PN-ABM-959

MAPPING IN THE U.S. FOREIGN ASSISTANCE PROGRAM [a]

By Charles K. Paul, [1] M. ASCE

ABSTRACT: Surveying and mapping are fundamental technologies in conducting the U.S. foreign assistance program. Mapped data play a key role in policy decisions made by the U.S. Agency for International Development (A.I.D.). These data also affect the well-being and economic development of people in the 71 nations that A.I.D. assists. Management of the rapidly evolving technologies in the mapping field is made even more complex by their application in remote, often harsh environments typically found in developing countries. The mapping component of a project and its level of technical sophistication are products of the development strategy of the country and the economic sectors it hopes to address. Examples include mapping for irrigation management in the Nile Delta, crop forecasting for famine in Sudan, severe

[a] Presented at the May 18-20, 1989, ASCE Specialty Conference on Surveying Engineering '89 Managing New Technologies held in Denver, Colorado

[1] Dep. Dir., S&T/FENR, 509C SA-18, U.S. Agency for Int'l. Dev., Washington, D.C. 20523

storm warning and flooding in Bangladesh, and highland forest development in Peru. Surveying and mapping services are contracted by A.I.D. through the U.S. private sector. A.I.D. considers technical competence, experience, understanding of the role of natural resources in developing economies, and language skills as important assets of contracted firms.

INTRODUCTION

It is one thing to map and monitor with the objective of providing information to policy makers; it is another thing altogether to use this information with the goal of enhancing economic development and natural resources management. In the former, the map and/or database is the end product, in the latter an improvement in the quality of life is the test. It couldn't have been better stated than by the then presidential candidate George Bush when on October 29, 1987, he stated before the employees at the George C. Marshall Space Flight Center: "Let us therefore use the great energy and excitement of our expeditions into space to look back, to discover what it is we are doing to our Earth, and to alter our self-destructive

course. Let us use our dreams to help us find solutions." (Republican National Committee 1988).

The surveying and mapping program conducted by A.I.D. is geared to solving problems and finding solutions to some of the most formidable issues facing the planet today. The environmental and natural resources issues that we face are mostly the result of unwise development. Thus any remedies proposed to combat deteriorating environments and threats to the natural resource base must come to grips with the economic and social aspirations of man.

Surveying and mapping technologies, which include remote sensing, geodesy, photogrammetry, and geographic information systems (GIS), are used to address problems in all sectors of development. These technologies also are routinely used to monitor environmental change. As such, they play a key role in the link between economic development and environmental sustainability.

Surveying and mapping have been integral parts of the U.S. foreign aid program since it was initiated to put Europe back on its feet after the Second World War. The Marshall

Plan left Europe as a working economic unit, a trading partner, and a strategic ally. The foreign aid program, including military, economic, and food aid, was consolidated by the creation of A.I.D. in 1961, with the goal as then enunciated by Secretary of State Dean Rusk "to build frontiers of freedom throughout the world."

One of A.I.D.'s great achievements was its support of the Green Revolution. Memories of the famines in India of two decades ago have faded with the country's self-reliance today in miracle wheat and rice varieties. "Without the Green Revolution, India would surely be less stable and quite likely not a democracy". (McPherson 1986). As India moved from a less developed country to newly industrialized, so did many other nations such as Brazil, Mexico, Korea, and others.

The economic return to the United States has been significant. In 1981, Korea bought more food from the United States than we had given them during 24 earlier years of food aid shipments. Mexico, which received $78 million in assistance from the United States, bought $1.7 billion worth of American products in 1983 alone. Of the

50 largest buyers of U.S. farm goods, 34 are countries that previously received U.S. food aid. In 1985, 30 percent of America's top export line - machinery and transport equipment - were sold to developing countries. It is in the fast-growing markets of the developing countries, not in the more mature markets of Europe and Japan, that we will see the demand for U.S. products rise at spectacular rates. (Woods 1988).

Mapmaking has been an integral part of the evolution of foreign economic assistance from the rebuilding of war-torn Europe to the Green Revolution. The mapping sciences have played critical roles in the U.S. responses to recent disasters. The United States provided seeds and funds to compensate for the destruction of one-half of Bangladesh's food crop and uprooting of 30 million people due to the floods of 1988. In addition, we provided tents, wool blankets, and reconstruction funds to house 60,000 people left homeless due to the March 1988 earthquake in northern Ecuador. Since the beginning of the most recent drought in Africa, maps and satellite remote sensing are being used to direct food aid efforts which have saved an estimated 20 million people from

starvation. Famine and early warning efforts are helping to keep alive five million to seven million people in Ethiopia alone.

The growth of remote sensing and mapping was promoted most strongly by the environmental sector. As early as 1976, coincident with the National Environmental Protection Act, A.I.D. adopted it first formal environmental procedures for its developing country projects. In 1977, the Foreign Assistance Act was amended, giving A.I.D. the authority to strengthen the capacity of developing countries to manage their natural resource base and take into consideration the environmental consequences of development actions. Section 103 of the Act, the section that deals with food and nutrition, was amended in 1978 to declare that deforestation and its consequences are threats to improving agricultural production and meeting the basic needs of the poor. It was in this year that the Agency sponsored the U.S. Strategy Conference on Tropical Deforestation.

The year 1980 brought incorporation of procedures on the use of pesticides into A.I.D.'s legislation. The World Conservation Strategy was issued and the Agency's Office

of Forestry, Environment and Natural Resources was born. Section 119 on endangered species was added to the Foreign Assistance Act in 1983. Section 118, which places a high priority on conservation and sustainable management of tropical forests, was added in 1986. Legislation was authorized this same year earmarking $2.5 million for the protection of biological diversity. In 1988 A.I.D. received directions through Section 537(g) of its appropriations act to monitor the economic and environmental soundness of all projects funded by the multilateral development banks.

Despite the brief history of the Agency's focus on environmental issues, A.I.D. has taken the leadership role in environment among all bilateral development agencies. The Agency has encouraged "debt-for-nature swaps", whereby a portion of a developing country's external debt is cancelled by the country's agreement to protect a portion of its natural resources. The historical development of this sector has led to the concept of sustainable development, defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

(WCED 1987). Sustainable development has fostered the notion that natural resources, just as infrastructure such as building and equipment, should be recorded against current income as asset depreciation if they are being depleted.

Map making has evolved with the notions of sustainability. A.I.D.'s mapping program has involved the development of a dozen national centers and three regional ones, all of which are maintained today because the emphasis of the centers is on sustainable development. The products derived from these mapping ventures are oriented toward economic growth that can be sustained over time.

MAPPING AND DEVELOPMENT STRATEGY

There is a long bureaucratic process from development strategy to a mapping activity. An understanding of this process leads to a recognition of the purpose of mapping in development assistance. The process begins with a strategy, which in turn is followed by action, a budget, several project documents, a Request for Proposals, an

implementing agreement, and finally an evaluation. A brief description of each of these phases follows. Throughout the description, the development of a real surveying and mapping project in Egypt is used as an illustration. That project is described in greater detail in the EXAMPLES section.

Strategy: A.I.D. has 71 Missions, Offices, and Representatives in the developing world. Mission staff in each country assess the overall economic progress and problems of the host country to which it is assigned. This analysis includes major structural problems in the economy, determines the priorities of all of the other donors working in the country, defines the obstacles in improving economic performance, and describes major global political events that factor into the country's development. This analysis is termed the Country Development Strategy Statement (CDSS), and is the foundation upon which U.S. development assistance for that country is based.

In its CDSS, for example, the U.S.A.I.D. Mission in Cairo identified inefficient management and control of Nile

River water as a major impediment to increasing crop production an additional 25 to 100 percent.

Washington offices of A.I.D. also prepare a similar document termed the Central Program Strategy Statement (CPSS), which reflects growing priorities in broad-based development techniques that generally apply to all developing nations. The environmental priorities described in the INTRODUCTION to this paper are now incorporated in the CPSS.

Action: The Action Plan translates strategy into a program for attacking problems which impede development. The Action Plan focuses on the basic problems in developing societies - hunger, inadequate income growth, illiteracy, health deficiencies, and unmanageable population pressures - and describes ways in which the A.I.D. Mission or Office intends to overcome them. Projects are ~~identified~~ conceptualized at this phase, and for the first time the needs for surveying and mapping (if appropriate) become identified. Indicators of progress are spelled out, and ways to measure them are identified.

The Action Plan for the U.S.A.I.D. Mission in Egypt discusses the ways for increasing overall water use efficiency in the irrigation distribution system by eight percent between fiscal years 1986 and 1991, as well as developing mechanisms for recovering the costs of this efficiency increase. Although surveying and mapping is not specifically stated, it is clear at this point of conceptualization that surveying and mapping will have to play a pivotal role in helping to increase irrigation and other water use efficiencies.

Budget: The Annual Budget Submission (ABS) lists the projects that are necessary to carry out the Action Plan and the resources required to support them. Projects are ranked and conceptualized in terms of cost and years of effort. The ABS also includes other operating costs of keeping the Mission or Office running.

Carrying the example along, the Mission in Egypt identifies an Irrigation Management Systems project for increasing the water use efficiency of the Nile. The project is ranked sixth in the Mission's portfolio, is budgeted for an additional $55 million in FY 1989,

bringing its accumulated obligated amount up to $230 million. (at the time of preparation, in May, 1987. The project is now designed for project funds totaling over $340 million).

Project Documents: Projects are next designed by teams comprised of A.I.D. staff and outside contractors. It is in the project design stage that appropriate requirements for surveying and mapping are determined. The Project Identification Document (PID) outlines the general mapping requirements. A later document, the Project Paper, is sufficiently detailed that, in some cases, a Scope of Work for a Request for Proposals can be written directly from it.

During project design of the Irrigation Management Systems project in Egypt, the PID identified the need to provide topographic, planimetric, and crop maps for the entire Nile River from the High Aswan Dam to and including the Delta. The Project Paper further refined the scales for the maps, the digital formats they needed to be in so that interfacing with a land information system would be possible, and a host of other criteria that could be translated into a scope of work for bids.

Implementing the Activity: As is evident from this description, A.I.D.'s surveying and mapping activities almost always are implemented in the context of a project. A great proportion of A.I.D. money is expended through projects. There are a few exceptions; disaster assistance to respond immediately around the globe, and small activities funds to conceptualize new thrusts in program areas are examples of implementing activities that fall outside of the project mode. (Incidentally, surveying and mapping have been carried out with funds from both of these kinds of activities).

Small Activity Funds of roughly $.5 million per year are used to design and evaluate surveying and mapping projects in A.I.D. activities. These usually are carried out by two Indefinite Quantity Contractors (IQCs) that were selected through the open competitive process. The IQCs are in place for three years, after which two new IQCs are selected through a new round of competition for the subsequent three years. The two IQCs presently retained by A.I.D. for services in surveying and mapping are the Earthsat Corporation of Chevy Chase, Maryland, and the Technology Applications Center of Albuquerque, New Mexico. These IQCs are in effect through June 1990.

There are various ways that A.I.D. implements a mapping activity in a project. The greatest number are carried out by contracts through the competitive process, with a scope of work developed (sometimes from the Project Paper) and placed in a Request for Technical Proposals which is provided to potential bidding firms. Notices of these Requests are listed in the Commerce Business Daily. The Surveying and Mapping is one of 10 components of the Egypt Irrigation Management Systems project. It was advertised and a contract awarded under open competition.

Some thematic mapping activities are carried out by agreements with other U.S. federal agencies. A Participating Agency Service Agreement (PASA) has been used to acquire mapping services with a specific objective in mind and a time limit. A Research Support Services Agreement (RSSA) is used for the hiring of services without defined goals and criteria. PASAs and RSSAs were used by A.I.D. mostly for advanced space remote sensing services in the past, when most of the knowledge of space applications were to be found in federal agencies such as NASA, the U.S. Geological Survey, and the U.S. Department of Agriculture. As more universities and the private

sector took over the applications of space remote sensing, the Agency has turned more to open procurement from the private sector for all mapping support.

In the past, when only a few major research organizations had capability in space remote sensing, the Agency awarded a few contracts based on sole source or predominant capability considerations. Today, it is difficult to imagine an area of surveying, mapping, remote sensing, photogrammetry, or geographic information systems, especially as they apply to economic development, in which one company would be the only source of knowledge, or have predominant capability.

Grants and cooperative agreements are two other ways in which mapping services could be provided. Unlike a contract, which is a legally binding agreement calling for specified goods and services, a grant is a conditional gift by A.I.D. to an individual or organization for the purpose of helping to carry out, improve, or expand an activity sponsored by the grantee which is consonant with the objectives of the Foreign Assistance Act. A cooperative agreement is a conditional gift to an

organization - such as a university, international research center, private voluntary organization or other entity - for a program sponsored by the recipient but in which a substantial degree of direct participation by A.I.D. is involved.

"Buy-Ins" are yet another way that surveying and mapping activities can be implemented. A "buy-in" is a contractual provision whereby any organizational A.I.D. unit (a Washington office or an overseas Mission) can transfer funds into an existing A.I.D. contract and purchase mapping services. The stipulation is that the desired services requested by the "buy-in" must be consistent with the objectives of both the project and contract into which the funding is transferred. The project and contract receiving the funds must have provisions for "buy-ins" in its design. Remote sensing and GIS activities are permitted, for example, as "buy-ins" to the Natural Resources Management Systems Project of A.I.D.'s Africa Bureau.

Evaluations: A.I.D. projects are held to rigid evaluation schedules. Because projects are carried out in remote

corners of the earth, under sometimes extreme environmental, political, and cultural diversity, all projects have evaluation criteria built into their design. It is not infrequent to find as much as 20 percent of a project's budget set aside for evaluations. An average seven-year project in natural resources budgeted at $10 million might be evaluated three times during its life at a total cost of $1 million - $1.5 million.

The reason for this relatively high proportion of evaluation-to-total project funds is three-fold: (1) strict accounting of U.S. public funds spent overseas, (2) the need to keep project activities focussed on major impediments to development; namely, hunger, low incomes, health threats, and overpopulation, and (3) the desirability of adding recent lessons learned to the historical database of development so that new and tried techniques can be replicated in the host of other developing countries experiencing similar difficulties.

Most surveying and mapping activites are conducted under more comprehensive natural resources and agricultural

development projects. As such, the bottom line in most evaluations of these types of activities is the increase in income and food consumption while maintaining or enhancing the natural resource base. It is usually difficult to evaluate the links between base maps and alleviation of hunger, or other such basic need. But the attempt must be made, and the evaluation must come to grips with these basic needs through economic analyses which will assist decision makers in the developing countries to determine the advisability of continuing the program without further assistance. In other words, the evaluation must provide the basis by which the ultimate usefulness of a project activity can be judged: whether the country itself will continue the project activity, or implement some procedure tested under the project, on its own.

Mid-term evaluations focus primarily on determining if the project's objectives will be met and if adjustments are required. End-of-project evaluations are designed to contribute to the decision-making process which determines whether to continue, redesign, or end the activity. On a higher intellectual plane, an A.I.D. evaluation of a project assesses the developmental impact of that project,

and identifies and documents lessons learned as a useful, substantive guide in planning and implementing future programs. A.I.D. is trying to come to grips with the idea of using generalized tracking indicators for the various sectors of development, much as the nation's leading economic indicators purport to track the economic health of the country. It is difficult to arrive at one or two leading indicators for natural resource sustainability, however.

EXAMPLES OF MAPPING ACTIVITIES

Four A.I.D. mapping activities will be described that illustrate the components and objectives of various programs.

1. Egypt Irrigation Management Systems: This example has been carried along under the MAPPING AND DEVELOPMENT STRATEGY section. Mapping is now getting underway to produce data necessary to improve the management of Egypt's scarce Nile River water.

The recent African drought raised two major concerns in Egypt: (1) conservation measures are not considered with regard to the use of water reserves behind the Aswan High Dam, and (2) there will undoubtedly be insufficient water to sustain Egypt's projected population by the year 2000 unless drastic conservation measures and management improvements are put into place during the next few years. (U.S.A.I.D./Cairo 1988).

Egypt's population of 50 million people is growing by 2.7 percent annually. The country imports 50 percent of its food and wants to increase agricultural production through the use of improved seeds and other agriculture technologies. In order to do so, the root zone environment of the crops must be improved. Irrigation water at the proper time and in the quantities required depends upon precise and accessible map data. The root zone of the crop must be free of water logging and salinity, both of which will be monitored by means of remotely sensed data. The U.S.A.I.D. project, Irrigation Management Systems, is a 10-year, $340 million project to address the monitoring and management of Nile River water.

The surveying and mapping activity is one of 10 components which make up this project and is believed to be the largest endeavor of its kind ever undertaken. Over 100,000 air photos will be taken covering all of the Nile River from the High Aswan Dam through and including the Nile Delta and the Fayoum Depression. The air photos will be used to map the entire area.

The surveying and mapping contract, valued at approximately $25 million, was awarded after competitive bidding to the Geonex Company of St. Petersburg, Florida. The Egyptian General Survey Authority is the cognizant Egyptian entity responsible for the mapping.

The base maps will consist of orthophoto mapsheets at 1:10,000 scale and one meter contour intervals, covering an area of 50,000 sq. km. Digital planimetric base maps will also be produced at 1:2,500 scale for 35,000 sq. km. of this same area. Four hundred towns will be planimetrically mapped and digitized at 1:500 and 1:1,000 scales. Cadastral surveys will be completed for four governorates of the country. Thousands of geodetic control points will have to be established, using both the

Global Positioning System and conventional techniques. Aerial photography at scales of 1:50,000 and 1:100,000 will also be collected during each of the three crop-growing seasons of the year, and analyzed to identify and measure 10 of the primary crops for production estimates. These photos also will be used to assess soil salinity and waterlogging problems affecting crop production in Egypt.

The central management tool for all of these mapped data will be one of the largest land information systems ever developed. Data that must be entered into this system include digitized topographic line sheets, crop polygons, and existing cadastral records going back one hundred years in Egypt.

The Land Information System will incorporate the latest U.S. technology in Geographic Information Systems (GIS) and CAD/CAM and AM/FM development. Over 10 million parcels of land data are expected to be eventually recorded in the system.

The surveying and mapping project includes a large

technology transfer component. Digital photogrammetric, image analysis, and GIS equipment and software will be purchased under the contract and transferred to the Egyptian General Survey Authority. Contract implementation will be carried out by Geonex with an eight-person team residing for three years in Egypt. Training in both Egypt and the United States will be provided under the contract.

2. Famine Early Warning in Sudan: At the height of the African famine in 1984 and 1985, several million people died of starvation and malnutrition because of failing crops and livestock and, tragically, because a comprehensive information system of crop forecasts and populations at risk was lacking. Although climate acted as the trigger, inappropriate governmental policies (such as low prices paid to farmers, parastatal marketing boards, and centralized extension services) led to deteriorating natural resources and the resulting famine. The outpouring of both official and non-governmental food aid was undoubtedly the most massive mobilization of humanitarian assistance the world has ever seen. Millions of Africans were saved as a result of this relief effort.

Not many people realize the contribution that mapping, remote sensing, and geographic information systems made to this relief effort. Immediate and dramatic benefits included the provision of Landsat Thematic Mapper images to heliocopter pilots, who used the images as their only source of maps to navigate over completely unknown and relatively unchartered terrain, to get food supplies into isolated villages. Of longer consequence was the setting up of country-wide programs for forecasting food aid requirements. The most important program is the Sudan Emergency Rehabilitation Information and Surveillance System (SERISS).

During Sudan's severe drought in 1984 and 1985, A.I.D. was bringing in food and other related disaster assistance valued at $250 million to feed people stricken by the drought. The lack of sufficient data about crop prospects in the country led the U.S.A.I.D. Mission to fund one million dollars and 500,000 Sudanese pounds to develop a system for forecasting crop production and estimating people at risk.

The SERISS technique is based on the area frame sample, a

statistical n thod employed for 60 years by the U.S. Dept. of Agriculture to use imagery to select primary sampling units, which are subsequently visited on the ground for the purpose of collecting the kinds of information necessary (in our case) to program food aid. SERISS mapping begins with interpretation of Landsat Multi-Spectral Scanner (MSS) and Thematic Mapper (TM) images to select sampling sites in the large mechanized fields east of the Nile and the very remote traditional agricultural fields in North and South Darfur and North and South Kordofan provinces. (Anderson 1989).

Field-collected data on feddans (one feddan equals 1.038 acres) of sorghum, millet, and other crops, their yields, and a host of other data are compiled in Khartoum and put into a geographic information system (TERRAMAR). Soils and rainfall data are also incorporated. Production estimates for sorghum during last year's (1987-1988) crop season was only 42 percent of the previous season's level; i.e., 1.38 million metric tons (MT) compared to 3.23 million MT the previous season. From follow-up field visits, A.I.D. was able to attribute this substantial drop in production to the low prices farmers received for their

crops in 1986-1987 (which discouraged them from planting in 1987), low and poor distribution of rainfall which led to late planting in 1987, and rat and other pest infestations which prevented and delayed plantings. The 1988-1989 harvests look more promising, as more normal rainfall patterns have returned to the African continent.

The Sudanese Ministry of Agriculture now has most of the capability to carry on with these crop forecasts, with a minimum of outside assistance. Much of the contractual assistance employed in this monitoring came from the Nairobi Regional Center for Services in Surveying, Mapping, and Remote Sensing, a first for A.I.D. because of the contractual implementation by a regional organization composed of developing country mappers.

3. Bangladesh Agro-Climatic Environmental Monitoring: A tremendous loss of life and property due to severe storms in the late 1970s led to the development of this $7.5 million project in Bangladesh. The project originated from an attempt to establish an early warning system for cyclones, floods, and monsoons. The initial emphasis was on the construction of a meteorological satellite

receiving station with associated data collection platforms scattered about in strategic locations in the country to continuously monitor river stage and other environmental parameters. (Paul 1986).

Extensive training in the operations and maintenance of the equipment has been provided to the Bangladesh Space Research and Remote Sensing Organization (SPARRSO), which operates the station. In addition, the organization has been trained in image analysis skills and database management techniques. The entire "space age" technology package is intended to enhance, and become an integral part of, the traditional warning system already in place. The synoptic pictures of tropical storm buildups assist the Bangladesh Government in improving its forecasting accuracy of cyclones and resulting flooding and storm surges as part of the development of disaster prediction and preparedness measures.

After hardware and software were put into place and data became readily available, it was apparent that the applications of these data to developmental sectors would have long-range benefits to the country. The project is

even today evolving into one that will improve the planning and management of natural resources in Bangladesh, especially those resources related to agriculture and water development. In combination with Landsat data, which are purchased from Thailand but can be processed at the SPARRSO station, crop yields and areas are determined for reporting production levels.

Landsat data are analyzed to survey forest resources and clearings. The meteorological satellite data, the Landsat data, and the data from the data collection platforms are used to deduce water runoff and stream flow. These data will be combined with aerial photography interpretations to drive water allocation models for irrigation, reservoir stage decisions, consumption, and industrial use. In addition, plans are to use all available remotely sensed data to detect phytoplankton, currents, eddies, and temperatures in coastal and estuarine waters for possible deduction of locations of fish and marine resources.

4. Highland Jungle Development in Peru: A project designed to promote conversion of highland tropical forests in Peru to crop and grazing lands was reevaluated

when it became apparent that the loss of virgin, old growth forests would prevent sustained agriculture and employment. The site of the project, the rugged Pichis-Palcazu region of Peru, is the ancestral home of both the Amuesha and Campa Indian tribes, which number about 15,000. Extensive, uncontrolled forest clearings on the hillsides would have led to siltation of the rivers and increased likelihood of flooding. There are an additional 6,000 new colonists in the region. It was easy to see that massive clearing and development would have had a disrupting effect on the culture of the indigenous populations, and adverse economic effects on all.

The Central Selva project, as the development is known, demonstrates the flexibility designed in large scale A.I.D. projects. The project began in 1982 fundamentally as a highway construction effort (the Carretera Marginal de la Selva) with an emphasis on extensive agricultural production. (Reid 1988). The highway was supposed to allow small farmers to have access to markets for their crops. The problems of sustaining infrastructure in highland jungle immediately became apparent. Tropical

forest covers 85 percent of the lower valleys, and the Palcazu area supports more than 1,000 species of trees. Heavy rainfall on the steep slopes results in extensive erosion in areas where trees have been cleared. The soils for the most part are acidic and infertile, with high aluminum toxicity.

Realizing this, the project quickly shifted objectives to one that deemphasized agricultural development to one that developed differing land uses appropriate to the natural resources and sustainable production. Some low-input farming technologies are employed, but most research and development was geared to the sustainability of the high jungle.

Grants and loans of $22 million have so far been expended to support clear cut strip forestry, a method of sustainable forest management that simulates natural gap generation in tropical forests. Strips 20 to 50 meters wide, roughly 200 meters apart, are cut to support tree harvests on 30- to 40-year rotations. Some tree species losses may be unavoidable, but clear cut strip forestry has far less impact on biodiversity than traditional clear

cutting. Of great importance is the acceptance of strip forestry by the indigenous people. The colonists do not accept the technique quite as readily, because of the large amount of technical assistance they continue to need to design harvest units and to foster the growth of appropriate species. In addition, colonists are finding it difficult to find markets for the limited amount of timber that can be harvested using this technique.

Interestingly, a large number of land uses are accommodated in the Palcazu, each limited in size to minimize environmental impact. Agriculture, livestock, coffee, palm heart, and sheep grazing are examples of the diverse uses to which Palcazu has been placed. In addition, 33 square kilometers of the San Matias mountain range has been set aside as a production forest, and 1,330 square kilometers of the neighboring Yanachaga range has been designated the Yanachaga-Chemillen National Park.

One year before the Palcazu project got underway, a mapping and geographic information system activity was recognized as a necessary ingredient to assess the impact of the highway and to assist in the planning of the

diverse land uses for the Palcazu. It was decided to choose a 100 square kilometer site near the town of Aucayacu in the Huallaga valley to demonstrate a geographic information system (GIS) that was specially designed and configured for this project. Information about soils, topography, and roads was entered into the GIS from existing maps and aerial photography. (Paul 1989). The GIS converted elevation contours into slope classes. Forests and agricultural land use classes were interpreted from aerial photography.

All of these data were geometrically registered in the GIS, and a series of analyses led to associations of cultivated row crops that are grown on specific soil types with less than two percent slope. Also demonstrated by the GIS are the locations and distributions of specific crops on four different slope classes. Crops, soil types, and slope associations are important for understanding erodibility of the land. Using the GIS, suitability for intensive cultivation in all areas in the demonstration site could be quickly assessed.

The GIS developed under the Palcazu project is operated by

the Peruvian Office of Natural Resource Evaluation (ONERN). Staff from ONERN were involved in all aspects of the data collection and analyses. ONERN's operation of the GIS permits it to make many iterations of analyses, varying the relative influence of design parameters so that acceptable alternatives can be derived which meet specific resource management needs. These alternatives can often be viewed and assessed in a matter of minutes or at most a few hours, due to the inherent processing speed of the GIS. In addition, all design parameters are treated in a consistent manner, helping to eliminate much of the bias and errors associated with manual analyses alone.

SURVEYING AND MAPPING WITH A.I.D.- A SUMMARY

Surveying and mapping activities in A.I.D. can be charaterized as follows:

1. Emphasis on private sector: Except for a few projects in which specific competence has been identified in other federal agencies, A.I.D.'s surveying and mapping projects

stress the participation of the U.S. private sector and local contractors in the host country. The technical expertise (especially in GIS) is predominantly in the private sector. Private companies can adapt to unexpected changes in the political and economic conditions found in developing countries. And, the most important reason of all for reliance on the U.S. private sector for services in mapping is the catalytic effect they play on promoting the private sector in the developing countries.

This growth of an indigenous private sector in the developing countries is one of A.I.D.'s pillars of development. "A.I.D. assistance to an LDC (Less Developed Country) should encourage social and economic development that promotes movement toward a democratic, free market society. It is A.I.D.'s view that such societies are most efficient for generating broad-based, sustained economic growth and social progress." (U.S. Agency for International Development March 1985). A.I.D.'s policy is to encourage the developing countries to open their economnies to a greater reliance on competitive markets, and to foster the growth of productive, self-sustaining income and job-producing private enterprises. What better

example for A.I.D. to demonstrate this commitment than by carrying out its basic mapping program through the U.S. private sector, thereby encouraging development of the private sector for mapping services in the developing countries.

A.I.D. is deeply committed to use of the private sector. Congress created the Revolving Fund in 1983 when it enacted Section 108 of the Foreign Assistance Act. This Act essentially permits the Private Enterprise Bureau of A.I.D. to invest in local entrepreneurial projects in the developing countries, stimulating the growth of the private sector, and then redepositing interest, fees, and repayments of these loans into the Revolving Fund to finance new projects. (Agency for International Development September 1988). The Revolving Fund provides the developing countries with unique international banking and business expertise. The staff of the Private Enterprise Bureau were recruited primarily from the U.S. private sector.

A.I.D.'s Office of Investment has undertaken 63 successful private enterprise projects in 30 nations. These projects

can be divided into policy reform, credit to private enterprise, agribusiness, business development, investment promotion, export development, and management development and technology transfer. (Agency for International Development 1987). Surveying and mapping certainly have the potential to contribute to a private enterprise project, since these sciences and their attendant applications can be seen to be a basis for the kinds of development described above. Thus, the potential for surveying and mapping applications and involvement with the stimulation of private sector markets is great in the developing countries.

2. Technical competence: Since A.I.D.'s relatively small number of surveying and mapping contracts are awarded through open competition of technical proposals, technical competence plays a strong role in A.I.D.'s program. This is especially important when considering the separation (both geographically and culturally) between sources and destinations of U.S. technical knowledge. Technical competence has been enhanced through association with A.I.D. due to opportunities afforded contractors to broaden their skill base when working in remote areas

where literally no other source of expertise is available. Especially in the case of A.I.D.'s two Indefinite Quantity Contractors, unanticipated responses to a host of mapping requirements have forced them into the mode of learning new techniques quickly.

3. Experience: Experience in working with the latest mapping technologies in developing countries is a real asset when working with A.I.D. This can be appreciated when one considers the usual lack of technical support for equipment and the sometimes harsh physical environment in which a surveyor can find himself or herself. However, A.I.D. always welcomes the opportunity to get fresh perspectives into its mapping program, and eagerly seeks out new companies for involvement in activities. In addition, A.I.D.'s policy is to weigh developing country experience no more than 10 percent in selection criteria for competitive procurement.

4. Natural resources proclivity: A great bulk of A.I.D.'s mapping activities are oriented toward natural resources management, as can be noted from this paper. Most firms offering services in mapping that work with A.I.D. have a

strong commitment to applications in the natural resources area. The Agency will always have mapping projects that support infrastructure, but the new and exciting applications will occur in management of tropical forests, conservation of biological diversity, and planning of water resources.

5. Language skills: Most A.I.D. mapping projects require long-term advisors and analysts in the countries in which the project is carried out. These advisers frequently must be proficient in the language of the host country. All of the Latin American countries where A.I.D. carries out projects (with the exception of those in the Caribbean Basin) require advisors with Spanish capability. The Francophone countries of Africa require French, and most of the Middle East countries require Arabic.

6. Cultural sensitivity: Successful mapping ventures require astute political perceptions and understanding of the rich cultures found in developing nations. An ability to work in and with the cultural environment of developing countries adds the dimension of respect to the technical relationship between a private contractor and the host country.

ACKNOWLEDGMENTS

The author would like to acknowledge the very generous editing assistance provided by Ms. Marcia Packer of the Program Office, Agency for International Development. Also, the critical insight and suggestions provided by Mrs. Carolyn Paul are greatly appreciated. This paper reflects the personal views of the author and is not to be construed as an official A.I.D. position or policy paper.

REFERENCES

Agency for International Development. (September, 1988). Annual Report of the Private Sector Revolving Fund for Fiscal Year 1988. Bureau for Private Enterprise, Washington, D.C., p. 8

Anderson, R.L., Falconer, A., and Smith, W.L. (1989). "Data for the Sudan Crop Estimation Project 1986/7." paper under review to be published in Photogrammetric Engineering and Remote Sensing. American Society for Photogrammetry and Remote Sensing, Falls Church, Va. A featured news story of the results of the forecasts is also expected to be published in the same issue of the journal.

McPherson, Peter M. (1986). speech by the Administrator of A.I.D. to the National Press Club on November 12, 1986, Washington, D.C.

Paul, C.K. (1986). "Support for Geographic Information Systems in Developing Countries." Geographic Information Systems in Government. A. Deepak Publishing, Hampton, Virginia, p. 10.

Paul, C.K., Imhoff, M.L., Moore, D.G., and Sellman, A.N. (1989). "Remote Sensing of Environmental Change in the Developing World". Changing the Global Environment - Perspectives on Human Involvement. Academic Press, Inc., Boston, Mass., pp. 206-207.

Reid, W.V., Barnes, J.N., and Blackwelder, B. (1988). Bankrolling Successes: A Portfolio of Sustainable Development Projects. Environmental Policy Institute & National Wildlife Federation, Washington, D.C., pp. 39-41.

Republican National Committee (1988). Leadership on the Issues. a compendium of the speeches and public statements of the Views of the President-Elect on Key Foreign Policy and Economic Development Issues, Washington, D.C.

U.S. Agency for International Development. (March 1985). "Private Enterprise Development - A.I.D. Policy Paper." Bureau for Program and Policy Coordination, Washington, D.C., p. 1.

U.S. Agency for International Develpment. (April, 1987). Economic Growth and the Third World. Bureau for Private Enterprise, Washington, D.C.,p. 9.

U.S.A.I.D./Cairo (1988). Irrigation Briefing Paper. Office of Irrigation and Land Development, Cairo, Egypt, p. 1.

Woods, Alan (1988). Administrator's Statement for Fiscal Year 1989 Congressional Presentation on U.S. Foreign Assistance Program, Washington, D.C.

World Commission on Environment and Development (1987). Our Common Future. Oxford University Press, Oxford, U.K., p. 43.