A COMBINED GEOGRAPHIC INFORMATION SYSTEM AND SOCIAL ACCOUNTING MATRIX APPROACH TO PROGRAM IMPACT EVALUTION OF U.S. FOREIGN DEVELOPMENT ASSISTANCE

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(Resumen)

La agencia Estadounidense para el Desarrollo Internacional en el Zaire depende de técnicas analíticas llevadas a cabo por científicos de la zona para computar el beneficio de la ayuda americana en el extranjero. El efecto de los proyectos de objetivo geográfico, tales como los servicios de sanidad, infraestructura, e extensión agrícola, se computa utilizando técnicas de sistema geográfico internacional. El efecto de asistencia de objetivo no geográfico como la reforma de tarifas de importación, la reforma en el sector financiero y la prevención del SIDA se computaron utilizando una técnica matriz de contabilidad social de la zona. Se resumen aquí las técnicas y los beneficios resultantes de combinar estos dos enfoques para organizar la investigación en la efectividad de coste de ayuda al extranjero.

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Policy analysts have debated the costs and effectiveness of U.S. foreign economic development assistance for decades[2]. In a continual search for an appropriate balance of development and security assistance the U.S. Congress has refined foreign assistance

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[2] Judith Tendler, *Inside Foreign Aid* (Baltimore: Johns Hopkins University, 1975); Raymond F. Mikesell, *The Economics of Foreign Aid and Self-Sustaining Development*, (Boulder: West View, 1983); David Porter,*Economic Foreign Aid: A Case Study of the United States Agency for International Development*, (New York: Garland Publishing, 1990); U.S.,Congress, House, June 16, 1989, July 25, 1990 and September 26, 1990.

objectives roughly every ten to fifteen years since WW II in 1948, 1961, 1973, and 1987[3] . In addition to refining objectives of foreign assistance these Acts represent an evolving Congressional strategy to guide foreign assistance. This strategy has evolved from administrative standards in 1961, to earmarking expenditure targets in 1973, and to experimenting with program impact evaluation in the context of more flexible funding in 1987.

This paper reviews the approach used by United States Agency for International Development (USAID) in Zaire between 1988 and 1991 to structure a research program for reporting on the cost- effectiveness of U.S. foreign assistance. This research was initiated in 1988 in response to the Development Fund for Africa (DFA) under which the Africa Bureau of the USAID agreed to report more rigorously on the impacts of foreign assistance. As developed in Zaire, Program Impact Evaluation (PIE) is a more cost effective organization of research than previous evaluation procedures for program budgeting and responds to U.S. Congressional demands for reporting on the welfare impacts of foreign assistance in Africa. Impact evaluation at the country program level but above the project level is still rare within USAID.

Program Impact Evaluation (PIE) as developed in Zaire is a framework for comparing and reporting the efficiency of alternative portfolios of development assistance to a single country. Conceptually PIE is an application of Bayesian statistical logic to the management sub-specialty of program evaluation[4]. As implemented PIE is technically a synthesis of earlier domestic program planning and budgeting techniques with project cost-benefit evaluation as developed in the 1970s (see Schmid (1989)). Institutionally PIE research contributes to an impact statement strategy of public sector reform as described by Taylor (1984:295-313).

Substantively the objective of PIE is to enable decision makers to improve the allocation of foreign assistance resources. Since the 1980s, the USAID has increasingly

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[3] Marshall Plan of March 1948; Foreign Assistance Act of 1961 (Public Law 87-195); Foreign Assistance Act of 1973 (Public Law 93-189); Continuing Appropriations, Fiscal Year 1988 (Public Law 100-202).

[4] Kurt Finsterbusch, *Methods for Social Analysis in Developing Countries* (Boulder: Westview, 1990); Colin Howson, Peter Urbach, *Scientific Reasoning: The Bayesian Approach* (La Salle: Open Court, 1989); Jack L. Franklin, Jean H. Thrasher, *An Introduction to Program Evaluation* (New York: John Wiley & Sons, 1976); Francis W. Hoole, *Evaluation Research and Development Activities*, Sage Library of Social Research, vol. 68 (Beverly Hills: Sage, 1978).

focused evaluation on concerns above the individual project level including welfare measures of effectiveness in addition to simpler measures of project outputs. PIE emphasizes decentralizing programmatic research to a USAID country mission level, a return to more rigorous research methods, and using the same cost effectiveness measures across sectors such as health and agriculture to compare alternative portfolios of assistance.

Procedurally PIE is a critical component of an impact statement strategy of Congressional guidance for USAID as a public organization. There are two key elements of an impact statement strategy of reform. First, the formal requirement for more rigorous impact evaluation and reporting which represents an external demand for a knowledge base and analysis. This leads an organization to formally set new goals, reorganize, and change its output mix. Second, the informal expectation is that this external demand will lead to having more "analyst advocates" inside the organization and more open decision making so external institutions such as universities or non-profit development organizations can elaborate and judge analytical quality. This analytical competition between internal and external analysts promoted by an impact statement system is expected to enhance the ability of a public organization to adapt to complex and changing problems (Mazmanian and Nienaber:191-193 and Taylor:296, 316-317).

Part two of this paper describes the Development Fund for Africa in the context of the evolving role that development assistance is expected to play in U.S. foreign relations. Parts three and four describe the objectives and organization of PIE research in Zaire. Part five reviews the process of using a combined social accounting matrix (SAM) and geographic information system (GIS) approach to research. Parts six and seven summarize accomplishments and empirical results. The paper draws conclusions for research implementation and future directions of PIE research using a combined GIS and SAM approach.

THE DEVELOPMENT FUND FOR AFRICA

The end of World War II marked the first time the U.S. adopted a policy of systematic and annual transfer of substantial economic resources to other countries during peacetime (Porter, 1990:5). During the 1950s the focus shifted from Marshall Plan reconstruction in Europe to military assistance for allies on the rim of the Soviet Union. The 1961 Act (Chapter 1, Sec. 102) shifted assistance to developing countries through a policy to "strengthen friendly foreign countries by encouraging development... based

upon social as well as economic aspects of development". The 1973 Act (Purposes of the Bill) mandated a restructuring of economic assistance within recipient countries through a policy that "projects would be selected which most directly benefit the poorest majority of the people in (poor) countries". Authorizations before 1973 provided funds by categories such as loans or grants while the 1973 Act authorized funds in five categories divided primarily according to sector or field of activity including selected development problems, countries, and organizations.

In the early 1980s concern about hunger in Africa led the U.S. Administration to ask for long term development assistance for Africa that resulted several years later in the Development Fund for Africa (DFA) (U.S., Senate, 1984:11). The 1987 Act provided more flexible development assistance by creating the DFA to be administered by USAID[5]. In addition to reiterating the 1973 focus on the poorest groups within recipient countries Congress ordered USAID to allocate DFA funds on the basis of two criteria: countries' needs for assistance and their commitment to alleviating poverty[6]. The DFA explicitly targeted economic development assistance to the poorest people within the neediest countries.

Provision of the DFA has linked more flexible programming procedures to improved reporting on the effectiveness of assistance in improving the welfare of specific population groups within specific countries. This linkage to assessment of program impacts represents the beginning of an impact statement strategy of Congressional guidance of USAID[7]. There has been no conclusive research on the shift of beneficiary groups among population groups within recipient countries since the 1973 or 1987 Acts.

Congress's request for improved accountability under the DFA has encouraged

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[5] The Development Fund for Africa is distinct from the African Development Fund which is part of multi-lateral foreign assistance. The DFA is a line item in foreign aid appropriations and is bi-lateral aid for development assistance to be provided on a grant basis only in Sub-Saharan Africa.

[6] Congressional Quarterly Almanac, 101st Congress, 2nd Session, 1990, Vol. XLVI: 836.

[7] Rep. David R. Obey, D-Wis., chairman of the House Appropriations Sub-Committee on Foreign Operations has called the foreign aid appropriations for fiscal 1992 which include an increased DFA a second installment "in a five-year plan to adjust foreign aid spending to the end of the Cold War". Funding for the DFA has increased to S1 billion for FY1992, a doubling of the initial FY1988 funding level of $500 million. Carroll Doherty, *A World of Different Lurks Behind Foreign Aid Vote* (Congressional Quarterly Weekly Report, June 22, 1991) 1680.

USAID to experiment with new forms of assistance, decentralize decision making, and increase the quality of research on cost effectiveness of foreign assistance. USAID is now restructuring its research and evaluation system at both the field Mission level and in Washington. Since the DFA was approved in December 1987 the USAID mission in Zaire has developed a combined social accounting matrix and geographic information system approach to provide the structure for research on the welfare impacts of assistance across population groups within Zaire.

OBJECTIVES OF PROGRAM IMPACT EVALUATION

The goal of PIE research is to enable decision makers to increase the cost-effectiveness of the country assistance program in encouraging economic growth that is broad based, market-oriented, and sustainable.

The U.S. Congress and the Administration, including USAID, decide on a total budget and the allocation among countries. Under the DFA funding is increasingly allocated on the basis of countries' needs for assistance and their commitment to alleviating poverty. Across countries need has been measured with a combination of economic welfare and physical quality of life measures including child mortality rates. Commitment to alleviating poverty is generally measured through evaluation of host government policies.

Staff of USAID field missions in individual countries in collaboration with host country governments allocate funding among types of assistance within countries. This includes three basic types of allocation decisions: 1) the mix of project and non-project (policy reform and sectoral restructuring) assistance, 2) the sectoral and within sector-mix of project assistance, and 3) the mix of non-project assistance. In response to the Congressional mandate these allocation decisions are increasingly based on cost effectiveness of various assistance modes and the interactive effects of non-project and project assistance for improving the welfare of specific population groups within the country.

Based on these needs and groups of decision makers PIE research has three operational objectives: 1) increase the capacity of USAID and Zairians to conduct

applied research in Zaire through capacity building initiatives[8]; 2) provide non-location specific analysis of households, enterprises, and individuals to answer questions related to linkages, behavior, and status of the basic decision making units in the Zairian economy; and 3) provide location specific analysis to answer questions related to where impact is occurring and where new development investments should be located within Zaire.

Providing information to in-country decision makers and reporting on effectiveness to Washington are the core purposes of research at the USAID field mission level. Research results are used as input to program design in Zaire and synthesized in an Assessment of Program Impact (API) that is sent to Washington. The API can be compared to the Environmental Impact Statement (EIS) in The National Environmental Policy Act of 1969. The API could increasingly play a role in improving the quality of foreign assistance in a manner similar to the role the EIS has played in government programs affecting the environment (see Taylor (1984:130-166) and Mazmanian and Nienaber (1979:191-194).

ORGANIZATION OF PROGRAM IMPACT EVALUATION IN ZAIRE

Some USAID projects in Zaire direct development resources to specific locations. This is particularly true for the agricultural development, roads, and health services projects. Other assistance, such as for policy reform or sectoral restructuring activities are regional or national in scope. Location specific projects can be evaluated using a with versus without project comparison across locations. Non-location specific assistance requires model building to make comparisons between "with assistance" and "without assistance" cases since the entire economy represents the "with assistance" case. This distinction between location specific versus non-location specific assistance is the reason PIE technical research activities are divided into location specific and non-location

[8] Sustainable development depends on host country decision makers in governmental and non-governmental organizations who allocate local resources in combination with foreign assistance received. Collaborative research with local researchers lowers the cost of research, increases the relevance of research questions pursued, and shortens the time required for incorporation of research findings into local decision making. For these reasons local decision makers are an explicit target group included in the research design. Stephen Hellinger, Douglas Hellinger, Fred M. O'Regan, *Aid for Just Development: Report on the Future of Foreign Assistance* (Boulder: Lynne, 1988).

specific databases and analyses.

Based on the objectives identified above PIE research is organized into three groups of activities for implementation purposes. These three groups are capacity building initiatives, analyses based on a social accounting matrix (SAM) for evaluation of non-location specific impacts, and analyses based on a geographic information system (GIS) for evaluation of location specific impacts. Use of SAM and GIS databases is allowing USAID to better coordinate the research it funds.

Capacity building initiatives include publishing annotated bibliographies, creating data dictionaries, linking local researchers to universities abroad, and funding small sequential research activities as competitive research contracts[9]. Though these initiatives increase the need for technical and contracting staff time within the USAID Mission they more than double the overall cost effectiveness of research the Mission funds. Total research costs are reduced while the utilization rate of completed research is increased. In addition to providing a base for subsequent technical research these activities are considered important initiatives of USAID in Zaire to improve local governance.

Creation of a social accounting matrix (SAM) has two objectives. First, a SAM is a framework for organizing and presenting information and research about the economic and social structure of an economy and linkages between a geographically defined national or regional economy and the outside world. Second, a SAM provides the statistical basis for building macro-economic models to simulate multi-sectoral economic change for policy analysis and impact evaluation. Accounting identities are used within the SAM to ensure consistency such as: 1) households can not spend more than they earn, 2) the same unit of labor cannot be simultaneously employed in two activities or different places, and 3) the economy as a whole must balance its payments with the rest of the world (Hertel, 1990:7). In Zaire, USAID research conducted within the framework of a SAM is being used primarily to evaluate reform of sectoral policies and the effectiveness of various methods to protect vulnerable groups during structural adjustment. In the future the SAM may be expanded to provide a framework for simulating the macro-economic effects of deforestation, financial sector reform, and the economic impact of AIDS (acquired immune deficiency syndrome).

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[9] Reviews of literature and secondary data were completed by local research teams. Nine annotated bibliographies and four data dictionaries are being produced covering critical sectors and geographic areas. See Rogers (1991) for a summary of reports being produced.

A geographic information system approach meets two similar objectives. First, a GIS is a framework for organizing and presenting spatial data and research about development interventions, population welfare status, and other characteristics related to specific geographic locations. Second, a GIS database provides the statistical basis for building micro-economic models to estimate impacts of program interventions or other exogenous factors on welfare. GIS can be used to build consistent cross-sectional databases by spatially linking previously independent data sets, identifying critical locations for which complete data is not available, and imputing data for locations with incomplete data. A GIS has been used to combine satellite imagery, computerized maps, survey data, and census data that are geographically coded. These data sets are being used to estimate the nutritional effects of short and long term deforestation and rural marketing, relationships between labor productivity and birth weights, and to geographically coordinate sectoral development efforts. In the future the GIS based analysis could be expanded to include data from school districts or local geographic political units for analysis of investments in human capital and institutional development.

Spatial analysis identifies where impacts are occurring as well as other confounding causes of change in economic welfare and physical quality of life such as environmental degradation or geographic market segmentation. Spatial analysis answers questions based on a "with versus without" comparison across geographic areas. For example, in impact evaluation this refers to comparisons of geographic population groups that have been affected by particular events, such as a geographically targeted development project, with those areas that have not been affected. Understanding the relationships between development interventions and welfare will allow USAID to target development resources more efficiently in the future.

In summary, PIE technical research in Zaire is divided into two complementary blocks of activities using a geographic information system
approach for spatial analysis and a social accounting matrix approach for economy-wide policy change or sectoral restructuring. The GIS and SAM research complement each other and enable USAID to use a stronger empirical and theoretical foundation than would otherwise, be possible.

IMPLEMENTATION OF PIE RESEARCH IN ZAIRE

Combining the GIS and SAM approaches has provided USAID a framework for synthesizing existing data, refining research questions, and shifting resources to data

analysis from data collection. The first research questions addressed were what impact categories to use, how to measure costs, and appropriate units of analysis for initial SAM and GIS databases.[10]

Defining Costs and Impact Categories

Four categories of program effects or impact were deemed relevant to all USAID technical divisions in Zaire which included agriculture, health, transportation, financial sector reform, and training. Nutritional status and child survival were selected as physical quality of life measures. Labor productivity and per capita consumption of goods and services were selected as economic welfare measures. Preliminary analysis of secondary data and synthesis of previous research findings were organized by these four categories. Both the SAM and GIS databases and models were organized to focus on these four types of program impacts.[11]

Cost-effectiveness requires some measure of cost for the assistance provided to different population groups within Zaire. Techniques were developed for estimating per capita assistance costs for population groups that are targeted with geographically overlapping projects[12]. The analysis emphasized micro-level spatial variation in health services, transportation infrastructure, and village water supply projects provided. Using communities of roughly 5,000 people the analysis demonstrated the high variability in assistance provided across communities which led to the expectation that program impacts would vary as well. An initial GIS database was created for this study though the cartographic analysis was completed manually. The GIS conceptual approach was crucial to identifying the geographic overlap of assistance efforts at the local level in different sectors.

Selection of Geographic Units of Analysis

Both the GIS and SAM approach can be used at almost any geographic level of analysis from the village, to project area, to regional geographic areas depending on data availability and research questions to be addressed.

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[10] Rogers (November 25, 1988; January 23, 1989).
[11] Rogers (September 14, 1988; November 23, 1988).
[12] USAID, Zaire, *A Baseline Study for the Lualaba Projects*, 1989.

Analysis of spatial variation using census data identified geographic patterns of economic welfare and physical quality of life[13]. Economic welfare as measured by out migration rates of men for example was found to vary across larger geographic units than physical quality of life measured by crude mortality rates. While economic welfare varied significantly across large zones with over 100,000 people, a smaller geographic unit of analysis, such as a health center service area with 5,000 people, was needed for physical quality of life measures. While broad variations in natural resource base and market access determine patterns of economic welfare at the local level, physical quality of life is critically determined by the existence, within a distance of 10 - 15 kilometers of the population center, of health care, potable water, local causes of morbidity, and micro-level environmental conditions such as local access to forests.

The initial SAM database was to be used primarily for evaluation of change in economic welfare related to regional macro-economic shifts which led to the use of a relatively large geographic unit of analysis containing a population of 10 million. If the SAM approach is later applied to looking at changes in physical quality of life within the capital city of Kinshasa or rural area development projects a much smaller unit of analysis could be adopted.

The initial GIS database was to be used primarily for evaluation of impacts on physical quality of life which led to the use of a relatively small geographic area as the unit of analysis. A health center service area of roughly 5,000 people and the administrative collectivity of 25,000 people were chosen as the units of analysis in an area where population densities are 37 per square kilometer. Smaller Units such as census tracts and village groupings with an average of 1,000 to 2,000 people were used for data processing and linking existing secondary data. Analysis of spatial variation has been conducted at various units of analysis depending on data availability.

BENEFITS OF USING A COMBINED SAM AND GIS APPROACH

The SAM approach has provided both conceptual and theoretical benefits. Conceptually the SAM approach has encouraged identifying typologies of the poor in Zaire and labor market linkages between specific population groups and macro-economic change. This focus and sectoral analysis has been a valuable input to micro-level hypothesis formulation and impact modeling using the GIS database. GIS mapping of

[13] Rogers (Winter, 1988) for summary of approach used and Elhance (July, 1991).

geographic welfare pattern has also been a valuable in macro-economic hypothesis formulation and modeling.

Even without actually building a SAM, the approach has improved USAID thinking about policy issues such as linkages between the financial and real sectors, urban and rural areas, or health and agricultural sectors. Multiplier analysis is possible with only a few elements of the SAM though more refined analyses will be possible when a more detailed SAM is completed. The initial USAID focus has been on conceptual use of the SAM for guiding partial equilibrium analysis and identifying high priority research areas rather than computable general equilibrium (CGE) modeling.

Though development economics has become the field of economic research in which CGE models have been used most extensively, it appears that simpler multiplier analysis and multi-sectoral disequilibrium models may be more useful for policy analysis of the dynamics of development[14].

Two analyses using multi-sectoral approaches for sub-national regional impact evaluation at the level of a local labor market have been completed in sub-saharan Africa. Lewis (1989) used a fixed price multiplier analysis based on a SAM to evaluate impacts of sectoral production activity on agricultural production, farmer income, wage employment, and income distribution. Rogers (1986) used a semi-input output flexible price model to estimate economic impacts of infrastructure, agricultural pricing, informal sector promotion, and land tenure policy. Sarris (1990) has proposed a more sophisticated research approach for analysis of structural adjustment in Africa in the future. These three studies have provided the guidance for the USAID research using a SAM in Zaire.

GIS approach has provided both conceptual and theoretical benefits. At every step of the research process GIS has helped to lower research costs, focus on program rather than project impact, complete research in time to be operationally useful, and increase the scientific rigor of the analysis by allowing use of quasi-experimental designs[15].

The GIS has lowered research costs by reducing the need for primary data collection and allowing researchers to share data collected independently. A synthesis of existing secondary data from various sources such as satellite images, agricultural

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[14] Bergmann (1990) 12-14; Srivastava and Rao (1990) 2-5.

[15] Rogers, Shaffer, and Pulver (1990) as well as Isserman and Merrifield (1987) for examples of quasi-experimental designs for geographic based analysis.

household surveys, aggregate health clinic records, rural manufacturing plants, and project field reports on road or environmental conditions has made more multi-sectoral data sets available. GIS software has been used to identify priority locations for data collection and the critical missing data for those locations thus reducing field research time. In combination with Global Positioning System[16] (GPS) equipment, GIS has been used to evaluate the quality of existing secondary data through geographically matching comparable indicators from different sources. In combination with a GPS the GIS has allowed USAID to link land use data based on satellite imagery with ground features such as roads or villages that are not visible in inexpensive imagery. These approaches have allowed elements of many existing data sets to be used when otherwise they would be rejected as unusable.

Using GIS to prepare geographic data sets for more theoretically based econometric modeling has allowed major reductions in cost and time. These data sets have been used to econometrically estimate a reduced form model of program impacts[17] which is a variation of the basic household model of economic welfare described in Singh, Squire, and Strauss (1986) and a model of child health status and survival developed in Thomas, Strauss, and Henriques (1990). With the availability of new software packages such as SPACESTAT by Anselin (1990) the use of these composite data sets will be easier in the future.

GIS has been used to computerize mapping that was previously done manually. This has allowed more timely and specialized maps to be produced for researchers and program managers. Green Larson (1991) has demonstrated the use of GIS for mapping malnutrition rates and error in prediction of malnutrition across broad geographic areas. Spatial analysis of econometric error terms is useful for understanding spatial variation in physical quality of life. Maps of program impact easily communicate detailed information about spatial variation in program impacts, potential program impacts, or community characteristics for geographic targetting of assistance.

GIS has allowed USAID to develop databases with large sample sizes for econometric analysis while simultaneously maintaining location specific information for

[16] GPS refers to a system of satellites that in combination with inexpensive receivers used in the field can provide latitude, longitude and altitude data. These coordinates of selected locations such as health clinics, schools, or land- use features can then be downloaded into a GIS computer program for mapping.

[17] Rogers, Green Larson, Barnes, and Larson (1991).

analysis and discussion related to individual rural communities. The ability to combine secondary data from local organizations for analysis while having results geographically disaggregated enough to be relevant to local decision makers that collect the data has improved local data quality and coverage.

PRELIMINARY RESULTS COMBINING SAM AND GIS ANALYSIS

The combined SAM and GIS approach to data collection and analysis has been outlined above. Initial estimates of impact obtained from these analyses were combined in 1990 with previous research results to produce an experimental Assessment of Program Impact report to meet two objectives (USAID,Zaire1990) . One objective was to report on program efficiency in a manner that encourages consideration of alternative programs of assistance to reflect changing priorities or expenditure levels. A second objective was to summarize program expenditures and welfare impacts related to specific population groups. These objectives were accomplished in three steps: 1) impacts and costs were estimated by intervention, 2) impacts and costs were estimated by target population group, 3) impact per dollar spent per capita by intervention was calculated. Simplified results of these three steps discussed below are presented in tables one, two, and three respectively.

There are four types of interventions chosen for this analysis: 1) primary health care including most importantly immunization against communicable,e childhood diseases such as measles, 2) sanitation programs including potable water sources and intestinal worm treatments, 3) rehabilitation of transportation infrastructure, and 4) agricultural development including extension of improved varieties and techniques. Four impact categories have been selected by USAID in Zaire at the program level including nutritional status of children, adult female labor productivity, child survival, and per capita consumption of goods and services.

Nutritional status is measured as the percentage of children under age five two standard deviations below the Boston standard weight for age. Child Survival is the negative of child mortality which is measured as the
annual number of children dying under age five per thousand. Consumption and to a lesser extent labor productivity impacts will be based on results from the SAM based analysis which is not yet available. Nutritional status and mortality impacts are based on GIS analysis and previous research. The results presented on labor productivity are considered illustrative as they are based on descriptive studies in project areas.

Conceptually labor productivity is the monetary value of output per physical unit of labor input.

These results rely on the GIS approach and previous research, but could be expanded to include population groups defined non-geographically within the SAM as well as consumption and productivity impacts for the geographic population groups selected. Refined indicators and coefficient estimates need to be developed. However, rather than drawing final conclusions on impact the purpose of this discussion is to show how such coefficient estimates obtained from a variety of studies could be incorporated into a summary assessment of program impact.

Estimated Impacts and Costs by Intervention

The estimated impacts and costs of the four types of interventions on three categories of impact are summarized in TABLE ONE. Most impact estimates at this initial stage are based on cross-sectional multi variate analysis using geographic areas selected as comparable areas. The average difference between geographic areas with versus without the intervention at the relevant point in time is interpreted as the net direct and indirect program impacts. In a few locations time series analysis has been used to look at impact on nutritional status and mortality rates. As additional years of data are processed the change over time in welfare status correlated with program interventions after controlling for confounding factors will be used as the estimate of program impact.

The magnitude of the expected impact varies according to initial conditions in the affected communities. For example, communities with high child mortality rates are expected to experience a larger drop in mortality as a result of health programs than communities with low mortality rates before the program was initiated. Communities with surplus production capacity due to available labor or better land quality are expected to have fewer negative effects and more positive interactive effects between health and agricultural development projects than those without this capacity (von Braun,1989).

Immunization programs have increased survival rates[18] . In some locations the effects of dramatic increases in child survival over a very short time period appear

[18] Estimates in Zaire based on cross-sectional comparisons are consistent with Koenig, Vauveau, and Wojtyniak (1991).

related to declines in measured nutritional status of 5 percentage points. Increased population pressures on local resources and increases in total time allocated to child care as a result of successful immunization programs may also reduce agricultural output per capita.

Sanitation programs including potable water are expected to increase nutritional status directly by decreasing illness such as diarrhea. Labor productivity increases due to reducing the number of sick days and in some locations the distance women walk for water. Both improved nutritional status and increased labor productivity lead to increased survival rates.

Transportation interventions in Bandundu, the region east of Kinshasa, appear to have reduced nutritional status and increased monetary measures of productivity during the 1980s. In rural Zaire labor supply constrains agricultural production given existing technology. When marketing opportunities increase rapidly, food crop sales initially increase faster than production leading to decreased food consumption, reduced child care, and sharp declines in nutritional status. Shifts in terms of trade in the context of limited increases in production shift consumption from food to non-food items. A major non-food item consumed is health care which leads to reduced mortality rates.

In a stable marketing environment the problem of excessive sales declines as the population learns to produce for market. However by the time this adjustment takes place the project is completed and road infrastructure begins to deteriorate. The decline in road quality results in higher malnutrition due to more limited crop diversity under conditions of falling farm gate prices for staple export products. Initial reductions in nutritional status can be on the order of 10 percentage points but this may be reduced overtime. Due to price shifts and some change in the physical allocation of labor, transport interventions can result in large increases in labor productivity.

It is likely that in Zaire the impacts of agricultural development such as use of improved inputs or techniques are primarily transmitted through improved labor productivity and to a lesser extent through increased agricultural output (Low, 1986). Increased labor productivity from agricultural development directly increases child survival and nutrition by increasing the time allocated to child care and directly increases consumption through reducing labor time required to produce a given level of agricultural output. Nutritional status increases by 5 percentage points and child survival is expected to increase by 8 per thousand as a result of intensive agricultural development efforts at a cost of over $27 per capita. Low intensity agricultural development efforts such as those implemented in much of central Bandundu at a cost

of $8 per capita have not had measurable impact and are not included in this summary.

Per capita costs shown in TABLE ONE represent a simple ratio of the total dollar and local currency cost of the intervention from 1986 through 1990 divided by the total targeted population. In the future it will be necessary to more carefully distinguish between the targeted and beneficiary population. In some project areas only a proportion of the targeted population can be considered actual beneficiaries of the intervention while impacts are estimated for actual beneficiaries. USAID supported primary health care and immunizations are targeted to 5 million people in Zaire at a per capita cost to USAID of $7. Potable water projects are targeted to 1.5 million people at a cost of $12 per capita. Transportation interventions have been targeted to 1.7 million people at a cost of $26 per capita. Agricultural development in combination with health and transportation interventions has been targeted to 0.7 million people at a per capita cost $27 in Shaba Region, in southern Zaire, and selected villages in Bandundu Region.

Total Expected Impact and Cost by Population Target Group

Typologies of population groups have been developed in the course of both the SAM and GIS research. For example, population groups can be defined by the portfolio of location specific development assistance they receive from USAID as shown in the left hand column of TABLE TWO. Population groups could also be defined by the type of non-location specific development assistance they receive for example workers in specific economic sectors such as transportation, rice production, or manufacturing. In this simplified presentation total impact and cost for a given population group is assumed to be a linear sum of the impacts and costs of individual interventions[19]. The total program impact is the population characteristic that could actually be observed through collection of field data to corroborate whether expectations are met.

TABLE TWO shows how different portfolios of assistance can be expected to affect poorer communities in rural Zaire. Per capita assistance levels vary across communities by nearly a factor of ten and expected impacts are larger in communities receiving higher assistance levels. However, there are important differences in the types

[19] When interactive effects of projects and initial conditions in communities are better understood methods of estimating expected impacts can be refined. The population estimates in the righthand column of TABLE TWO are geographically mutually exclusive in contrast to TABLE ONE where there is geographic overlap in interventions.

of impacts expected. If health care is emphasized impacts show up mostly as reduced mortality. If transportation and agriculture are emphasized impacts show up as increased labor productivity. Fortunately there are few communities receiving health and transportation interventions in isolation as these are expected to lead to sharp declines in nutritional status. Policy issues raised by the results in TABLE TWO include the desirability of concentrating resources on fewer communities or the appropriate mix of interventions for specific communities.

Expected Impact Per Dollar of Assistance Per Capita

Program budgeting requires a comparable measure of efficiency across program cost elements and across program impact or effectiveness categories. TABLE THREE indicates the relative cost-effectiveness of different interventions for each of the three measures of effectiveness selected. Results categorized in this manner can be used to compare the cost-effectiveness of program elements in achieving different goals or to compare the cost-effectiveness of alternative interventions on a single goal. Implicit tradeoffs among program goals could also be calculated.

Health care is more cost effective in reducing mortality than any other intervention in communities with initially high mortality rates. It is not clear that this is true in areas with low mortality rates. For each dollar spent on primary health care in a population target area, mortality is reduced by nearly 6 per thousand. In contrast for each dollar spent on agricultural development mortality is reduced only 0.3 per thousand.

Based on the estimates presented sanitation interventions are more cost effective than agricultural development in improving nutritional status and in increasing labor productivity. Agricultural interventions are more cost effective in improving nutritional status than transportation or health interventions.

During 1990 this understanding of impacts was used to begin research in Zaire on the nutritional effects of rapid increases in immunization coverage, the importance of sanitation projects in increasing women's labor time available for agriculture, the effects of agricultural development on labor productivity, and an examination of how transportation projects can be made more cost-effective.

CONCLUSIONS

The combined GIS and SAM framework for program impact evaluation has proven to be a feasible approach for meeting both the substantive and procedural objectives established. The cost effectiveness of research expenditures has notably increased. Research costs have been substantially lowered, quality and utilization of research has improved, and the impact statement strategy has helped improve the effectiveness of assistance provided.

Procedurally PIE has enabled over fifty Zairian researchers at the professional level in government and non-governmental organizations to be more involved in development policy research. As a result of the impact statement requirement the USAID mission has increased the number of analyst-advocates working inside the USAID mission to the equivalent of over five percent of total mission professional staff time. The agricultural and health division staff within the USAID mission in Zaire have increasingly focused on impacts common to the two technical divisions and improved their knowledge base for analysis.

In the future refined research on these issues could be used to improve the spatial or sectoral targeting of development interventions to special problem areas. These initial empirical results are a way to focus analysis and project implementation review on critical tradeoffs and problems of specific population groups that can most benefit from the USAID interventions. The framework should be considered for other USAID field Missions and other similar public institutions concerned with economic and social development.

TABLE ONE

IMPACTS AND COSTS OF SELECTED USAID PROGRAM INTERVENTIONS IN ZAIRE 1986-1990

INTERVENTION	NUTRITIONAL STATUS	CHILD SURVIVAL	FEMALE LABOR PRODUCTIVITY	TOTAL COST $1000s	TOTAL COST PER CAPITA	TARGETED POPULATION
HEALTH CARE	-5	40	-4	$35,000	$7	5,000,000
SANITATION	5	10	8	$18,000	$12	1,500,000
TRANSPORT	-10	10	20	$44,200	$26	1,700,000
AGRICULTURE	5	8	10	$18,900	$27	700,000

TABLE TWO

TOTAL EXPECTED IMPACT AND PER CAPITA COSTS BY POPULATION TARGET GROUP

PROGRAM OF INTERVENTIONS DEFINING POPULATION GROUP	NUTRITIONAL STATUS	CHILD SURVIVAL	FEMALE LABOR PRODUCTIVITY	TOTAL COST PER CAPITA	TARGET POPULAT.
HEALTH CARE	-5	40	-4	$7	2,800,000
HEALTH CARE AND SANITATION	O	50	4	$19	1,100,000
HEALTH,SANIT.AND TRANSPORT	-10	60	24	$45	400,000
HEALTH,TRANSP.AND AGRICULT.	-10	58	26	$60	700,000

TABLE THREE

EXPECTED IMPACT PER DOLLAR OF ASSISTANCE PER CAPITA BY USAID PROGRAM INTERVENTION

INTERVENTION	NUTRITIONAL STATUS	CHILD SURVIVAL	FEMALE LABOR PRODUCTIVITY
HEALTH CARE	-0.7	5.7	-0.6
SANATION	0.4	0.8	0.7
TRANSPORT	-0.4	0.4	0.8
AGRICULTURE	0.2	0.3	0.4

Impact coefficients are considered credible within plus or minus 60% of the value of the coefficient.

Results presented in these tables are a simplified and revised version of results presented in USAID, Zaire (1990).

Labor productivity results are presented for illustrative purposes only.

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