

Report No. 1039

World Bank Approaches to the Environment in Brazil: A Review of Selected Projects

(In Five Volumes) Volume IV: The Middle and Lower San Francisco Valley

April 30, 1992

Operations Evaluation Department

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ABBREVIATIONS AND ACRONYMS

AMZA	Amazonia Mineracoes S.A. (Amazon Mining Inc.)
CETESB	Companhia de Tecnologia de Saneamento Ambiental (Environmental Sanitation Technology Company)
CHESF	Companhia Hidro-eletrica do Sao Francisco (Sao Francisco Hydroelectric Company)
CIDA	Canadian International Development Agency
CODEVASF	Companhia de Desenvolvimento do Vale do Sao Francisco (Sao Francisco Valley Development Company)
CONAMA	Conselho Nacional de Meio Ambiente (National Environmental Council)
CVRD	Companhia Vale do Rio Doce (Rio Doce Valley Company)
ELETRORBRAS	Central Elétricas Brasileiras S.A. (Brazilian Central Electrical Company Inc.)
ESMAP	Energy Management Assistance Program
ESW	Economic and Sector Work
FAO	Food and Agricultural Organization, United Nations
FUNAI	Fundação Nacional do Índio (National Indian Foundation)
IBAMA	Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis (Brazilian Institute for the Environment and Renewable Natural Resources)
IDB	Inter-American Development Bank
INCRA	Instituto Nacional de Colonização e Reforma Agrária (National Colonization and Agrarian Reform Institute)
INPES	Instituto Nacional de Pesquisas Econômicas e Sociais, IPEA (National Economic and Social Research Institute, IPEA)
IPEA	Instituto de Pesquisa Econômica Aplicada (Institute of Applied Economic Research)
NGO	Non-governmental Organization
OAS	Organization of American States
OD	Operational Directive, World Bank
OECD	Organization for Economic Co-operation and Development
OED	Operations Evaluation Department, World Bank
OMS	Operational Manual Statement, World Bank
PGC	Programa Grande Carajás (Greater Carajás Program)
PLANVASF	Plano de Desenvolvimento do Vale do Sao Francisco (Development Plan for the Sao Francisco Valley)
POLONOROESTE	Programa de Desenvolvimento Integrado do Noroeste do Brasil (Northwest Integrated Development Program)
POLOSINDICAL	(Rural labor union confederation, lower-middle Sao Francisco valley)
PROCOP	Programa de Controle de Poluição, CETESB (Pollution Control Program, CETESB)
RIMA	Relatório de Impacto sobre o Meio Ambiente (Environmental Impact Report)
SDR-PR	Secretaria de Desenvolvimento Regional, Presidência da República (Secretariat of Regional Development, Presidency of the Republic)
SEAIN	Secretaria de Assuntos Internacionais, SEPLAN (International Affairs Secretariat, SEPLAN)
SEMA	Secretaria Especial do Meio Ambiente, Ministério do Interior (Special Environmental Secretariat, Ministry of the Interior)
SEMAM	Secretaria do Meio Ambiente, Presidência da República (Environmental Secretariat, Presidency of the Republic)
SEPLAN	Secretaria de Planejamento, Presidência da República (Secretariat of Planning, Presidency of the Republic)
SISNAMA	Sistema Nacional do Meio Ambiente (National Environmental System)
SPMA	Sao Paulo Metropolitan Area
SUDECO	Superintendência de Desenvolvimento do Centro-Oeste (Superintendency for the Development of the Center-West)
UNDP	United Nations Development Program

ABBREVIATIONS AND ACRONYMS

ATIR	Assistencia Tecnica para Implantacao de Reservatorios, CHESF (Technical Assistance for Implementation of Reservoirs, CHESF)
BNB	Banco do Nordeste do Brasil (Bank of Northeast Brazil)
CDM	Conselho de Desenvolvimento Municipal (Municipal Development Council)
CDR	Conselho de Desenvolvimento Rural (Rural Development Council)
CEPA-AL	Comissao de Planejamento Agricola - Alagoas (Agricultural Planning Commission - Alagoas)
CEPED	Centro de Pesquisa e Desenvolvimento, Bahia (Research and Development Center, Bahia)
CHESF	Companhia Hidro-eletrica do Sao Francisco (Sao Francisco Hydroelectric Company)
CODEVASF	Companhia de Desenvolvimento do Vale do Sao Francisco (Sao Francisco Valley Development Company)
COPPE	Coordenacao de Programas de Pos-graduacao em Engenharia, Federal University of Rio de Janeiro (Coordination of Post-graduate Programs in Engineering, Federal University of Rio de Janeiro)
CNEN	Comissao Nacional de Energia Nuclear (National Nuclear Energy Commission)
CONAMA	Conselho Nacional de Meio Ambiente (National Environmental Council)
CPATSA	Centro de Pesquisa Agricola do Tropico Semi-arido (Semi-Arid Tropics Agricultural Research Center)
CPRH	Companhia para o Controle de Poluicao Ambiental e Administracao de Recursos Hidricos, Pernambuco (Environmental Pollution Control and Water Resource Administration Company, Pernambuco)
CPT	Comissao Pastoral da Terra (Pastoral Land Commission)
CRA	Centro de Recursos do Meio Ambiente, Bahia (Environmental Resource Center, Bahia)
CVSF	Comissao do Vale do Sao Francisco (Sao Francisco Valley Commission)

DIR Departamento de Implantacao de Reservatorios, CHESF
 (Department for Implementation of Reservoirs, CHESF)

DNOCS Departamento Nacional de Obras contra as Secas
 (National Department of Works against the Drought)

DNPA Departamento Nacional de Planejamento e Avaliacao, MEFP
 (National Department of Planning and Evaluation, MEFP)

EDI Economic Development Institute, World Bank

ELETOBRAS Centrais Eletricas Brasileiras S.A.
 (Brazilian Central Electrical Company Inc.)

ELETRONORTE Centrais Eletricas do Norte
 (Central Electrical Company of the North)

EMATER Empresa de Assistencia Tecnica e Extensao Rural
 (Rural Technical Assistance and Extension Enterprise)

EMBRAPA Empresa Brasileira de Pesquisa Agricola
 (Brazilian Agricultural Research Enterprise)

FAO Food and Agricultural Organization, United Nations

FIPE Fundacao Instituto de Pesquisas Economicas, Universidade de
 Sao Paulo
 (Institute of Economic Research Foundation, University of Sao
 Paulo)

FUNAI Fundacao Nacional do Indio
 (National Indian Foundation)

GEIDA Grupo de Irrigacao para o Desenvolvimento Agricola
 (Irrigation Group for Agricultural Development)

IAEA International Atomic Energy Agency

IBAMA Instituto Brasileiro de Meio Ambiente e Recursos Naturais
 Renovaveis
 (Brazilian Institute of the Environment and Renewable Natural
 Resources)

IBRD International Bank for Reconstruction and Development

IDB Inter-American Development Bank

ILO International Labor Organization, United Nations

INCRA Instituto Nacional de Colonizacao e Reforma Agraria
 (National Institute of Colonization and Agrarian Reform)

IPEA Instituto de Pesquisa Economica Aplicada
 (Institute of Applied Economic Research)

IPLAN Instituto de Planejamento, IPEA
(Institute of Planning, IPEA)

IRGA Institute Riograndense do Arroz
(Rice Institute of Rio Grande do Sul)

Kwh Kilowatt hour

MEFP Ministerio de Economia, Financas e Planejamento
(Ministry of Economy, Finance and Planning)

MME Ministerio de Minas e Energia
(Ministry of Mines and Energy)

NGO Non-governmental organization

OAS Organization of American States

OED Operations Evaluation Department, World Bank

OMS Operational Manual Statement, World Bank

OPN Operational Policy Note, World Bank

PAPP Programa de Apoio ao Pequeno Produtor Rural
(Small Farmer Support Program)

PA IV Paulo Afonso IV Hydroelectric Project

PCR Project Completion Report

PDRI Projeto de Desenvolvimento Rural Integrado
(Integrated Rural Development Project)

PIN Programa de Integracao Nacional

PLANVASF Plano de Desenvolvimento do Vale do Sao Francisco
(Development Plan for the Sao Francisco Valley)

PNRA Programa Nacional de Reforma Agraria
(National Agrarian Reform Program)

POLONORDESTE Programa de Desenvolvimento de Areas Integradas do Nordeste
(Northeast Integrated Area Development Program)

POLOSINDICAL (Rural labor union confederation, lower-middle Sao Francisco
valley)

PPAR Project Performance Audit Report

PROALCOOL Programa Nacional do Alcool
(National Alcohol Program)

PROCANOR	Programa de Desenvolvimento da Area Canavieira do Nordeste (Northeast Sugar Cane Area Development Program)
PRODIAT	Programa de Desenvolvimento da Bacia Araguaia-Tocantins (Araguaia-Tocantins Basin Development Program)
PROFIR	Programa de Financiamento de Equipamentos de Irrigacao (Program to Finance Irrigation Equipment)
PROHIDRO	Programa de Uso de Recursos Hidricos (Water Resource Use Program)
PROINE	Programa de Irrigacao do Nordeste (Northeast Irrigation Program)
PRONI	Programa Nacional de Irrigacao (National Irrigation Program)
PROTERRA	Programa de Redistribuicao de Terras e Estimulo a Agroindustria (Land Redistribution and Agro-industrial Incentive Program)
PROVALE	Programa de Desenvolvimento do Vale do Sao Francisco (Sao Francisco Valley Development Program)
PROVARZEAS	Programa de Desenvolvimento das Varzeas (Programa for the Development of Floodplains)
RIMA	Relatorio de Impacto sobre o Meio Ambiente (Environmental Impact Report)
SAR	Staff Appraisal Report
SEMA	Secretaria Especial do Meio Ambiente, Ministerio do Interior (Special Environmental Secretariat, Ministry of the Interior)
SEPLAN	Secretaria de Planejamento e Coordenacao, Presidencia da Republica (Secretariat of Planning and Coordination, Presidency of the Republic)
SF I	Lower Sao Francisco Polders Project
SF II	Sao Francisco II Irrigation Project
SISNAMA	Sistema Nacional de Meio Ambiente (National Environmental System)
SUCAM	Superintendencia de Campanhas de Saude Publica (Superintendency of Public Health Campaigns)
SUDENE	Superintendencia de Desenvolvimento do Nordeste (Superintendency for the Development of the Northeast)

SUDEPE **Superintendencia de Desenvolvimento da Pesca**
 (Superintendency for Fisheries Development)

SUVALE **Superintendencia do Vale do Sao Francisco**
 (Sao Francisco Valley Superintendency)

UNDP **United Nations Development Program**

UNICAMP **Universidade Estadual de Campinas, Sao Paulo**
 (State University at Campinas, Sao Paulo)

WORLD BANK APPROACHES TO THE ENVIRONMENT IN BRAZIL:

A REVIEW OF SELECTED PROJECTS

THE MIDDLE AND LOWER SAO FRANCISCO VALLEY

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WORLD BANK APPROACHES TO THE ENVIRONMENT IN BRAZIL: A REVIEW OF SELECTED PROJECTS

THE MIDDLE AND LOWER SAO FRANCISCO VALLEY

PREFACE

1. This is a report on the third of four case studies undertaken by OED and the (then) Brazilian federal Secretariat of Planning (SEPLAN) as part of a larger study entitled "The World Bank and the Environment in Brazil: A Review of Selected Projects." From the perspective of OED, the objective of the larger study is to determine how -- and how well -- the World Bank has perceived and dealt with environmental issues and problems in the context of several major infrastructure and regional development projects in one particular country. Brazil was selected both because it is one of the Bank's principal borrowers and because Bank operations have encountered a wide range of ecological conditions and environmental issues in the country. SEPLAN (as of March 1990 part of the newly created Ministry of the Economy, Finance and Planning - MEFP), in turn, is focusing on how the federal government and its agencies have addressed environmental issues in the course of project preparation and implementation.

2. In addition to hydropower, irrigation and resettlement projects in the middle and lower Sao Francisco River valley, the OED/SEPLAN exercise examines Bank-assisted operations in the eastern (Carajas iron ore) and western (POLONOROESTE) parts of the vast, tropical Amazon region and (pollution control) in the highly urbanized and industrialized state of Sao Paulo. In these distinct geographic settings, more concretely, the study is concerned with the principal physical and human environmental impacts of Bank-financed investments. Where applicable, moreover, it also attempts to assess the adequacy, effectiveness and sustainability of specific project components (or parallel programs) designed to protect the natural environment and/or vulnerable social groups, including both Amerindian communities and populations that are forced to relocate on account of such interventions as dam and port construction.

3. The objective of the present case study is to determine how -- and how effectively -- the Bank and its Borrowers and Executors (the Brazilian Government, the Sao Francisco Hydroelectric Company - CHESF, and the Sao Francisco Valley Development Company - CODEVASF) anticipated and dealt with the principal environmental consequences of the major infrastructure (Sobradinho dam and reservoir) and productive (irrigation) activities whose installation was co-financed by the Bank. Unlike the other case studies in the series, the Sao Francisco study will concentrate primarily, although by no means exclusively, on the human environmental impacts of Banks-supported investments in the region. This will be the focus both because the involuntary dislocation of substantial numbers of rural and urban inhabitants occurred in connection with these interventions and because one of the operations reviewed, the Itaparica Resettlement and Irrigation Project, is the Bank's first free-standing resettlement operation.

4. Unlike the other studies in this series, moreover, the present case study examines an operation (the Itaparica Resettlement and Irrigation Project) that was approved relatively recently (November 1987) and is still under implementation. This project was included in the study at the specific request of the Brazilian Government. The joint -- although, in the case of Itaparica, obviously preliminary -- review of the resettlement experiences associated with construction of the Sobradinho and Itaparica dams over a period of nearly two decades, however, offers the possibility of assessing the extent to which lessons learned as a result of the former intervention were effectively applied in connection with the latter both by the Bank and by the principal government agencies involved.

5. Located in the heart of the semi-arid Northeast, in addition to the challenges presented by the need for involuntary resettlement, recent developments in the Sao Francisco valley also raise another complex and important longer-term environmental issue confronting Brazil and other countries, that of comprehensive river basin or regional water resource management. In this particular case, the major -- and increasingly competing -- demands for the utilization of Sao Francisco River water are hydropower generation and private and public irrigated agriculture, although urban, industrial, recreational and other "uses" including evaporation are also a factor. The principal trade-offs and institutional problems, as well as some of the broader physical environmental considerations, associated with this issue are touched upon in the report. How and how well the Bank and the Brazilian Government have dealt with this issue to date is likewise preliminarily assessed.

6. The present report is based on a detailed review of Bank project files, Staff Appraisal and President's Reports, Loan and Guarantee Agreements, Project Completion and Performance Audit Reports (where available), minutes of the Bank Board meetings at which the respective operations were approved and other relevant documentation. It is also based on interviews with Bank staff involved in project appraisal and/or supervision and a three week field mission including visits to the headquarters of CHESF (Recife) and CODEVASF (Brasilia) and to the lower and middle Sao Francisco valley region in July-August 1989 during which CHESF and CODEVASF staff, other federal officials, state environmental agencies (Pernambuco and Bahia), universities, research institutes, local labor unions, church groups and other NGOs, together with affected urban and rural communities, were contacted. With the logistical support of CHESF and CODEVASF, the lower and middle Sao Francisco valley was surveyed by a combination of air and ground transportation and project-supported or related facilities were visited at Ibotirama (Tuxa Amerindians) and Bom Jesus da Lapa (Serra do Ramalho colonization project) in the upper-middle Sao Francisco valley; Petrolina, Juazeiro, Sobradinho, Pau a Pique, Remanso, Fazenda Ouro Verde, Bebedouro, Sento Se, Santana, Casa Nova, Algodoes, Piri and Sao Joaquim in the middle valley; Paulo Afonso, Itaparica, Belem do Sao Francisco, Manga de Baixo and Brigida irrigation projects, Itacuruba, the Pankaruru indigenous reserve, Petrolandia and Nova Rodelas in the lower-middle valley; and Penedo, Propria, Betume and Cotinguiba-Pindoba in the lower valley. The assistance provided to the OED/SEPLAN mission by CHESF and CODEVASF is gratefully acknowledged. Numerous helpful comments by CHESF, CODEVASF, FUNAI, the Ministry of Infrastructure and the National Departments of Planning and Evaluation (DNPA) and DEAIN of MEFP have been incorporated in the present version of this report.

7. While all field visits made in connection with this and the other case studies undertaken as part of the larger OED/SEPLAN exercise were carried out jointly, due to the differences in focus mentioned above, the two agencies decided from the outset to prepare separate reports. During the Sao Francisco case study, SEPLAN was represented by an environmental economist from the Institute of Economic Research of the Institute of Social and Economic Planning (IPEA/INPES) and a hydrological engineer and an anthropologist from the Environmental Analysis Unit of the Secretariat of Economic and Social Planning (SEPE/CAA) under the overall guidance of the then Secretariat, now Department of International Affairs (DEAIN). OED, in turn, was represented by one regular staff member during part of the visit and specialized consultants, possessing considerable prior familiarity with the project region, in the areas of physical and human environmental impact evaluation. Members of CHESF's Technical Assistance for Reservoir Implementation (ATIR) Unit and CODEVASF's central and local staff accompanied the OED/SEPLAN mission while visiting the project areas.

8. The report which follows will be divided into seven chapters having the following organization. After a short introduction (Chapter I), Chapter II summarily reviews the general regional development and institutional context in which the specific projects surveyed in this document were undertaken. This includes a brief discussion of the role and early development of the lower and middle Sao Francisco valley, particularly in the areas of hydropower generation (CHESF) and irrigation (CODEVASF). Other regional and rural -- including water resource -- development agencies and programs affecting the lower and middle Sao Francisco valley since the mid-1970's will also be briefly described. Chapter III sketches the principal ecological, demographic and socio-economic characteristics of the lower and middle Sao Francisco valley as of the early 1970's when the Bank-assisted interventions examined in this report were initiated; particular attention is given to the major physical environmental issues and constraints affecting the region's development. Chapter IV, in turn, summarizes the basic characteristics of the Bank-supported projects per se, highlighting their implementation experience and the principle lessons learned to date in each case.

9. Chapters V and VI, which constitute the bulk of the report, assess the physical and human environmental impacts of the Sao Francisco projects, respectively. In each case, the Paulo Afonso IV, lower Sao Francisco polders/second irrigation and Itaparica resettlement and irrigation projects are analyzed separately. In Chapter V, much of the focus is on water quality and water resource management issues. In Chapter VI, in turn, while most of the discussion concerns the rural and urban resettlement experience, other human environmental impacts of the projects considered, including their effects on migration and employment, rural and agro-industrial development, urbanization and public health, at the regional level are also briefly examined. Finally, Chapter VII looks more closely at how the Bank and the Brazilian Government perceived and attempted to deal with the environmental aspects and impacts of the hydropower, irrigation and resettlement projects undertaken over the past two decades in the lower and middle Sao Francisco valley and puts forward the principle conclusions and lessons to be drawn from this experience to date. The latter include implications for Bank procedures and future operations both in the Sao Francisco valley itself and elsewhere where similar issues may arise.

WORLD BANK APPROACHES TO THE ENVIRONMENT IN BRAZIL: A REVIEW OF SELECTED PROJECTSTHE MIDDLE AND LOWER SAO FRANCISCO VALLEYSUMMARY AND CONCLUSIONSBank-Assisted Projects and Major Impacts

1. The four Bank-supported projects considered in this report have had a profound impact on the Sao Francisco valley in Northeast Brazil. The development of hydropower and associated irrigation facilities at Sobradinho, on the lower Sao Francisco "polders" and, most recently, in connection with the on-going Itaparica scheme have helped precipitate wide-ranging human and physical environmental changes in the area. In choosing to become closely involved with the development of the middle and lower valley, the Bank shares responsibility for subsequent outcomes, both positive and negative, direct and indirect. The projects in question have, for example, displaced about 170,000 people from their lands and homes, requiring resettlement solutions which have been tackled in contrasting and frequently unsatisfactory ways. At the same time, these interventions have had a important catalytic effect on wider development processes in the region.

2. The Bank-funded schemes under review are especially critical in light of the historically important role of the Sao Francisco River in the northeastern economy as the region's only significant perennial waterway, a fact which has conveyed to the valley a number of distinctive features and advantages. A major transport route into Brazil's interior and a privileged region in terms of climate when compared with the surrounding dry caatinga, it has acquired a relatively dense population of small farmers, as well as growing urban centers. The total population of the middle and lower valley stood at 1.4 million in 1970, three-quarters of which was rural. The resulting physical, economic and social characteristics of the valley have had fundamental implications for the nature and scale of subsequent environmental impacts induced by the operations under consideration, greatly extending their areas of influence beyond immediate project boundaries.

3. In 1974, the Bank approved a loan in the amount of US\$ 81 million to assist CHESF, the regional power company, with the Paulo Afonso IV Hydropower Project, comprising construction of the Sobradinho regulating dam, the installation of additional generating capacity near Paulo Afonso falls, the expansion of transmission lines and other components. Although the project has clearly resulted in substantial economic and social benefits due to the increased generation and distribution of electric energy to hundreds of thousands of people in the region, it has also had a number of less positive consequences on the physical and, especially, human environments. The project's most direct environmental impact was displacement by the reservoir of some 65-70,000 people, consisting of over 9,000 farm families and 3,000 families from four small towns. While urban relocation was fairly successful, the rural resettlement program

was seriously flawed. It was erroneously assumed that half of the rural displacees would opt for relocation to an official colonization project at Serra do Ramalho nearly one thousand kilometers upstream, while only a small minority would want to remain near the lakeside. The reverse, in fact, turned out to be the case, while the colonization scheme at Serra do Ramalho, near the town of Bom Jesus da Lapa in the upper Sao Francisco valley, proved to be an economic failure and was subsequently abandoned by most of the settlers from Sobradinho, who were, thus, deprived of vital social and production support.

4. Similarly, the poorly planned and ill-equipped Sobradinho lakeside communities (agrovilas) have not prospered, with farmers frequently being denied the official credit and other support necessary to overcome problems caused by poor soils, lack of irrigation facilities, changing water levels and increased distances to markets. Nor was a Bank-recommended fisheries program ever developed. In addition, social infrastructure in the agrovilas is often non-existent or inadequate, failing to meet people's basic needs. Consequently, many families have either abandoned the area outright or sold their lands to commercial farmers from outside, resulting in the reconcentration of holdings. A large number of previously independent smallholders, moreover, has migrated to the towns and/or become agricultural laborers on nearby private irrigation schemes.

5. Many of the problems currently experienced by small farmers at Sobradinho, more than ten years after their original displacement, can be traced to inadequate Government indemnification policies which compensated only those possessing legal titles for the loss of their lands and effectively decapitalized a large number of long-standing producers whose livelihoods as riverine cultivators had been wiped out by the project. Furthermore, the passage of time should not be allowed to obscure the fact that resettlement for many was a highly traumatic experience, occasionally associated with violent confrontational situations in which local populations were subjected to extreme and often illegal pressures to rapidly vacate the areas to be flooded. While such tensions are to some degree inevitable in situations of this kind, the enduring psychological stress of displacement, which is still evident over a decade later, was exacerbated by CHESF's use of strong-arm tactics during project implementation.

6. The physical environmental impacts of Sobradinho have also been significant. Downstream, regulation of the Sao Francisco River resulted in a large increase in the lowflow, thus threatening to flood some 9,000 hectares of fertile rice-paddy and necessitating the lower valley "emergency" polders and irrigation projects discussed below. Upstream of the dam, in turn, a number of problems have become evident including the loss of fertile riverine lands and the destruction of floodplain (vazante) farming, progressive siltation and over-fishing due to the uncontrolled use of illegal methods. An increasingly serious problem is likely to arise in the future, moreover, from potential water shortages due to growing competition among consumers in different sectors (and subregions), namely electricity generation, irrigation and urban domestic and industrial use. Increased evaporation due to the formation of large reservoirs will heighten the water scarcity problem, while the impact of Sobradinho -- which is the second largest (and the largest man-made) lake in South America -- on the regional climate is still uncertain.

7. The Lower Sao Francisco Polders and Second Irrigation Projects (SF I and II), in turn, were "emergency" measures prompted by the increase in minimum flow in the lower valley caused directly as a result of the construction of Sobradinho dam. Bank loans totalling over US\$ 66 million were approved in 1975 and 1979, respectively, to protect the floodplains (or varzeas) near the mouth of the river through a series of dikes and pumping stations and to establish five irrigated "polders" on some 25,000 hectares of land which was to be expropriated and redistributed in small plots to roughly 3,800 farmers from the region. The solution adopted was found by Bank staff to be the only feasible alternative considering the physical, economic and social environment, while the resulting projects had to be implemented under considerable time pressure and social tension created by the conclusion of the dam and power station upstream at Sobradinho, a factor over which the executing agency, the Sao Francisco Valley Development Company (CODEVASF), had no control.

8. The lower Sao Francisco projects, moreover, were justified not just on "emergency" grounds (ie. as a compensatory scheme to ameliorate the adverse impacts of Sobradinho on the rural population in the lower valley), but, more broadly, as a conscious intervention to promote the economic and social advancement of the rural poor. Prior to these operations, the lower valley was characterized by a heavy concentration of land and income, as fewer than 100 landowners controlled 90% of the project area. Incomes were skewed, but the majority of the population was very poor, with average per capita income in the area on the order of half the national average. In this context, the land redistribution component of the polders project represented a pioneering attempt to promote small-scale agrarian reform in the region. The projects included large investments in social infrastructure, particularly schools and health posts, in an area that was traditionally one of the poorest in the country and were among the first externally supported efforts to raise the living standards of the rural poor on an area specific basis in Brazil. As such, they were also the direct precursors of a large number of small-farmer oriented integrated rural development operations in the Northeast undertaken during the latter 1970's and throughout the 1980's. In many respects, however, despite the "reformist" rhetoric which has accompanied them, these interventions may have been as disruptive for much of the population affected as the events upstream at Sobradinho.

9. In the first instance, these "emergency" projects were accompanied by the eviction of more than 50,000 rural dwellers in the lower valley, while the new irrigation schemes absorbed only 15,000 to 20,000, apparently resulting in a net displacement of at least 30,000 people. Unlike Sobradinho, there was no attempt to devise a wider resettlement strategy, the absence of which contributed to significant out-migration, clearly reflected in the low or negative rates of both rural and urban demographic growth in the area during the 1970's which were atypical of the Sao Francisco valley as a whole. A number of factors contributed to this net displacement including delays of several years between land expropriation and project operation, limited financial compensation, heavy-handed eviction methods, the relatively low labor-absorption capacity of the new irrigation schemes and selective recruitment methods by CODEVASF which disqualified many local applicants, together with such non-project factors as serious flooding and the rapid expansion of sugar cane production in parts of the area. Because most of the people living in the lower Sao Francisco varzeas

were sharecroppers, tenants or salaried workers, moreover, there was no reliable information concerning their number when the polders project was initially appraised. As at Sobradinho, however, local church groups made vociferous protests to the Government in an attempt to win greater compensation for dispossessed communities, attracting unfavorable publicity over both CODEVASF's and the Bank's perceived roles in this process.

10. The subsequent economic performance of the five CODEVASF-run irrigation schemes in the lower valley has been largely disappointing, registering a 7% rate of return which is well below the appraisal estimate of 22%. Problems of inadequate drainage, salinization and lack of extension support for colonists have produced poor rice yields, low production levels and highly variable individual farmer incomes, despite promising results with integrated "pig-rice-fish" farming. There is some evidence, moreover, that farmer indebtedness may be leading to premature abandonment of the land and the concentration of holdings. Initial steps have been taken by CODEVASF to introduce a system of irrigation cooperatives with administrative and financial autonomy ("emancipation"), but the economic and managerial feasibility of these entities have yet to be carefully studied.

11. In terms of physical environmental impacts, the substitution of traditional vazante agriculture by "polder" irrigation schemes has given rise to a number of problems. The trapping of alluvium by Sobradinho has rendered soils in the lower valley less fertile, necessitating increased applications of chemical fertilizers which could have serious public health consequences. Yields are also affected by poor water quality in many of the affluents of the Sao Francisco which cross the polder irrigation projects, leading to soil salinization as the result of periodic flooding and inadequate drainage. The predominance of rice monoculture may aggravate risks of infestation by pests and disease and is already reportedly encouraging the excessive and potentially dangerous use of agrototoxic substances by farmers.

12. Itaparica, the final Bank-funded project under review, marks a significant breakthrough in dealing with large-scale population displacement in Northeast Brazil. Unlike the situation at Sobradinho and in the lower valley, dam and reservoir construction were accompanied by a comprehensive resettlement program in which the affected communities had some involvement in the decision-making process. Even though this participation has, in practice, been limited and had to be actively fought for by the rural trade union consortium, known as POLOSINDICAL, it, nevertheless, represents a major innovative step that has potentially profound implications for future policy-making and project implementation in the valley, both for CHESF and the Bank. Following appraisal of the first power sector loan for Brazil in 1985, the Bank approved an initial US\$ 132 million in 1987, followed by an as yet unsigned supplemental loan of US\$ 100 million in 1990, to fund agricultural production and rural infrastructure and services in five major irrigation projects in connection with the new Itaparica reservoir, formed in 1988.

13. The campaign for a comprehensive resettlement program at Itaparica was started by POLOSINDICAL in 1979. While CHESF had hoped to follow past practice by rehousing the displaced urban population and offering only monetary compensation to eligible farmers, POLOSINDICAL negotiated with CHESF over a

prolonged period for the right of those evicted to alternative land and livelihoods. In the face of long official silences over their proposed fate, the local population, sensitized by the earlier experiences at Sobradinho and in the lower valley, resorted to mass public demonstrations which received national and even international media coverage. As a result, the population was able to exert some influence over project design and POLOSINDICAL negotiated a written agreement with CHESF in 1986 over such crucial aspects as site selection for the irrigation subprojects and the provision of maintenance payments to all relocated families, pending operation of these schemes.

14. Due largely to the actions of POLOSINDICAL and well-organized local resistance, together with later Bank participation, the outcome of this on-going project has thus far been significantly different from that of the previous experiences at Sobradinho and in the lower valley. Despite minor problems with compensation procedures, relocation of some 40,000 people during 1987-88 went smoothly, with three-quarters of the total opting for resettlement in 109 agrovilas, equipped with basic health, sanitation and educational infrastructure. About 5,000 farm families have been transferred to six irrigation schemes covering 20,000 hectares. However, as of early 1990, only half of these families had received their plots and none of the large projects was operational. The first of these schemes are now expected (perhaps optimistically) to come on stream in December 1990, some two years behind schedule.

15. Although the physical transfer of people has been carried out relatively successfully, problems have subsequently arisen at Itaparica due to the long delay in commencing irrigated agricultural production. Intra-communal violence, alcohol abuse, family disintegration, low morale and a generally tense atmosphere characterized the agrovilas during much of 1988 and 1989. Prolonged idleness, limited local employment opportunities and the occasionally poor quality of social services in the agrovilas have all contributed to a climate of uncertainty and frustration. This has been exacerbated by the slowness to establish local administrative and management structures to cope with the transition from traditional to more modern and capital-intensive irrigated agriculture under the new system.

16. The final cost of resettlement at Itaparica may reach more than US\$ 63,000 per family which is high and considered excessive by Brazilian Government authorities. Nonetheless, the proposed interventions are still considered to be the least-cost solution for carrying out a comprehensive resettlement program of this nature and indicate the financial repercussions that are likely when executing and funding agencies are required to meet full relocation obligations to the affected populations. This again contrasts with earlier situations, such as Sobradinho, in which the real social and economic costs are hidden by the provision of only partial resettlement requirements or the failure to relocate a majority of the displaced population, as was the case in the lower Sao Francisco valley.

17. The immediate ecological impacts of Itaparica, in turn, have thus far been modest and seem to have been largely attenuated by CHESF's advance planning to institute appropriate controls in the physical, biological and socio-cultural spheres, following negotiations with state environmental authorities in Pernambuco and Bahia (although, at the time of the OED/SEPLAN mission in mid-

1989, the latter had yet to grant CHESF an operating license for Itaparica). These controls include soil use and water quality monitoring, as well as an animal rescue plan and an aquatic fauna conservation program. On the evidence of Sobradinho, however, future problems are likely to include the risk of lake contamination by agrototoxic chemicals used in irrigated agricultural activities, together with untreated urban and industrial wastes, while yields on irrigation schemes may be undermined by salinization. Excessive evaporation, moreover, could exacerbate the growing problem of competition among water users (mainly power versus irrigation) in the middle valley. These phenomena will require careful monitoring since both public and private irrigation projects are expected to expand significantly in the region over the next decade.

18. While the direct, localized human and physical environmental impacts of the three schemes examined have been profound, these projects have also had wider consequences for the Sao Francisco valley as a whole. In terms of production, the creation of Lake Sobradinho has facilitated the expansion of capital-intensive irrigated agriculture (about 177,000 hectares by 1988, well over half of which was in private hands). Much of this production is oriented toward higher-value export crops and is largely concentrated in the area polarized by Petrolina and Juazeiro. There has been a corresponding spread of agro-industrial processing enterprises, served by an increasingly sophisticated transport and communications network. This has had an important multiplier effect, helping to stimulate local commerce and creating employment, especially temporary wage labor.

19. The impressive economic growth in the middle valley over the past two decades, however, has also been accompanied by a process of land concentration as small farming has become less viable and land values have risen, encouraging land sales and out-migration. As a result, the traditional class of independent semi-subsistence smallholders is gradually being eroded and replaced by more capitalized and commercially oriented farmers, many of whom have come to the area from other parts of Brazil or abroad. Although it is difficult to predict how far this process will advance, more traditional tenure relations such as sharecropping are finding a place in the new production systems. Nevertheless, these marked alterations in cropping patterns, landownership and employment structures may have an adverse impact on local poverty levels and food security, while also contributing to the rapid growth of urban squatter settlements.

20. Recent agrarian changes have led in no uncertain terms to the rapid pace of urbanization in the middle Sao Francisco valley where the major centers have probably quadrupled in size since 1970. Yet, much of this expansion is accounted for by the spread of low-income settlements, generally characterized by inadequate housing and local services -- even in the new townships around Sobradinho -- and accompanied by a worsening of social problems associated with unemployment and poverty. The geographic distribution of urban impacts along the valley, moreover, has been uneven. While Petrolina-Juazeiro and smaller urban centers near Sobradinho have benefitted from substantial industrial and commercial spin-off generated by irrigated agriculture, towns such as Belem do Sao Francisco and Itacuruba in the middle valley and Penedo and Propria near the mouth of the river have derived little advantage, appearing instead to have stagnated economically in part as a result of the projects in question.

21. The major ecological hazard facing the valley as a whole springs from the largely uncontrolled use of agrototoxic substances such as fertilizers, herbicides and pesticides for irrigated agriculture. Contamination of domestic water supplies, crops and even fish could present a major danger to public health in the future, with some initial symptoms already being apparent. The impact of Lakes Sobradinho and Itaparica on climate at the regional level, in turn, is presently unclear and requires close monitoring. As the area of irrigated land continues to expand, finally, soil salinization, which is a potential problem with any irrigation project and has already occurred in other areas under irrigation in the Northeast, may become more widespread unless local water management techniques continue to be improved.

Principal Conclusions and Lessons Learned

22. The experience with the Bank-supported projects surveyed in this report has often been unsatisfactory, especially from a human environmental standpoint. Without denying that considerable progress has occurred over the past decade, the projects undertaken during the 1970's resulted in substantial human costs. The most critical consideration at this juncture, however, is the extent to which the organizations involved have learned from previous errors and oversights so as to correct present and future policies and practices. In this context, there is no doubt that all three schemes have yielded important lessons for planners and policy makers which have implications for both the Bank and Borrower institutions.

23. During the 1970's, when Paulo Afonso IV/Sobradinho and the lower Sao Francisco operations were appraised, the Bank lacked a policy on involuntary resettlement to guide project planning and execution. Although CHESF and the Bank had been alerted to potentially adverse environmental impacts, Sobradinho was conceived essentially as a hydropower scheme, while social, ecological and other local development considerations were marginalized. During this period, the Bank clearly did not pay adequate attention to human and physical environmental issues in project design and implementation and was poorly staffed to tackle such dimensions. The Sobradinho experience was, nevertheless, instrumental in the formulation of subsequent Bank policies on involuntary resettlement, namely the 1980 Operational Manual Statement (OMS), the 1986 Operational Policy Note (OPN) and the extensive guidelines published in 1988. The existence of a resettlement policy, however, does not guarantee its full adoption, a point which is brought home both by the execution of SF II in the lower valley and the Bank's relatively late participation in the Itaparica resettlement program, discussed below.

24. The Borrowers/Executors (CHESF and CODEVASF), similarly, lacked a coherent resettlement policy and tended initially to conceive relocation primarily as a set of relief and welfare measures, rather than as a longer-term development exercise. In the cases of both Sobradinho and the lower Sao Francisco polders and irrigation schemes, this led to the adverse consequences described above as a combination of an authoritarian strategy that largely ignored the needs of the affected local populations and inadequate monetary compensation resulted in the destruction of livelihoods and, ultimately, increased poverty and human suffering. This narrow approach can be explained

in good measure by a number of contextual factors including the top priority attached to energy production in Brazil during the oil crises of the 1970's, the institutionalized engineering bias within CHESF and CODEVASF, the prevailing repressive political climate under military rule during much of the period under review and straightforward and understandable desires to minimize project costs. While significant changes have subsequently occurred in many areas, improvements are, nevertheless, still required in others. Brazil, for example, still lacks a national policy on involuntary resettlement.

25. From the Bank's point of view, Sobradinho clearly demonstrates the undesirable consequences of not having explicit environmental protection and resettlement policies and, thus, of having had to rely on ad hoc procedures to deal with complex ecological and social issues. The lack of proper guidelines for Bank personnel, together with the failure to provide adequate physical and human environmental expertise, contributed to the setting of insufficient loan conditionalities, incomplete appraisal and supervision from an environmental standpoint and late participation in the project which reduced the Bank's influence on project design and execution.

26. In the lower Sao Francisco valley, in turn, the fact that neither the Bank, nor the Borrower had a comprehensive resettlement plan resulted in the anomaly of an "emergency" project with social objectives that appears to have failed to compensate over 30,000 people for the loss of livelihood induced by construction of the Sobradinho dam. This contributed to large-scale out-migration from the area, a phenomenon which is glossed over in Bank supervision and completion reports. The problem is more serious in view of the fact that the irrigation projects under SF II were implemented after the Bank had published its OMS on resettlement in 1980. The Bank, thus, forfeited an opportunity to ensure that inequities were minimized and benefits were spread more widely among the entire affected rural population.

27. Itaparica is the first comprehensive involuntary resettlement program undertaken in Brazil and, for those directly affected, represents a major advance in relation to the traumatic earlier experiences at Sobradinho and in the lower Sao Francisco valley. Unfortunately however, this progress was not primarily the product of enlightened policy and procedures on the part of CHESF, but, rather, was largely due to sustained political pressure by rural labor unions and other groups throughout the 1980's. Itaparica, thus, illustrates the potential usefulness to planners and policy makers of vigorous "grass root" popular participation.

28. The Bank's involvement at Itaparica, where pre-construction activities began in the late 1970's, also came rather late and in response to environmental concerns first raised in 1985 in connection with the preparation and subsequent appraisal of the power sector loan for Brazil, approved the following year. Although the Bank performed a crucial role in responding to CHESF's request for assistance and in helping to cement the power company's agreements with POLOSINDICAL, because of its relatively late entry into the process, the Bank's influence on project design was less than it might otherwise have been. Perhaps the principal lesson that can be learned from the experience at Itaparica at this point, accordingly, is the danger of entering a (resettlement) project so late in the cycle of a related (hydropower) operation

that could not have been slowed down. The tense social situation generated to a large degree by the inadequate planning of the latter vis-a-vis resettlement of the displaced population forced both the implementing agency and the Bank into accepting design criteria and a mode of operation that greatly increased the cost of the former. Despite this shortcoming, if the Itaparica Resettlement and Irrigation Project is implemented as designed, it could become a major development pole in the lower-middle Sao Francisco valley, directly and indirectly providing employment and income for thousands of people.

Recommendations

29. A number of recommendations arise from the Bank's experience in the middle and lower Sao Francisco valley to date. As far as future Bank operations in the valley and elsewhere are concerned, these should be prepared and appraised with greater sensitivity to the human and physical environmental dimensions of local development. This is justified on the grounds of both economic efficiency and social equity. Project preparation and appraisal procedures, additionally, should ensure that resettlement and environmental protection costs are fully assessed and considered in the economic evaluation of the infrastructure and/or productive projects that give rise to them in the first place and that the necessary mitigatory, corrective or compensatory measures are fully defined, costed and financed. As the cases of SF II and Itaparica reveal, moreover, it is not sufficient for the Bank to have resettlement and environmental protection policies alone. A firm institutional commitment to the full and timely application of the associated guidelines must also exist throughout the project cycle.

30. Allied to this commitment, there is a clear need to make more extensive and systematic use of environmental and social expertise in the preparation, appraisal and supervision of hydropower, irrigation and resettlement (among other types of) projects. More generally, rather than relying on ad hoc and often imperfectly gathered information, the Bank should more actively promote the institutionalized integration of social science and environmental knowledge in all phases of project development, but especially during the identification and preparation stages. In addition, greater participation by local communities and non-governmental organizations should be encouraged so as to ensure that borrowing country planners and policy makers and Bank technical staff give adequate priority to these issues and to help them to design interventions which are more responsive to the needs of local ecosystems, project beneficiaries and other impacted populations.

31. Itaparica, furthermore, illustrates the importance of adequately assessing the potential physical and human environmental problems associated with individual projects supported, if only indirectly, through sector loans. In relation to large hydropower projects in particular, the Bank, in consultation with executing agencies and the affected communities, should attempt to identify the likely impacts of dam construction and other infrastructure components as early as possible, so that prompt action can be taken to design effective measures to avoid or alleviate potential adverse human and physical environmental consequences at the project level. Power sector investment and/or adjustment loans, moreover, should specifically seek to create, improve and/or reinforce

environmental impact assessment mechanisms and procedures at the sectoral level, as, in fact, is presently occurring in Brazil.

32. Such early participation by the Bank in sector or project loans involving or requiring major involuntary resettlement efforts should likewise aim at obtaining a clear and unequivocal commitment by executing agencies to adopt a comprehensive relocation plan which gives adequate attention to the socio-economic reestablishment of displaced populations, rather than the largely piecemeal welfare type solutions frequently attempted in the past. The level of forced removal, moreover, should be minimized, and full compensation and alternative employment within a longer-term structured rural development program should be offered to those who desire such support. The choice of technological inputs, such as new irrigation methods, however, should be made only after consultation with intended beneficiaries has taken place. To help executing agencies meet these requirements, the Bank should give greater emphasis to strengthening institutional capacity in the pertinent areas. More generally, countries such as Brazil should be encouraged to develop explicit national involuntary resettlement policies.

33. With respect to physical environmental issues, in turn, in view of the growing competition among large water users (particularly hydropower and public and private irrigation), there is a need for improved cross-sectoral, multi-state water resource planning and management in the Sao Francisco valley. In the process, the inevitable trade-offs and differing institutional interests involved in long-run water resource use decisions for the Sao Francisco basin should be clearly identified and explicitly dealt with by federal planning and environmental agencies, in consultation with CHESF, CODEVASF and other relevant actors, including state and local governments. In appraising future irrigation projects in the valley, moreover, the Bank should be fully aware of the potential ecological hazards involved, especially salinization and agrotoxic pollution, and assist in defining and monitoring the implementation of appropriate safeguards.

34. As far as possible, critical and, especially, large-scale Bank-supported infrastructure and productive sector projects that are likely to have a catalytic effect on the local economy should also be viewed within their regional context, rather than as isolated interventions having purely extra-local objectives such as the increased supply of power to distant state capital cities. In this context, additionally, due consideration should be given to both the potential positive and negative local development impacts of these investments. All of the projects under review in this report have had, or will have, significant broader repercussions on their immediate and larger areas of influence, yet this dimension was largely ignored in project preparation. Again, consultation with a range of representative local organizations, such as trade unions, church groups, community associations and other non-governmental organizations, during project preparation can help to build a more comprehensive picture in relation to the likely physical and human environmental impacts of large investments at the regional level and, thus, inform decisions about the nature and scale of the financial and other assistance required in order to deal adequately with them.

35. Finally, even though these projects have yielded useful lessons, critical gaps in our knowledge still exist. Accordingly, it would be helpful for the future design and implementation of similar operations if further research were to be carried out in a number of key areas. The most important of these include: (i) the wider socio-economic impacts of different resettlement outcomes in the Sao Francisco valley (comparing Sobradinho with Itaparica, for example); (ii) the organization and management of irrigated production at Itaparica, including the feasibility of "emancipated" public projects; (iii) the effects of increasing competition within the valley for water resource use, especially energy versus irrigation; and (iv) climate monitoring and modelling studies to determine changes in local weather (and, possibly, production) patterns arising from the formation of large reservoirs. Such research, in all likelihood, would also be of relevance for river basin development in semi-arid regions more generally.

WORLD BANK APPROACHES TO THE ENVIRONMENT IN BRAZIL: A REVIEW OF SELECTED PROJECTS

THE MIDDLE AND LOWER SAO FRANCISCO VALLEY

I. INTRODUCTION

1.01 Loan 1008-BR in the amount of US\$ 81.0 million was approved on June 4, 1974 to help finance the Paulo Afonso IV Hydroelectric (PA IV) Project. The Borrower and Executor of the project was the Companhia Hidro Eletrica do Sao Francisco (CHESF), the regional electrical power company for Northeast Brazil, and the federal government was the Guarantor of the loan. CHESF was one of the Bank's first borrowers, as one of the latter's earliest operations, approved in 1950, supported installation of the initial hydropower plant near Paulo Afonso falls on the Sao Francisco River. At appraisal, the PA IV operation was expected to have a total cost of US\$ 692.6 million. In addition to the Bank loan, external funding was to be provided both by the Inter-American Development Bank (US\$ 84.8 million) and by bilateral sources (US\$ 71.9 million). The project was closed on June 30, 1983, at which time an unused loan balance of US\$ 1.23 million was cancelled.

1.02 With the objective of expanding hydropower development in the Sao Francisco River valley, PA IV, as appraised, consisted primarily of the construction of a large dam and reservoir at Sobradinho, some 790 kilometers from the mouth of the river, the expansion of generating capacity at Paulo Afonso, 470 kilometers downstream from Sobradinho, and the installation of transmission lines, substations and related facilities. Creation of the Sobradinho reservoir was expected to flood an area of roughly 4,150 square kilometers and displace about 70,000 rural and urban residents upstream of the dam. In order to relocate these families, a specific resettlement program was implemented parallel to construction of the Sobradinho dam. Below the dam, the project was expected to regulate water flow in order to improve hydropower generation at Paulo Afonso and other points along the river, subsequently also including Itaparica, in the process substantially altering traditional flooding patterns in subsistence rice producing areas in the lower Sao Francisco valley.

1.03 In order to protect rice production and the livelihood of small farmers adversely affected by the modification of river flow in the lower Sao Francisco valley an "Emergency Plan" was prepared by the then Superintendency for the Sao Francisco Valley (SUVALE), which was later transformed into the present-day Company for the Development of the Sao Francisco Valley (CODEVASF). Implementation of this plan was financed by the Bank through two complementary projects, the Lower Sao Francisco Polders Project (hereafter SF I) and the Sao Francisco II Irrigation Project (SF II). These operations were among the earliest Bank-supported projects in the agricultural sector in Northeast Brazil, as well as the first such projects specifically involving irrigation in the country. The polders project was partially funded by Loan 1153-BR in the amount of US\$ 23.0 million, approved on June 9, 1975. The SF II operation, in turn, was supported by Loan 1729-BR for US\$ 28.0 million, approved on June 19, 1979.

In both cases, the Brazilian Government was the Borrower and CODEVASF was the Executor. SF I and II closed on September 30, 1983 and June 30, 1987, respectively. Both loans were fully disbursed.

1.04 The two lower Sao Francisco projects, as appraised, consisted of a combination of physical infrastructure -- particularly dikes and pumping stations -- agricultural support services and social facilities, together with measures to provide land tenure to low-income rice farmers, the majority of which had formerly occupied areas along the floodplain (or varzeas) as sharecroppers. SF I, more specifically, was intended to preserve rice production in six large and some 15 to 20 smaller varzeas and to fully develop irrigation works in two of the large varzeas, while SF II would provide additional irrigation infrastructure, support services and social facilities in the other four large varzea areas. SF II, in short, was a direct extension of the polders project and, thus, for purposes of the present report, the two operations will be considered as two overlapping stages of a single undertaking implemented over a twelve year period.

1.05 Finally, Loan 2883-BR in the amount of US\$ 132.0 million for the Itaparica Resettlement and Irrigation (hereafter Itaparica) Project was approved on November 17, 1987. This loan has an expected closing date of June 30, 1994. Due to significant dollar cost overruns experienced during implementation thus far, together with a shortage of local counterpart funds, a supplementary loan (2883-1-BR) in the amount of US\$ 100 million was approved for this operation on February 20, 1990 without altering the projected closing date. In both cases, the Borrower is the Central Electrical Holding Company of the Brazilian Government (ELETROBRAS) and the Executor is CHESF. As of February 28, 1991, roughly US\$ 112.6 million of Loan 2883 had been disbursed, but Loan 2883-1 had not yet become effective.

1.06 The principal declared objective of the project is to restore and improve the living standards of some 8,100 families displaced by installation of the Itaparica dam and reservoir, located some 30 kilometers upstream from Paulo Afonso. Although the Itaparica dam and hydropower plant were not themselves financed by the Bank, the need to accelerate and upgrade resettlement provisions for the population to be relocated was identified during the course of a Bank review of environmental and social issues in connection with appraisal of the first power sector operation for Brazil (Loan 2720-BR in the amount of US\$ 500 million) which was approved in June 1986. In contrast to the earlier resettlement measures taken in parallel to the construction of Sobradinho dam, the Itaparica Project involves not only the physical relocation of rural and urban populations, but the provision of substantial productive (i.e. irrigation) infrastructure and support services for rural development activities. Unlike the earlier experience at Sobradinho, moreover, the design and implementation of the resettlement program for Itaparica has involved significant beneficiary participation, largely through the intervention of a local rural trade union consortium known as POLOSINDICAL.

1.07 Although the Bank has recently approved other irrigation loans for or including the Sao Francisco valley -- specifically, Loan 2680-BR (US\$ 48 million) for the Northeast Irrigation Engineering Project, approved in April 1986; Loan 2719-BR (US\$ 57.0 million) for the Upper and Middle Sao Francisco

Irrigation Project, approved in June 1986; Loan 3013-BR (US\$ 71.0 million) for the Jaiba Irrigation Project, approved in December 1988; and, most recently, Loan 3170-BR (US\$ 210.0 million) for the Northeast Irrigation I Project, approved in February 1990 -- the present report is restricted to the four operations mentioned in the preceding paragraphs. Among these earlier operations, however, there is a clear linkage between the PA IV/Sobradinho Project and the two irrigation projects in the lower Sao Francisco valley since the latter are a direct consequence of the change in river regime generated by the former. The Itaparica Project, in turn, was a response by the Bank to the need to resettle population dislocated by construction of another major dam in the Sao Francisco valley and, thus, to confront a similar situation to that encountered a decade earlier in connection with Sobradinho. Accordingly, a preliminary examination of the on-going Itaparica Resettlement Project presents an opportunity to determine how effectively the lessons arising out of the Sobradinho experience were learned by the Bank and the Brazilian agencies involved and incorporated into the design of the more recent operation. The evolving Itaparica experience likewise raises several additional issues with which the Bank will need to deal more adequately in the future.

1.08 The present case study also illustrates several problems related to regional natural resource -- especially water resource -- management and to river basin development more generally. These problems cut across sectors -- particularly power and agriculture -- and, thus, necessarily involve different sectoral institutions such as CHESF and CODEVASF, among others. In the present case, they also cut across the boundaries of several states (ie. Bahia, Pernambuco, Sergipe and Alagoas), thereby requiring coordination among different state governments, including different state environmental protection agencies, as well as overall guidance, monitoring and control on the part of federal planning and environmental institutions. Furthermore, in cases like the Sao Francisco valley, where competition for resource use among different sectors may increase to the point where the underlying resource base may ultimately be unable to sustain projected levels of future economic activity, basic public sector policy and investment decisions affecting regional (including water) resource utilization should take development alternatives and constraints (including environmental constraints) extending beyond the region itself clearly into account. Such decisions that potentially involve several regions, as well as a variety of sectors, will likewise require improved planning and coordination at the federal level.

II. BACKGROUND

2.01 The Sao Francisco River valley has historically played an important role both in the development of the impoverished and drought-prone Northeast and in that of the larger Brazilian economy and society as a whole. Furthermore, since the Second World War, the Sao Francisco valley has received increasing attention by the federal government as part of its evolving efforts to reduce widening income and other disparities between northeastern and South-Central Brazil and, in particular, to promote urban-industrial development and combat rural poverty in the Northeast. The Bank-assisted projects reviewed in this report have contributed directly to these broader government initiatives. Before examining these operations in further detail, therefore, it is useful to situate them in terms of the larger government interventions affecting the Sao Francisco basin undertaken over the past several decades. Many of the difficulties encountered in the programs briefly considered below, moreover, have also characterized Bank-supported irrigation projects in the lower and middle Sao Francisco valley.

A. The Role and Early Development of the Lower and Middle Sao Francisco Valley

2.02 Discovered by Amerigo Vespucci on October, 4, 1501, the Sao Francisco River served as a major route into the interior of northeastern Brazil throughout the colonial period. The town of Penedo, located near the mouth of the river, was founded in 1560 and prospered as a major port for ocean-going vessels and center of the Amerindian slave market. Expeditions by frontier explorers and the granting of large tracts to individuals favored by the Portuguese Crown, in turn, led to establishment of a livestock-based economy in the valley. This was supplemented in the nineteenth century by cotton production, stimulated by high prices resulting from shortages caused by the American Civil War. Gradual occupation by small farmers also gave rise to floodplain (varzea) production of staple food crops to support the growing population. Until the significant expansion of the federal and state road networks in the 1950's and 1960's, moreover, the river served as a major transportation corridor for both passengers and freight over the distance of more than 2,000 kilometers between Paulo Afonso falls in northern Bahia and the town of Pirapora in north-central Minas Gerais. The twin cities of Juazeiro (Bahia) and Petrolina (Pernambuco) in the middle Sao Francisco valley owe their origins to this traffic. The river continued to perform this role, albeit at a reduced level, until formation of the Sobradinho reservoir in 1977.

2.03 During the 1930's and 1940's, the federal government began to turn its attention away from the semi-arid interior (sertao) of the Northeast, where a policy of reservoir construction (acudagem) by the National Department of Works against the Drought (DNOCS) had produced few positive results in terms of drought alleviation, to the Sao Francisco basin.¹ The comparatively much vaster

¹ The history of federal government efforts through the early 1960's to deal with the periodic droughts and, subsequently, to promote regional development, including that of the Sao Francisco valley, is well documented by Albert O. Hirschman (Journeys Toward Progress, Twentieth Century Fund, New York,

water resources of the latter seemed to offer substantially greater potential for "drought-proofing" the region. One early, if grandiose, proposal, for example, was to divert some of the Sao Francisco's waters northward to regulate the flow of the non-perennial Jaguaribe River in Ceara state. Later, embryonic ideas were put forward for establishing irrigation schemes that would serve as a haven for drought victims farther to the north. Dam construction to stabilize seasonal flow variations would also help the river fulfil its traditional role as the main transportation artery between the northeastern interior and the Center-South of Brazil. Following the end of the first Vargas administration in 1945, the federal government specifically earmarked funds to develop the Sao Francisco valley and help preserve national unity. With these objectives also in mind, CHESF and the predecessor agencies to the present-day CODEVASF were established in the late 1940's.

B. CHESF and Hydropower Development in the Sao Francisco Valley

2.04 Small-scale electricity generation had been initiated in the Sao Francisco valley by private entrepreneurs as early as 1913 in order to power cotton yarn and textile production near Paulo Afonso. However, State involvement in regional hydropower development started with the formation of the Companhia Hidro Eletrica do Sao Francisco (CHESF) in 1945. The company was initially granted a concession to develop the hydropower resources of the Sao Francisco at Paulo Afonso and was given responsibility for supplying power to the distributing utilities of the region's largest cities, Recife and Salvador. CHESF eventually provided electricity to nine distribution companies, although this number was later reduced to eight (Ceara, Pernambuco, Paraiba, Rio Grande do Norte, Piaui, Alagoas, Sergipe and Bahia) run by the respective state governments. CHESF is presently one of four regional operating subsidiaries of ELETROBRAS, the mixed economy holding company of the Brazilian power sector established in 1967, under the jurisdiction of the Ministry of Mines and Energy (MME).² In 1975, CHESF relocated its headquarters from Rio de Janeiro to Recife, losing about 80% of its personnel in the process.

2.05 The Bank first assisted CHESF in 1950 through Loan 25-BR for US\$ 15 million to finance the initial stage (120 MW) of the Paulo Afonso hydroelectric project. This first significant attempt to use the river's power generating potential was completed in 1955. Since then, CHESF has substantially increased both its installed capacity and electricity sales. By 1974, CHESF had an installed capacity of 1,346 MW and sales of 3,215 GWh. Ten years later these figures had increased to 6,076 MW and 24,269 GWh, respectively, while the company operated some 12,250 km of transmission lines and 72 substations. Much of this expansion was undertaken on the basis of studies sponsored by MME in 1969, which projected rapid growth in regional demand for electricity at least through the early 1980's. Hydroelectric development of the Sao Francisco valley was

1963, Chapter I) and Stefan H. Robock (Brazil's Developing Northeast, The Brookings Institution, Washington, 1963).

² The other subsidiaries are ELETROSUL, ELETRONORTE and FURNAS for the south, north and eastern (ie. Rio de Janeiro, Espirito Santo and Minas Gerais) regions, respectively.

determined to be the least-cost alternative for meeting this expected demand and a multi-year development program was proposed consisting of a large regulating dam at Sobradinho, complemented by the progressive construction of hydropower plants at Moxoto (400 MW),³ Paulo Afonso IV (1,900 MW) and Xingo (4,000 MW), to be followed at a later date by the installation of generating capacity at the foot of Sobradinho dam.

C. CODEVASF and Early Irrigation Development in the Sao Francisco Valley

2.06 Soon after CHESF was established in 1945, the Comissao do Vale do Sao Francisco (CVSF) was set up in 1948. CVSF was modelled on the American Tennessee Valley Authority and assigned the ambitious objective of overseeing the integrated development of the entire river basin covering an area of some 630,000 square kilometers. To achieve this goal, the commission was allotted several tasks including river flow regulation, flood control, irrigation, the improvement of river and road transport and communications and regional land use planning. CVSF was renamed the Superintendencia do Vale do Sao Francisco (SUVALE) in 1967 and acquired its current name, the Companhia do Desenvolvimento do Vale do Sao Francisco (CODEVASF), in 1974. Initially located in Rio de Janeiro, its headquarters were subsequently transferred to Brasilia after inauguration of the new federal capital in 1960. The organization's early record is generally agreed to have been disappointing, its achievements largely limited to the construction of feeder roads and social infrastructure, together with the provision of water and electricity to towns in the valley.⁴ Originally under the jurisdiction of the Ministry of the Interior and, more recently, the (now defunct) Ministry of Irrigation, CODEVASF was subordinated to the Ministry of Agriculture in January 1989.

2.07 CODEVASF first became involved with irrigation in a minor way during the 1950's when it introduced and encouraged the spread of waterwheels and, later, small diesel-fuelled pumps along the river banks, a practice which subsequently became widespread throughout the middle Sao Francisco valley. This relatively simple technology has, in fact, generated a large class of small irrigation farmers (including owner-occupiers, tenant farmers and sharecroppers) with a substantial number of dependents. Largely as a result, the middle valley has become a major onion-producing area, as well as a supplier of fruits and vegetables to markets in both northeastern and southern Brazil. In the late 1960's, the regional development superintendency for the Northeast (SUDENE) and the United Nations' Food and Agricultural Organization (FAO) jointly undertook

³ The Moxoto Project, involving a total cost estimated at roughly US\$ 690 million, was implemented between 1970 and 1977. It was partially financed by three loans totalling US\$ 57.2 million approved by the Inter-American Development Bank (IDB) in October 1972. This project was evaluated by the Operations Evaluation Office of IDB in a report (No. OER-41/84) dated December 1984.

⁴ In its observations on an earlier version of this report, CODEVASF noted that, in addition to smaller works of local interest, CVSF carried out a number of important large projects, such as the Tres Marias dam in Minas Gerais, and left a heritage of indispensable technical knowledge with respect to project implementation to its successor agencies.

a study of irrigation potential in the middle Sao Francisco valley, resulting in a Master Plan for the area, while a similar exercise was carried out for the Jaguaribe River valley in the state of Ceara by SUDENE and a French technical cooperation mission. SUDENE also initiated the Bebedouro irrigation project near Petrolina in 1969, but this remained a small-scale venture with only some 100 families installed through the mid-1970's. Since the 1960's, CODEVASF's main activities have been to identify priority areas for larger-scale irrigation and agricultural development, to implement selected public irrigation projects and to encourage expansion of private irrigation schemes in the valley.⁵

D. SUDENE and the First Regional Development Efforts

2.08 The need to coordinate the development activities of a growing number of agencies in the region (including CHESF, CVSF, DNOCS and the Bank of Northeast Brazil - BNB, among others) led the Government to establish the Superintendencia do Desenvolvimento do Nordeste (SUDENE) in 1959. It's creation was inspired by an analysis of the Northeast's deep-seated social and economic problems carried out by a working group under the leadership of Celso Furtado, SUDENE's first Superintendent. The working group criticized discriminatory national economic policies which worked against the interests of the Northeast, while also demonstrating the limited relevance of both short-term drought relief efforts and the longer-term strategy of reservoir construction in the sertao which, it was argued, failed either to increase agricultural productivity or to transfer benefits to the bulk of the rural population.

2.09 SUDENE's proposed development program for the region was based on: (i) industrialization; (ii) increasing agricultural productivity in the humid coastal zone to supply rapidly growing urban areas; (iii) improving agricultural performance and drought-resistance in the semi-arid interior; and (iv) directed colonization in the state of Maranhao to absorb so-called "excess" rural population.⁶ Headquartered in Recife, SUDENE was at first linked directly to the office of the Brazilian President, enjoying ministerial status until 1965, after which time it became a dependency of the Ministry of the Interior. SUDENE was also initially allocated a 2% share of federal tax revenues which was specifically earmarked to finance a succession of regional development plans (Planos Diretores) produced by the agency during the 1960's and 1970's.

2.10 Although, in principle, the establishment of SUDENE opened the way for a comprehensive program of regional development for the Northeast, in practice this initiative faced numerous obstacles. Lack of cooperation among

⁵ The expansion of public and private irrigation which has taken place since the 1970's, facilitated by construction of the Sobradinho dam and reservoir, is discussed in section D of Chapter VI below.

⁶ SUDENE attempted to achieve this latter objective through implementation of a colonization project in the transition area between the Northeast and the Amazon basin. In its first specific intervention in the agricultural sector in the region, the Bank supported this venture through the Alto Turi Land Settlement Project (Loan 0853-BR), approved in July 1972. See OED Report No. 4242, dated December 29, 1982, for a review of the experience under this operation.

sectoral agencies reduced their effective participation and only about half of the funds proposed in the Planos Diretores were actually appropriated. In addition, political interference by hostile interests in the federal Congress, as well as disagreements among the northeastern Governors on SUDENE's board itself, seriously hampered achievement of the agency's major goals. As far as development in the Sao Francisco valley is concerned, the Government did not publish a systematic irrigation plan until 1971 (see section F. below). SUDENE did implement two pilot irrigation projects near Petrolina which were subsequently taken over by CVSF. Other measures for the Northeast as a whole included a set of fiscal incentives (originally known as 34/18 and later renamed FINOR) to encourage industrial, agricultural and livestock expansion, primarily the former.⁷

2.11 By 1970, however, considerable disillusionment had set in at the federal government level with the ineffectual nature of SUDENE's interventions during the previous decade, a sentiment underlined by the impact of another catastrophic region-wide drought that same year. As a result, the Plan for National Integration (PIN) and the First National Development Plan (1972-74) attempted to break new ground by linking the agricultural and industrial development of the Northeast with a policy of government-sponsored colonization in Amazonia. Public irrigation development was also to be encouraged, while a new program entitled PROTERRA proposed an "agrarian reform" by attempting to stimulate voluntary land sales for redistribution to tenant farmers. By 1976, however, PROTERRA had attained less than one quarter of its land acquisition target (170,000 hectares distributed to only 920 beneficiaries) and the emphasis of regional policy shifted increasingly to the financing of agro-industrial modernization.

E. Regional Development since the mid-1970's

2.12 Following the poor performance of PIN/PROTERRA, the federal government established a number of new "special programs" for the rural Northeast which would attempt to integrate the activities of existing public agencies by focusing on the needs of specific geographical subareas and target populations. Not coincidentally, this was very much in line with the "poverty-focused" integrated rural development approach adopted by the Bank and other international aid institutions at the time. These programs include POLONORDESTE and Projeto Sertanejo, which covered the interior of the region, as well as PROCANOR for the sugar-producing coastal zone which will not be discussed in this report. Other rural programs implemented simultaneously in the Northeast included DNOCS irrigation projects, scattered throughout the semi-arid interior, and the emergency drought relief program, neither of which will be touched upon further here since they are not directly relevant to development of the Sao Francisco valley. Other key interventions since the mid-1970's, such as the Water Resource Use Program (PROHIDRO), PROVARZEAS and PROFIR, however, will be briefly assessed in the following paragraphs. In addition, Projeto Nordeste or PAPP, the region-

⁷ The experience with these incentives and with regional industrialization more generally is analyzed in an unpublished report (No. 6077-BR) entitled Brazil: Industrial Development Issues of the Northeast, World Bank, February 25, 1987.

wide successor to POLONORDESTE, will be summarily discussed as will PRONI, the national irrigation incentive scheme.⁶

1. POLONORDESTE

2.13 The Northeast Integrated Area Development Program (POLONORDESTE) was established in 1974 to stimulate agricultural and livestock development in selected "growth poles" throughout the region. Initially, twenty-four areas were chosen on the basis of agricultural potential and political criteria for the implementation of integrated rural development projects (PDRIs), which would target landless, quasi-landless and small farmer groups as the major beneficiaries. By 1981, POLONORDESTE had expanded to include forty-three PDRIs and four colonization schemes, covering more than 500,000 km² in all nine northeastern states, with project areas that varied considerably in both territorial and demographic size. The World Bank and the Inter-American Development Bank each financed a number of these projects.⁹ Five of the PDRIs, moreover, were located in or substantially overlapped sections of the Sao Francisco valley.

2.14 Basic program instruments included investment in feeder roads, rural electrification, crop storage facilities, agricultural research and extension, subsidized credit and complementary investments in social infrastructure such as health, education and water supply. To these were added support for cooperatives and small non-agricultural enterprises, land-titling and fisheries. The management structure of POLONORDESTE, however, was unwieldy, with the program being administered at four different levels: federal (Economic Development Council), regional (SUDENE), state and municipal.

2.15 By 1980, POLONORDESTE's achievements had fallen far short of its initial targets: only 37% of the projected number of farmers had actually been assisted, 18% had received credit, fewer than 6% of the anticipated land titles had been distributed and less than a third of the planned health posts and water supply systems had been built. Benefits, moreover, had for the most part been monopolized by some 100,000 owner-occupiers, with the bulk of the program's three million low-income rural families, especially landless farmers, being largely excluded from credit and agricultural services. There were several major

⁶ The experience with POLONORDESTE and PAPP to date is the subject of a separate OED evaluation by Judith Tendler, et. al. in a report entitled "New Lessons from Old Projects: The Dynamics of Rural Development in Northeast Brazil" (Washington, January 1991). These two programs will, thus, be only briefly described in the present document.

⁹ Project Completion Reports (PCRs) and/or Project Performance Audit Reports (PPARs) have been sent to the Board for a number of the POLONORDESTE projects supported by the World Bank. See OED Reports No. 6776 (Rio Grande do Norte and Sergipe-Tabuleiros Sul Rural Development Projects), dated May 27, 1987; No. 7331 (Bahia-Paraguacu Rural Development), dated June 27, 1988; No. 7910 (Ceara-Ibiapaba, Paraiba-Brejo and Pernambuco-Agrete Setentrional Rural Development Projects), dated June 28, 1989; and No. 8380 (Ceara-Second Rural Development Project), dated February 9, 1990.

obstacles to implementation.¹⁰ POLONORDESTE's complex administrative structure made it difficult to achieve effective coordination among executing agencies with multiple levels of responsibility, overlapping functions and complicated mechanisms for allocating and transferring funds. These problems were compounded by the impact of another major drought between 1979-83 and, more importantly, by the persisting long-term land distribution and tenure problem in the Northeast.¹¹ In addition, the program was excessively "top-down", allowing virtually no local participation in the design of its components and individual investments.

2. Projeto Sertanejo

2.16 A second significant initiative was the Special Development Assistance Program for Semi-Arid Regions (Projeto Sertanejo), established by SUDENE in 1976 with the objective of increasing the productivity, incomes and drought-resistance of the agricultural sector in the sertao. An interministerial group in Brasilia and a regional team based at SUDENE were responsible for overall coordination. This effort was to be implemented by DNOCS or CODEVASF in areas where these agencies already had projects and by state governments elsewhere in the semi-arid interior. Each Sertanejo "nucleus" would have a 30-kilometer radius within which agricultural services would be targeted at small, medium and large landowners. Both irrigated and dryland farming were supported through small reservoir construction, livestock production and soil improvement, facilitated through the provision of technical assistance and heavily subsidized rural credit (carrying a 5% annual unindexed interest rate with twenty year and six year repayment and grace periods, at a time of 100% annual inflation).

2.17 By 1981, some 46 operational "nuclei" had been established, all except one under the jurisdiction of DNOCS or state agricultural secretariats. According to a SUDENE evaluation at the time, Projeto Sertanejo's results had already fallen far short of its original targets: irrigated land amounted to only 4,560 hectares (5.4% of the initial target), land placed under rainfed crops was 14,000 hectares (5.0%), land placed under pasture was 49,300 hectares (5.0%) and permanent jobs created reached 9,800 (7.5%). In distributive terms also, the results were disappointing. Medium-sized and large farmers with 100 hectares or more received a disproportionately large share of the subsidized credit, particularly for livestock development, while almost no funds had been made available for land acquisition by small farmers. Once again, poor coordination among implementing agencies, coupled with fundamental political distortions in

¹⁰ World Bank, Brazil: An Interim Assessment of Rural Development Programs for the Northeast, Washington, 1983. For a more general review of the Bank's experience with integrated rural development projects, see Operations Evaluation Department, Rural Development: World Bank Experience 1965-86, Washington, 1988.

¹¹ The importance and intractability of land distribution and tenure problems in the region were highlighted in a World Bank study reported in a book by Gary Kutcher and Pasquale Scandizzo entitled The Agricultural Economy of Northeast Brazil, Johns Hopkins University Press, Baltimore, 1981.

resource distribution at the local level and the failure to address the land issue, seriously undermined the program, which was eventually abolished.

3. Water Resource Use Program (PROHIDRO)

2.18 PROHIDRO was set up in 1979 to complement the activities of DNOCS and CODEVASF by increasing the availability of water to small farmers, both for human and animal consumption and for irrigation, in the semi-arid Northeast. Coordinated by SUDENE at the regional level and by the Ministry of the Interior nationally, specific measures included the construction of public and private reservoirs, installation and maintenance of community wells and the regulation of the water flow (perenizacao) along the region's rivers, which experience large seasonal fluctuations, through the construction of small dams. This was intended to permit more regular use of the fertile valleys and floodplains (varzeas) with small-scale irrigation technology.

2.19 In practice, however, the program was biased toward more traditional water conservation techniques. By the early 1980's, private reservoir construction had advanced rapidly, achieving 75% of its target, while only 12% of planned community wells had been built and just a handful of the twenty-five proposed river flow regulation projects had been executed. There was some evidence, moreover, from the associated "Asa Branca" state water resource development program in Pernambuco to suggest that rising land values in benefitted valleys tended to drive out small farmers and lead to increased land concentration. Lack of extension assistance, technical flaws with dam construction, the failure to include a land titling component, salinization and pollution from agro-chemicals also threatened to undermine the effectiveness of the scheme.¹²

F. Parallel Rural Development Projects

1. PROVARZEAS, PROFIR and PRONI

2.20 The Program for the Development of Floodplains (PROVARZEAS) began as a state initiative in Minas Gerais in 1975, but was extended to the rest of Brazil, including the Northeast, by the Ministry of Agriculture in 1981. It is essentially a program of subsidized credits and technical assistance for on-farm investments in irrigation and drainage works for private farms of all sizes. PROVARZEAS also assists farmers in securing investment credit from official banks. In 1982, this program was supplemented by PROFIR to finance irrigation equipment such as overhead pressure systems. PROFIR was initially designed primarily to help promote wheat production in the central Brazilian plateau (cerrado), but was subsequently extended to the Northeast and is, at least in principle, available to small, as well as medium and large, farmers.

2.21 Again, quantitative results have fallen well short of the ambitious goals originally set. While the Brazilian Government hoped that PROVARZEAS and PROFIR would irrigate no less than 750,000 hectares by 1986, the programs, in

¹² Anthony Hall, "A Re-Appraisal of Government Irrigation Strategy in Northeast Brazil," mimeo, London, 1983.

fact, achieved less than 10% of this target (72,000 hectares), while only 3,300 hectares were benefitted in the Northeast during this period.¹³ Problems observed included the comparatively high cost of the scheme, the lack of adequate soil and water surveys, the limited labor absorption capacity of newly irrigated lands and the possibility of land concentration which would squeeze out smaller farmers.

2.22 A first attempt to coordinate irrigation development in Brazil, hitherto undertaken by a variety of federal, regional and state institutions, was made in 1979 with publication of the Irrigation Law which set out the first National Irrigation Policy under the direction of the Ministry of the Interior. However, little action was forthcoming until the Irrigation Program for the Northeast (PROINE) and the National Irrigation Program (PRONI) were established in January and February 1986, respectively, under a new, if shortlived, Ministry of Irrigation. PRONI has since absorbed PROINE and is now under the wing of the Irrigation Secretariat of the Ministry of Agriculture, which coordinates the activities of DNOCS and CODEVASF and oversees the private initiatives supported through PROVARZEAS and PROFIR. Between 1989 and 1995, it is envisaged that 350,000 hectares will be irrigated annually under PRONI, 100,000 of which would be in the Northeast and at least 40% by private enterprise.¹⁴

2. Projeto Nordeste

2.23 Following a decade of "special programs" for the Brazilian Northeast which had made little impact on regional poverty or productivity, in an attempt to define development goals more clearly and to rationalize and better coordinate the activities of existing agencies, the Government created a new umbrella program in 1985. The first stage of Projeto Nordeste is being implemented through the Program of Special Assistance to Small Producers (PAPP) and, in practice, the two have become synonymous. The major focus is on: (i) the regulation of landownership, including land redistribution, titling and resettlement; and (ii) water resource development, including public and private small-scale irrigation and water supply and storage. Supporting activities include the provision of rural credit, adapted agricultural research, farm extension services, marketing and official support for existing community organizations. While Projeto Nordeste covers the entire region, like POLONORDESTE, its interventions are concentrated in priority areas including those where land reform is underway, where development schemes have already been initiated, areas of "social tension," along river valleys or where there is a heavy concentration of poorer sharecroppers, squatters and tenant farmers.

2.24 In its first planning period (1985-89), Projeto Nordeste aimed to benefit some 600,000 families at a cost of US\$ 3.36 billion, 70% of which was

¹³ Programa Nacional de Irrigacao - PRONI, Ministry of Agriculture, Brasilia, 1986.

¹⁴ Programa Nacional de Irrigacao - PRONI: Resenha Setorial de Irrigacao no Brasil, Ministry of Agriculture, Brasilia, 1989. For recent developments with respect to irrigation development in Brazil, see also World Bank, Brazil - Irrigation Subsector Review, Report No. 7797-BR, 1989.

to be funded internally from domestic resources, with the World Bank providing 22% and the IDB the remaining 8%. The program is overseen nationally by an interministerial council and at regional level by SUDENE. At the state level, in turn, a Rural Development Council (CDR) -- comprising various secretariats and representatives of federal agencies such as DNOCS, BNB and CODEVASF -- is responsible for coordination. Unlike its predecessor, POLONORDESTE, Projeto Nordeste/PAPP places substantial emphasis on the decentralization of decision-making to Municipal Development Councils (CDMs), composed of local political leaders and trade union and other community representatives.

2.25 In the absence of concrete empirical evidence, it is not yet possible to draw clear conclusions regarding the performance of Projeto Nordeste/PAPP to date. The picture is further complicated by the withdrawal of the land component from the regional sphere to the ill-fated National Agrarian Reform Program (PNRA), introduced in 1985. Yet initial research provides some indications of likely program results.¹⁵ The omission from PAPP of certain components included under POLONORDESTE is widely perceived to have limited the new program's impact; these components include infrastructural investment in roads, electrification, water supply, health and education, as well as working capital, credit and subsistence crops (as opposed to longer-term investment credit and cash crops, which have been effectively favored under PAPP) and support to small non-agricultural enterprises. These omissions have been compounded by the persistence of institutional and political obstacles to the more widespread and equitable distribution of program resources and, hence, of potential benefits. Furthermore, the low political pay-off to state Governors of the remaining, somewhat concentrationist, agricultural components within PAPP, appear to have decreased its attractiveness and, thereby, undermined its implementation.

G. Conclusion

2.26 Since the 1970's, the Brazilian Northeast has witnessed a series of regional programs designed to promote rural development which have met with only mixed success. In view of the relatively unimpressive performance of dryland-based initiatives, the tapping of relatively scarce hydrological resources for energy and agricultural production has been perceived by planners and policy makers as an increasingly important means of promoting rural productivity and economic growth in the region. In the midst of a much larger area which has consistently suffered from erratic rainfall distribution and periodic and often catastrophic droughts, the comparatively privileged Sao Francisco valley has become a focal point for the expansion of both hydropower generation and irrigated commercial agriculture, building upon its traditional role as a perennial waterway and center of rural subsistence activity in the interior of the region.

¹⁵ Tendler, Judith, "Northeast Brazil Rural Development Evaluation: First Impressions," mimeo, OED, December 1988, and "Northeast Brazil Rural Development Evaluation," partial draft, OED, December 1989.

III. THE MIDDLE AND LOWER SAO FRANCISCO VALLEY

A. Project Areas of Influence

3.01 The four Bank-funded projects analyzed in this report have had wide repercussions in the Sao Francisco valley and have helped to accelerate the pace of social and economic change in the region. These changes include both the direct impacts on affected populations in the immediate vicinity of the projects themselves and their longer-term and more indirect, but no less important, consequences for the on-going development process in and around the valley more generally. Thus, the areas of influence of the schemes in question go far beyond the nominal project boundaries. The broader influences of these initiatives on the society and economy of the valley are dealt with below.¹ The construction of the Sobradinho dam and associated reservoir, which was a crucial component of the Paulo Afonso IV (PA IV) Hydropower Project, for example, has triggered a major transformation in the demographic and productive structures of the lakeside area, whose full consequences are just beginning to be felt.

3.02 Sobradinho also reveals the potentially profound and far-reaching implications of hydropower development projects in densely populated valleys. The lower Sao Francisco polders and irrigation (SF I and SF II) projects were conceived as a direct response to the adverse consequences of Sobradinho on the rural population living almost 800 kilometers downstream near the mouth of the river. Regulation of the Sao Francisco's seasonal variation increased the lowflow and threatened to permanently flood large areas of productive farmland, thereby disrupting the traditional rural economy of the region. Furthermore, even though it is presently difficult to assess future broader impacts in the Itaparica region, the installation of large irrigation schemes as part of a structured resettlement program is likely to exert a significant influence on the future development of a large area surrounding the reservoir, as well as considerably farther upstream where a number of these subprojects are located.

B. Ecological Characteristics of the Sao Francisco Valley

1. General Features of the Sao Francisco Valley

3.03 The 2,700 kilometer Sao Francisco, traditionally known as the "river of national integration," crosses five states in south-central (Minas Gerais) and northeastern Brazil (Bahia, Pernambuco, Sergipe and Alagoas) and has affluents in a sixth (Goiás). The entire river basin covers 640,000 square kilometers -- or 7.5% of Brazilian territory -- representing an area roughly the size of Afghanistan and larger than that of Spain and Portugal combined. Just over half of the Sao Francisco basin is situated within the "drought polygon" in the Northeast. The river, whose rate of flow averages some 2,000 m³/second, rises in the Canastra mountains in Minas Gerais and flows northward, then eastward, crossing several different ecosystems characterized by large variations in soils and climate. The upper Sao Francisco valley has a wet season from November to March, with rainfall averaging 1,200 mm per annum, while the middle

¹ See section D of Chapter VI below.

Sao Francisco has half this amount of precipitation at 600 mm per annum. The lower-middle valley -- site of the Sobradinho and Itaparica reservoirs -- in turn, has a semi-arid climate, with 400 mm of yearly rainfall, in sharp contrast to the lower Sao Francisco, which is characterized by tropical moist weather and over 1,000 mm of annual rainfall. Unlike the upper valley, moreover, the wet season in the lower Sao Francisco region extends from June to August.

3.04 The Sao Francisco River has 36 tributaries, roughly half of which are perennial. The remainder, located in the semi-arid interior, are dry except during the rainy season. The rate of flow of the Sao Francisco itself varies considerably, from 14 liters per second at the source, to 4.8 liters/second overall. Here also, there is a marked seasonal variation which has a dramatic impact on the valley. In the upper and middle reaches, flooding occurs during the wet summer months (ie. November-March) with drier conditions during the winter. In the lower Sao Francisco, however, this sequence is reversed, with the rainy season coinciding with the winter months. Thus, the lower Sao Francisco normally experiences two periods of flooding, one caused by rains falling upstream of Paulo Afonso during the summer and the other due to winter rainfall occurring in the lower valley itself.

3.05 Significant pluriannual variations also occur in this pattern. During 1932-49, for example, there was above-average discharge, while from 1974-77 the flow was below normal levels. Such changes have serious implications for flow regulation by reservoirs which, in turn, may have drastic consequences for riverine populations. As a result of damage caused by serious floods in 1979, an "Interministerial Commission for the Study of Flooding on the Sao Francisco River" was established. This body recommended that a quantity of 1,290 cubic hectometers should constitute a reserve level in the Tres Marias reservoir in the upper Sao Francisco valley. Although Sobradinho had not originally been planned for this purpose, it was also decided to use this lake for flood control, with a reserve of 8,200 cubic hectometers, the equivalent of 28% of its total capacity.

3.06 The Tres Marias and Sobradinho reservoirs likewise reduce the impact of the periodic droughts in the Northeast by guaranteeing minimal flows along critical stretches of the river. Nevertheless, there are periods of below-average rainfall during which these dams cannot effectively ensure projected minimum flow levels. Thus, for example, the discharge at Sobradinho in mid-1989 was well below the planned constant minimum flow of 2,060 m³/second. The worst flooding in the valley over the past half century occurred in 1946, 1949, 1975, 1979 and 1985. The potential adverse impact of the 1979 flood, however, was substantially reduced by Sobradinho, when the river flow rate at Juazeiro of 18,000 m³/second was cut to 14,000 m³/second on account of the dam.

2. Surface Water Resources: Competing Uses

3.07 The waters of the Sao Francisco are utilized or otherwise "consumed" by several competing activities, namely, electricity generation, irrigation, urban development, navigation and evaporation. Due to growing competition for water resource use, there is likely to be a shortage of water from the Sao Francisco during periods of below-average rainfall in the foreseeable future. PLANVASF estimates that the total volume of water stored in the more than one hundred large

and small reservoirs in the Sao Francisco valley is on the order of 60.0 billion m³, of which 54.7 billion m³ are stored along the main river itself for purposes of electricity generation.² These reservoirs, especially Sobradinho, should enable a minimum flow rate of 2,060 m³/second to be maintained downstream of the dam. Water is currently used for the purposes briefly described below.

3.08 Hydropower Generation. According to PLANVASF, power stations in the valley generated 5,913 MW of electricity in 1988. Adding the subsequent 1,000 MW from the first stage of Itaparica gives a figure of 6,913 MW for 1989. Two additional turbines due to come on stream at Itaparica will raise this figure to 7,413 MW, only 49 MW of which is generated on affluents of the Sao Francisco.

3.09 Irrigation. Irrigation projects in the Sao Francisco valley may be divided into two major categories, public and private. According to PLANVASF, in 1983, public irrigation schemes occupied 73,775 ha, consuming roughly 85 m³ of water per second, while private irrigation schemes consumed roughly another 11 m³/second. More recently, informed sources put the total irrigated area in the Sao Francisco Valley at some 250,000 ha, whose water use ranges from 0.5 to 2.3 liters/sec/ha, giving an average consumption of about 350 m³/second.³ Under PLANVASF, some 1.45 million hectares are planned to be developed in public irrigation projects, with a total projected water demand of 690 m³/second. This figure, however, seems rather conservative considering the irrigation technology currently in use. To this figure, moreover, an unknown amount must be added for future private irrigation expansion. Private irrigation schemes, which are presently estimated by CODEVASF to occupy around 100,000 ha in the valley as a whole,⁴ but are likely to expand considerably over the coming decades.

3.10 Urban Consumption. Figures for urban water consumption are incomplete. PLANVASF calculated the 1985 rate as 11.5 m³/second, based on a consumption of 100 liters per person per day. However, given the dry climatic conditions prevalent in the region, this is probably about half the actual amount. Assuming an urban population share of 50% and considering the recent rapid growth of towns and cities and industrial (especially agro-industrial) activities, the likely urban consumption rate was probably between 20 and 30 m³/second in 1989.

3.11 Evaporation. The annual water loss for Itaparica, Moxoto, Tres Marias and Sobradinho reservoirs is conservatively put at 315 m³/second in 1989.⁵ When additional reservoirs at Ibo, Oroco, Paratinga and Pao de Acucar are included, however, the total figure rises to 520 m³/second.

² Plano Diretor Para o Desenvolvimento do Vale do Sao Francisco (Recursos Hidricos Superficiais), RTE 86/16, Brasilia, October 1988. PLANVASF was prepared during the period 1984-87 period by the Brazilian Government, through CODEVASF and SUDENE, together with the Regional Development Department of the Organization of American States (OAS).

³ Ibid., Table IV.

⁴ See Annex 2.

⁵ PLANVASF, op. cit.

3.12 Navigation. In order to ensure that the Sao Francisco is navigable, minimum flow rates of 500 m³/second at Pirapora and 2,000 m³/second downstream from Sobradinho are necessary. These amounts are essential for the operational system which links energy generation along the river valley, together with the other sources of demand for water use.

3.13 Water Transfer to Other River Basins. Plans have existed since 1910 for the transfer of water from the Sao Francisco to irrigate land in the semi-arid interior of the states of Ceara, Rio Grande do Norte and Paraiba. PLANVASF reviewed several proposals, the most grandiose being a plan to transport 330 m³/second of water through a project estimated to cost US\$ 1 billion that would tap the river at Cabrobo (Pernambuco) in the middle valley, utilizing four pumping stations, 30 kilometers of canals and 14 dams.

3. Climate and Salinization

3.14 As already mentioned, the Sao Francisco valley has a varied and complex climate, with three contrasting ecosystems and rainfall regimes. Annual precipitation ranges from 350 to 1,600 mm and average temperatures vary from 18 to 27 degrees Centigrade. In the lower valley near the coast, rainfall peaks in May, while in the middle portion rainfall is most heavily concentrated in March and in the upper reaches in December. Superimposed on this broad distribution are further variations and areas of transition. The Sao Francisco River, moreover, flows through the semi-arid sertao for over half of its course. This area is characterized by low and variable rainfall, a crystalline rock structure, soils with poor permeability and aquifers which are too small to regulate river flow. Thus, due to geological features and a distribution of rainfall which is highly concentrated over a short period, many of the rivers in the vicinity are intermittent. During the dry season, which may last up to eight months, accordingly, the surface flow of the Sao Francisco is largely dependent on the arrival of waters from southern tributaries in Minas Gerais and Goias.

3.15 Natural salinization of the water table is common throughout the semi-arid Northeast. Wells bored through crystalline rocks demonstrate a low water output of 4 m³/hour with a salinity level which varies from 500 to 20,000 parts per million (ppm), averaging 2,000 ppm. In crystalline structures, chlorates of sodium and magnesium predominate, making water unfit for human consumption and creating serious problems for irrigation. Such water is normally used only for domestic animals. A number of research projects have been undertaken which attempt to explain the dynamics of salinization.⁶ These studies conclude that waters in

⁶ See especially those by Eneas Salati et. al.: "Estudo Preliminar das Concentracoes de 18 O e D em Aguas do Nordeste Brasileiro," Boletim Cientifico, BC-002, CENA/USP/CNEN, 1971; "Environmental Isotopes Used in a Hydrogeological Study of Northeastern Brazil," in Isotope Techniques in Groundwater Hydrology, Vol.I, IAEA, Vienna, 1974; "Utilization of Natural Isotopes in the Study of Salinization of the Waters in the Pajeu River Valley, Northeast Brazil," in Arid-Zone Hydrology; Investigations With Isotope Techniques, IAEA, Vienna, 1980; and, Otimizacao do Manejo de Agua da Regiao Semi-arida do Nordeste Brasileiro, IV Simposio Brasileiro de Hidrologia e Recursos Hidricos, Fortaleza, November 1981.

sedimentary formations are the oldest -- sometimes over 100,000 years as in some deep wells -- while water in crystalline rock areas is of relatively recent origin, with a recycling time ranging from 30 to 300 years. These salts are of oceanic origin, carried to the region by rainfall. Rainwater has a chlorate concentration of from 0.5 to 5 ppm. This salt concentration is in a stable state of dynamic equilibrium at present but is liable to change depending upon the hydrological balance, itself subject to modification by human activity such as settlement. Of critical importance for the present study is the fact that rainfall in the region brings about 10-30 kgs/ha per annum of salt, which is concentrated through the process of evaporation in surface and subterranean water supplies.

3.16 The use of surface water for irrigation gives rise to additional problems of salinization. Even the best quality river water, such as that of the Sao Francisco, has a salt concentration over ten times higher than that of rainwater. The Sao Francisco introduces, annually, about 800 kgs/ha of salt when its waters are used for irrigation. Thus, in the absence of adequate natural or manmade drainage, there is an automatic tendency for salinization to occur given the intense evaporation which takes place in the region. This tendency has long been noted, and it is estimated that about 10% of irrigated lands in the Northeast, or a total of some 25,000 ha, experience salinization problems.

3.17 In most cases, salty soils are subject to recuperation as long as a proper drainage system exists.⁷ Adequate drainage allows water to flow away and permits a lower water table, thereby facilitating aeration of plant root systems. The major problem encountered in this respect is poor maintenance of drainage canals, which are frequently choked with vegetation that prevents water from escaping. In other cases, however, salinization may bring more serious problems when the soil is saturated with sodium ions. Other problems arise from salinized tributaries in the lower Sao Francisco valley which feed into the main river and local irrigation schemes, occasionally causing widespread unanticipated flooding.

C. Demographic Characteristics

3.18 As the major waterway in the Northeast and the only perennial river crossing the semi-arid sertao, over the centuries the Sao Francisco valley has acquired a relatively high population density. Colonial penetration of the interior and subsequent trade and transportation activities gave rise to relatively large urban centers such as Penedo, Petrolina and Juazeiro. Agricultural settlement and livestock development along the fertile floodplain also occurred, attracting a substantial farming population and offering a far more favorable environment for settlement than the surrounding drylands. This historically high demographic density has had the effect of maximizing the human environmental impacts of the Bank-supported projects examined in this report.

⁷ C.R. Valdivieso-Salazar and C.G. Cordeiro, Projeto de Drenagem Subterranea da Estacao Experimental da EMBRAPA no Perimetro Irrigado de Bebedouro, Pernambuco, EMBRAPA-CPATSA, Publication No. 52, 1988. C.R. Valdivieso-Salazar, Drenagem Agricola: Relacao na Producao e Procedimentos de Diagnostico, EMBRAPA-CPATSA, Publication No. 53, 1988.

3.19 Prior to the implementation of the operations under review, all three of the specific subregions involved possessed sizeable urban and rural populations, mainly concentrated along the floodplain. The total population of the areas in the middle and lower Sao Francisco valley directly or indirectly affected by the Sobradinho dam, associated emergency irrigation projects and subsequent developments at Itaparica, according to the 1970 census, stood at around 1.4 million, 75% of which was officially classified as rural. Petrolina was the largest city in the middle and lower valley, with 37,800 inhabitants, closely followed by Juazeiro with 36,300 and Penedo with 23,400. Most other urban centers were small, including Remanso (7,000), Casa Nova (2,400), Pilao Arcado (1,300) and Sento Se (1,200), all of which had to be relocated as a result of the PA IV Project. The most densely populated area, however, was the lower valley, which had 540,000 inhabitants in 1970, of which 213,000 -- or roughly 40% -- were located in the eighteen riparian municipalities directly affected by the projects under consideration.

D. Socio-Economic Characteristics

1. Middle Sao Francisco Valley⁸

3.20 By the early 1970's, productive activities in the middle valley had evolved into a complex and delicately balanced system which was carefully attuned to local geography and environmental conditions, broadly divided between the fertile valley and semi-arid scrubland or caatinga.⁹ Although pasture accounted for about two-thirds of total land in rural establishments, the rearing of beef cattle and goats was responsible for only one-quarter of the total value of production. While livestock was then -- and continues to be -- a strategically important investment for large and small farmers alike as a form of capital accumulation and longer-term insurance against climatic (ie. drought-induced) and economic uncertainties, the rural economy of the region was based mainly on agriculture.

3.21 The rural population and the bulk of agricultural production was concentrated along the river banks and in the mid-stream "islands" of the Sao Francisco. Some 12% of farmland accounted for 75% of productive output in terms of value, mainly on the Pernambuco side of the river. The diversity of agriculture in the region was reflected in a combination of traditional rainfed crops such as maize, manioc, beans, castor and cotton, alongside an increasingly important irrigated output of onions, tomatoes, rice, melons, grapes and bananas. Riverine lands were used to practice varzea farming during the rainy season in the

⁸ For purposes of this study, the middle Sao Francisco valley comprises the area between Barra, Bahia at the southern tip of Lake Sobradinho and the town of Pao de Acucar in Alagoas downstream of Paulo Afonso, covering a distance of more than 900 kilometers.

⁹ This section draws on the following: Tim Campbell, "Social and Economic Consequences of Resettlement - the Case of the Sobradinho Hydropower Dam, Brazil," mimeo, Inter-American Development Bank, Washington D.C., 1984, and Fundacao Joaquim Nabuco, Hidreletrica de Itaparica: Impactos e Mudanca no Meio Rural, Recife, 1988.

alluvium-rich floodzone, while small-scale diesel-pump irrigation was used in the dry season. The area of irrigated land in the middle valley expanded steadily during the 1970's, with some municipalities such as Petrolandia in Pernambuco and Rodelas in Bahia witnessing a four-fold increase during the decade, with up to 20% of total farmland under irrigation. This period likewise saw a significant increase in the use of tractors and other modern farm inputs in the area, which appears to have been associated with the generalized process of land concentration as northeastern agriculture was becoming more capitalized.¹⁰

3.22 In accordance with the general pattern in Northeast Brazil, landownership in the middle Sao Francisco valley was heavily concentrated. In the area subsequently flooded by the Itaparica reservoir, for example, data collected by the National Colonization and Agrarian Reform Institute (INCRA) show that minifundia (average size under 15 hectares) accounted for 81% of all properties, but occupied only 19% of total farmland. Latifundia (average size 283 hectares), on the other hand, formed only 16% of total properties, but covered 71% of the land. "Rural enterprises" (average size 343 hectares), in turn, represented 1.7% of all units and cultivated 9% of total farmland. Legal ownership rights were unclear and had evolved in various directions. Technically, the "islands" and the land on the riverbanks up to 15 meters from the water's edge at maximum level belonged to the Ministry of the Navy. Over the generations, however, these areas had been occupied by "owners" and leaseholders who did not possess legal title. Many of these occupants, in turn, sub-let the land to other parties.

3.23 Over half of the farms in the middle valley were cultivated by non-owners, and tenure relationships were dominated by a combination of sharecropping, tenancy and wage-labor. Ties of social dependency and debt-bondage with landowners (in which up to 50% or more of production went to the owner in exchange for usufruct rights), along with the domination of marketing by monopolistic intermediaries serving under-resourced small cultivators, helped to perpetuate a situation of generalized poverty and deprivation. However, in spite of the inherently exploitative nature of this system, it did allow many independent small farmers to make an adequate living from the land and, by and large, to meet their basic household needs.

2. Lower Sao Francisco Valley¹¹

3.24 The agricultural economy of the lower valley, in contrast, has traditionally been dominated by rice cultivation, which followed the natural rise and fall of the Sao Francisco's waters during its annual cycle. Prior to the construction of Sobradinho dam, the regular deposits of alluvium precluded the need for large applications of fertilizers. In what is now CODEVASF's project

¹⁰ See, for example, Redwood, John III, "A Evolucao Recente da Agricultura Nordeste: Principais Tendencias e Transformacoes," DRIN-BRAZIL Document No. A-15, Recife, March 1983 and Redwood et. al., "Estrutura Fundiaria e Transformacoes Recentes no Setor Agricola em Pernambuco," DRIN-BRAZIL Document No. A-10, Recife, May 1982.

¹¹ The lower Sao Francisco valley corresponds to the section of the river between Pao de Acucar and the mouth of the river some 220 kilometers downstream.

area, some 20,000 hectares of varzea were planted to rice, employing over 10,000 families directly on the land. Additional activities included production of other staple foods such as beans and manioc, as well as some short-cycle herbaceous cotton, coconut extraction, artesanal fishing and cattle raising.¹²

3.25 For historical reasons, land distribution in the region, as elsewhere in the Northeast, was heavily skewed. According to 1970 census figures, only 7% of rural establishments occupied 80% of total farmland, with fewer than 100 proprietors controlling 90% of this area. At the other extreme, some 90% of all rural properties were under 10 hectares in area, occupying just under a quarter of the arable land. Nevertheless, the region's fertility and productivity, together with the extensive use of sharecropping and tenancy, accounting for 75% of farmers in the area, favored a high population density of up to 174 inhabitants per square km., compared with a figure of 50 persons per km² for the state of Alagoas and 18 persons/km² for the Northeast region as a whole.¹³

3.26 The generally exploitative nature of sharecropping, in which half or more of the rice crop went to the landowner, was partially offset by access to fishing for supplementary income, as well as the freedom to plant subsistence crops. Sharecroppers normally had the right to cultivate 1 to 1.5 hectares of low-lying riceland, together with about one hectare of land at a higher elevation. However, mechanisms such as the use of informal credit and advance fixing of crop prices tended to decrease the cultivator's net disposable income, which was estimated in the early 1970's to be on the order of US\$ 100 per annum, or about half the average rural income in the Northeast.¹⁴ In view of the widespread practice of subsistence farming, however, this figure probably understates real living standards in the area. In any event, the increasing substitution of sharecropping by wage-labor, as well as the spread of sugar cane plantations in response to incentives granted under the PROALCOOL program,¹⁵ especially in southern Alagoas, was beginning to undermine the traditional system by the mid-1970's.

¹² Appraisal of the Lower Sao Francisco Polders Project, Report No. 714a-BR, World Bank, Washington, May 16, 1975 and H. O. M. Barros, "Modernizacao Agricola Autoritaria e Desestruturacao do Ecosistema: O Caso do Baixo Sao Francisco," Cadernos de Estudos Sociais, Fundacao Joaquim Nabuco, Recife, Vol. 1, January-June 1985.

¹³ Barros, *ibid.*

¹⁴ Appraisal of the Lower Sao Francisco Polders Project, *op. cit.*, pg. 5.

¹⁵ The National Alcohol Program (or PROALCOOL) was initiated by the Brazilian Government in 1975 in response to the first petroleum price shock and consisted of subsidized credits and other incentives to private producers of (for the most part) sugar cane-based alcohol to be used as a fuel for light vehicles either to supplement ("gasohol") or substitute gasoline, derived, at that time, largely from imported oil. After the second oil price increase in 1979, PROALCOOL was expanded with the support of Bank Loan 1989-BR in the amount of US\$ 250.0 million, approved in July 1980. This operation, which closed in March 1987, has recently been audited by OED (Report No. 8887 dated June 29, 1990).

E. Conclusion

3.27 During the early 1970's, therefore, the ecological, demographic and socio-economic characteristics of the middle and lower Sao Francisco valley mirrored the situation in other Northeastern valleys, particularly those with perennial rivers. A relatively concentrated rural and urban population had, over the centuries, become established in the region by virtue of favorable environmental conditions in comparison with the semi-arid interior. Ready access to water for domestic, industrial, irrigation and transportation purposes was complemented by the availability of fertile alluvium-rich soils along the valley floor which supported a productive rural economy and a small, but growing, urban sector.

3.28 On the other hand, quasi-feudal land ownership and tenure arrangements had led to a concentration of wealth and political power over the same period, with correspondingly poor living standards and low income levels for the vast majority of farmers. In the region's towns and cities, in turn, few formal employment opportunities were provided. Given that there was little likelihood of this situation experiencing fundamental change on the basis of existing development tendencies, the Bank-assisted projects considered in further detail below have played a key role in the significant transformations which have taken place in the middle and lower Sao Francisco valley since the 1970's.

IV. BANK-ASSISTED DEVELOPMENT PROJECTS

4.01 Before turning to the physical and human environmental impacts of Bank-supported hydropower, irrigation and resettlement projects undertaken in the middle and lower Sao Francisco valley over the past two decades, it is useful to briefly describe these operations, their implementation experience and principal non-environmental results. In doing so, reference will be made to the projects' origins, objectives and main components, as well as to their institutional arrangements, general performance and major outcomes. Since all but one (Itaparica) of these operations have been completed and have, thus, been the object of performance audit and/or completion reports, moreover, the basic conclusions and lessons presented in these documents -- including those specifically related to environmental issues and aspects -- will also be briefly summarized.

A. The Paulo Afonso IV Hydropower Project

1. Origins, Objectives and Description¹

4.02 As indicated in para. 2.05 above, the Paulo Afonso IV Hydropower (PA IV) Project had its origins in studies by the Ministry of Mines and Energy in the late 1960's. Based largely on expected rapid rates of urban and industrial expansion in the Northeast, these studies projected a growth rate of energy demand of nearly 14% a year through 1982. CHESF determined that the least-cost alternative to supplying anticipated regional power needs through the mid-1980's was the progressive hydroelectric development of the Sao Francisco valley, complementing earlier investments at Paulo Afonso. This would include installation of the Sobradinho dam and reservoir, the expansion of generating capacity at Paulo Afonso and the construction of new generating plants at Moxoto and Kingo. The subsequent development of the Itaparica dam and reservoir was also part of this program.

4.03 The Inter-American Development Bank (IDB) and the World Bank (IBRD) were approached by ELETROBRAS, on behalf of CHESF, in mid-1972 to provide funding for the PA IV Project. Agreements had previously been reached with the IDB for the financing of the Moxoto plant, which was already under implementation at the time. CHESF presented feasibility studies for the PA IV operation in early 1973 including preliminary plans for the resettlement of some 9,700 families to be displaced upstream as a result of the Sobradinho reservoir. The project was appraised jointly by IDB and IBRD in July-August 1973, with a follow-up World Bank mission in October-November 1973. IDB's loan for US\$ 84.8 million was approved on December 20, 1973 and, after negotiations in April-May 1974, IBRD

¹ This and the following sections are largely based on the President's Report (No. P-1414-BR), dated May 22, 1974, the Staff Appraisal Report (No. 396a-BR), dated May 15, 1974, and the project completion and audit reports (OED Report No. 6578), dated December 31, 1986, for the Paulo Afonso IV Hydropower Project.

funding in the amount of US\$ 81.0 million was approved on June 4, 1974. Both loans were signed on June 17, 1974.

4.04 The principal rationale for IBRD assistance to the project was to support the Government's broader development efforts for the Northeast, the poorest region in Brazil, and to maximize the mobilization of external resources for CHESF's multi-year investment program. The latter objective was met through the securing of US\$ 71.9 million in bilateral financing for the operation in addition to the multilateral loans themselves. The PA IV Project was further justified in terms of its potential contribution to the reduction of Brazil's rapidly rising petroleum import bill, as the operation's expected increment of some 8,300 Kwh/year of hydro-based power generation represented the equivalent of an estimated 1.9 million tons of fuel oil (or roughly 6% of Brazilian oil imports at the time) that would have been required to produce the same amount of energy in the absence of the project. This argument was specifically raised in the staff introduction to the IBRD Board discussion of the project on June 4, 1974. Much of this discussion, however, focused on the adequacy of the proposed resettlement arrangements and the degree of the Bank's leverage over the Borrower in this regard. As a result of the Board's concern, President McNamara personally agreed to review the detailed resettlement plans that were required, under the Loan and Guarantee Agreements, to be submitted within nine months after loan signing.²

4.05 The PA IV Project consisted of the principal elements of CHESF's fifth expansion plan, specifically the Sobradinho dam and reservoir, the Paulo Afonso IV underground power station,³ transmission facilities and associated substations and project-related equipment and training. More concretely, the components of the project were:

- (a) a 3.4 km long dam at Sobradinho including a 64 meter long concrete spillway and earth-fill embankments and lateral earth dikes on either side of the main structure, together with a navigation canal and locks on the right bank, at an estimated total cost of US\$ 217.3 million;

² Section 3.06 of the Loan Agreement between IBRD and CHESF, dated June 17, 1974, specifically states that "the Borrower shall (i) prepare, jointly with the Guarantor, detailed plans for the resettlement of the population now living in the areas which will be flooded by the Sobradinho reservoir in a manner which will enable that population to earn a living under conditions at least equal to those now existing; (ii) within nine months after the date of this Agreement, or such other date as shall be agreed with the Bank, furnish such plans to the Bank for its comments; and (iii) put such plans into effect in a manner satisfactory to the Bank." Section 3.03 of the Guarantee Agreement likewise refers to this obligation.

³ Paulo Afonso I had been partially financed by IBRD Loan 25-BR in the early 1950's, while the second and third stage expansions at Paulo Afonso were supported by funding from the IDB, as was construction of the Moxoto dam and generating plant which formed part of CHESF's fourth expansion plan.

- (b) the Paulo Afonso IV hydroelectric power station comprising a 5 km bypass canal and an underground plant with space for six generating units, four of which, each having 375 MW capacity, were to be installed under the project, with a projected cost of US\$ 235.3 million;
- (c) some 390 kilometers of 500 kV and 2,350 km of 230 kV transmission lines, together with 22 substations having an aggregate transforming capacity of about 5,100 MVA, at an estimated cost of US\$ 234.4 million; and,
- (d) transportation equipment and training, at a projected cost of US\$ 5.6 million.

4.06 Construction of the Sobradinho dam, which was already underway at the time the Bank loan was approved, was expected to create a reservoir with a usable storage capacity of about 29.4 billion cubic meters, thereby increasing minimum river flow from 1,150 m³/second to 2,060 m³/second and raising annual generating capacity by about 8,300 GWh at plants already in operation and by roughly 19,000 GWh at future generating plants to be installed downstream. The Sobradinho reservoir was expected to extend some 300 kilometers upstream to the town of Barra and inundate an area of approximately 4,150 square kilometers, making it the largest inland water body in Latin America after Lake Titicaca between Peru and Bolivia in the Andean highlands. The transmission lines to be installed under the project, in turn, would extend from Paulo Afonso to the rapidly growing metropolitan areas (and industrial centers) of Recife, Salvador and Fortaleza, as well as to and/or between other state capitals (eg. Natal, Aracaju) and important secondary cities (eg. Campina Grande, Juazeiro) in the region.

4.07 In view of the very considerable dimensions of the reservoir and the project's potentially significant consequences for the existing physical and human environments both upstream and downstream of the Sobradinho dam, an environmental impact "reconnaissance" was commissioned as part of the project preparation process. The results of this effort were formally presented to CHESF, IBRD and IDB in September 1973.⁴ This study, while not constituting a detailed environmental impact assessment of the project, nevertheless, was quite comprehensive and the corresponding report presented specific recommendations in such areas as human ecology (resettlement and environmental health), plant and animal life, climate modification, water supply, irrigation and agro-industry and environmental engineering.

4.08 The report singled out the displacement of some 70,000 people as the potentially most adverse consequence of the project. This dislocation, however, was also seen to present an "unparalleled opportunity for the economic development of these people and their region." Observing that "the relocation of the displaced population is more complicated than construction of the dam,"

⁴ Goodland, Robert, "Sobradinho Hydroelectric Project: Environmental Impact Reconnaissance," The Cary Arboretum of the New York Botanical Garden, New York, September 1973.

the report recommended that the relocation process should "start at once and must be accorded all attention and resources necessary, commensurate with its importance." ⁵ Other recommendations included the establishment of a "small powerful executive force, possibly to be led by SUDENE and INCRA, to stimulate and coordinate the present plethora of official agencies with overlapping responsibilities and jurisdictions in the area." It was further proposed that this executive group be responsible for the integration of relocation activities with "economic and regional development, emphasizing irrigation and fish production."

4.09 The report likewise suggested that community development units be set up in each of the four small towns that would have to be rebuilt so as to "provide adequate liaison between CHESF and the affected populations, minimize the stress of relocation and promote community synthesis after relocation" and that an "agricultural policy" for the area be planned and implemented. ⁶ The report affirmed, moreover, that, while CHESF would be the main beneficiary of the operation and, thus, should bear prime responsibility for its execution, "this is an integrated project and it should be made quite clear that it is an indivisible one as the human cost is the most onerous." Finally, the report observed that the project offered "a grand opportunity towards agrarian reform on a limited scale" and that all land "in any way affected by the project should be acquired and developed by and for the benefit of the displaced people." ⁷

4.10 As is indicated in greater detail in Chapter VI below, in order to accommodate the population displaced by the reservoir -- about 35% of which resided in the towns of Remanso, Sento Se, Pilao Arcado and Casa Nova, while the rest were scattered in rural areas -- plans were made to physically relocate the townships and resettle roughly 50% of the rural families in an agricultural colonization project to be implemented by INCRA near Bom Jesus da Lapa, roughly 1,000 kilometers upstream from the Sobradinho dam. Of the other rural residents, it was expected that one-fifth (or 10% of the overall total) would accept monetary indemnification and leave the area altogether, another one-fifth would find employment in project-related construction activities, while the remaining three-fifths would attempt to relocate, at least initially, along the margins of the new reservoir where, according to the SAR, "farming conditions will in general be worse than those of the present river shore." ⁸ This latter group, however, was also expected to eventually resettle elsewhere.

⁵ Ibid., pg. 20.

⁶ Ibid., pg. 21. It was mentioned in this context, more specifically, that agricultural extension agents and demonstration plots would be necessary and that plots should be assigned to rural displacees as soon as possible in order "to allow time for livestock and food plants, especially fruit trees, to become established before relocation occurs."

⁷ Ibid., pg. 22.

⁸ Report No. 396a-BR, op. cit., para. 4.21.

4.11 INCRA's role in accommodating the rural families to be displaced by Sobradinho was formalized through an agreement signed with CHESF and ELETROBRAS in October 1973 and subsequently ratified by a joint decree of the Ministries of Agriculture and of Mines and Energy.⁹ Under this agreement, CHESF, which established a specific Resettlement Unit in 1972, assumed direct responsibility for relocating the urban population. Overall resettlement activities were to be financed by CHESF with funds to be provided by ELETROBRAS and drawn from a special federal program for the development of the Sao Francisco valley (PROVALE). CHESF, finally, would be responsible for resettling, along the shores of the reservoir, that part of the rural population (characterized by the SAR as "presumably the poorest and least educated") that was either ineligible or unwilling to transfer to the proposed colonization scheme, "according to standards to be decided on an ad hoc basis." The SAR also affirms that:

the poor quality of the land around the reservoir and the fact that operation of the reservoir will cause its shores to recede periodically up to several kilometers will make the resettlement difficult in its immediate vicinity. The relocation task is therefore complex; it will require detailed planning if the reservoir area is going to be evacuated on time and the affected population is to receive proper attention.¹⁰

4.12 Other ecological problems potentially resulting from the Sobradinho dam and reservoir, mentioned in the SAR and contemplated in project legal documents, were also initially identified by the environmental reconnaissance described above. In this connection -- and in addition to the detailed resettlement plan already cited -- CHESF and the Brazilian Government were required to prepare and submit for Bank comment, within nine months after loan signature, plans to: (i) minimize the future distribution and exacerbation of plague, schistosomiasis and malaria in the reservoir area; (ii) minimize the undesirable effects of decaying vegetation on the biochemical properties of the reservoir; and (iii) promote fish conservation and production in the reservoir.¹¹ Due, moreover, to a concern that the expected increase in minimum river flow might adversely affect agricultural production by permanently inundating some arable land in that part of the middle Sao Francisco valley below the dam, CHESF and the Brazilian Government agreed to present to the Bank an evaluation of such potential effects within twelve months after loan signature and to provide adequate compensation to any population suffering damages or requiring

⁹ These arrangements are described in para. 4.22 of the SAR.

¹⁰ Ibid., para. 4.22. The contractual obligation, cited in note 2 above, requiring the Brazilian Government and CHESF to present detailed resettlement plans for the Bank's "review and comment" within nine months after loan signature is specifically mentioned in this context.

¹¹ SAR, para. 4.24; Loan Agreement, Section 3.07 and Guarantee Agreement, Section 3.03.

resettlement as a consequence within six months after submitting this assessment.¹²

4.13 Finally, both the SAR and project legal documents recognized that some 9,000 hectares of rice land in the lower Sao Francisco varzeas would be lost due to the project-induced change in river regime unless adequate protective measures were taken.¹³ Of this area, however, some 1,800 ha were expected to be protected under an existing polder project, prepared by SUVALE (ie. CODEVASF's immediate predecessor) with technical assistance from the FAO and an "emergency plan" would be elaborated in order to preserve the remaining 7,200 ha through a network of dikes and pumping stations. In this regard, during negotiations for the PA IV Project, the Brazilian Government agreed that the engineering study and cost estimates for the "lower Sao Francisco emergency plan" would be submitted to the Bank for comment within nine months of loan signature and that this plan would be implemented by the end of 1978. The Government further agreed to prepare a "comprehensive development program to cause the benefits of the lower Sao Francisco emergency project...to be shared equitably by landholders, sharecroppers and laborers in the area of such project."¹⁴ This "emergency plan" subsequently became the Lower Sao Francisco Polders and Second Irrigation Projects discussed below.

2. Implementation Experience and Principal Results

4.14 The IBRD loan for the PA IV operation became effective on April 16, 1975, four months later than initially expected, due to delays by CHESF in hiring consultants for the execution and supervision of certain aspects of the project. Shortly after loan signing, IBRD and IDB formally agreed to divide project supervision tasks with the former assuming responsibility for overseeing implementation of the resettlement program at Sobradinho and the INCRA colonization project (Serra do Ramalho) at Bom Jesus da Lapa, together with installation of the 500 kV and 230 kV transmission lines and the 230 kV substations, while the latter would supervise construction of the Sobradinho dam, the Paulo Afonso IV hydroelectric station and the 500 kV substations.

¹² SAR, para. 4.25; Loan Agreement, Section 3.08; and Guarantee Agreement, Section 3.03. For purposes of this requirement, the "middle Sao Francisco" valley specifically referred to the 560 kilometer section of the river between Sobradinho dam and the town of Pao de Acucar, downstream from Paulo Afonso, in the state of Alagoas.

¹³ More specifically, preliminary studies undertaken by consultants to SUVALE indicated that, as a result of the modification of river flow, "instead of the 17,500 ha that are at present subject to seasonal flooding for eight out of every ten years, about 3,100 ha would be permanently flooded, 6,700 would continue to be subject to seasonal flooding and 5,900 ha would cease to be flooded." (SAR, para. 4.27)

¹⁴ SAR, paras. 4.26-4.28; Guarantee Agreement, Sections 3.04-3.05. For purposes of this requirement, the Guarantee Agreement specifically identified the "lower Sao Francisco" as the section between Pao de Acucar and the river's mouth, covering a distance of 220 kilometers.

While the undertaking of joint supervision missions was considered desirable, in practice, only one such mission, which focused on the urban resettlement program, actually occurred.

4.15 The project underwent substantial design changes during execution with an associated increase in total costs. As detailed in the PCR, excluding finance charges, actual costs on completion were estimated at roughly US\$ 1,414 million, as compared with an expected US\$ 693 million at appraisal.¹⁵ The additional costs were financed by CHESF and ELETROBRAS, together with further suppliers and bilateral credits, while relatively small portions of the original IDB and IBRD loans were eventually cancelled. The actual cost of the Sobradinho dam and relocation program in current prices more than doubled from the appraisal projection of US\$ 177 million to US\$ 371 million. This increase was due largely to major design changes in the dam, modification of construction methods on account of supply and time constraints resulting from these design changes and the expanded scope of relocation activities, but they also reflected a substantial initial underestimation of construction costs.¹⁶

4.16 The principal design changes reflected CHESF's decision, shortly after the Bank loan was approved, to anticipate installation of a 1,050 MW power station at Sobradinho to coincide with completion of the dam rather than in the early 1990's as originally planned and to include a 50 m³/second water intake for the large Massangano (later renamed "Senador Nilo Coelho") public irrigation project in the municipality of Petrolina, some 20 kilometers northeast of the dam. According to the PCR, the decision to accelerate construction of the power station was taken for a combination of "market" and "national strategic" considerations. The former included higher than expected regional energy demands, together with the need for CHESF to supply electricity to ELETROBRAS' subsidiary for Amazonia, ELETRONORTE, until the projected 1982 (later 1984) start-up of the Tucuruí hydropower plant on the Tocantins River in the state of Para. Strategic considerations, in turn, involved reducing Brazilian dependence on imported petroleum to meet future energy needs by accelerating domestic hydropower development. The additional generating capacity at Sobradinho contributed directly to this latter objective by permitting the elimination of gasoline-powered thermal generation in CHESF's system.

4.17 Changes also occurred during implementation in the Paulo Afonso IV power station, resulting in a rise in costs from the US\$ 203 million projected at appraisal to an actual figure of US\$ 383 million on completion, according to the PCR.¹⁷ In this case, the major design change involved an increase from four 375 MW (ie. 1,500 MW) to six 410 MW (ie. 2,460 MW) turbines and generators in response to the same "market" and "strategic" factors mentioned in the preceding paragraph. The third major project component, transmission lines and

¹⁵ OED Report No. 6578, op. cit., PCR, Section 3.4 and Annex 3.1.

¹⁶ Ibid, see PCR Section 3.5 for details. The resettlement program alone reportedly involved an actual cost of US\$ 62.2 million, as compared with an appraisal estimate of US\$ 12.1 million.

¹⁷ Ibid, PCR, Section 3.6.

substations, likewise experienced a significant cost increment, from an anticipated US\$ 206 million at appraisal to US\$ 350 million on completion.¹⁸ Changes in overall project design, combined with considerable planning and procurement delays, were largely responsible for the cost overrun experienced by this component which was not fully completed until March 1985, even though most transmission investments were, in fact, undertaken between 1977 and 1982. In addition to design modifications, planning delays were also due to staff turnover as a result of the transfer of CHESF's headquarters from Rio de Janeiro to Recife in 1975.

4.18 The physical construction of Sobradinho dam, which began in January 1973, continued until March 1979, two years later than originally expected. Despite the design changes and implementation delays mentioned above, however, filling of the Sobradinho reservoir began in February 1977, only one month after the date initially anticipated. As a result of these changes and delays, on the other hand, the original project closing date (December 31, 1978) was eventually extended three times for a total of four and a half years, such that actual closing did not occur until June 30, 1983, while Bank loan disbursements continued until October 1983.

4.19 IBRD supervision of the operation was ultimately divided between two project divisions. Shortly after loan signing, the Latin America Energy Division, realizing that it did not possess sufficient human resources to supervise the resettlement component, requested support from the Agricultural Projects Division responsible for Brazil. This assistance, however, did not formally commence until March 1975, some nine months after loan approval. In addition, IDB later agreed to supervise urban resettlement activities through a staff architect residing in Brazil.

4.20 With specific regard to the various environmental protection measures to be taken in connection with the project, CHESF and the Brazilian Government formally complied with their contractual obligations to submit reports to the Bank on resettlement of the population displaced by the reservoir, combatting endemic diseases, minimizing the undesirable effects of decaying vegetation, promoting fish production, evaluating the effect of the dam on the middle Sao Francisco and preparing an "emergency project" for the lower Sao Francisco varzeas. The experience with the Sobradinho resettlement and fisheries components and the lower Sao Francisco emergency plan will be further discussed in Chapters V and VI below. In relation to the other requirements, according to the PCR, the report on endemic diseases resulted in health programs considered "satisfactory" by the Bank, while the Bank likewise accepted Government findings that decaying vegetation would have only "short-lived undesirable effects" on the reservoir and that construction of the dam would

¹⁸ Engineering, supervision and administration costs, finally, also proved to be significantly higher than expected at appraisal, increasing from a projected US\$ 105 million to US\$ 307 million. Most of this difference was due to the substantially higher engineering costs and longer implementation period than originally anticipated.

have but a minor impact on the population residing in the middle Sao Francisco valley.¹⁹

4.21 Despite significant execution delays and cost overruns, the PA IV Project was largely successful. As a result of the operation, CHESF effectively expanded its generating capacity both at Paulo Afonso (by 2,460 MW) and -- with the utilization of non-project resources to purchase and install the corresponding generators -- at Sobradinho (1,050 MW). The project, in short, clearly achieved its basic objectives of supporting broader Government development efforts in the Northeast, by increasing the supply of electric energy to the region's rapidly growing metropolitan areas and other large urban centers, and mobilizing additional external resources for CHESF's investment program. On the less positive side, however, as will be discussed in Chapter VI below, the resettlement component proved both difficult to implement and produced mixed results "at the cost of substantial human hardship."²⁰

3. The Bank's Role and Lessons Learned

4.22 During appraisal of the Paulo Afonso IV Project, many Bank staff members had expressed reservations about its likely adverse environmental impacts, as well as about the clearly inadequate provisions made by INCRA and CHESF for relocation and compensation of the population displaced by Lake Sobradinho. In particular, there was much disquiet about the emergency nature of resettlement proposals, about CHESF's decision (without consulting the local population) to divide displacees between the lakeside agrovilas and the colonization scheme at Bom Jesus da Lapa and about the failure to adopt a longer-term, more sustainable development strategy for the rural population of small farmers and fishermen.²¹ Such was the groundswell of concern that Bank President McNamara, as previously noted, made a commitment to personally review resettlement plans at Sobradinho and visited the region himself to inspect the situation in late 1974.²²

4.23 It appears, however, that mounting criticism during the mid-1970's from both within and outside the Bank was not translated into significantly

¹⁹ Ibid., PCR, Annex 2.1, pg. 5.

²⁰ Ibid, PPAR, Evaluation Summary, pg. v. Resettlement, in fact, is characterized by this report as "the most difficult problem CHESF had to resolve in connection with the project."

²¹ An Issues Paper submitted by a Bank engineer and financial analyst following an identification mission for the project in December 1973, for example, already raised many of these problems, while several subsequent internal memoranda from Bank staff involved in its appraisal highlight concern over the inadequacy of resettlement plans and of the institutional arrangements proposed to implement them. Many of these same issues were also discussed in the environmental reconnaissance study undertaken by Robert Goodland (op. cit.).

²² President McNamara's visit is mentioned in an internal memorandum dated September 12, 1974.

improved resettlement provisions. In spite of the expressed concern over such issues by numerous Bank staff members and even the Bank's President himself, factors largely beyond their individual control appear to have rendered these statements of little consequence. To summarize these factors include: (i) political pressure to speedily execute a strategically important hydropower scheme; (ii) the resulting relatively low priority given to environmental issues at the time by both the Bank and implementing agencies; (iii) a lack of institutional and staff capacity, on the part of either the Bank or the Brazilian executing institutions to adequately integrate environmental concerns into project planning and implementation and the comparative marginalization of such concerns as did exist; and (iv) the consequent weakness of loan conditionalities which left the Bank with little leverage. These factors are dealt with in greater detail later in this report, but additional comments are in order here on the two latter points.

4.24 Conditionalities regarding resettlement arrangements were built into the loan agreement signed in June 1974, but Bank staff preoccupations persisted. The Bank did not give itself the contractual authority to hold up project construction in the event of the Government's failure to comply with the provisions of loan covenants concerning resettlement and the environment. Both the Bank and CHESF were apparently eager to begin funding and construction of PA IV without undue delay.²³ All the Bank appears to have been able to do was to periodically express its strong concern over any failings and delays in resettlement activities identified by supervision missions.²⁴ By the time that resettlement reached a crisis point, however, most of the loan funds for the hydropower project had already been disbursed and the Bank had essentially lost its leverage. Illustrative of this is the fact that the Bank's later request that the Government develop a strategy for longer-term regional (including fisheries) development met with a muted response and little, if any, concrete action on the part of the Government.

4.25 It should also be observed that the role of the Bank's -- at that time very small number of -- environmental specialists in the project appraisal and supervision process appears to have been relatively minor. More specifically, judging on the basis of the contents of the project files, the role of the Bank's Environmental Advisor was rather passive. Although he was apparently informed about key decisions related to the operation as they were being taken within the Bank, his own intervention appears to have been very limited and strictly of an advisory character. Accordingly, it appears that environmental issues may not have been taken sufficiently seriously early enough

²³ The minutes of a meeting between CHESF and Bank personnel in Brasilia on May 22, 1973 to discuss resettlement plans clearly suggest the secondary priority given to the latter vis-a-vis maintaining the proposed construction schedule for the Sobradinho dam.

²⁴ For example, after the first two project supervision missions in May and August 1975, respectively, the Bank remained concerned about the progress of resettlement planning and implementation and, as a result, requested that the Government provide quarterly progress reports on resettlement activities.

in the project cycle and, thus, had comparatively little influence either on loan conditionalities or subsequent implementation and supervision.²⁵

4.26 Reflecting this situation, the PCR later acknowledged that, during preparation and appraisal, the Bank, CHESF and the Brazilian Government all "underestimated" the complexity of the "resettlement problem" despite the recommendation of the environmental reconnaissance that adequate attention be given to this particularly "complicated" feature of the project. Even though, after March 1975, the Bank significantly intensified its supervision effort in relation to resettlement, to the point where this component may ultimately have received more systematic attention than the project's technical and financial aspects,²⁶ difficulties stemming from inadequate initial planning persisted. Coordination between IBRD and IDB supervision activities was apparently also inadequate.²⁷

4.27 Discussion of the principal lessons learned from the project in both the PCR and the PPAR concentrates on the resettlement experience which was first assessed by the Bank in OED's 1980 supervision study cited above and will be further examined in Chapter VI below. The major lesson of the PA IV Project, according to the earlier OED study, was "that planning for resettlement was as important as planning for the hydroelectric project and that the inclusion of covenants providing for resettlement did not assure the effective preparation and implementation of such plans."²⁸ A "companion lesson," according to the PCR, was that resettlement efforts on the scale of those occurring at Sobradinho

²⁵ By this stage, however, outside protests had become numerous. In addition to various criticisms from the local church and the Diocese of Juazeiro, the Human Rights Center of the Diocese of Joao Pessoa also strongly criticized resettlement conditions at Bom Jesus da Lapa. Professor Johannes Augel of the University of Bielefeld submitted a study of resettlement problems to the Bank in September 1977, while, in 1980, a German television documentary was highly critical of the Sao Francisco projects.

²⁶ In this connection, the PCR (op. cit., para. 6.2.1) cites and agrees with an earlier OED review of Bank project supervision experience that took the PA IV operation as one of its case studies. The OED report concluded that supervision of the project's power component by the Bank's Energy Division for Latin America was less thorough and effective than that of its resettlement component. See OED Report No. 2858, Operational Policy Review - The Supervision of Bank Projects, dated February 22, 1980, for additional details.

²⁷ The Audit report (op. cit., paras. 35-36) observes, for example, that "whereas at the country program level, the collaboration [between the Bank and IDB] seems to have worked smoothly, at the project level some difficulties occurred" and that the "separation of supervision activities had the effect that, ultimately, neither bank really looked anymore at the project in its entirety, but concentrated on the part which it supervised."

²⁸ PCR, op. cit., para. 7.2.1.

should probably be undertaken in the form of a separate project in order to ensure "appropriate" levels of government funding and interest.²⁹

4.28 The audit report, finally, in agreeing with the conclusions of the PCR and the OED supervision study in this regard, adds that "planning resettlement mostly deals with people and calls for adjusted planning methods usually implying a strong participation of the population to be affected by the project. Such planning is likely to take more time than that of a physical facility like a power plant. But even under the best of circumstances, the uncertainty about the outcome is likely to be much larger than that associated with an essentially technical project."³⁰ The PPAR likewise agreed with the completion report's conclusion that, in the case of a large-scale resettlement program, the possibility of carrying out a separate, but not independent, project should be considered.

B. The Lower Sao Francisco Polders and Second Irrigation Projects

1. Origins, Objectives and Description³¹

4.29 The origins of the polders (SF I) and second irrigation (SF II) projects in the lower Sao Francisco valley are essentially the same as those of the PA IV operation itself. Since these have already been described in paras. 4.02 and 4.13 above, they will not be restated here. It should be observed, however, that the SF I operation was a pioneering project in a number of respects. Other than the Alto Turi Land Resettlement Project (Loan 0853-BR), approved in July 1972, SF I was the Bank's first attempt to support integrated rural development in the Northeast and was the first Bank project involving irrigation in Brazil. As mentioned in the staff presentation of the project to the Board, moreover, it was also the first Bank operation in the country to include an agrarian reform component.³² Finally, as will be further described

²⁹ Ibid, para. 7.2.1. In a footnote to this paragraph, however, the PCR indicates that one Bank staff member presented a "contrasting" opinion to the effect that "resettlement of this magnitude needs to be well advanced before work on the reservoir is started." These recommendations, in fact, are complementary.

³⁰ PPAR, op. cit., para. 39.

³¹ This and the following sections are largely based on the respective Staff Appraisal Reports (No. 714a-BR, dated May 16, 1975 and No. 2265a-BR, dated June 4, 1979), President's Reports (P-1610a-BR, dated May 23, 1975, and P-2583-BR, dated June 6, 1975), PCRs and (for SF I) PPAR (OED Reports No. 5669, dated May 23, 1985, and No. 8158, dated November 6, 1989).

³² The staff introduction of the SF I Project to the Board further affirmed that it would give the Bank and the Brazilian Government an opportunity to gain improved knowledge both as to how to implement changes in land tenure patterns and how to adapt agricultural technology and delivery systems to the needs of small farmers. Although there were no specific comments by Board members on the operation during the meeting, the Bank's President indicated his personal satisfaction with what he characterized as an extraordinarily complex

below, implementation of SF I encountered unique problems as a result of what the audit report later described as the "extremely difficult physical conditions prevailing in the flood plains of the lower Sao Francisco valley...complicated by the independently controlled operations upstream of the hydroelectric facilities."³³

4.30 As previously indicated, the projects were prepared as part of an "emergency" program to protect agricultural areas near the mouth of the Sao Francisco River that would otherwise be permanently flooded as a result of the Sobradinho dam. As an initial response to this situation, CODEVASF elaborated and implemented an emergency polders project in two (Propria and Itiuba) of the eight large varzeas in the lower valley in 1973. The SF I operation, in turn, was designed to protect the rest of the affected areas. The project was based on preliminary studies undertaken by an international consulting firm with the assistance of the World Bank-FAO cooperative program. Due to the emergency nature of the operation, however, these studies were less detailed than normally required by the Bank and, according to the PCR, two "critical" issues which later plagued project execution, namely, the "hydrology and hydraulics" of the lower Sao Francisco River and the "social and economic environment" in the project area, were not adequately considered.³⁴

4.31 According to the corresponding President's Report, the larger objectives of the SF I project were to support the Brazilian Government's efforts "to alleviate poverty, increase gainful employment, redistribute income and increase small farmer productivity" and to "offset the adverse effects on agriculture in the lower Sao Francisco valley resulting from completion of hydroelectric facilities at Sobradinho and Paulo Afonso," partially financed by Bank Loan 1008-BR described above.³⁵ More specific objectives were to bring about substantial increases in output and employment through controlled irrigated rice production. As a result of the operation, it was expected that local rice production would increase by roughly 25,000 tons per year and that some 18,000 permanent jobs would be created, while average family income would rise to approximately US\$ 1,500 per annum after full development, some nine years after project initiation.

4.32 To achieve these objectives, the SF I operation would protect six large and some 15 to 20 small varzeas by providing flood protection dikes and dual-purpose irrigation-drainage pumps. Two large varzeas (Marituba in Alagoas and Betume in Sergipe), moreover, would be provided with complete internal

and fascinating undertaking.

³³ OED Report No. 5669, op. cit., PPAR, para. 8.

³⁴ Ibid., PCR, para. 2.09. More specifically, in the words of the PCR, the former "caused serious repercussions along the lower river system, including its main tributaries, after the closure of some of the varzea dikes," while poor understanding of the latter "led to many confrontations between CODEVASF and local people and institutions during the first years of project implementation."

³⁵ Report No. P-1610a-BR, op. cit., para. 28.

irrigation and drainage systems to permit improved production practices, including the double cropping of rice. A second stage, involving full development of the other large varzeas, was to be prepared for Bank financing at a later date. This eventually became the SF II Project described below. Under the SF I operation, however, 13,500 ha of rice land was to be protected, benefitting an estimated 36,000 people, while some 4,400 ha of rice land and 750 ha of other land, benefitting an estimated 10,800 people, was to be provided with full irrigation and drainage systems.³⁶ At the time of appraisal, the area to be irrigated under the project represented about 8% of all irrigated land in the Northeast and about 15% of the total land developed by CODEVASF.³⁷

4.33 In order to prevent windfall profits from accruing to a small number of comparatively wealthy landholders and to ensure that the much larger number of sharecroppers and small and medium farm owners would benefit from the project, agrarian reform and land redistribution were to be carried out as essential parts of the operation. For this purpose, the Brazilian Government issued a decree in March 1975 declaring all lands covered by the project to be subject to expropriation. According to the SAR, once acquired, such lands would be subdivided and leased to "qualified farmers," possibly with the utilization of some form of cooperative ownership.³⁸

4.34 The land redistribution aspect of the project, in fact, represented an unprecedented attempt at the time to raise the standards of living of the rural poor in the Northeast. Prior to the operation, the area was characterized by a heavy concentration of land and income. Fewer than 100 landowners controlled 90% of the project area. Incomes were also highly skewed, but the majority were very poor, with average per capita income in the project area, at about US\$ 200, being about half the corresponding national figure. Because most of the people living in the lower Sao Francisco varzeas were sharecroppers, tenants or salaried workers, however, there was no reliable information concerning their exact numbers at the time the polders project was appraised.

4.35 The Brazilian Government was the borrower of the Bank loan (No. 1153-BR) in the amount of US\$ 23.0 million for the SF I operation, which was approved on June 9, 1975. CODEVASF was the executing agency for the project. Total project costs were estimated at appraisal to be US\$ 52.6 million and the closing date was set for December 31, 1979. Project components, as appraised, can be grouped into six categories containing the following subcomponents:

- (a) Directly productive components: (i) emergency dikes and pumping stations for four varzeas (Boacica in Alagoas and

³⁶ Report No. 714a-BR, op. cit., para. 4.01. The total (ie. rice and non-rice) area to be protected under the SF I operation was estimated by the SAR to be 32,000 ha, affecting some 47,000 people.

³⁷ OED Report No. 5669, op. cit., PCR, para. 2.10.

³⁸ Report No. 714a-BR, op. cit., para. 4.02.

Cotinguiba, Pindoba and Brejo Grande in Sergipe); ³⁹ (ii) full development of the Marituba (1,800 ha) and Betume (3,400 ha) varzeas which were to be provided with protective dikes, pumping stations and internal irrigation and drainage networks; (iii) equipment for the operation and maintenance of dikes, pumping stations, irrigation and drainage systems and ancillary works; (iv) improved agricultural extension services and the establishment of cooperatives; (v) fish production; and (vi) resettlement of about 1,000 families living in small varzeas that would not be protected from flooding.

- (b) Indirectly productive components: (i) field trial and research stations for rice, corn and other crops; (ii) fish hatcheries and research; (iii) upgrading or construction of some 94 km of feeder roads; (iv) training of newly settled farmers, extensionists, tractor drivers and machine operators; and (v) seed production and certification.
- (c) Social infrastructure: (i) installation of eight village water systems; (ii) construction of thirteen new elementary school classrooms and several vocational training workshops; (iii) provision of rural electricity to some 2,500 people; and (iv) construction of a health post in Marituba and a dispensary in Betume, together with assistance to an existing malaria control program.
- (d) Studies, surveys and plans: preparation of a detailed master plan and feasibility study for an integrated rural development project for the lower valley region, as well as the surveys and designs required for full development of the four large varzeas to be undertaken by SF II.
- (e) Monitoring: establishment of a system to monitor project progress and costs and collect data for project evaluation.
- (f) Land: acquisition of all land required for rights-of-way and full development of the Betume and Marituba varzeas.

4.36 With respect to its environmental aspects, the SAR emphasizes that a "unique feature" of the operation was that one of its primary purposes would be to offset the adverse impact of another Bank-assisted project. The appraisal report likewise affirms that, by reducing extensive flooding in the two varzeas selected for full development, the project would improve the general environment

³⁹ The lands in these varzeas, however, would not be redistributed under SF I. Instead, they would continue to be flooded annually by gravity, through sluice gates when flood levels permitted and by pumping during years of low flow. Smaller varzeas were to be similarly protected and operated except in those cases where the amount of land affected was insufficient to justify protection.

in these areas.⁴⁰ Furthermore, even though development of the varzeas was expected to have a negative effect on local fisheries, the project would partially offset this impact through investments in fish hatcheries and research.⁴¹ The latter would include a detailed study of the requirements for the preservation and enhancement of fisheries resources in the entire lower Sao Francisco valley. Through its agricultural extension activities, finally, CODEVASF was expected to orient farmers with respect to the selection of pesticides that would not be harmful to fish, other crops or public health. The agency would also help establish programs to monitor and control local use of agricultural chemicals.

4.37 The SF II project, in turn, was approved on June 19, 1979 and received an initial Bank loan (1729-BR) of US\$ 28.0 million, which was later supplemented by a second loan (1729-1-BR) in the amount of US\$ 7.7 million, approved on December 7, 1983. Total project costs were initially estimated at US\$ 74.7 million and the operation was expected to close on June 30, 1985. As also occurred with SF I, the project was prepared by CODEVASF assisted by the World Bank-FAO cooperative program. According to the respective SAR, as a complementary and follow-on project to the polders operation that was still under execution, SF II was "conceived along lines very similar to the irrigation works of Betume and Marituba since the physical and social environment created by SF I have left little scope for fundamentally different alternatives."⁴²

4.38 As stated in the respective SAR, the project's specific objectives were to: (i) increase the incomes of some 2,700 farmer families, who were among the poorest in the lower Sao Francisco valley, by from 50% to 250% depending on the farm model adopted; (ii) provide improved health and education facilities; (iii) increase the quantity and improve the quality of local rice production; and (iv) strengthen CODEVASF's management capabilities. These goals were to be achieved by: (i) providing irrigation facilities; (ii) developing cooperatively owned family plots to replace the previous highly skewed land distribution pattern; (iii) providing cooperative production and marketing structures and preparing local farmers to participate in cooperative activities; (iv) introducing yield-enhancing technological improvements through better input supply, farm mechanization and reduced post-harvest losses; (v) developing improved extension services and applied research in small farm agricultural and post-harvest practices; (vi) developing better storage facilities and a modern paddy processing plant that would increase value added in the region; (vii) providing the area with improved social and support infrastructure; and (viii) reinforcing CODEVASF with locally recruited professional staff, initially

⁴⁰ Ibid., para. 4.29.

⁴¹ More concretely, according to the SAR (para. 4.11), the elimination of flooding in the two fully developed varzeas was expected to decrease annual freshwater fish production by about 300 tons out of an estimated total output of 1,150 tons. Measures to be pursued under the project, however, were expected to result in roughly 200 tons of additional fish production annually.

⁴² Report No. 2265a-BR, op. cit., para. 4.05.

advised by FAO specialists.⁴³ Both irrigated rice and rainfed non-rice (eg. corn, cotton) production in adjacent highland (or "tabuleiro") areas would be promoted under the project.

4.39 SF II, as appraised, contained the following components:

- (a) Physical works: (i) installation of irrigation, pumping, drainage and associated electrical works in, and acquisition of operation and maintenance equipment for, the Boacica, Cotinguiba-Pindoba and Brejo Grande varzeas; (ii) construction of a feeder road network (21 kms); and (iii) construction of three paddy storage and drying units and additional rice milling facilities in the nearby city of Propria (Sergipe).
- (b) Institutional strengthening: (i) support to farmer associations (buildings, equipment and incremental operating costs over a five year period); (ii) training of CODEVASF staff; and (iii) technical assistance to farmer associations and CODEVASF.
- (c) Social infrastructure: (i) construction of some 1,000 houses for displaced farmers or to replace deficient existing dwellings; (ii) construction and equipment of seventeen primary schools, twelve of which to replace existing structures; (iii) construction and equipment of eight rural health posts and training of local primary health care providers, together with improved water supply through ten wells and an equal number of public fountains; and (iv) electrification of six villages.
- (d) Studies, monitoring and evaluation: (i) technical and social studies for additional CODEVASF projects in the Sao Francisco basin; (ii) a detailed analysis of on-going CODEVASF operations in the middle and upper Sao Francisco valley; (iii) a review of CODEVASF's structure and functions; (iv) a study for improvement of the sewerage network in Propria, upon which additional demands would be placed as a result of the project's "industrial" (ie. rice milling) component; and (v) monitoring and evaluation of on-going SF I and SF II activities by the University of Vicosa in Minas Gerais.

4.40 As was also the case with the polders project, according to the corresponding SAR, SF II was expected to have a positive impact on the physical environment. In this connection, more specifically, it was anticipated that more than one-third of the total SF II project area, which was either "idle or under low-yield natural pasture" at the time of appraisal, would be "recuperated for intensive, mainly irrigated agriculture." In addition, it was affirmed that widespread schistosomiasis in the region, "which could tend to increase under the proposed irrigation activities," would, in fact, diminish as the result of

⁴³ Ibid., para. 4.06.

a project-supported endemic disease control program to be developed by the national Superintendency of Public Health Campaigns (SUCAM). Finally, project-supplied housing and sanitation and public health facilities were expected to improve environmental conditions in the area, while CODEVASF would continue to advise local farmers in relation to proper pesticide use.⁴⁴

2. Implementation Experience and Principal Results

4.41 Implementation of the SF I operation proved to be very complex and problematic for a combination of environmental, engineering and socio-political reasons. Together, these factors led to substantial revisions in the original project design⁴⁵ and a five year extension of the project execution period. As a result, SF I closed in September 1983, rather than December 1979 as originally expected, and works were not physically completed until June 1984, instead of June 1979. A 16% overrun in total project costs in dollar terms (US\$ 60.9 million, as compared to the appraisal estimate of US\$ 52.6 million) was also experienced. Since the socio-political factors affecting project implementation will be examined more fully in Chapter VI below, the present discussion will focus on the natural and technical difficulties encountered by the operation.

4.42 According to the PCR, the principal factor causing delays in physical implementation of the project was a "limited knowledge of the local hydrological conditions and soil foundation characteristics."⁴⁶ The combination of heavy rains in April-May 1977 and insufficient preparation resulted in an initial one year delay in construction activities. Project implementation was further delayed on account of very extensive flooding in April 1979.⁴⁷ Detailed hydraulic engineering and geotechnical studies, in turn, led to substantial design modifications at a number of project sites, causing additional time lags,

⁴⁴ Ibid., para. 9.06.

⁴⁵ The principal revisions to the project during execution were: (i) elimination of protection works for the small varzeas; (ii) substitution of the planned full development of Marituba varzea by rehabilitation of existing irrigation and drainage networks at Propria and Itiuba varzeas; and (iii) deletion of the protection dikes at Brejo Grande (Sergipe) and their replacement by construction of an earth dam to control overflow from the Betume River, a local affluent of the Sao Francisco.

⁴⁶ OED Report No. 5669, op. cit., PCR, para. 3.06.

⁴⁷ More specifically, high rainfall levels in the upper Sao Francisco valley in Minas Gerais forced CHESF to release more than 12,000 m³/second from the Sobradinho reservoir, which was about three times above the normal discharge. This high volume of water from upstream caused a major disruption of on-going flood protection and drainage works in the SF I project area, particularly in the Betume varzea. The 1979 flood, moreover, reportedly resulted in serious damage, destroyed one rice harvest and impeded planting for the following one. The Betume varzea was again adversely affected by heavy flooding in 1981, this time due to above average rainfall levels in the lower valley region itself.

as did difficulties in land expropriation and the compensation of displaced sharecroppers. This also generated strong protests from the affected population, as well as from church and other local groups.

4.43 The other major "hydraulic" factor affecting implementation of SF I involved the scheduling of "controlled flooding" in connection with the construction of Sobradinho dam. More specifically, execution of the main SF I project works by CODEVASF was dependent upon the timing and volume of water discharges by CHESF upstream at Sobradinho, such that construction planning for the former was based on forecasts of (what the PCR describes as) the "semi-controlled river floods" expected in connection with implementation of the dam. In practice, however, due to design changes in the PA IV Project, especially the decision to install generating capacity at Sobradinho, maximum discharges during dam construction considerably exceeded those initially projected, seriously hampering physical execution of drainage and irrigation works in the lower valley.

4.44 SF II likewise experienced substantial delays and changes in scope during implementation. As a result, the project completion date was extended twice for a total of two years, from December 1985 to December 1987, while loan closing occurred three years later than originally expected (ie. in June 1988 rather than June 1985). Design changes included alteration of the irrigation works in most of the varzeas, elimination of the Brejo Grande varzea and the rainfed agriculture component from the project and introduction of a pig-rice-fish ("suino-rizi-piscicultura") subproject.⁴⁸ Once again, implementation was affected by local flooding which, according to the PCR, had initially been underestimated,⁴⁹ caused severe damage to irrigation works and eventually obliged CODEVASF to seek additional funding for the project. As a result of these alterations and delays, moreover, actual costs of drainage and irrigation works executed under SF II were roughly 55% higher than those projected at appraisal, even though, on account of the aforementioned reductions in project scope, total dollar costs on completion (US\$ 75.1 million) were not very different from those estimated at appraisal (US\$ 74.7 million).

4.45 SF I benefitted some 1,350 small farmers, or about 550 fewer families than originally expected, through the construction of irrigation works and other project investments. During implementation, CODEVASF prepared a detailed survey which revealed that the number of farmers opting for irrigation was smaller than the number of irrigated plots offered by this and the second project. Response to the operations, moreover, apparently varied primarily along economic lines. Larger landowners preferred to move out after receiving

⁴⁸ Details of these changes are provided in the PCR (OED Report No. 8158), op. cit., paras. 1.15-1.26.

⁴⁹ The PCR for the second irrigation project (para. 1.20) observes, for example, that neither the appraisal of SF I, nor that of SF II considered the issue of crop and work damages due to flooding of the Boacica River upstream of the varzea. These floods, however, had a major negative impact on local development possibilities since they precluded double cropping in about 70% of the varzea.

monetary compensation for their holdings, while many salaried workers reportedly also left the area in search of better working and living conditions elsewhere. In contrast, medium-sized landowners, farmers and sharecroppers preferred the irrigation option.

4.46 According to the PCR for SF I, rice yields "increased significantly in the project area under the effects of controlled irrigation, improved soil preparation and use of improved seed."⁵⁰ Projected incremental rice production (27,700 tons per year), moreover, exceeded the appraisal target (25,000 tons) by roughly 10%. Additionally, it was estimated that the project created some 1,400 new jobs as a result of the increased intensity of rice production and the combination of rice, pig and fish farming activities. Substantial improvements in farmer incomes have also reportedly occurred.⁵¹ The audit report points out, however, that the project's unit investment costs (including finance charges during construction) were on the order of US\$ 14,100 per irrigated hectare and US\$ 55,600 per settler family, which were considered high.⁵²

4.46 The long run sustainability of project benefits was also questioned by the PPAR which observed that, at the time of completion, full benefit levels had not yet been achieved and would require certain preconditions (such as the organization and education of farmers and the provision of adequate support services), that were by no means assured.⁵³ It was likewise observed that the operation of irrigation facilities had revealed certain "technical deficiencies, as well as the tendency of some soils to become saline with irrigation," while local water management practices were found to be "far from optimal." Finally, it was noted that the "natural dynamics" of the river system in the lower Sao Francisco valley, including erosion and sedimentation processes, pose a longer

⁵⁰ OED Report No. 5669, op. cit., PCR, Annex 2, para. 3. Rice productivity, more specifically, is reported to have increased from an average of about 1.6 tons/ha to 3.5 tons/ha in the area.

⁵¹ According to the PCR (Annex 2, Table A), average family incomes of rice farmers rose very dramatically from a projected US\$ 360 per year in the "without project" scenario to US\$ 3,349 per year in the "with project at full development" situation, while pig-rice-fish farmers were estimated to attain an average annual "full project development" income of US\$ 4,915.

⁵² OED Report No. 5669, op. cit., PPAR, paras. 25-26. These estimates assume that the 1,350 settler families benefitted under SF I would eventually cultivate a total of 5,325 ha of irrigated land and that the cost of irrigation and related investments in 1983 dollars was US\$ 75 million. Extending the analysis to include those families also expected to benefit from SF II, as well as from non-project investments in the Propria and Itiuba varzeas (ie. a total of some 3,440 farm families working approximately 11,600 ha of irrigated land), the corresponding unit costs were US\$ 14,200 per irrigated hectare and US\$ 48,000 per settler family in 1983 constant dollars, which, in the words of the PPAR, were still "unacceptably high."

⁵³ These and the following observations are drawn directly from the PPAR op. cit., para. 31.

run uncertainty for the polders installed under the operation. In addition, the PPAR concludes that "strong institutional control and supervision" by CODEVASF would be required in order "to enhance the chances of continued functional existence of project structures and proper operation of irrigation and drainage facilities."

4.47 According to its PCR, in turn, SF II directly benefitted another 1,823 small farmers -- 1,287 in the Boacica and Cotinguiba-Pindoba varzeas and the remaining 536 in the Itiuba and Propria varzeas -- a total which corresponds to roughly two-thirds of the initial appraisal target.⁵⁴ In addition, 34 new schools were built and another 36 existing schools were upgraded, while ten health centers were constructed and eight village water systems were installed. On the other hand, the PCR observes that rice output in the project area was substantially lower than anticipated at appraisal, with the value actually generated in 1988 (22,200 tons) being only 27% of the amount originally projected (83,000 tons) for that year.⁵⁵ The production of other crops was also considerably below initial expectations. As a consequence, the project's reestimated economic rate of return on completion was only 7%, as opposed to an appraisal forecast of 22%.

4.48 A study conducted by the International Labor Organization and the United Nations Development Program in 1987, however, showed a considerable improvement in net incomes of the families accommodated in the lower Sao Francisco irrigation schemes, particularly when they were able to reap two harvests a year through the application of better water control and soil management practices. According to this source, as of December 1985, a total of 3,164 families practiced irrigated agriculture on some 7,114 hectares in the five CODEVASF projects in the area.⁵⁶ The study estimates, moreover, that an average (7.7 ha) irrigated lot in the lower Sao Francisco valley can generate roughly 2.8 jobs a year.⁵⁷ Based on survey data for 1985-86, most of this

⁵⁴ OED Report No. 8158, op. cit., paras. 1.27-1.40. According to this source, moreover, farm budgets revealed that annual net returns from 3.5 ha paddy farms in 1987 ranged from US\$ 1,430 to US\$ 2,550, as compared with a pre-project range from US\$ 700 to US\$ 1,025.

⁵⁵ In their comments on an earlier version of this report (memorandum dated July 24, 1990), however, Bank regional staff point out that, "while rice yields in the irrigated areas are substantially higher than those estimated at appraisal, the total production of rice is below estimates. The cropping intensity remained below appraisal estimates, primarily due to lack of credit. The agricultural extension services provided by CODEVASF to project beneficiaries through IRGA (Instituto Riograndense do Arroz) were very intensive and of widely acknowledged high quality."

⁵⁶ ILO-UNDP, Emprego e Renda na Agricultura Irrigada: O Caso do Arroz no Baixo Parnaiba e Baixo Sao Francisco, Brasilia, 1988, pg. 52. Of this total, 1,318 families were "ceded" a total of 1,104 ha of irrigated lands, while 1,846 irrigation farmers directly cultivated the remaining 6,010 ha.

⁵⁷ Ibid., pg. 127.

employment, however, involved family labor, although temporary workers were used extensively during planting and harvest periods (December-January and May), reaching more than 40% of the total in peak months. In off-peak periods (eg. especially February-March, June and August), however, family labor accounted for 85% or more of the total, while permanent labor represented no more than 3% throughout the year.⁵⁸

4.49 The ILO/UNDP study likewise observes that, due to larger labor and fertilizer inputs, rice production costs per hectare are considerably higher in public, than in private, irrigation schemes, but that per hectare revenues were also generally higher in the former.⁵⁹ The average net income per family settled by the project was reported by Bank regional staff to be US\$ 4,200 per year.⁶⁰ Assuming six persons per household, the net per capita income for this group is about US\$ 700 per year, or several times higher than that estimated at the time of appraisal.

4.50 From an environmental standpoint, the PCR concludes that SF II was largely benign.⁶¹ The project, reportedly, had not caused the pollution of any local aquifer since fertilizer and pesticide use, at the time of completion, was limited. The PCR argues, moreover, that, even if such chemicals were to be applied more intensively in the future, "the flow of the Sao Francisco is so enormous that it would not produce any detrimental effects on water quality." This observation, however, ignores the potential negative impact of such chemicals on the varzeas themselves. The completion report likewise affirms that the project did not include land clearing or cause environmental problems through erosion, while generally improving health and educational conditions in the area through its social infrastructure component. On the human environmental side, however, the PCR reveals that CODEVASF experienced "some difficulties" in settling forty Amerindian families in the Itiuba varzea because they either rented their lots or chose not to irrigate them. The abandoned lots apparently later became infested by rats, thereby presenting a problem to other local residents.

4.51 The sustainability of benefit flows from the SF II Project is highly uncertain. As indicated in the PCR, "development of the varzeas of the lower Sao Francisco has so far been a difficult and lengthy process because of the complexity...[of] project facilities and the limited experience of the beneficiaries in irrigation and production management."⁶² Furthermore, at full development, operation and maintenance requirements for project drainage and irrigation infrastructure are likely to be "extensive" and the associated costs "substantial." Accordingly, local output will have to increase significantly

⁵⁸ Ibid., Table 36, pg. 84.

⁵⁹ Ibid., Table 38, pg. 102 and pg. 128.

⁶⁰ Internal memorandum to OED dated July 24, 1990 (op. cit.).

⁶¹ These observations are taken from para. 1.40 of the PCR.

⁶² Ibid., paras. 1.41-1.44.

and the collection of water charges be strictly enforced if the resources necessary for adequate operation and maintenance are to be generated without large additional public subsidies.

3. The Bank's Role and Lessons Learned

4.52 The Bank's performance in relation to the two lower Sao Francisco operations was mixed. While supervision of SF I is reported by the PCR to have been generally satisfactory, even though insufficient continuity of participating staff and the absence of an agriculturalist during a substantial part of the implementation period were specifically identified as problems, the audit report seriously questions the Bank's having handled the operation as an "emergency" project.⁶³ This observation is particularly germane in view of the significant implementation problems resulting, at least in part, from inadequate project preparation. Poor preparation, in turn, was itself largely due to an insufficient initial information base, especially with respect to local geological, hydrological and socio-economic conditions. In any case, the lower Sao Francisco valley clearly presented a difficult physical and human environment in which to attempt a complex and ambitious engineering and area development project. The relative inexperience of CODEVASF with this type of undertaking, together with the poor coordination between this agency and CHESF, which was simultaneously engaged in another major Bank-supported operation in the middle valley, further exacerbated the inherently problematic nature of the lower Sao Francisco projects.

4.53 Even though preparation of SF II appears to have been more adequate than that of the earlier polders project, many of the same implementation difficulties encountered by SF I were also experienced by the follow-on operation. While the PCR for the latter concludes that many of these problems were probably unavoidable, it likewise affirms that, in light of the relatively weak initial information base, "the risk analysis could have been more thorough, in particular as regards natural conditions (climate, soils, hydrology) and their possible consequences on the design of the project," noting additionally that the risk of undertaking the operation subsequently proved to be much greater than perceived at appraisal.⁶⁴ On the other hand, the PCR also argues that the "overriding objective of compensating the farmers for the negative effects of the Sobradinho dam" did not permit the "lengthy data gathering process" (ie. about a decade) that would have been necessary in order to obtain "meaningful" hydrological information. With regard to Bank supervision, finally, while a total of eighteen missions occurred at regular intervals between August 1979 and late 1988 in connection with the SF II operation, most were carried out by an irrigation engineer, occasionally assisted by other specialists. In retrospect, the PCR observes that, while the emphasis on irrigation infrastructure was largely appropriate, in view of the project's poor

⁶³ OED Report No. 5669, op. cit., PCR, paras. 3.16-3.18, and PPAR, paras. 12-16.

⁶⁴ OED Report No. 8158, op. cit., para. 1.48.

agricultural performance, the Bank should have given equal attention to its "production aspects."⁶⁵

4.54 The principal lessons from the SF I and II experiences, as identified in the respective completion and/or audit reports, include the need to pay greater attention during project preparation and appraisal to the underlying physical and human environmental constraints that are likely to affect subsequent project implementation, as well as to the basic institutional preconditions, including the need for adequate inter-institutional coordination,⁶⁶ which must be satisfied in order for such interventions to be successfully undertaken. In relation to the latter, more specifically, the PPAR for SF I observes that, in view of CODEVASF's "persistent weaknesses," particularly with respect to agricultural development and resettlement, the Bank should have given more attention to improving the agency's capabilities. The audit report further recommends that, in future situations where there is a need to coordinate the activities of institutions in different sectors, "Bank appraisal should attempt to establish an effective mechanism by which...differences can be resolved equitably and consistently, ie. where the country's interests are maximized and not those of one agency or the other."⁶⁷

C. The Itaparica Resettlement and Irrigation Project

1. Origins, Objectives and Description⁶⁸

4.55 In order to support Brazilian Government efforts to increase electric energy supply, the Bank began preparation of a loan for the power sector in 1985. This loan (2720-BR, in the amount of US\$ 500 million) was

⁶⁵ Ibid., para. 1.47. Only two supervision missions, for example, included participation of an agronomist.

⁶⁶ The audit report for SF I (para. 30) argues that CHESF took "little active interest" in CODEVASF's activities downstream from its power facilities, further observing that it took years before the former agency agreed to provide electric energy to the latter in compensation for some of the adverse effects of its dams and that some of the project's principal execution problems "derived from CHESF's management of its reservoirs which occasionally interfered not only with work scheduled by CODEVASF's contractors but, in later years, also with the operation of irrigation facilities."

⁶⁷ Ibid., paras. 28 and 30. The PPAR (para. 30) likewise notes that, even though an interministerial committee was established in June 1979 to study flood control in the Sao Francisco valley and that periodic meetings had been held by CODEVASF and CHESF in this connection, "these agencies' conflicting interests could not always be reconciled."

⁶⁸ This and the following sections are largely based on the Staff Appraisal Report (No. 6914-BR) and President's Report (No. P-4670-BR), both dated October 27, 1987, for the initial Bank loan for the Itaparica Project and the President's Report (No. P-5181-BR), dated January 10, 1990, for the supplementary loan for this operation.

subsequently approved in June 1986. As part of the preparation work, a review of social and environmental issues affecting the sector was undertaken. Among other findings, this survey identified considerable delays in the resettlement planning for the approximately 7,900 families to be displaced by the reservoir to be created in connection with the Itaparica hydropower plant, located some 30 kilometers upstream of Paulo Afonso in the lower-middle Sao Francisco valley. Of the families to be resettled, roughly 5,300 -- including 190 Tuxa Indian families in the municipality of Rodelas⁶⁹ -- lived in rural areas.

4.56 As had previously occurred in relation to the resettlement program carried out in connection with the Sobradinho reservoir, plans for the rural population were found to be particularly inadequate.⁷⁰ As a result, disbursement of the first tranche of the power sector loan was made conditional upon submission of a satisfactory resettlement plan for Itaparica, while release of the second tranche was made dependent on attainment of adequate progress in the implementation of this plan. Furthermore, at the time the power sector loan was presented to the Board, Bank staff agreed to assist the Brazilian Government in order to ensure that resettlement at Itaparica would be undertaken in such a way as to avoid the hardships caused by the earlier dislocation of population at Sobradinho. In the process, particular emphasis would be given to the economic "reestablishment" of the rural population, a factor which had received insufficient attention in the case of Sobradinho.

4.57 Preparation of the Itaparica Resettlement and Irrigation Project, which was approved by the Bank on November 17, 1987 (Loan 2883-BR in the amount of US\$ 132.0 million), began on an "emergency" basis in June 1986. As will be further described in Chapter VI, unlike the earlier experience at Sobradinho, however, the population to be displaced at Itaparica had a direct role in the planning of the resettlement operation, primarily through the intervention of a local rural labor union confederation, POLOSINDICAL. Basic project design criteria, in fact, were negotiated between this latter organization and CHESF in December 1986, following a strike by settlers at the dam site.⁷¹ Engineering

⁶⁹ Of these families, 98 were to be resettled on an area of 4,000 ha in Rodelas, near their original homeland, and 92 would be relocated on some 2,100 ha acquired by CHESF roughly 15 km from the town of Ibotirama (Bahia) in the upper Sao Francisco valley.

⁷⁰ The SAR for the Itaparica Project (para. 2.07), echoing the findings of the earlier PCR and PPAR for the PA IV operation, specifically affirms that rural resettlement at Sobradinho had been "inadequately planned and implemented, resulting in unnecessary hardship for the evacuees."

⁷¹ According to the President's Report for the supplementary loan (P-5181-BR, op. cit., para. 5), these "design criteria" included: (i) families owning or renting 6 ha or more of irrigated area would receive a 6 ha irrigated lot; (ii) single rural laborers above the age of 18 who did not meet the preceding criterion would receive a 3 ha irrigated lot; (iii) families irrigating less than 6 ha would receive an irrigated area according to a formula which took family size into account; and (iv) CHESF would provide special credit facilities and guarantee technical assistance, agricultural extension and marketing support to

of the proposed irrigation systems and rural and urban infrastructure, in turn, was undertaken by local consulting firms under the orientation of CHESF's Directorate of Engineering assisted by a US Bureau of Reclamation team located at the time in the (then) Ministry of Irrigation in Brasilia. The operation was appraised by the Bank in June 1987 and negotiated in October 1987. At the time the project was approved, physical relocation of the population at Itaparica had already initiated and was expected to be completed by January 1988.

4.58 The Itaparica reservoir was expected to flood roughly 840 square kilometers on either side of the river in the states of Pernambuco and Bahia, including some 18,000 ha of irrigable land and another 40,000 ha previously utilized for rainfed agriculture or grazing activities. With the filling of the reservoir, most of the irrigable land in the region would be lost. Due to the low levels of annual rainfall (350 mm) in the area and the frequent occurrence of droughts, it was resolved that rural resettlement should be based on irrigated farming. However, since soils in much of the immediate vicinity of the Itaparica reservoir were judged to be inadequate, less than half of the displaced rural population could be productively relocated in the area. The remaining families, accordingly, would be resettled in irrigation projects located up to 270 kilometers from their former places of residence. Four existing townships (Petrolandia and Itacuruba in Pernambuco and Rodelas and Barra do Tarrachil in Bahia) would also be relocated.

4.59 In view of the "important contribution toward alleviating critical power shortages in Northeast Brazil" expected to be made by the non-Bank financed Itaparica power project -- whose eventual generating capacity will be 2,500 MW -- basic objectives of the resettlement and irrigation project, as stated in the SAR, are to "maintain and, if possible, improve the living standards of the 7,900 families to be resettled." ⁷² For the families to be relocated in the new irrigation perimeters, more specifically, project goals are to "improve agricultural production, provide adequate housing in small rural centers (agrovilas) and improve land ownership conditions." The urban relocatees, in turn, would be moved to new towns "planned and designed to modern town planning standards" and provided with a relatively high level of municipal services. Total project costs were estimated at appraisal to be on the order of US\$ 303.7 million and the operation was expected to be implemented over a seven year period. Completion of all physical infrastructure and irrigation facilities was originally scheduled for December 1988 and that of all agricultural development services by July 1993.

4.60 The project, as appraised, consists of three major components: (i) construction of irrigation infrastructure and the provision of agricultural support services; (ii) installation of rural infrastructure and services including housing, water supply systems, roads, electrical energy, health, education and other social services; and (iii) the provision of urban

settlers in all phases of the resettlement/reestablishment process.

⁷² Ibid., para. 3.07. The more recent President's Report for the supplementary loan (P-5181-BR, op. cit., para. 2) mentions a figure of 8,300 families.

infrastructure including housing, public buildings and road construction, electrical, water supply and sanitation systems. Irrigation infrastructure, more specifically, would include pumping stations and water distribution systems, on-farm irrigation equipment and power lines to the pumping stations. A total of 18,000 ha would be subdivided into some 5,200 farms in five distinct project areas, including some 7,900 ha (2,400 farms) on both sides of the Itaparica reservoir (Bordo do Lago-BA and Bordo do Lago-PE) and three new irrigation perimeters (Brigida and Caraibas between the towns of Cabrobo and Santa Maria da Boa Vista in Pernambuco and Pedra Branca across the river in Bahia), at varying distances from the dam site.⁷³

4.61 Since soil management and irrigation techniques in the new irrigation areas will be considerably different from traditional practices along the river near Itaparica, agricultural extension, farmer training and other support services are a key part of the project.⁷⁴ A private consultant firm having responsibility for overall management of the irrigation subproject areas and coordination of operation and maintenance activities, together with provision of organizational support to farmer organizations and on-farm technical assistance to individual settlers, would be specifically hired for this purpose. Rural housing, in turn, would be grouped into 121 small agrovilas serviced with water supply and treatment systems, internal road networks, linkages to existing highways, electricity and a total of 59 new rural schools and eight new health posts. Some 3,200 families would be accommodated in the new urban centers.

4.62 The project was expected to be implemented in three discrete stages: (i) an "urban and rural relocation phase" ending in December 1987; (ii) an "irrigation infrastructure construction phase" during 1988; and (iii) a "rural production and socioeconomic consolidation phase" from January 1989 to December 1993. The first phase was expected to be completed roughly simultaneously with formation of the Itaparica reservoir which CHESF formally agreed not to initiate filling until physical relocation of the affected population had finished.⁷⁵ Furthermore, since irrigation infrastructure was not expected to be concluded until several months after physical resettlement, monthly payments would be made

⁷³ More precisely, an estimated 430 farms would be located on some 1,500 ha at Brigida, 1,600 farms on 5,600 ha at Caraibas and 750 farms on 2,700 ha at Pedra Branca.

⁷⁴ As a complement to project production support activities, medium and long-term agricultural investment credit is expected to be made available to resettled farmers under the regular Northeast Irrigation Program (PROINE), briefly described in para. 2.22 above.

⁷⁵ This was stated in Section 2.09 of the Project Agreement signed between CHESF and the Bank on December 7, 1987.

to farmers for work on land clearing, road construction, the building of irrigation systems and other tasks. ⁷⁶

4.63 CHESF would have overall responsibility for resettlement and be directly in charge of all rural (including irrigation) and urban infrastructure construction during the first and second stages of project implementation. The power company would likewise be responsible for acquiring all land required for the operation, as well as for its eventual transfer to project beneficiaries, or, in the case of the Tuxa Amerindians, to the National Indian Foundation (FUNAI). During the third stage, however, responsibility for overseeing rural development activities would be delegated to CODEVASF, ⁷⁷ while administration of the new urban centers would be handed over to the respective municipal governments. FUNAI, assisted by CHESF, would assume responsibility for relocation of the Tuxa Indians, as well as for the subsequent provision of agricultural and social extension services to their communities, while the Pernambuco and Bahia state governments would furnish health and education services. Finally, a Recife-based non-governmental research institute, the Joaquim Nabuco Foundation, would carry out an on-going evaluation of the resettlement program under contract to CHESF.

4.64 Since the Itaparica dam and hydropower plant were already under construction by the time (1981) the Brazilian Government began to require environmental impact statements (RIMA) for major infrastructure projects, such a document had not yet been concluded at the time the resettlement operation was appraised by the Bank. An environmental assessment of the project, however, was in elaboration by a private consulting firm hired by CHESF specifically for this purpose. Accordingly, CHESF agreed both to provide the results of this analysis to the Bank for comment not later than June 30, 1988 and to follow its recommendations in carrying out the resettlement/irrigation project, taking the Bank's observations into account. ⁷⁸

⁷⁶ More specifically, CHESF assured that it would make monthly support payments of 2.5 minimum salaries to all rural families from the date of their relocation up to nine months after water had become available for irrigation on their farms. This agreement was formalized in Section 2.01(b)(iii)(A)(i) of the aforementioned Project Agreement. The following subsection of this Agreement indicates, moreover, that if problems of salinity not resulting from negligence on the part of the farm family should occur within five years of the resettlement date, each family would be entitled to a new plot of irrigated land.

⁷⁷ A CHESF/CODEVASF working group was specifically established by the Ministry of Irrigation in October 1986 to plan the agricultural development of the new rural resettlement areas. This working group was expected to continue to operate during the entire project implementation period. Ownership of all rural infrastructure, moreover, would be transferred to CODEVASF upon completion of project execution.

⁷⁸ This agreement was formalized in subsections 2.08(a) and (b) of the Project Agreement.

2. Implementation Experience and Preliminary Results

4.65 Through the end of 1988, the project was implemented largely in accordance with the original plan. By that time, physical relocation of the population in the reservoir area had been concluded and most of the urban and rural infrastructure was in place. A year later the relocated towns were fully operational and economic and social conditions were reportedly "returning to normal," while 109 agrovilas had been installed and were benefitting from improved social services and other community facilities. By December 1989, furthermore, roughly 46% of the displaced rural families had received their lots, while most of the remaining ones were in the process of demarcation. On the other hand, none of the irrigation subprojects had yet been completed and most farmers remained largely unemployed, even though, in accordance with the terms of the POLOSINDICAL/CHESF and Bank Loan agreements, monthly maintenance payments equivalent to 2.5 minimum salaries were being made to most of the affected families.

4.66 Throughout 1989, in fact, little progress was registered in the physical implementation of project irrigation infrastructure due primarily to a shortage of funds resulting from the "unexpectedly rapid" escalation of construction costs in an increasingly inflationary macroeconomic environment in Brazil.⁷⁹ As a consequence, work on the irrigation systems virtually stopped during the latter half of the year and it is anticipated that considerable additional investment will be required in order to complete the project as originally designed. To assist in this effort, the Bank approved a supplementary loan (2883-1-BR) in the amount of US\$ 100.0 million on February 20, 1990 without altering the expected June 1993 project closing date. As of this writing (July 1990), however, the Brazilian Government had not yet signed the contract for this second Itaparica loan.

4.67 At the time the supplementary loan was approved, a revised estimate of project costs indicated a 114% increase over the original (ie. 1987) US\$ 304 million figure, to a projected total of US\$ 649.7 million. Most of this increment would be absorbed by the irrigation subprojects, whose cost was reestimated to be on the order of US\$ 327.1 million, as compared with the original appraisal estimate of US\$ 129.0 million, representing an increase of nearly 154%. At this reestimated total cost, projected expenditures for the five irrigation subprojects alone would be on the order of US\$ 18,570 per hectare or US\$ 63,270 per family, as compared with initial estimates of US\$

⁷⁹ Since no major changes in physical design have taken place and all land required for project implementation had been acquired prior to approval of the original Bank loan, the dollar cost overrun was not due to increases in physical quantities of works, goods and/or services to be provided under the operation. Rather, the overrun appears to be due, in part, to the escalation of domestic currency (at the time, cruzado construction costs in relation to the devaluation of the cruzado vis-a-vis the US dollar and, in part, to an initial understatement of project costs in domestic currency terms. The President's Report for the supplementary loan (P-5181-BR, op. cit., paras. 14-18) provides a more detailed discussion of these factors.

7,320 per hectare and US\$ 24,950 per family. ⁸⁰ Significant cost increases were also projected for most other project components, particularly rural education, health and social services (205%), rural housing (145%), agricultural support services (76%), rural roads (74%) and urban infrastructure (62%). ⁸¹

4.68 With Bank approval of the supplementary loan and on the assumption that the necessary counterpart funding will be forthcoming from ELETROBRAS, it was anticipated that CHESF could complete the irrigation subprojects by December 1990, some 18 to 24 months behind schedule. ⁸² Additional Bank financing for the project was justified in order to guarantee sustainability of the investments made thus far. In this context, the President's Report argued that project achievements would only be sustainable if the operation "is completed with as little delay as possible and the settlers get the benefits as planned." ⁸³ It was likewise affirmed that, in view of budgetary constraints faced by ELETROBRAS and the Brazilian Government more generally, in the absence of additional Bank funding, further delays would be a "virtual certainty," while a decision not to go ahead with the supplementary loan would "put at great risk the project's overall objective of restoring the livelihood of the rural settlers, would increase even further the difficulties that these families have endured and would result in the project's failure." It was argued, finally, that, if the latter should occur, outside observers would question the Bank's commitment both to the project and to its own resettlement policy, while future Bank-Government dialogue on the social and environmental aspects of hydropower development might be jeopardized.

⁸⁰ The President's Report (P-5181-BR, op. cit., para. 21) observes that, while these investment costs are roughly three times higher than the historical average for public irrigation schemes in the Northeast, this reflects "not only the cumulative impact of sharply rising construction prices and construction delays during project implementation, but also the inherently high cost of providing irrigation to areas located far from perennial sources of water and in an inhospitable environment." According to this source also, despite these elevated costs, the approach followed by the project was, nevertheless, the least cost solution "given the demands of settlers, of meeting the agreement between POLOSINDICAL and CHESF and adhering to Bank resettlement guidelines."

⁸¹ In absolute terms, the most important of these categories is rural housing, for which it is estimated that costs will increase from an appraisal projection of US\$ 78.4 million to a completion total of US\$ 133.9 million.

⁸² The impact of the economic plan of the new federal administration that took office in March 1990, however, may result in additional delays.

⁸³ Additionally, as will be further described in Chapter VI, the President's Report for the supplementary loan (P-5181-BR, op. cit., para. 20) noted that the delay in installing project irrigation infrastructure "has aggravated the settlers' hardships, [while] in the agrovilas social tensions have increased significantly and threaten to erupt in a violent confrontation between settlers and CHESF field staff."

3. The Bank's Role and Lessons Learned

4.69 The Bank's role in the preparation of the Itaparica Project was important. As indicated both in the staff introduction to the Board discussion of the initial loan for the resettlement operation and in the President's Report for the supplementary loan, the Bank assisted CHESF in identifying the most cost-effective means of meeting the project's income objectives for the rural population to be displaced by the reservoir.⁸⁴ According to the President's Report for the more recent loan, particular attention was given to designing irrigation schemes so as to guarantee their technical feasibility at the lowest possible cost in the presence of such significant constraints as: (i) the tight implementation schedule for resettlement; (ii) the Bank's involvement at a relatively late stage; (iii) the "strong settlers' union with vocal international support;" (iv) the inherent limitations of the physical environment in terms of soil quality, climate and the lack of suitable areas for irrigation; and (v) "the need to comply with the requirements of Brazilian law and Bank policy that settlers not be adversely affected in an economic sense by the move."⁸⁵

4.70 The "extraordinary" efforts of Bank staff in providing assistance to CHESF to prepare the project were explicitly recognized by the Board in its consideration of the first loan for the operation, as was the fact that the issues involved had probably received closer attention in this instance than in other Bank-supported resettlement schemes by virtue of its having been presented as a free-standing project. Strong beneficiary (ie. POLOSINDICAL) and NGO (ie. Fundacao Joaquim Nabuco) participation were also cited as positive features of the operation. Despite its numerous positive features, however, due to the unique circumstances leading to Bank participation and the serious time constraints on preparation described above, senior Bank management affirmed that the Itaparica operation should not be considered as a "model" for future Bank involvement in resettlement programs.

4.71 As a project still under implementation, it is too early to make conclusive judgments as to the project's results and major lessons. Nonetheless, some preliminary lessons, reinforcing those already learned from the earlier Sobradinho experience, are clear and will be further explored in the following chapters. One of these is the need to allow adequate time and resources for the planning and implementation of resettlement activities, including those which are essential for the economic "reestablishment" of the

⁸⁴ The staff introduction to the Board discussion of the project on November 17, 1987, in highlighting the Bank's involvement, noted, moreover, that a "balance" had to be struck between the urgency of filling the reservoir and relocating the affected population, given increasing power shortages in the Northeast, and ensuring that sound resettlement plans were in place.

⁸⁵ President's Report for the supplementary loan (P-5181-BR, op. cit., para. 7). In some cases, however, project costs were increased, rather than decreased, as, for example, when most of the lakeside areas originally identified by CHESF were found to be unsuitable for irrigation and had to be replaced by sites at distances of up to 270 kilometers from the reservoir.

displaced (especially rural) population. That this process must involve direct and effective beneficiary participation is also evident. A third lesson is that such resettlement efforts are likely to be costly and that these costs need to be both realistically assessed and explicitly included in the ex-ante economic evaluation of the project which has given rise to them.

4.72 A fourth lesson is that, especially for rural communities, the mere physical relocation and rehousing of a population displaced by a hydropower or other large project is, in and of itself, insufficient to guarantee a level of livelihood similar or superior to that existing prior to resettlement. Specific measures to support the economic "reestablishment" of this population and, ideally, to enhance their long-run income generation possibilities are also required. This implies the need to situate physical displacement and resettlement in the context of a broader socio-economic development effort in benefit of the rural and urban populations involved, as, indeed, the Itaparica Project is currently attempting to do, albeit at considerably greater financial costs than initially anticipated. Furthermore, resettlement and economic reestablishment activities, particularly the latter, are likely to be highly complex, especially when there is a change not only in the physical -- and frequently social -- environment in which productive activities must take place, but also in the predominant technologies involved. This complexity needs to be adequately appreciated and taken into account both in the initial preparation of resettlement programs and throughout the course of their implementation.

D. Conclusion

4.73 This brief review of the Bank-supported Paulo Afonso IV Hydropower, Lower Sao Francisco Polders and Second Irrigation and Itaparica Resettlement and Irrigation Projects illustrates a number of the characteristics and problems frequently associated with water resource use and management in a large river basin. On the one hand, physical interventions that occur at one place in the basin are likely to have an impact on much of the rest of the system. The Sobradinho dam, more concretely, not only resulted in a reservoir extending more than 300 kilometers upstream and inundating an area of some 4,150 km², but also altered natural flooding patterns near the mouth of the river more than 700 kilometers downstream. It likewise displaced a large number of people both in the area flooded by the reservoir itself and in the lower Sao Francisco varzeas. To the extent that the dam provided one of the major justifications for the agricultural colonization project at Bom Jesus da Lapa, roughly 1,000 kilometers upstream of Sobradinho, moreover, its impact extended into the upper Sao Francisco valley as well.

4.74 It can also be concluded from the experience in the middle and lower Sao Francisco valley that the physical displacement of an existing population almost automatically results in its socio-economic displacement as well, in large measure because this leads to a significant change in the natural environment on which that population's livelihood frequently depends. In the specific case of the Sao Francisco valley, rural families that formerly relied on the river banks, "islands" and/or floodplains for subsistence and/or commercial agricultural production and on the river itself for fish and transportation were forced to adapt to new, and generally far less productive, physical surroundings along the lakeside or in colonization and irrigation

schemes located several hundred kilometers or more from their original places of residence. Such adaptation, furthermore, often requires the development of new production technologies and skills and, in many instances, of a new set of social relations as well.

4.75 In the specific case of Sobradinho, additionally, much of the affected population was forced to adapt to its new physical and social surroundings with only limited assistance from the agency responsible for its original displacement. In this case, moreover, the opportunity to undertake a more comprehensive (and participative) local development effort in conjunction with the involuntary resettlement of the population dislocated by the dam, as had been explicitly recommended in the 1973 environmental reconnaissance report, was lost by both the Bank and the Brazilian Government. In contrast, even though they have been beset by serious implementation problems and their outcomes to date have not been universally positive, the lower Sao Francisco and Itaparica projects have, nevertheless, consciously attempted to bring about the socio-economic, as well as physical, reestablishment of at least part (SF I and II), if not all (Itaparica), of the displaced rural populations.

4.76 The experience in the lower Sao Francisco valley also illustrates the difficulties of implementing a complex engineering project in the face of environmental and institutional impediments which are beyond the control of the executing agency. Natural flooding due both to heavy rainfall upstream and in the lower valley itself plagued physical execution of the polders and second irrigation projects, as did CHESF's "controlled" flooding in connection with construction of the Sobradinho dam. Poor coordination between CHESF and CODEVASF appears to have been a factor in the latter. Inadequate knowledge of local geological and hydrological conditions in the lower valley, however, aggravated efforts to install dikes, drainage and pumping facilities and other protective works. These physical problems were also exacerbated by unexpected socio-political resistance, described in Chapter VI below, which, similarly, reflected poor understanding of the ex-ante situation in the project area.

4.77 Finally, as will also be discussed in greater detail in Chapter VI, the Paulo Afonso IV Project in particular has contributed to significant demographic growth in, and the rapid socio-economic transformation of, much of the middle Sao Francisco valley, especially the area (including the cities of Petrolina and Juazeiro) in the vicinity of the Sobradinho dam. This transformation, however, was not an explicit objective of the PA IV operation even though this project was clearly designed to support urban-industrial development, through increased energy provision, elsewhere in the Northeast. The more localized regional development impact of the Sobradinho dam and hydropower investments has, nevertheless, been important, generating both benefits and costs for the local population, as well as helping to stimulate significant migration to, and the rapid expansion of rural and urban productive activities in, the area.

4.78 In the future, accordingly, the potential local development impacts of large-scale infrastructural investments, such as major hydropower operations, should be more adequately identified and assessed in the project preparation and appraisal process. Furthermore, appropriate measures should be designed to assist the region to take fuller advantage of project benefits (eg. increased

local power supply and other physical infrastructure, greater or more regular water availability for irrigation and other uses), as well as to better absorb its indirect and potential long-run social and environmental costs (ie. the displacement of small subsistence farmers by larger commercial agricultural enterprises, pollution by agro-chemicals, possible shortages due to increasing competition for water resource use, etc.). In short, the likely medium and long run effects of the project's "insertion" into its regional context should be more adequately considered and a more systematic effort undertaken to maximize the local benefits and minimize the local costs resulting from the frequently complex and multiple transformations associated with such investments.

V. PHYSICAL ENVIRONMENTAL IMPACTS AND PROTECTION MEASURES

A. Paulo Afonso IV Hydropower Project

1. Environmental Problems Associated with the Sobradinho Dam

5.01 A feasibility study to regulate the flow of the Sao Francisco River was undertaken in 1972 with the aim of stabilizing Paulo Afonso's energy generation at 2,460 MW and guaranteeing the production of future plants including Itaparica. The Paulo Afonso IV station was built below the three existing generating plants and is designed to take advantage of the difference in level resulting from Paulo Afonso falls. From a physical environmental standpoint, however, the Sobradinho dam has caused problems both upstream and downstream.¹

5.02 Downstream problems include the permanent flooding of traditional floodplain agricultural areas near the mouth of the river in Alagoas and Sergipe which gave origin to the SF I and II Projects described in the previous chapter. Another major ecological impact of Sobradinho on the lower valley has been the trapping of alluvial sediments and nutrients by the dam, thus rendering soils downstream less fertile than they would have been in the absence of the dam. In addition, the flooding of vast areas of fish breeding grounds in the lower valley with saline water is likely to alter the biological balance of aquatic fauna, as well as of some species of terrestrial fauna.

5.03 Upstream of Sobradinho, a number of problems have also occurred. There has been a permanent loss of fertile riverine farmland both in the area inundated by the reservoir, as well as farther above the lake, due to the rise in lowflow level as a result of regulation. Furthermore, a progressive siltation process is occurring in the reservoir, as are changes in water quality. The latter have affected aquatic fauna, which are likewise influenced by the shift from running to stationary water caused by the impoundment. Terrestrial fauna in the surrounding brushland (caatinga) has undoubtedly also been affected to some extent. On the other hand, while some accumulation of aquatic plants² has occurred, especially in the mid-section of the lake, this does not appear to constitute a serious ecological problem at present. Water pollution as the result of agrototoxic waste and domestic effluents, which might stimulate an undesirable proliferation of water plants in the future, however, has been observed in the area.

¹ Many of the physical environmental impacts of Sobradinho were foreseen by Robert Goodland in his pre-appraisal study entitled, Sobradinho Hydroelectric Project Environmental Impact Reconnaissance, op. cit. The risks to public health, disruption of terrestrial and aquatic ecosystems, climatic disturbances, dangers of impoundment and need for watershed protection from extensive deforestation, as well as the environmental costs of irrigation, are all discussed at length in this report.

² For example, *Eichornia* sp and *Salvinia*. These plants may, in fact, have a beneficial effect by providing protected areas that facilitate fish breeding.

5.04 The physical impact of Sobradinho in recent years, moreover, has been influenced by the fact that, throughout the 1985-89 period, the lake did not reach its maximum operational flow of 2,060 m³/second.³ Various hypotheses have been advanced to explain this phenomenon. These include: (i) poor quality of the data used to calculate optimal operational river flow; (ii) lower-than-average rainfall in the immediate Sao Francisco catchment area; (iii) low rainfall in the central Brazilian plateau due to increasing Amazonian deforestation; (iv) changes in the hydrological balance caused by deforestation at the headwaters of the river in Minas Gerais; (v) heavy and increasing water use upstream of the Sobradinho dam by public and private irrigation schemes; and (vi) delays in the construction of the Itaparica dam which required increased power generation at Paulo Afonso and Moxoto and, thus, the liberation of a larger than normal volume of water from the Sobradinho reservoir. Among these factors, the lower than normal rainfall levels in the upper Sao Francisco drainage area in Minas Gerais and the "excessive and premature" release of water from Lake Sobradinho due to the delays at Itaparica appear to have been the main reasons for the low level of the Sobradinho reservoir after 1985, according to CHESF and the Ministry of Infrastructure.⁴ The possible (individual and collective) contribution of these factors to declining water levels in the river, however, needs to be further assessed and should be systematically monitored in the future. In any event, the substantial drop in water level in Lake Sobradinho during the latter 1980's has resulted in water supply problems for numerous agrovilas, as water pumps have been left high and dry, as well as in conflicts between small farmers and large landowners due to competition over the occupation of exposed lakeside lands.⁵

5.05 Fish production in the lake expanded considerably in the first few years after impoundment, reaching a total of 20,000 tons in 1980. After the fourth year, however, the total catch declined significantly, to a current figure of some 4,000 tons per annum. These data, however, probably do not fully take into account the extensive unregistered (and largely uncontrolled) fishing that presently takes place on the lake. According to a recent study, once the situation on the lake is stabilized, the potential annual catch should be on the

³ This situation apparently changed quite dramatically in late 1989 and early 1990, however, when heavy rains in northeastern and central Brazil significantly increased the discharge of the Sao Francisco River, requiring Sobradinho's sluiceways to be opened for the first time in four years.

⁴ Comments on an earlier version of this report. These two agencies also observe that, despite the unexpectedly large volume of water drawn from the Sobradinho reservoir and the significant transfer of energy from the Tucuruí hydropower plant in the Amazonian state of Para, energy distribution -- and hence consumption -- had to be rationed in the Northeast during 1987.

⁵ See Chapter VI below for additional details on the socio-economic impacts of this phenomenon.

order of 5,000 tons. ⁶ It should also be observed in this context that, even though CHESF submitted a preliminary framework for fisheries development in Lake Sobradinho in March 1975, in accordance with the Loan and Guarantee Agreements for the Paulo Afonso IV Project, no final plans were ever presented, nor was sufficient vegetation cleared prior to the filling of the reservoir to facilitate local fishing activity despite the recommendations of a Bank consultant in 1977 that an emergency program be prepared for this purpose. ⁷

5.06 A number of potentially serious problems, moreover, have arisen in recent years in relation to the fishing industry on Lake Sobradinho. At present, production is severely affected by predatory practices involving the use of illegal fine-mesh nets. Furthermore, not only is the increasing contamination of fish by agrottoxics dumped or washed into the reservoir of growing concern as a potential public health hazard, but cases have been reported of pesticide use to preserve fish, as well as of the use of dynamite for fishing purposes. None of these issues has been adequately addressed by state environmental agencies or other responsible authorities. Even though the state government of Bahia, through its Research and Development Center (CEPED), has recommended the adoption of a number of measures to avoid or control these problems, at the time of the OED/SEPLAN mission in July-August 1989, no action had yet been taken. ⁸ In spite of CEPED's warnings of insufficient demand, furthermore, three fish refrigeration and storage units were set up and have subsequently (and predictably) incurred substantial financial losses, while potentially more useful fishing terminals recommended by the same agency have yet to be established. ⁹

⁶ J.F. Paredes et. al., "Sao Francisco River Hydrobiological Studies" in The Dammed Lake of Sobradinho, University of Hamburg, 1983, and "Producao e Problematica das Pescas no Lago e Represado de Sobradinho-Bahia," mimeo, CEPED, Bahia, 1989.

⁷ Inter-American Development Bank, "Sobradinho Hydroelectric Project: The Population Resettlement Component," Project Performance Review, PPR-18/84, Operations Evaluation Office, November 1984, paras. 4.06-4.07. More generally, this report concludes that "from the beginning CHESF sought to limit its responsibilities for overall economic development....No long-term provisions were made in the larger social and economic development strategy for the region despite the creation of water, fisheries, transportation and irrigation resources on a large scale."

⁸ J.F. Paredes and F.N. Pacheco, "Producao e Problematica das Pescas no Lago e Represado de Sobradinho-Bahia," op. cit.

⁹ In its comments on the draft of this report, CHESF observes that the development and implementation of an adequate plan for the rational exploitation of fisheries in Lake Sobradinho (and elsewhere in Brazil) require considerable prior institutional strengthening of the specialized federal and state agencies responsible for the sector, provision of the necessary financial resources and clear transfer of the legal authority for -- as well as the political onus associated with -- associated control activities.

2. Water Evaporation from Sobradinho Lake

5.07 Sobradinho has a maximum surface area of 4,126 km² and forms the largest reservoir in South America. It is situated in a semi-arid region, characterized by strong sunlight and winds and, hence, by high rates of evaporation. Initial studies suggested evaporation of 2,200 mm per year when the lake is full, indicating a loss of 290 m³/second, or slightly more than 10% of the total flow at Juazeiro -- located 40 kilometers downstream from the dam -- which is estimated at 2,800 m³/second. More recent studies estimate annual water loss through evaporation as being in the range of from 1,947 to 2,251 mm.¹⁰ According to the OED/SEPLAN mission's field estimates, the normal loss through evaporation is around 10% of the flow at Sobradinho of 2,060 m³/second. However, given the reduced volume of water in the lake during most of the period since 1984, the loss rate could be higher. Utilizing an evaporation rate of 2,000 mm per year, it can be estimated that about nine billion cubic meters of water are converted to vapor annually in this way. More detailed studies of this phenomenon are necessary, however, in view of the fact that water loss through evaporation could eventually reduce the average flow of the Sao Francisco by up to 50%, with potentially serious implications for competing water users in the middle and lower valley.

5.08 As far as broader climate changes are concerned, presently available data is insufficient to draw firm conclusions. However, it is conceivable that a change in thermal currents as a result of the reservoir could alter local rainfall patterns and bring about increased precipitation. To determine the likelihood of this occurring, however, systematic studies of evaporation rates before and after the formation of Lake Sobradinho, as well as of wind profiles within its larger area of influence, are required. The high rate of evaporation, together with the projected future expansion of irrigated land to over one million hectares, nevertheless, could result in the production of some 38 billion tons of water vapor annually.

3. Water Scarcity in the Valley: Energy versus Irrigation

5.09 As noted above, Sobradinho was built in order to stabilize the downstream river flow at 2,060 m³/second. From its source to the sea, the Sao Francisco drops by 1,000 meters with the steepest gradients occurring in the upper and lower reaches. The largest drop is in the lower valley. Below Paulo Afonso, the river falls by 100 meters in the space of a few kilometers, while in the 13 kilometers separating Moxoto and Pao de Acucar, it drops by 211 meters. The location of the steepest gradients near the mouth of the river means that increasing water consumption upstream due to irrigation evaporation and other "uses" has severe implications for future power generation, since it will result in a reduction in flow to the turbines.

¹⁰ N. Dias and M.F. Gobbi, "Quanto Evapora o Lago de Sobradinho?" COPPE, Federal University of Rio de Janeiro, 1988.

5.10 According to PLANVASF, ¹¹ projected public irrigation schemes alone will cover 1,440,105 hectares and consume 690 m³/second of water. This seems to be a rather conservative estimate considering the current extent of water use in irrigation projects in the valley. To this figure must be added water consumption by private schemes, which is presently unknown, although there has been an significant proliferation of such projects around Petrolina over the past two decades. Based on current projections, it is not difficult to imagine that as much as half of the Sao Francisco's discharge could be utilized for irrigation purposes in the future.

5.11 As far as losses through evaporation are concerned, a more detailed analysis of the situation is needed. Including the reservoirs of Itaparica, Moxoto, Sobradinho and Tres Marias, an evaporation loss rate conservatively put at 315 m³/second is obtained. When the reservoirs at Ibo, Oroco, Paratinga and Formoso are also considered, this figure rises to 490 m³/second. It is thought that losses incurred downstream of Moxoto do not affect the system in terms of power generation, but, if the planned reservoirs of Xingo and Pao de Acucar are included, the total rate of water loss through evaporation in the Sao Francisco valley increases to 520 m³/second, or roughly 25% of the river's regulated discharge.

5.12 The above figures give some idea of the complexity of the system and of the potential for a relative shortage of water in the Sao Francisco valley as a result of the multiple, and increasingly ambitious, water use objectives set, often independently, by the public and private sectors. Serious consideration must, therefore, be given in the future to alternative measures, such as the use of other river basins (including the Amazon) for power generation, improving the efficiency of, and eventually limiting, water consumption by irrigation projects and/or transferring water from other rivers to the Sao Francisco. In any event, a multi-region, multi-sector assessment of longer run development options and constraints for the Sao Francisco valley is necessary.

B. The Lower Sao Francisco Polders and Second Irrigation Projects

1. Changes in Land Use

5.13 Before the Sobradinho dam was built, agricultural activities in the lower Sao Francisco valley were closely tied to the seasonal rise and fall of the river. The banks were flooded during periods of maximum discharge, after which rice was planted on the exposed margin (vazante). This was essentially the same system used in the Nile valley for thousands of years. Floodwaters brought rich sediments from the upper reaches of the river to fertilize the lower valley. A particular production system and social structure developed that was adapted to this annual phenomenon. With the closing of the Sobradinho dam, however, the river's flow was stabilized at around 2,060 m³/second, changing the traditional flood pattern and bringing potentially drastic consequences for the farming population, especially small rice cultivators. To prevent the permanent

¹¹ Plano Diretor Para o Desenvolvimento do Vale do Sao Francisco (Recursos Hidricos Superficiais), RTE 86/16, Brasilia, October 1988.

flooding of low-lying areas and to control water levels, accordingly, a complex system of dikes, floodgates and pumping stations was established.¹²

5.14 Five irrigation schemes were set up by CODEVASF on the "polders" formed by flood-protection structures and related investments: Cotinguiba-Pindoba (2,500 ha), Boacica (5,400 ha), Propria (1,200 ha), Betume (3,000 ha) and Itiuba (2,100 ha). Although paddy-rice is still the major crop, attempts are being made to diversify production with cotton, corn, sweet potatoes, peanuts, fruits and green vegetables. In addition, fish-farming, carried out in association with pig-rearing, has expanded significantly in the area.

2. Integrated Pig-Rice-Fish Farming

5.15 Although fish-farming is still at an embryonic stage in Brazil, due to favorable local conditions, it has become a reasonably well-established activity in the lower Sao Francisco valley over the past decade. Since 1982, the Itiuba pilot fish-farm has been supplying young fish to settlers for commercial production to supplement their incomes in conjunction with rice cultivation and pig-farming. In some cases, the three activities are fully integrated. These activities are dependent upon the production of young fish from centers at the Betume project, which has a present capacity of two million fish annually and a long-run potential of 12 million fish, and at Itiuba, which could eventually produce another 15 million young fish a year.

5.16 The typical fish-farming unit covers about 5,000 m², adjacent to which a piggery is built with an area of 35 m². Jointly, such facilities can produce roughly 30 pigs per harvest and 5,000 fish a year. The pigs are bred in confinement for 120 days, adding some 70 kilos in weight, while the fish are fed twice a day on pig droppings. Fish varieties include curimata pacu (*Prochilodus marginatus*), tambaqui (*Colossoma macropomum*), the common carp (*Cyprinus carpio*) and silver carp (*Hypophthalmichthys molitrix*).¹³ This appears to be one of the more successful features of the lower Sao Francisco Projects.

3. Major Problems

5.17 On the less positive side, the poor water quality of many of the affluents of the Sao Francisco which cross the irrigation projects in the lower valley, including the Itiuba, Jacare and Propria Rivers, has led to soil salinization and declining crop yields. Efforts have been made to minimize this problem by improving project defenses against the penetration of saline waters. One such measure has been the construction of a rainwater retention pond at Boacica to help prevent flooding during the wet season in the lower valley.

5.18 Due to the types of soils and geological structures that predominate in the region, moreover, serious problems appear to affect maintenance of pumphouses, sluiceways and other structures. At Propria, for example, the

¹² See section B of Chapter VI below for details of social impacts.

¹³ For further details, see E.J.O. Motta, Programa de Suino-riçicultura do Baixo Sao Francisco, CODEVASF, 1989.

OED/SEPLAN mission found that soil slippages and subsidence had put the system out of alignment. Partial erosion of protective dikes along the Sao Francisco has also occurred. There likewise appears to be a lack of concern for the preservation of forested areas and terrestrial and aquatic fauna at some project locations. With more adequate intervention by CODEVASF and state environmental and other agencies, these aspects could be improved, thereby affording greater environmental protection.

5.19 Given the predominance of rice monoculture in the irrigation projects, it is likely that problems of pests and disease may become more common in the future, requiring proper corrective measures. Local technicians acknowledge that serious problems of infection by nematodes (thread worms) and fungi already exist in the area. At present, irrigation farmers are spraying insecticides without adequate protection or due care. Better orientation in the use of agrototoxic substances is clearly required, as is chemical analysis of irrigation water to determine the present extent of possible contamination.

C. Itaparica Hydropower and Resettlement Projects

1. Water Quality and Fish Production Potential at Itaparica

5.20 The Itaparica reservoir is fed mainly by the water which leaves Sobradinho after it has passed through a process of natural regeneration on its downstream journey of several hundred kilometers. Water quality at Sobradinho has been analyzed since August 1982 and the reservoir can be divided into three areas.¹⁴ As mentioned in para. 5.05 above, studies have indicated an annual fish production potential for Sobradinho of roughly 11 kgs/ha, giving a total for the lake of 5,000 tons, well below the maximum recorded catch of 20,000 tons. By trapping sediments from the river, Sobradinho greatly alters the quality of the water, which also undergoes seasonal variations in different parts of the lake, as well as determining the water quality further downstream at Itaparica. Based on calculations similar to those made for Sobradinho, fishing potential at Itaparica, at about 2-3 kgs/ha per annum, is considerably lower than at the former. However, water drained into the lake by tributaries below Sobradinho, as well as other biochemical factors, may affect this estimate.

¹⁴ J.F. Paredes, et. al., "Sao Francisco Hydrobiological Studies," op. cit. Area 1, from the dam upstream to Remanso, is characterized by a sluggish flow in which the water is almost stationary. This is the deepest part of the lake, averaging eight meters, its waters are transparent and subject to strong winds, with little surface vegetation. The presence of microcrustaceans allows young fish and plankton to proliferate. Area 2, from Remanso to station 11, is a zone of transition from moving to stationary water, whose main current follows the old Sao Francisco riverbed. It is fed by three major tributaries and has an average depth of four meters, with many small pools forming during the dry season. This region has the highest concentration of nitrates, due to the slow movement and decay of organic matter, as well as the highest levels of water hardness and chlorates, and is ideal for the regeneration of fish stocks. Area 3 corresponds to the initial stretch, beyond station 11, up to Barra. The water, for the most part, is fast-moving and muddy with few plankton.

2. Lake Itaparica and Flooded Areas

5.21 Lake Itaparica covers 834 km², stores some 11 billion cubic meters of water and is situated entirely within the semi-arid climate of the sertao. This area has an annual rainfall of less than 400 mm, concentrated in the period from December to March. However, the headwaters of many tributaries which feed into the Sao Francisco are located in more humid regions, where annual rainfall can reach 800 mm. Evaporation loss from the lake amounts to 40 m³/second, or roughly 2% of the river's average discharge of 2,060 m³/second.

5.22 As indicated in para. 4.51 above, some 18,000 hectares of land submerged by the Itaparica reservoir were irrigable, of which 8,000 ha were being farmed prior to inundation. An additional 40,000 hectares of now flooded land were devoted to pasture and riverine or yazante agriculture, producing a range of crops. Vegetation in the flooded area was mainly xerophytic, typical of the caatinga, although in some areas forest cover was still in evidence, characterized by trees such as the crabeira (*Tabebuia caraiba*), quixabeira (*Bumelia sartorum*), juazeiro (*Ziziphus joazeiro*), marizeiro (*Geoffraea spinosa*) and the common algorobeira (*Prosopis juliflora*). It was decided not to remove existing vegetation in most of the reservoir area prior to flooding since this was not expected to affect water quality and would provide a refuge for fish. However, certain areas near the town of Petrolandia, which should have been cleared, were only partially deforested.

3. The Rescue of Terrestrial Fauna

5.23 Although the wild animal life of the semi-arid Northeast has been largely decimated over time, both directly by man and as a result of the destruction of natural habitats, important species survive in the forests and more humid areas.¹⁵ Mammals include the saguim monkey (*Callithrix jacchus*), common in forested regions. Rodents include the moco (*Kerodon rupestris*) and punare (*Trichomys apercoides*). Larger animals such as the fox (*Lycalopex vertulus*) and wildcat (*Felis* sp) are also still found. A variety of bird species is encountered, ranging from the ribaca (Columbidae) and codorna or pigeon (Tinamidae) to the anu or anum (Cuculidae) and acaia or laughing falcon (Falconidae). Reptiles include a variety of lizards such as iguanas, chameleons and teju (Geckonidae, Iguanidae and Teiidae). Snakes range from the jararaca (*Bothrops* sp) to the sucuri (Boidae family), most of which are not harmful to man and feed on small animals.

5.24 A rescue operation for terrestrial fauna, known as "Operation Saci," was undertaken by CHESF prior to filling the lake. Altogether, some 52,000 animals were captured, or 0.8 animals per hectare. Reptiles accounted for 80% of the total, consisting mainly of lizards. Most of the rescued animals were released at the site of the planned Itaparica ecological station near the town of Floresta, Pernambuco. In contrast to the comparatively poor record at

¹⁵ Braga, Ricardo and Lima, Raimundo, "Bichos e Plantas no Doce Mar do Sertao," Ciencia Hoje, Vol. 10, No. 56, August 1989.

Sobradinho, CHESF appears to have taken considerable pains to preserve fauna and the physical environment, more generally, at Itaparica.

4. The Environmental Protection Plan for Itaparica

5.25 Within its organizational structure, CHESF has recently established special departments which are responsible for environmental control,¹⁶ as well as an environmental protection plan for Itaparica. The latter is composed of physical, biotic and socio-cultural components.¹⁷ Physical controls, more specifically, include: (i) the collection of meteorological data by CHESF's Division of Environmental Control through a series of weather and fluvial stations to be supplemented by information gathered at posts on irrigation projects; (ii) the monitoring of seismic activity through instruments installed by the Astronomical and Geophysical Institute of the University of Sao Paulo; (iii) a program to monitor soil use and the contamination of lakewaters, not yet implemented, to be set up by a private agricultural extension company contracted to take charge of project irrigation schemes once these come on stream; (iv) a water quality monitoring program, currently already underway, that includes the establishment of testing posts, together with the regular chemical and microbiological analysis of samples, covering agrototoxic chemicals and heavy metals, among other substances; and (v) landscaping of the dam construction site, involving an area of 320 ha upstream of the impoundment, the replacement of topsoil lost during excavations and reforestation with native and exotic species.

5.26 Biological programs, in turn, include: (i) the cleaning of the area to be flooded which involved some deforestation to preserve water quality and the removal of domestic septic tanks from urban areas; (ii) Operation Saci, already mentioned, which was successfully executed in parallel to the filling of the reservoir under an agreement with CESP and currently includes an arrangement with the Federal Rural University of Pernambuco for monitoring fauna in the area; (iii) a conservation program for aquatic fauna which includes stocking the reservoir with fish, preserving existing species and undertaking studies to identify natural fish breeding grounds with the aim of avoiding their extinction downstream from Sobradinho. The latter program is currently being implemented, while a fish farm at Paulo Afonso is presently producing young fish to assist in restocking Lake Itaparica.¹⁸

5.27 Cultural measures, finally, entail a program for preserving items of historical and archeological value that is currently being executed through

¹⁶ See CHESF's organization chart in Annex 3 to this report.

¹⁷ Social issues relating to the relocation of urban and rural populations are discussed at length in Chapter VI below. Studies were also initiated in May 1989, under an agreement between CHESF and CESP, to determine the potential of Lake Itaparica for recreational activities.

¹⁸ The fish restocking program was approved in 1988 by the now extinct SUDEPE/PE. CHESF has signed an agreement with the new federal environmental coordinating body, IBAMA, for the monitoring of fishing activities, as well as for the issuing and renovation of fishing licenses for Itaparica reservoir.

an agreement between CHESF and the Federal Universities of Bahia and Pernambuco. This program involves archival research into cartorial and church records and cataloguing of the information gathered, together with the investigation of archeological sites and the collection of Amerindian artifacts.

5. Licensing Problems for Itaparica: the Role of State Environmental Protection Agencies

5.28 From the time construction activities initiated at Itaparica through the closing of the sluiceways and the subsequent start-up of electricity generation, there have been a number of modifications to Brazilian environmental legislation. As a result, licensing of the Itaparica power station has encountered several problems such that, at the time of the OED/SEPLAN mission in mid-1989, even though the plant was in operation, it had not yet been granted a full operating licence. In order to comply with current federal environmental legislation, moreover, CHESF contracted an engineering firm to carry out an environmental impact study (known as the RIMA), which was formally submitted to state environmental control authorities in Bahia and Pernambuco in July 1987.

5.29 The Pernambuco state government, through its Company for the Control of Environmental Pollution and Administration of Hydraulic Resources (CPRH), in turn, contracted a team from the Federal University of Pernambuco to analyze the environmental protection program drawn up on CHESF's behalf. CPRH's report concluded, however, that the RIMA was inadequate both in terms of its analysis of the project's potential negative impacts and in terms of the proposed corrective measures and ruled that a more comprehensive plan for integrated regional development was necessary. An agreement was subsequently reached between CHESF and the state government through which a provisional licence was granted on the understanding that an improved program for environmental control in the reservoir area would be prepared.¹⁹

5.30 The state government of Bahia raised similar concerns through its own agency, the Center for Environmental Resources (CRA). CRA highlighted a number of the critical issues discussed by CPRH, which remained to be addressed by CHESF. Consequently, and in contrast to the outcome in Pernambuco, at the time of the OED/SEPLAN mission, CRA still had not issued an operating licence to CHESF for Itaparica.

¹⁹ Licence number LO 123/88, of 14 July 1988. The terms of the agreement stipulate that CHESF would take a number of concrete steps toward improving its environmental actions. These included streamlining Operation Saci, setting up an ecological station, increasing fish stocks in the lake, drawing up an operational plan for water use from the reservoir at minimum and maximum levels, preparing a plan for demarcating and distributing irrigated plots and agreeing to provide periodic progress reports to CPRH.

6. Likely Future Problems

5.31 The reorganization of federal government agencies responsible for environmental monitoring following the creation of IBAMA in February 1989,²⁰ may result in short term problems for the implementation of environmental controls at Itaparica. Furthermore, the transfer of responsibilities from federal to state agencies is still unclear and the pertinent official agreements have yet to be signed. In the case of Itaparica in particular, the involvement of two states further complicates matters since the federal government must ensure that the state programs are consistent in terms of both goals and monitoring and enforcement procedures. More generally, in situations such as that at Itaparica where two or more states are involved -- especially when the respective state agencies are not in agreement as to the quality of a particular project's environmental impact assessment and/or the adequacy of the corresponding control and/or mitigation measures to be taken -- there is clearly a need for direct intervention, or at least coordination, from the federal level.

5.32 The most serious future physical environmental problems at Itaparica, as at Sobradinho, will probably involve water quality, predatory fishing activities and the possible contamination of lake waters by agrototoxic substances and/or urban and industrial wastes. In the irrigation projects, more specifically, salinization is likely to be encountered, while a heavy use of chemical fertilizers and pesticides may lead to the contamination of both soils and food crops. Urban areas in the region, in turn, are likely to experience basic sanitation problems similar to those in many other Brazilian towns and cities, especially in terms of untreated sewage, poorly disposed solid waste and insufficient investment in the maintenance of water treatment plants, where these exist at all.

D. Conclusion

5.33 From a physical environmental standpoint, a number of significant impacts have resulted from the formation of two sizeable artificial lakes, the expansion of irrigated farming, increased energy production and associated urban growth in the middle and lower Sao Francisco valley. Some of these side effects (eg. predatory fishing practices) are already quite apparent, while others (eg. pollution of waterways by agro-chemicals) are only beginning to emerge or may do so only in the future. Many of the ecological changes associated either directly or indirectly with the operations in question, moreover, were predicted on the basis on comparable experiences with hydropower and irrigation schemes elsewhere and by specific ex-ante environmental "reconnaissance" surveys in the immediate areas of influence of the projects themselves.

5.34 In terms of anticipating potentially adverse impacts and undertaking adequate preventive or corrective measures, however, the record thus far has been mixed. In the case of Sobradinho, while many of the impacts were probably unavoidable in the first instance (silt retention, possible localized climate

²⁰ IBAMA incorporated SEMA, the previous national environmental secretariat, IBDF, the former Brazilian Forestry Development Institute, and SUDEPE, the former Fisheries Development Superintendency.

change, flooding of riverine lands, modifications in aquatic and terrestrial fauna, etc.), remedial action, where necessary, was slow. In terms of controlling predatory fishing and increasing water pollution by agrotoxics and domestic waste, more specifically, much still remains to be done.

5.35 In the lower Sao Francisco valley, similarly, water contamination and salinization of irrigated areas require more effective maintenance and control. At Itaparica, on the other hand, while some problems remain, in general CHESF demonstrates a much greater awareness -- especially when compared with the earlier experience at Sobradinho -- of ecological requirements and a comprehensive protection plan is presently being implemented to tackle the various physical, biological and cultural problems associated with the hydropower project. A clear need, nevertheless, remains for the careful monitoring of environmental changes, particularly water quality, once the irrigation subprojects begin production and the local rural economy develops.

VI. HUMAN ENVIRONMENTAL IMPACTS AND RESETTLEMENT EXPERIENCE

A. Paulo Afonso IV Hydropower Project

1. Introduction

6.01 Construction of the Sobradinho dam and reservoir as part of the Bank-assisted Paulo Afonso IV Hydropower Project has brought about major social and economic changes in the middle and lower Sao Francisco valley. It is no exaggeration to say that Sobradinho has triggered a transformation in the demographic and productive structure of the region, both in the immediate vicinity of the lake and farther downstream. In the short term, this project involved critical issues of how to cope with large-scale population displacements, the payment of compensation and the physical relocation of those affected. In the longer-run, equally important questions concern the provision of viable development options for displacees and how this whole situation relates to, and is constrained by, the wider parallel changes in the local economy set in motion by Sobradinho. The following paragraphs deal with the more immediate impacts, while section D below assesses the broader transformations currently underway in the region.

6.02 Both the Bank and CHESF were aware of the vast scale and potentially adverse social impacts of Sobradinho. In the first instance, this involved the forced displacement and relocation of some 65,000 people from the lake area itself, as well as of an estimated 10,000 rice farmers in the lower Sao Francisco valley. In response to this situation, a Resettlement Unit was established within CHESF in 1972, an agreement was signed between CHESF and INCRA in October 1973, to define responsibilities for transferring the population to other areas and providing alternative livelihoods, and an environmental reconnaissance of the reservoir area, which diagnosed a number of potential problems concerning ecological degradation, health conditions and the destruction of existing riverine farming systems, was undertaken by a consultant in mid-1973.¹

6.03 With the findings of the environmental reconnaissance in mind, the Bank used the pre-appraisal (June 1972), appraisal (July 1973) and loan negotiation stages (April-May 1974) to focus attention on resettlement issues and persuade the Brazilian Government of the need for adequate compensatory measures. Insofar as Sobradinho was concerned, the Loan Agreement for the project established that CHESF and the Government would submit to the Bank, for review and comment, (a) within nine months of loan signing (ie. by March 17, 1975), plans for resettling the population living in the lake area, setting up health and environmental controls and promoting fish production, and (b) within 12 months of loan signing (ie. by June 17, 1975), an evaluation of the effects

¹ Robert Goodland, Sobradinho Hydroelectric Project Environmental Impact Reconnaissance, op. cit. While concentrating on physical impacts, as noted in Chapter IV above, this study took pains to highlight the risk of widespread unemployment as a result of massive population displacements, together with the need for multi-sectoral planning to rebuild the local economy in favor of those directly affected.

of dam construction and flow regulation on the middle Sao Francisco valley. It should be stressed, however, that, throughout the appraisal and most of the implementation period for the PA IV Project, the Bank did not possess an explicit policy on involuntary resettlement.

2. Population Displacement and Resettlement

6.04 According to official figures, up to 65,000 people (almost 12,000 families) were displaced by Lake Sobradinho. Just over one-quarter of those affected were from the riverside towns of Remanso, Casa Nova, Sento Se and Pilao Arcado, while the remainder were of rural origin.² The engineering consulting firm contracted by CHESF to design the resettlement program estimated that 10% of the rural displacees would accept cash indemnity and move elsewhere, a further 10% would find employment in the local construction boom, 30% would settle in 13 new lakeside villages (agrovilas), while the remaining 50% would travel some 800 kilometers upstream to an official colonization project (Serra do Ramalho) at Bom Jesus da Lapa. At the time of appraisal in mid-1973, it was understood that CHESF would take responsibility for compensating those affected, for the urban resettlement and for establishing the lakeside agrovilas, while INCRA would administer the colonization scheme.

6.05 However, these estimates were based on a limited sample survey of one town (Casa Nova) alone, which was unrepresentative of the area as a whole and yielded information which proved to be wildly inaccurate for more general planning purposes. As it turned out, 19% accepted cash compensation and moved independently, while almost 70% remained in the immediate vicinity (32% in the new towns, 22% in agrovilas and 15% in the dryland or caatinga) and only 8% opted for INCRA's project at Bom Jesus da Lapa.³ These miscalculations severely compromised the resettlement effort and obliged the institutions involved to undertake belated and largely unsatisfactory remedial measures as a result of unexpectedly having to cope with a much larger remaining lakeside population than originally anticipated.

3. The Serra do Ramalho Colonization Project

6.06 The most striking debacle occurred at Serra do Ramalho, where just over 1,000 of the expected 4,500 or so families displaced by Sobradinho chose to resettle.⁴ Each family was to receive a free brick house and use of a plot of land ranging in size from 20 to 200 hectares depending on the quality of the

² CHESF, Aspectos Socio-Economicos da Implantacao do Reservatorio de Sobradinho, Recife, 1980.

³ Shelton Davis, "Social Issues Associated With Resettlement," mimeo, Consultant's Report to PPDES, World Bank, January 29, 1987.

⁴ In its comments on an earlier version of this report, CHESF argues that much of the reason for the inability of this project to absorb families displaced from Sobradinho was because INCRA handled it as a conventional land settlement scheme without considering the special needs, traditional production systems and previous social organization of the small farmers who were forced to relocate.

terrain. House and farm were to be purchased over a period of 20 years. Many settlers, however, got off to a disastrous start, losing their possessions and farm animals during the five-day boat and bus journey upstream. Distraught farmers, moreover, received no compensation for their losses and were left to fend for themselves as best they could, seriously compromising the credibility of both INCRA and CHESF.

6.07 A location many hundreds of kilometers from Sobradinho was deemed necessary because, even though a large area of relatively fertile soils was potentially available near the lake, this had been reserved by CODEVASF for implantation of an irrigation scheme (ie. Massangano, near Petrolina). Chosen for its apparent similarity with the resettlers' areas of origin, in practice, Serra do Ramalho held little appeal for these farmers. It was situated at a considerable distance from the Sao Francisco River and no irrigation facilities were available. Even though most settlers had been accustomed to wetland varzea farming and irrigated agriculture on the banks of the Sao Francisco, CHESF and INCRA assumed that displacees would be able to earn their livelihoods from the vastly different, rainfed terrain at Serra do Ramalho. In addition to this basic misunderstanding of farmers' adaptive dispositions and capacities, technical support and credit were in short supply, while the failure to provide adequate housing, health, educational and other basic facilities eventually discouraged additional settlers from coming once news of this situation filtered back to Sobradinho. According to a subsequent Bank mission, furthermore, over half of the land designated for resettlement at Serra do Ramalho was, in fact, unsuitable for agriculture. As a result, many of the original settlers eventually returned to the Sobradinho area at their own expense.

6.08 In the absence of rural trade union activity or other social movements in the region at the time, the Church took up the settlers' cause. A protest campaign was mounted by priests and bishops from the diocese of Juazeiro (where Sobradinho was situated) and the Pastoral Land Commission (CPT), which publicized the adverse impacts of the Sobradinho relocation exercise and advised people against moving to Serra do Ramalho. Local politicians, anxious not to lose their followers, also applied pressure on INCRA and CHESF for greater resettlement provisions to be made locally. Even the national press gave attention to the problems of disillusioned colonists at Bom Jesus da Lapa.⁵ By 1977, consequently, the occupancy rate of the 3,500 houses in 10 agrovilas at Serra do Ramalho was only 50%. The low take-up by Sobradinho displacees finally led INCRA to open up the project to colonists from other parts of Brazil, thereby defeating its original purpose.

6.09 After 14 years, the precarious economic situation at Bom Jesus da Lapa does not appear to have improved. Many farmers, unable to make a living from the land, now work as wage laborers on the adjacent private and public (ie. CODEVASF) irrigation schemes. The project now has some 8,000 families and is being increasingly occupied (about 1,500 families to date) by squatters (posseiros) from conflict-ridden areas such as that around Carajas in eastern Amazonia. About 210,000 of its 250,000 hectares are occupied and INCRA is under

⁵ Jornal do Brasil, report on August 29, 1976 entitled "INCRA Transfere Familias para Desocupar Sobradinho."

pressure to expand the scheme further to absorb additional migrants. However, a severe funding shortage has led to the gradual decay of the project's basic infrastructure, including schools, roads and domestic water supply, which are in desperate need of repair. Further problems have been caused by the gradual decline in annual rainfall, attributed by many observers to deforestation to the west of the Sao Francisco River, resulting in falling yields of staple crops, cotton and cattle. The Bank, however, is currently funding feasibility studies of groundwater irrigation potential for small farmers at Serra do Ramalho.

4. Rural Resettlement Around Sobradinho

6.10 From the outset, CHESF had planned to accommodate some 2,300 rural families (about 14,000 people) in agrovilas, either bordering on or located near the new lake. By 1980, 2,655 families had been settled in 25 rural nuclei, 21 of which were situated on the lake's margins. Of the total, seventeen are located in the municipality of Sento Se, four in Casa Nova, and two each in Juazeiro and Remanso. These communities varied in size, from as few as six to as many as 250 families. An additional 1,777 families of dryland herder-farmers (caatingueiros) were resettled at a greater distance from the water's edge.⁶ Altogether, a total of over 22,000 rural resettleses were assisted in the lake area, about 50% more than originally anticipated. The number of planned agrovilas was expanded from the original 13 to 25 and implementation proceeded relatively smoothly. The increase in the number of agrovila residents occurred as a result of the original miscalculations, the return of disappointed ex-colonists from Serra do Ramalho and accelerated migration from other rural areas as land concentration accompanied the rapid spread of private mechanized and irrigated farming and poor farmers sought basic health and educational services for their families.

6.11 According to CHESF's plan, these rural nuclei were to be provided with domestic water supplies, access roads and community buildings such as schools, health posts, a post office, etc. Resettleses' belongings were to be transferred from their old homes, they would receive 70% funding towards the cost of a new house and half the amount needed to prepare a two hectare plot of farmland by the lakeside, designed to diversify production and sustain a family of six.⁷ However, the difficulties of farmer adaptation in a substantially different physical environment, combined with poor site selection procedures and inadequate official support for the communities in question, adversely affected this part of the resettlement effort.⁸ As a result, a follow-up study of

⁶ CHESF, op. cit., 1980.

⁷ CHESF, op. cit., 1980, and IDB, Project Performance Audit Review, Sobradinho Hydroelectric Project: the Population Resettlement Component, op. cit.

⁸ In its comments on an earlier version of this report, CHESF observes that, while its own actions in this connection did not constitute an "agricultural project" because the distribution of land to rural displacees was not accompanied by the technical, economic and financial support necessary to "systematize" agro-ranching activities, the state government of Bahia did later

agrovila residents found that half suffered from insufficient food, an inability to farm and lack of other employment, as well as from psychological stress.⁹

6.12 Small farmers in the lakeside agrovilas have found it difficult to sustain a livelihood from the land for several reasons. The reservoir inundated, at a single stroke most of the fertile alluvial soils which had accumulated over the centuries and which had previously permitted a delicately balanced system of floodplain and dryland agriculture to be developed. This balance was replaced by farming and living arrangements in which the displacees had no choice and that were designed by outsiders having little knowledge of the area. Not only were the areas that were set aside for smallholders characterized by relatively infertile sandy soils, but the plots were frequently too small to be economically viable. This was particularly serious in light of CHESF's failure to provide adequate maintenance support for the affected families while they awaited the first harvest, combined with a general lack of technical assistance and rural credit.

6.13 Displacees were put under further strain due to the fact that only those property owners with legal title were given compensation for the loss of farmland. Those without proof of ownership, who had squatting rights or were sharecroppers and tenant farmers, were compensated only for improvements (benfeitorias). This instantly decapitalized many previously independent smallholders and made it more difficult for them to reestablish themselves in the new communities. The repercussions of this compensation procedure may be gauged from the fact that, according to a survey carried out by CHESF in 1973, roughly two-thirds of farmers in the reservoir area were non-owners in the legal sense.¹⁰ Many farmers, moreover, were obliged to use their small compensation payments simply to survive, bridging the gap between abandoning their former homes and reaping their first harvests. Others abandoned their new plots altogether, selling out, where possible, to wealthier incoming commercial farmers.

6.14 In addition to inadequate compensation, CHESF was widely accused of adopting heavy-handed tactics to remove recalcitrant populations from the reservoir area. First-hand accounts mention the use of special contractors who issued threats to local populations and bulldozed houses with their occupants barely out the door. In other areas, such as Pilao Arcado, for example, farmers were allegedly moved out with no alternative accommodation being provided.¹¹ Land speculation, sparked by rising property values associated with Sobradinho's

undertake various such actions under a special development program for the Lake Sobradinho region.

⁹ OED Report No. 6578, op. cit., and Tim Campbell, "Social and Economic Consequences of Resettlement - the Case of the Sobradinho Hydropower Dam, Bahia, Brazil," mimeo, Inter-American Development Bank, Washington, D.C., 1984.

¹⁰ IDB, Project Performance Audit Review, op. cit.

¹¹ CPT, As Ilhas de Resistencia: Os Lavradores no Vale do Sao Francisco, Comissao Pastoral da Terra, Goiania, 1979.

poor infrastructure and other developments, also led to cases of violence. One victim of 27 sharecropper families reportedly resulted in a death and several serious injuries.¹²

6.15 Visits to several rural resettlement nuclei near Sobradinho by the OED/SEPLAN mission in mid-1989 revealed a common situation in which farming on poorer lakeside soils, as predicted, is far more difficult than it had been on the former river margins. With some investment, production of staples, as well as cash crops, is feasible, as long as sufficient support is provided. The general impression at present, however, is one of a disrupted subsistence farming economy where few have achieved the economic stability anticipated by planners. The most viable communities seem to be those which have succeeded in obtaining funding from outside NGOs or have been sufficiently well-organized to pressure CHESF for additional resources. Otherwise, the present inhabitants of the agrovilas claim to be generally neglected by both CHESF and the relevant state government authorities.

6.16 The substantial drop in the water level at Sobradinho between 1985 and 1989, moreover, exposed several kilometers of floodplain (varzea) near these communities. While this temporarily provided additional areas for cultivation, it also set in motion several land conflicts as former proprietors around the lake attempted to repossess their lands.¹³ Educational and health facilities are in notoriously short supply, while domestic water supplies are often non-existent or precarious as the lake-edge has receded from the communities. The agrovila of Algodoes, for instance, which was visited by the OED/SEPLAN mission, has carried on a four-year battle with CHESF to secure assistance in transferring its diesel water pump to accompany the steadily lower water level.

6.17 Living standards and general conditions seem to vary considerably among these communities. For some, the move undoubtedly represented a significant change for the better. However, the above-mentioned factors have placed severe pressures on much of the resettled rural population. This has led to several unforeseen phenomena such as increased out-migration to urban areas and the reconcentration of landholdings as small farmers are unable to survive and capitalized outsiders have arrived to buy up abandoned plots at bargain prices. For example, in the agrovila of Bem Bom, also visited by the OED/SEPLAN mission, onion-growers from the town of Belem do Sao Francisco have taken over a number of properties in this way. Similarly, many farmers in the communities of Sao Goncalo and Algodao Velho have sold off their plots to a private shrimp nursery project. This process has been facilitated by the slowness of INTERBA, the Bahia State Land Institute, in distributing titles to resettled farmers, thereby increasing their vulnerability and making it difficult to obtain official credit through the local banking system.

¹² Tina Kimes, "Case History of Paulo Afonso IV (Sobradinho): The Human Impact of a Hydroelectric Project," mimeo, World Bank, 1978.

¹³ Caminhar Juntos, Bulletin of the Diocese of Juazeiro, No. 139, January-February 1989.

6.18 Many farmers have reverted to artesanal fishing in an attempt to make ends meet, but, as stated in paragraph 5.05 above, yields have recently been falling due to over-fishing in the lake and no systematic fisheries development has taken place, despite the recommendations of a World Bank consultant to this effect in 1976. Bank supervision missions suggested in 1978, moreover, that CHESF develop an integrated rural development program for the resettled lakeside population, including livestock, irrigated farming and fishing, as well as complementary land tenure, marketing and social service inputs, but no further action has been taken in this regard.

5. Urban Resettlement

6.19 Some 3,200 families (about 16,000 inhabitants) were transferred from the old towns of Remanso, Casa Nova, Sento Se and Pilao Arcado to new communities with the same names. More than 11% of rural displacees chose to move to the new towns, while less than 1% of urban settlers went to agrovilas. In the towns, CHESF gave people the option of cash compensation or a straight exchange (permuta) of their old houses for an equivalent new model. Most wealthier citizens chose to accept cash indemnity and build their own houses, while lower-income town dwellers tended to opt for substitute houses. The new urban centers, moreover, were provided with basic transport, sanitation, health, education, leisure and other community infrastructure. Since the late 1970's, there is no doubt that these towns have become quite prosperous and provided better living standards for a large proportion of their expanding populations.

6.20 By 1980, for example, Remanso had doubled its population to 13,000, while Casa Nova showed the most dramatic increase, growing from just under 2,400 in 1970 to a total of 11,000 inhabitants ten years later. Casa Nova has continued to expand with the growth of irrigated agriculture and local informants currently put the number of residents at some 15,000. Remanso, strategically situated at the junction of two major highways (the lakeside BA-235 and the interstate BR-234 to Sao Raimundo Nonato in the neighboring state of Piaui) has grown faster still as commercial activities have expanded, partly in response to the spread of small-scale private irrigated farming; since 1980 its population has almost tripled to 31,000. Whereas in 1970 about one-quarter of the population in the middle and lower Sao Francisco valley was classified as urban and, by 1980, the proportion had risen to one-third, today the figure is probably over 40%.

6.21 It should be borne in mind, however, that much of this urban growth is in fact due to the rapid spread of impoverished shanty-towns populated by rural out-migrants expelled from the land as the result of agricultural modernization, a process which Sobradinho has greatly facilitated. One unforeseen negative consequence of the project, for example, has been the creation of Sao Joaquim, a town of some 15,000 workers and their dependents, located near CHESF's operational headquarters for the Sobradinho hydropower complex. Although Sao Joaquim provided many jobs during the construction phase of the PA IV Project, it now has a largely unemployed population and growing social problems. Contrary to planners' expectations, fewer people than anticipated left Sao Joaquim once the building and service boom finished. Originally a district of Juazeiro, it is now a separate municipality.

6.22 Although one survey found that two-thirds of new town inhabitants were satisfied with resettlement, it also discovered that more than a third of the displacees did not receive plots of land in the new towns. This number included return migrants from Serra do Ramalho, as well as people who had absented themselves during the resettlement period in order to seek employment nearby in the construction industry. As far as CHESF was concerned, rights to compensation and relocation did not extend beyond the first move.¹⁴ Problems also arose initially from the failure to coordinate population transfers with the installation of infrastructure. In Sento Se, for example, electricity supplies were late and no sewage facilities were provided in the early months, leading to public health problems.

6.23 The survey cited in the previous paragraph also found that one-third of the new urban residents were dissatisfied with their transfer for a variety of reasons including the lack of local employment opportunities once the initial building boom had subsided, the impossibility of obtaining subsistence plots to guarantee basic minimum food requirements and the high cost of urban services. Even though the combination of cash, building materials and housing given to urban displacees was a significant improvement over the earlier experience at Moxoto, the compensation provided at Sobradinho was still often insufficient to see families through the first difficult years after relocation.¹⁵

B. The Lower Sao Francisco Polders and Irrigation Projects

1. Introduction

6.24 The Lower Sao Francisco polders and irrigation projects were conceived as a direct response to the adverse consequences of the Sobradinho dam and reservoir on the rural population living in the lower valley. Regulation of the river's seasonal variation increased the lowflow from 700 to 2,000 m³/second and meant that, in the absence of protective works, some 9,000 hectares of productive varzea riceland would have been permanently flooded. As described in Chapter IV above, the resulting "emergency" project, accordingly, aimed initially at protecting the floodplain through a series of protective dikes and pumping stations, and developing irrigated farming on two polders, Betume and Marituba (SF I). This approach was extended, in a second stage, to cover the polders of Cotinguiba-Pindoba, Boacica and Brejo Grande (SF II). Following the expropriation of existing properties and the distribution of 3.5-hectare plots to selected colonists, the projects were expected to absorb a total of some 3,800 small irrigation farmers on over 16,000 hectares of irrigated and 6,000 hectares of non-irrigated land.

6.25 Just as the Sobradinho experience transformed the lives of the 65,000 people displaced by the reservoir, the Lower Sao Francisco projects have had an equally profound impact on the estimated 50,000 rural dwellers inhabiting the varzea areas in question. In the short-term, these impacts have resulted from

¹⁴ Projeto Sobradinho: Avaliacao Socio-Economica de Relocalizacao Populacional, Fundacao Joaquim Nabuco/CHESF, Recife, 1983.

¹⁵ Fundacao Joaquim Nabuco and Project Performance Review, op. cit.

population displacement and CODEVASF's management of the area, compensation procedures, changes in levels of local agricultural production, related social conflicts and rural out-migration from the lower valley. Longer-term consequences involve the nature and sustainability of the CODEVASF-run irrigation projects themselves including the extent to which the agency has assisted the local population during the transition period, the subsequent agro-economic performance of these schemes and their likely future as independently administered enterprises.

2. Population Displacement and Agricultural Development

6.26 The wholesale expropriation of 25,000 hectares of land in the densely populated lower valley between 1975 and 1980 is estimated to have displaced a total of some 10,200 rural families. These comprised 2,800 smallholders, 100 medium and larger proprietors and 7,300 sharecroppers and tenant farmers, or over 50,000 people altogether.¹⁶ Since the projects in question had directly absorbed less than 3,200 families by 1985,¹⁷ this suggests that a net displacement of over 7,000 families, or approximately 35,000 people, may have occurred in the project area.¹⁸ The local impact of this net demographic loss is partially reflected in the slow growth of Penedo, the region's largest town. While cities in the middle Sao Francisco valley doubled in size between 1970 and 1980, the population of Penedo increased by only 15%, to reach 27,000 in the latter year. More generally, rural population declined in absolute terms in eight of the fourteen municipalities composing the lower Sao Francisco region between 1970 and 1980, while four of these municipalities suffered absolute losses in their total population.¹⁹ In those areas where population growth was

¹⁶ H.O.M. Barros, "Modernizacao Agricola Autoritaria e Desestruturacao do Ecosistema: O Caso do Baixo Sao Francisco," Cadernos de Estudos Sociais, Fundacao Joaquim Nabuco, Recife, Vol. 1, No. 1, January-June 1985.

¹⁷ This figure is drawn from ILO/UNDP, Emprego e Renda..., op. cit., Table 19, pg. 52. According to Bank regional staff (internal memorandum dated July 24, 1990), the Bank had originally argued in favor of 2 ha irrigation plots, which would have accommodated twice the number of displacees, but, in a compromise with CODEVASF, which sought to implement 6 ha lots, finally agreed on an intermediate size of 4 ha on the basis that the smaller lots "would have created a rural slum." The projects, were, thus, actually able to directly absorb some 3,000 families, but another 4,000 families were reportedly able to remain in the area as workers and/or sharecroppers. This compares very favorably with the alternatives of leaving the entire area to be flooded, which would have required all 10,000 families to leave, of a simple polders project with no irrigation which would probably have benefitted only 1,000 of the better off families or a polder-cum-drainage alternative which might have retained 2,000 of the original 10,000 families in the area.

¹⁸ Bank operational staff familiar with the lower Sao Francisco projects are under the impression that, directly or indirectly, these operations, in fact, absorbed a larger number of people, but more precise figures are not available.

¹⁹ ILO/UNDP, op. cit., Table 3, pg. 27.

positive, moreover, the rates were very low (in most cases less than 1% a year), indicating positive rates of net out-migration.

6.27 The immediate post-land acquisition phase in the lower Sao Francisco valley was somewhat different in terms of its human environmental impact than that at Sobradinho where some attempt was made to provide alternative livelihoods for most of the farmers displaced by the reservoir, imperfect though these efforts may have been. In the lower Sao Francisco, no provisions were made for resettlement of that part of the displaced population not absorbed by the irrigation schemes. Assistance was confined to short-term emergency employment programs. These people, perhaps two-thirds of the total population involuntarily removed, in the final analysis were left largely to fend for themselves.

6.28 More recent data suggest, however, that it may be important to differentiate the period before and after 1980 with respect to rural development tendencies in the lower Sao Francisco valley. The table below presents selected indicators based on the Agricultural Census data for the 1970-85 period with respect to the growth of the number of agricultural establishments, the total area in farms, the area in crops (as opposed to pasture or other non-crop uses), rural employment, the cattle population and, as a proxy for mechanization, tractors for the two microregions (Penedo in Alagoas and Propria in Sergipe) which make up the lower valley region.²⁰ Figures on average farm size, cropping intensity, employment and crop area per farm unit and heads of cattle and tractors per rural establishment are also presented.

6.29 These figures reveal that, while rural employment in the lower Sao Francisco valley did, in fact, decline somewhat in absolute terms between 1970 and 1980, by contrast, it grew substantially -- from 41,400 to 51,600 -- during the early 1980's, as did the number of rural establishments, which increased by some 3,600 units between 1980 and 1985, to a total of more than 18,300 in the latter year. As a result, the average area per establishment fell sharply between 1980 and 1985, reversing the tendency for a slight increase in average farm size during the 1970's. Just the opposite trend, moreover, characterized the evolution of the cattle population in the region, since its rapid growth during the 1970's was totally reversed in the early 1980's. As a consequence, the average number of heads of cattle per rural establishment was lower in 1985 than it had been in 1970.²¹ Interestingly also, while the total area occupied by rural establishments decreased between 1980 and 1985, the area in crops increased substantially, from 44,700 ha in the former year to 55,500 ha in the

²⁰ These microregions include the following municipalities: (i) Penedo - Feliz Deserto, Igreja Nova, Penedo, Piacabacu, and Porto Real do Colegio; (ii) Propria - Amparo do Sao Francisco, Brejo Grande, Canhoba, Ilha das Flores, Neopolis, Nossa Senhora de Lourdes, Pacatuba, Propria and Telha.

²¹ While ranching has never been a major activity in the lower valley, the possession of relatively small amounts of cattle has traditionally accompanied small-scale agricultural (ie. rice and subsistence crop) activities in the region and forms part of the survival strategy of many peasant farmers in the area. See Mario Lacerda de Melo, Regionalizacao Agraria do Nordeste, SUDENE, Recife, 1978, Part II, Chapter 3. pp. 154-55 for additional details.

latter. On the other hand, the expansion in total crop area was essentially the result of the growth in the number of rural establishments, since the average crop area per farm remained exactly the same (ie. 3.0 ha/establishment) between 1970 and 1985. In addition, the average number of persons employed per farm in the lower valley remained the same between 1980 and 1985 and was lower in both years than in 1970, again reflecting the net outflow of rural workers during the 1970's.²²

Table 1

Lower Sao Francisco Valley: Selected Agricultural Indicators, 1970-85

A. <u>Annual Growth Rates (%)</u>	<u>1970-80</u>	<u>1980-85</u>	<u>1970-85</u>
Establishments	1.3	4.5	2.3
Total Area Occupied	1.6	-2.4	0.2
Crop Area	1.4	4.8	2.3
Employment	-0.1	4.5	1.4
Cattle Population	5.5	-4.9	1.9
Tractors	3.0	2.4	2.8
B. <u>Indicators</u>	<u>1970</u>	<u>1980</u>	<u>1985</u>
Area/Establishment (ha)	13.4	13.9	9.9
Crop Area/Establishment (ha)	3.0	3.0	3.0
Crop Area/Total Area	22.3%	22.0%	30.2%
Employment/Estab. (persons)	3.2	2.8	2.8
Cattle/Estab. (heads)	4.0	6.0	3.7
Tractors/Estab. (No.)	0.02	0.02	0.02

Source: IBGE, Agricultural Census, 1970, 1980, 1985.

6.30 The above figures suggest, in short, that, after an initial period of dislocation, accompanied by a slight decrease in rural employment and a more substantial increase in small-scale ranching activities, the project-supported irrigation schemes may, indeed, have had an important -- and positive -- impact on both rural land distribution and employment in the lower Sao Francisco valley. The actual extent of this impact, however, remains to be determined in light of two questions which may only be possible to answer with further direct field research in the region. The first refers to the extent to which the observed changes are, in fact, due to irrigated rice production rather than to other

²² The average number of persons employed per rural establishment (2.8) in 1980 and 1985, according to the agricultural census, moreover, was exactly the same as that encountered by the ILO/UNDP study (op. cit.) for irrigated farms in the region for the latter year, even though the average area per establishment in 1985 was found to be somewhat higher by the former source (9.0 ha) than by the latter (7.7 ha), suggesting that farm sizes, on the average, were higher outside the irrigation projects.

tendencies simultaneously affecting the municipalities in the area, particularly the expansion of labor intensive sugar cane production in response to the national alcohol program (PROALCOOL) in the Alagoas portion of the region.²³

6.31 In this connection, it should be observed that, while 67% of the increment in rural employment in the lower Sao Francisco valley in the early 1980's occurred in the Alagoas section of the region, only 36% of the families settled in CODEVASF irrigation projects were located in this state.²⁴ Furthermore, most of the expansion in rural employment between 1980 and 1985 occurred in the municipality of Penedo (4,200 workers), while CODEVASF's projects in Alagoas (Itiuba and Boacica) are located farther to the west in the municipalities of Igreja Nova and Porto Real do Colegio, whose combined increase in rural employment between 1980 and 1985 was on the order of 1,500 people, or only about 15% of the total increment in the agricultural work force for the entire area.²⁵ It should also be noted that, while rice cultivation declined by 40% in area planted and 18% in volume produced in the municipality of Propria and 39% in area and 7% in volume in Penedo between 1970 and 1980, sugar cane production increased by 12,500% in area planted and 25,800% in volume of output in the former município and by 20,500% in area and 136,000% in volume in the latter over the same period.²⁶

²³ This was a national program involving credit and other incentives for the production of sugar cane-based alcohol as a vehicle fuel to substitute imported petroleum products such as gasoline. PROALCOOL was partially funded by Bank loan 1989-BR, approved in May 1981, for the Alcohol and Biomass Energy Development Project, which was closed in March 1987. See OED Report 8887 dated June 29, 1990 for additional information on this program and the related Bank-loan.

²⁴ Moreover, of the 1,138 families accommodated in irrigation projects in Alagoas, fully 65% (739) were cultivating "ceded" lands with an average size of 0.8 hectares, as opposed to only 30% producing on "ceded" lands in the irrigation projects in Sergipe, according to the ILO/UNDP study cited above.

²⁵ The Marituba varzea, located in Penedo municipality, was originally to have been fully developed under SF I, but was later substituted by the rehabilitation of existing drainage works in the Propria and Itiuba varzeas because of difficulties in acquiring the necessary land (see paras. 4.30 and 4.36 above). The PCR (OED Report No. 5669, op. cit.) specifically refers (Annex 3, para. 5) to the fact that "the redistribution of about 1,800 ha in the Marituba area was never advanced beyond the discrimination phase because of strong opposition from large land owners. This was particularly severe because Marituba was one of the few areas in the project which still had unused land for the resettlement of excess farmers." (Emphasis OED)

²⁶ ILO/UNDP, op. cit., Table 15, pg. 45. More specifically, the area in rice decreased from 6,341 ha to 3,885 ha in Penedo and from 7,646 ha to 4,562 ha in Propria during the 1970's, while the area in sugar cane increased from 32 ha to 6,543 ha in the former and from 2 ha to 252 ha in the latter over the decade. The area planted in and output of corn also declined in Penedo during the period, while the area and output in corn, beans and manioc in Propria all

6.32 The other relevant question concerns the extent to which those persons or families which have been employed in the irrigation schemes after 1980 are the same ones that were displaced from the varzeas during the late 1970's. To the extent that these families and individuals are not the same families, despite the projects' positive results in terms of increased rural employment, installation of the irrigation schemes may still have had a significant negative impact on many of the original residents of the area. While this is a subject that requires and merits further investigation, as the following sections indicate, there are substantial reasons to conclude that the lower Sao Francisco polder and irrigation projects -- and ultimately, the Paulo Afonso IV Hydropower Project that made them necessary in the first place -- appear to have had a major disruptive impact on a large number of rural families in the region.

6.33 Even allowing for the reabsorption of some displaced farmers as irrigation colonists or agricultural laborers, in short, a significant loss of livelihood may have occurred for many of the original rural residents of the lower valley. This is somewhat anomalous in view of the fact that SF I and II were considered "emergency" projects having the "social" purpose of providing protection to a population threatened by the permanent flooding of their farmlands. Even though, in principle, displaced from the lower valley were to receive preferential treatment by CODEVASF in the allocation of irrigated plots, a number of factors served to minimize the impact of this compensatory measure and to fuel the movement of people from the area. These factors include the wholesale loss of lands and sudden decrease in local agricultural production, inadequate provisions for compensating those who had lost their sources of employment on the land, the frequently violent nature of the expropriation process itself, the subsequent long delays in project implementation and the highly selective nature of CODEVASF's farmer recruitment procedures.

3. Expropriation and Compensation Procedures

6.34 CODEVASF began expropriations in the heavily populated varzeas of Betume in 1975 and Boacica in 1976. Following the provisions of the 1964 Rural Land Statute (Estatuto da Terra), which allows for the expropriation of lands "in the social interest" to establish official colonization programs and other public projects, compensation was paid only to property owners having legal title. As at Sobradinho, those occupants with no such proof received payment only for improvements to the land (benfeitorias). Sharecroppers, who formed 75% of the displaced population, received nothing at all. They were, instead, to receive priority in recruitment to the new irrigation schemes.

6.35 Strong local discontent was aroused over the summary way in which many people suddenly lost their livelihoods. Resentment was likewise expressed at alleged inconsistencies in the payment of compensation. Contractors hired by CODEVASF were widely accused of using violent tactics to clear the land for project preparation. Once productive farmers were, overnight in many instances, reduced to a state of penury and forced to depend on emergency food rations and

decreased by 35% or more during the 1970's, although much of this may have been due to the 1979 flood which is not specifically mentioned by this source.

temporary shelter provided by the diocese of Propria.²⁷ CODEVASF did subsequently introduce several emergency work schemes, recruiting displaced labor for project construction and land preparation activities. However, it is unlikely that these measures were sufficient to offset the longer-term consequences on the local population in view of the fact that no resettlement provisions were made for the majority of those forced to leave the immediate area.

6.36 Not surprisingly under the circumstances, a serious confrontational situation developed between the local population and CODEVASF. Simultaneous expropriations in all varzeas served only to heighten local objections, especially as CODEVASF was unable to immediately use the land it had acquired and which remained idle for a lengthy period as a result. In September 1976, there was a major public reaction against CODEVASF, and the Bishop of Propria, Dom Jose Brandao de Castro, wrote a letter to the Minister of the Interior protesting events in the area. At that time, moreover, sixty ex-laborers from the former Fazenda Betume took legal action against CODEVASF for compensation to cover their loss of employment.²⁸ The Brazilian press subsequently gave coverage to this case and associated problems in the lower valley, affording CODEVASF much unfavorable publicity.²⁹ The combination of local protests and a lack of financial resources eventually resulted in a slowing down of the rate of land acquisition.³⁰

6.37 An acute conflict also emerged between CODEVASF and the Cariri-Xoco Indians, long-standing inhabitants of the lower valley, who were also affected by the scheme. The Amerindians took action in 1978 to repossess their traditional lands on which CODEVASF had set up a demonstration farm (fazenda modelo). Negotiations led to the lands being ceded back to the tribe under the supervision of FUNAI. These families were later joined by the majority of a group of forty Cariri-Xoco who had been resettled on the Itiuba polder. However, many of the Indians experienced difficulties in adapting to irrigated farming and either abandoned or rented out their plots for a small fee. Lack of credit and drainage problems have also contributed to the permanence of just four Amerindian farmers in the Itiuba project by 1989.

6.38 Many of these conflicts owe their origins to the fact that CODEVASF had no coherent strategy for dealing with the potential problems associated with

²⁷ Estado de Sao Paulo, August 24, 1982, "Trabalhadores Rurais Apela por Posseiros."

²⁸ The Federal courts, however, reached a judgement in favor of the plaintiffs only in 1987.

²⁹ See, for example, A Tarde, Salvador, report on December 16, 1979 entitled "Cinco Anos de CODEVASF, Cinco Anos de Fracasso," ("Five years of CODEVASF, Five Years of Failure") and Jornal do Brasil, January 19, 1981, "CODEVASF Prejudica Agricultores" ("CODEVASF Harms Farmers").

³⁰ R. Moreno, "Consultant's Report from Pre-Appraisal Mission for SF II Irrigation Project," World Bank, December 29, 1977.

land expropriation. Such problems should have been anticipated in a densely populated area characterized by a high degree of property fragmentation and concentration where many sharecroppers had been residing for thirty years or more. CHESF's experience at Sobradinho should also have provided useful lessons. However, CODEVASF expected these disputes to be resolved on an ad hoc basis by its field staff handling the process. The agency's approach appears to have been largely limited to attempting to improve its image through public relations exercises and providing emergency social investments such as schools and health posts.

4. Decrease in Agricultural Production and Rural Land Use Changes

6.39 These factors were further exacerbated by a significant decrease in (non-sugar cane) agricultural output in the lower valley during the latter 1970's, caused in part by the serious flooding of the Sao Francisco River in 1979, previously mentioned in para. 4.42 above, which also contributed to substantial execution delays in the SF I Project. As indicated in Table 1 and para. 6.31 above, moreover, the slow growth of agricultural activity between 1970 and 1980 was also accompanied both by an absolute decrease in rural employment and a significant change in rural land use which involved a shift from the production of rice and other subsistence food crops (ie. corn, beans and manioc) to sugar cane and cattle raising, particularly in the Alagoas portion of the region, as well as substantial rural and urban out-migration.³¹

6.40 This led the ILO/UNDP study of rice production in the lower Sao Francisco valley to conclude, upon examining demographic tendencies in the region during the 1970's, that "neither primary sector activities, nor urban activities were able to fix the region's population, a result perhaps of the expansion of cattle and the stagnation of regional agricultural production both for the market and for subsistence."³² This study, furthermore, cites a document prepared by the state Agricultural Planning Commission of Alagoas (CEPA-AL) in indicating another reason for the stagnation of rice output during the late 1970's: "Alagoas' rice production is going through a period of decline motivated by the expectation of expropriation by CODEVASF of the entire rice region and also by the non-fulfillment of the targets foreseen in the referred entity's [ie. CODEVASF's] settlement plan."³³

5. Project Implementation and Farmer Recruitment

6.41 Problems experienced during the land acquisition phases of SF I and II were also compounded by CODEVASF's self-confessed failure to devise a satisfactory strategy for handling social questions during and after project

³¹ The cattle population in the Penedo microrregion (Alagoas) increased from roughly 18,500 in 1970 to 43,500 in 1980, while that in the Propria microrregion (Sergipe) increased from some 33,500 in the former year to 44,700 in the latter.

³² ILO/UNDP. op. cit., pg. 26 (emphasis OED).

³³ Ibid., pg. 46 (emphasis OED). The document cited is CEPA-AL's Plano Anual de Producao e Abastecimento, Maceio, 1979.

construction. There are several clear indicators of this shortcoming. No funds were made available, nor were any actions taken to compensate farmers for the harvest losses as a result of the emergency works undertaken by CODEVASF during the execution of SF I, resulting in massive rural out-migration. As far as can be ascertained, similar policies were pursued in connection with the implementation of SF II, with largely similar results. In an effort to relieve some of the social stress thus caused, CODEVASF did set up emergency employment programs or "work fronts." At Betume, for example, 1,800 workers were absorbed by such a program. However, these were short-term relief measures having little productive outcome other than temporarily supplying the population with a subsistence wage.

6.42 These critical social issues appear to have been accorded a low priority at the time by CODEVASF management in Brasilia. Handling of the local population, according to a Bank consultant's report, was delegated to the agency's regional director, without his being given clear instructions on how to deal with the problems encountered or provided adequate logistical and administrative support. Furthermore, there appears to have been a fundamental difference of opinion within CODEVASF regarding the source of these problems. While its President at the time dismissed them as largely the product of Church "provocation," other agency officials recognized the need for changes in company policy and field procedures.³⁴

6.43 There was a basic fallacy, moreover, in CODEVASF's stated aim of resettling the entire population formerly living off the land within the project area. The irrigation projects, by their very nature, were incapable of either directly absorbing the total number of farmers or creating sufficient additional employment. Barely one-third of the total number of displaced farmers could, in fact, have been reabsorbed as colonists in the new schemes, especially after the possibility of using the Marituba varzea in Alagoas for this purpose was lost. The social and economic problems arising from this fundamental contradiction between objectives and strategy were compounded by CODEVASF's farmer recruitment methods, which were widely accused of being arbitrary and discriminatory. Settler selection criteria, which, in SF I, were not made known to the local population beforehand, eliminated many applicants on the basis of age, family size or illness. Allegations were also made that favoritism based on political allegiances influenced the selection procedures. In view of these problems, some modifications to CODEVASF's settler recruitment criteria were introduced at the Bank's insistence during the execution of SF II.

6. Project Performance

6.44 A number of design problems caused delays in project execution and cost overruns, affecting economic performance. As indicated in Chapter IV, moreover, serious flooding occurred in some varzeas such as Propria and Boacica, the latter requiring installation of a retention dam on the river of the same name which was still under construction at the time of the OED/SEPLAN visit in mid-1989. Modifications to the drainage system to avoid flooding have also been required in other varzeas, such as Cotinguiba-Pindoba. Long delays in project

³⁴ Ibid.

execution, however, meant that many displacees chose to migrate, rather than remaining in the area in the hope of securing employment in the projects. At the appraisal of SF II in 1979, for example, it was anticipated that the new irrigation schemes would be completed within six years. However, ten years later, only 67% of the farmer settlement target has been met.

6.45 While there is no doubt that SF I and II provided valuable social infrastructure (schools, health clinics, etc.) in the lower valley, economic performance of the irrigation schemes has not been as good as anticipated.³⁵ The PCR for SF II, moreover, concluded that "the financial sustainability of the project still needs to be proven."³⁶ This economic weakness is due partly to the above mentioned problems in the land acquisition and project execution phases, but is also the result of CODEVASF's lack of expertise in promoting agricultural production. Paddy yields and overall output have lagged substantially behind schedule, currently standing at about one-quarter of appraisal estimates. Production of crops other than rice is also considerably lower than anticipated, while rice monoculture is still the norm despite project attempts at the diversification of local output.

6.46 These shortfalls have been due to several factors. Problems of poor drainage and salinization have rendered large areas unproductive. Initially CODEVASF and later the Alagoas and Sergipe state rural extension services (EMATERs) provided inadequate technical support to irrigation farmers. This has been partly rectified by the contracting of IRGA, the Rice Institute of Rio Grande do Sul, which resulted in rice yields increasing substantially, to over four tons per hectare in 1988. However, withdrawal of this expertise due to financial constraints has recently led to a decline in productivity.³⁷ Another serious and general problem is the lack of production credit for irrigation farmers.

6.47 Farm budget figures reveal a doubling or tripling of net farmer incomes, while additional revenue from "pig-rice-fish farming" has boosted returns for the roughly 10% of project producers engaged in such activities.³⁸ However, these aggregate figures mask inequalities in the distribution of farmer incomes. Although precise data are not available, it is evident that, while a substantial number of settlers has prospered, many have not fared as well. This is due partly to differences in individual capacity and experience with irrigated

³⁵ In its comments on an earlier version of this report, CODEVASF affirmed in this regard that, as SF I and II were "emergency" projects carried out in response to construction of the Sobradinho dam, they would not otherwise have figured among the agency's priorities in technical, economic or social terms. Furthermore, CODEVASF argues that the costs and benefits of these two projects should be analyzed together with those of Sobradinho rather than considered totally independently.

³⁶ OED Report No. 8158, op. cit.

³⁷ Ibid.

³⁸ Ibid.

farming. Another basic cause, however, is the varying quality of the plots supplied to settlers. Many have been adversely affected by problems of flooding and salinization, disrupting their farming activities. It has also been observed that low yields, combined with the high cost of inputs such as fertilizers, made necessary because of the loss of alluvium and natural fertility in the lower valley following the construction of Sobradinho and other dams, and pesticides, has contributed to farmer turnover. At the time of the OED/SEPLAN visit, moreover, it was estimated by local officials that roughly 10% of the farmers in Propria, the oldest irrigation project in the lower valley, were in debt to the cooperative.

6.48 Farmer indebtedness, among other factors, may also be leading to farmer turnover and land concentration in the lower Sao Francisco irrigation schemes. Although the resale of irrigated plots is not permitted under the contracts signed with CODEVASF, farmers may transfer usufruct rights. CODEVASF officials admitted that the more successful producers were thus able to expand their area of control and, hence, their income-generating capacity. Furthermore, their lower-than-expected yields means that farmers need a plot much larger than the standard 3.5 hectares -- perhaps double or triple this area according to local technicians -- to meet family needs. In view of these observations, the impact of differential farmer productivity on economic feasibility and subsequent land tenure patterns within public irrigation schemes, together with their implications for future project design and implementation, is an area requiring further research.

7. Cooperative Organization and "Emancipation"

6.49 CODEVASF's original proposal was to establish a giant cooperative for some 8,000 farmers along the lines conceived by INCRA for agricultural colonization schemes in general. However, following consultation with the Bank, this model was rejected in favor of a more decentralized structure. Under SF II, farmer associations were to be set up in each of the varzeas. After four years, these associations would be transformed into primary cooperatives, owning their land. At present, four of the five varzeas are thus covered, namely, Betume (CAMIB), Itiuba (COOPERMIT), Cotinguiba-Pindoba (COOPERCAM) and Boacica (COOPERCICA). These local cooperatives are statutorily linked to a central regional marketing cooperative in Propria, which also provides inputs and technical assistance. Sufficient information is not yet available to permit a proper evaluation of the efficiency of the cooperative structure. However, its popularity is perhaps accurately reflected in the fact that many settlers have chosen not to join. Indeed, in the Boacica scheme, for example, only about one-third of the 600 or so farmers are cooperative members.

6.50 Due to slow progress in improving yields and encouraging cooperative membership among irrigation farmers, as well as rising administrative costs, CODEVASF has sought to increase farmer involvement in the lower Sao Francisco projects through a policy of "emancipation". This was announced in 1986 by CODEVASF as a general policy for all its irrigation schemes. A five-year period of joint farmer administration with CODEVASF (co-gestacao), during which the local cooperatives would gradually take over management of the projects, is to be followed by total administrative and financial autonomy. This independent status will be recognized through a written contract between the project

cooperative and the Ministry of Agriculture.³⁹ The first project to adopt this procedure was Gorutuba in Minas Gerais. A new organization, CONVASF (Social and Economic Development Council for Lower Sao Francisco Irrigation Perimeters), has been created to coordinate the activities of newly "independent" projects in the region.

6.51 There is some evidence in the lower valley that a start has been made in the direction of "emancipating" CODEVASF's projects. However, it is still unclear whether these schemes will be able to achieve full technical and financial autonomy. The policy seems to have been the brainchild of CODEVASF's President during the previous federal administration and not even the regional directors were involved in its formulation. The policy, moreover, was apparently imposed on the organization without wider consultation among its staff, thereby generating some internal resentment. As far as can be ascertained, no studies were undertaken to test the economic feasibility of "emancipating" the projects. Given their shaky economic performance to date, therefore, considerable doubt must be expressed as to whether the projects in the lower Sao Francisco valley will be able to fully assume current public sector functions.

C. Itaparica Resettlement and Irrigation Project

1. Introduction

6.52 The human environmental impacts of the (non-Bank financed) Itaparica hydropower project are on a similar scale to those of the earlier Bank-assisted Sobradinho and lower Sao Francisco projects, in this case directly involving some 8,000 families, or roughly 40,000 people. However, what sets Itaparica apart from these experiences and, indeed, from any other similar project in Northeast Brazil is that, for the first time, large-scale dam construction has been accompanied by a comprehensive resettlement program, designed to benefit the entire displaced population. Although the dam itself was planned in the mid-1970's, Bank involvement is quite recent, being initiated in 1985 during preparation of a power sector loan that was approved in June 1986. As observed in Chapter IV above, a review of social and environmental issues in the sector revealed severe inadequacies in CHESF's resettlement provisions for Itaparica, a problem of particular urgency as the reservoir was scheduled to be filled in early 1988. As a result, disbursements of the first and second tranches of the power sector loan were made conditional upon CHESF's submission of an acceptable resettlement plan and attainment of adequate progress in the implementation of this plan, respectively.

6.53 The Bank's US\$ 132 million loan was designed to "restore and improve the living standards of the families to be resettled as a result of the Itaparica Hydroelectric Project."⁴⁰ The Bank's major priority was the rural population, which comprised 75% of the total; hence, about 80% of the loan was allocated to support irrigation and agricultural production, rural infrastructure and services

³⁹ CODEVASF, CODEVASF 1985-88, Ministerio da Agricultura, 1989.

⁴⁰ Loan Memorandum for the Itaparica Resettlement and Irrigation Project, World Bank, October 27, 1987.

in five major schemes located at varying distances from the reservoir. CHESF's overall objectives were framed in terms of promoting regional development, creating a class of small independent farming families and encouraging community participation in the resettlement process as a means of minimizing potential conflicts.⁴¹

6.54 The major human environmental impacts of Itaparica concern the immediate consequences of land acquisition and expropriation between 1979 and 1987, the physical transfer of people to their new homes during 1987-88 and the (present) transition period between occupation of the projects and initiation of irrigated agricultural production. An additional issue involves the loss of potentially valuable archeological sites through flooding. Following on the earlier experiences at Sobradinho and in the lower Sao Francisco valley, the Itaparica Project, although still under implementation, nevertheless, brings important additional lessons for the Bank, for the executing agency, CHESF, and for the affected population itself.

6.55 Underlying the whole issue of human environmental impacts at Itaparica is the decisive role played by the local rural trade union consortium, the Polo Sindical do Submedio Sao Francisco (hereafter POLOSINDICAL) and its influence on the scale and nature of the resettlement plans finally adopted by CHESF. If resettlement at Itaparica, unlike the previous experiences at Sobradinho and in the lower valley, has been characterized by a comprehensive strategy aimed at benefitting all those affected, this can be attributed in good measure to the pressure brought to bear by POLOSINDICAL on CHESF,⁴² the Brazilian Government and, by extension, the Bank. Its presence throughout the process guaranteed that rural displacees were able to effectively participate in the basic decisions governing their future.

2. Local Participation: the Role of POLOSINDICAL

6.56 The decade separating the first land expropriations for Itaparica in 1977 and the commencement of resettlement in 1987 saw fundamental changes in the way in which relocation problems were dealt with by CHESF, by the affected populations and by the Bank itself. The most important single event lying at the root of these changed attitudes and official responses was the emergence and consolidation of a major social movement in the lower-middle Sao Francisco valley in the form of POLOSINDICAL.

6.57 When dam construction works started for Itaparica in 1980, CHESF's intention was to rehouse the urban population, but to offer only financial compensation to farmers, optimistically hoping that they would peacefully move elsewhere. No resettlement plan had, at this stage, been drawn up. The first

⁴¹ CHESF, Reservatorio de Itaparica: Plano de Desocupacao, Recife, 1985.

⁴² In its observations on the draft of this report, CHESF affirms that, considering its "institutional isolation" and the indefiniteness with respect to financial resource availability for resettlement activities, in reacting to "external pressures" of various kinds, it is unlikely that its response at the time could have been significantly different.

evictions in order to set up a construction camp (canteiro de obras) at Itaparica took place in 1979. Apparently, due to what was subsequently described as a "communications failure" between CHESF engineers in charge of construction and DIR (Departamento de Implantacao de Reservatorios), the internal unit responsible for dealing with displaced populations, a strong local conflict broke out.⁴³

6.58 Alerted by the knowledge that a major project was to be undertaken, and having learned from the earlier social upheavals at Sobradinho, Moxoto and the lower Sao Francisco, the surrounding rural population embarked on a policy of non-cooperation with CHESF, requesting proper compensation for all displacees. Largely for this purpose, POLOSINDICAL was established in 1979 with Church and NGO support and based in Petrolandia, one of the towns to be relocated. It brought together twelve neighboring rural trade unions in a direct response to the perceived threat of the Itaparica Hydroelectric Project to local livelihoods. Significantly, it was the first time that this local sertanejo (or backlands) population had ever become involved in organized political activity.

6.59 The initial organizational phase gave way to more systematic and widespread campaigns for access to CHESF's plans and maps of the project area so that its full impact could be gauged, for the relocation of all displacees on alternative lakeside lands and for the provision of basic production support services and social infrastructure. Under the banner of "Land in Exchange for Land along the Lakeside" ("Terra por Terra na Margem do Lago") and justified by the 1964 Land Statute, the rural union movement staged a number of mass demonstrations calling for resettlement plans to be drawn up and made public. A regular newsletter spelling out problems faced by the local population was also published.⁴⁴ In 1984, local demands were formalized in a document presented to CHESF.

6.60 The 1985-86 period saw a hardening of relations between CHESF and POLOSINDICAL. CHESF resisted entering into a dialogue with the local population and, even though the agency had formed a specific working group to address resettlement issues, the rural workers' consortium was not invited to participate. In 1985, CHESF underwent an internal reorganization, but its new directorate was even less willing to incorporate the wishes of the population to be displaced at Itaparica. Apparently without consulting either its own new division responsible for resettlement planning (ATIR) or the affected communities themselves, plans for lakeside irrigation schemes were drawn up. However, later feasibility studies revealed that most of the proposed sites were unsuitable due to saline soils and other problems. In response, another mass demonstration against CHESF occurred in October 1985 with presentation of a list of grievances to the federal government, including land appropriation for resettlement purposes and the installation of adequate irrigation facilities.

⁴³ Interview with Margarida Dantas de Oliveira, CHESF/ATIR, Recife, August 25, 1989.

⁴⁴ Boletim dos Trabalhadores Rurais Atingidos pela Barragem de Itaparica, Petrolandia.

6.61 In August 1986, events began to accelerate. With land acquisition due to be completed by early 1987 and the floodgates due to be closed in January 1988, a Bank mission visited Itaparica as part of its review of the Environmental Sector Master Plan in connection with the power loan. This period also witnessed a strong protest campaign mounted by international NGOs against CHESF, as well as against the Bank over its role in financing energy expansion in Brazil. Representatives of POLOSINDICAL wrote to the Bank in October 1986, expressing their own concern and highlighting a number of inadequacies in CHESF's proposed lakeside resettlement plans. Among other aspects, POLOSINDICAL objected to the superficial nature of pedological studies, the poor soil quality in the areas chosen for lakeside projects, the criteria used to establish plot sizes and plans to reserve 30-hectare tracts for large rural enterprises.⁴⁵

6.62 In addition, growing frustration on the part of the local population over CHESF's failure to respond to their criticisms and demand that a mutually acceptable resettlement plan be formalized culminated in a sit-in by several thousand local men, women and children at the dam site, paralyzing operations for six days and attracting national media coverage. The subsequent agreement between CHESF and the rural unions, signed on December 6, 1986, set out several important preconditions including: (i) firm dates for land acquisitions, the building of housing and irrigation infrastructure and transfer of the population; (ii) the indexation of compensation payments; (iii) the granting of larger irrigated plots than originally planned based on family size and prior land-owning status; and (iv) the provision of maintenance payments of 2.5 minimum salaries per month to settler families pending the first harvests.⁴⁶

6.63 Soon afterwards, CHESF updated the cadastre of families to be resettled initially undertaken in urban centers in 1982-83 and in the rural areas in 1984-85⁴⁷ and began a series of routine preparatory measures with each community to familiarize their residents with the options open to them. The company likewise began to reach resettlement agreements with individual families, as well as with the communities collectively, and to make arrangements for the physical transfer of people and their possessions. Beginning in May 1987, thirty-seven special four person teams were trained and fielded to carry out this process. In 1987 also, CHESF introduced a new Department of Resettlement Coordination, liaising between DIR and ATIR, to take charge of these functions and carry out continuing negotiations with POLOSINDICAL. Thus, by the time the Bank appraised the resettlement project in June-July 1987, the major parameters both for the transfer of population and the subsequent initiation of

⁴⁵ "Critica aos Anteprojetos para a Borda do Lago PE/BA Apresentados pela CHESF," mimeo, POLOSINDICAL, Petrolandia, October 22, 1986.

⁴⁶ "Acordo entre a CHESF e Trabalhadores Rurais Atingidos pelo Reservatorio da Usina Hidreletrica de Itaparica, com a Presenca do Ministro das Minas e Energia," POLOSINDICAL, Petrolandia, December 6, 1986.

⁴⁷ Updating of the cadastre, according to CHESF, involved accounting for the formation of new families and seasonal migration to and from the project area as a result of the agricultural cycle and construction activities at the dam site and in the new urban centers.

irrigated agricultural production had been largely established by means of a formal agreement between CHESF and POLOSINDICAL.

3. Expropriation and Compensation

6.64 In the cases of both Sobradinho and the lower Sao Francisco projects, official procedures for acquiring land and compensating occupants had been major bones of contention. Factors such as the ineligibility of untitled farmers, inadequate payments for land improvements (benfeitorias) and the failure to provide alternative livelihoods for displacees gave rise to frequently intense open conflicts whose reverberations can still be felt in the region. Although official reports tend to gloss over the subject, the livelihoods of many displacees from Sobradinho and the lower valley had, in effect, been ruined, especially those of smallholders and sharecroppers who received little or no compensation or were ineligible to join the new projects. Even in the case of Itaparica, late payments to a number of displaced farmers, as well as some inconsistency in calculating indemnification, left some people (eg. the Tuxa Indians in Rodelas) unsatisfied. However, the advance negotiations which took place between CHESF and POLOSINDICAL helped to ensure that expropriation and indemnification procedures for Itaparica, by and large, avoided past errors and injustices.

6.65 Constant pressure on CHESF from the rural union movement, particularly after 1985 as the deadline for closing the floodgates approached, helped to widen the range of options open to Itaparica displacees. CHESF's belated resettlement plan, the Plano de Desocupacao,⁴⁸ offered four possibilities to the rural population: (i) cash compensation for business people; (ii) places in the new towns for the elderly; (iii) lakeside irrigation projects for smallholders and (iv) collective schemes for landless workers, tenants and sharecroppers.⁴⁹ Further discussions and revised plans meant that the rural population of over 30,000 eventually chose the following solutions:⁵⁰

- (a) 11.8%, mainly wealthier farmers, opted for cash compensation and free transport to a destination of their own choice within a 500 kilometer radius.

⁴⁸ CHESF, op. cit., 1985.

⁴⁹ In its comments on the preliminary draft of this report, CHESF observes that rural displacees initially expressed their concerns in terms of obtaining "the necessary means to develop water for [agricultural] production on their own lands." Only later was the specific idea of developing irrigation projects introduced which brought with it a number of difficulties in order to achieve compatibility between the physical and technical requirements of such undertakings and the interests of the affected families. This experience suggests that resettlement efforts involving irrigation cannot follow the design parameters established for conventional public irrigation schemes.

⁵⁰ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica: Impactos e Mudanca no Meio Rural - Relatorio Final de Avaliacao do Reassentamento da Populacao Rural de Itaparica, Recife, 1988.

- (b) 3.1% moved to small group projects elaborated on the initiative of the farmers themselves and built by CHESF. This involves a total of nine schemes, including the 25-family Manga de Baixo pilot project, Riacho do Bento and Ibotirama for the Tuxa Amerindians, as well as Apolonio Sales, near Petrolandia.
- (c) 0.3% opted for the new fish-farms set up in the region following CODEVAS's comparatively successful experience in the lower valley. This option was presented to resettleses whose allocated lands are too poor to sustain agriculture.
- (d) 8.1% of rural displacees decided to live in the new townships of Petrolandia, Itacuruba, Rodelas and Barra do Tarrachil.
- (e) 22.9% went to two large lakeside irrigation projects totalling almost 8,000 hectares, situated in the states of Pernambuco (Barreiras and Ico-Mandantes, or Borda do Lago-PE) and Bahia (Borda do Lago-BA).
- (f) The remaining 53.8% have been resettled on four "special" irrigation projects (Brigida, Pedra Branca, Caraibas and Gloria) situated at varying distances from Itaparica and covering a total of 10,000 hectares.

6.66 For the first time in any comparable Brazilian project, therefore, displacees were offered a comprehensive range of resettlement options which did not automatically spell disaster for a large proportion of those affected. This was the product of strong local pressure on CHESF, as well as Bank participation in the power sector loan and subsequent Itaparica plan. The importance of community involvement in decision-making processes at this critical stage is illustrated by the example of the Salitre resettlement site, which was to have accommodated 1,500 families, but was dropped in 1986 due to lack of support from the local population.

4. Displacement and Resettlement of the Population

6.67 Given the somewhat belated, but relatively wide-ranging, advance preparations made by CHESF at Itaparica, the physical transfer of the population to their new homes proceeded fairly smoothly. Itaparica's floodgates were finally closed in February 1988 and, by April of that year, relocation of families from the area to be inundated was virtually complete. During February and March as many as 100 families were being moved daily.⁵¹ Some 5,000 families were taken to the new agrovilas, where each received a masonry house and the right to an irrigated plot. Basic sanitation, health and educational infrastructure had been installed. Even though, as described below, there were several problems with these facilities, a total of 109 agrovilas were built and their residents installed in a relatively short period of time.

⁵¹ Daniel Gross, "Itaparica Resettlement: Final Draft Supervision Report", mimeo, World Bank, April 26, 1988.

6.68 Pending the commencement of agricultural production -- which, as of late 1989, had not yet occurred on any of the major projects -- each family was to receive a monthly maintenance payment of 2.5 "reference" minimum salaries, equivalent to about US\$ 75. An additional 317 families were moved to urban areas, while another 500 waived their right to resettlement and farmland in exchange for cash compensation. Altogether, some 2,700 families were transferred to the relocated towns, where people were able to opt for a new house, a combination of cash compensation and a serviced plot or, in the case of non-property owners, materials for the construction of their own dwellings.

6.69 Although relocation was generally well planned and executed, several problems, nevertheless, occurred. Some time prior to the actual move, for example, CHESF resettlement teams advised farmers not to plant crops since they were likely to be lost in the rising waters of Itaparica. However, delays in building the agrovilas meant that those producers who followed this advice experienced shortages of basic foodstuffs such as beans, rice and manioc. Maintenance payments, moreover, could only be made after resettlement had taken place. Although CHESF did provide some emergency relief, many felt the amounts involved were insufficient. Financial problems, in turn, arose for a considerable number of farmers whose negotiated compensation payments had still not been initiated by CHESF several months after the move.⁵² In general terms, however, the transfer went well and, as one consultant expressed it, "there were remarkably few complaints about this phase."⁵³ This stands in direct contrast to the traumatic experiences at Sobradinho and the lower Sao Francisco valley and represents a significant advance in the handling of forced resettlement in the Brazilian Northeast.

6.70 Another set of issues arising from formation of the Itaparica reservoir, the wholesale transfer of population involved and the consequent relocation of productive activities concerns the differential spatial impact of resettlement in the middle Sao Francisco valley.⁵⁴ The municipalities of Itacuruba and Rodelas, for example, have witnessed a substantial decrease in their populations. In the case of Itacuruba, there is no compensatory irrigation activity in connection with the project. On the other hand, as a result of the operation, Curaca in Bahia, together with Oroco and Santa Maria da Boa Vista in Pernambuco, will receive large influxes of irrigation farmers. This is likely to result in substantial benefits for the local economies of these latter municipalities over time in the form of increased agricultural production and urban growth and associated tax revenues and other externalities. Once the new irrigation projects are fully operational, moreover, there is likely to be a further concentration of economic spin-off benefits in the Petrolina-Juazeiro nexus arising from the processing of fruits and vegetables, possibly at the expense of Arcoverde, Belo Jardim and Pesqueira in central-western Pernambuco.

⁵² "Trabalhadores Denunciam a Grave Situacao do Reassentamento de Itaparica," POLOSINDICAL, Petrolandia, October 27, 1988.

⁵³ Gross, op. cit., pg. 1.

⁵⁴ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica, op cit.

6.71 Raising the lowflow level of the Sao Francisco as a result of Itaparica, furthermore, has adversely affected the rural economy of the municipality of Belem do Sao Francisco by causing the permanent flooding of previously productive riverine lands. These rich alluvial soils, irrigated by small diesel pumps during the dry season, made Belem one of the major onion-producing regions in the middle valley. Literally overnight, according to local informants, 70% of this farmland was lost. Although some 350 farmers have been resettled in the Caraibas project, many have chosen to leave the area altogether. In addition, the risk of flooding in the town itself -- which was not relocated -- has increased and local officials are negotiating with CHESF for the construction of protective dikes. In any event, taken together these developments have greatly reduced commercial activity in this once thriving market town. Furthermore, it is unlikely that the start of irrigated production at Caraibas will benefit Belem, since the project is 100 kilometers away and the nearest town is Santa Maria da Boa Vista, at a distance of 40 kilometers.

6.72 Immediately beneficial social impacts, on the other hand, are also observable as a direct result of the Itaparica resettlement program. In what has turned out to be, in effect, a localized agrarian reform, traditional structures have been extensively replaced by new forms of land tenure and production. In the expropriated areas, land ownership was highly concentrated. According to 1980 census figures, which tend to understate the actual degree of concentration, 82% of farms in the lower-middle Sao Francisco valley occupied only 19% of the land, while a mere 1.7% of owners accounted for 72% of total farmland. More than half of the farmers on the Pernambuco side of the river were non-owners, bound to their employers by traditional tenancy or sharecropping arrangements in which 50% or more of their agricultural output went to the property owner in exchange for usufruct rights.

6.73 Larger farmers and owners of irrigation pumping equipment used on the river have, therefore, have lost much of their political and social force in the region. This is due both to the overall strength of POLOSINDICAL in defending the livelihoods of its members and the restructured land tenure system in the irrigation projects themselves, which, together have transformed many previously landless rural workers into independent smallholders. While the potential held by this reorganization for farmers' economic success and changing social relations will only become fully apparent once agricultural production is properly instituted and the agrovilas become stable communities, on the basis of progress to date, it is, nonetheless, clear that Itaparica has offered a significantly wider range of viable opportunities for its resettles than either Sobradinho or the lower Sao Francisco projects.⁵⁵

⁵⁵ However, as noted in paragraph 6.96 below, traditional forms of tenure such as sharecropping are likely to persist within the new irrigation projects.

5. The Impact of Itaparica on Amerindians

(a) The Tuxa

6.74 A special case has involved the relocation of some 190 families of acculturated Tuxa Amerindians from the old town of Rodelas and rural areas of the municipality of Itacuruba, where they had lived for several centuries. The community earned its living from cultivating the extremely fertile mid-stream island known as the "Ilha da Viuva." Its 108 hectares were irrigated by a combination of aqueducts and diesel pumps to produce bountiful crops of onions, rice, beans and manioc, as well as a range of fruits, thereby providing for the group's subsistence needs and generating a commercial surplus. Even though the Tuxa no longer speak their original native language, the tribe has an internal political structure and possesses characteristic mythical and religious beliefs and rituals.

6.75 Due to a partisan political dispute which divided the community during municipal elections in the early 1980's, when the time came to relocate, the Tuxa decided to set up two separate resettlement projects. Ninety-two (later 107) families decided to move to Ibotirama, 1200 kilometers upstream on the Sao Francisco River, to an area of 2,000 hectares, of which roughly 200 ha will be irrigated. The remaining 98 families chose to relocate in a special section of Nova Rodelas and were granted 4,000 hectares of drier sertao -- some twenty kilometers from their new place of residence -- of which 100 hectares are suitable for irrigation. In a written agreement (convenio) signed in July 1986, CHESF committed itself to provide production and social infrastructure and temporary maintenance payments to the two communities, as well as to demarcate the land. FUNAI, in turn, would directly provide administrative support, staff the schools and health posts and furnish agricultural extension services.⁵⁶

6.76 Aside from technical hitches and delays that have put irrigated production in both projects well behind schedule (see below), socio-psychological problems have apparently also been associated with the transfer of the Tuxa from their traditional lands to these new areas, exacerbating the impact of the political schism occurring independently of the project several years prior to their relocation. Although such disorientation is a general problem with resettled communities along the Sao Francisco valley,⁵⁷ it is even more marked

⁵⁶ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica, op cit., and Report No. 6914-BR, op. cit.

⁵⁷ In their comments on an earlier version of this report (internal memorandum dated July 24, 1990), moreover, Bank operational staff point out that "if anything the Tuxa have received considerably more attention, resources and services than other affected groups. Their problem is basically the same as [that] of the other rural resettles plus the general difficulties they experience as Indians under the jurisdiction of FUNAI."

among Amerindians such as the Tuxa.⁵⁸ Although acculturated, their ancient, but still strong, mythical-religious belief systems created an important bond between the people and their land. Once broken, a process of increasing social disintegration appears to have been set in motion. This is probably aggravated - by economic pressures resulting from delays in project implementation. In any event, internecine family quarrels and alcohol abuse, previously rare among the Tuxa, have reportedly become commonplace at both Rodelas and Ibotirama. This situation was exacerbated in the case of Ibotirama by the violent response of the military police to a murder in the village in June 1989 which generated a climate of insecurity and prompted twelve members to take refuge in Rodelas.

(b) The Pankaruru

6.77 Although not directly involved in the Itaparica resettlement program, the Pankaruru tribe has, nevertheless, suffered from the demographic changes set in motion in the region. Located near Petrolandia at Brejo dos Padres, some 5,000 Pankaruru Indians occupy an official 8,100-hectare reserve whose origins date back to the eighteenth century and was originally demarcated in 1940 by FUNAI's predecessor, the Indian Protection Service, but was ratified only in 1987 as part of a strategy to remove non-Amerindians from the area.⁵⁹ Since the 1950's, their fertile tribal lands have gradually been taken over by squatter farmers, who now occupy almost half of the area. The pressures and ensuing conflicts, some involving loss of life, have resulted in the Pankaruru being gradually forced into the less productive nearby foothills. Community members observe that this problem has recently been accentuated due to increasing pressure on local land resulting from resettlement at Itaparica and the growing population attracted into the region. Once irrigated production starts on the nearby Borda do Lago-PE project and land values rise, this situation could worsen.

6.78 The Pankaruru issue, moreover, places POLOSINDICAL in a dilemma and, at the same time, exposes some of the limits on its ability to help resolve land and resettlement issues for all those affected by Itaparica. Historically, white farmers have been hostile to Indians' territorial claims and cultural identity. This tradition continues at Itaparica, where Pankaruru interests are represented by FUNAI. The socio-political distance between the tribe, on the

⁵⁸ In its comments on an earlier version of this report, FUNAI observes that the Tuxa have, indeed, been affected in a socio-psychological sense as a result of their forced relocation on account of Itaparica. It also points out that the federal Constitution adopted in October 1988 (Article 230) now requires that the exploitation of hydrological resources, including potential energy uses, on tribal lands can only be authorized by the Congress after hearing the affected communities. The Constitution likewise prohibits the removal of Amerindians from their lands except in cases of catastrophe, epidemics or for reasons of national sovereignty as determined by the Congress or the occupation of tribal lands or exploitation of the resources on these lands except in the public interest.

⁵⁹ In commenting on an earlier version of this report, FUNAI observed that the area was recently redemarcated by the Army and that non-Amerindian occupants were in the process of being inventoried for subsequent relocation.

one hand, and other local farmers, as represented by POLOSINDICAL, on the other, is heightened by the fact that several prominent union leaders, including the presidents of both the consortium and the Petrolandia rural labor union, occupy lands within the reserve. According to the Indians, during 1989 trade unionists staged a public demonstration in support of posseiros and against the Pankaruru. FUNAI, moreover, appears to have done little thus far in response to the group's demands for protection against further invasions of their territory.

6. The Transition Period: Employment, Social Services and Pre-Production Preparation

6.79 Following the relatively successful transfer of the populations displaced by Itaparica to their new urban and rural homes, the next major challenge involves the resumption of productive activities. This problem is particularly acute for the roughly 5,170 families relocated into irrigation projects which have yet to come on stream. While the longer-term economic future of the new irrigation schemes is difficult to predict, it is, nevertheless, possible to assess developments occurring during the "transition phase" from the initial arrival of resettles in late 1987 through early 1990.

6.80 Most outside observers are in agreement that resettles in the agrovilas are, on balance, satisfied with the move to brick houses and new communities that offer a range of facilities to which they previously had little or no access.⁶⁰ However, since the actual population transfer took place in late 1987 and early 1988, the level of frustration and associated social problems have markedly increased. Intra-communal violence associated with alcohol abuse has become more widespread since the move, leading to the disintegration of some families and a climate of tension within the community. Morale is generally low and, although farmers continue to look to the future with a degree of cautious optimism, this is tempered by growing despair over CHESF's failure to guarantee the prompt resumption of economic activities. According to company sources, resentment against officials was running so high in Caraibas that, for fear of being assaulted, CHESF personnel could only visit the project in unmarked cars. CHESF has been subjected to a steady stream of protest notes over this issue, both from white farmers through POLOSINDICAL and from the Tuxa Amerindians.

6.81 Discussions with leaders of POLOSINDICAL and CHESF personnel during the OED/SEPLAN mission in July-August 1989 also revealed a certain resentment toward the Bank for its perceived responsibility in delaying additional funding to permit resumption of irrigation works, which were slowed down in mid-1989. CHESF staff, in particular, tended to attribute project delays to this factor, ignoring their own organization's role in the matter. Delays in project works, however, can not be attributed to the Bank since an undisbursed balance of US\$ 34.4 million remained in the original (ie. 2883-BR) loan account for the project as of May 31, 1990, while the supplementary loan (2883-1-BR), approved by the Bank in February 1990, has yet to be signed by the Brazilian Government. Shortages in local counterpart funding appear to be the principal reason for such delays. The generally poor social climate in the projects, in turn, derives from

⁶⁰ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica, op cit., and Gross, op. cit.

various problems associated with project implementation to date, and may be considered, more specifically, in terms of: (a) the employment situation; (b) social services; and (c) pre-production preparation.⁶¹

(a) Employment

6.82 The most serious immediate problem during the transition period has been the lack of stable and productive employment for agrovila residents. Even though monthly maintenance support payments have been made by CHESF to such families during the period since relocation, these are widely observed to be insufficient to meet the basic needs of resettlers. Inflation and delays, in fact, have reduced the value of these payments by 20% or more in real terms.⁶² In addition to the financial question per se, moreover, is the risk that long-term dependence on such payments may undermine individual pride and the self-esteem of this once extremely active and productive population. Several residents have set up small enterprises such as charcoal-making, building and retail sales, while others have found work with the construction companies installing the irrigation projects, but comparatively few settlers have, in fact, been or remain employed owing to the lack of specific non-agricultural skills among this population and the slow-down in project execution.

6.83 Following a campaign by resettlers and negotiations with POLOSINDICAL, still other farmers are receiving additional payments from CHESF to clear their own irrigation plots of thick scrub (caatinga), at an estimated average cost of US\$ 300 per plot.⁶³ This will enable settlers awaiting the initiation of irrigated farming to gain at least some income in addition to the monthly maintenance payments, as well as to plant rainfed crops for subsistence purposes. Resettled families have also been using domestic water supplies to establish small irrigated gardens for the purpose of growing their own food. These are important sources of additional sustenance for the population, in view of the relatively high price or non-availability of staple foods in the shops, following the disruptive impact of Itaparica on local agricultural production.

(b) Social services

6.84 Concern has also been expressed by project beneficiaries over the varying quality of social service provision. Primary schools have been built, but, in many cases, classes have not yet started because of delays in state

⁶¹ In commenting on the previous version of this report (internal memorandum dated July 24, 1990), Bank operational staff correctly observe, moreover, that "even under the best of circumstances, dissatisfaction would have arisen due to the gap between actual resettlement and the beginning of agricultural production. While employment generation, social services and project preparation could all stand improvement, they cannot mitigate against the lack of production infrastructure."

⁶² Itaparica Resettlement and Irrigation Project: Second Progress Report on Project Execution, January 1990.

⁶³ Gross, op. cit., pg. 4.

recruitment of teachers. It has also been common for state-appointed teachers to leave their posts because of poor conditions in the agrovilas and/or due to the non-payment of their salaries. This is extremely disappointing for resettlers, since the possibility of obtaining better education for their children following relocation is a strong ambition of most parents. Health posts have likewise been built, but staffing is sporadic. It is not clear whether permanent medical assistance from practical nurses is currently available in all cases, although CHESF is supposed to provide weekly doctors' visits to each community. These general problems in the provision of social services have been compounded by physical obstacles arising in some instances from impassable roads, power failures and water shortages.⁶⁴ The irregularity of public transport services, provided by CHESF to take people from the relatively isolated agrovilas to the nearest towns, was also highlighted by villagers as a serious problem.

6.85 During the transition phase, CHESF's relocation teams -- composed of social workers and agricultural technicians -- have shifted their attention from transferring people to solving specific problems arising in the agrovilas. The team in each project engages in a wide variety of activities such as communicating CHESF policy to villagers, assisting families not receiving support payments, facilitating access to social services and processing requests for home repairs. Due to the accumulation of resettlement problems, however, CHESF's teams find themselves increasingly in the position of having to attempt to defuse growing intra-communal tensions and of bearing the brunt of local resentment.

(c) Pre-production Preparation

6.86 The current mood of frustration is clearly related to the significant changes in lifestyle to which many displacees have been subjected in a short space of time, as well as to the aforementioned problems with the provision of community services. Perhaps the major source of resentment is the long delay in commencement of irrigated production. Even by December 1989, just half of the 5,000 or so rural families had received their plots. The first projects, moreover, were due to come on stream in July 1988, according to the agreement signed between CHESF and POLOSINDICAL in December 1986. However, by late 1989, only the 25-family Manga de Baixo pilot scheme was in operation, cultivating 87 hectares out of a total of nearly 20,000 hectares due to be irrigated in connection with Itaparica. CHESF has anticipated, somewhat optimistically, that the Brigida and Borda do Lago-BA projects would come on stream by March 1990, with the other projects following six months later. By late 1989, in Caraibas, where 1,550 families (or over 7,000 people) have been resettled, even though the primary water conveyance works had been underway for some time, as a result of the perceived slow pace at which the irrigation network was being installed, colonists were reported to be particularly antagonistic towards CHESF. According to the revised project implementation schedule, CHESF is expected to complete all the irrigation schemes by December 1990, some 18-24 months behind the original target date.

⁶⁴ Ibid. Some cases of poor housing construction (eg. cracking walls and foundations in units built on expansive soils) have also occurred, but CHESF is reportedly taking adequate remedial action.

6.87 Questions have occasionally been raised, moreover, in connection with the technical and economic feasibility of some of the individual irrigation projects. Doubts have arisen, for example, with respect to the design of the water conveyance systems in two such projects.⁶⁵ Bank operational staff, however, feel confident that the irrigation schemes are sound and will perform as designed.

6.88 Marketing is another critical issue and has been a common problem with public irrigation in the Northeast in the past.⁶⁶ It is not yet clear whether sufficient thought has been given to the capacity of local, regional and national markets to absorb the projected increases in the production of onions, beans, melons and tomatoes in the Itaparica schemes. While the Producers' Association at the small (ie. 25-family) Manga de Baixo pilot project appears to have been successfully able to sell its output thus far, the extent to which the much larger number of settlers will be able to market their produce when all the Itaparica schemes come on stream is a question which will require careful monitoring.⁶⁷ If evolving market possibilities are not given adequate attention, moreover, project farmers may ultimately be forced to sell their output below cost, as has already happened with their riverside crops.⁶⁸ Serious doubts likewise exist as to whether fish-farming is a viable activity in the middle Sao Francisco in view of expected competition from lake fishing.

6.89 Following the unsatisfactory results of international tendering for the provision of irrigation training and extension support for Itaparica, CODEVASF has agreed to assume responsibility for these tasks. Thus far, however, CHESF and CODEVASF have been tardy in setting up arrangements for farmer training and project administration. While farmer training and pilot projects have been underway for nearly two years in various localities, as of September 1989, no formal agreement had yet been reached between the two agencies even though some projects were due to start agricultural production less than a year later. At Brigida, which is due to come on stream in June 1990, for example, through the end of July 1989, there had been only a single visit by a CODEVASF technician unaccompanied by CHESF.

⁶⁵ "Itaparica Resettlement: Back-to-Office Report," World Bank, March 17, 1987.

⁶⁶ Anthony Hall, Drought and Irrigation in North-East Brazil, Cambridge University Press, 1978.

⁶⁷ In any event, given its fairly isolated location, it seems improbable that local markets at Ibotirama will be able to absorb the expected output once the Tuxa's new irrigation project becomes operational. More generally, however, the Bank's operational staff believes that, given their locations closer to important urban-industrial centers such as Petrolina-Juazeiro and the existence of good transport links, it is reasonable to assume that marketing and processing facilities will be developed still closer to the irrigation project sites and that, over time, regional, national and even international markets will be able to absorb the products of the Itaparica farmers.

⁶⁸ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica, op. cit.

6.90 Training is of crucial importance, moreover, since, although most of the resettled farmers have irrigation experience, the new system will be distinctly different from that to which they are accustomed. Sprinkler irrigation, more specifically, will require watering techniques different than those utilized in the traditional diesel pump and gravity-feed system common among small producers in the middle Sao Francisco valley. Furthermore, given the much poorer caatinga soils where the new projects are located, when compared with the fertile alluvial deposits of varzea agriculture, there will undoubtedly be a need for heavier inputs of fertilizers and other chemical treatments. These differences have implications not only for labor-force intensity and organization of the agricultural calendar, but also for production costs and, ultimately, the economic feasibility of the new technology.

6.91 Furthermore, although considerable attention has reportedly been given to the longer-term organization of irrigation farmers and there are nascent organizations in many agrovilas that may evolve into full-fledged farmer associations in the future,⁶⁹ the large-scale formal type of cooperative structure likely to be required stands in direct contrast to the traditional forms of more spontaneous small-group farmer cooperation that have evolved in the lower-middle Sao Francisco valley. In addition, the fact that as many as half of project farmers were previously sharecroppers and tenants, dependent upon vertical patron-client relationships with landowners and lacking any form of collective structure, renders the creation and nurturing of appropriate organizational arrangements for irrigated agriculture even more important, if potentially more problematic.

7. Costs of Project Implementation, Farmer Incomes and Equity

(a) Project Costs

6.92 As previously indicated in Chapter IV, of a total estimated project cost at appraisal of US\$ 303.7 million, the Bank contributed an initial loan of US\$ 132 million, some 80% of which was allocated for the development of irrigation facilities and rural infrastructure. The Bank's contribution was subsequently increased by a supplemental loan of US\$100 million in February 1990, while total project cost was revised upward to US\$ 650 million. The five irrigation subprojects are expected to have a total of 5,170 irrigated family plots, whose overall rate of return was initially estimated at 13% over a 25 years period. With the upward revision of project cost figures, however, the rate of return estimate was revised downwards to just under 11%. Partial cost recovery is planned via individual farm water charges to cover operation and maintenance, although CHESF would subsidize production during the first five years by absorbing electricity charges. In view of the involuntary nature of the Itaparica resettlement, statutory provisions for imposing area-based water charges to recover public investments have been waived in this case.⁷⁰

⁶⁹ As indicated above, a successful farmer's association exists, for example, in the Manga de Baixo pilot project.

⁷⁰ Report No. 6914-BR, op, cit.

6.93 The appraised cost of Itaparica is at first sight quite reasonable when compared with similar resettlement experiences in Northeast Brazil. According to the Bank's recent Irrigation Subsector Review for Brazil, in public irrigation projects in the region, the total cost of on-farm investment (land preparation, drainage and irrigation equipment) and off-farm investment (including water conveyance, drainage, roads and energy) has varied from US\$ 4,500 to US\$ 7,500 per hectare, not including agricultural support services or operational support.⁷¹ The total cost per resettled family in irrigation schemes administered by DNOCS and CODEVASF, in turn, is officially put in the range of US\$ 40,000-60,000. This compares with an appraised cost at Itaparica of between US\$ 5,800-8,100 per hectare, or US\$ 19,200-28,000 per family. In view of the recently-approved second Bank loan and the revised total costs for Itaparica, the average cost in real terms is presently expected to rise to a level somewhat above the general figure for public irrigation in the Northeast given above. Even though the cost of resettlement may be slightly more than US\$ 63,000 per family,⁷² Bank irrigation specialists still consider this to be the least-cost solution for carrying out the resettlement agreement negotiated by CHESF with the impacted communities. Brazilian Government officials, however, view these costs as "excessive" and argue that they should not be considered as the norm for similar projects elsewhere in the country.⁷³

6.94 In considering the reasons for the comparatively high per family irrigation costs associated with the Itaparica Project, moreover, it is important to reemphasize that the single most important factor in the high cost of the operation, as designed, was the high level of militancy engendered by CHESF's handling of the resettlement component prior to Bank involvement. As a consequence of this situation, CHESF was in a weak position when it finally sat down at the bargaining table with the rural unions.⁷⁴ A second significant

⁷¹ Report No. 7797-BR, op. cit.

⁷² In its comments on an earlier version of this document, DNPA/MEFP observes that the draft report does not give sufficient attention to the "extraordinary cost projections for implementation of the project concerning which doubts exist if they can effectively be met." According to DNPA's analysis, "the current (ie. December 1990) cost estimates for the project are: US\$ 545.5 million for the agricultural component, US\$ 104.2 million for the urban component and US\$ 301 million for relocation and indemnizations. This represents...US\$ 173,000 per family. The agricultural component alone represents US\$ 99,300 per family or US\$ 29,500 per hectare, exorbitant levels that are without parallel in international terms. The subsidy costs to the families at present are on the order of US\$ 9.7 million."

⁷³ Observations on an earlier draft of this report by the Ministry of Infrastructure.

⁷⁴ In its observations on the draft of this report, CHESF attributes much of the high resettlement cost per family to the "negotiated" lot sizes which were larger than those normally developed by CODEVASF in its conventional irrigation projects. These larger-sized plots reflected resettlers' preferences for areas

factor was the fact that CHESF allegedly allowed hundreds of families to move into the area to be flooded after construction began.⁷⁵ These families later became candidates for resettlement with the same rights as those residing in the area for generations, greatly increasing the cost of the project.⁷⁶

6.95 Notwithstanding the eventual financial costs of resettlement at Itaparica and their underlying causes, this calculation is not the only, nor necessarily the most important, consideration in this and similar situations. A relatively heavy financial cost may be the inevitable price that must be paid in order to implement a hydropower project that adversely affects a large number of people. Such costs, however, should be fully assessed as part of the initial appraisal of the project which has given origin to them and have a direct bearing on the decision whether to undertake the specific investment or sector loan designed to support the operation with which the resettlement in question is associated.

6.96 In an involuntary resettlement program, the first priority of executing and funding agencies should be to guarantee the livelihoods of the displaced farming population and other impacted groups. The major challenge at Itaparica, accordingly, is to establish a system of irrigated agriculture which will provide adequate employment and income to resettles and, after the initial adaptation period, permit them to become economically self-sufficient. The ultimate success of irrigation at Itaparica, therefore, will depend on how well CHESF and CODEVASF retrain and help to organize farmers, as well as on the provision of necessary inputs, pricing and marketing structures to service the projects themselves. It is often automatically assumed that it is difficult, if not impossible, to simultaneously meet both economic (production) and social (resettlement) goals through resettlement schemes, but there is no logical reason why these objectives should be irreconcilable. Itaparica will provide a fertile testing ground for this hypothesis.

which could accommodate both the present and potential future family labor force by providing for the anticipated land requirements of the next generation (ie. the sons and daughters of the original plottolders) as well.

⁷⁵ CHESF points out in this regard, however, that it would have been virtually impossible to "cordon off" the project area for the close to twelve year period required which implementation of the Itaparica dam and reservoir eventually required.

⁷⁶ This latter factor was reported to OED by Bank regional project staff in their comments (internal memorandum dated July 24, 1990) on an earlier version of this document. It was also observed in this context that "the technical literature on the subject, available since before this project was launched, clearly states the importance of preparing a cadastre of candidates for resettlement early in the planning stage, providing them with appropriate identification and firmly discouraging others who might consider attempting to gain resettlement benefits through an address change."

(b) Farmer Incomes and Equity

6.97 A standard criticism of public sector irrigation projects in the Northeast and elsewhere is that they create small "islands" of privileged farmers who not only enjoy substantially higher incomes than producers in adjacent rainfed lands, but who also frequently benefit to a relatively greater extent than other small producers from a variety of social facilities such as improved housing, schools and health clinics. It was estimated at appraisal that, when the sub-projects are fully operational, Itaparica's annual farm incomes will range from US\$ 2,100 (on 1.5 hectare plots) to US\$ 5,900 (on six hectare plots). Average regional income figures are of little use for comparative purposes in this situation. However, 1980 census data indicate that, before resettlement, some 40% of the working population in this part of the middle-valley earned at least one minimum salary (about US\$ 40 per month, or US\$ 480 per year), while only 30% earned less than half a minimum salary.⁷⁷ Although these monetary figures do not take the subsistence element of farmer incomes into account, they, nevertheless, clearly suggest that, if the anticipated income streams are achieved, irrigation farmers and their families are likely to be significantly better-off in a financial sense than prior to resettlement.

6.98 Furthermore, in addition to the employment and incomes generated directly for project beneficiaries themselves, benefits are likely to be spread into the surrounding local economy. Judging from the experience of other irrigated zones in the Northeast, it is likely that considerable secondary employment may be generated. Although traditional labor relationships are liable to be replaced to some extent by temporary wage-labor, however, it is probable that sharecropping will survive as a flexible and mutually advantageous arrangement for landowner and worker.⁷⁸ The extensive use of gravity-fed technology in the Itaparica irrigation projects, moreover, will demand relatively labor-intensive artesanal methods in contrast to central-pivot and other more highly mechanized systems found in the area around Petrolina and Juazeiro.

6.99 Without careful project implementation, these potential benefits could, nevertheless, be undermined by problems which are already familiar in other irrigation schemes in the region, such as the salinization of soils, poor water management, inefficient cooperative structures and insufficient farmer access to essential inputs. As has been witnessed in the lower Sao Francisco valley and elsewhere in the Northeast, these handicaps could eventually lead to growing farmer indebtedness and increasing producer turnover and land concentration, in the process defeating the original objectives of the resettlement program.⁷⁹

⁷⁷ Fundacao Joaquim Nabuco, Hidreletrica de Itaparica, op cit.

⁷⁸ J. Graziano da Silva (ed.), A Irrigacao e a Problematica Fundiaria no Nordeste, Instituto de Economia, UNICAMP/PRONI, Sao Paulo, 1989.

⁷⁹ In its observations on an earlier draft of this report, DNPA/MEFP argues that the document "does not properly analyze the real difficulties in implanting viable irrigated agriculture [in the Itaparica schemes] in view of the social and economic constraints that will be difficult to overcome within a period of

8. Archaeological Sites

6.100 One of the more unavoidable costs of the Itaparica project is the permanent loss of archaeological sites and artifacts. The Sao Francisco has long been recognized as an ancient site of human habitation, as reflected in the petroglyphs (designs carved out on rock face, known in the region as itacoatiaras) that extend for long distances along the valley. Research undertaken prior to flooding at Itaparica by the Federal University of Pernambuco, in collaboration with CHESF and foreign universities, has yielded additional information on some 200 archaeological sites.⁸⁰ These were first settled roughly 10,000 years ago by hunter-gatherers from what are now the states of Goias and Piaui, forming the "Itacoatiara tradition," and some 2,000 years ago by Aratu Amerindians. Although the petroglyphs were, for the most part, lost to the waters of Itaparica, researchers managed to salvage ceramics, stone tools and funeral urns. The ceramic tradition is partly continued locally today by the Pankaruru and Atikum indigenous groups. Historical material which has been lost, moreover, includes Franciscan mission buildings established during the early colonial period on some of the mid-stream islands in the river.

D. Other Human Environmental Impacts

1. Population, Migration and Employment

6.101 Wider demographic and socio-economic changes occurring in the middle and lower Sao Francisco valley during the 1970's and subsequently have been both substantial and uneven in their consequences. The total population in the area expanded from 1.4 million to nearly 1.9 million between 1970 and 1980, an increase of more than 30%. This figure is significantly higher than the average for the northeastern states as a whole, where population growth during this same period was only on the order of 15-20%. While some of this difference may be due to differential rates of natural increase, the formation of Sobradinho and the events set in motion by it, especially the rapid expansion of irrigated agriculture and of associated industrial and urban service activities, have attracted a large number of migrants to the middle Sao Francisco valley, thereby

less than 10 years, even if the affected populations are provided with all the (especially financial-economic) support required so that they can produce economically. These constraints are very substantial: the socio-economic ones which are derived from the poverty and backwardness of a population which presently possesses no resources except its own unskilled labor; the financial ones which are manifested in the present shortage of resources in the country as a whole to finance poor farmers in capital-intensive activities and in the lack of schemes to absorb risks, until [the Itaparica farmers] are consolidated which will require 5 to 6 years at least; the commercial ones which are reflected in the absence of indispensable alternatives (agro-industries) which will emerge only when [agricultural] production is consolidated; and the environmental ones, with low fertility soils, once higher production costs are imposed."

⁸⁰ Gabriela Martin, "Dez Mil Anos de Historia, Adeus," Ciencia Hoje, Vol. 10, No. 56, August 1989.

accelerating the pace of change in the region. Itaparica, further downstream, may well precipitate a similar, if less dramatic, process during the 1990's.

6.102 Demographic change, however, has by no means been uniform in the areas of influence of the projects under review. The middle valley has fared better, its population having grown by 36% over the same period, while that in the lower Sao Francisco increased by 26%. The most spectacular jump in population occurred in the municipality of Petrolina, which increased by almost 130% during the 1970's, to reach a total of 104,000 by 1980. This huge increase is closely related to the expansion of economic activities in the region resulting from Sobradinho and the growth of public and, especially, private irrigation.⁸¹ This situation contrasts strongly with that in the lower Sao Francisco valley where many of the municipalities witnessed very small or even negative rates of population growth over the same period.

6.103 In common with regional trends for Northeast Brazil as a whole, the middle and lower valley has experienced a marked process of rural out-migration, coupled with rapid urbanization.⁸² While this is closely associated with general demographic, social and economic transformations, the speed of change has undoubtedly been increased by the direct and indirect impacts of the Sao Francisco projects. These have had both negative consequences, in terms of displacing more people than were resettled, and positive effects insofar as the areas have already experienced and/or will benefit in the future from new sources of economic growth.

6.104 While there has been an overall decrease in the proportion of the total population classified as rural in the middle and lower valley, this decline has also been more dramatic in some areas than in others. Rural areas directly impacted by Sobradinho, for instance, experienced a sharp decrease in rural population not only in relative, but also in absolute, terms.⁸³ During the 1970's, however, this phenomenon was most marked in the lower valley, where heavy net out-migration appears to have occurred as a result of the changes induced by Sobradinho and the irrigation projects.⁸⁴ Again, this situation

⁸¹ See sections 2 and 3 below.

⁸² Urban growth is dealt with in more detail in section 4 below.

⁸³ In Casa Nova, for example, the rural population fell from 31,627 in 1970 to 28,361 in 1980, a loss of 1.1% per annum.

⁸⁴ In Microregion 124 in Sergipe (municipalities of Ilha das Flores, Neopolis, Propria, Brejo Grande, Amparo de Sao Francisco, Nossa Senhora de Lourdes, Pacatuba and Telha), for example, which covers an important estuary of the Sao Francisco and where much land acquisition and expropriation took place during the 1970's, there was an absolute decrease in population from 38,000 to 35,000, representing a negative growth rate of 2 to 3% a year.

contrasts sharply with that in Petrolina, whose rural population grew significantly over the same period.⁸⁵

6.105 In terms of employment generation, although little concrete data exists to permit an evaluation of the projects' wider consequences, some observations are, nevertheless, possible. The process of land concentration which has been observed around Lake Sobradinho is likely to result in a reduction in the proportion (or even the absolute number) of farm owner-operators with a corresponding increase in wage labor. The establishment of new irrigated farming enterprises will create other kinds of jobs. However, research has shown that the expansion of irrigated farming does not necessarily lead to a total breakdown of traditional land tenure relations. It has been found, for example, that sharecropping and leasing arrangements may well persist in the region in order to ensure an adequate labor supply for large-scale irrigation enterprises.⁸⁶ Due to the heavy initial out-migration in the lower valley, on the other hand, irrigated farming may possibly experience a labor shortage problem in the future.

6.106 While it is difficult, at present, to predict the employment generating capacity of irrigated agriculture, research undertaken in the middle Sao Francisco valley suggests that it has the potential to expand rural job opportunities significantly. A recent study of public and private farms in the region concluded that irrigation development has significantly increased local demand for labor, attracting workers, and hence migrants, from other areas. Private irrigated agriculture, especially for high-value commercial crops such as grapes, industrial tomatoes and rice, were found to be particularly labor-intensive.⁸⁷ The finding that considerable potential exists for the expansion of small private owner-operator irrigated farms is heartening for the middle valley, especially in the light of the Itaparica resettlement program which will involve over 5,000 producers. While generally encouraging, these results should, nevertheless, be treated with caution due to methodological problems.⁸⁸

⁸⁵ The rural population in this municipality increased from 23,000 in 1970 to almost 30,000 in 1980, or at an annual rate of 2.5%. Petrolina's urban population, in turn, increased even more substantially, from 38,000 to almost 75,000, or at more than 7% per annum.

⁸⁶ This is because sharecropping provides a stable supply of workers for labor-intensive gravity irrigation techniques and is a flexible form of relationship that allows the worker to perform multiple roles as manager or lesser partner in an enterprise if the situation demands it. See, J. Graziano da Silva (ed.), op. cit.

⁸⁷ Eugenio Maffei, Jose Ferreira Irmao and Herminio Ramos de Souza, Irrigacao e Emprego no Sertao do Sao Francisco, OIT/PNUD/SUDENE, Recife, 1986. According to the calculations of these authors, private irrigation absorbs 0.7 workers per hectare, compared with a figure of 0.06 for dryland farming in the Northeast.

⁸⁸ For example, the stratified sample on which the calculations were based included only 40 farmers (15 on public projects and 25 on private farms). In addition, the two sectors are ill-defined; "private farms" include both small

Furthermore, the study does not address the issue of the potential limits to the growth of irrigated agriculture imposed by demand constraints or the fact that current high cost technologies and the implicit risks for small farmers discourage the irrigated production of low-value staple crops which are crucial to food security in rural areas.

6.107 The rapid growth of Petrolina, Juazeiro and smaller towns in the middle valley suggest a parallel expansion of urban job opportunities in the region. Indeed, the development of food processing and other large and small-scale industries and associated commercial and service activities testify to a certain degree of additional employment creation. However, the information presently available is insufficient to permit firm conclusions as to the extent to which the increasing urban population is being productively absorbed in such activities. The rapid expansion of shanty-towns and urban social problems noted by local observers may, in fact, reflect a serious mismatch between population growth as the result of rural-urban migration, on the one hand, and the number of new jobs available, on the other. In any event, there has, almost certainly, been a significant expansion of the urban informal sector, together with the (probably much smaller) increase in formal job opportunities. This is an area requiring further research.

2. Rural Development

6.108 The first systematic irrigation plan for Brazil, published in 1971, was carried out by a Brazilian-Israeli consortium and set clear goals for 1980.⁸⁹ In the Northeast, DNOCS was given responsibility for irrigating 78,000 hectares in 36 public schemes scattered throughout the semi-arid interior of the region, while CODEVASF was assigned an irrigation target of 112,000 hectares in 17 projects in the Sao Francisco valley. The major objectives of the plan were to increase employment, farmers' income levels and agricultural output. The plan anticipated, for example, the direct creation of 115,000 jobs in the Northeast by 1980, as well as twice this amount of indirect employment. The National Integration Plan (PIN) of 1970 gave added impetus to irrigation development in the Northeast as part of an anti-drought and production strategy, linked to a policy of directed resettlement in the Amazon region. PIN projected the irrigation of 40,000 hectares in the region between 1972 and 1974 alone. CODEVASF, however, fell far short of its targets, such that, by the end of 1980, it had irrigated only 9,800 hectares (20%) of a revised 50,000 ha target for the decade and settled 2,780 families. At that time, moreover, only 54% of the area irrigated by CODEVASF was settled by small farmers with the remaining 46% occupied by large commercial ventures.

family units and large agro-industrial enterprises such as AGROVALE which employs only 0.02 workers/ hectare. Judgments as to the more general validity of labor-absorption coefficients estimated for particular crops, moreover, must also take the technology employed into account.

⁸⁹ GEIDA, Programa Plurianual de Irrigacao, Grupo de Irrigacao para o Desenvolvimento Agricola, Brasilia, 1971.

6.109 The 1980's, in contrast, have witnessed a significant expansion of the area irrigated by CODEVASF, which, by 1988, had reached 66,000 hectares in 14 projects absorbing nearly 6,200 farmers. Two recently inaugurated projects, Senador Nilo Coelho (formerly Massangano) near Sobradinho and Boacica in the lower valley, however, account for a large proportion of the 35% increase in the total area irrigated by the agency since 1984. Over half (ie. close to 37,000 hectares) of CODEVASF's irrigated area, furthermore, is concentrated in the Petrolina-Juazeiro axis (see Annex 2). During 1989, the agency planned to irrigate an additional 25,000 hectares in five projects located in different parts of the valley: Formoso A, Gorutuba, Marituba, Expansao Nilo Coelho and Miriros. CODEVASF was also expected to commence implementation of several major new schemes during 1989, including the World Bank-supported Jaiba (22,000 ha) and Jequitai (35,000 ha) projects. Another 196,000 hectares were at the feasibility and design stages.⁹⁰

6.110 Construction of the Sobradinho dam and reservoir during the mid-1970's, by regulating the flow of the Sao Francisco and increasing the supply of electric energy, has permitted the rapid expansion of private, as well as public, irrigation schemes and attracted an increasing number of farming, agribusiness and agro-industrial enterprises to the region, which are discussed in the following section.⁹¹ While this has undoubtedly increased agricultural output and provided additional employment, another apparent consequence has been to exacerbate the historical tendency toward land concentration in the Brazilian countryside. Even though a more detailed study of rural land transactions and land use changes over the period would be required in order to more precisely identify the role of increasing public and private irrigation in the recent concentration of land holdings in the middle Sao Francisco valley, there can be little doubt that such concentration did, in fact, occur between 1970 and 1985.

6.111 Annex 1 below presents census data on rural land distribution for key regions around Lake Sobradinho. It reveals that, since the late 1970's, the percentage of farmland in smallholdings has gradually decreased, while there has been a simultaneous expansion of larger estates. In Microregion 133, which covers the northern periphery of the lake, for example, small plots with less than 10 hectares have seen their share of farmland fall by one-quarter, from 6% in 1970 to 4.6% in 1985. At the same time, land held in properties of 100 to 1,000 hectares accounted for 26% of the total in 1980 and 37% in 1985. In the municipality of Petrolina, this trend is even more pronounced, while in neighboring Juazeiro the acquisition of land by large enterprises for irrigation

⁹⁰ E. Assirati, "Situacao Atual do Investimento em Irrigacao Publica no Nordeste", mimeo, IPLAN, Brasilia, 1988.

⁹¹ See, for example, Manoel Correia de Andrade, "Producao de Energia e Modernizacao do Vale do Sao Francisco," Revista de Economia Politica, Vol. 4, No. 1, January-March 1984, pp. 43-55.

purposes drove up the Gini coefficient of land concentration from 0.74 in 1980 to 0.86 in 1985.⁹²

6.112 It should also be observed, however, that the Itaparica Project, as designed, would decrease, rather than increase, rural land concentration in the areas occupied by the new irrigation schemes. Under the terms of the agreement with the rural unions, moreover, irrigation farmers cannot sell their lots within five years of receiving them. While informal sales may, indeed, take place during this period, perhaps leading to some concentration of land holdings within the projects, neither the Government nor the Bank has any control over this.

3. Agro-Industrial Development

6.113 In most of the Northeast, the direct benefits of irrigation tend to be limited to the immediate project areas in question and few broader economic transformations have occurred. However, this is clearly not the case around Petrolina-Juazeiro. The spread of publicly-sponsored irrigation and accompanying physical infrastructure has attracted many private enterprises to the region. By 1988, it is estimated that some 100,000 hectares had been privately irrigated in the Sao Francisco valley, compared with CODEVASF's 66,000 hectares. Once again, the Petrolina-Juazeiro area accounts for the largest share at 45% (see Annex II). This region has likewise developed an increasingly sophisticated transport, communications, processing and marketing infrastructure in order to cope with the rapid growth in agricultural production, especially fruits and vegetables, and to attract further private investment. Fiscal incentives have also been provided through the FINOR ALIMENTOS program administered by SUDENE. Between May 1988 and July 1989, for example, grants were made to 17 irrigated farming enterprises in the Sao Francisco valley, totalling over 13 million cruzados, or one-third of the total approved for the entire Northeast under this scheme. About half of the total irrigation costs of these projects were financed through FINOR ALIMENTOS.

6.114 A broad range of high-value fruits and vegetables is currently being produced, most of which were not cultivated on any significant scale, if at all, in the valley prior to the recent spread of irrigation technology. These products include grapes, melons, figs and asparagus, as well as more common crops such as rice, corn, beans, yams, pumpkins, cotton and onions. The use of expensive technology, such as central-pivot and drip-feed irrigation systems, is also becoming more widespread. According to CODEVASF estimates, the value of agricultural exports from the Petrolina-Juazeiro "development pole" was on the order of US\$ 20 million in 1988. The middle Sao Francisco valley, moreover,

⁹² Census data, however, do not capture the full magnitude of the changes arising from irrigation development. The IBGE census offers only partial geographical coverage (only 25% of Petrolina municipality in 1980, for example), while the more recent implementation of numerous large projects is not reflected in the official figures. In Petrolina, for example, the Gini coefficient of land concentration was artificially lowered between 1978 and 1984 due to the expansion of the area surveyed, the expropriation of 41,000 hectares for CODEVASF's Nilo Coelho project and a land-titling program in the region to secure future compensation for landowners (see Graziano da Silva, op. cit., pp. 68-69).

presently accounts for 46% of Brazil's installed tomato processing capacity. Major agro-industrial enterprises in the region include CICA, Etti, Frutos do Vale and grape/wine-producing farms at Casa Nova (Fazenda Ouro Verde) and Santa Maria da Boa Vista (Fazenda Catalunha). A manufacturer of irrigation equipment, Dantas Irrigacao, moreover, opened a factory in Petrolina's industrial district in 1988.

4. Urban Development

6.115 Generally speaking, urban development in the Sao Francisco valley has proceeded at a rapid pace since 1970. The proportion of the total population in the valley officially classified as "urban" varies from one-third in Bahia to two-thirds in Pernambuco. By 1980, the city of Petrolina had doubled in size to over 73,000, while its twin city of Juazeiro had reached 61,000.⁹³ This pattern appears to have been maintained and perhaps even intensified during the 1980's. Although precise figures are not available, it seems likely that the city of Petrolina may have again doubled its population, to around 150,000 today, while the increase in Juazeiro may be slightly lower. The new towns along the lakeside, built to replace the original urban settlements inundated by the Sobradinho reservoir, have also grown rapidly and were discussed above.

6.116 The pace of urbanization, however, has by no means been universally high in the areas affected by the projects under consideration in this report. The population displacements and social conflicts associated with CODEVASF's emergency polders project in the lower Sao Francisco valley, for example, have contributed to a much slower than average growth rate for the city of Penedo in southern Alagoas. This phenomenon is also related to Penedo's historical decline as a regional port and fording point for north-south highway traffic with the building of a bridge for the BR-101 highway over the Sao Francisco upstream at Propria in the 1970's. While other urban centers were growing by up to 100% between 1970 and 1980, as already noted, Penedo's population rose by just 15% and does not appear to have advanced much further since then.

6.117 Other towns have also been adversely affected as a result of the schemes in question. Belem do Sao Francisco (with a population of 9,000 in 1980), for example, located at the western extreme of Lake Itaparica, has not fared well. Once a prosperous market town catering to the needs of a thriving local farming economy based on small-scale irrigation on the river banks and mid-stream islands, its future is now a matter of concern. Regulation of the Sao Francisco has effectively flooded 70% of this rich farmland, causing economic losses and a population exodus which have seriously affected local commerce. Dikes still need to be built to protect the town itself from potentially extensive flooding. According to local opinion, however, even these actions are unlikely to revive the town's flagging fortunes in the medium to longer-term.

⁹³ The regional importance and rapid growth of Petrolina and Juazeiro led them to be included among the thirteen urban areas in different parts of Brazil covered in the Bank-supported Medium-Sized Cities Project (Loan 1720-BR, approved in June 1979). See OED Report No. 8302, dated December 29, 1989, for details.

6.118 The new town of Petrolandia, on Lake Itaparica, by contrast, has grown rapidly to reach a current estimated size of 18,000, compared with the old town's population of 10,000 in 1980, before its relocation. Resettlement has apparently resulted in demographic expansion, although a note of caution should be sounded since the municipality was already quite prosperous on the basis of the significant small-scale riverside irrigation development that has grown up since the 1960's. The town's population, in fact, doubled between 1970 and 1980. It remains to be seen, moreover, whether Petrolandia will continue to grow as rapidly after 1990, when the irrigation schemes for the rural population resettled from Itaparica are scheduled to come on stream.

5. Public Health Aspects

6.119 By and large, the improved infrastructure within the new towns, smaller communities and agrovilas at Sobradinho and Itaparica, together with increased access to project-provided health-care facilities in the lower Sao Francisco valley, should lead to an overall improvement in public health in the immediate areas covered by the operations under review. In general terms and despite the lack of detailed information, it may be concluded that the current pattern of disease is no different in intensity and distribution to that prevailing prior to construction of the reservoirs and irrigation works. Yet, some problems have occurred that were predicted at the pre-appraisal stages.⁹⁴ These have largely involved water contamination, resulting from poor sanitation and the uncontrolled use of agrototoxic substances in irrigated agriculture.

6.120 At Itaparica, more specifically, delays in building a water treatment plant following the filling of the lake are thought by some observers to have facilitated an outbreak of water-borne gastro-intestinal diseases.⁹⁵ This was believed to have been caused in the first instance by the rotting of uncleared biomass, together with a proliferation of algae and water contamination by fertilizers. Laboratory tests, in fact, revealed a number of infectious bacteria.⁹⁶ Subsequent investigation into the matter by epidemiological experts suggests that the event was probably unrelated to construction of the reservoir. Nevertheless, given that some urban and many rural communities in the areas of influence of the middle valley projects, especially around Sobradinho, still use untreated water for domestic purposes, it is possible that gastro-intestinal problems remain underreported. It should be noted, however, that CHESF's environmental plan for Itaparica includes both water-monitoring and public health programs, the latter involving agreements with state government authorities to provide improved health care facilities at the community level.

6.121 A major growing public health problem throughout the middle and lower Sao Francisco valley arises from the largely uncontrolled use of agrototoxic substances such as fertilizers, herbicides and pesticides. The rapid expansion

⁹⁴ Goodland, Sobradinho Hydroelectric Project, op. cit.

⁹⁵ Braga and Lima, op. cit.

⁹⁶ Ibid. These bacteria included *Enterobacter* sp, *Klebsiella* sp, *Escherichia coli* and *Pseudomonas aeruginosa*, among others.

of both large and small-scale private irrigation during the 1980's has resulted in the widespread use of chemicals to protect valuable crops and increase yields. Washed into the river, lakes and subsoil, these chemicals are an increasingly serious threat to public health, especially in those areas where human and animal water supplies are either untreated or ineffectually treated.⁹⁷ Furthermore, as mentioned in the previous chapter, the use of agricultural chemicals for the preservation of fish, an activity which local reports suggest may be common in the Sobradinho area, could have harmful health effects on consumers.

E. Conclusion

6.122 On the basis of current evidence, it is evident that the projects reviewed in this report have had far-reaching impacts within the middle and lower Sao Francisco valley itself and beyond. They have directly affected the lives and livelihoods of about 170,000 displaced people and accelerated the pace of existing social and economic change for a great many more. At the same time, major new activities have been introduced in the region, including capital-intensive irrigated farming and associated agribusiness enterprises, which promise to bring increasing economic prosperity to the area.

6.123 The effects of these changes upon the local population, however, have been mixed. Some groups, such as capitalized landowners and many urban dwellers, appear to have benefitted significantly. Others, such as uncompensated sharecroppers and tenant farmers, may have suffered irrecoverable losses. Many of these consequences, moreover, were not envisaged at the time or, if anticipated, were not adequately taken into account in project design and execution. Environmental repercussions, both physical and human, direct and indirect, were, thus, dealt with in what was, in many instances, a haphazard and imperfect manner.

6.124 Yet, out of these experiences have come warning signs for future projects of a similar nature in Brazil and elsewhere. These will be briefly reviewed in the next chapter. Planners and policy-makers should take the opportunity to incorporate these lessons into current knowledge and perceptions, as well as to bring them to bear on the crucial environmental aspects of both on-going and future interventions.

⁹⁷ Local informants around Sobradinho, for example, complained to the OED/SEPLAN mission that direct contact with the lakewater caused skin irritations and "itchiness."

VII. THE WORLD BANK AND THE ENVIRONMENT IN THE SAO FRANCISCO VALLEY

A. Bank and Borrower Perceptions of Environmental Issues

1. The Bank

7.01 During the 1970's and 1980's, many lessons were learned concerning what constitute appropriate procedures for dealing with the resettlement of large populations dislocated by hydropower and other development projects. At the time of the appraisal of the Sobradinho (ie. Paulo Afonso IV) and Lower Sao Francisco operations, however, the Bank had not yet formulated an explicit policy on involuntary resettlement. Although concern over such issues had been expressed by individual staff members and consultants, the lack of a policy framework contributed to many of the substantive and procedural errors committed. These experiences served as major examples of the potential pitfalls to be avoided by future programs and were instrumental in leading the Bank to focus more closely on resettlement and associated environmental issues in large infrastructure projects. It is probably no coincidence that the Bank's most recent policy statement on involuntary resettlement includes a photograph of a village being demolished in preparation for Sobradinho on its front cover.¹

7.02 In February 1980, an internal statement was issued to Bank staff delineating a specific policy with respect to forced resettlement.² Further guidelines on involuntary resettlement were drawn up in 1986, shortly before the Itaparica loan was signed, which duly acknowledged that "the Bank has sometimes not applied the policy and its related operational procedures with adequate vigor."³ Accordingly, extensive recommendations were made concerning procedures to be followed throughout the project cycle in order to ensure that resettlement measures were given adequate priority and provided for both organizationally and financially. These guidelines included the recommendation that sectoral lending operations should "take into account the need for sound resettlement

¹ See Cernea, Michael, "Involuntary Resettlement in Development Projects: Policy Guidelines in World-Bank Financed Projects," World Bank Technical Paper No. 80, Washington, D.C., 1988.

² This indicated that "the Bank recognizes the human suffering and hardship caused by involuntary resettlement, and therefore tries to avoid or minimize such resettlement...[and that where resettlement is unavoidable, there should be]...a well prepared resettlement plan...the major objective [of which] is to ensure that settlers are afforded opportunities to become established and economically self-sustaining in the shortest possible period, at living standards that at least match those before resettlement." See Social Issues Associated With Involuntary Resettlement in Bank-Financed Projects, Operations Manual Statement No. 2.33, February 1980, pg. 3.

³ Operations Issues in the Treatment of Involuntary Resettlement in Bank-Financed Projects, Operations Policy Note No. 10.08, October 8, 1986.

policies and the country's willingness and ability to handle involuntary resettlement." ⁴

7.03 These recommendations were further refined and extended to form a comprehensive and much-acclaimed set of policy-guidelines for Bank-funded involuntary resettlement projects, published in 1988. ⁵ This document specifically recognizes that projects funded by the Bank during the 1960's and 1970's, including Sobradinho, "sometimes contained relocation operations that were flawed by the lack of social planning...[and which] failed to restore, let alone improve, the social and economic well-being of the displaced population.... Resettlement operations were left out of the main project design, and implicitly out of the Bank's concern for implementation and assistance to the borrowing agency responsible." ⁶ The policy measures now in force, moreover, reflect the Bank's desire to promote a development, as opposed to welfare, oriented approach to resettlement, as well as to ensure that such issues, in conjunction with other project goals such as infrastructure expansion, are given adequate attention throughout the project cycle.

7.04 Although less dramatic than the social impact caused by the displacement of tens of thousands of people, physical environmental issues were also highlighted by the experience of Sobradinho. Problems of soil erosion, silt retention, public health and possible climatic disturbances were identified at appraisal, during supervision and on project completion. The experience in the Sao Francisco valley also contributed to internal Bank debate about the environmental aspects of dam-building, as well as to subsequent Bank policy formulation, which now requires such operations to be based on sound natural resource management. ⁷

7.05 As far as Bank activity in Brazil is concerned, the growing concern with the environmental impacts of dam construction was instrumental in the inclusion of steps to improve appraisal procedures for the first Power Sector Loan, approved in 1986, which specifically included a review of resettlement plans in connection with installation of the Itaparica hydropower plant. While the Bank was under no direct obligation to finance this resettlement program, it decided to do so in good measure because of its increasingly strong policy commitment in this area. The leading role played by the Brazil Department in

⁴ Ibid., pg. 4.

⁵ Cernea, op. cit. The Bank is still the only international development agency to have adopted an explicit policy and set of procedures for handling involuntary resettlement operations. The Bank's current guidelines, however, are used as a reference point by other multilateral, as well as bilateral, aid organizations.

⁶ Ibid., pp. 9-10.

⁷ Environmental Policies and Procedures of the World Bank, World Bank, May 1, 1984. It seems likely that this experience also contributed to the impetus for the later (ie. 1987) strengthening and restructuring of the environmental review process within the Bank more generally.

this initiative should be specifically acknowledged. The Bank's involvement in the Sao Francisco valley has, thus, clearly constituted a major learning experience for the institution. It has also helped to raise overall awareness within the Bank of the potential pitfalls and human costs of failing to deal adequately with forced resettlement, while providing an impetus for the strengthening and revision of the relevant internal policies and the adoption of appropriate measures in terms of staffing inputs.⁸

2. The Borrower

7.06 During the 1970's and early 1980's, the perceptions of the principal executing agencies with regard to both physical and human environmental issues associated with Bank-supported development projects in the middle and lower Sao Francisco valley were, at best, inadequate and, at worst, seriously deficient.⁹ Resettlement of the population displaced by Sobradinho was conceived by CHESF as essentially a relief exercise. As a power company, it had little notion of, or concern with, the region's longer-term socio-economic development requirements.¹⁰ Similarly, in the lower valley, CODEVASF's perceptions of the ecological and social dimensions of the problems faced was limited by its primary role as an irrigation, rather than a resettlement, regional development or environmental protection, agency. Despite the "emergency" nature of the polders and irrigation projects, which were designed to rectify the negative impacts of regulating river flow upstream at Sobradinho on the population in the lower valley, there was little apparent awareness within CODEVASF of the wider repercussions of the net population displacement involved, nor was consideration

⁸ For example, during 1986-87, the Bank sent staff and consultant sociologists and anthropologists on 45 project missions to assess resettlement needs and issues. See Michael Cernea, "Involuntary Resettlement and Development," Finance and Development, September 1988.

⁹ In its comments on an earlier version of this report, the Ministry of Infrastructure observes that the principal problems identified by the case study could have been better anticipated and dealt with had environmental assessments, which are now required by Brazilian law, been carried out at the time of project preparation. This is clearly demonstrated by the fact that, even though they were undertaken after preparation was well advanced, such studies in the case of Itaparica generated results which permitted a more satisfactory treatment of environmental issues than at Sobradinho.

¹⁰ In commenting on the previous version of this document, CHESF affirmed that the social and environmental impacts of its dams were not subject to more extensive study prior to their implementation because of the relatively lesser attention given to these aspects by public agencies in the power and other sectors, as well as by external lending agencies, at the time. Nonetheless, CHESF also points out that its involuntary resettlement efforts represented a "pioneering" experience in Brazil in this regard. In its comments on the draft report, in turn, CODEVASF made similar observations in relation to the comparatively recent concern of external funding agencies with environmental protection matters.

given to providing alternative livelihoods for those not employed locally in the new public irrigation schemes.

7.07 The lessons of Sobradinho and the lower valley might reasonably have been expected to engender a different, more comprehensive, view of resettlement needs at Itaparica, CHESF's next major project in the Sao Francisco basin. Initially, however, this was not the case. In spite of its relatively poor record of rural resettlement in connection with Sobradinho, CHESF had not originally intended to undertake a comprehensive relocation program of the kind now in implementation at Itaparica. Once again, CHESF appears to have thought, optimistically, that the rural population would be content to accept monetary compensation and then abandon the area.

7.08 It was largely the political pressure of the local trade union consortium (POLOSINDICAL) from 1979 onward, together with an unfavorable publicity campaign mounted by Brazilian and international NGOs against the Government and the Bank, which obliged CHESF to draw up a more extensive resettlement plan for the rural population, undertake negotiations with POLOSINDICAL and then seek Bank funding to undertake the program. Although its perceptions on resettlement and other environmental issues have undoubtedly improved, the impetus for such changes sprang, for the most part, not from CHESF itself, nor indeed the Bank in the first instance, but directly from the affected population. To this day, in fact, Brazil lacks a national policy on forced resettlement, which is still tackled on a piecemeal, project-by-project basis.

B. Project Design and Effectiveness With Regard to Environmental Issues

7.09 In all of the projects under review, there is a clear link between Bank and Borrower perceptions regarding environmental issues, the methodological and organizational provisions for dealing with these questions and subsequent project outcomes. In Sobradinho and the lower Sao Francisco polders and irrigation projects, the absence of a Bank policy on involuntary resettlement led to environmental issues being conceived in relatively narrow terms, with the needs of large segments of the affected populations and ecosystems being either ignored or underplayed. This resulted in inadequate project design, as well as negative social and ecological consequences, and also contributed to increased financial costs. In both cases, the lack of a comprehensive resettlement plan prevented a correct cost estimate at appraisal and led to inadequate budgeting procedures and insufficient financial resources during project implementation.

7.10 Sobradinho was conceived by both the Bank and the Borrower as a sectoral, hydropower expansion project above all else. Although a resettlement program was incorporated, it was marginalized in the planning process and, thus, proved to be seriously deficient in practice. While the urban plan appears to have been relatively carefully prepared and catered reasonably well to the needs of the 13,000 or so people thus relocated, the rural population of over 50,000 was dealt with in a more haphazard fashion and no broader development program was formulated, contrary to previous recommendations.¹¹ As described in the previous chapter, the INCRA colonization project upstream at Serra do Ramalho

¹¹ See Goodland, op. cit.

was a resounding failure in terms of absorbing the Sobradinho population. The arbitrary selection of a dryland area for irrigation farmers, poor soil conditions and the lack of adequate farming and social infrastructure, led to its abandonment by Sobradinho displacees and their replacement by landless cultivators from other regions.

7.11 The swollen lakeside population, whose numbers were initially grossly underestimated by CHESF, has had to struggle to make ends meet. Fertile alluvial soils have been lost, while basic support for agricultural activities, as well as educational and sanitation facilities, has been in short supply. This has resulted in plot abandonment and the acquisition of lands by capitalized outsiders. The use of heavy-handed eviction techniques by CHESF as part of the relocation package, as well as shortcomings in compensation procedures, deepened the rift between the agency and the local rural population. A major potential opportunity to promote rational fisheries development was also lost, leading to predatory practices and the possible depletion of a valuable economic resource for the area. The failure to take more seriously the risks of ecological damage from the largely uncontrolled use of agrototoxic substances for fishing and farming purposes is likely to become an increasingly significant problem over time, especially as both public and private irrigation project continue to expand in the vicinity.

7.12 In the lower valley also, fundamental misperceptions about the centrality of environmental issues was reflected both in poor initial project preparation and considerable subsequent implementation difficulties. Although conceived as an "emergency" response to the consequences of Sobradinho, the polders and irrigation schemes have fallen far short of adequately dealing with the complex social and ecological issues raised. Due to basic design shortcomings, the irrigation schemes in the lower Sao Francisco would never have been capable of directly or indirectly creating jobs for the entire displaced rural population of some 50-60,000. CODEVASF's highly selective recruitment criteria, delays of several years between the initial loss of farmland and irrigation project operation, as well as inadequate and sometimes harsh compensation and eviction methods (occasionally generating violent confrontation), all combined to create a net population loss of over 30,000 in the area. The fact that implementation of SF II took place after the Bank issued its OMS on resettlement policy in 1980 should be emphasized. However, no corrective action was taken in the light of these new guidelines, even though this might have improved project execution and ensured a more adequate relocation process.

7.13 The failure to take due account of human environmental issues at the identification and design stages has had both implications for on-going project operation and wider repercussions in the lower Sao Francisco valley. The history of local conflicts surrounding the expropriation, displacement and resettlement process has soured relations between CODEVASF and local farmers, possibly contributing to low farmer take-up of irrigated plots and membership in project cooperatives. Dependency and paternalism have also been encouraged by the agency's traditional "top-down" management style, which has not generally incorporated irrigation farmers into decision-making. Even though poor economic performance has been due in good measure to engineering and physical design factors, poor social relations have played a crucial role in exacerbating the

problems. Economic performance has also been adversely affected by the failure to adequately plan for ecological side-effects such as salinization, while the future public health implications of the increasing and possibly excessive agrototoxic use in the area could be serious.

7.14 The improved design and execution of the Itaparica resettlement program from an environmental perspective, on the other hand, is a major advance on past practices and reflects a clear evolution in thinking on the part of both the Bank and the Borrower. This is the first full-scale free standing Bank operation in Brazil that attempts to integrate major population displacement and relocation within a longer-term development program for all of those directly impacted by a hydropower project. The desires of the 40,000 people affected by Itaparica were eventually taken into account by CHESF in planning for the post-displacement and land acquisition phases and a range of alternative solutions have been offered. The population has likewise been provided with temporary maintenance support, pending operation of the irrigation schemes, and discussions are underway between CHESF, CODEVASF and representatives of the affected population (POLOSINDICAL) over the future organization of production and administration of the schemes. In terms of ecological impacts also, the Bank and CHESF have been aware of potential problems and have taken steps to introduce appropriate controls.¹⁰

C. Project Limitations in Relation to Wider Environmental Issues

1. Physical Environmental Impacts

7.15 In addition to the immediate ecological repercussions of the projects under review, there are wider implications for the Sao Francisco valley as a whole. In common with similar dams elsewhere, Sobradinho and Itaparica retain much of the river's alluvium. Without controls such as lake-dredging, over the long run this will reduce the power stations' working life as the lake silts up, thereby reducing energy production. Furthermore, by disrupting the annual flood cycle and reducing silt deposits, the fertility of downstream riverine soils is reduced. This will affect agricultural yields and is likely to necessitate larger applications of fertilizers by farmers along the river, both within and outside of public irrigation schemes.

7.16 The increased use of chemical fertilizers and other agrotoxics such as pesticides, in turn, has serious implications for water quality and increases the risk of both surface and ground water contamination. This problem is further compounded by the steadily increasing volume of untreated human and industrial effluents deposited in the lakes, the main river and/or its tributaries, arising from the rapid demographic, urban and agro-industrial growth stimulated in good measure by these projects -- and by Sobradinho in particular -- together with parallel private investments.

7.17 Another broader environmental issue concerns the growing competition over access to available water resources among different users including public

¹⁰ Report No. 6914-BR, op. cit., para. 4.03 (e). See also Chapter V above.

and private irrigation, energy production and domestic and industrial consumption. Given the region's semi-arid climate, together with the greatly expanded surface area as a result of the Sobradinho and Itaparica reservoirs, increasing evaporation threatens to further diminish the total volume of water available by up to 25% or more.¹¹ In the Northeast's largest perennial river valley, therefore, water could, paradoxically, become an increasingly scarce resource in the future due to the rapid pace of change, induced to a large extent by Sobradinho in the first instance and, more recently, by the rapid expansion of public and private irrigation schemes.

7.18 Limits on the availability of water could place serious constraints on future economic growth in both the Sao Francisco valley and, in the case of power generation, on the Northeast more generally, so that the area could ultimately become a victim of its own success. The fast-growing irrigated agricultural sector, CHESF's plans to build further dams in the middle and lower Sao Francisco, as well as the increase in domestic use as towns and cities continue to expand, will all increase future competition over water resources in the valley and necessitate additional solutions. These should begin with more systematic cross-sectoral water resource use planning and management.¹²

7.19 A further potential, if largely unknown, future environmental problem relates to local and regional climatic change which may be induced by the formation of large artificial water bodies such as Sobradinho and Itaparica lakes. Similar experiences in other parts of the world have suggested that alterations in the weather patterns are likely under such circumstances, possibly leading to increased cloud formation, cooling of the area and greater precipitation. However, this positive effect could be offset by the adverse impact of deforestation in the river catchment area or in neighboring regions, especially at the headwaters and in eastern Amazonia, for example. Clearly, further research into these phenomena are required and an inter-regional perspective should be taken.

2. Human Environmental Impacts

7.20 In addition to their physical environmental consequences, the projects reviewed in this report have had significant social impacts within the valley and beyond. Most obviously, the displacement of some 120,000 people by Sobradinho and the lower valley "emergency" schemes has had several major repercussions. By destroying the community structures of over 40,000 rural dwellers and failing to provide them with sustainable, alternative livelihoods, Sobradinho has greatly exacerbated the pace of rural-urban migration. This has

¹¹ See Chapter V above.

¹² This conclusion reinforces the findings of the Bank's recent irrigation subsector review for Brazil (Report No. 7797-BR, op. cit., para. 27) which observes: "Along the main stem of the Sao Francisco River, water management should focus on the allocation of water between hydropower and irrigation requirements. For this purpose consumptive water use limits for irrigation need to be established. Along the smaller tributaries of the river, control structures should be designed primarily to enhance irrigation potential."

contributed to the rapid growth of urban centers in the area and the associated expansion of shanty-towns and increased demand for local services. The same conclusion can be reached with respect to the lower Sao Francisco polders and irrigation schemes, which made even less provision for the "excess" of some 30,000 people which is estimated to have left the immediate area altogether. The impact of this migration on regional capitals such as Aracaju and Maceio, although unmeasured, is likely to have been significant.

7.21 Regulation of the Sao Francisco covered the fertile varzeas and effectively eliminated the traditional system of floodplain farming based on the seasonal rise and fall of the river, thereby affecting the livelihoods of agriculturalists within and beyond the immediate projects themselves both upstream and downstream of the dams. On the other hand, the rapid expansion of private irrigation which has been facilitated by the creation of Lake Sobradinho (and probably also Lake Itaparica in the future) appears to have led to increasing land concentration in the hands of capitalized outsiders, who have been able to purchase plots from struggling small producers unable to continue farming activities under these new conditions.¹³ The projects have, thus, set in motion trends beyond their control which are likely to have strong social, as well as economic, implications over the long run.

7.22 An important, but frequently neglected, dimension of project human environmental impacts concerns the nature of the relations between the executing agencies, CHESF and CODEVASF in the present instance, and the local population. In this respect, a major sour point of the operations under review has been the well-documented confrontational stance between these institutions and the impacted groups that characterized all three experiences. Due both to the authoritarian macro-political climate in Brazil during the 1970's and early 1980's and the low priority given to resettlement planning which resulted in poor project design and implementation, relations between the two executing agencies and the affected populations were strongly marred. The area around Sobradinho and the lower valley were both the scene of long and acrimonious disputes between CHESF and CODEVASF, on the one hand, and the populations threatened with summary eviction, on the other. At Itaparica also, POLOSINDICAL fought during eight years to force changes in CHESF's resettlement strategy and win adequate compensatory benefits for those affected, especially among the rural population.

7.23 Whatever has happened in the past, however, the conflict-ridden history of interaction between official agencies and local populations in the middle and lower Sao Francisco valley has implications for current development challenges in the region. These soured relations have polarized public opinion and made existing negotiations (at Itaparica, for example) more problematic, the

¹³ Since the land is no longer naturally irrigated by the river, these new circumstances require farmers to invest heavily in irrigation equipment, while the poorer soils (away from the old river margins) mean that recurrent costs for inputs have also increased substantially. Without the necessary funds, many have little choice but to sell out when an opportunity arises and to attempt to earn their livelihoods elsewhere, either in the city or as farm laborers with all the implications that this has for incomes, food security and other aspects of social welfare.

seeds of mutual distrust having been sown over the past two decades. The failure of the projects surveyed in this report to deal satisfactorily with this dimension is, thus, potentially a major limiting factor on future project success to the extent, for example, that it may undermine the effective establishment of production, operation and maintenance systems on the Itaparica irrigation subprojects. It could also jeopardize future hydropower development in the region.

D. Lessons From the Sao Francisco Valley Experiences

1. Paulo Afonso IV/Sobradinho Project

7.24 The Sobradinho experience provides all the institutions involved in its planning and implementation with valuable lessons on the potential pitfalls to be avoided in projects of this kind, as well as with respect to how to carry out more environmentally (ie. socially and ecologically) sound resettlement programs. At the same time, while, with the benefit of hindsight, it is possible to draw such conclusions, it should also be clearly borne in mind that Sobradinho must be seen within the particular economic, political and institutional context of Brazil during the 1970's.¹⁴ Furthermore, as already discussed above, more recent Bank policy guidelines on involuntary resettlement have addressed many of the issues raised in this report. Nonetheless, valuable lessons were learned from Sobradinho¹⁵ in the following areas:

¹⁴ In its comments on the draft of this report, DNPA/MEFP observes that "the relative failure of [resettlement at Sobradinho] was due to the historic neglect of marginal populations in Brazil in terms of formulating more adequate agricultural policies and providing improved economic and social support services. In this connection, water supply problems at Serra do Ramalho...were responsible for how many [Sobradinho resettles] abandoning the project? However, the Brazilian Government and INCRA in particular should be given credit for offering the alternative of Serra do Ramalho where excellent soils were available, rainfed agricultural was possible, and there was important regional infrastructure and land of high economic value. On the other hand, notorious difficulties exist in the country in terms of providing cheap resources to more than 3 million needy small farmers, which the authors of the report should highlight in so insistently criticizing the lack of credit for smallholders."

¹⁵ In commenting on the preliminary report, DNPA/MEFP observes that the analysis should have further explored two important phenomena which contain rich lessons: "the reemergence of the relocated towns around the lake as new commercial and service centers, which represents a real alternative for the reconstitution of economic activity,...[and] the migration [to the area] which is occurring due to the attraction of the agroindustrial pole at Petrolina/Juazeiro. Both of these phenomena reveal that, in the approach to the issues of dislocated populations, a broader prospective vision was lacking, [as was] consideration of alternatives other than agricultural resettlement, which could have avoided great sacrifices on the part of the communities affected by the hydroelectric investments."

(a) Loan Negotiation and Conditionalities

7.25 From the beginning of the project cycle, the Bank, in practice, paid insufficient attention to the question of resettlement. During the loan negotiation stage, for example, no satisfactory program for relocating displacees was established. Moreover, the Bank seems to have adopted an unduly flexible line with CHESF and the Brazilian Government in terms of loan conditionalities for environmental and resettlement issues. As expressed in a Decision Memorandum of January 1974, these components were to be submitted to the Bank for "review and comment" only, rather than to the Bank's "satisfaction".¹⁶ A stronger Bank response at this critical juncture might have elicited a more comprehensive and effective relocation plan from CHESF and the Brazilian Government. The Bank was overly optimistic in its apparent belief that the mere inclusion of covenants for resettlement would ensure the adequate preparation and implementation of comprehensive relocation plans. Nevertheless, the Sobradinho experience did make a direct, and ultimately positive, contribution to the formulation of current Bank policy on resettlement.¹⁵

(b) Bank Appraisal and Supervision Procedures

7.26 As far as the Bank's role is concerned, a number of critical factors led to the complex issue of resettlement at Sobradinho receiving incomplete consideration during project appraisal. The Bank assumed responsibility for supervision of the Sobradinho rural resettlement, while IDB took charge of the urban component. There was a lack of suitable staff within the LAC Energy Division, which was clearly not equipped to supervise resettlement. Support was, therefore, requested from the Agriculture Projects Division responsible for Brazil. This division, however, had not participated in the earlier preparation or appraisal of the resettlement program. Moreover, the first mission to supervise the rural component was sent only in May 1975, almost a year after the signing of the Loan Agreement. It was only at this stage that severe planning deficiencies were identified -- for example, the relative failure of the Serra do Ramalho colonization scheme and the higher than expected number of farmers who chose to remain at the lakeside -- and the full implications of the Bank's involvement in the project became apparent.

¹⁶ At a decision meeting to review resettlement and environmental mitigation preparations on January 14, 1974, it was concluded that the Bank should not accept full responsibility for the soundness of the plans, as implied in the draft document in which it was recommended that CHESF and the Brazilian Government submit proposals to the Bank's "satisfaction". Consequently, the wording was changed so that the final loan document of June 17, 1974 required only that such plans be submitted for the Bank's "comments" (Loan Agreement Section 3.08).

¹⁵ Observations by the Bank's central Agricultural Projects Division made during execution of Sobradinho during 1978 were used to formulate draft policy guidelines, which were widely discussed internally, sensitizing staff and alerting them to the problems encountered. In view of the seriousness of the issues raised, these guidelines were adopted and issued in 1980 as an OMS (op. cit.).

7.27 For a project with such massive repercussions on the region, the Bank's appraisal report pays scant attention to the potentially adverse social impacts of Sobradinho. While a consultant's recommendations regarding the need for environmental safeguards are acknowledged in the report,¹⁶ the full implications of the undertaking for the urban and rural populations are dealt with too superficially. There is a notable lack of sociological or anthropological inputs at this critical stage. This observation also applies, it should be added, to the numerous supervision missions which took place between 1975 and 1978. Due in part to miscalculations of the scale and nature of the resettlement, effort, the cost of the Sobradinho dam and relocation increased from US\$ 177 million to US\$ 371 million in constant prices.¹⁷

7.28 The Bank's limited impact on the design of the Sobradinho resettlement program is due also to its late participation in the project more generally, whose implementation had already begun when the Bank and the IDB appraised the operation in 1973. The timing of the Bank's involvement probably served to reduce any leverage that it might have otherwise have had to influence project outcomes. After 1975, supervision missions, of which there were seven by 1978, increased in frequency, together with their critical appreciation of what was happening on the ground. Many sound and valuable recommendations were made at the time by these missions regarding the need for longer-term farming and fishing activities and criticisms were made of CHESF's handling of the situation. However, since the Bank lacked leverage at this stage, the executing agencies do not appear to have taken this advice as seriously as they might have done earlier in the process.

(c) CHESF's Policy Priorities and Institutional Capacity

7.29 Effective resettlement planning in the case of Sobradinho was likewise severely hampered by the fact that, at a time of rising oil prices, CHESF was under increasing pressure to give priority to power generation over all other considerations. The macroeconomic climate, together with CHESF's internal engineering bias, meant that resettlement was erroneously perceived as a secondary issue and, thus, received a substantially lower priority than the agency's overriding energy production goals. It was thought that these complex social issues could be easily resolved through a certain, but ultimately insufficient, measure of planned intervention, coupled with a firm hand. Technically, therefore, CHESF did not properly equip itself to deal with resettlement on the scale necessary. On the operational side, the agreement between CHESF and INCRA was insufficient to assure proper institutional coordination and an adequate response to the needs of displacees, either in the short or the longer term.¹⁸

¹⁶ Goodland, op. cit.

¹⁷ OED Report No. 6578, op. cit., PCR.

¹⁸ Interestingly, as pointed out in Chapter IV above, Robert Goodland's ex-ante environmental reconnaissance study (op. cit.) had stressed the need for a comprehensive and well-coordinated resettlement strategy at Sobradinho which

(d) Compensation

7.30 Indemnification procedures for the rural population did not, in a large number of cases, adequately compensate those displaced for their loss of livelihood arising directly from the project. This involved the loss of farmlands which had been cultivated, if not legally owned de jure, for several generations by large numbers of smallholders and other peasant farmers. Loss of other productive assets built up over long periods of time, while nominally compensated at market values, was often found to be irreparable in practice. Furthermore, intangible socio-cultural assets such as community structure, cohesiveness and support networks were severely affected, without due attention given to the granting of appropriate compensation or, more importantly, the setting up alternative community support mechanisms.

(e) Comprehensive Rural Development

7.31 The harsh impact of limited compensation procedures was exacerbated by the failure to provide sufficiently for longer term development. There is considerable evidence to indicate that, on balance, much of the rural population displaced from the Sobradinho reservoir area is materially worse off than beforehand, in addition to which many suffered severe trauma and psychological stress. In some measure, this negative outcome is due to poor planning and insensitive handling of the actual population transfer. However, it is also attributable to a basic misconception, namely that the whole relocation exercise should be conceived as an emergency welfare or relief measure rather than as part of a longer-term rural development strategy.

7.32 From the outset, CHESF was essentially geared to providing short-term relief and minimizing resettlement costs and broader socio-economic involvement. The apparent indifference shown by CHESF and other government bodies to the plight of rural displacees is reflected in several ways including: (i) the failure to provide essential social and economic infrastructure in the lakeside agrovilas, still evident in 1989, over a decade later; (ii) INCRA's inability to make Serra do Ramalho an economically viable proposition for small farmers; and (iii) the failure, despite firm Bank advice, to develop a comprehensive fisheries management plan for the lake, which could have provided employment and helped avoid predatory and ecologically damaging activities.

7.33 Perhaps the most glaring omission in this connection, however, given the heavy investment in large-scale public and private irrigation which took place at the time or shortly thereafter and continues to expand in the area was the failure by the Government to systematically develop small-scale irrigated agriculture along the lake margins or elsewhere to specifically benefit rural displacees. The absence of an adequate integrated rural development program goes much of the way toward explaining the lakeside population's current vulnerability

would have incorporated a larger number of government agencies in order to deal with the complex economic and social problems likely to arise. For the most part, however, this recommendation appears to have been ignored by both CHESF and the Bank.

and its continuing dissatisfaction with CHESF.¹⁹ In contrast, the resettled urban population has fared much better and, not surprisingly, is relatively pleased with the outcome.

(f) Local Participation

7.34 Sobradinho is a classical, almost stereotypical, example of a "top-down" or "blueprint" approach to involuntary resettlement. All major decisions were taken by government agencies such as CHESF and INCRA or by outside engineering firms. Although opinion surveys about site preferences were carried out at the time of the initial planning, no institutional mechanism was introduced for systematically consulting the local population as part of the decision-making process. On the contrary, official policy appears to have been one of releasing only minimal information about what was happening and ultimately presenting the affected population with a fait accompli. Lack of information, misinformation and the use of heavy-handed tactics by CHESF and its contractors put the local population on the defensive and led to instances of physical resistance. The lack of communication, especially during the early phases of the Sobradinho undertaking, appears to have been instrumental in generating a climate of fear and mistrust both toward CHESF and, to a not inconsiderable extent, toward the Bank as well.

7.35 In the absence of active trade union or grass roots movements at a time of strong political repression in Brazil, it was left to local opinion leaders such as the Church to take up the cause of the impacted population. Only in this way and through negative media coverage and protest letters to key institutions including the Bank did news of the situation in Sobradinho acquire wider circulation. It must also be observed in this context that, judging from back-to-office reports, the numerous Bank supervision missions to Sobradinho seem to have failed to pick up the true extent of local dissatisfaction with CHESF's intervention. The Bank became more fully aware of what was happening somewhat late in the resettlement process. During an interview with the OED/SEPLAN mission in August 1989, for example, the well-informed and active Bishop of Juazeiro, Dom Jose Rodrigues de Souza, stated that, at no time after his arrival in the area in February 1975, did any Bank mission attempt to contact him for clarification or advice about events there. The use of social expertise, while no panacea, would, nevertheless, have assisted the Bank in making a fuller assessment of the evolving situation.

(g) Ecological Hazards

7.36 From an ecological perspective, Sobradinho has demonstrated that, unless properly controlled, pollution by agrototoxic substances and human effluents can present serious long-term problems in large-scale hydropower and associated irrigation development contexts. It is also important to ensure that fishing activities are carefully monitored and controlled in order to avoid the depletion

¹⁹ Once again, Goodland (op. cit., pg. 20) clearly suggested in 1973 that relocation of Sobradinho's displaced population should be integrated with wider economic and regional development plans "emphasizing irrigation and fish production."

of stocks and possible contamination through the use of agrotocics for fish preservation after the catch. Sobradinho has also shown that high water loss through evaporation and the rapid proliferation of irrigated agriculture may accentuate potential conflicting demand among competing consumers (hydropower, irrigation, domestic and industrial) over the long run. This could have adverse consequences for both the local and regional economies, possibly leading to the formation of growth bottlenecks in the Sao Francisco valley.

2. Lower Sao Francisco Polders and Irrigation Projects

7.37 In common with CHESF's operations at Sobradinho, CODEVASF's approach in the lower valley teaches salutary lessons in relation to undesirable human and physical environmental outcomes which similar future projects should take into account. Again, experience in the lower Sao Francisco valley, as at Sobradinho, should be viewed in the larger context of an authoritarian public sector in Brazil during the 1970's and early 1980's which precluded direct popular participation in the design and execution even of "emergency" projects. However, with the subsequent change to a more open and democratic political process in Brazil, the experience has important implications for comparable future interventions.

(a) CODEVASF's Policies and Implementation Procedures

7.38 SF I and II were intended as "emergency" projects, designed to help resolve the problem of permanent flooding in the lower valley caused by Sobradinho's success in regulating river flow. They were thus conceived within a spirit of protecting the substantial population of riverine farmers through a program of flood prevention and systematic small farmer irrigation development on a number of traditional varzeas which were to be transformed into polders and whose lands were to be expropriated and redistributed. This spirit is well-captured in the Bank's appraisal report for SF I which refers to these schemes as constituting an "agrarian reform to help ensure that project benefits would be shared equitably."²⁰ Reference is also made to the fact that such public irrigation operations perform essentially a "social" function rather than being commercially inspired. The Brazilian Government's official position was that such schemes were designed primarily to benefit sharecroppers and other small farmers whose traditional riverine farming activities had been adversely affected by Sobradinho.²¹

7.39 While some measure of success has been achieved in attaining these objectives, it is, nevertheless, clear that a major contradiction exists between the stated aims and the results of these projects. As has already been mentioned, far from permitting total reabsorption of the displaced population (some 50,000 people altogether), SF I and II resulted in substantial out-migration from the area. Although precise figures are not available, it is quite possible that the net population loss may have exceeded 30,000 people.

²⁰ Report No. 714a-BR, op. cit., pg. 1.

²¹ CODEVASF, CODEVASF 1985-88, op. cit., 1989, and OED Report No. 8158, op. cit.

This is attributable to many factors including: (i) the heavy-handed nature of forced displacement in the lower valley; (ii) the long delay in project execution; (iii) CODEVASF's highly selective recruitment procedures; (iv) the very design of the irrigation schemes themselves, which were incapable of accommodating labor on the land at previous levels of intensity; and, (v) non-project factors including serious flooding of the Sao Francisco River and the very rapid expansion of sugar cane production in parts of the area.

7.40 A first important lesson of the lower valley experience is, therefore, that "emergency" projects conceived in such circumstances by no means guarantee that the executing agency will either choose or be able to deal comprehensively with the resettlement dimension and, thus, adequately cater to the needs of all those affected. Second, and as a corollary to the above, CODEVASF's previous experience lay primarily in the design and execution of relatively small irrigation schemes. Accordingly, it was ill-equipped to deal with the large-scale human resettlement required in the lower Sao Francisco. It can, thus, legitimately be argued that it was unrealistic to expect CODEVASF to perform this role, just as CHESF was similarly handicapped at Sobradinho, and that alternative or complementary organizational arrangements should have been contemplated to assist the irrigation agency in its task.

(b) Bank Appraisal Procedures

7.41 Given that the lower valley polders and irrigation schemes were viewed as a solution to economic and social problems resulting from Sobradinho, it is surprising that the Bank itself does not acknowledge this large net population displacement in the lower valley. Frequent reference is made in project documents to the numbers of people who would be absorbed by the new schemes, as well as to the Bank's concern that resettlement and/or compensation provisions should be comprehensive.²² However, neither CODEVASF, nor the Bank appears to have taken full account of those who, for a variety of reasons, could not be thus employed. In late 1977 and early 1978, a Bank consultant spelled out in detail some of the then current and impending social conflicts in the area, as well as CODEVASF's lack of any coherent strategy for dealing with resettlement.²³ Shortly thereafter, a staff member of the Bank's (then) Office of Environmental and Health Affairs reported his concern about health and resettlement problems.²⁴ However, these issues are underplayed by the Bank's

²² For example, section 3.05 of the Loan Agreement, dated August 4, 1975, states that the Borrower "shall furnish plans acceptable to the Bank for resettling farmers in the Project Area who shall be adversely affected by the construction of hydroelectric installations upstream on the Sao Francisco River and who shall not benefit from the facilities under Part A of the Project."

²³ R. Moreno, "Consultant's Report for the Pre-Appraisal Mission for SF II Irrigation Project," December 29, 1977, and "Lower Sao Francisco Irrigation Project: Conflicts in the Lower Sao Francisco Valley," January 16, 1978.

²⁴ In memoranda dated March 1 and May 24, 1978, this staff member specifically expresses concern about the exclusion of a health component and comments on CODEVASF's lack of community workers to deal with social problems.

appraisal reports for SF I and II and both seem to implicitly assume that the amount of direct and (especially) indirect employment expected to be created by the projects would be sufficient to deal with the phenomenon of negative net displacement. This shortcoming is particularly serious in the case of SF II, which was appraised in 1978 at a time when the difficult social and economic conditions created by SF I had become quite evident.

7.42 Somewhat belatedly, the human environmental repercussions of SF I are acknowledged in the PPAR, which raises questions about the "impact of the project and the possibilities of exacerbating local tensions due to massive dislocation of people."²⁵ However, neither this document, nor the project completion report upon which it is based mention the actual scale of the problem, largely restricting their comments to CODEVASF's "limited understanding" of social issues and the problems with managing farmer settlement. Little or nothing is said, in short, about the fate of those who were not resettled.

7.43 Even the project completion report for SF II, having the advantage of an additional decade of accumulated experience, as well as more up-to-date information on project impacts, fails to document this major problem. Although the PCR certainly acknowledges some degree of social attrition and the confrontation between CODEVASF and the local population, on the basis of current evidence, it is unjustified in asserting that "CODEVASF handled with success the difficult social situation which prevailed in the project area during the implementation of the project" and that tensions "disappeared once the irrigation works were completed and irrigation farmers were settled."²⁶ The PCR's attention is concentrated on the internal organization and economic performance of the polder irrigation projects, while the issue of net population displacement and its repercussions both within the immediate area and farther afield is not mentioned. As stated above, SF II was implemented after the issuing of the Bank's 1980 OMS on involuntary resettlement and some corrective action could have been taken even at this relatively late stage.

7.44 As far as the Bank's role at the appraisal stage is concerned, therefore, two major lessons emerge from the lower Sao Francisco experience. First, the Bank was ill-equipped to be able to satisfactorily appraise the full physical and, particularly, human environmental repercussions of the polders and irrigation schemes. This was compounded by the absence of Bank policy guidelines to direct actions at the field level.²⁷ Social issues were not treated with the detailed attention demanded by the complexity and potential gravity of the situation and this has had negative consequences whose repercussions are still

²⁵ OED Report No. 5569, PPAR, op. cit., pg. v.

²⁶ OED Report No. 8158, op. cit., pp. 11, 13.

²⁷ Since June 1990, moreover, the Bank has had a policy (OD 4.30, para. 16) requiring compensation for landless families involuntarily displaced by the projects receiving its support, a provision that was not present in the original Bank resettlement guidelines adopted in 1980.

evident in the region. Second, the Bank's implicit or explicit acceptance of CODEVASF's assurances that the new irrigation projects would fully absorb the displaced population was unwarranted. Proper investigation of these dimensions would have revealed this flaw and allowed more adequate compensatory measures to be designed.

(c) Implementation and Supervision of Irrigation Projects

7.45 It seems apparent that insufficient attention was paid by CODEVASF and the Bank to complex issues of farmer settlement in the irrigation schemes. Although modifications to established procedures were suggested by Bank staff, progress in their implementation was frequently slow. This also raises serious doubts about the long-run technical and economic feasibility of these schemes, especially if CODEVASF relinquishes direct support and obliges them to become totally independent enterprises. The indiscriminate and sometimes violent way in which CODEVASF handled the land acquisition phase of SF I and II has been well documented. The climate of fear and apprehension thus induced among the poor majority of displacees in the lower valley, moreover, does not augur well for future relations between CODEVASF and the local population, which continue to be characterized by a large element of mutual distrust.

7.46 The "blueprint" approach²⁸ adopted by CODEVASF is also reflected in the subsequent implementation of the polder irrigation projects. Research has shown that the public irrigation model in Northeast Brazil has traditionally been marked by a high degree of authoritarianism and paternalism.²⁹ This fact, together with the poor economic performance of the schemes thus far, has led to some farmer turnover and the beginnings of land concentration in some project areas, as less successful farmers are squeezed out. Another indication of colonists' reticence to subject themselves to the CODEVASF regime lies in the fact that a large proportion of producers have chosen not to join the respective official cooperatives, a decision presumably based on a perception of where their best interests lie.

7.47 Unlike the situation at Sobradinho, where the Bank's potential leverage was constrained by its late entry into the Paulo Afonso IV Project, in the lower valley a clear opportunity existed for the Bank to insist that benefits be more equitably distributed to the displaced population and, thus, to minimize social and economic upheaval. However, this opportunity appears to have been largely foregone. While careful Bank monitoring did positively influence irrigation farmer recruitment criteria and other technical aspects of the projects, the basic social issues were not confronted. Part of the explanation may be found in the low priority given to social planning during appraisal and supervision and the relative absence of social and environmental analysis. However, its persistence during execution and even after project completion suggests that these gaps are symptomatic of more complex causal factors. These are closely bound up with a possible lack of institutional commitment on the

²⁸ Dennis Rondinelli, Development Projects as Policy Experiments, Methuen, 1983.

²⁹ Anthony Hall, Drought and Irrigation in North-East Brazil, op cit.

Bank's part to addressing the resettlement issue in as full and comprehensive a way as possible at the time when project appraisal and loan approval took place.

7.48 With regard to project implementation and supervision, therefore, the principal lesson to be grasped is that the Bank must not only be adequately equipped in manpower terms to tackle difficult and sensitive social and environmental issues but that, in addition, it must be institutionally committed to exerting leverage at critical junctures to ensure that potentially negative impacts on vulnerable populations, such as those residing in the lower Sao Francisco valley, are averted or minimized. In this particular case, for example, a strategic Bank intervention during the implementation stage might have led to introduction of a fairer and more comprehensive compensation strategy for sharecroppers and untitled smallholders. Provision could also have been made for resettling the large surplus rural population that could not be accommodated in the new irrigation schemes in the lower valley in similar projects elsewhere, as is currently being done in the case of Itaparica, even if this meant involving other government agencies and additional Bank funding for a more all-embracing resettlement strategy.

(d) Local Participation

7.49 The now self-confessed occasionally insensitive nature of CODEVASF's actions in the lower Sao Francisco during the late 1970's and early 1980's were largely responsible for the ensuing social tensions in the region. A more constructive approach would have been for the agency to have established mechanisms for creating an effective dialogue with the local communities over the timing, scale and nature of CODEVASF's plans. Somewhat paralleling the experience at Sobradinho, it was, to a large extent, pressure from the local Church which succeeded in drawing public attention to the social repercussions of SF I and II and obliged CODEVASF to incorporate short-term relief measures. The polders and lower Sao Francisco irrigation projects, both in the earlier execution and later production stages, thus, illustrate the potentially negative repercussions of failing to consult impacted groups and project beneficiaries. An important lesson, therefore, is that all such schemes should include institutionalized mechanisms for conferring with the local population as a means of helping to avoid such problems in the future.

(e) Ecological Issues

7.50 The economic performance of the lower Sao Francisco irrigation schemes reaffirms the problem of declining soil fertility due to the retention of alluvium by Lake Sobradinho. This has led to a substantial increase in the application of fertilizers in order to maintain declining yields and production levels. It has also been demonstrated that monocrop rice cultivation has increased vulnerability to pests and plant diseases, requiring applications of agrotoxics, which has led to growing risks of water contamination and a potential public health hazard. A further lesson is that poor organization and management of basic project infrastructure may lead to problems of poor drainage and the exacerbation of already serious salinization caused by physical factors associated with the geology of the region and high evaporation rates.

3. Itaparica Resettlement and Irrigation Project

7.51 With important lessons having been learned as a result of experiences at Sobradinho and, to some extent, in the lower Sao Francisco valley, Itaparica represents a pioneering advance. Notably, it is the first such scheme in Brazil to plan both for the physical relocation and the socio-economic reestablishment of the entire displaced population, providing a range of options for those directly affected and emphasizing the longer-term economic security of rural relocatees within a program of irrigated agriculture.³⁰ Notwithstanding this major progress, however, both CHESF and the Bank can derive useful lessons from this on-going program, as follows:

(a) CHESF and Resettlement Planning

7.52 Although a resettlement plan was designed and implemented for those displaced by the Itaparica dam and reservoir, its relative success so far and, indeed, its very existence are due largely to sustained pressure upon CHESF by POLOSINDICAL and the local population more generally. Despite the traumatic and widely publicized events at Sobradinho in the mid and late-1970's, in the early 1980's, CHESF did not appear to have profited from this experience. In other words, CHESF did not, of its own volition, plan for comprehensive relocation at Itaparica, but did so only under duress. Had there been no such pressure applied, it is likely that Itaparica would have witnessed a repetition of events at Sobradinho.

7.53 Given CHESF's initial lack of preparation for handling large-scale resettlement, the project's achievements thus far are a tribute to those within the agency who have dedicated themselves to resolving resettlement problems. Nevertheless, CHESF is still characterized by a strong engineering bias which

³⁰ In its observations on the preliminary draft of this document, DNPA/MEFP argues that, in view of the very high costs of resettlement at Itaparica, "the report does not warn of the impropriety of continuing to blindly invest resources in such projects, nor of the economic and social consequences of the 'assistencialist' scheme in effect, which was conceived for the short term, but is likely to perpetuate itself, whether in the form of direct subsidies (which are perverse as presently practiced) or heavy subsidies to production. What is missing in the report are proposals to radically reformulate the concept implemented at Itaparica. It is important that project resources be immediately reoriented to make viable a broader intervention to reactivate the microregional economy (not exclusively agriculture) and provide training to permit reintegration of the affected population into the labor market. With respect to irrigation, investments should be reprogrammed so as to rapidly conclude several smaller-scale projects and immediately implement agricultural activities....[P]art of the investments should be redirected to make other employment alternatives viable." Elsewhere DNPA notes that "the report commits a grave sin in not analyzing the economic-financial perspectives of Itaparica resettlement, [thereby] further contributing to the maintenance of an extremely undesirable status quo with predictable consequences: the waste of scarce resources poorly applied in one of the poorest regions of the world and the exodus and marginalization of the least favored populations of the region."

tends to result in the marginalization of resettlement planning. The fact that mass popular pressure was needed to ensure that a comprehensive relocation strategy was elaborated suggests that there may still be a need for institutional restructuring within CHESF to increase the relative priority given to resettlement in the process of hydropower development in Northeast Brazil.

(b) Local Participation

7.54 The central role played by POLOSINDICAL throughout the Itaparica experience suggests that social issues may only be adequately and fully addressed in project situations where a strong process of local community participation exists. Accordingly, from the course of events at Itaparica, it appears that a degree of "bottom-up" pressure, guaranteeing an active dialogue between executing agencies and representative organizations, may be a necessary prerequisite for successful planning.³¹ CHESF's secretive stance in the early 1980's and its general reluctance to consult the local population resulted in unnecessary delays and cost overruns, while creating a climate of mutual antagonism. The actions of POLOSINDICAL, in turn, have become so influential that they not only have helped to determine the outcome at Itaparica, but are likely to exert a strong influence on all future hydropower development in the Sao Francisco valley.

7.55 In the case of hydroelectric schemes, community participation is important not just during the expropriation and population transfer phases, but also for the process of establishing viable new communities and productive activities suited to people's needs. Although the trade union consortium did manage to acquire a say in some major decisions, it did not take part in basic project design. The poor performance of fish-farms at Itaparica and doubts about the technical and economic feasibility of the new irrigation schemes suggest, however, that, in such cases, more effective local participation could facilitate project sustainability. By avoiding unnecessary mistakes in project design and execution, a process which could be assisted through prior consultation with affected populations, experience shows that implementation costs could also be reduced. Many of the current social problems in the agrovilas for instance, might also have been avoided had such cooperation been actively sought by CHESF from the outset.

³¹ In its observations on the preliminary draft of this report, CHESF acknowledges that "organized social pressures (which were almost non-existent at Sobradinho and very expressive at Itaparica) created a favorable climate to improve planned actions to carry out resettlement." CHESF also points out that, due to their complexity, resettlement activities require differentiated treatment from conventional public sector irrigation and colonization projects so as to permit relocated populations to adjust to their new circumstances. This process is necessarily a slow one and is likely to be most effective when there is systematic negotiation between the affected communities and the agencies involved in relation to the conditions under which resettlement will take place and the targets to be achieved. This also implies the need to avoid "emergency" situations where both the social and financial costs of relocation are likely to be high.

(c) Bank Appraisal of Sectoral Loans

7.56 The Bank too can learn critical lessons from Itaparica. While justifiably held up as a major advance on past experiences, especially in Brazil, legitimate criticisms can be advanced of the Bank's role. Although the Bank took rapid steps to provide necessary technical assistance and funding once the potential impacts of Itaparica became apparent and its support was requested by CHESF, this corrective action, nevertheless, came rather late. The human environmental implications of Itaparica were officially revealed only in 1985 when the Bank began preparing a power sector loan. However, the tumultuous situation in the Sao Francisco valley at Petrolandia had been known to Bank staff well before 1985, through the media, through personal contacts in the area and via NGO representations. The Bank was asked by CHESF to provide emergency financial assistance in mid-1986 when the dam was already 80% built and a tight deadline had already been established for its completion in view of pressing regional energy requirements.

7.57 Due to its late entry, the Bank was once again handicapped in its ability to influence basic project design. Although the Bank was able to exercise some choice over site selection for the irrigation subprojects and on details such as the requirement that domestic water supplies be installed, it had no voice in the choice of the irrigation model. This continues to be a source of preoccupation in terms of the scheme's longer-run technical and economic feasibility. While the Bank was undoubtedly correct, in view of the wider social repercussions, to go ahead with its funding despite these reservations, this has, nonetheless, placed severe constraints on the Bank's ability to modify the pattern of intervention. The knowledge held informally by Bank staff members concerning the confrontational situation between CHESF and the local population at Itaparica should have been acted upon during the very earliest discussions about the Bank's possible participation in the 1986 power sector loan, ie. well before 1985. This would have put the Bank in a far stronger position to influence the outcome at Itaparica.

(d) Ecological Aspects

7.58 The experience thus far at Itaparica shows that, in spite of persistent problems already outlined, with proper planning it is possible to take preventive measures to ameliorate potentially adverse ecological impacts. Operation Saci to rescue terrestrial fauna, as well as the various other environmental protection programs elaborated by CHESF embracing physical, biological and cultural dimensions, are testimony to this fact. However, it is also clear that continued monitoring of these aspects is necessary, especially in view of the planned expansion of irrigated agriculture around the lake which is likely to involve the intensive use of chemical fertilizers, pesticides and herbicides that, judging from evidence at Sobradinho and elsewhere, could have serious repercussions both on local ecosystems and the human population.

E. Implications for Future Bank Projects

1. In the Sao Francisco Valley

(a) Sensitivity to Environmental Issues

7.59 Future Bank projects in the Sao Francisco valley must incorporate a greater sensitivity to human and physical environmental factors.³² This is of crucial importance from several standpoints. First, the Bank must be seen to match its officially stated concern for social and ecological priorities with concrete measures to effectively tackle these dimensions. This is essential for reasons of both project efficiency and social justice. Furthermore, the establishment and enforcement of such priorities would help to maintain the Bank's credibility as an environmentally conscious institution. Second, the incomplete procedures adopted by the Bank at Sobradinho and in the lower Sao Francisco emergency projects have resulted in heavy social costs. These are not only unacceptable on the grounds of social equity, but are also detrimental in financial terms due to the delays and cost overruns which subsequently resulted. These issues have been addressed more adequately at Itaparica than in earlier operations, but such concerns should be continually present in the on-going Bank-supported development of the Sao Francisco valley.

(b) Local Participation

7.60 The emergence of a strong local community movement at Itaparica through the trade union consortium signifies a new phase in the preparation and implementation of hydropower and public irrigation projects in the Sao Francisco valley. It has, in effect, set a major precedent for future interventions involving large-scale population displacements in the region. The perceptions and resettlement strategies of executing agencies such as CHESF and CODEVASF must now fully incorporate the concept of local participation in the design and execution (indeed, in the whole cycle) of comprehensive development projects and programs.³³ The Bank, with its strong policy initiatives in this field, will also be in a stronger position to assist such agencies in preparing suitably designed interventions and providing appropriate funding.

³² In its observations on the previous version of this report, CODEVASF highlighted the need for future economic infrastructure projects in the region to include adequate environmental protection measures and for the corresponding costs to be defined, analyzed and financed as an integral part of these investments.

³³ In its observations on the previous version of this report, DNPA/MEFP reaches a similar conclusion: "resettlement actions, which should always be minimized, should be the object of broad participation on the part of the communities involved, while the 'simplism' of bureaucratic solutions, which generally result in excessive social costs, should be fought against."

(c) Water Resource Planning and Management

7.61 At present, the Sao Francisco River is able to cope with the multiple demands made upon it for energy generation, irrigated agriculture and urban domestic and industrial use. However, growing competition among these users, coupled with further losses through evaporation as additional reservoirs are created, are likely to make river water an increasingly scarce resource in the future, a problem which is exacerbated in the short term by abnormally low rainfall (as between 1985-89). Hence, there is an urgent need for a permanent process of cross-sectoral water resource use planning and management for the Sao Francisco valley. This will require direct interministerial intervention at the federal government level and could, perhaps, take the form of a renewed and strengthened PLANVASF. This would, it is hoped, permit a greater degree of control to be exercised with respect to future growth in regional demand for water, allowing the balanced development of urban and rural activities within the resource capacity of the valley.

2. For Large Hydropower Projects in General

(a) Power Sector Loans

7.62 Many of the problems discussed in this report were due at least in part to the Bank's late participation in designing appropriate interventions to address environmental problems, such as the need for comprehensive resettlement arising from hydropower development. Although a broader sectoral approach increases Bank leverage at the sectoral level, there is also a risk that individual projects carried out by sectoral agencies may not be scrutinized with the same rigor as those financed by specific investment operations. Thus, the Bank should endeavor to assess as early as possible individual hydropower projects whose planning and/or implementation may be financed through power sector loans. This would help ensure that physical and human environmental issues are analyzed in a timely fashion at the earliest stage in the project cycle and that appropriate corrective measures can be designed in consultation with the executing agency and affected populations in question.³⁴ Otherwise, the Bank risks being called in on a purely emergency basis which imposes severe constraints on its ability to influence basic project design, as has been seen at Sobradinho, in the lower valley and even at Itaparica, and has implications for the social, economic and environmental sustainability of sectoral investments.

7.63 More generally, environmental planning and impact assessment mechanisms and procedures should be put into place at the sectoral level. This process, in fact, was successfully initiated in Brazil in connection with the Bank's power sector loan (No. 2720-BR) through the establishment of Environmental Departments at ELETROBRAS and in each of its regional subsidiaries, including CHESF, in the mid-1980's. A manual for identifying and dealing with the

³⁴ This point is developed in G. Edward Schuh, Guy le Moigne, Michael Gernea and Robert Goodland, "Social and Environmental Impacts of Dams: the World Bank Experience," Commission Internationale des Grandes Barrages, San Francisco, 1988.

potential environmental and social consequences of hydroelectric projects was subsequently prepared by ELETROBRAS and a series of specific studies to assess the physical and human environmental impacts of past and on-going developments, including the Sobradinho and Itaparica hydropower projects, have been, or are currently in the process of being, carried out by consultants.³⁵ Under existing federal legislation, moreover, all major new hydroelectric (including both generation and transmission) projects must present environmental impact assessments (RIMAs) to the appropriate state and/or federal environmental authorities in order to obtain the licenses required for construction and subsequent operation.³⁶ The Bank should encourage or support similar arrangements and activities, where necessary, in all other countries where it undertakes program lending for the power sector.

(b) Rural Development

7.64 Planning for longer-term rural development deemed necessary as the direct result of population displacements caused by hydropower projects should be undertaken simultaneously with that for dam construction and associated infrastructure works. This is the only way to avoid major delays in the implementation of rural development interventions (such as the Itaparica irrigation subprojects), together with economic hardships that will inevitably follow. Wherever possible, moreover, adequate development (including irrigation) programs for displaced rural populations should be implemented in as close proximity as possible to their previous (ie. pre-resettlement) locations in order to avoid the problems experienced at Sobradinho when nearby lands in the possession of another public agency (CODEVASF) were not made available for this purpose. This may require firm interinstitutional coordination across sectors that is frequently difficult to achieve in the context of what are essentially single sector investment operations.

(c) Ecological Hazards

7.65 It is clear from the experience at Sobradinho, as well as early evidence from Itaparica and that in other countries more generally, that the

³⁵ ELETROBRAS, Manual for Studies of Environmental Effects of Electric Systems, Rio de Janeiro, June 1986. The Sobradinho/Itaparica study, whose specific focus concerns the regional "insertion" of these projects, is being undertaken by the Economic Research Institute Foundation (FIPE) of the University of Sao Paulo. The results of this study, however, were not available for consideration in the present report.

³⁶ The pertinent legislation is federal Law No. 6938 of August 31, 1981, which defined a national environmental policy, established a national environmental system for Brazil (SISNAMA) and created a national environmental council (CONAMA), and Decree No. 88,351 of June 1, 1983, which authorized CONAMA to determine the conditions under which potentially environmentally degrading activities would be required to undertake environmental impact assessments (RIMAs) prior to licensing. These conditions, together with the basic characteristics and coverage of the corresponding RIMAs, were subsequently specified by CONAMA Resolution No. 1 of January 23, 1986.

building of artificial reservoirs carries with it major potential environmental risks in terms of changes in water quality and downstream soil fertility, as well as adverse impacts on aquatic and terrestrial flora and fauna, not to mention still poorly understood effects on local and even regional climate. In Brazil, as elsewhere, these consequences are likely to multiply and intensify over time as the development of the country's hydropower potential expands. The Bank, accordingly, should be fully cognizant of these aspects and consider ways in which they can be ameliorated.

3. For Irrigation Projects in General ³⁷

(a) Population Displacement and Absorption

7.66 Public irrigation projects in Northeast Brazil have tended to have a net displacement impact, as occurred in the lower Sao Francisco irrigation schemes. Wherever the Bank is involved in funding such projects or programs, steps should be taken to minimize the level of forced removal and to provide alternative long-term stable employment opportunities on the land for those who are displaced.

(b) Irrigation Technology

7.67 Given the frequently high cost capital-intensive nature of irrigation technology adopted on public schemes in the Northeast and the inherent problems of guaranteeing a favorable economic rate of return, greater emphasis should be placed on developing less expensive, simpler methods having lower investment, operation and maintenance costs. ³⁸ This would also facilitate the removal of official subsidies and the organizational independence of projects which would become farmer-managed.

(c) Project "Emancipation"

7.68 The traditional lack of farmer participation in the management of public irrigation schemes in Northeast Brazil is currently being addressed by recently introduced policies of project "emancipation." This policy, however, has been decreed by CODEVASF (and DNOCS) without prior consultation with the irrigation farmers themselves. Hence, caution should be exercised by the Bank in uncritically endorsing such an innovation since feasibility studies have not

³⁷ For additional lessons and recommendations related to the Bank's experience with irrigation projects, including their environmental dimensions, see recent OED Reports No. 7876, dated June 15, 1989, and No. 8494, dated March 22, 1990, which examine the socio-economic, institutional and technical impacts of specific irrigation operations in Mexico (Rio Sinaloa and Panuco), Morocco (Doukkala I and II), the Phillipines (Upper Pampanga and Aurora-Penarnada) and Thailand (Northeast I and II).

³⁸ In its comments on the draft of this report, CHESF emphasized the persisting need to clarify the appropriate irrigation technology and social and land tenure organization which should be adopted in future resettlement projects in the region.

yet been made to test the potential for administrative autonomy or economic self-determination of existing and planned future projects. This problem is all the more serious in view of the above mentioned high cost nature of the irrigation model itself, together with the traditionally low income generating capacity of public irrigated farming in the region.³⁹ Given the often significant differences among specific irrigation projects and their beneficiary populations, moreover, the viability of this scheme should, at least initially, be determined on a case by case basis.

(d) Agrotoxic Pollution

7.69 The expansion of public and, especially, private irrigated agriculture in the Northeast has greatly increased the long run risk of water contamination by chemical pollutants such as fertilizers, pesticides and herbicides. In some of the areas surveyed by the OED/SEPLAN mission, this is already having serious repercussions on fishing and, through the food chain, as well as by direct contact, on the human and animal populations. The Bank should, therefore, address this problem in future irrigation projects it is requested to finance in Brazil or elsewhere. More concretely, it should ensure that executing agencies are adequately prepared to orient their clients with respect to the proper use of agro-chemicals and that national and/or subnational environmental protection agencies are adequately equipped to monitor and control the affected waterways, as well as to enforce whatever sanctions may be required.

4. For Involuntary Resettlement Programs

(a) Implementing Agency Commitment to Resettlement

7.70 Borrower commitment to appropriate resettlement objectives and procedures at the policy level should be reflected in preparation by the executing agency of a comprehensive resettlement plan prior to loan negotiations, while adequate conditionalities must be introduced to guarantee implementation of any such plan to the Bank's full satisfaction. Such measures, moreover, must provide assistance both for the immediate post-displacement period and for longer-term sustainable development of the affected communities. Although the Bank has little, if any, control over the broader processes of regional development which are also bound to influence the settler reestablishment process, it can, nevertheless, insist that proper measures be taken to support and strengthen productive activities, as well as to limit adverse environmental impacts, in the areas under the project's direct control.

³⁹ With respect to the question of "emancipation," DNPA/MEFP, in commenting on the draft report, observes that it should have given more attention to the "administrative and economic-financial management" of the lower Sao Francisco projects. It further notes that "similar to other irrigation projects whose infrastructure was implanted by the Government, those implemented by CODEVASF in the lower Sao Francisco will, for many years, depend on public resources for their operation and maintenance in virtue of the limited productive perspectives (objectively, too little land and rice monoculture) of those resettled on them."

(b) Timing of Population Transfers

7.71 During project implementation, dam construction and resettlement should be carefully synchronized so that population relocation is complete well before flooding commences. In addition, more thought needs to be given to appropriate forms of compensation, while suitable procedures should be established to avoid undue delays in payment.

(c) Institutional Capacity of Executing Agencies

7.72 Accordingly, before entering into loan agreements, the Bank should ensure that implementing agencies such as CHESF and CODEVASF are adequately structured and staffed to execute major resettlement programs, as well as to identify and undertake needed environmental protection measures. In the absence of such institutional preconditions, the Bank should be prepared to delay, or even deny, funding in cases where the livelihoods of large populations are threatened or where there is a risk of major environmental damage. Greater emphasis should be placed on institution building at the level of the executing agency, introducing appropriate in-house expertise and assisting with organizational restructuring, if necessary,⁴⁰ to permit, for example, greater cooperation between engineering and resettlement divisions.⁴¹

5. For River Basin Development in General(a) A Regional Development Perspective

7.73 Major river basin interventions such as Sobradinho and Itaparica should be seen within the wider regional development context rather than simply as individual single sector investment projects.⁴² The wide-ranging human

⁴⁰ CHESF is currently undergoing a process of internal restructuring which, it is hoped, will enable it to better address resettlement problems.

⁴¹ In commenting on an earlier draft of this report, furthermore, CHESF affirmed that carrying out large-scale resettlement through a free-standing Bank-financed operation as at Itaparica was "very opportune" in view of the generally limited experience and technical capabilities of power companies in this regard and the complexities of the rural settlement (Sobradinho) and/or irrigation (Itaparica) activities involved.

⁴² In Latin America, the Organization of American States (OAS), through its Department of Regional Development, has traditionally supported an integrated approach to river basin development. In Brazil, specifically, both the Sao Francisco (PLANVASF) and the Araguaia-Tocantins (PRODIAT) systems, the latter in eastern Amazonia, among other river basins, have recently benefitted from such assistance. For additional information on the OAS approach and experience, see the following OAS publications: Environmental Quality and River Basin Development: A Model for Integrated Analysis and Planning, Washington, 1978; Integrated Regional Development Planning: Guidelines and Case Studies from OAS Experience, Washington, January 1984; and Minimum Conflict: Guidelines for Planning the Use of American Humid Tropic Environments, Washington, 1987. On

environmental repercussions of the Bank-funded projects under review both within the Sao Francisco valley and farther afield suggest that a broader perspective is necessary so that schemes may be designed to ameliorate potentially harmful impacts.⁴³ For example, the minimization of population displacements and the provision of sustainable and comprehensive alternative livelihoods in farming or fishing activities for those affected can reduce rural-urban migration caused by project intervention into a local economy and society. Similarly, measures to control water contamination from fertilizers used by commercial agriculture which expands as a direct result of such Bank-financed public investments could help to reduce wider ecological problems.

(b) Local Participation

7.74 The involvement of local populations in the preparation and execution of hydropower and irrigation development projects can greatly facilitate the adoption of environmentally sound strategies from both an ecological and a social perspective. Clearly, the efficacy of such participation will depend on several factors including the precise nature of such consultations and at what stage of the project cycle they are introduced or develop. However, events at Itaparica and in other river basins show that, while no panacea, local involvement is one essential prerequisite that can assist planners and policy-makers to devise and implement both resettlement and broader development strategies which are more likely to be economically, socially and ecologically sustainable. A more open and flexible attitude may sometimes be required in such negotiations and a dialogue should be initiated early on with a range of representative bodies such as trade unions, community associations, church groups and other non-governmental organizations, both domestic and international.⁴⁴

F. Implications For Bank Procedures

1. Country Policy Dialogue

(a) Resettlement as a Policy Priority.

7.75 The Bank must ensure that, whenever loans are negotiated for hydropower and irrigation development involving population displacements, either

the Asian experience, in turn, see Sun, Peter, "Land and Water Management in Asia," EDI Policy Seminar Report No. 20, World Bank, Washington, October 1989.

⁴³ In its comments on the preliminary draft of this report, the Ministry of Infrastructure stressed the "enormous structuring power" of these two large hydropower investments, both in terms of the territorial organization of their areas of influence and, more importantly, with respect to their impact on regional patterns of human settlement and productive occupation in the middle and lower Sao Francisco valley.

⁴⁴ See, for example, Michael Cernea, Non-Government Organizations and Local Development, The World Bank, Washington, 1988 and Robert Goodland, "Environment and Development: Progress of the World Bank," mimeo, Washington D.C., February 1989.

at the project, program or sectoral level, that adequate resettlement provisions be accorded a high priority. The Bank should also encourage Borrower countries to formulate their own explicit resettlement policies. It should be a matter of national policy, for example, that there is no net displacement effect associated with large infrastructure and/or productive sector investments or at least that all those relocated are fully and adequately compensated so that they are able to resume their economic activities elsewhere with minimal trauma and disruption. Furthermore, the Bank should consider assisting Borrowers to formulate national involuntary resettlement policies in order to help avoid the current ad hoc, largely piecemeal approach adopted by many countries.

(b) Timing of Resettlement

7.76 Ideally, the resettlement component should be designed and prepared by the Borrower parallel to or even before engineering works get underway. It is an unsatisfactory state of affairs when, even with the benefit of previous project experiences (eg. Sobradinho), the provision of adequate resettlement and compensation provisions is heavily dependent upon the existence of a strong local popular protest movement (as at Itaparica). Such priorities need to be fully internalized in both central governments and the relevant sectoral executing agencies, as well as within the Bank itself.

2. Project Identification, Preparation and Appraisal

(a) Early Bank Involvement

7.77 The experience of Sobradinho in particular suggests that, wherever possible, the Bank should be involved in the earliest stages of project identification and preparation, so that it may exert timely pressure, where necessary, to ensure that environmental protection and resettlement provisions are properly defined and costed from the outset as integral components of the larger project which has given origin to the need for them, rather than being appended as an afterthought.

(b) Social and Environmental Expertise

7.78 It is essential, moreover, that appropriate social and environmental impact assessments are carried out during the initial stages by qualified personnel, whether Bank staff or consultants. Such key issues may, thus, be openly debated and provided for in the actual project design. In both the Sobradinho and the lower Sao Francisco valley experiences, these aspects were not sufficiently explored ex-ante, with unnecessarily negative consequences, particularly in terms of human impacts. The inclusion of such professional expertise, however, is a necessary, but not sufficient precondition for the proper appreciation and diagnosis of environmental (ie. both ecological and social) dimensions. It is likewise necessary to institute mechanisms which will ensure a more systematic and institutionalized integration of social science and environmental knowledge into Bank procedures.

(c) Local Participation

7.79 The experience of Itaparica and the history of POLOSINDICAL strongly suggest that the interests and livelihoods of displaced populations may be significantly enhanced if they are actively involved in dialogue with executing and funding agencies at the earliest stages of the project cycle. Thus, conscious efforts should be made to contact local representative organizations and to consult with them about both short-term emergency relief provisions and compensatory procedures and the design of longer-term resettlement/economic reestablishment programs. Local participation is particularly important as a way of alerting funding and executing agencies to potentially negative impacts.

3. Project Implementation and Supervision

(a) Environmental and Social Inputs

7.80 Once a project is underway, from a human and physical environmental standpoint it is important that Bank supervision likewise include qualified personnel to monitor progress and advise on corrective measures where necessary. It is unrealistic to expect that even the best-intentioned economists, hydrologists and power or irrigation engineers are likely to be technically equipped to adequately cover the social and ecological dimensions of project execution.⁴⁵

(b) Local Participation

7.81 It is now increasingly recognized by development practitioners that active involvement of beneficiaries in decision-making during project implementation not only helps schemes run more efficiently and cost-effectively, but also encourages social stability and environmental sustainability.⁴⁶ Through such bodies as trade unions, community associations, church and other NGOs, not only can local needs be expressed more readily, and valuable information provided for project design, but executing agencies can be lobbied more effectively.⁴⁷ Itaparica has become a classic example of this process in action.

⁴⁵ The comments made in para. 7.78 also apply here.

⁴⁶ See, for example, B. Bagadion and F. Kortzen, "Developing Irrigators' Organizations: A Learning Process Approach," in Michael Cernea (ed.), Putting People First: Sociological Variables in Rural Development, Oxford University Press, 1985.

⁴⁷ M.Cernea, Non-Governmental Organizations and Local Development, op cit.

G. Recommendations for Future Research and Impact Evaluation

1. In the Sao Francisco Valley

(a) Human Environmental Issues

7.82 A number of study areas are suggested by the experience of the Bank-assisted projects reviewed above which would help in the future design and implementation of more appropriate and sustainable resettlement strategies:

(i) Post-resettlement experience at Sobradinho shows the need to investigate small-scale private irrigation systems for flood-plain farmers in less fertile areas displaced from their traditional riverine lands. This should help to determine which particular measures and support packages are necessary to assist displacees in the recomposition of their farming livelihoods. Moreover, this would have wider application and, even in the context of a more comprehensive approach such as Itaparica, enable the assessment of low-cost technologies as a possible alternative to capital-intensive strategies.

(ii) A comparative study of the longer-term spread effects and wider socio-economic impacts of the different resettlement approaches pursued at Sobradinho, Itaparica and in the lower Sao Francisco valley would provide pointers for the most appropriate strategies from a regional development perspective.

(iii) At Itaparica, appraisal studies are urgently needed as to how best to organize the management of agricultural production and small farmer organizations, as well as with respect to the manpower requirements for such a task. In view of the relatively large scale of these irrigation subprojects in the Northeast Brazilian context, the success of these ventures could stand or fall on how well or how badly their constituent populations are brought together economically and socially. In view of the currently high expectations regarding project "emancipation" policies, feasibility studies to examine this potential are urgently required in order to avoid the danger of such schemes being given their "independence" prematurely.

(iv) Research is required into the impacts of irrigation in the Sao Francisco valley on rural and urban growth and employment patterns, including informal sector development.

(b) Physical Environmental Issues

7.83 There are also important gaps in our knowledge regarding the ecological consequences that are likely to result from further development of hydropower and irrigation potential in the Sao Francisco valley. Additional studies are, therefore, recommended in the following areas:

(i) In terms of the growing competition among water users in the valley, notably electricity generation and irrigation, investigation is needed into possible alternative sources of energy production, as well as more efficient irrigation technologies and practices from the standpoint of water consumption.

(ii) In connection with the same issue, detailed and more accurate studies of evaporation loss rates in the Sao Francisco basin will assist in calculations of possible water shortages which may occur in the future, as well as to plan for appropriate measures.

(iii) Climate modelling studies would help to predict likely changes in local weather patterns. Unstable air circulation conditions and increased precipitation may be induced both by large bodies of water such as Sobradinho and Itaparica lakes and extensive irrigated areas. There is, accordingly, a need for studies of the broader impacts of these reservoirs on regional climate and production patterns.

(iv) In view of the increasing risk of water contamination by agrotoxics as irrigated agriculture expands in the valley, together with their potentially adverse impact on animal and human populations, this is an issue that deserves careful and systematic investigation. At present, little or no research is being undertaken into water quality in the area.

2. In Large River Basins in General

7.84 Many of the gaps in planners' and policy-makers' knowledge that have become apparent during the execution of projects in the Sao Francisco valley have implications for the development of large river basins more generally.

(a) Human Environmental Aspects

7.85 There is an overall need to better understand the social dimensions and impacts of river basin development involving hydropower and irrigation schemes. Several major areas can be highlighted:

(i) Investigations into the human impacts of major population displacements, including the consequences for family structure and economy, agricultural production levels and patterns, public health and other major socio-economic indicators.

(ii) Studies of mechanisms for involving displaced populations in the preparation and implementation of comprehensive resettlement schemes with the purpose of minimizing disruption in the short-term, while helping to ensure the longer-term economic sustainability of resettlement/irrigation projects.

(iii) Research into appropriate production technologies, as well as organization and management structures, to facilitate the reintegration of displaced and other impacted populations into the regional economy.

(b) Physical Environmental Dimensions

7.86 Similarly, the ecological consequences of the Bank-supported interventions in the Sao Francisco valley suggest areas of further research which have a wider relevance in terms of river basin development:

(i) The impacts of large artificial reservoirs on water quality for agricultural, industrial and domestic use.

(ii) The effects of silt retention by dams on downstream soil fertility and agricultural production.

(iii) The consequences of water pollution brought about by rapid irrigation development and use of agrototoxic chemicals.

(iv) The physical limitations on river basin and larger regional development imposed by finite river water supplies and increasing competition among users in different sectors and locations.

(v) Climate changes due to the formation of large bodies of water and their likely impacts upon the regional environment.

ANNEX I

Table 1: Distribution of Landownership in Key Areas
of the Middle Sao Francisco Valley, 1970-85

	1970		1980		1985	
	N	A	N	A	N	A
MR 133*						
(hectares)						
under 10	80.3	6.0	68.9	4.8	70.6	4.6
10-100	15.7	14.1	25.7	14.1	23.6	13.0
100-1000	3.5	27.0	4.8	24.2	4.7	24.1
1000-10000	0.4	30.7	0.5	26.6	0.8	37.2
over 10000	0.1	22.3	0.1	30.2	0.1	21.1
PETROLINA						
under 10	61.2	10.5	41.0	4.7	40.1	4.9
10-100	36.3	37.1	52.2	38.5	51.1	39.1
100-1000	2.3	21.5	6.5	31.2	8.4	39.5
1000-10000	0.1	10.6	0.3	20.6	0.3	16.5
over 10000	0.1	20.3	0.1	5.0	-	-

* Includes the municipalities of Barra, Campo Alegre de Lourdes, Casa Nova, Pilao Arcado, Remanso and Sento Se.

N = % of properties.

A = % of farmland occupied.

Source: Agricultural Census (IBGE) for 1970, 1980 and 1985.

ANNEX II

Table 2: Irrigated Area in "Development Poles"
Along the Sao Francisco River Valley

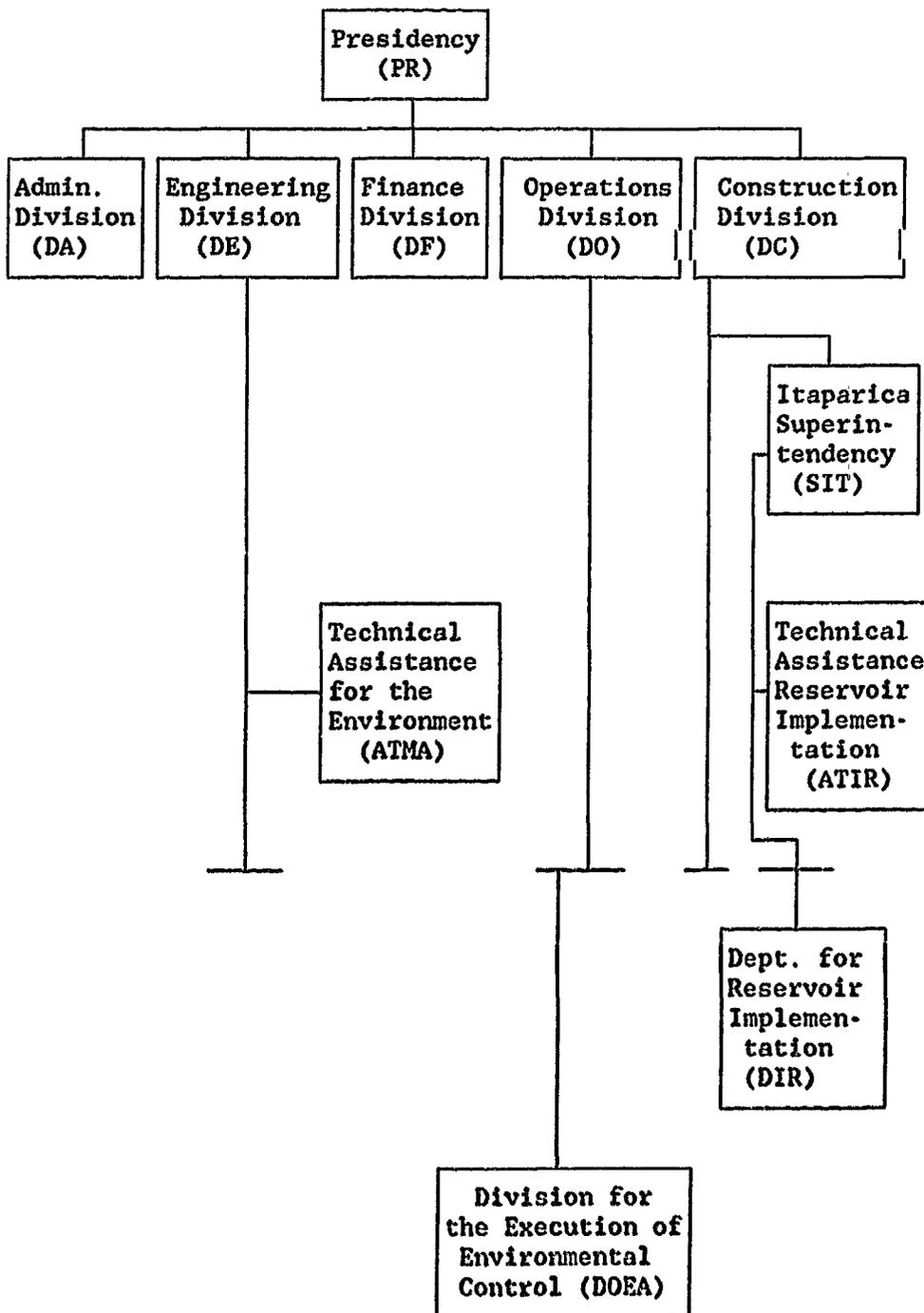
Projects	Hectares Irrigated (December 1988)
<u>CODEVASF</u>	
Northern Minas Gerais	12,870
Bom Jesus da Lapa	3,606
Barreiras	2,250
Petrolina-Juazeiro	36,959
Lower Sao Francisco	10,345
	<hr/>
Subtotal	66,030
 <u>PRIVATE PROJECTS</u> (estimate)	
Northern Minas Gerais	40,000
Bom Jesus da Lapa	7,000
Barreiras	6,800
Petrolina-Juazeiro	45,000
Lower Sao Francisco	2,000
	<hr/>
Subtotal	100,800
	<hr/>
<u>TOTAL</u>	166,830

Source: CODEVASF, CODEVASF 1985-88, Ministry of Agriculture, Brasilia, 1989.

ANNEX III

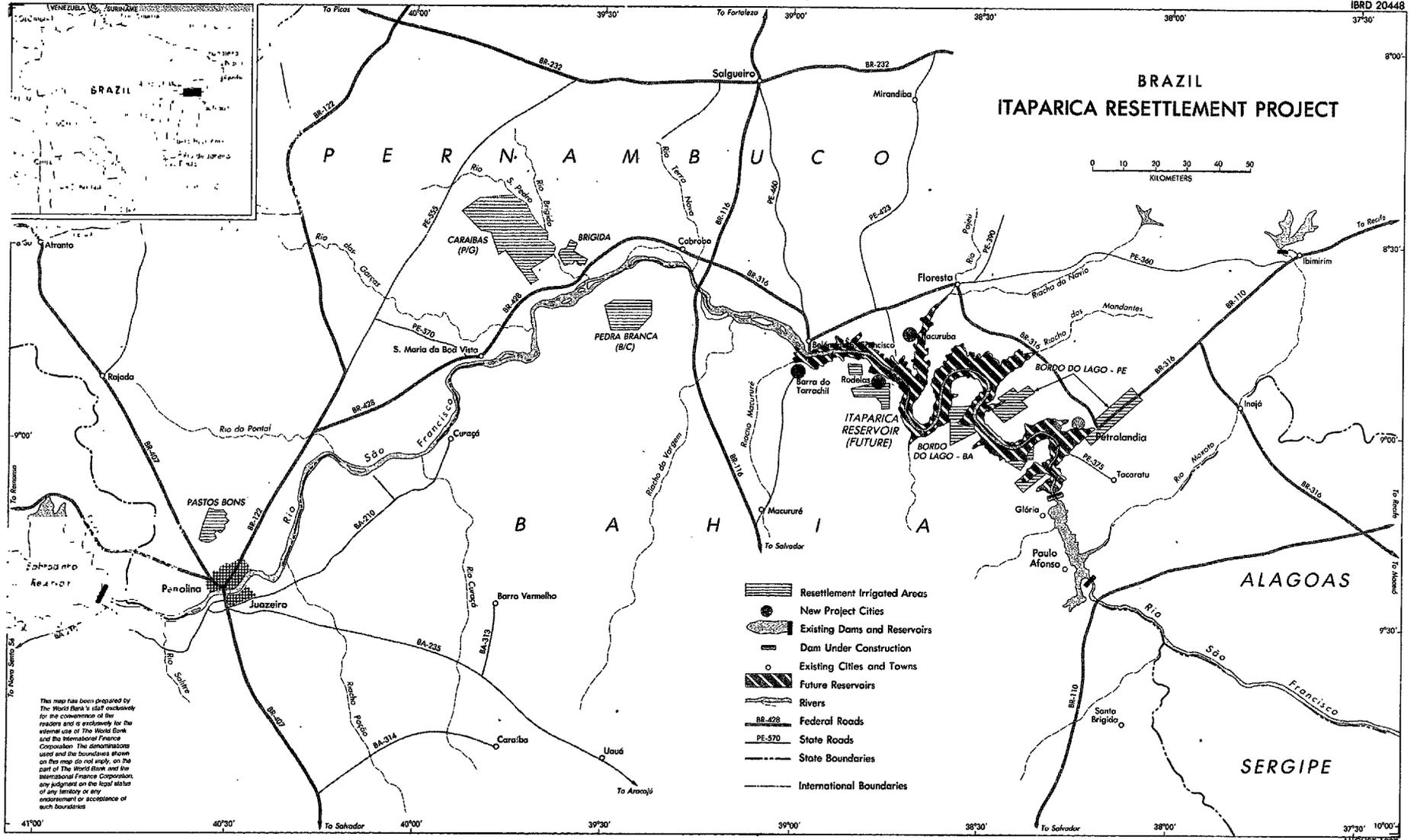
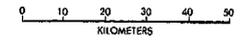
Organizational Structure of CHESF

(Environmental Units)



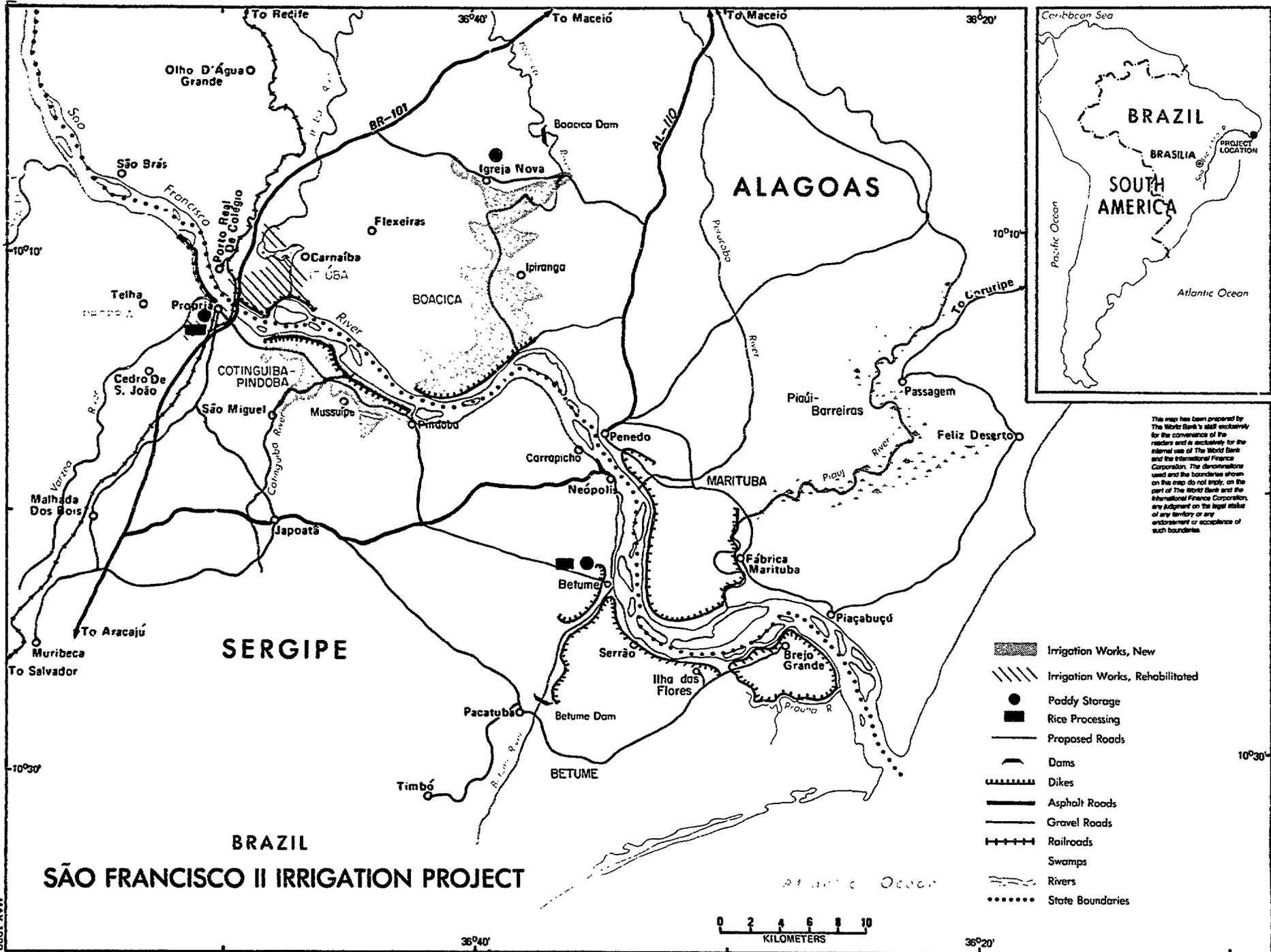
MAP SECTION

BRAZIL ITAPARICA RESETTLEMENT PROJECT

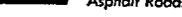


- Resettlement Irrigated Areas
- New Project Cities
- Existing Dams and Reservoirs
- Dam Under Construction
- Existing Cities and Towns
- Future Reservoirs
- Rivers
- Federal Roads
- State Roads
- State Boundaries
- International Boundaries

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-  Irrigation Works, New
-  Irrigation Works, Rehabilitated
-  Paddy Storage
-  Rice Processing
-  Proposed Roads
-  Dams
-  Dikes
-  Asphalt Roads
-  Gravel Roads
-  Railroads
-  Swamps
-  Rivers
-  State Boundaries



SÃO FRANCISCO II IRRIGATION PROJECT