NATURAL RESOURCE INVENTORIES IN DEVELOPING COUNTRIES:

THE CASE OF CENTRAL AMERICA

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NATURAL RESOURCE INVENTORIES IN DEVELOPING COUNTRIES: THE CASE OF CENTRAL AMERICA[1]

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Inherent socio-economic pressures for rapid development in Central America have led to the degradation of the natural resource base. Efforts to date have not successfully provided a continuous nor appropriate technology for the inventory of resources. Several programs have recently been initiated by national governments with technical assistance from international aid organizations, using current technology, to provide an accurate accounting of resources for purposes of their rational utilization and conservation.

INTRODUCTION

The need for accurate information is paramount in the provision of a good planning base for the rational development and allocation of natural resources in Central America[3]. In the absence of such information, development takes place in ignorance of quantity, quality, or the ecological interrelationships of resources, thereby leading to their degradation. Such a lesson is old, yet because of disparities in developing countries, the lesson is still part of the curriculum.

The first priority for virtually every recent resource development assistance program in Central America is given to the survey of the actual state of the resources in order to first determine: what can be developed and how. A review of past projects has revealed that this was the same priority accorded project strategies in those days. Yet a hard look at the current availability of information concerning the natural resource base yields an observation that, although there have been recent efforts at gathering natural resources information, data is voluminous but is dispersed, outdated, and in many cases of a calibre that is inappropriate for its current use. The absence of accurate resource information is one of the most perplexing problems facing planners and land managers in the countries of Central America.

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[3] Central America is here considered the countries of El Salvador, Costa Rica, Honduras, Nicaragua, Guatemala and Panamá.

This paper is not intended to sense the entire spectrum of natural resource inventory activities in Central America. A bibliography of the inventories carried out in the region, both small scale and large, would require a cart and oxen for its transport. It is the intent however, to examine the constraints which impede inventory efforts in the region. Also examined are the inventory efforts from the near past to the present, assessing their importance to the development of the region. Recent observations of the actual quality of natural resources in the various Central American countries and on-going inventory activities designed to qualify and quantify these resources, provide the writer with a basis for constructive criticism. Limiting the scope of this examination is the implausibility of knowing all resource inventory activities currently being carried out or planned in the region by the numerous national and international organizations.

INHERENT SOCIO-ECONOMIC PRESSURES AND RESOURCE EXPLOITATION

Socio-economic underdevelopment exerts enormous pressures on the natural resources base of developing countries. Population rates are outpacing local economic and technical capabilities in the developing countries of Central America. Problems of poverty (poor health and nutrition, illiteracy, inadequate infrastructure and amenities, landlessness) culminate in social unrest. To overcome the obstacles of underdevelopment, national governments are ideologically oriented toward providing the basic human needs (food, water, energy, and shelter) to their populace.

Central American countries are primary producers. Although some income comes from extraction industries (minerals) and secondary sector (processed goods), they derive most of their income as well as the subsistence of their peoples from the agriculture/forest sector. Exports from these countries include agricultural products and their derivitives: tree crops (coffee, cacao), sugar, fruits, fibers, and beef; and forest products. The availability of arable land is limited due to the mountainous nature of most of Central America. Production of these commodities, essentially in plantation or monoculture systems, occupies the lands best suited for agriculture, thereby limiting most subsistence farmers to marginal lands. As is the tradition in developing countries, energy as well as building needs come directly from local forests. Fuelwood is the most important source of domestic energy in Central America as approximately 80 percent of the households in the region use fuelwood for cooking (USAID, Regional Office for Central American Programs, 1979). The basic needs of the primary producer economies of the countries are provided by land resources. Other needs are imported, especially those of technology and energy[4].

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[4] The countries of Central America obtain approximately 55 percent of their overall energy needs from petroleum. Fuelwood and charcoal account for 31 percent of the total (USAID, Regional Office of Central American Programs, 1979).

Due to development pressures, the exploitation of natural resources has exceeded the government's efforts to control it. Because of the lack of information concerning these resources, land managers have little idea of where to place priorities. This has resulted in a marked deterioration in the resource base. Although various examples concerning the use and abuse of natural resources can be examined, the most serious problem is chosen for a case-in-point- deforestation.

According to USAID (1979), most government officials and resource managers in Central America view deforestation as the most critical of natural resource problems. In El Salvador for example tropical forests once covered 90-percent of the land area. This vegetative cover has been nearly totally removed and the land is now under plantations grazing lands, and degraded secondary growth (Eckholm, 1976). Fifty-percent of Guatemala forests have disappeared since 1950 (Berry and Ford, 1979). In Honduras, Canadian forestry technicians working with the host government forest agency estimate that commercial forest stands will be depleted within 8 to 10 years due to overexploitation (U.S. Forest Service, 1980). Landless subsistence farmers have encroached onto lands of the watershed serving the Panama Canal,denuding existing forest cover through shifting cultivations practices, increasing the sedimentation rate to the point that by the year 2000, the storage capacity of Lake Alajuela will have been reduced by 40 percent (Wadsworth, 1978).

The recent crisis of energy has caused the rapid unraveling of what stability there was in the economies of these countries, further compounding their underdevelopment with lopsided deficit-of-trade balances which immediately translate into soaring national inflation rates. Higher prices exacerbate the existent social unrest, resulting in political crises and in some cases insurrection. Governments answer these crises by intensifying the development of natural resources, trying to squeeze more out of the land. Priorities switch from using resources to provide basic human needs, to trying to reverse the trend of the balance of payments and inflation. Basic human needs take a back seat and the cycle is repeated.

PROBLEMS IN THE EXECUTION OF INVENTORIES

Existing environmental, socio-economic, political and institutional factors influence the collection of natural resources information in Central America.

Environmental Factors

Central America is wholly located in the Tropics. Due to geomorphologic and climatic influences a series of complex and diverse ecosystems has evolved. These climate-soils-vegetation associations are poorly understood and the severity of the impact of their development can not be accurately predicted. It is therefore difficult to decide what to inventory in order to determine resource interrelationships.

In observations of the interaction between humans and the tropical environment, Bennett wrote:

> "... The existing data base for environmental paramenters such as microclimatology, pedology, hydrology, biota, geomorphology, and geologic structure is insufficient for the development of ecologically sound land-management practices that are applicable to the American tropics."[5]

Regionally rugged and mountainous topography creates problems of access, scale and vertical and horizontal control. The tropical climate creates special problems for remote sensing: seldom is the region not at least partially covered with clouds.

Socio-Economic Factors

Developing countries are generally poor in terms of capital. Priorities given other phases of development because of inherent socio-economic pressures, leave little support for information gathering activities which are thought to be expensive and time consuming. Cultural values within a country give priorities to the development of resources which may not be conducive to their quality and quantity. Traditional lifestyles (socio-cultures) dictate an "as-perceived-exploited" development strategy, historically in disregard of information that admonished a more conservative approach.

Political Factors

As explained, development can be dictated by socio-economic pressures necessitating a government to set need-related policies. Development decisions are usually made in the political arena, in many cases disregarding available resource information. Policies may be further influenced by the political situation in the region. A spirit of nationalism, inherent in each country occasionally results in armed conflict or border clashes with neighbors (border war between El Salvador and Honduras in 1969 Factions of opposing political views within the countries are involved in insurrection activities. The instability of internal affairs in Central America brings about changes in the national governments through the electoral process, coups, or revolution (changes in government in Nicaragua in 1979, current conflicts in El Salvador and Guatemala). These oscillations in the regional political climate disrupt efforts of data collection, or can lead to radical changes in the organization of resource agencies. Complicated

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[5] BENNETT, C. et al. 1974. Interaction of man and tropical environments, p. 139-182. In Fragile ecosystems: evaluation of research and applications in the neotropics. Farnsworth, Edward and Golley, Frank, editors. 258 p. Report of the Institute of Ecology. Springer-Verlag, New York.

land tenure policies based on traditional ownership and a milieu or agrarian reform have dissected land into minute parcels making land-use patterns difficult to interpret.

Nationalism also causes an isolationist attitude among countries. This has brought about a failure of countries to adopt standardized data collection methodologies and scales. Methods in the collection of information on such resources as climate, soils, and vegetation differ from country to country. Therefore cooperation in similar resource investigation or inventories is difficult at best.

Institutional Factors

The lack of coordination of information gathering between agencies within the same country aggravates the compilation of resource data. Information gathering responsibilities are dispersed throughout numerous agencies. Climatological data in Honduras for example, is collected by the Ministry of Natural Resources, the Forestry Development Corporation, the Electric Energy Company, the Water and Sewage Service, and the Cadastral Service.[6] These agencies have not collaborated to enjoin a national network. This "agencyism", or pride (or jealousy) is an obstacle to the needed cooperation between agencies.

The lack of sufficient personnel trained in the collection, interpretation and application of natural resources information has led in many cases to resource development in a vacuum--not knowing how the development will affect the resources. Resource managers in developing countries have been led to believe that the inventory of natural resources is a series of projects rather than an on-going process. In the past inventory projects in these countries have required large expenditures for imported technology and technicians to perform the work.

PAST EFFORTS IN THE INVENTORY OF NATURAL RESOURCES

From colonial times until the end of the nineteenth century, Central America has epitomized a region of exploitation of natural resources by foreign governments. Resources were exploited as soon as perceived and were shipped to waiting markets in Europe and the United States. With the advent of mono-fructicultural systems at the turn of the nineteenth century, the countries were inundated with resource-hungry entrepreneurs. United and Standard Fruit Companies performed localized in-situ inventories in order to delineate their one-time fruit growing dynasties. Local forest resources were exploited as railroads and roads were built to connect banana farms with ports. The first important accurate accounting and classification of many of the natural resources in the region, especially soils and forests, was achieved by the fruit companies (United Fuit Co., 1918). Although data gathering continued up until the Second World War, inventory efforts were dispersed in various exploitation localities.

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6 Personal observation of the writer. Tegucigalpa, Honduras, 1981.

In 1946 the Inter-American Geodetic Survey was created as a special unit of the U.S. Army Corps of Engineers to assist cartographic agencies of Latin America to become self-sufficient in the production of accurate maps and charts using standardized procedures (Unverferth, 1963). This project was most important in providing vertical and horizontal controls, aerial photographs, and base maps upon which all other natural resource mapping activities are based. The original program is just now reaching its termination with the final 1:50,000 topographic sheets currently being prepared for Honduras by the Honduran National Geographic Institute.[7]

With the first accurate base maps being procured for Central American countries in the early 1950's, other organized natural resource inventories were mounted with the assistance of international aid organizations, especially the United Nations Food and Agriculture Organization (FAO), and the United States Agency for International Development (USAID). Beginning in the early 1950's FAO initiated an aid policy orienting technical assistance programs around the development of forest and agricultural resources (FAO, 1968). USAID followed suit in the late 1950's with agricultural assistance programs (Inter-American Institute of Agricultural Sciences, 1956-1959). Both of these organizations provided assistance at institutional levels, yet on projects with a localized focus. Thus, very little resources information of sufficient coverage was procured.

It was the Organization of American States (OAS) that made the first major attempt to consolidate natural resources information for each of the countries of Central America. OAS through its Pan-American Institute of Geography and History (1953-1956) compiled existing information concerning topography, soils, geology, hydrology, meteorology, vegetation and hunting and fishing resources for each country and further suggested the coordination of the monitoring of data as well as projects to bring resource inventories up to date.

The 1960's brought about a new focus to assistance programs as organizations realized that the lack of information concerning natural resources was a major obstacle in their development. FAO in collaboration with the United Nations Education, Scientific and Cultural Organization (UNESCO) initiated its Soil Map of the World Project in 1961. Soils information was collected from existing sources and extrapolated for the Central American region in the early 1960's (FAO, 1965). The information was then transcribed to the FAO soils classification and publised in 1965. The soils map is still the only regional study of its kind in Central America and is gaining popularity as a planning tool. Because of its scale however (1:4,000,000) it cannot be considered worthwhile as a local development tool. FAO also sponsored a land-use capacity study for the region (Plath and Van der Sluis, 1964) at a scale of 1:1,000,000 based primarily on soils classifications. Again due to the small scale the study has value only as a regional planning tool.

Holdridge (1978) devised a system in the 1950's to classify the complex environment of the American tropics by ecological associations. The system is based on a hexagonal-matrix schematization of the climatic factors of biotemperature (the range of temperature critical for a certain vegetation

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[7] Personnel of the Instituto Geográfico Nacional. 1981. Personal communication. Tegucigalpa, Honduras.

association), precipitation and potential evapotranspiration. Latitude and altitude are also considered in the system, thus compensating for differences in the length of solar day, radiation and atmosphereic pressure. The system has recently found wide acceptance in Central America due to its interpretation of rather simple parameters to classify the complex tropical environment into potential management units. Other efforts at consolidating existing information produced several resource guides including an annotated index to air photos and topographic maps of the region (OAS, 1964).

The most important contribution of the decade was made by USAID (1965-1967) in cooperation with the Permanent Secretary for the General Treaty of Central American Economic Integration, which published a natural resources atlas for each country. Existing information was collected and updated on natural resources using photogrammic techniques and field work. The atlases contain an excellent collection of small-scale maps (1:1,000,000) for each of the resources as well as annotations. Various other inventory activities taking advantage of the ever-increasing coverage of air photos, continued throughout the 1960's and into the 1970's providing still more information of greater detail, especially for soil and forest resources. Each of the countries of Central America has published periodic atlases based on census and other existing data. There is also a large number of maps concerning areas of special resource significance (e.g. mineral outcrops, commercial timber) and areas of agricultural significance such as valley floors (Centro Interamericano de Documentación e Información Agrícola-CIDIA, 1975).

CURRENT INVENTORY ACTIVITIES

Three events that evolved in the late 1960's and early 1970's influenced the inventory of natural resource information in Central America throughout the last decade and up to the present: concern for the environment, the development of remote sensing from satellites, and the evolution of computerized information management. Although these factors had immediate impact on resource inventories in developed countries such as the United States, they are only recently finding application in Central America through technical assistance and training programs.

Concern for the Environment

The United Nations Conference on the Environment in Stockholm in 1972 fomented a new focus on the collection of natural resources information throughout the world (Berry, 1976). The realization that resources are ecologically interrelated and that human activities directly affect these interrelationships greatly increased the awareness that natural systems must be continually monitored in order to manage them correctly and prevent possibly irreversible adverse socio-economic as well as environmental impacts. The American tropics (including Central America) has been viewed as possessing the following characteristics in 1974: "... a) an unprecendented increase in human numbers within a framework of limited resources, b) a concomitant demand for food and other resources within the tropical region, and c) a concomitant deterioration of the human environment to the extent that many feel that contemporary environmental problems are more critical in developing countries of the

tropics than industrialized nations."[8] With this in the minds of those in technical assistance organizations, an interest was kindled for a more complete study of the changing environment.

FAO continued its assistance to developing countries in forestry and agricultural projects but expanded efforts to better assess the impacts of these developments on the environment. USAID among others sponsored a study to again compile existing soils data and scrutinize national institutional capabilities in order to eventually develop a system of soil analogs which would facilitate the transfer of interrelated management techniques within the region (Bazán et al, 1978). The life-zone ecological land classification developed by Holdridge (1978) is becoming more widely recognized as a potential land management tool. Maps of the classification which were developed in the countries in the 1950's are being updated on a larger-scale format (1:50,000 is considered a good planning format.)[9] USAID was instructed by Congress to carry out country specific studies in order to identify major environmental and natural resource problems in developing countries and the ability of local institutions to solve these problems (Blake et al, 1980). These "environmental profiles" are just being prepared for the Central American countries and will include the compilation of existing natural resource data.[10] The profiles will be used as a basis for developing future USAID programs. The Pan-American Institute of Geography and History is assisting in the publication of periodic "guides for investigators" for the Central American countries (Instituto Geográfico Nacional de Costa Rica, 1977). These guides consist of an annotated bibliography of existing natural resources information in each country, maps and air photo indexes, etc.

Remote Sensing from Satellite

The advent of satellite imagery as a resource inventory tool has only recently reached Central America. Although several studies and pilot projects were carried out in the region, they had little applicability because host government technicians knew little about the technology, did not know how to interpret it, nor did they know how to apply it. Remote sensing as the name implies, has the unique quality of not being limited by land obstacles (topography, limited access), satellite imagery being no different from aerial photography. Aerial photography, however, has always been a necessary, but prohibitively expensive resource inventory tool for the capital-poor Central American countries. Coverage by air photos is usually only a one-time affair, partial to localized exploitment areas in the countries. Complete coverage of the countries was done only once, back in the days of initial topographic map making. Non-periodic aerial photos fail to give an accurate view of the ever-changing status of natural resources of the region, and for that matter were perhaps never meant to.

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8 BENNETT, C, et al. op. cit.

9 TOSI, J. 1981. Personal communication. Tropical Sciences Center, San José, Costa Rica.

10 ZADROGA, F. Environmental Officer. 1981. Personal communication. USAID/ROCAP, Guatemala.

In the situation of socio-economic pressures for development and a rapidly deteriorating resource base, it is absolutely necessary to have a measuring medium for the dynamic status of natural resources in Central America. Currently there is no on-going inventory or monitoring program using satellite imagery in Central America. Two assistance programs however, are intended to transfer satellite remote sensing technology to the various countries in Central America for use in their resource inventory and monitoring. USAID began a pilot study in Costa Rica in 1978 to test the applicability of various combinations of remote sensing tools (infra-red aerial photographs and landsat imagery) in Central America (Resource Development Associates, 1979).

USAID is currently attempting to combine its assistance efforts with an on-going project of the Inter-American Development Bank (BID) to carry out the same type of technology transfer. The BID project, "Land Use Evaluation Utilizing Remote Sensing Techniques", was begun in 1980 in collaboration with the Costa Rican Geographic Institute. The objectives of this combined effort project would be: a) study areas of agricultural, mineral and marine resource importance, b) the inventory of forest and water resources watersheds, c) the creation of a permanent system of remote sensing to achieve a) and b), d) the updating, integration and dissemination of information pertinent to the development plans of the countries.[11] In theory the project would be carried out in coordination with the geodetic or geographic agencies of each of the countries. The orientation of the project will be more towards an accounting of current land use incorporating imagery techniques at a scale of 1:200,000 to 1:250,000. Infra-red aerial photography would then be used in combination with ground truthing for selected areas of development or conservation interests.

Another system using satellite imagery as a basis for resources data collection has been developed in the International Center for Tropical Agriculture in Cali, Colombia (Cochrane et al, 1979). The system uses landsat imagery to identify land-forms, hydrology, and vegetation in the study area (Tropical America). This information is combined with that of climate and soils, and coded into a computer data bank and is intended to be used to identify analogs for purposes of transfering germ-plasm based technology for the improvement of food production in the tropics. Although the project has mapped over a billion hectares in Latin America (including part of Guatemala) at the 1:1,000,000 scale, funding problems have halted its planned coverage of Central America.[12] The systems minimum geographical resolution, five minutes latitude by four minutes longitude (roughly 68 square kilometers) is definitely a limit to the systems applicability in Central America when considering the region's mountainous terrain.

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11 González, Juan Bautista. BID Program Coordinator. 1981. Personal communication. Instituto Geográfico Nacional, San José, Costa Rica.

12 Cochrane, Thomas. Resource Evaluation Project Coordinator, 1981. Personnal communication. Centro Internacional de Agricultura Tropical, Cali, Colombia.

Computerized Information Management

As explained earlier, one of the problems in the inventory of natural resources is the limited availability of existing information. If information is dispersed throughout various organizations within a country, its collection is near impossible. The amount of information can be voluminous on a subject, but because of poor data management it may be lost or forgotten. Efforts by FAO, OAS and USAID in the 1970's are greatly improving collection, documentation and dissemination of natural resources information.

FAO has been a perennial leader in the management of natural resources information developing the International System for the Agricultural Sciences and Technology (AGRIS) in the late 1960's for the documentation and dissemination of information. This computerized system is tied-in with virtually every other related information service in the world.

The OAS through its Inter-American Institute of Cooperation for Agriculture (IICA) has long been at the forefront in information management in the region. Its regional library in Turrialba, Costa Rica holds the best collection of natural resources related information in Central América. In 1970 IICA created the Inter-American Center for Documentation and Information (CIDIA, 1978) with the objectives of strengthening Latin American information systems and consolidating them in the Inter- American Agricultural Information System (AGRINTER) at the national level. The system is essentially oriented to agriculture and rural development. AGRINTER's ongoing activities include the consolidation and dissemination of existing information within a standardized framework, and the training of personnel at national and regional levels to achieve the best possible use of existing information agencies. AGRINTER periodically publishes useful annotated bibliographies on information concerning agriculture, natural resources, and rural development and is tied-in with several other information systems, including AGRIS, which permit worldwide communication.

IICA (1976) in collaboration with USAID initiated their Agricultural Information Program for the Central American Isthmus in 1976 to further the efforts of IICA-CIDIA. This program initated a regional computer-based data bank for IICA in San José, Costa Rica. With the cooperation of various packaged computer programs (such as the Statistical Analysis System) IICA is able to manage and statistically analize data as well as call up special data for the preparation of reports (Garro, 1979). This system is being incorporated into the AGRINTER program. Perhaps the most promising development in computerized information management in terms of natural resource inventories in Central America is the incorporation of the Comprehensive Resource Inventory and Evaluation System (CRIES) into the IICA system. This system, developed by the U.S. Department of Agriculture with the University of Michigan is based on the computerized management of existing data and information of a geographical nature. Information concerning natural resources is geographically coded into the computer using grid-cell identification (Land Information System). The geographical grid is set up on a row-column basis, using a resolution factor of one square kilometer. Depending on the types of information fed into the system, CRIES is able to produce a variety of statistical analyses and histrograms, and can be adapted to produce computer-plotted maps for areal

analyses.[13] The system can also utilize directly the data from Landsat tapes. Adaptation of the system is still in the formative stages at IICA. Its successful implementation will depend on future monetary support and its acceptance at the national level. Current plans are to develop CRIES data banks in each of the Central American countries initially comprising basic physical and cultural resource parameters (climate, ecology, population, density, land use, etc.) to be used in regional development studies.[14]

Training

Perhaps the most important aspect in the transfer of resource inventory technology is training. Most all past and present technical assistance programs have (or had) a training element. Regional schools and universities have been created for this expressed purpose. The Pan-American Agricultural School and National Forestry Sciences Schools in Honduras and the Tropical Agriculture Research and Training Center (CATIE), in Turrialba, Costa Rica are prime examples. In the past, ineffective technology transfers were caused by the inappropriate orientation of training programs. When students are sent to foreign countries for training, the working environment is usually quite different from that in their home countries. Many times a group of experts sent to a country to perform an inventory and incorporate national personnel, simply worked "over the heads" of their counterparts, leaving the inventory, but not leaving the technology of how to use it or how to update the information. The priority then, is to transfer the technology so that national personnel can perform their own inventories.

FAO has been producing useful manuals for the inventory and management of specific resources. The organization started the National Forestry Sciences School in Honduras, a regionally important technical training center. FAO development programs usually have incorporated a training element including scholarships to foreign universities. Personnel from separate national agencies have also received FAO assistance in short courses and workshops.

World Wildlife Fund (1980) published a strategy for the development of personnel and institutions of Latin America in natural resources and environmental management. The strategy is oriented primarily around the establishment of sub-regional and national training institutions. Such a program would provide recipient countries with participation in the ordering of priorities and design of the program and training at decision making, planning, and management levels. The Natural Resources Unit of OAS (1969) developed a technical training program in the late 1960's to assist OAS member countries in the evaluation

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13 Garro, Alvaro. Information Specialist. 1981. Personal communication, Instituto Interamericano de Cooperación para la Agricultura, San José, Costa Rica.

14 Ibid.

and development of their natural resources. One outcome of the program was an excellent handbook-style casebook, specifically geared to the socio-economic and environmental situations in Latin America. In the end, national personnel should know not only how to perform an inventory, but also how to use it. Any assistance program should incorporate host country agencies and personnel as full participants in the design of inventories and the technology should be adapted for its transfer to them.

CONCLUSIONS AND RECOMMENDATIONS

The current situation of natural resource inventories in the developing countries of Central America can be described in one word--developing. The burgeoning population and unprecedented demands on natural resources are affecting a rapid deterioration of the resource base. Past efforts at inventories have been inept in providing land managers with appropriate up-to-date information so desperately needed to develop management strategies for optimal allocation and utilization of resources. On-going efforts to utilize the interpretation of satellite imagery in addition to the more conventional techniques of aerial photo reconnaissance and ground-truthing offer an inexpensive, more flexible technique to monitor the dynamic state of the resource base in developing countries. The documentation and dissemination of information is essential to better understand and utilize natural resources. The following are recommendations based on the current situation of natural resources and their inventory in Central America. Some of the recommendations are only to emphasize the importance of existing programs while others are suggestions for needed programs.

1. A land-use capacity classification appropriate for Tropical America should be adopted by the countries of Central America and initially maps of priority areas of development and protection should be prepared at a scale of at least 1:50,000. Such a classification would provide a land-management framework within which inventories of resource elements could be related and quantified. Mapping of other areas would then follow. This classification, standardized throughout the region, would facilitate the development of analogs of similar land characteristics allowing the transfer of management technology from area to area and country to country.

2. Inventories should be geared to each country's needs and resource base. Host country land and resource managers should participate in the design of inventory programs so that information generated will be used and not be produced only for library purposes. Resources utilization and conservation strategies should be developed as a guide to inventory preparation.

3. Resource inventories should be carried out on two levels in each country:

   First level. Consists of inventories used as a focusing and planning tool for the determination of priority management areas. Satellite imagery interpreted at a scale of 1:200,000 would be the most appropriate method for this inventory. This level would involve the monitoring of the basic

natural resources of land use, forests, water resources, and soil conditions in order to discern qualitative trends.

Second level. Consists of detailed inventories involving conventional techniques for use in active development or management activities. Aerial photomapping and ground studies would be carried out at scales of from 1:10,000 to 1:50,000 as dictated by the activity. Inventories can be resource specific or integrated depending on the activity.

Assistance for the implementation of both levels of inventories should be provided in each of the countries to national geodetic or natural resource agencies.

4. Existing information and documentation agencies should expand their scope to include more resources-related services.. (These agencies are, at present, more agriculture oriented). Standardized data processing methods should be integrated into information agencies at a national level and be interconnected through a regional agency. An information "clearing house" should be created in these same agencies in each country and should compile and publish at an interval of appoximately every three years, annotated bibliographies of pertinent existing resources information for use by laymen, studentes, investigators, land managers and developers alike.

5. Training for purposes of appropriate technology transfer should be carried out in each of the respective countries using a "hands-on" approach. A resources inventory team, preferably through an agency of the Organization of American States, should be dispatched to each country to provide the necessary training. Manuals should be developed incorporating all applicable appropriate inventory techniques. Training should be provided at both technical, planning, and decision making levels. Inventories should employ standardized techniques to facilitate information transfer between countries. Training for information, documentation and dissemination services should be carried out in similar fashion. Short courses and seminars should be provided periodically on national and regional levels to keep tecnicians, planners, and decision makers abreast of changing tecnologies, to share experiences, and to gain an interchange of feedback from other countries.

Finally, the most important thought to keep in mind is that of the importance of accurate information to resource managers:

"Because the health, nutrition and general well-being of the poor majority are directly dependent on the integrity and productivity of resources, the capability of governments to manage them effectively over the long term may well be the single most important prerequisite to the eradication of poverty, the fulfillment of basic human needs, and the ultimate achievement of sustained development. Conversely, it is the poor who suffer most from the failure to address these problems successfully".[15]

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15 U.S. Agency for International Development. 1979. Environmental and Natural Resource Management in Developing Countries: A Report to Congress. p. 1. Vol. 1, 184 p. Washington, D.C.

LITERATURE CITED

BAZAN, R. et al. 1978. Proyecto Centroamericano de fertilidad de suelos; Informe final. 62 p. Centro Agronómico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica.

BENNETT, C. et al. 1974. Interaction of man and tropical environments. p. 139-182. In Fragile ecosystems: Evaluation of research and applications in the neotropics. Farnworth, E. and Golley, F. editors. 258 p. Report of the Institute of Ecology. Springer-Verlag, New York.

BERRY, L. 1976. Implications, interactions, and impacts of technology environment, and social conditions on natural resources development. p. 11-19. In AID pre-strategy for environment and natural resources: proceedings of the symposium (Tucson, Ariz. March 21-24, 1976). 147 p. (mimeo). U.S. Agency for International Development, Washington, D.C.

BERRY, L. and FORD, R. 1979. Recommendations for a five-year program in environmental protection and natural resource management. 306 p. Center for Technology, Environment, and Development. Clarck University, Worchester, Massachusetts.

BLAKE, R.O. et al. 1980. Aiding the environment: A study of the environmental policies, procedures and performance of the U.S. Agency for International Development. 227 p. Natural Resources Defense Council. Washington, D.C.

CENTRO INTERAMERICANO DE DOCUMENTACION E INFORMACION AGRICOLA. 1975. Indice de mapas de América Latina y el Caribe existentes en el IICA-CIDIA. 223 p. Instituto Interamericano de Ciencias Agrícolas, Turrialba, Costa Rica.

COCHRANE, T. et al. 1979. An explanatory manual for CIAT's computerized land resource study of Tropical America. 49 p. Centro Internacional de Agricultural Tropical. Cali, Colombia.

ECKHOLM, E. 1976. Losing ground: Environmental stress and world food prospects. 279 p. W.W. Norton, New York.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, DOCUMENTATION CENTER 1968. FAO Documentation-Index. 1945-1966. SP 1, 4 and 8. Rome.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 1965. The soil resources of Latin America, second draft. 115 p. United Nations Educational, Scientific and Cultural Organization. Rome.

HERFINDAHL, O.C. 1969. Natural resource information for economic development. Resources for the Future, Inc. John Hopkins Press, Baltimore, Md.

HOLDRIDGE, L.R. 1978. Ecología basada en zonas de vida. 216 p. Instituto Interamericano de Ciencias Agrícolas. San José, Costa Rica.

INSTITUTO GEOGRAFICO NACIONAL DE COSTA RICA. 1977. Guía para los investigadores. 138 p. San José, Costa Rica.

INTER-AMERICAN INSTITUTE OF AGRICULTURAL SCIENCES OF THE ORGANIZATION OF AMERICAN STATES. 1956-1959. Status reports on regional services to the U.S. operations missions in Latin America. (nine reports). Turrialba, Costa Rica.

INSTITUTO INTERAMERICANO DE CIENCIAS AGRICOLAS. 1976. Programa de información agropecuaria del istmo centroamericano: organización, propósitos y actividades. 12 p. San José, Costa Rica.

_____. 1978. Centro Interamericano de Documentación e Información Agrícola. Organization of American States (folleto). San José, Costa Rica.

INSTITUTO PANAMERICANO DE GEOGRAFIA E HISTORIA. 1953-1956. Los estudios sobre recursos naturales en las Américas. Proyecto 29 del Programa de Cooperación Técnica de la Organización de los Estados Americanos. Tomos 1, 5, 6 y 9. México.

ORGANIZATION OF AMERICAN STATES, NATURAL RESOURCES PROGRAM. 1964. Indice anotado de los recubrimientos aerofotográficos y de los mapas topográficos y de recursos naturales de América Latina (varios tomos por país). Washington, D.C.

ORGANIZATION OF AMERICAN STATES, NATURAL RESOURCES UNIT. 1969. Physical resource investigations for economic development: A casebook of OAS field experience in Latin America. 439 p. Washington, D.C.

PLATH, C.N. y VAN EYK SLUIS, A.J. 1964. Uso potencial de la tierra de Centroamérica. Organización de las Naciones Unidas para la Agricultura y la Alimentación. Partes 1-6. Roma.

RESOURCE DEVELOPMENT ASSOCIATES. 1979. Diseño de un inventario y sistema de información de recursos naturales para Costa Rica: Informe del proyecto piloto. 207 p. Report to USAID. Los Altos, California.

UNITED FRUIT COMPANY. 1918. Examination of tropical soils. 594 p. Boston, Mass.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT, RESOURCES INVENTORY CENTER. 1965-1967. Regional analysis of physical resources: Central America and Panama (seven volumes). U.S. Army Corps of Engineers, Washington, D.C.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT. 1979. Environmental and natural resources management in developing countries: A report to Congress. Vol. 1, 164 p. Washington, D.C.

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT. REGIONAL OFFICE FOR CENTRAL AMERICAN PROGRAMS. 1979. Fuelwood and Alternative Energy Sources: Project paper. Washington, D.C.

U.S. FOREST SERVICE, FOREST PRODUCTS LABORATORY STUDY TEAM. 1980. Forestry activities and deforestation problems in developing countries. 115 p. (plus appendixes). U.S. Agency for International Development, Washington, D.C.

UNVERFERTH, J.W. 1963. International cooperation in surveying and mapping in the Americas. p. 332-343. In United States papers prepared for U.N. Conference on the application of science and technology for the benefit of the less developed areas. Vol. 2, 335 p. U.S. Government Printing Office, Washingotn, D.C.

WADSWORTH, F. 1978. Deforestation -- Death to the Panama Canal. In Proceedings of the U.S. Strategy Conference on Tropical Deforestation. USAID. June 12 - 14, 1978. Washington, D.C.

WORLD WILDLIFE FUND. 1980. Strategy for training in natural resources and environment: A proposal for development of personnel and institutions in Latin America and the Caribbean. 117 p. (plus appendixes). Washington, D.C.