/information problems in integrated planning excercises of courses in "Principles of Natural Resource Economics" and "Land Use Inventory and Planning".

Besides these training activities, there exists a need for training country coordinators in two aspects of data base management. One is the ability to retrieve information from the system. In a short course of at least 1 week at CATIE the use of the system will be demonstrated via a well documented user's manual.

The second training need is to introduce the data base design to the coordinators and selected technicians, to train them in data collection, use of data collection forms developed by project specialists and the checking and processing of data. This short course of 2 weeks could also be used to help the coordination of data collection efforts in countries and among countries. The need for providing maintenance and updating must be strongly conveyed during the proposed course. Follow-up visits in each country by the data specialists and repeats of the course will be necessary because data collection is frequently outside the experience of country personnel.

10. Role of Watershed Management Data Base/Specialist in Training

The centralized data base should play a major role in training and promotional activities. As an example, a short course developed for training of planners and decision makers might develop practical exercise in decision making that are supported by only conventional data and by an organized data base. After the initial assignment of the problem, maybe even previous mailing to participants with instructions to bring all readily available planning documents, i.e., maps, data and reports, teams will be assembled to solve the planning problem. After discussion of the various proposed solutions, the data base/information system will be introduced to the participants by the specialist.

Participants then formulate with the help of the specialist specific information needs. The specialist retrieves available information for the teams which then repeat the planning exercise. The comparison of the solutions to the problem or plans produced would be a valuable lesson in decision making with information of varying quality and can help promote the utilization of the central data base in national problems.

To facilitate the incorporation of data into economic decision making modules, a computer program developed by Rose and Gregersen (1980) and implemented on the CATIE computer (Rose 1983c) would be encouraged. Other similar programs exist around the world, but this specific program was developed for FAO to facilitate forestry and agricultural project analyses. Because of its automatic execution of sensitivity analyses, it provides information on the impact of uncertainty on major measures of project performance. Furthermore, this system has been tested extensively and been used in classroom instruction in the U.S. and is fully operational at CATIE's computer center. This program could be incorporated into the courses "Principles of Natural Resource Economics" and "Land Use Inventory and Planning", as well as short courses for planners and decision makers.

The specialist together with the instructional materials specialist and computer center staff should carry out or coordinate the training of secretarial staff on the word processing system to be described later.

11. Role of Country Coordinator in Information Retrieval and Data Collection

Cooperation in information collection activities and

coordination of this effort among institutions can only be achieved by a successful promotion of the utility of a central data bank. Much of the initial effort in establishing this information base and of logically organizing the role and potential contributions of country and regional institutions must be placed into the hand of the data base specialist. Coordinators established within a key institution of each country will be the primary contact for discussions concerning the needs and possible contributions of country institutions to the central data bank. The coordinators might assemble advisory committees composed of representatives of all key institutions with an existing or potential role in watershed management activities. These advisory committees would decide on processes and responsibilities for data collection and provide input on types of data needed. Development of recording forms and formats should be the task of the data base manager at CATIE. Country institutions might accept primary responsibility for country specific data collection while leaving the responsibility for collection of data of general usefulness with CATIE. It should be the emphasized, however, that initial survey of all information sources, and organization and coordination of the data base must be the prime responsibility of the CATIE specialist.

Coordinators set up in a key institution should serve a dual role. For one, they should prepare requests for information for any institution which needs this service. Their second role would be to keep the data bank administrator advised of a new watershed management projects as potentially new data sources and to periodically provide updates on information to the data bank specialist.

12. Coordination with Computer Center

Demands on the staff of the computer center are high. The center's staff will not be able to provide substantial time in support of the data base specialist because all but three persons are assigned to donor-funded projects. It is, therefore, highly desirable to contract a person who has experience with the VM operating system and with computer programming. The IBM 4331 system is easy to operate and should require a person, familiar with computer operations, only a minimum of time to be able to run the system.

13. Coordination with Other Projects

In line with the recommendation that the data base specialist position and the technical support would be carried eventually by CATIE's core budget, the specialist should begin coordinating activities with other projects at CATIE. This

role would involve promoting organized data collection and storage and advise on how to design project specific data bases. The specialist should work closely with Mr. John Palmer from the British Overseas Development Agency, who is coordinating field data collection and entry activities for a number of projects, e.g., the Fuelwood and Agroforestry Projects.

14. Role of Computer Center

The development of the data base capabilities of the watershed management system will require a number of structural changes in the operation of the CATIE computer center. The system currently is composed of:

IBM 4331 with IBM processor capacity and diskette unit, 1 MByte
IBM 3278 operator console
IBM 8809 tape drive 20-120 KBS
IBM 3262 line printer, 650 Lpm
6 IBM 3278 display units, 1920 characters (1 on order)
4 IBM 3310 disks, 64.5 MBytes each

Current computer center staffing consists of the following:

Type	Source of Fund	End of Contract
1 Biometrician (Director of Center	ROCAP	Sept. 83
1 System's analyst	ROCAP	Sept. 83
1 M/C Operator	ROCAP	Sept. 83
2 Assistant Programmers	ROCAP	Sept. 83
1 Key Punch Operator	ROCAP	Sept. 83
1 Computer Programmer	IBM (Part time)	Oct. 83
2 Key Punch Operators	GTZ	Dec. 83
1 Assistant Programmer	CATIE	Dec. 83
1 Graduate Assistant for Data Analysis	CATIE	Dec. 83
1 Secretary	IBM	Dec. 83
1 Applications Programmer	ODA	Aug.83-March 84

Current only 2 of the positions are funded by CATIE's core budget. All other positions are funded by projects all of which are ending this year. Planning is currently underway to make at least all major positions part of the core budget at CATIE. This strategy is the only logical alternative to having staff of this vital support center be on short-term contracts. The center probably can generate sufficient funds to support its staff and to cover equipment replacement and variable operating costs. One of its major users, the GTZ Genetic Resources Project is, however, exempt from payment. All costs except for personnel are built into the center's user cost structure. Projects are generally charged by the center for all types of uses.

The computer is designed to handle up to 16 I/O devices. Currently, 6 terminals, a printer and a tape unit are connected to the computer. When all terminals are occupied and several users run the statistical package SAS (SAS 1980), the system exhibits substantial slowdowns in processing time. This problem is partially of a technical nature and is caused by insufficient available real disk memory. Another problem is that the VM/CMS System of job and user-id priorities is not being used. SAS jobs could be set to low priority.

15. Equipment Needs for Data Base/Information System

The functions and products and services envisoned for this project component will add substantial demands for personnel and equipment and some requirements for extra space.

The IBM 4331 computer at CATIE is currently being used for the task of data base management. A serious technical limitation is the lack of sufficient central memory space for running large data bases. The proposed watershed management data base system cannot be handled by the current system without severely interrupting work of other projects and will, therefore, require purchase of disk space. System's operations could also be optimized by creating job priorities among users and projects. Since most user access is interactive, longer operating hours could be considered. With sufficient demand

for the system, night operation could be investigated. CATIE currently does not allow overtime payment. Shift working would require contracting of at least one second-shift operators for whom there is no money in CATIE's core budget.

For BATCH JOB running, one terminal would have to be logged on all the time to receive batch jobs. In the current system, one cannot log-on a batch job user-id and then disconnect to face the terminal. With the present and foreseable shortage of terminals, batch job running is not economical.

The existence of only one tape drive makes data storage and data transfer tedious. Only one of the operations, "read" or "write" can be performed at one time. For the proposed central data base, storage of data on tape to tape transfer of data is necessary. This operation will require the purchase of an additional tape drive or the replacement of the current, unreliable single drive by a faster twin-drive unit.

To upgrade the CRIES system, purchase of a digitizer, plotter and terminal is required. To meet the demand for printed materials from the data bank as well as instructional materials, and to complete the word processing capabilities for the project, the purchase of a high quality printer is recommended as well as the purchase of several terminals. Two

terminals will serve as word-entry stations for secretarial staff. Two additional terminals will be necessary for the day to day work of the data base and instructional materials specialist. To efficiently support and process the additional workload of the computer center with the addition of a digitizer, plotter and additional terminals, acquisition of a control unit as well as augmentation of processor capacity are necessary. A graphics terminal or the conversion of one or more of the existing IBM 3278 terminals into graphics terminals by fitting of a board would allow pre-scanning of proposed plots before using the notoriously unreliable electro-mechanical plotters. Graphics terminals also have great value for analytical work and teaching.

Finally, to facilitate data entry, a data entry station should be added to the system.

Summary of Equipment Needs for Project

Item	Cost
IBM 3370 Disk, 570 MBytes Capacity	45,000
IBM 9809 Tape Drive, 20-120 KBS	13,500
IBM 3262 Printer, 600 Lpm	18,500
Plotter	15,000
4 terminals	12,000
Data Entry Station	6,500
3277 Terminal, Graphic Attachment (to run Plotter)	8,000
*3274 Control Unit (32 terminals)	25,000
*Increased processor capacity, 2 MBytes	50,000
TOTAL	193,500

*To run disk, tape, printer, plotter and terminal

A digitizer will be bought with currently available funds by CATIE at an approximate cost of $15,000.

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16. Operations Considerations Including Staffing

Space is at a premium at the current computer center. Installation of some additional equipment within the existing facilities is feasible. It would include additional disk storage, a high quality printer, digitizing equipment and plotter. Beyond this, additional terminals for the project should be installed in the project offices, connected to the center by cable.

The extra equipment may well overload the heat-removal capacity of the single air-conditioner. No backup unit is available in case of a breakdown. Budgeting for more cooling capacity is recommended.

Acquisition of a digitizer, incremental plotter, high-quality line printer and other hardware will involve negotiation with IBM to ensure that warranties remain valid as well as maintenance contracts. Difficulties in interfacing equipment must be anticipated and provision made to bypass the absence of competent electronic engineers and system software programmers. It may be best to pay for the manufacturers' engineers to come in and install the equipment and provide 2-3 weeks of debugging and training time.

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Extra computing capacity, mainly through extra fixed disk space, should go hand in hand with optimization of the operating system to cope with the extra number of terminals and the kind of work which they will do. The capacity for optimization does not exist in Costa Rica. A short-term consultant familiar with the operating system should be called in for a period of 2-4 weeks during the first year to reset the VM/CMS operating system. CATIE should also consider training one of their project computing staff, preferrably in the U.S.

The programmed computer operating costs of $10,000 per year are below estimated costs of running and maintaining the data base and activities related to instructional materials development. Due to the considerable contribution of this project to the computer center's increased capacity and efficiency, this project should receive unlimited access and use of the computer including fixed and variable costs above $10,000/year for the life of the project with no additional charge.

The data base specialist will come on board 6 months after the arrival of the project administrator. This early arrival will provide some time to organize some of the available information that staff members will require to give technical advice. The specialist will be supported by a full-time

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technician and will be responsible for data base management functions and a data entry person. The staff specialist will also train the technician in all aspects of management of an information system.

Detailed job descriptions of the specialist and technician are shown in an annex to the project paper.

17. Continuity of Services of Data Base/Information System

Towards the end of the project, the operation of the data base/information system should be taken over by CATIE through its core budget. It means that the salaries of the data base specialist and the technical assistant must be covered as well as the operational costs of providing information services to the countries. This self-sufficiency of the information center can be achieved by developing an appropriate service cost structure similarly to the one currently used to cover replacement and operation cost of the existing computer facility. Thought must be given to how and when to begin to charge for the services of the center. Initially, to promote the utility of a central data bank, information examples should probably be provided free of charge. However, when specific information requests for actual planning jobs are received, the introduction of a service

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charge reflecting reasonable replacement and operation costs could be considered even before the project ends to build a small continuation fund. Operating costs would include personnel costs, supplies, mailing costs and repair and maintenance. Funds generated through central data bank services must be earmarked for the continued operation of the center and not be combined with other income producing activities. This will require a change in current CATIE procedures.

18. Evaluation of Data Base/Information System

The major check on the success of the data base/information system will be the number of information requests that are received by the center. Another measure of success would be the willingness of key institutions within countries to participate in data collection activities for a central computer data bank.

19. Support of Data Base Specialist in Program Evaluation

Graduates of all short courses, the certification program and degree programs should be monitored to evaluate the success of the training activities. For this purpose, it will be necessary to establish an information system including

background information on incoming students and to maintain an updated file on each student after their departure from the training program. A survey form should be mailed at yearly or longer intervals to former students and questions would be designed to gain insight into various aspects of the graduate curriculum and of short courses (e.g., how useful specific courses were, what were major deficiencies, what changes are recommended, etc.).

This follow up would be one measure of the success or failure of these sessions and provide feedback for future training.

REFERENCES

ACP Handbook, USDA Agriculture Stabilization Conservation Practice.

Agency for International Development. 1978. Panama Project Paper-Watershed Management, 71 p. (plus appendices).

Agency for International Development, 1979a. ROCAP Project Paper-Fuelwood and Alternative Energy Sources. Washington, D.C., 117 P. (plus appendices).

Agency for International Development. 1979b. Costa Rica Project Paper-Natural Resources Conservation. Washington, D.C. 92 p. (plus appendices).

Agency for International Development. 1980a. Honduras Project Paper-Natural Resources Management. Washington, D.C. 44 p. (plus appendices).

Agency for International Development. 1980b. Project Paper-Rural Resource Conservation and Utilization. Washington D.C., 28 p. (plus appendices).

Agency for International Development. 1980c. An Environmental Profile of Guatemala. Assessment of Environmental Problems and Short-and-Long Term Strategies for Problem Solution. Washington, D.C. 115 p. (plus appendices).

Agency for International Development. 1980d. Panama Country Environmental Profile. Washington, D.C. 175 p. (plus appendices).

Agency for International Development. 1981. Dominican Republic Project Paper-Natural Resource Management. 111 p. (plus appendices).

Agency for International Development. 1982. Honduras Country Environmental Profile. A Field Study. Washington, D.C. 161 p. (plus appendices).

Agency for International Development. 1983. Project Paper Asia Regional. Asian Watershed Project. 29 p. (plus annexes).

ANDREWS, J.R. 1983. Technical Assistance Required for Preparation of Project Paper-Watershed Management. Unpubl. Report to ROCAP, Guatemala, 9p.

ANTHONY, R.N. 1965. Planning and Control Systems: A Framework for Analysis. Harvard Graduate School of Business Administration. Cambridge, MA.

CATIE, Watershed Project. 1981. An analysis of the regional watershed management survey. Unpubl. report. CATIE, Turrialba, Costa Rica.

CDS/ISIS 1979. UNESCO computerized documentation system (CDS): A general description. 16 p.

CRIES, 1982. A user's guide to the CRIES Geographic Information and Analytical System. Resource Development Occasional Paper 82-1. Michigan State University, East Lansing, Michigan.

DOUROJEANNI, R.J. 1981. Renewable Natural Resources of Latin America and the Caribbean: Situation and Trends. World Wildlife Fund, Washington, D.C. 495 p.

DULIN, P. 1982 a. Agroforestry as an appropriate land use system in the American Tropics. Paper presented at the Agroforestry for the Humid Tropics, Short Course, USAID/CATIE. Turrialba, Costa Rica. 22p.

DULIN, P. 1982 b. Natural Resource Inventories in Developing Countries: The Case of Central America. Department of Natural Resources, CATIE, Turrialba, Costa Rica, 15 p.

DULIN, P. 1982 c. Suggestions for a Regional Watershed Management Project. Consultant Report to Regional Office for Central American Programs. Guatemala, Guatemala. 39 p. (plus appendices).

DULIN, P. 1982 d. (undated) Comentarios Sobre el Sistema CRIES. Unpubl. Report to CATIE. 9 p.

DUTCHOVER, J.T., U.S.D.A. Soil Conservation Service, "Land Use Soil Conservation Component". Guatemala, Joint IDB/IBRD/AID Agricultural Mission. 1975.

Engineering Field Manual for Conservation Practices. USDA Soil Conservation Service. 6-79.

Federal Register, Part IX Water Resources Council. 12/14/79

FFOLLIOTT, P.F. 1981. Watershed Resource Management and Environmental Monitoring. Problem Manual. Regional Training Course developed for Man and the Biosphere. Washington, D.C.

FFOLLIOTT, P.F. 1981. Manejo de Cuencas y Monitoreo Ambiental. Curso Regional de Entrenamiento. Man and the Biosphere. Washington, D.C. 116p.

GARCIA, L. 1982. Analysis of Watershed Management (El Salvador, Guatemala, Honduras). Consultant Report to Regional Office for Central American Programs. Guatemala, Guatemala. 97 p. (plus appendices).

Guatemala, Ministerio de Agricultura. 1981.
Sub-Programa II. Estudios integrados de areas rurales
-Clasificacion agricola. 35 p.
-Uso actual de la tierra. 23 p.
-Recursos hidraulicos, 120 p.
-Unidades de suelos y potencial de suelos. 84 p.
-Clima y vegetacion. 72 p.
-Resumen. 17 p.
-Anexo: Produccion agricola. 173 p.

HOUSEAL, B., L. WALKER and E. VALLESTER. 1982. The Role of Parks and Reserves in Panama's Watershed Management Project. Unpublished prepared for AID, Panama. 23 p.

Hydraulics. Engineering Handbook Sections USDA Soil Conservation service.

Hydrology. Section 4 National Engineering Handbook. USDA Soil Conservation Service 8-72.

MRI Systems Corporation. 1974. System 2000 Reference Manual. Austin, Texas.

MURPHY, D.L. 1981. A decision support system approach to timber harvest scheduling. University of Minnesota, College of Forestry, Doctoral Dissertation. St. Paul, Minnesota. 188 p.

National Operation and Maintenance Manual. 6/18/82. USDA Soil Conservation Service.

National Watersheds Manual. Chapter 5. USDA Soil Conservation Service.

Office of Technology Assessment. 1982. Professional Education and Technical Training to Support Development and Implementation of Technologies to Sustain Tropical Resources (draft). Washington, D.C. 65 p.

Peru, Pasa Soil Conservation Team. Ray T. Mango, Eugene J. Pope. Soil Conservation Service, Clayton, Cgg Esas USAID. 5/80.

QBE. 1980. Query-by-example. Program Description/Operations Manual (3rd. ed.) and Terminal User's Guide (3rd. Ed.) International Business Machines Corporation.

ROCAP. 1983. Statement of Work for Watershed Management Project. PID/T No. 596-0000.3-3-30005. 21 p. (plus attachments).

ROSE, D.W. and M.M. Gregersen. 1980. A General Computer Program for Discounted Cash-Flow Analyses. Minnesota Agric. Exp. Str. Tech. Bull. 328 p.

ROSE, D.W. 1983 a. Some Thoughts on a Management Information System for the Fuelwood Project at CATIE. Fuelwood Project, CATIE, Turrialba, Costa Rica. 8 p.

ROSE, D.W. 1983 b. Development of a Management Information System for the Fuelwood Project at CATIE. Fuelwood Project, CATIE, Turrialba, Costa Rica. 7 p.

ROSE, D.W. 1983 c. Collection of computer programs developed and implemented on CATIE's IBM 4331 as consultant to Fuelwood Project. Program documentation, input restrictions, output examples, program listings and diskettes available from Mrs. Heather Palmer, CATIE computer center. Turrialba, Costa Rica.

SAS. 1980. Statistical Analysis System. User's Guide. SAS Institute, Inc., Cary, North Carolina.

SCRIPT. 1979. Document Composition Facility and Document Library Facility - General Information (2nd. ed.) International Business Machines Corporation.

SHENG, T. Review of PID No. 596-0106. Watershed Management Overall Comments. 2/7/83

Soil Water Conservation Program for Northeast Thailand. USAID - USDA Soil Conservation service. 10/20/82.

STAIRS. 1981. Storage and Information Retrieval System/Conversational Monitor System. Terminal User's Guide-Program Description and Operations Manual (2nd. ed.). International Business Machines Corporation.

The Rainfall Agricultural Projects (RNI). 10/20/82. Soil Water Conservation Program for Northeast Thailand.

USDA 1981. The Relationship between the AREA-FRAME and CRIES Projects. U.S. Department of Agriculture, Natural Resources Economic Division. Washington D.C. 44 p. Staff Report.

WALKER, D. 1982. Natural Resources Programming - Present Status. Unpubl. Report. 13 p.

Watershed Plan and Environmental Impact Statement. Espanola, Rio Chama Watershed. 1976. Espanola, New Mexico.

Watershed Planning Handbook. USDA Soil Conservation Service.

Work Plan for Watershed Protection and Flood Prevention. Sebastian Martin Black Mesa Watershed. Rio Arriba Country, New Mexico. 1978.

World Wildlife Fund. 1980a. Strategy for Training in Natural Resources and Environment. A proposal for Development of Personnel and Institutions in Latin America and the Caribbean. 1980. Washington, D.C. 208 p. (plus appendices).

World Wildlife Fund. 1980b. An Environmental Profile of Guatemala. Assessment of Environmental Problems and Short and Long-term Strategies for Problem Solution. Washington, D.C. 115 p. (plus appendices).

World Wildlife Fund. 1980c. Panama Country Environmental Profile. Washington, D.C. 175 p. (plus appendices).

APPENDIX

DATA/BASE INFORMATION SYSTEMS SPECIALIST

Qualifications: A Doctorate degree in a quantitative area such as statistics, computer science, operation research or quantitative analysis with at least one degree in natural resources.

Trained in data base management or with substantial experience, knowledge of at least one programming language, back-

ground in statistics incl. sampling. A U.S. National, fluent in spanish and with some knowledge of Central America.

Duties: 1) Assist in statistics course.

2) Teach a course in Principles of Data Base Management and computer applications.

3) Contribute to courses in Natural Resource Economics and Land Use Planning.

4) Collect and screen information to design a data base management system.

5) Develop information request forms and retrieval programs.

6) Design data collection forms for country use.

7) Teach a short-term course on use of data base system.

8) Teach short-courses in countries in data collection, use of data forms and data entry.

9) Provide technical advise to country institutions for installation of in-country data base activiaties.

10) Supervise central data entry.

11) Maintain and update data base.

12) Coordinate data base development of other projects in CATIE.

13) Provide technical and information support advising teams to in-country activities.

DATA BASE/INFORMATION SYSTEMS TECHNICIAN

Qualifications: Experience with data entry equipment and use of equipment; experience with use of canned statistical packages.

Duties:

1) Assist data base specialist in screening information.
2) Carry our data entry
3) Produce reports for data base/information requests.
4) Handle responses and mailing of responses to information requests.
5) Assist in data collection and coordination.