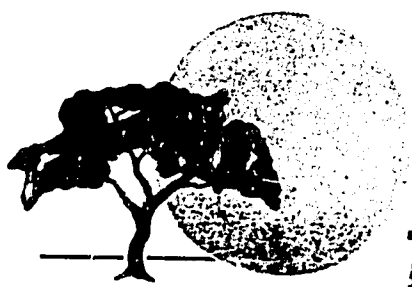
PN-AAZ-929

Jubba Environmental and Socioeconomic Studies

VOLUME I: EXECUTIVE REPORT



JESS *Jubba Environmental and Socioeconomic Studies*

Daraasaadka Dooxada Jubba

A project of • Ministry of National Planning and Jubba Valley Development • United States Agency for International Development • Associates in Rural Development, Inc.

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Executive Report *i*

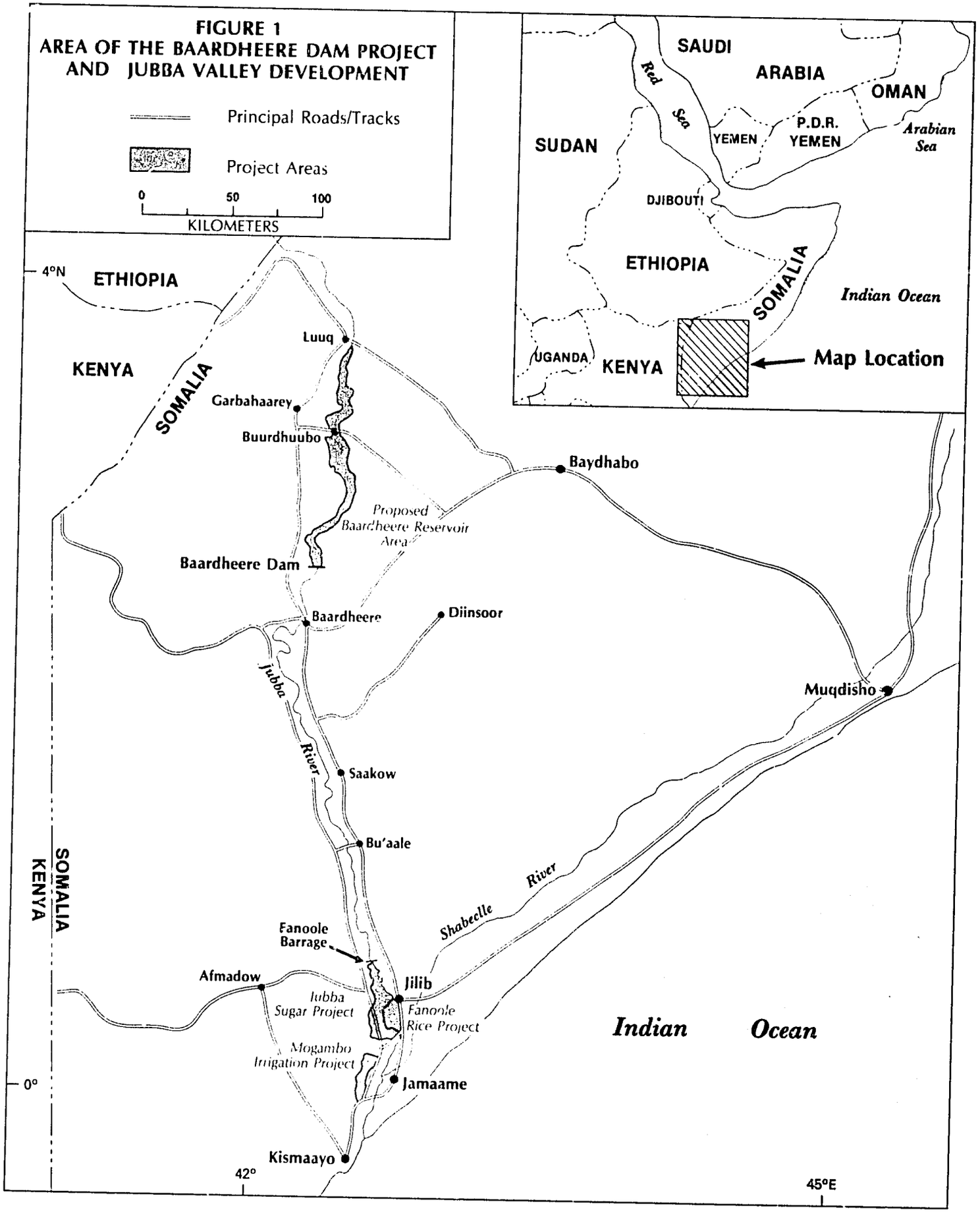
FIGURE 1
AREA OF THE BAARDHEERE DAM PROJECT
AND JUBBA VALLEY DEVELOPMENT
Principal Roads/Tracks
Project Areas
0
50
100
KILOMETERS
SAUDI
ARABIA
OMAN
Red
Sea
SUDAN
YEMEN
P.D.R.
YEMEN
Arabian
Sea
DJIBOUTI
ETHIOPIA
SOMALIA
Indian Ocean
UGANDA
KENYA
Map Location
4°N
ETHIOPIA
KENYA
SOMALIA
Luuq
Garbahaarey
Buurdhuubo
Baydhabo
Proposed
Baardheere Reservoir
Area
Baardheere Dam
Baardheere
Diinsoor
Jubba
River
Muqdisho
Saakow
Bu'aale
Shabeelle
River
SOMALIA
KENYA
Fanoole
Barrage
Afmadow
Jilib
Jubba
Sugar Project
Fanoole
Rice Project
Mogambo
Irrigation Project
Indian
Ocean
0°
Jamaame
Kismaayo
42°
45°E

Jubba Environmental and Socioeconomic Studies (JESS) were part of the Jubba Development Analytical Studies Project (JuDAS), implemented in southern Somalia by the U.S. Agency for International Development (USAID) and Ministry of National Planning and Jubba Valley Development (MNPJVD) of the Government of the Somali Democratic Republic (GSDR). Associates in Rural Development, Inc. (ARD), of Burlington, Vermont, provided technical assistance and project management for JESS under USAID contract number AFR-0134-C-00-5047-00. The JuDAS Project also included a soils and land-use classification project, completed in 1987 by the U.S. Bureau of Reclamation (USBR), and a long-term training component administered by USAID. In addition, the Board on Science and Technology for International Development (BOSTID) of the National Academy of Sciences (NAS) provided advisory services to USAID and MNPJVD under JuDAS.

JESS began in September 1985 and ended in March 1989 with publication of this final report. It was carried out as a three-phase project to collect environmental and socioeconomic data in Somalia's Jubba Valley—the site of proposed development of a large hydroelectric dam with the following characteristics:

Specifications of Proposed Baardheere Dam and Reservoir[1]

Installed generating capacity	105 mw
Dam height	75 m
Dam length	609 m
Elevation at dam crest	144 masl
Reservoir water level	
min. normal operation (at penstocks)	128 masl
max. normal operation	142 masl
max. exceptional (flood)	148 masl
max. normal fluctuation[2]	14 m
Reservoir characteristics[3]	
length	160 km
surface area	310 km^2
volume	3,400 million m^3
Discharge[4]	
annual monthly mean	152 cumecs
max. operation	203 cumecs
design flood	750 cumecs
Average residence time for inflows during max. normal operation	191 days

1. Values are approximate, based on preliminary design (ELC 1985).
2. Drawdown in typical year is 7 m. 3. Approximated for 142 masl.
4. Information updated by AHT (personal communications, 1988).

Complementary to construction of the dam, various plans are being prepared for subsequent development of irrigated agriculture in the middle and lower Jubba Valley. Numerous environmental and socioeconomic changes will occur with dam construction, filling of the reservoir, infrastructural enhancement, and intensification of agriculture.

The JuDAS Project had two major purposes:

- **to gather necessary information on soils/land use and socioeconomic and environmental factors to be incorporated into a master planning process for Jubba Valley development; and**
- **to provide MNPJVD with technical support and training.**

As one of its objectives was to assist Jubba Valley development, JESS continuously supplied results from its socioeconomic and environmental studies to a master planning team assigned to MNPJVD. The team was financed by the German Agency for Technical Cooperation (GTZ) and staffed through Agrar- und HydroTechnik, GMbH (AHT). JESS also provided practical, informal training for its Somali counterparts and served in an advisory capacity to USAID and MNPJVD on long-term training. The three phases of JESS are described below.

Phase I was a six-month period from September 1985 to March 1986 that was used to review and assemble data from existing literature, studies, and ongoing programs in the project area. Based on information gaps and an overview of the area, JESS prepared a work plan to conduct appropriate baseline and problem-specific studies concerning environmental and socioeconomic conditions in the Valley.

Phase II lasted for 24 months, from April 1986 to March 1988, and focused on intensive field data collection, including two longer-term baseline studies (on socioeconomics and terrestrial ecology) and various separate short-term investigations on a variety of environmental and socioeconomic factors relevant to Jubba Valley development.

Phase III, from April 1988 to March 1989, consisted of data analysis, synthesis, interpretation of research results and report writing. This phase culminated in the present comprehensive final report

which presents pertinent research findings, and recommendations for enhancing the positive effects and avoiding or mitigating negative impacts of dam construction and operation, as well as development of the Jubba Valley.

The main vehicle for NAS/BOSTID's interaction with the JESS team, USAID and MNPJVD, was a series of workshops/technical advisory meetings. The first workshop, which was held in Somalia at the end of January 1986 and included a field trip to the Jubba Valley, was organized to give direct input to the design of JESS Phase II studies. This workshop was followed up with a two-day meeting in April at ARD's offices in Burlington, Vermont with the panel reviewing the JESS draft Phase II work plan. Beginning in late September 1986, a one-week workshop was held in Kenya to visit water development projects in the Athi and Tana River basins, to review and discuss lessons learned and avoid problems which could occur in similar developments in the Jubba Valley. A final workshop was held in Coolfont, West Virginia in May 1987, and was used to review progress of JESS research, after more than a year of field activities. In late 1988 and early 1989, panel members also reviewed earlier drafts of final reports on longer-term research included in these volumes. During implementation of JESS, the following scientists participated on NAS's Jubba Valley Advisory Panel:

Thayer Scudder, Ph.D. (Chairman), Director, Institute for Development and Anthropology, California Institute of Technology

Claudia Carr, Ph.D., Professor, Department of Conservation and Resource Studies, University of California

Lee Cassanelli, Ph.D., Associate Professor of History, University of Pennsylvania

Charles W. Howe, Ph.D., Professor of Economics, University of Colorado

John M. Hunter, Ph.D., Professor of Community Health Sciences & Professor of Geography, Michigan State University

Walter J. Lusigi, Ph.D., United Nations Educational, Scientific and Cultural Organization, Nairobi

Peter Rogers, Ph.D., Professor, Division of Applied Sciences, Harvard University

Berekat H. Selassi, Ph.D., Professor, Howard University & Georgetown University

Michael Dow, Ph.D., Associate Director, BOSTID

Jeffrey A. Gritzner, Ph.D., Senior Program Officer, BOSTID

Susan M. Piarulli, Program Assistant, BOSTID

The environmental studies proposed in the Phase II work plan were oriented around a longer-term effort, *Terrestrial Ecology Baseline Studies* (TEBS), due to a shift in focus to the study of vegetation and land-use changes in riverine and floodplain areas associated with the Jubba River. JESS' tropical ecologist led the TEBS effort with support from various consultants in forestry, botany, wildlife management, and remote sensing.

The longer-term *Socioeconomic Baseline Studies* (SEBS) were planned around a comprehensive household/family survey of randomly selected villages and towns in the Jubba Valley. The survey covered many aspects, such as a demographic profile, family resources management and allocation, health and nutrition, social services, land tenure, and resources-use rights. SEBS later had an additional special emphasis through a *Women's Baseline Study* (WBS), used to assess issues related to the role of women in development. A separate initiative was also undertaken for a brief survey to assess marketing and price structures for agricultural commodities. These studies were directed by JESS anthropologists and the JESS socioeconomist.

Thirty short-term environmental and socioeconomic investigations were also carried out during Phase II to fill gaps in the technical information for scientifically narrow areas. Reports emanating from these studies and project-management reporting are listed on the following page. It should be understood that JESS short-term consultants worked, in most cases, in isolation from each other and produced certain findings and recommendations that were not comparable. While JESS has reproduced the findings and recommendations of each of these scientists as reported, Volume I (*Executive Report*) and reports based on JESS longer-term studies (TEBS and SEBS) represent the most comprehensive assessment of the overall JESS effort: these reports consider and, in most cases, summarize the findings of other investigations.

With the final design and specifications of the proposed Baardheere Dam and development projects for the Jubba Valley still undergoing study and revision, the need for JESS environmental and socioeconomic assessments was more generic. The flexibility and responsiveness of USAID project management and ARD's field team permitted various studies to be revised or rescheduled based on the realities of an evolving development project.

Complete List of JESS Reports.

Phase I Review and Phase II Work Plan for the JESS Project; July 1986. Report No. 1.

Bibliography for the JESS Project; July 1986. Report No. 2.

JESS Manpower and Training Assessment; Richard Z. Donovan; July 1986. Report No. 3.

Jubba Environmental and Socioeconomic Studies First Annual Report; November 1986. Report No. 4.

JESS Interim Report on Health Impacts of Design Alternatives for Proposed Baardheere Dam; William R. Jobin; November 1986. Report No. 5.

JESS Interim Report on Health Consequences of Design Criteria for Water Supply and Sanitation in New and Resettled Communities; William R. Jobin; November 1986. Report No. 6.

JESS Consultancy Report on Water Quality and Public Health Engineering; William R. Jobin; November 1986. Report No. 7.

JESS Interim Report on Cultural Heritage Sites in Proposed Baardheere Reservoir Area; Steven A. Brandt; November 1986. Report No. 8.

Interim Report on Vegetation Survey of the Jubba Valley; Christopher F. Hemming; October 1986 Report No. 9.

JESS Phase I Design Studies; William R. Jobin, Peter A. Bloch, James C. Riddell, Curt R. Schneider and James F. Ruff; July 1986 Report No. 10.

JESS Second Consultancy Report on Water Quality and Public Health Engineering; William R. Jobin; January 1987. Report No. 11.

JESS Fisheries Consultancy I Report; Earl K. Meredith; June 1987. Report No. 12.

JESS Interim Report on Aerial Photography Interpretation; Eric Trump; June 1987. Report No. 13.

JESS Preliminary Report on Aerial Survey of the Jubba River; R. Murray Watson; June 1987 Report No. 14.

JESS Third Consultancy Report on Water Quality and Public Health Engineering; William R. Jobin; July 1987. Report No. 15.

JESS Working Paper: Pre-construction Concerns with the Baardheere Dam; R. E. Tillman; November 1987. Report No. 16.

JESS Interim Report: Riverine Forests of the Jubba Valley. Issues and Recommendations for Conservation; Ian Deshmukh; November 1987. Report No. 17.

JESS Interim Report: Mapping Jess Research Results; Paul Dulin; October 1987. Report No. 18.

JESS Interim Report: Survey of Palearctic Migrant Birds in Somalia's Middle and Lower Jubba Valley; David Pearson; October 1987. Report No.19.

JESS Interim Report: Long-term Environmental and Socioeconomic Monitoring; Paul Dulin; October 1987. Report No. 20.

JESS Report on Water Balance and Sediment Transport in the Jubba River Watershed; Donald Alford; August 1987. Report No. 21.

JESS Interim Report: Data Management and Analysis; Leonard A. Malczynski; November 1987. Report No. 22.

JESS Interim Report: Vegetation Survey of Baardheere Reservoir Zone; Christopher F. Hemming; August 1987. Report No. 23.

Jubba *Environmental and Socioeconomic Studies: Second Annual Report;* December 1987. Report No. 24.

JESS Interim Report: Second Survey of Palearctic Migrant Birds in Somalia's Middle and Lower Jubba Valley; David Pearson; December 1987. Report No. 25.

JESS Report on Cultural Heritage Survey of the Proposed Baardheere Reservoir; Steven A. Brandt and Thomas H. Gresham, with contributions from Robert Benson, Nanny Carder, and James Ellison; June 1988. Report No. 26.

JESS Report on Forestry in the Jubba Valley; T. J. Synnott; March 1988. Report No. 27.

JESS Report on Biological Limnology of the Jubba River; Steven G. Njuguna and Francis M. Muthuri; March 1988. Report No. 28.

JESS Report on Malaria Endemicity in the Lower Jubba Region; Marian Warsame Yusuf; April 1988 Report No. 29.

Phase II Report and Phase III Work Plan; March 1988. Report No. 30.

JESS Report on Land Tenure Dynamics in the Jubba Valley; James C. Riddell; May 1988. Report No. 31.

JESS Report on Fisheries; Earl K. Meredith; June 1988. Report No. 32.

JESS Report on Pastoral Economy and Seasonal Livestock Movements in the Jubba Valley; Jorg Janzen; August 1988 Report No. 33..

JESS Report on Land Tenure in the Middle Jubba Valley: Issues and Policy Recommendations; Catherine Besteman and Michael Roth; August 1988. Report No. 34.

JESS Report on Economic History of the Lower Jubba: Implications for Development Planning; Ken Menkhaus; August 1988. Report No. 35.

JESS Summary Report on Bilharzia and Distribution of Bulinus Abyssinicus *in the Jubba Valley;* Ralph Klumpp; August 1988. Report No. 36. (Included in *JESS Report No. 39.*)

JESS Report On Aerial Resource and Land-use Surveys in the Jubba Valley; Murray Watson and Jennifer Nimmo; May 1988. Report No. 37.

JESS Report on Upper Jubba Watershed Performance; Tom Hart; August 1988. Report No.38.

JESS Report on Water Quality and Public Health Aspects; William Jobin; August 1988. Report No. 39.

Throughout the life of the project, JESS cooperated with other projects and ministries, often exchanging data at informal and formal levels. Such exchanges always took place with full knowledge of MPNJVD and USAID. The following descriptions illustrate the wide range of contacts established during the project.

Land Tenure Center (LTC) of the University of Wisconsin — From the outset, JESS encouraged a close working relationship with two LTC researchers engaged in land tenure assessments in middle Jubba Valley. JESS assisted with logistics, personnel, and advice, and received considerable support in terms of data collection. LTC researchers routinely visited JESS team members and participated in some team meetings to exchange information whenever they returned to Muqdisho from their fieldwork. The JESS team made attempts to visit LTC field sites in the Jubba Valley whenever their activities were in proximity to those sites. As a result of this close liaison, LTC produced a report on land-tenure issues in the Jubba Valley for JESS.

Settlement and Resource Systems Analysis (SARSA) — JESS established close working relationships with the SARSA team. This one-year project studied rural-urban linkages within an approximate 100 km around Kismaayo. Several joint team meetings were held, data were freely exchanged, and both teams made an effort to coordinate their work and standardize data collection to avoid overlapping efforts.

Livestock Marketing and Health (LMH) Project — While it was not necessary to hold joint team meetings, JESS and LMH freely exchanged data on livestock practices in the Jubba Valley. Members of both teams routinely attended consultant debriefings of common interest.

Central Rangelands Development Project (CRDP) — While JESS and CRDP had different geographic venues of interest, information on numerous shared sectoral and technical activities was commonly exchanged between them. Terrestrial ecologists from both teams pooled their resources at times for taxonomic assistance, and the social scientists compared survey techniques. To a limited degree, the projects provided each other with assistance in logistics.

British Forestry Project — The JESS ecologist had numerous meetings with members of the British Forestry Project concerning vegetation and land-use mapping.

World Concern — JESS had two unique experiences with World Concern. During the floods in May 1987, World Concern asked JESS to assist with rescue operations near Luuq. Refugee fields had been severely flooded, and many irrigation pumps were underwater. JESS responded with a loan of a boat and two boat pilots, which enabled World Concern to rescue a majority of refugee irrigation pumps before they rusted beyond repair. In a second instance, World Concern volunteered to perform an anemia survey in Jilib after JESS was forced to cancel a similar study with the Refugee Health Unit (RHU) of the National Refugee Commission. Under this agreement, JESS loaned World Concern hemoglobin spectrophotometers that had been purchased for the RHU study in exchange for the data collected between March and September 1988.

Halcrow-Fox Associates (HFA) — HFA conducted a study for MNPJVD concerning resettlement of the population currently situated in the area of the proposed reservoir. JESS was HFA's first contact in Somalia concerning information and logistic support. During 1987 and early 1988, a very close working relationship developed between the two groups. Incoming HFA consultants were routinely briefed by the team before the onset of their fieldwork. With the permission of MPNJVD, HFA relied heavily on JESS equipment for its fieldwork.

World Bank — One of the principal objectives of JESS is to make its research results available to potential donors in order to meet requirements for financial and development plans. JESS provided considerable assistance to a World Bank preappraisal mission for the Baardheere Dam regarding environmental and resettlement issues, organized and implemented a field trip to the reservoir area for the World Bank team and provided liaison between MNPJVD and the bank in terms of archaeology studies. Copies of all JESS reports have been continuously supplied to the Bank during all phases of the project.

United Nations High Commissioner for Refugees (UNHCR) — JESS held several meetings with resettlement teams from UNHCR. Reports and field notes were made available to these teams as well as remote sensing products developed during JESS.

Somali Academy of Science (SOMAC) — In its studies on archaeology and land tenure, JESS worked with counterparts in an attempt to encourage wider participation of Somali scientists.

National University of Somalia (NUS) — JESS utilized expertise from the faculties of medicine and chemistry to conduct studies in epidemiology, water quality, limnology, and land tenure. JESS was instrumental in arranging the turnover of a USBR atomic-absorption spectrophotometer and other laboratory equipment to NUS before the end of the JuDAS project.

Ministry of Health (MOH) — JESS worked closely with MOH in planning and implementing epidemiology surveys in the lower Jubba Valley. MOH supervisors and technicians conducted this study with JESS financing, logistics, and technical assistance.

World Health Organization (WHO) — JESS also worked closely with WHO officials in planning and implementing the epidemiology surveys. Based on this liaison, surveys were conducted under standards endorsed by WHO. Reports on study results were presented to WHO at an individual debriefing.

Ministry of Fish and Marine Resources (MFMR) — JESS maintained a close relationship with MFMR throughout its studies in Phase II. Personnel from this ministry used JESS boats and equipment to conduct freshwater fisheries research in two Somali rivers and assist fishery cooperatives, one on each river.

Baardheere Dam Technical Committee — The JESS team leader was a member of this committee at the invitation of the Baardheere Dam Project.

Agrar- und HydroTechnik — According to USAID's JuDAS project paper and the scope of work in ARD's technical assistance contract, the purpose of JESS was to generate environmental and socioeconomic information necessary for the creation of a master plan for Jubba Valley development. MNPJVD has overall authority for coordination of the master plan, while GTZ is financing technical assistance through the AHT master planning team. JESS and master planning efforts were to be coordinated in a timely manner by MNPJVD. However, JESS and master plan schedules were *not* in synchronization. Because these projects were funded, negotiated, designed, and planned by different donors, their schedules were not coordinated.

JESS' Phase II began in April 1986 and ended in March 1988. Outputs of that phase were to be used by master planners for preparation of *Master Plan Volume 1: Present Stage of Development*, but this volume was released in December 1987.

AHT's *Master Plan Volume 2: Regional Development Strategy* was released in July 1988. It briefly defines a series of alternative development projects for the Jubba Valley. While AHT took advantage of JESS' Phase II baseline information, analyses of baseline studies data were not completed until the end of Phase III, with the release of the preliminary drafts of the JESS final report in August 1988. AHT's *Master Plan Volume 3: Jubba Valley Development Investment Program* was originally scheduled for release in December 1988, before the planned presentation of the JESS final report.

With these timing and scheduling constraints, JESS staff had to open informal channels of information exchange with the AHT master planning team. Throughout Phase II, USAID, MNPJVD, AHT, and a wide audience of reviewers were kept informed of JESS activities and research results through the release of timely interim reports prepared by consultants and long-term JESS staff. In addition, 28 monthly reports, prepared during the implementation of Phases I and II, were widely distributed in Somalia and elsewhere. SEBS data bases and other research materials, including aerial photographs, water-quality sampling data, field-trip notes, vegetation maps and the results of aerial censuses, were turned over to the master planning team as a matter of course. Various debriefings were presented by JESS consultants after completing their short-term investigations. JESS/AHT interteam meetings, and informal one-on-one collaboration between JESS staff and AHT consultants were mutually beneficial to both teams' efforts in data collection.

As intended in the design of JESS, information collected during Phase II was processed and analyzed during Phase III. Full reports were prepared for both of the longer-term baseline studies (SEBS and TEBS). These, in combination with the group of short-term, intermittent investigation reports, complete JESS' contribution of environmental and socioeconomic studies relative to proposed development in Jubba Valley development. Recommendations are included for enhancement of the beneficial aspects and mitigation and/or avoidance of negative impacts associated with

proposed developments, while guidelines for environmental and socioeconomic monitoring take into account the inherent limitations of Somalia's sociopolitical and economic constraints.

This final report was prepared from direct analyses of JESS research and reviews of other data and literature relevant to Jubba Valley development. The ***Executive Report (Volume I)*** synthesizes available information concerning the environmental and socioeconomic implications of construction of the Baardheere Dam and subsequent development of the Jubba Valley. All other JESS reports on long-term baseline studies and short-term investigations are annexed to the *Executive Report:* **Volume II (Environmental Studies), Volume III (Socioeconomic Studies),** and **Volume IV (Bibliography).**

Copies of research materials, including principal data bases and code books, tabular data, field maps, site descriptions, photographic slides, and aerial photographs, were prepared and transferred to the five *JESS Data Repositories*—MNPJVD, USAID/Somalia, USAID/REDSO/ESA, USAID/Washington, and ARD/Burlington. A list of repository materials is included in Volume IV.

As of 31 March 1989, the JESS technical assistance team included:

Robert "Gus" Tillman, Ph.D.—team leader, environmental assessment;

Kathryn Craven, Ph.D.—socioeconomics;

Ian Deshmukh, Ph.D.—ecology, vegetation, and wildlife;

James Merryman, Ph.D.—anthropology;

Nancy Merryman, Ph.D.—women's issues, administrative coordination;

Marie Tillman—data center coordination, bibliographer; and

Robert Ondrusek—information management.

Two personnel changes occurred during the three and one-half years of the project. Dr. E. Drannon Buskirk served as team leader from November 1985 until February 1987, when Dr. Tillman assumed this role. Mr. Richard Donovan was ARD's home-office project manager from the inception of the project until May 1987. Mr. Paul Dulin then managed JESS until completion of the contract and coordinated the preparation of the final report.

Throughout the life of the project, ARD home-office staff participated in various aspects of project management, administration, technical assistance and logistics. Dr. George Burrill, ARD's president, maintained overall management responsibility for the contract. Mr. Richard Hart, the firm's business manager, provided administrative coordination. Mr. Kevin Fitzcharles assisted with project management, hiring consultants, and handling logistics. Mr. Ross Bryant and Mr. Ted O'Shaughnessy supervised procurement. Dr. Alfred Waldstein provided intermittent technical assistance in the preparation of the SEBS final report. Star Albright and Clair Dunn were responsible for editorial production of the final report.

For USAID/Somalia, Sally Patton was project manager from the inception of JuDAS until July 1987. Weston Fisher then managed the project until its completion. Both gave generously of their time and were instrumental in the implementation of this complex project.

A	A.A.P.G.	American Association of Petroleum Geologists
	ACMRR	Advisory Committee of Experts on Marine Resources Research
	ADC	Agricultural Development Corporation
	AETFAT	Association pour l'Etude Taxonomique de la Flore d'Afrique Tropicale
	AFIS	Administrazione Fiduciaria Italiana della Somalia
	AHT	Agrar-und HydroTechnik, GMbH
	AID	U.S. Agency for International Development
	AIDS	acquired immune deficiency syndrome
	AIRD	Associates for International Resources and Development
	ARD	Associates in Rural Development, Inc.
	ARIS	Aerial Resource Inventory System
	ARTEMIS	African Real-Time Environmental Monitoring using Imaging Satellites
	ASCE	American Society of Civil Engineers
	ASD	Air Survey and Development, Inc.
	ASEAN	Association of Southeast Asian Nations
	ASGA	Association des Services Geologiques Africains
	AVHRR	Advanced Very High Resolution Radiometer
B	B.P.	before present (present being 1952, when radiocarbon dating became commercially available)
	BDP	Baardheere Dam Project
	BFPS	British Forestry Project, Somalia
	BMZ	Bundesministerium fuer Wirtschaftliche Zusammenarbeit
	BNA	Blue Nile Associates
	BOSTID	Board on Science and Technology for International Development
C	ca.	*circa* (approximately)
	CAS	catch assessment survey
	CDA	Cooperation for Development in Africa
	CEC	Commission of the European Communities
	CIFA	Committee for Inland Fisheries of Africa
	CILSS	Comite Permanent Interetats de Lutte contre la Secheresse dans le Sahel
	CISP	Comitato Internazionale per lo Sviluppo dei Popolo
	CITES	Convention on International Trade in Endangered Species
	CPCA	Comite des Peches Continentales pour l'Afrique (FAO)
	CPUE	catch per unit of (fishing) effort
	CRDP	Central Rangelands Development Project
	cumecs	cubic meters per second
	CV	coefficient of variation
	CWS	Church World Services

D	D.V.W.K.	German Association for Water Resources and Land Improvement
	DAP	disodium ammonium phosphate
	DC	district commissioner
	DLWR	Department of Land and Water Resources
E	EC	electrical conductivity
	EC25	electrical conductivity at 25°C.
	EEC	European Economic Community
	EIFAC	European Inland Fisheries Advisory Commission
	ELC	Electroconsult
	EMRO	Eastern Mediterranean Regional Office (WHO)
	ENC	Ente Nazionale Commercio
	ERDAS	Earth Resources Data Analysis Systems, Inc.
	ERP	European Recovery Programme
	ERS	Economic Research Service
F	FAO	Food and Agriculture Organization of the United Nations
	FBS	fish biology sampling
	FEWSD	Food Early Warning System Department
	FR	Forest Reserve
	FSP	fish sampling program
G	GDP	Gross Domestic Product
	GJV	Greater Jubba Valley
	gm	gram
	gn	gill net
	GNP	gross national product
	GOE	Government of Ethiopia
	GSDR	Government of the Somali Democratic Republic
	GTZ	German Agency for Technical Cooperation
H	ha	hectare
	hl	hook line
	HMSO	Her Majesty's Stationery Office
	hn	hoop net
I	IBRD	International Bank for Reconstruction and Development (World Bank)
	ICA	International Center for Aquaculture
	ICE	Instituto Nazionale per Il Commercio Estero
	ICOLD	International Commission on Large Dams
	ICRAF	International Council for Research in Agroforestry
	ICTA	Instituto Ciencia y Tecnología Agrícolas (Guatemala) (Institute of Agricultural Science and Technology)
	IDC	International Development Corporation
	IFAD	International Fund for Agricultural Development

	IFO	Institut fuer Wirtschaftforschung
	IIASA	International Institute for Applied Systems Analysis
	IIED	International Institute for Environment and Development
	IIIC	International Irrigation Information Centre
	ILCA	International Livestock Center for Africa
	ILO	International Labour Office
	IMF	International Monetary Fund
	IPAL	Integrated Project on Arid Lands
	IPM	Integrated Pest Management
	ISNAR	International Service for National Agricultural Research
	ITC	International Institute for Aerial Survey and Earth Sciences
	ITE	Institute of Terrestrial Ecology
	IUCN	International Union for Conservation of Nature and Natural Resources
	IWR	Institute for Water Resources
J	JASPA	Jobs and Skills Programme for Africa
	JESS	Jubba Environmental and Socioeconomic Studies
	JSP	Juba Sugar Project
	JuDAS	Jubba Development Analytical Studies
K	KFW	Kreditanstalt fur Wiederaufbau, German Aid Funding Organization
	kph	knots per hour
	KREMU	Kenya Rangeland Ecological Monitoring Unit
L	LDC	less developed countries
	ln	natural logarithm
	LRDC	Land Resources Development Centre (now part of TDRI, Tropical Resources Development Institute)
	LSA	Later Stone Age
	LSU	Land System Units
	LWR	Department of Land and Water Resources, Ministry of Agriculture
M	MAB	Man and the Biosphere Programme
	MARC	Monitoring and Assessment Research Centre
	MARS	Market Study
	masl	meters above sea level
	maxcpue	maximum catch per unit of effort
	MCC	Mennonite Central Committee
	mcm	million cubic meters
	mcpue	mean catch per unit of effort
	MEI	morphoredaphic index
	MFMR	Ministry of Fisheries and Marine Resources
	mincpue	minimum catch per unit of effort
	MIP	Mogambo Irrigation Project

	MJVD	Ministry of Jubba Valley Development
	MMP	Sir Malcolm MacDonald and Partners, Ltd.
	MNPJVD	Ministry of National Planning and Jubba Valley Development (formerly MJVD)
	MOA	Minister of Agriculture
	MOH	Ministry of Health
	MSA	Middle Stone Age
	MSY	maximum sustainable yield
N	n.d.	no date
	NAS	National Academy of Sciences
	NASA	National Aeronautics and Space Administration
	NERC	Natural Environment Research Council
	NES	National Environment Secretariat
	NESDIS	National Environmental, Satellite, Data and Information Service
	NHWL	Normal High Water Level in Reservoir
	NLITH	number of lithics found in a density sample
	NOAA AVHRR	National Oceanic and Atmospheric Administration, Advanced Very High Resolution Radiometry
	NRA	National Range Agency
	NTTCP	National Tsetse and *Trypanosomiasis* Control Project
	NUS	National University of Somalia
O	OAS	Organization of American States
	ODA	Overseas Development Administration
	ODI	Overseas Development Institute
	ODU	Overseas Development Unit
	OECD	Organization for Economic Cooperation
	OEF	Overseas Education Fund
	OMVG	Organization pour la Mise en Valeur du Fleuve Gambie
	ORS	oral rehydration salts
	ORT	oral rehydration therapy
P	PA18	Piper 18 (Super Cub) airplane
	pET	potential evapotranspiration
	PHC	Primary Health Care
	PPC	Bureau for Program and Policy Coordination
	ppm	parts per million
	PVO	Private and Voluntary Organizations
R	r^2	coefficient of determination in regression analysis
	RAO	Regional Agricultural Officer
	REDSO	Regional Economic Development Services Offices
	RGS	river gauging stations
	RMR	Resource Management and Research, Ltd.

S	SAIS	Studio Architetti Ingegneri Specializzati
	SAREC	Swedish Agency for Research Cooperation with Developing Countries
	SCOPE	Scientific Committee on Problems of the Environment
	SDR	Somali Democratic Republic
	SEBS	Socioeconomic Baseline Studies (of JESS)
	SES	Somali Ecological Society
	SG	specific gravity
	SIATSA	Tropical Agricultural Research Services
	SIDA	Swedish International Development Agency
	SLR	single lens reflex camera
	SMP	Somali Marine Projects
	SOGREAH	Societe Grenobloise d'Etudes et d'Applications Hydroliques
	SOMAC	Somalia Academy of Arts and Sciences
	SRC	Synergic Resources Corporation
	SRCS	Somali Red Crescent Society
	SRP	Somalia Research Project (University College of London)
	SRS	Southern Rangelands Survey
	SSh	Somali shillings
	SWDO	Somali Women's Democratic Organization
T	t	metric ton, metric tonne
	TAMS	Tippetts-Abbett-McCarthy-Stratton
	TARDA	Tana and Athi River Development Authority
	TDS	total dissolved solids
	TEBS	Terrestrial Ecology Baseline Studies (of JESS)
	TLU	Tropical Livestock Unit
	TSS	total suspended sediment
	TVA	Tennessee Valley Authority
U	UN	United Nations
	UNCTAD	United Nations Conference on Trade and Development
	UNDP	United Nations Development Programme
	UNEP	United Nations Environment Programme
	UNESCO	United Nations Educational, Scientific, and Cultural Organization
	UNHCR	United Nations High Commission for Refugees
	UNICEF	United Nations Children's Fund
	UNIDO	United Nations Industrial Development Organization
	USAID	U.S. Agency for International Development
	USBR	U.S. Bureau of Reclamation
	USDA	U.S. Department of Agriculture
	USEPA	U.S. Environmental Protection Agency
	USGPO	U.S. Government Printing Office

V	VITA	Volunteers for International Technical Assistance, Inc.
W	WASH	Water and Sanitation for Health Project
	WBS	Women's Baseline Study
	WDA	Water Development Agency
	WHO	World Health Organization
	WWF	World Wide Fund for Nature (formerly World Wildlife Fund)
Y	YMCA	Young Men's Christian Association

Throughout this report scientific units follow standard international practice. For example, kg km^{-2} $year^{-1}$ means kilograms per square kilometer per year.

The International Monetary Fund calculated the average official exchange rate for 1987 at 105.6 SSh to the U.S. dollar. The purchasing power parity during the same period, however, was just over 166 SSh to the U.S. dollar.

The following glossary of standard Somali place names and terms used in JESS reports represents a close approximation to Somali pronunciation and orthography. Words in *parentheses* are alternate spellings that are commonly seen, but which JESS feels are non-standard. The spelling of "Jubba" is an obvious example—by far, the most commonly encountered spelling of the river has only one "b," but based on the most common Somali pronunciation of this word, the double "b" spelling is considered standard. Words appearing in *square brackets* indicate another, different Somali or foreign name for the same place. For example, the most common Somali name for the capital is not Muqdisho, Mogadishu, or Mogadiscio, but Xamar (pronounced "hamar").

Place Names

Afgooye
Afmadow
Arbay Cabdi
Baardheere (Bardera, Bardere, Bardhere)
Badhaadhe
Banta
Baraawe (Brava, Baraw
Baydhabo (Baidoa)
Beledul Kariim
Bidi
Birbiriso
Bu'aale [mistakenly identified on some maps as Dujuuma]
Buulo Maamow
Buur Fuule
Buurdhuubo (Burdubo)
Cabdulle Kakane
Canjeel
Cusbooley
Deex — grazing area between lower Jubba River and the coast
Demo
Dhacar — grazing area in lower Jubba, west of the river
Dheshceg Radiile
Dhoobey — grazing area east of lower Middle Jubba
Dhesheeg Waamo (Deshek Uamo)
Dujuuma
Faafxadhuun
Farioole
Fuuma
Gaduudey
Garbahaarey
Golweyn
Gomeeni Yare
Goob Weyn
Gurmeyso
Hakaka
Haraawe
Hiloshiid
Hombooy
Honqorre
Hurufle
Iskandariya [Alessandria]
Jabbi
Jamaame [Margherita]
Jilib (Gelib)
Jowarri — grazing area east of upper Middle Jubba and bay
Kalaanje
Kaytooy
Kismaayo (Kismayo, Chisimaio, Kismayu)
Kumbareera
Kumtiire
Kuudka
Libaanga
Libooye
Luuq (Luq, Luk, Lugh, Lugh Ferrandi, Lugh Ganane)
Madiina
Mana Moofa
Manaane
Mardha
Mareerey
Maykoreebe
Mogambo
Mokomane
Moofa
Muqdisho (Mogadishu, Mogadisho, Mogadiscio) [Xamar]
Nafta Quur

Nasiib Buundo
Nyiireey
Qalaaliyo
Qoraxey
Saakow (Saacow, Sakow)
Sareiley
Sarsaar
Shabeelle
Shangaani
Tansaaniya
Turdho
Wandiid — grazing area east of Saakow; east of Banaada
Webi Jubba (Uebi Juba) [Ganaane] — Jubba River
Xagar Buulo
Yontooy

Houses

aqal - portable nomad hut
baraako - rectangular with tin roof
cariish - rectangular wattle or mud and wattle
hoori - portable nomad hut
mundul - round wattle or mud and wattle
sar - cement or cement-brick house

Measures and Storage

boosto — about 1/24 of a hectare
darab — about 1/4 of a hectare
kintaal — quintal or about 100 kilograms
shood — 1/4 of a suus or .62 to .75 kilograms
suus — 2.5 to 3.0 kilograms
tenc – large ghee tin

Physical Features

bakool — white soils
ceel — well
degaan — "home areas" of pastoralists
dhesheeg (deshek, desheek, dhasheeg) — depression
dhoobey — dark/black clay soils
doonk — inland rainfed soil
dooy — red clay soil
gosha — of the forest
haro — lake
hilo — watering place
jiimo — riverbank
shiid — stone
tog, togga (tug, toog) — seasonal stream
war — manmade pond
webi — river

Politics

beel — subdistrict
guddi — committee
guddoomiye — chairman
madaxweyne — president
nabadoon — peacemaker
sheikh — Islamic religious leader
tuulo — village
xaafad — neighborhood

Seasons

gu' — big rains (April to June)
xagaa — dry season (June to September)
deyr — small rains (October to November)
jiilaal — very dry season (December to February)

Executive Report

prepared by
Robert E. Tillman, Ph.D.

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The rigors of working the Jubba Valley, coordinating the work of a team of long-term advisors, field staff, and a host of short-term consultants, and facing day-to-day logistical challenges to move humans and machines from their origins to and throughout Somalia, somehow evolved into this, the JESS Final Report. Without the determination and collaborative spirit of those involved, JESS would not have been.

The author wishes to thank those who stood with him and withstood him during JESS, both home and abroad. The authors of the various studies presented in JESS Final Report acknowledge many of their counterparts and field assistants. This author also extends his thanks to all JESS field personnel. Many thanks to the JESS long-term team, made up of Ian Deshmukh, Kathryn Craven, James and Nancy Merryman, and, of course, Marie Tillman, and to the short-term and intermittent consultants, all of whose work makes up the foundation of JESS.

Acknowledgement is also given to JESS counterparts in the Ministry of National Planning and Jubba Valley Development: Minister Habib Ahmed Habib; Director General, Cabdi Cali Macalin; Director of Administration, Cali Warsame Aden; Director of Planning, Cabdiraxman Islow Maxdalle; ex-Director of Planning and ex-Director of Baardheere Dam Project, Aweys Xaji Yusuf; and ex-Director of Planning, Yasiin Cusman Nur. Heiko Brünken and Wolfgang Haupt of Agrar- und Hydrotechnik, GMbH and Tony Hurrell of Halcrow-Fox Associates provided collaboration and advice.

U.S. Ambassador Frank Crigler was always supportive of JESS. USAID supported JESS from beginning to end and appreciation goes to Director, Lois Richards; ex-Director, Lou Cohen; ex-Deputy Directory, Gary Nelson and Deputy Director, Dale Pfeiffer; JuDAS Project Officer, Sally Patton; and a good friend and confidante, Weston Fisher, JuDAS Project Officer.

Finally, gratitude goes to Abdi Jama Samatar, JESS accountant; Sayiid Hussein Hirsi, JESS logistics assistant; and Roda Mohamad, JESS secretary.

I. EXECUTIVE SUMMARY

The Government of the Somali Democratic Republic (GSDR) is seeking financial support for constructing a multipurpose high dam on Jubba River near Baardheere (see Figure 1). The objectives of this dam are to:

- generate 105 MW of electricity;
- provide downstream flood control; and,
- provide year-round stable river flow for irrigation development.

High dams create significant environmental and social changes: commonly distributing benefits to urban centers while contributing to deteriorating quality of life of local rural populations whose natural resource base changes as a result of dam construction. Water development projects resulting from impoundments, such as irrigation, impose social and environmental costs on local populations while improving the well-being of urban dwellers. To help GSDR in reducing net social and environmental costs of Jubba Valley development and retaining local benefits, Jubba Environmental and Socioeconomic Studies (JESS) collected environmental, social, and economic data for more than two years in Somalia with special emphasis on field research in Jubba Valley (see Appendix – Work Statement).

Recommendations for optimizing development (*e.g.*, enhancement of positive changes and mitigation of negative effects) are written into the text of each of the reports featured in Volumes II and II of JESS Final Report. However, major recommendations have been collated and repeated with brief discussion in Chapter V of this report. Recommendations from all JESS investigations are further encapsulated in matrix-form and presented at the end of this executive summary. A 1:500,000 scale map is provided at the back of this volume which depicts areas of project research and potential development impact.

Physical and Biological Environment

Jubba Valley is a remote and undeveloped area in Southern Somalia with an estimated population of slightly over one million. The economy is based almost exclusively on agriculture and mobile livestock herding. Climate is subhumid to semiarid with rainfall between 200 and 700 mm per annum depending on location. Rainfall is highly variable seasonally and annually, normally occurring during two wet seasons of *gu'* (April to June) and *deyr* (October to November).

JuDAS social studies determined that approximately 360,000 ha of the one million ha classified were suitable for irrigation, of which, 17,000 are currently irrigated. The generally impermeable soils are subject to salinization and waterlogging problems, and high concentrations of boron were found in several sites.

Jubba River begins just north of the Ethiopian border from a confluence of three rivers with Ethiopian highland origins. Over 90 percent of the Jubba River flow originates in these highland areas. Average annual flow is slightly over 6,000 million cubic meters (mcm) ranging between measured extremes of 2,700 and 10,300 mcm. Variation in monthly flow is between 0.1 and 1.9 mcm.

Water quality is acceptable for domestic and agricultural uses for most of the year. During flood peaks, electrical conductivity exceeds 1,000 μmhos/cm^2 for several days. Similar peaks of phosphate, nitrate, and suspended solids occur, coinciding with high river flow.

In terms of vegetation and land use, undisturbed areas are limited to small patches of gallery forest along Jubba River. Only two patches exceed 100 ha in size and the total area of remaining riverine forest is less than 900 ha. Clearing rates for agriculture are accelerating; therefore, gallery forest is not likely to remain until 2000 unless protective intervention occurs.

Forest resources in Jubba Valley are sufficient to meet present demands for fuelwood and construction material if extraction is spread over a wider geographic base. Human concentrations at refugee camps, large agricultural projects, and urban centers have caused local deforestation—especially in floodplain areas.

Nonfloodplain areas are dominated by *Acacia/Commiphora* brushlands which can only support agriculture in years with above average rainfall. There are some areas near Jilib which receive 750 mm or more rainfall during some years; these areas have rainfed cultivation. Nonfloodplain

is mostly used for grazing livestock. Livestock population estimates are 350,000 camels, 600,000 cattle, 420,000 sheep, and 700,000 goats, mostly in seasonally migratory herds.

Much floodplain land is used for irrigation or flood-recession agriculture. In middle Jubba, large lateral depressions, or *dhesheegs*, adjacent to the river frequently fill with flood or rainwater. Approximately 7,000 ha of a potential 21,000 ha of dhesheegs are cultivated in recession agriculture. Approximately 17,000 ha of land is being irrigated by three large, state-operated projects and medium-scale banana plantations. The state projects grow mostly sugar and rice.

Wildlife is not abundant as wild animals constitute less than five percent of the total herbivore biomass. Very small numbers of elephant and rhino are present, but are susceptible to poaching. Other large mammals have declined severely and only small mammals, such as dik-dik, duiker, lesser kudu, and gerenuk, maintain viable populations. Hippos, crocodiles, warthogs, and baboons are serious pests which endanger crops, livestock, and human life.

Fishing is not common in Jubba River, although the river is capable of producing an estimated sustained yield of 1,600 metric tons per year. There are no commercial activities beyond part-time cooperative fishing. Most fishing is artisanal and takes place during low flows of the dry seasons.

Socioeconomic Environment

The valley population of slightly over one million is growing at three percent per year. With 46 percent under 14 years of age and 68 percent under 25 years, the population is young and expanding. In the SEBS sample, each household had slightly more than six individuals, with an estimated 170,000 households in the valley.

Education and training levels are low. Only 36 percent of adult males claim an ability to read and write Somali and 15 percent of adult females read and write. Formal education and vocational training are almost nonexistent. Over 75 percent claim agriculture or livestock herding as their primary occupation.

Approximately 10,000 individuals work as wage laborers at large-scale projects, but at wages below subsistence levels. Less than 30 percent of SEBS respondents reported wage labor, mostly as part-time labor for neighbors. Many farmers hire non-household labor during land preparing, weeding, or harvesting.

Health conditions are not good and will worsen with increased irrigation development. Malaria and bilharzia are common throughout Jubba Valley, but at alarming levels in villages near irrigated fields in the lower Jubba. Prevalence rate for urinary bilharzia in children under 14 years of age was nearly 75 percent in one JESS survey. Data for malaria, neonatal tetanus, gastroenteric disease, and respiratory problems are of similar concern, since health facilities are virtually lacking in the valley. Only three PVO-operated clinics and one hospital in Kismaayo are operating to support a population in excess of one million individuals. Most medical treatments are prescribed and dispensed by untrained pharmacists.

Agriculture and livestock herding is at subsistence levels in an overwhelming majority of households. Except for small-scale irrigation of onions and some vegetables, crops are grown primarily for household consumption. Surpluses are bartered for milk products or meat, or sold in local markets. There are few specialized markets or fixed places where bulking for wholesale occurs, except for cotton and bananas. Major household crops consists of sorghum, maize, sesame, and small amounts of table vegetables or fruit.

Over 30,000 ha are in three state-owned projects: Juba Sugar Project, Fanoole Rice Project and Mogambo Irrigation Project. Juba Sugar and Fanoole Rice produce the bulk of Somalia's production of sugar and rice. The projects have caused great social disruption and are not economically successful No households were compensated for loss of land to projects, even in compensatory employment. Not one project has met goals for project cost, implementation schedule, and crop production. All three projects have been handicapped with a lack of project management experience and foreign exchange for purchasing equipment and parts. All three projects are in poor states of maintenance and nearly two-thirds of the 30,000 ha of project lands were not in agricultural use in 1987.

There has been a rapid increase in smallholder irrigation—particularly in Gedo Region. Use of small 20-liter-per-second pumps has been encouraged by low import taxes and subsidized diesel fuel. PVOs have also stimulated small-scale irriga-

tion around refugee camps and the technology has spread to other farmers. In many cases, sharecropping arrangements have evolved where urban investors purchase pumps and exchange pump use for land and labor from farmers for equal crop shares. It is estimated that over 7,000 ha are being irrigated by small pumps. Competition for limited water resources between smallholders and large projects will be a very serious issue in the near future if the government does not promulgate water-use legislation which would control water allocations among users.

Over 8,000 ha are controlled by 54 privately owned banana plantations in medium-scale irrigation operations. Of the total, only 3,315 ha were in cultivation as a result of declining international markets for Somali bananas. Somali banana exports have dropped from 73,300 tons in 1972 to 22,700 tons in 1987. Banana marketing is controlled by Somalfruit—a company jointly owned by government and foreign private investors.

Agriculture has been constrained by a lack of land-tenure security. In 1975, agricultural land in Somalia was nationalized with the Agricultural Land Law. Under this law, government grants and registers 50-year leases on agricultural lands to applicants after they successfully complete the registration process. Since 1975, 30,000 ha of relatively fertile cropland has been taken from smallholders for government agricultural projects without compensation for land or improvements. Uncompensated taking of land is still legally occurring because the law permits registration of any unregistered land, even if it has been occupied and productively cultivated by others for generations. Numerous land disputes resulting from registration of occupied land have surfaced in the Shabeelle and Jubba valleys.

Livestock herding figures prominently in national and valley economic and social systems. Nearly 50 percent of SEBS households reported household income from livestock. Livestock account for 35 percent of the gross domestic product and more than 80 percent of Somalia's export earnings. Since 1983, a Saudi Arabian import ban on Somali livestock severely cut livestock exports as Saudi Arabia was a major importer for Somali livestock. Exports declined from U.S. $123 million in 1982 to U.S. $47 million in 1984.

Livestock are kept in mixed herds of camels, cattle, sheep, and goats which move to seasonally available water and forage. Regions of tsetse infestations near Jubba River restrict but do not eliminate floodplain grazing opportunities. The upper Jubba floodplain (future reservoir) is an important dry-season grazing area for a large part of the national livestock herd. Part of this area will be lost through inundation, but livestock forage in the future drawdown zone will partially compensate for grazing loss.

Livestock production is primarily for household consumption and not for sale of live animals. Household livestock management is directed toward milk and milk products which are sold in village markets. However, local market livestock sales in Jubba Valley are healthy—especially in Kismaayo, which helps service the vigorous Kenya livestock trade of over 300,000 head per year.

Livestock are largely managed by mobile herders who move large herds seasonally on routes roughly parallelling Jubba River. During dry seasons, herds move from north to south, seeking graze and water near Afmadow or Shabeelle wetlands. In wet seasons, herds disperse, taking advantage of ephemeral dryland graze and watering points.

A new subsistence mode is emerging in Jubba Valley which combines fixed settlement and seasonal cultivation of rainfed crops with a degree of open-range livestock herding. This agro-pastoralist strategy diversifies household economic dependence and is less susceptible to drought. Many former pastoralists have adopted this survival mode in a response to a range of ecological and economic stresses. Much of the agro-pastoralism is occurring in nonfloodplain areas, generally in the middle Jubba.

Effects of Proposed Development in the Jubba River Valley

The future Baardheere Reservoir will impound 3,400 mcm, or roughly 55 percent of the annual Jubba River flow. The 160-km long reservoir will inundate 310 km^2 at 142 masl, mostly marginal grazing land, but including 7,000 ha of irrigated or recession agriculture. A 14-meter vertical drawdown will expose up to 20,000 ha for varying durations allowing for drawdown agriculture and forage production on at least 10,000 ha.

Baardheere Dam is designed to remain below a 700-cumec discharge in a one-in-one-hundred-year

flood. Bottom outlets permit discharges greater than 700 cumecs if dam operators decide to create overbank flooding to support recession agriculture. Flooding in the middle Jubba will be eliminated unless controlled floods are employed. Minor flooding will continue to occur in the lower Jubba because river banks are not sufficient to contain 700 cumecs and local rainfall contributes to heavy surface runoff.

Before Baardheere Dam, average monthly discharges at Baardheere range from below ten cumecs to over 462 cumecs. The dam will regulate and stabilize discharge between 130 to 260 cumecs, assuring a steady flow of water each month.

Seawater intrusion in the estuary will be curtailed if agricultural off-take can be controlled to retain approximately 20 cumecs flow in the estuary. Since the Jubba estuary is not complex or extensive, very little physical change will occur in this area.

Groundwater levels will change, especially in the floodplain. In dry seasons, the water table will be higher than in pre-dam conditions. In wet seasons, the water table will be depressed when compared to a non-dam situation.

Overall water quality will improve as a result of impoundment. Reservoir discharges will be acceptable for domestic use (after treatment) and agriculture. The saline peaks associated with floods will be diluted in the reservoir and discharges should be below 600 μmhos/cm^2 throughout the year. Increased use of fertilizers and biocides will cause deterioration of downstream water quality.

Baardheere Dam will diminish Jubba River's floodplain and alter the vegetation toward non-floodplain conditions. Native floodplain vegetation will disappear through changes in the water regime and through increased clearing because of flood reduction and increased access.

The reservoir will create an entirely new habitat, changing from semiarid brushland to lake. Aquatic vegetation will develop around shorelines, but proliferation of floating aquatic weeds is not expected. Aquatic birds will increase dramatically as will crocodile populations. Hippos are not likely to increase in the short-term because of a lack of forage, but will become more numerous if drawdown agriculture is successful.

The dam is not likely to have direct effects on terrestrial mammals as most large mammals have been reduced in numbers by poaching and habitat loss. Wildlife will be significantly affected indirectly as flood control will encourage more clearing of natural vegetation for expanded agriculture. Floodplain areas will be denied to most wildlife species as they are considered crop or livestock pests.

Crocodiles will increase in the reservoir area and will continue to be threatening to humans and livestock in downstream areas. Control programs have been recommended to reduce crocodile populations.

Fish populations in Jubba River will change after Baardheere Dam. Some species seek spawning areas in flooded lands, such as dhesheegs which will be reduced in area. Fishing pressure is likely to increase with moderate and stable river flows. A reservoir fishery will become established very quickly and expand rapidly until nutrient balances are established after a few years.

Of numerous social issues revealed in the JESS socioeconomic baseline study, four are highlighted in this report. These issues comprise resettlement, health, land tenure, and settlement planning.

Over 100,000 refugees at multiple camp sites will be affected by inundation. Refugee relocation was specifically excluded from the JESS scope of work and therefore, is not the focus in any report volume. JESS studies involved work on a settled population of 13,000 individuals currently residing within the limits of the future reservoir. During the study period, JESS worked with another contractor commissioned by MNPJVD to survey the resettlement population and plan relocation strategies.

A proposal to relocate displaced families on multiple sites in middle and lower Jubba Valley is recommended by JESS. No site could be found which was large enough to accommodate all resettlement households in one location. In addition, the reservoir-area communities are culturally distinct and warrant relocation at multiple sites. A special land registration process is recommended as a part of the resettlement program.

Water-related disease will increase from implementing Baardheere Dam and developing additional irrigation. There will be increased incidence of urinary bilharzia, malaria, and gastroenteric disease. Health conditions are already unacceptable and these will worsen. River blindness, Rift Valley

fever, and AIDS could become significant health risks in Jubba Valley as a result of dam construction. It is not likely that projects to improve health can be instituted to keep pace with increased disease threats. Health components should be attached to all development projects until a more comprehensive plan to improve health can be implemented throughout the valley.

Security of land tenure is a major discussion point in both river valleys of Somalia. The present land law permits inequities and provides a legal mechanism for land taking without compensation. If agricultural development is to occur at desired rates in Jubba Valley, the land law will need to be amended to increase security of tenure which, in turn, will encourage investment in agricultural production.

Lastly, settlements will increase in size and functions at an accelerated rate. A construction camp will be created at Baardheere with all the problems of increased growth without attendant benefits. Middle and lower Jubba Valley urban centers are also expected to grow rapidly, especially if an all-weather road is built between Jilib and Baardheere. Somalia lacks settlement planning experience, thus, settlement growth is likely to be unplanned and uncontrolled.

Mitigation

JESS studies indicate that Baardheere Dam should be an environmentally and socially benign development, if mitigatory and compensatory actions are planned and implemented in timely fashion and with full support of government and the donor/lender community. In support of future mitigation/compensation planning, JESS prepared a series of recommendations which should serve as a basis for discussion between government and potential dam financiers. These recommendations are designed to serve as guidelines for development planning in Jubba Valley.

It will be the responsibility of master planners and, ultimately, the developers of the proposed projects—GSDR, in collaboration with donors and development assistance organizations—to ensure that potentially negative environmental and socioeconomic impacts are either avoided or mitigated, and that positive elements of proposed developments are enhanced to provide benefits to the greatest number of people in the valley. JESS recommends that GSDR, through its dam operations group, establish an Environmental and Socioeconomic Monitoring Unit (ESMU) and develop a monitoring program using JESS reports and field data as a baseline.

II. INTRODUCTION

Somalia's Jubba Valley is a remote, underdeveloped land and water resource of significant national importance to the Government of the Somali Democratic Republic. A vital key for economic development of Jubba Valley lies in constructing a multipurpose high dam north of Baardheere, approximately 300 km from the Indian Ocean. As conceived, this dam will reduce or eliminate frequent floods, generate 105 MW of hydroelectric power, and provide more stable river flows for expanding irrigated agriculture.

Given a lack of national experience in hydropower development and operation, donor reluctance to finance a high dam on Jubba River prior to extensive studies has been characteristic of the Baardheere Dam Project (BDP) during its 15-year existence—first, in the Ministry of National Planning and later, in the Ministry of Jubba Valley Development. In 1987, a government reorganization fused MNP and MJVD into the Ministry of National Planning and Jubba Valley Development (MNPJVD).

While the concept of a high dam near Baardheere was considered early in the colonial era, serious studies did not begin until shortly after the socialist revolution in 1969. Since that time, GSDR has conducted extensive studies to demonstrate economic, social, environmental, and engineering feasibility of Baardheere Dam to potential donors and lenders.

In July 1988, AHT released the first two draft master plan volumes: Volume I, *Present Stage of Development*, and Volume II, *Regional Development Programme*. These volumes utilized a significant amount of JESS baseline and special study results, as had been envisioned by project designers. A pending third volume will present an investment strategy for selected development alternatives.

View of proposed dam site at Markabley looking north toward the Jubba Gorge. (J. Janzen)

With publication of two draft master plan volumes, the primary objective of JESS—data collection for master planning—had been satisfied. However, a project of a scope and magnitude of JESS cannot be judged complete until final reports are prepared. These reports must provide details on methods, results, analyses, and integration of data collected during two years of fieldwork in Jubba Valley. Not all project data are of immediate relevance to master planning, but they may have greater significance for project-level design, implementation, and monitoring. Information in the JESS data base also adds to a general body of knowledge for environmental and social sciences.

This volume synthesizes significant results from JESS work in Somalia. It also draws upon previous and parallel studies of Jubba Valley to present a succinct overview for development planners and policy makers. A dam near Baardheere will not lead to optimal valley development unless plans and policies are established to take advantage of benefits and to reduce the social and environmental costs which often accompany dam construction in developing countries. Somalia lacks the necessary experience in dam construction and operation to anticipate all development opportunities and potential problems. Donors and lenders should provide guidance and financing to ensure that the dam produces benefits at expected levels for a majority of the implementing nation's population.

For further details on methodologies, techniques, and full results of JESS, readers are advised to refer to Volumes II and III for descriptions of social, economic, and environmental studies conducted by JESS long-term staff and consultants. For reference, a folded 1:500,000 map which illustrates areas in JESS Studies is included at the back of this report.

III. BACKGROUND

The AHT master plan study area boundaries enclose an area of 38,860 km^2. JESS studies go beyond these because highly mobile pastoral populations forced JESS to accept more fluid boundaries. Compared to the master plan area, the JESS study area extends further in northern valley regions, spreading laterally in both directions from the river. In contrast, AHT designated a narrow northern cone from the proposed dam site to an apex at Luuq. The JESS study area coincides with administrative regions of Gedo, Middle Jubba and Lower Jubba regions (Figure 1). Area and estimated population of these three regions are given in Table 1.

Table 1. JUBBA VALLEY AREA AND ESTIMATED POPULATION

REGION	AREA (km^2)	POPULATION*	DENSITY PER km
Gedo	38,592	224,200	5.8
Middle Jubba	43,572	362,700	8.3
Lower Jubba	35,114	447,200	12.7
Valley Totals	117,278	1,034,100	8.8

**Modified from Watson and Nimmo 1985*

In the master plan study area, AHT estimates a population of 510,000 people (13/km^2), growing at an estimated rate of 2.8% per annum. In the Southern Rangelands Survey, Watson and Nimmo (1985) estimated a total valley population of 1,034,000 residents. Lacking reliable national census data, both estimates are uncorroborated, but demonstrate low population densities in the valley.

A. Physical and Biological Environment

1. Climate

The master plan for Jubba Valley development (hereafter referred to as the master plan) continues a focus on agricultural development (AHT 1988). Jubba Valley's subhumid to semiarid climate has been a constraint to agriculture since times of early settlement. Mean monthly temperatures exceed 25 C in lower Jubba and increasing northerly with maximum mean monthly temperatures of 31° C. at Luuq. Low rainfall, ranging from 200 mm in the north to above 700 mm near Jamaame and Jilib, coupled with evaporation rates in excess of 2,000 mm per annum, pose serious constraints to agriculture. Wind is constantly present, varying in direction by season.

Jubba Valley follows the East African equatorial pattern of two annual wet seasons with rain expected during the gu' (April to June) and deyr (October to November) seasons. Jiilaal (December to March) is very dry throughout the valley, while the other dry season, xagaa (July to September) can produce light rainfall in coastal areas. Due to xagaa rains, some areas in lower Jubba Valley receive larger amounts of rainfall.

Jubba Valley lacks reliable data from long-term meteorological stations, but adequate data exist to define annual precipitation patterns. However, these averages are misleading. As in other semiarid areas, variation within and between years can be extreme. JESS studies, primarily conducted in 1987, covered a statistically average rainfall year but with some temporal anomalies. Table 2 (next page) summarizes long-term averages and 1987 rainfall data for meteorological stations near Baardheere, Jilib, and Mareerey.

2. Geomorphology

Geomorphology and soils have been studied in another component of JuDAS (USBR 1987) and only significant points are summarized here.

Jubba Valley is an emerged coastline with associated marine limestones, shales, and marls with outcrops of Cretaceous and Tertiary sedimentary rocks. Soils away from the river are typically composed of weathering limestone and marl with karstic characteristics. Alluvial soils are present in riverine floodplains and ancient coastlines (USBR 1987).

With a north-south elevation gradient between 0.0003 and 0.00015, surface runoff is slow and subsurface drainage is severely restricted except in floodplain alluvial soils (Alford 1987). In certain areas, notably in depressions known as dhesheegs, flood or rain waters can persist for more than two years, being lost almost entirely through evaporation. Valley farmers frequently use dhesheegs for recession agriculture as one resource in a farming system which also includes dryland and riverbank plots.

Table 2. RAINFALL IN JUBBA VALLEY (mm)

STATION	YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
JILIB	1987	3	0	0	89	163	34	22	158	21	15	62	30	597
	Long-term	2	1	8	139	111	54	53	18	18	74	60	48	586
MAREEREY	1987	2	0	0	3	205	45	N/A	188	26	2	69	88	628
	Long-term	2	10	32	120	187	66	79	27	8	65	122	46	764
BAARDHEERE	1987	0	0	8	90	107	5	0	0	0	1	98	3	312
	Long-term	5	5	20	93	56	13	20	5	6	65	68	28	384

USBR classified 1,000,000 ha in Jubba Valley and determined that 360,000 ha were suitable for irrigation. Of these, 27,350 ha are part of existing irrigation projects (USBR 1987). However, AHT (1988) estimates only 17,000 ha are actually being irrigated. USBR classified soils as Class 1, 2, R1, R2, and 6. Class 1 and 2 soils are suitable for irrigation with minimum constraints. Class R1 and R2 soils are considered suitable for paddy rice in periodic rotation with non-flooded crops and Class 6 soils are non-arable due to soil or topographic limitations. Continuous irrigation on R1 and R2 soils will create salinity hazards. R2 soils would require one year of leaching before the top 0.5 m of root zone would be suitable for crop growth and nine years of leaching before a safe root zone could be extended to 0.9 m (USBR 1987). USBR noted that rapid flooding and horizontal flushing might remove salts from the surface zone. USBR's summary of land classification is presented in Table 3.

Table 3. JUBBA VALLEY LAND CLASSIFICATION SUMMARY (ha)

CLASS	ARABLE	IN IRRIGATION	TOTAL	NONARABLE
1	9,750	11,253	21,003	
2	134,035	16,099	150,134	
R1	22,270		22,270	
R2	167,176		167,176	
6				689,521
Total	333,231	27,352	360,583	689,521

Source: USBR 1987

Some lands classified as arable may have agricultural constraints due to high boron levels. Boron is toxic to crops at levels greater than 3 mg/l. Of 83 samples which were chemically analyzed by USBR, only 13 percent were below 2 mg/l and 38.6 percent were greater than 10 mg/l. Three samples were higher than 40 mg/l. These findings underscore a necessity to conduct soil chemical testing for proposed agricultural projects before planning proceeds to implementation. The significance of boron concentrations was not highlighted in the USBR report.

It is estimated that Somalia has 8.1 million hectares of arable land; consequently, the USBR study area contains approximately five percent of Somalia's arable land total (World Bank 1985). However, there is a difference between the World Bank estimate of 360,000 hectares suitable for irrigation in all of Somalia and the USBR estimate of 360,583 hectares in Jubba Valley alone. Given salinity hazards associated with USBR's R1 and R2 soils, the World Bank estimate is more realistic for sustainable irrigation.

3. Water Resources

Hydrology

Jubba River is formed by a confluence of three rivers: Dawa Wenz, Genale Wenz, and Webi Gestro Wenz, originating in the Ethiopian highlands approximately 1,300 km from the Indian Ocean. Jubba River proper begins near the disputed border between Ethiopia and Somalia, approximately 880 km from the coast. Of the 220,000 km^2 catchment area, 167,000 km^2 lie upstream of Luuq. JESS and AHT hydrological studies estimate that as much as 90 percent of Jubba River flow originates in less than 10 percent of the catchment area—mostly above

2,000 meters above sea level (masl) in Ethiopia (Alford 1987).

Elevation and associated high rainfall dominate river flow regimes, particularly in the Bale Mountains in the upper catchment. Alford (1987) summarized elevation-area relationships of the entire catchment to illustrate the importance of a relatively small highland range with intense rainfall (Table 4).

Table 4. AREA/ELEVATION RELATIONSHIPS OF JUBBA WATERSHED

ELEVATION (masl)	AREA (km^2)	% TOTAL
4,001 - 4,500	1,100	0.5
3,501 - 4,000	1,540	0.7
3,001 - 3,500	2,200	1.0
2,501 - 3,000	7,700	3.5
2,001 - 2,500	9,900	4.5
1,501 - 2,000	18,700	8.5
1,001 - 1,500	22,000	10.0
501 - 1,000	25,300	11.5
0 - 500	132,000	60.0
Total	220,440	100.0

JESS commissioned a rainfall model of the upper catchment using satellite imagery as a base for a geographic information system (GIS) data base. Components of the data base include vegetation cover, topography, slope, soil storage capacity, geomorphology, soils, and rainfall. Water balance, moisture-surfacing, and surface runoff models were developed and compared with discharge data from Luuq. From this analysis, it can be shown that the upper catchment runoff year has three parts:

- dormant period from November to March;
- peak flood in May from Genale Wenz and Dawa Wenz; and
- surge in July from Genale Wenz and Webi Gestro Wenz.

The study also shows that the Upper Genale Wenz is the most important runoff production area with one-third of total runoff (Hart 1988). Based on the models, the Ethiopian catchment has a surface runoff of 5,270 million cubic meters (mcm), which compared favorably with Luuq discharge records. Of greater significance, the models indicated that time lag between major rainfall events in the upper catchments and arrival of peak flows at Luuq may be as long as one or two weeks—especially at the onset of rainy seasons. If this finding is correct, dam operators will be able to operate with more precision if they can receive timely information on rainfall in the upper Genale catchment.

FAO has instituted the ARTEMIS (Africa Real Time Environmental Monitoring Using Imaging Satellites) project to deliver weather monitoring data for Africa. This system is operational and is capable of delivering Meteosat imagery for 10-day periods. A receiving station for these data has already been established in Kenya.

Average annual discharge at Luuq (upper end of proposed reservoir) is 6,200 mcm, but with extreme variations. Minimum measured annual discharge was 2,700 mcm in 1980 and 10,300 mcm in 1977 (USBR 1987). Flow data must be viewed with caution as only six gauging stations operate on Jubba River with discontinuous records and a lack of calibrated rating curves. Alford (1987) felt that due to a lack of reliable discharge records, there may be an error of plus or minus 15 percent.

Monthly and seasonal variations in river flow are also significant, ranging from zero surface flows along some river reaches during extreme dry periods to overbank floods once every three years. Flooding can be localized or universal in the floodplain because bank-full capacity varies between regions, 700 cubic meters per second (cumecs) at Baardheere and 450 cumecs at Jamaame (AHT 1988). Figure 2 shows variations in river flow with histograms of 10-day mean discharges for different probabilities of occurrence at Luuq.

Floods nearly coincide with Somali wet seasons, but since more than 90 percent of the flow originates in the Ethiopian highlands, heavy flooding can occur without rainfall in Somalia. In 1987, gu' rains were poor in Jubba Valley, but late flooding caused severe crop damage from Luuq to the coast. Local rains combined with surface flow from Shabeelle wetlands can cause overbank floods below Jilib without any flooding in the upper reaches.

Although total off-take for irrigation is relatively low at present, demand exceeds supply during dry seasons, particularly during jiilaal when discharge drops below 50 cumecs at Luuq. Large state-owned projects at Mareerey, Fanoole, and Mogambo are forced to restrict irrigation pumping between

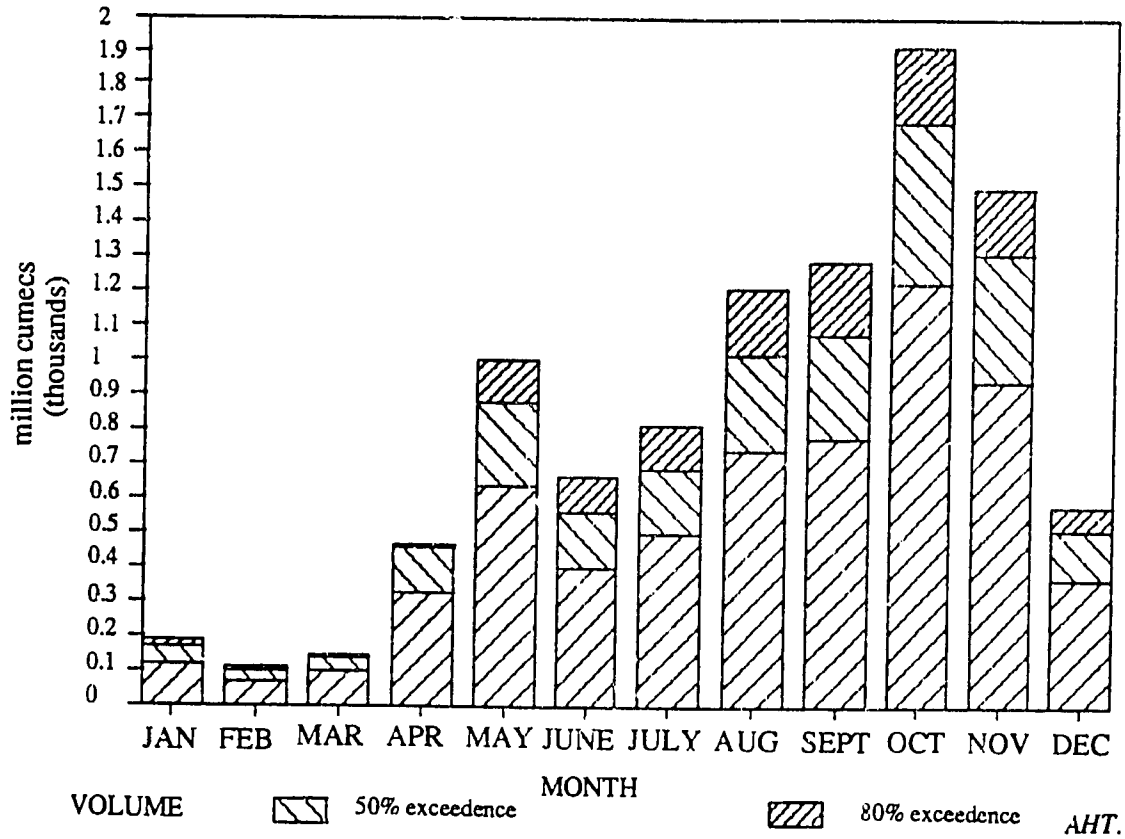


Figure 2. Average Monthly Runoff and Discharge

January and March. Banana plantations below Jamaame also incur reduced production during low-flow periods. Baardheere Dam will stabilize river flows and yield an average monthly discharge rates greater than 130 cumecs which will permit irrigation in Middle and Lower Jubba regions throughout the year if off-take in upper reaches does not increase significantly. However, upper Jubba off-take is increasing rapidly with small-scale diesel pumping systems. Small-scale irrigation has grown from an estimated 260 pumps in 1984 to over 900 in 1988 (AHT 1988). This uncontrolled off-take jeopardizes large state-owned projects in Lower Jubba, but has increased overall production in Jubba Valley. Undoubtedly, small pump owners will increase and become more successful with regulation of river flows.

There is increasing concern over irrigation development in the upper catchment. According to World Bank sources, Ethiopia has plans to develop 7,000 ha for irrigation in the near future, but none within the Jubba watershed. However, some of the upper Jubba catchment has irrigation potential and Ethiopia may choose to develop these areas in the future.

Water Quality

Water-quality data for Jubba River are limited. Juba Sugar Project has been taking water-quality samples since 1977 which is the longest continuous record. In 1986, JESS initiated a one-year study of water quality involving monthly sampling at Baardheere Bridge, Jilib Ferry, Araare Bridge, and Goob Weyn (Jobin 1986). During flood stages, samples were taken weekly and even daily to measure salt peaks which were said to be common during gu' and deyr floods. During the sampling period, salt peaks were verified for 1987 gu' season with a maximum electrical conductivity (EC) of 2,400 µmhos /cm^2 in May 1987 at Baardheere.

During this period, field measurements for water temperature, clarity, EC, and pH were taken. Acidified samples were later analyzed for phosphates, nitrates, sulfates, suspended sediments, and trace elements by the Faculty of Chemistry at National University of Somalia (NUS). Randomly-selected duplicate samples were analyzed for the same parameters at the certified Water Control Laboratory in Hopkinton, Massachusetts for verification. Trace element testing was limited to arsenic, boron, and selenium.

In summary, JESS water-quality surveys show that EC values were below 750 µmhos/cm^2 for most of the year which is acceptable for irrigating crops. However, monthly means for March and April 1986 exceeded 1,200 µmhos/cm^2 and the monthly mean for March 1987 reached 1,300 µmhos/cm^2. EC values greater than 750 µmhos/cm^2 in irrigation water pose soil salinity hazards and reduce crop yields. Suspended solids averaged 348 (xagaa), 148 (deyr), 28 (jiilaal), and 1,515 (gu') mg/l. Values of 4,000 mg/l are reported during gu' floods (Jobin 1987).

Jubba River carried high concentrations of phosphate in solution and suspended sediments with average values decreasing downstream. Nitrate concentrations were relatively low, but generally increasing below the agricultural projects at Juba Sugar and Fanoole Rice projects. A JESS limnological survey concluded that neither phosphates nor nitrates should be limiting factors for prolific algal growth (Njuguna and Muthuri 1988). The limnological survey demonstrated eutrophic conditions, but did not show rich planktonic or benthic populations, which could have been due to river flooding prior to the study and high arsenic concentrations.

Arsenic concentrations in river and well water were often above 0.05 mg/l which has been established as a safe level for drinking water. River water arsenic levels reached 0.25 mg/l during jiilaal 1987 and a shallow well near Mogambo Irrigation Project produced concentrations of 0.48 mg/l, nearly 10 times higher than acceptable safe levels. Jobin (1988) notes that residents with chronic exposure to high arsenic levels develop tolerance to arsenic, but visitors are at risk of serious illness from drinking the water.

Boron concentrations were at safe levels and selenium was never detected in any samples. However, sulfates will pose problems for in-river construction during jiilaal. Sulfates in excess of 1,000 mg/l causes spalling in concrete unless remedial measures are taken. JESS surveys found sulfates at 1,500 mg/l at the end of jiilaal which dropped below 100 mg/l with onset of gu' rains. Dam construction will need to avoid using river water for mixing cement during this period.

Somalias's only perennial river, the Jubba, is used for potable water, irrigation, and watering livestock. The flow regime will change markedly with closure of the dam and subsequent irrigation development of the valley. (P. Dulin)

During a prolonged jiilaal, river flow decreases to a point that it is unable to prevent seawater incursions for as much as 45 km inland. Since municipal domestic water intakes for Kismaayo are approximately 30 km upstream from the coast, residents are forced to use undiluted seawater for domestic use (cooking, laundry, and bathing) until gu' flows increase to approximately 15 cumecs at the estuary (AHT 1988).

By daily sampling at Baardheere Bridge and Juba Sugar Project at Mareerey during onset of gu' floods, it was possible to time the travel of salt flushes between the two points at different discharge rates. Table 5 demonstrates travel times elaborated from these comparisons.

Table 5. RIVER TRAVEL TIME BETWEEN BAARDHEERE AND MAREEREY

DISCHARGE (cumecs)	TIME (days)	VELOCITY (cm/s)
45	11	36
156	8	49
1300	5	79

Source: Jobin 1988

During JESS water-quality surveys, no measurements were made for bacterial or viral contamination. Direct observation shows that fecal contaminants from humans, livestock, and wildlife are present. Details on domestic surface-water use and human health will be covered in subsequent sections.

Groundwater

Although knowledge of Jubba Valley hydrogeology has increased significantly in the past 30 years, little has relevance to development except that groundwater resources have extremely limited value for domestic and agricultural purposes. Except for a few locations, deep and shallow wells yield water of high salinity. Industrialized countries use 350 µmhos as an acceptable upper EC limit for drinking and 750 µmhos for irrigation water. Jubba Valley residents are so accustomed to drinking saline water that they consider water at 1,000 to 1,500 µmhos as sweet water. Deep tubewells drilled near Baardheere have EC values over 10,000 µmhos. During jiilaal 1987, Jobin (1988) calculated groundwater filtrate to Jubba River at Baardheere and Jilib at 1,500 and 2,000 µmhos, respectively. Below Jamaame, Jobin postulates groundwater contributions from Shabeelle Swamps and Dhesheeg Waamo of much lower salinities.

In summary, except for ephemeral, shallow, freshwater lenses near the coast and at tributaries in the upper valley, known Jubba Valley groundwater resources are virtually nonexistent.

4. Land Resources

Undeveloped Areas

There are no significant tracts of undisturbed or wilderness areas in Jubba Valley. However, this statement is not intended to imply that there are no areas worthy of preservation or protection from further development. Jubba Valley, while not densely populated, has been exploited by transhumant livestock herds for centuries. More recently, the valley has served as a recent locus for rapidly intensifying agricultural activities.

For discussion of land use, it is convenient to separate the valley into simple classes of floodplain and nonfloodplain, as was done in JESS terrestrial ecology baseline studies. The ecological studies further stratified with respect to distance from the coast which is also in near conformity to different valley rainfall regimes. Vegetation and land-use differences were more pronounced between floodplain and nonfloodplain boundaries than between cross-cutting strata.

There are differences between undisturbed floodplain vegetation and that found in upland areas. Nonfloodplain vegetation is dominated by *Acacia/Commiphora* associations characteristic of semiarid East African savanna while floodplain sites are dominated by *Phyllanthus/Acacia*. Variations on canopy closure, ranging from 0 to 100 percent, result from differences in soil moisture, texture and fertility, microclimate, and disturbances by humans or livestock. Floodplain vegetation is frequently modified by fires which escape from land clearing for agriculture or are set for other purposes.

Other than species composition, the most important difference between floodplain and nonfloodplain is a potential for biological productivity. For instance, JESS studies measured herbaceous standing crop on both types of sites. Nonfloodplain peak standing crop dry weight values averaged between 700 kg/ha and 300 kg/ha through three different dry-season measurements of multiple sites. In contrast, floodplain averages were between 1,900 kg/ha and 940 kg/ha at the same sampling times—a nearly threefold difference. Two moist floodplain sites

(which were not included in the samples) produced up to 10 metric tons per hectare (t/ha) with dense, two-meter-high grasses.

Woody vegetation demonstrates similar differences between floodplain and nonfloodplain. Earlier, riverine forests covered most of the floodplain, but these forests have been reduced to relict status, especially during the last two decades. Riverine forest has diminished from over 9,300 ha in 1960 to less than 900 ha in 1987 (Deshmukh 1987). Rates of forest clearing have increased during this period. Between 1960 and 1983, riverine forests were cleared at an approximate rate of 300 ha per annum, accelerating to over 420 ha per annum between 1983 and 1987. The number of forest patches and their average size has decreased to a point that few sites remain which warrant protection.

The Somali Research Project (SRP) and JESS have identified only two viable sites of riverine forest greater than 100 ha at Barako Madow (140 ha) and Shoonto (265 ha). Both sites are in Middle Jubba Region between Fanoole Barrage and Bu'aale. Both sites are designated as forest reserves by the National Range Agency (NRA), but are not effectively gazetted, delineated, or protected. Farmers have encroached on both areas with agricultural clearing. Flooding in both forests during 1987 delayed further clearing. Since they represent the largest tracts of riverine forest in Somalia, both sites deserve to receive attention under compensatory wildland preservation, if they are still intact when loan negotiations for dam construction take place.

Neither site contains plant associations which are unique in an international context, but they contain wildlife species which are not found elsewhere (SRP 1988). Jubba Valley riverine forests are biogeographically the northernmost extensions of East African lowland forest. JESS researchers collected a plant specimen which may be a new species of the genus, *Cola*, which could be a Jubba Valley endemic. Since the biota are not well-known, a sense of stewardship dictates that some elements of natural forest be preserved for future study and use.

Of great importance to ecosystem stability and wildland preservation are interriverine swamps located between Shabeelle River and lower Jubba Valley. Fed by wet-season flow of the Shabeelle River, these areas are of unparalleled importance to wildlife and livestock. This series of linked wetlands provide dry-season forage and water for wildlife and livestock herds which migrate from northern areas, such as Baardheere, Luuq, and Diinsoor (Janzen 1988). These wetland areas are now the easternmost extension of the range for elephants and African buffalo which are rapidly being exterminated through poaching and habitat destruction.

In addition to providing wildlife habitat and dry-season haven for livestock herds, these extensive wetlands have provided natural flood control for the lower Shabeelle and lower Jubba valleys. These wetlands have enormous capacity to absorb Shabeelle River flood flows, thereby, either preventing or mitigating damaging floods between Jilib and the coast.

In discussing wildland compensatory measures for BDP, these lower Shabeelle wetlands must be considered as prime candidates for protection in order to prevent unwise drainage for future agricultural expansion. Loss of these irreplaceable wetlands will necessitate implementation of expensive flood control works to protect agricultural areas in lower Jubba Valley. Livestock herders would lose important dry-season forage and watering points without these wetlands. Loss of wildlife habitat would also be unacceptable to most donors and lending institutions.

Land Use

This subsection treats land use in terms of areal distribution and importance in the valley. Subsequent discussions in the section, Socioeconomic Environment, further describe land use and production systems.

Of the 3.5 million hectares in the master plan study area, 86 percent (3.1 million hectares) is classified as bushland and forest suitable for supporting transhumant livestock herds of mixed composition (AHT 1988). Vegetation structure of these bushlands/forest consists of thorny trees and bushes (*Acacia/Commiphora*), shrubs (*Grewia/Cordia*), and herbaceous growth with extremely variable amounts of canopy and cover. JESS ecology studies detail Jubba Valley vegetation in terms of species composition, dominance, percent of canopy, phenology, and productivity.

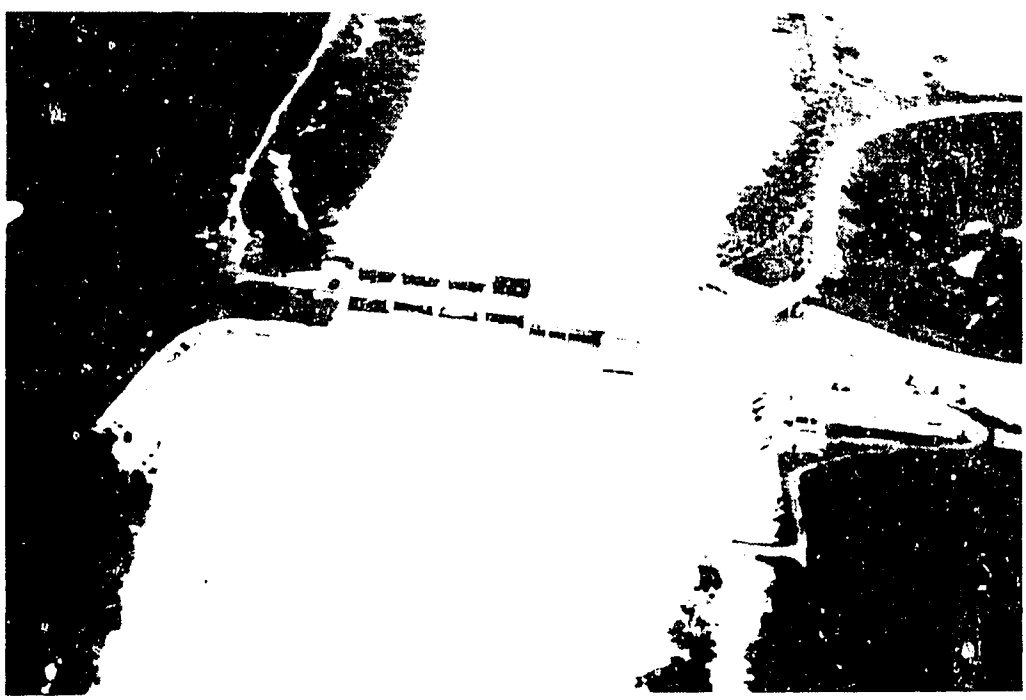
Bushland/forest of Jubba Valley currently provides forage for approximately 350,000 camels, 600,000 cattle, 420,000 sheep, and 700,000 goats which are owned by transhumant pastoralists and settled farmers. Palatable biomass and water availability are not sufficient to sustain long-term livestock

concentrations in one location; consequently, a pattern of seasonal livestock movements has evolved over the centuries of valley occupation. Man-made environmental modifications, such as large-scale agricultural projects and artificial watering points, have changed migratory patterns. The significance of these changes is discussed in detail by Janzen (1988). Summary points are discussed in a later section on livestock in this report.

In a range resource assessment, JESS studies show that nonfloodplain sites, especially in northern districts produce fewer herbaceous plants than expected when compared to similar environments in East Africa. These nonfloodplain sites are close to Jubba River and presumably subject to heavy grazing from livestock. A common practice of grazing livestock away from the tsetse-infected floodplain, but close enough for periodic watering, is probably causing range degradation and loss of productivity.

Bushland/forest is also exploited for fuelwood which is the most common energy source for Jubba Valley. JESS forestry studies indicate that this resource is robust and sustainable at present rates of extraction with exceptions of deforested areas around refugee camps in upper Jubba and near large agricultural projects in lower Jubba (Synnott 1988). Near the river, human population densities are higher and evidence of overexploitation of fuelwood resources is becoming apparent. Unless fuelwood extraction is diverted to inland areas, woody vegetation may become severely degraded. With increasing population (projected at 1,700,000 by 2005) and expanded clearing for agriculture, fuelwood resources will pass beyond a point of sustainability, most likely before 2005. The AHT master plan wisely calls for investigation into fuelwood plantations and alternate sources of energy.

Nonirrigated agriculture in floodplain and nonfloodplain areas is the predominant form of crop production with over 120,000 ha under cultivation supporting more than 20,000 families (AHT 1988). The master plan projects growth in rainfed cultivation to 195,000 ha with 33,000 families by 2005. Levels of farming technology are low with minimal inputs of mechanization, biocides, fertilizers, and



Fanoole Barrage diverts Jubba waters to large- and medium-scale projects in Lower Jubba Region. (R. Tillman)

improved seeds. As expected, crop yields are low and variable seasonally and annually. In addition to limited availability of technology and markets, weather extremes—varying between drought and flood—also contribute to low yields and high farming risk. Farming is below subsistence levels in Jubba Valley since most residents are forced into supplemental survival strategies, such as providing wage labor for others, temporary out-migration of some family members for employment or sustenance, hunting, fishing, fuelwood sales, and gathering forest products for food or for sale. While these activities may coexist with farming under normal conditions, at certain times, these non-agricultural pursuits become the sole source of household income and nutrition.

Of 360,000 ha with irrigation potential, only 17,100 ha are presently under irrigation, primarily limited to Class 1 alluvial soils and to large-scale projects. According to water management experts, the unregulated flow of Jubba River could be used to irrigate 30,000 ha at present irrigation efficiencies of 30 percent (AHT 1988). With Baardheere Dam, the master plan calls for extending irrigation in annual increments of 1,250 ha to an ultimate potential of 120,000 ha beyond year 2015, assuming irrigation efficiency is improved to 40 percent. Both assumptions call for achieving ambitious goals which would tax technical resources of a more highly-developed area.

Most irrigation is under large-scale, state-owned projects and medium-scale banana plantations. Banana growers in Jubba Valley control 8,300 ha of which, approximately 3,315 ha were cultivated in 1987. Since fallow periods are necessary, only 2,300 ha were actually producing bananas in 1987 (Evans *et al.* 1988). However, there is potential to recover underutilized banana plantation land if additional markets can be identified.

Fanoole Rice Project controls 8,200 ha, of which approximately 800 ha are planted in rice at any one time. Although double cropping was planned in project design, the practice has not been implemented. At Fanoole, over 6,000 ha, mostly cleared, remain idle and are not available for smallholder farming.

Juba Sugar Project (JSP) controls 7,200 ha for sprinkler irrigation of sugarcane. While the project was to be in full production by 1982, only 2,817 ha of sugarcane were harvested in 1987, down from a project high of 6,575 ha in 1985. Project management permits an undetermined number of smallholders to farm unused portions of the project area.

Mogambo Irrigation Project (MIP) currently has 2,200 ha in surface (2,040 ha) and sprinkler (160 ha) irrigation. Envisioned as a rice-growing project, MIP diversified when smallholders were invited to participate. By 1987, 300 families on two-hectare plots were incorporated into the project. Rice cultivation has suffered severe depredations by birds (*Quelea*) with losses reported at 58 percent in 1986. Severe *Quelea* damage was reported also in 1988 (Murray Watson, personal communication). These depredations are an inevitable consequence of small-grain cultivation in East Africa for which there seem to be few effective chemical or physical control measures. If losses are to remain above 50 percent, MIP would be an unacceptable investment for Somalia and a wiser course would be to return to smallholder cultivation of larger grain cereals.

Additional discussion of socioeconomic effects of large-scale projects will appear in subsequent sections of this volume and in companion volumes of this report. It is important to note reasons for a universal failure of these projects to match projected outputs. Lack of foreign exchange, spare parts, fuel, and limited technical and managerial skills are cited in evaluations for each project. Shortage of seasonal labor is also identified as a constraint in spite of each project being surrounded by a human population living at subsistence levels or below. These conditions are not likely to change quickly, even with construction of Baardheere Dam. With over 17,000 ha being controlled by large-scale irrigation projects, this type of production system has been tested in Jubba Valley and has not met donor and government expectations. At this point, Jubba Valley physical, social, and economic environments are not conducive to large-scale irrigation projects.

In middle and lower stretches, Jubba River is often flanked by lateral depressions (*dhesheegs*)—many of which exceed 50 ha in area. During overbank floods, some of these dhesheegs fill with flood waters. Groundwater and surface runoff also contribute to dhesheeg-filling. Natural river levees or artificial bunds obstruct return flow when flood waters recede. Nearly 7,000 ha of these dhesheegs are cultivated in flood-recession agriculture.

Dhesheeg soils are fine silt and clay which form a nearly impenetrable barrier to infiltration and many retain standing water for more than two years. Mostly, water loss through evaporation (2,000 mm/year) causes water levels to subside within dhesheegs. Farmers plant crops on allotted space at the perimeter—usually combinations of maize, sesame, and vegetables (depending on season and location). In some dhesheegs, new plantings occur concentrically as water recedes in a line toward the dhesheeg center until the next wet season is about to commence. Aerial photographs show pie-shaped planting patterns in which planting and harvesting occur simultaneously, and a continuum of crop maturational stages is apparent.

AHT (1988) estimates a potential for 21,000 ha of dhesheeg agriculture before Baardheere Dam is completed. Controlled flows of less than 700 cumecs (a design specification) will eliminate most flood-recession agriculture in Middle Jubba as river bank-full capacity is approximately 700 to 800 cumecs. However, with the present dam design, there is potential to create controlled, temporary floods greater than 800 cumecs which would quickly be absorbed in dhesheegs by natural surface flows or through ditches and pipes. Jubba River presently produces floods of greater than 1,100 cumecs, once in every three years, on average.

Without flood control, dhesheeg agriculture has uncertainties because flooding is so frequent and occurs at unpredictable times. For instance, valley farmers considered a late flood in 1987 particularly disastrous, not so much due to volume, but rather to its occurrence after crops had been planted in dhesheegs and along the riverbank. With controlled and predictable discharges regulated by Baardheere Dam, flood risk in dhesheeg agriculture will be eliminated.

Present reservoir operation plans were prepared to optimize power generation and did not consider releases for agricultural water use or controlled overbank floods. Planned floods for dhesheeg agriculture can and should be factored into reservoir operation schedules. Somalia cannot afford to forego loss of agricultural production from these 7,000 ha of valuable cropland.

Controlled floods for continued dhesheeg agriculture could provide an invaluable crop production buffer for the period between dam closure and additional irrigation development utilizing pumps or diversion structures. Dhesheeg agriculture with little risk and high yields would provide more time for smallholders to convert from dhesheeg cultivation to pumped irrigation. Controlled floods will come without handicap to power generation since Somalia will not utilize optimal generating capacity until some time in the future. Recent studies have shown that recession agriculture with controlled floods is likely to be the most productive use of African rivers (Scudder 1985). At present, Jubba Valley agriculture traditionally relies heavily on recession agriculture and a sudden termination of flood events will be economically and socially disruptive.

5. Biological Resources

Vegetation

Ecological descriptions of Jubba Valley vegetation can be found in Volume II of this report. In general, this section focuses on past events which have shaped valley vegetation and on present and future uses of vegetation by valley residents.

Currently, only floodplain vegetation (notably riparian forest) is in threat of eradication. For centuries, this vegetation has been protected from livestock exploitation by the presence of tsetse fly which transmits human and livestock trypanasomiasis. Human trypanasomiasis is not a factor in Jubba Valley history, but livestock varieties are common. Herders approach riparian vegetation with extreme caution—usually avoiding riverine areas (except during jiilaal and periods of drought) or quickly watering livestock and departing to safer areas. Even if tsetse infestation in Jubba Valley is not severe, herders perceive tsetse zones as places to avoid, if possible. Destruction of riparian forest in Jubba Valley has occurred as a result of agriculturalists clearing fertile alluvial soils for cultivation.

JESS studies show that sedentary agriculture in lower Jubba Valley originated with Bantu-speaking slaves who escaped from Shabeelle River plantations in the mid-19th century. These slaves, originally from what are now Kenya, Tanzania, Mozambique, and Malawi, were brought to Somalia by Arab traders to work in grain fields of the Benadir Coast. By 1900, an estimated 30,000 to 40,000 ex-slaves and their descendents were working croplands along Jubba River (Menkhaus 1988). Social conflict erupted between these new settlers and Somali pastoralists, but disputes were regulated by

herders' reluctance to enter tsetse-infected riverine farming zones.

Through this century, sedentary agriculture prospered as new communities split off from older areas with consequent clearing of more riparian forest. Farm surpluses were legendary, noted by 19th century European explorers who also described rudimentary irrigation systems used by valley farmers. A brisk trade developed with Jubba Valley surpluses heading toward Zanzibari Empire markets. More agricultural expansion occurred during the early colonial period (1888 to 1935) with British occupation of Jubaland from the west bank of Jubba River to Kenya and Italian dominance from the east bank along the Somali coast. A more detailed account of the social and economic disruptions to Jubba Valley can be found in Volume III (Menkhaus 1988).

Generally, British and Italian adventurers cleared riverbank land for cotton cultivation following European plantation models established in Asia. Most plantations were failures, being plagued by a lack of labor. This labor shortage led to forced-labor schemes which caused valley residents to flee once again to uncleared areas to avoid labor conscription. Food surpluses and brisk trade passed into history.

Later in the colonial period (1935 to 1951), banana cultivation was introduced and spread along both Somali rivers, supported by conscripted and forced labor. During and after World War II, British Military Administration used Jubba Valley plantations to produce staple foods for the war effort and post-war recovery in Europe. Under Italian prisoner-of-war management, banana plantations were converted to maize and rice production with reports of excellent yields (Menkhaus 1988). During this period, very little new land was cleared for cultivation.

Until 1960, Jubba Valley vegetation remained mostly in a natural state with riparian clearing being confined to areas around Jamaame and small village clearings near Jilib. Dryland vegetation remained virtually untouched by agriculture, serving solely as extensive grazing areas for livestock and wildlife. Large-scale clearing has been characteristic only of the past two decades, most notably for the Fanoole Rice and Juba Sugar projects. With less than 800 ha of riparian forest remaining in all of Jubba Valley at present, it is unlikely that any will persist to the year 2000 without quick and effective government intervention.

Riparian forest supplies important building materials and provides timbers for canoe construction. Synnott (1988) noted that timbers for house supports were generally not available; this observation is reaffirmed by other JESS studies. JESS market data verify high costs for center support poles and roof beams. Housing designs in Jubba Valley favor materials which can be found in local forests and are relatively abundant. Long, sinewy wood bands are wound horizontally through larger vertical poles that are 3" (75 mm) in diameter and sometimes covered with mud. Later, houses may be painted or whitewashed. These long, slender poles are produced by coppicing dryland and floodplain woody plants. However, both round and rectangular housing styles require large and sturdy support timbers for center or corner posts.

Synnott (1988) believes that, at present, Jubba Valley dryland forest is sufficient to supply building materials and fuelwood for valley residents at present at slightly higher rates of extraction. However, his outlook for riparian forest is less optimistic as better roads penetrate middle Jubba Valley. It is possible that commercial fuelwood cutters supplying Muqdisho may be attracted to this region even though the preferred charcoal species, *Acacia busei* is not common. Presently, Muqdisho fuelwood is mainly extracted from Bay Region at levels which cannot be sustained (Bird 1988). A shift from Bay Region to middle Jubba as an urban fuelwood source would have negative environmental repercussions on forest resources and valley residents.

Deshmukh (1989) estimates conservatively that the TEBS study area floodplain contains 10,850 metric tons of usable wood biomass and nonfloodplain areas hold 410,000 tons. Usable wood production rates are assumed to vary from 0.6 t/ha per year in floodplain forest to 0.05 t/ha in open bushland and wooded grassland. It is estimated that, per capita, settled population wood use is approximately one ton per year for fuelwood and construction materials (Synnott 1988). Wood use by pastoralists has not been quantified in Somalia, but Deshmukh (1989) believes that it is higher than per capita fuelwood use of 0.1 t/ha measured in Marasibit, Kenya because Somali herders are increasing household consumption of grains and grain products which require cooking. However, Somali herders are less likely to construct woody animal

corrals to protect livestock from wild predators and theft than their Kenyan counterparts.

While supporting Synnott's contention that Jubba Valley has a healthy woody vegetation resource, Deshmukh (1989) believes that this condition is temporary overall and does not accurately reflect differences between floodplain and nonfloodplain areas. Increased clearing for agriculture in floodplain zones is removing the most productive woodland areas. In addition, cleared material is commonly burned *in situ* because poor roads preclude transport to outside markets. Finally, riverine human densities are too great to support a sustainable extraction from the floodplain. Synnott's assessment of overall forest resources is correct, but when applied to floodplain only, the resource is definitely in jeopardy.

FAO was to initiate a Forestry Sector Support and Training Project in Jubba Valley (planned for 1988). This project will provide forestry and wildlife development teams in middle and lower Jubba to make technical assistance available to local communities. The project plans to assess community forestry needs and to assist government in formulating sound policies and legislation for forest and wildlife management. This project should build on existing PVO community development projects which have demonstrated success in Jubba Valley. An important element contributing to rapid devegetation is an interpretation of the Agricultural Land Law of 1975. This law will be discussed in more detail in a subsequent section on land tenure, but in a forestry context, it merits attention here. Under land law provisions, a registrant must "improve" a leasehold within two years or be at risk of lease forfeiture. Clearing vegetation is accepted as proof of improvement and an intent to cultivate by land law officials. New registrants clear larger areas than they intend to cultivate merely to protect land leases. If forest resources are to be used wisely, the land law needs to be interpreted in a way which recognizes social and environmental values of woodland management. Maintaining woody vegetation for fuelwood and construction material while serving as windbreaks and erosion shields must be recognized as a legitimate and desirable land improvement as a part of an agroforestry production system.

Wildlife

JESS wildlife study strategy was to secure an overall view of larger wildlife species through aerial census and concomitantly support detailed wildlife investigations in middle Jubba Valley in 1986 by a research team from University College of London (Madgwick *et al.* 1988). Results are summarized in Volume II of this report.

While little-known, Jubba Valley wildlife, especially large mammals, is not abundant. Wild herbivores constituted only four percent of total herbivore biomass in a late jiilaal aerial census (Watson and Nimmo 1988). Mammalian populations, including elephant, buffalo, large predators, giraffe, and large ungulates were common to Jubba Valley prior to mid-20th century. Herds of 200 elephants were reported at Dhesheeg Radiile as late as 1973. During JESS fieldwork, no elephants were observed except for two dead young males near Dhesheeg Radiile in Bu'aale District. Valley residents report not seeing elephants within the past three years, although Watson recorded six elephants during a late jiilaal aerial census (Watson and Nimmo 1988). Large predators, such as lion, leopard, and cheetah, have been largely exterminated and are now infrequently reported–as are large ungulates, such as buffalo, eland, and oryx. Smaller herbivores, including lesser kudu, gerenuk, duiker, and dik-dik, appear to be common, as are baboons, vervet monkeys, and warthogs.

Hippopotamus and crocodile populations flourish in Jubba River and lateral wetlands. Watson counted 587 hippos in March/April aerial surveys and, based on tested correction factors elsewhere, calculates a probable valley population between 3,000 and 6,000 hippos (Watson and Nimmo 1988). Watson first calculated a Jubba River crocodile population between 6,000 and 20,000 individuals based on an early jiilaal census (Watson 1987). After a low-water census in late jiilaal, Watson revised his estimate upwards to between 45,000 and 150,000 crocodiles (Watson and Nimmo 1988). JESS field interviews with valley residents provided support for high populations of hippos and crocodiles as hippos were consistently listed as a major crop pest and crocodile incidents—usually human and livestock fatalities—were frequently reported. Residents commonly protect riverbank watering points with thorny bush barriers in hopes of deterring or inhibiting crocodile attacks.

When calculating livestock forage consumption, Deshmukh (1989) calculated hippopotamus forage consumption from aerial census data collected in the middle and lower Jubba floodplain where hippos are

most common. Figure 3 compares hippo forage consumption with consumption estimates for camels and cattle in those floodplain sections. Hippos consume far more forage, including crops, than camels and nearly equal forage figures for cattle. Camels are not concentrated in these areas which are commonly used for cattle grazing. In northern sections of Jubba River, hippos are less common because of a lack of forage.

Watson and Nimmo (1988) strongly recommend hippo and crocodile control programs. At present, members of fishing cooperatives often enlist aid from soldiers or bandits to kill crocodiles at preferred fishing sites. In the same report, Watson and Nimmo point out that a crocodile control program with international sales of hides might produce a sustainable annual income of U.S. $1.5 to 3.4 million and these earnings would occur in much needed foreign currency. Such a program would require an exemption from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which could be requested through the International Union for Conservation of Nature and Natural Resources (IUCN) before skins could legally enter international markets. A recent publication of the National Research Council of the U.S. National Academy of Science provides details of crocodile management programs and successful models can be observed in nearby Kenya and Tanzania (NRC 1983). Rather than attempt a crocodile control program with inexperienced personnel, the government should seek harvesting and marketing agreements with companies who specialize in crocodile management programs in other African nations. Crocodile harvesting is dangerous and processing of hides requires experience to prevent rendering the hide worthless for international markets.

JESS overflights also verified the importance of the Shabeelle Swamps as excellent habitat for wildlife which occurs there at much higher densities than are found in Jubba River floodplains or river-dependent zones. The World Bank's Semi-mechanized Rainfed Agriculture Project has taken preliminary steps to protect Sablaale Swamp on Shabelle River under the bank's compensatory wildland provisions (Tillman 1987b; Bauer 1988). BDP, under similar compensatory wildland provisions, could produce financing to extend protection to swamps downstream from Sablaale. It should be noted that

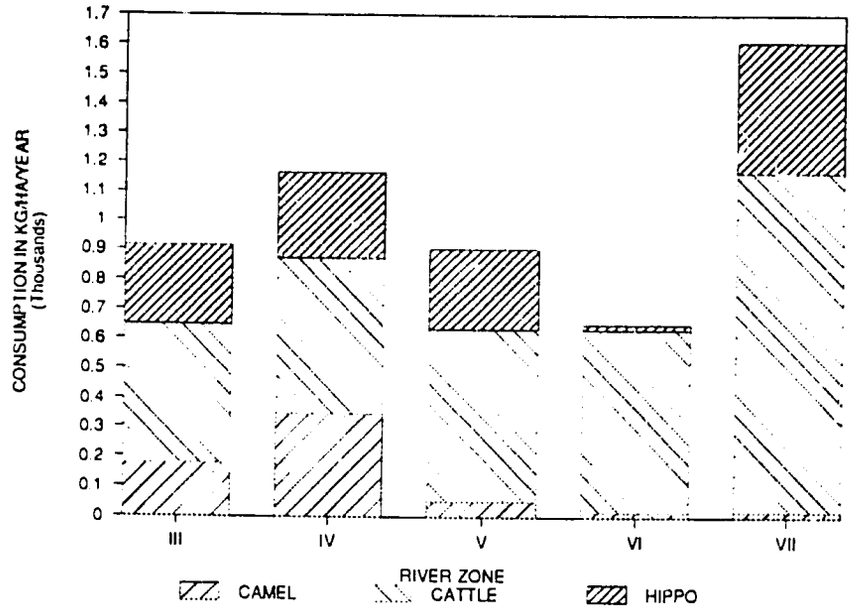


Figure 3. Camel, Cattle, and Hippo Forage Consumption in the Jubba Valley.

national parks should *not* be recommended as protective devices. A large proportion of Jubba Valley livestock herds use these areas for dry-season forage and water. National parks would preclude this use and create conflict with herders similar to those encountered with Masai herders at Amboseli National Park in Kenya (Western 1983). Loss of wetland areas to dry-season grazing would be counterproductive for Somalia's economy with concomitant effects on viability of conservation measures in Somalia.

A preferred conservation option would be to create a wildland reserve similar to biosphere reserve models endorsed and promoted by Unesco. In a biosphere reserve, traditional uses are permitted if they are not in conflict with conservation objectives (Unesco 1975). Experience in Mexico has shown that herders can negotiate grazing and watering agreements with reserve managers under mutually beneficial and agreeable conditions (Halffter 1981). At present, coexistence between livestock and wildlife in Somalia's riverine swamps appear to be in balance. There are no compelling reasons to disturb this balance, but a focus should be placed on legislation and enforcement to preserve this balance for the future with wildland reserves.

Based on Jubba Valley's position between summer and winter habitats for migrating palearctic birds, JESS commissioned two ornithological surveys in March and November 1987 to assess Jubba Valley's status as a migratory corridor or wintering ground (Pearson 1987a,1987b). These surveys were the first systematic avian surveys of lower Jubba Valley. A total of 313 bird species were recorded during two surveys, including 13 new records for Jubba Valley and five new records for Somalia. No rare or endangered species were recorded. Lower Jubba Valley is an important habitat for migrant wading birds, but less important for palearctic land birds. A variety of other transient land birds were recorded, but in small numbers. Migrant and resident birds of prey were uncommon.

Pearson (1987b) noted that dam construction and development will not be detrimental to migrant or resident birds. Most migrant species utilize wet areas on or around irrigation fields and dhesheeg margins. Since overall area of wetlands and irrigation command areas will increase, net effect on bird populations will be increased numbers. A new reservoir will provide hundreds of hectares of additional habitat for wading and aquatic species. If the reservoir perimeter develops woody vegetation, land birds will benefit accordingly.

Other than crocodiles, Jubba Valley reptiles and amphibians were not studied by JESS and have yet to be studied systematically by any scientist or scientific institution. The same is true of invertebrate populations, of which, virtually nothing is known.

Fish

Due to periodic overbank floods and high nutrient levels, Jubba River provides excellent habitat for freshwater fish. Without a defined delta with woody riparian vegetation, such as mangrove, production of estuarine fish and shellfish is slight. Neither resource is being exploited beyond artisanal levels. Marine areas adjacent to Jubba River discharge have an extremely rich, but severely underexploited marine fishery.

JESS fish study results in Jubba River, conducted during deyr 1986 and pre-gu' 1987, indicate a potential sustainable annual catch of 1,600 to 1,800 metric tons with an estimated value of 80 to 90 million SSh at an average local market price (Meredith 1987). JESS market data indicate that 50 SSh/kg is a common price for fish throughout the valley. Opportunities exist for export markets in Kenya, Europe, and Asia to increase potential value of this catch and generate foreign exchange. Currently, fish processing facilities of Somali Marine Products in Kismaayo are operating below capacity and the company is interested in processing and marketing freshwater fish from Jubba River if a dependable supply can be assured and markets aggressively sought (Meredith 1987).

Regardless of export markets, annual fish catch from Jubba River could provide 400 tons of animal protein at an approximate market price of 250 SSh/kg. Considering only protein components, comparable current prices for livestock protein prices are between 1,000 to 1,500 SSh/kg making Jubba River fish a bargain for local residents. Fish protein from Jubba River, if fully exploited at a sustainable level, would provide annual protein requirements for more than 31,000 people, if they consumed no other forms of protein. Clearly, the Jubba River fishery merits more development attention.

Currently, most fishing is *ad hoc*, intended primarily for household consumption. Fishing generally supplements household diets and income derived

from farming, often taking place when farming activities do not demand the entire family labor or when fish are easily caught in shallow pools during late jiilaal (Meredith 1987). Normally, low-river flow and reduced farm labor demand occur in late jiilaal. Fishing techniques are mostly limited to hook and lines and spearing or scooping, although some fishermen use set or hand-pulled monofilament seines purchased at Somali Marine Products (Meredith 1987). Watson (1988) recorded 13 basket traps during a river survey, but could not verify their use for fishing. JESS field teams noted that some fishermen use fish traps during low flow.

When surplus fish are caught, they are either sold from the fisherman's residence as fresh fish, or, more frequently, they are cut, salted, and sun-dried on wood racks or riverbank vegetation. Dried fish are most often sold to market vendors for resale. Meredith (1987) did not find evidence of any effort to systematically market fish except for one cooperative venture at Dhesheeg Waamo.

It is not recommended that the government or donors increase support for developing a Jubba River freshwater fishery beyond limited extension and education efforts which are being carried out by the Ministry of Fisheries and Marine Resources (MFMR) at small scale. Somalia has 3,300 km of coast line with an excellent marine fishery capable of producing a sustained yield of 180,000 tons annually, or simply, 100-fold greater than a Jubba River annual yield. Yet, this drought-resistant resource is exploited at less than one percent (World Bank 1985). Government and donors should concentrate limited financial resources on developing a marine fishery resource which is most likely to earn foreign exchange. Fishing nations worldwide do not have difficulty in finding ready international markets for marine products. Somalia's marine fishery is a far more important development priority than that for Jubba River.

However, government could take inexpensive steps to foster artisanal fishing in Jubba River and thereby, enhance a local and regional resource of considerable economic and social value. JESS studies were assisted by trained freshwater fish biologists from MFMR with excellent international training and experience. These individuals have had admirable experience and success developing fishery cooperatives on Shabeelle River and more recent (although limited) activities on Jubba River. They have developed a participatory extension model where a technician becomes a participating member/advisor for the cooperatives. This model has proven effective on both rivers. Daily earnings, after fuel, maintenance, and marketing costs are deducted, can amount to 4,000 SSh per day per member, although this level is not the norm. With few exceptions, participating fishermen are not full-time, but use fishing to supplement household incomes. Muqdisho fish markets are eager to purchase all fish caught and often, much of the catch is sold at roadside stops in smaller villages before arriving at the Muqdisho market. This small-scale fishery program merits further stimulation by government and/or donors, but without heavy capital investment or recurrent costs. Past fishing projects have shown that large-scale intervention has not worked, but ingredients for successful small-scale promotion are already present in MFMR.

Freshwater fishing in Jubba River could be further stimulated by simple, low-cost education programs to encourage purchase and use of fish for family nutritional benefits. These programs need to be little more than radio spots or posters describing methods of preparing fish meals and describing benefits derived from fish consumption. The Somali Women's Democratic Organization (SWDO) could also be used to distribute information on fish preparation to rural villages. There is evidence that artisanal fishing is increasing, or has been underestimated in Jubba Valley, but could profit by more government stimulation. MFMR used low-cost JESS research boats to support fishing cooperatives at Jowhar Reservoir on Shabelle River and at locations in lower Jubba Valley with considerable success.

A rich, ephemeral reservoir fishery is a certainty, once the dam is completed. African reservoirs undergo a dramatic increase in fish populations during initial stages while inundated vegetation decomposes and releases nutrients into the water. Before the reservoir matures, fish populations will explode at spectacular rates, until nutrients wane and fish predator populations increase. Within a decade, annual fish harvests will decline and come into balance with a slower rate of nutrient inputs. Even after the reservoir attains maturity, fish stocks will still remain a significant resource.

In the interim, excellent yields can be expected (Meredith 1987; Njuguna and Muthuri 1987). It is unlikely that the government could muster sufficient financial and human resources to take ad-

vantage of this initial burst of reservoir productivity. It would be advantageous to government and the national economy to seek partners for fishing concessions in the new reservoir. Concessionaires should make payments for fish extracted and develop training programs for local fishermen. In return, government could grant to the concessionaire exclusive commercial fishing rights, limited duty-free status for importing boats, fishing gear, and processing equipment under agreement that these items would remain in-country at the end of the concession for use by local fishermen. It is possible that Asian and African entrepreneurs would bid on such a concession. Certainly, there is ample time to explore reservoir fish concessions, perhaps with technical assistance from FAO. It is expected that local fishermen would gain adequate skills to maintain a successful reservoir fishery after the concession period. Scudder (personal communication 1988) noted problems with fishing concessions granted on Lake Kariba, especially a failure to help develop a local fishery. Government would need to work closely with concessionaires to ensure compliance with all conditions.

Plans for developing aquaculture projects in Jubba Valley should be relegated to a distant future. While the valley offers ideal conditions for aquaculture, existing freshwater and marine rich fish resources are barely exploited. Aquaculture management and technical skills are currently lacking in Somalia, and when present, these skills will be more cost-effective when directed at a freshwater fishery which requires less capital investment and recurrent costs in foreign exchange. Aquaculture projects would inflict a recurring economic drain.

B. Socioeconomic Environment

At the onset of JESS studies in late 1985, it was expected that social and economic structures in Jubba Valley would be varied, complex, and poorly understood. Social and economic baseline data were lacking with only rudimentary statistics available from isolated studies for various development projects. Large-scale development projects in Jubba Valley had not included socioeconomic studies as a prelude to implementation. Most commonly, assumptions, rather than empirical data were the bases for describing social and economic systems.

JESS fieldwork consisted of a two-year phase that followed a six-month preliminary phase used for literature review and fieldwork planning strategies. After one year of socioeconomic reconnaissance and pre-testing a questionnaire, JESS began collecting socioeconomic baseline data (SEBS) in January 1987. A target sample size of 1,000 households was set with a distribution of 25 percent pastoral, 25 percent urban and 50 percent rural sedentary households. A stratified random-sampling design was employed to select villages and household heads within villages, except for pastoralists who were opportunistically sampled at watering points, but with near equal regional distribution.

Detailed descriptions of methodologies, data management, analyses, and results are provided in Volume III, Part A of this report (Craven, Merryman, and Merryman 1989). Data tables, charts, and maps summarizing SEBS results are included in or appended to that report. Copies of original data sets have been copied to 5 ¼" floppy disks for personal computers and are in the following repositories:

- Ministry of Jubba Valley Development, Muqdisho;
- USAID/Somalia, Muqdisho;
- USAID/REDSO/ESA, Nairobi, Kenya;
- AID Documentation Center in Washington, DC; and
- Associates in Rural Development, Inc., Burlington, Vermont.

SEBS data are in dBASE III Plus files and JESS marketing data are in Lotus 1-2-3 files. User manuals for files are attached to each set of disks. Questionnaires have been transferred to the AID Documentation Center where microfiche copies are planned in the near future.

1. SEBS Sample

In February 1988, JESS completed 1,060 SEBS household interviews with a distribution of 211 (19.9 percent) pastoral, 282 (26.6 percent) urban and 567 (53.5 percent) rural settled households. Average household size was slightly over seven individuals for a SEBS sample population of 7,504 individuals including household members absent from the valley. Information on deceased and absentee members of each household was taken during each interview. Riverine households were separated from nonriverine families because agricultural production systems were significantly different. Thus, the SEBS sample was broadly sub-

divided by administrative region (Gedo, Middle Jubba, and Lower Jubba) and socio-ecological sector (pastoral, urban, riverine agriculture, and nonriverine agriculture). Breakdown of the SEBS sample population living at home by socio-ecological sector (SES) and region are summarized in Table 6.

Table 6. SEBS POPULATION BY TYPE AND REGION

SES	GEDO	MIDDLE	LOWER	TOTAL
Pastoral	645	228	480	1,353
Urban	426	450	844	1,720
Riverine	1,316	746	301	2,363
Nonriverine	213	524	396	1,133
Totals	2,600	1,948	2,021	6,569

SES samples were not equally distributed between the three political regions, but rather, distributed to reflect valley characteristics. Most pastoralists use middle Jubba Valley in transition between dry- and wet-season grazing areas in upper and lower Jubba Valley. Therefore, pastoral households were sampled less in Middle Jubba.

More urban households were interviewed in lower Jubba because a majority of the urban population is located in this region. Since a principal SEBS focus concerned resettlement, riverine households were weighted toward inundation zone populations. Riverine households are reduced in number in the lower Jubba Valley because three large-scale projects have expropriated more than 17,000 ha of riverine farmland. Also, Jubba River meanders extensively, most notably in middle Jubba. If river length is compared to straight-line distance between river entrance and exit by region, a ratio of 2.1:1 is obtained for middle Jubba and only 1.5:1 for upper Jubba (Table 7). Middle Jubba has proportionately more riverbank land than other regions, which has implications for land registration since riverbank is preferred agricultural land.

Table 7. RIVER LENGTH BY REGION (km)

REGION	LENGTH	RIVER LENGTH	RATIO
Gedo	249	375	1.5:1
Middle Jubba	122	255	2.1:1
Lower Jubba	123	215	1.8:1

Nonriverine agriculture is less common in Gedo Region due to inadequate rainfall and stony soils. The best nonfloodplain soils in the lower Jubba are under irrigation in banana plantations and large state-owned projects. More nonriverine cultivation takes place in Middle Jubba which is reflected in the SEBS sample.

2. Sample Population Age and Structure

Figure 4 shows an age and sex pyramid for the SEBS sample population. The population shows a broad juvenile base, typical of expanding populations in most developing countries of Africa. For example, the Jubba Valley birth to 14 years age group at 46 percent compares with 45 percent estimated for all of Africa for the same group (IIED 1986). This broad juvenile base shows a potential for population growth greater than the annual 2.8 percent estimated in the master plan, especially if better health services and facilities are made available. Less than 10 percent of the population survives beyond 55 years old which is reflected in the average life expectancy of 46 years (World Bank 1985).

Women are more numerous than men during prime childbearing years between age 20 and 40. Since polygyny is prevalent in Jubba Valley, a potential for dramatic population increase exists if there is improvement in maternal and infant health care. Annual population growth rates could soar to four percent if family planning does not accompany improvements in public health services. High maternal mortality (1.1 percent) and heavy domestic workloads for females contribute to lower percentages of women living beyond 40 years of age. In a JESS survey, of wives and daughters who had been reported to have died, 60 percent were under 30 years of age.

An anomaly of more males in the 40 to 49 age cohort than in the 30 to 39 age group can be attributed to recent international conflicts which would have impacted the 30 to 39 year cohort while in their 20s—an age group that nations choose to put at greatest risk during periods of war. Since polygyny is common, reductions in male cohorts will not create changes in population growth rates.

Somalia has an infant mortality rate of 143 deaths per 1,000 births before the age of one year. This rate is higher than the average infant mortality rate of 114 per 1,000 calculated for all African nations (IIED 1986). SEBS data permit calculation of mor-

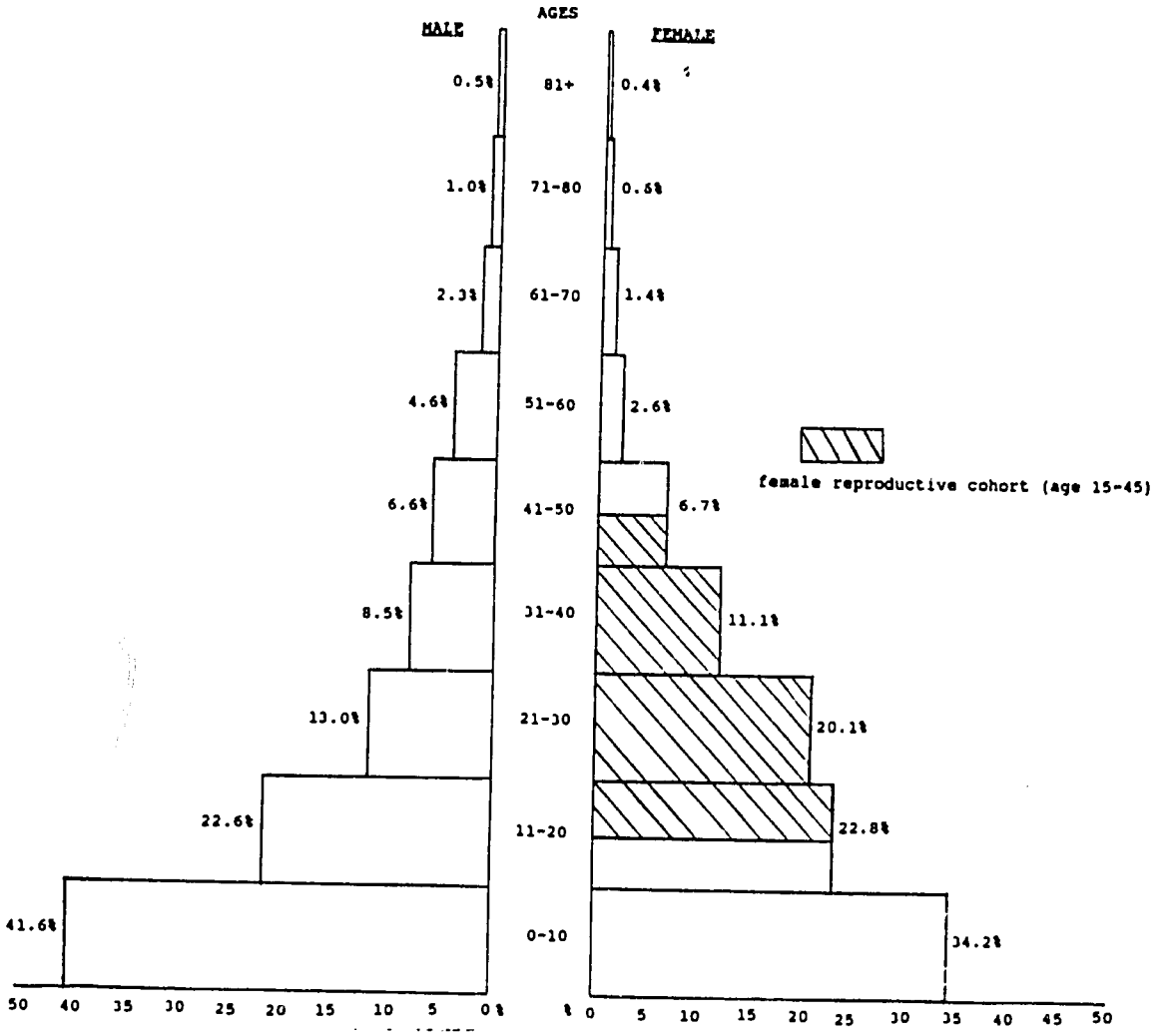


Figure 4. Jubba Valley population pyramid.

tality rates for children less than two months of age and two years of age. Rates for these two groups are 64 and 130 per 1,000, respectively—less than the Somali national rate. Variation between years of the infant mortality rate in Jubba Valley is considerable, ranging from 42 to 111 per 1,000 for the two month old cohort and from 92 to 241 per 1,000 in the two year old cohort. SEBS data were also used to calculate mortality rates for children in a five year old cohort. The peaks in infant mortality in this brief period generally correspond to low flow years of Jubba River. Drought and low-river flow are likely to be significant contributors to infant mortality since most villages do not have access to safe water.

3. Population Characteristics

Cultural Heritage

In an effort to understand settlement of the Jubba Valley in an historical context and to anticipate any irretrievable loss of historical information, JESS carried out a series of cultural heritage investigations in the area of the future reservoir.

Based on knowledge gained in a 1986 JESS reconnaissance of cultural heritage sites in the proposed Baardheere reservoir area, a large follow-up field survey was conducted in 1987 which identified 686 sites comprising open-air lithic and ceramic scatters, caves and rockshelters, rock art, cairns, and cemetaries. These sites were preliminarily dated to range between 150,000 years before present to within the last 3,000 to 5,000 years. Based on JESS recommendations (Brandt and Gresham, *et al.* 1988), GSDR, in association with World Bank, financed a series of follow-up intensive archaeological investigations to fully document the most historically important sites and assess the needs for their salvage. A ceramic pottery site 10 km south of Luuq, a cave 25 km north of Buurdhuubo, and a cave with rock art 12 km south of Buurdhuubo in the Jubba Gorge were excavated; collections were made and classified, but salvage was deemed inappropriate.

A series of cultural heritage investigations cast light on the evolution of Somali populations spanning the Middle Stone Age up to circa 3,000 years ago. (T. Gresham)

Labor

Discussions of Jubba Valley labor force tend toward confusion instead of clarity when statistics are cited. This condition is not unusual for subsistence economies where labor allocations must remain fluid for household survival. Inclement weather, government price policies, crop failures, livestock disease, or sickness and death in a household can force re-allocation of family labor outside of normal activities: these allocations change by season and year. It is not realistic in a Somali context to classify a subsistence farmer as strictly a farmer since environmental or social conditions often force other means of income generation, mostly outside agriculture. JESS studies show that household members devote considerable time to wage labor; cutting fuelwood for sale, gathering honey, fishing, doing craft work, or foraging for natural forest products in addition to cultivating farm plots and herding livestock. Similarly, civil servants, teachers, and shopkeepers own and farm plots of land or invest in livestock. For instance, 68 percent of all SEBS respondents own farm land including 41 percent of the urban and pastoral households. Risk-aversion strategies for subsistence are demonstrated by the wide range of economic activities pursued by each household. Attempting to classify residents by a single economic activity demonstrates a lack of understanding of Jubba Valley production systems and is misleading for development planning.

It is safe to accept the statistic that more than 90 percent of valley residents are engaged in agriculture as their primary or secondary activity. The small amount of non-agricultural employment is equally distributed among civil servants, small business owners, and wage labor in simple trades. The master plan indicates that 78 percent of the valley population claim agriculture as their primary occupation and the remainder indicate nonfarm employment as their primary source of income (AHT 1988).

In the SEBS sample, a majority of households derive income from agriculture (90 percent) while 11 percent of households report income from crafts, 23 percent operate family businesses (usually tea shops or small market stalls), and 28 percent report household income from wage labor.

Approximately 10,000 residents in lower Jubba Valley find employment at large-scale projects, mostly for seasonal work. Similar employment opportunities are not available elsewhere in the valley, except as part-time labor for other smallholders. Large-scale projects report labor shortages which can be explained, in part, by the low wages offered for seasonal and full-time employees. Seasonal labor earns between 30 and 140 SSh per day and full-time labor earns 1,500 SSh per month for non-managerial positions. At these low rates, subsistence farming under marginal conditions or hunting/gathering are more remunerative options. For instance, charcoal workers can earn over 400 SSh per day and fishermen in cooperatives collect over 1,000 SSh per day during high points in the season.

Education

Illiteracy in Somalia is very high, due, in part, to a lack of a written language until 1972. National literacy rates are 28 percent for males and six percent for females, while in Jubba Valley, rates are 36.2 and 14.8 percent, respectively. Table 8 summarizes literacy in Jubba Valley by gender, SES, and region.

Table 8. JUBBA VALLEY LITERACY (percent)

SES/REGION	MALES	FEMALES
Urban	77.0	37.3
Riverine	29.7	8.4
Nonriverine	24.6	6.7
Pastoral	9.6	2.5
GedoRegion	30.9	10.8
Middle Jubba Region	32.1	10.9
Lower Jubba Region	46.5	22.8
Jubba Valley	36.2	14.8
Somalia	28.0	6.0

From Table 8, it appears that Jubba Valley enjoys higher literacy rates than the national norms. In SEBS interviews, respondents were asked how many in a household could read and write, but they

Agro-pastoralists and sedentary agriculturalists like these in the village of Caanoole, south of Baardheere, will experience development pressures associated with the new dam. The extent to which these impacts are positive depends on how the villagers' way of life is considered by development planners. (P. Dulin)

were not required to demonstrate. It is likely that respondents may have been optimistic in their self-assessments. However, the data are valuable in demonstrating differences between sectors and regions. Pastoral populations do not have education advantages equal to settled populations except in natural (survival) sciences. The highest exposure to written language is in urban areas, as reflected in the SEBS results.

It is clear that urban men have a significant literacy advantage over all other groups, regardless of gender. If government were to rely solely on newspapers or other printed documents to dispense information on development plans or changes in legislation, urban males could take immediate investment advantage over their less fortunate rural counterparts. Also, if government or donor/lenders intend to actively seek community participation in economic development planning, it will be necessary to utilize radio or village meetings to stimulate dialogue.

Literacy and communications becomes more complex in Jubba Valley when multiple languages are considered. Most households (92 percent) know Maxadtirey, the official Somali dialect. However, over 55 percent use Afmaay-maay, a Southern Somalia dialect, as their first language for communication. SEBS data also show common use of Arabic and Swahili in some villages. Italian and English are the most frequently spoken European languages, but both are known by less than 10 percent of the adult population.

Low literacy rates can be expected considering the lack of education infrastructure and minimal budgetary support. There is little formal educational opportunity, as Jubba Valley has 97 primary schools (AHT 1988) to serve an estimated population of 475,700 children under 14 years old, or one school for each 4,900 children. Schools have inadequate physical facilities and an absence of trained teachers. Monthly salaries of 600 to 800 SSh are not sufficient to attract field labor, much less to entice and retain professional teachers—especially for rural communities where teachers are less likely to find supplemental employment. Supplies and books are lacking at all schools.

Secondary schools are also grossly inadequate with only 10 schools in the entire valley (AHT 1988). Conditions are similar to elementary levels: lacking facilities, learning materials, and qualified teachers.

Post-secondary education is completely lacking in Jubba Valley. The closest post-secondary institutions are at Afgooye and Muqdisho.

Fifty percent of males and more than 80 percent of females in Jubba Valley lack any formal education. Urban/pastoral sectors represent sample extremes with 79 percent of urban males receiving some education and only 14 percent of pastoral males. Comparison of urban (41 percent) and pastoral (six percent) females with some formal education demonstrates the similar urban education advantage. When formal education is reported by household members, it rarely exceeds more than three years. In the more than 1,000 households of the SEBS sample, only 100 males completed 12 years of schooling (89 urban and 11 sedentary agriculturalists; no pastoralists) and eight of these completed a college degree. Only 32 females completed 12 years and three received college degrees.

Lack of trained labor has been viewed as a serious development constraint, especially in conjunction with large-scale irrigation projects. It is clear that this situation will not change quickly, considering the current status of education. Government has decreased expenditures to education from 10 percent in 1975 to two percent in 1986 (LaPin *et al.* 1988) and negatively affecting the valley.

Even in villages where schools are present, the schedules of operation are erratic. During visits by JESS, villagers explained that schools were closed for holiday or dismissed for agricultural work. It was not possible to determine when schools were in session or when they had last been in session.

Health

JESS public health and epidemiology studies highlight what should be a significant development and humanitarian concern for Jubba Valley. It should be emphasized that vastly increased incidence of bilharzia, malaria, and gastroenteric (dysentery and diarrhea) disease have been tragic and consistent consequences of tropical water development projects in spite of numerous pre- and post-implementation studies. Without serious government and donor/lender commitment and intervention in public health, already unacceptable levels of water-related diseases will be significantly increased through economic development projects envisaged for Jubba Valley.

Connections between disease and water development projects are demonstrated in lower Jubba Val-

ley where irrigation projects are concentrated. Near Jamaame, which is a center of irrigation development, JESS epidemiology studies showed alarmingly high incidence of urinary bilharzia and malaria (Klumpp 1988; Warsame 1988). In fact, bilharzia conditions were the worst that the researcher had found in 20 years of epidemiological studies conducted throughout Africa.

An assessment of health conditions based on JESS studies and other sources cannot be viewed with optimism. Infant mortality induced by neonatal tetanus, malaria, polio/meningitis, and gastroenteric infections is extremely high. High morbidity and mortality can be partially attributed to the fact that only 21 percent of Somalia's rural population has access to reasonably safe drinking water (IIED 1986). Jubba Valley domestic water sources vary with socio-ecological sector as shown in Table 9.

Table 9. PRIMARY SOURCE OF DOMESTIC WATER (percent of households)

Sector	River	War*	Well	Dhesheeg/canal
Riverine	92	3	5	12
Nonriverine	51	5	32	12
Pastoral	12	10	73	5
Urban	22		42	36

* *Man-made depressions to store water.*

Frequently, households are forced to go to secondary sources as wells, wars, dhesheegs, and canals become dry or saline. The table shows a high reliance on untreated water from the river, dhesheegs, and wars. Water from wells is obviously safer than other sources, but since wells are not sealed or covered, contamination is probable.

In a JESS assessment of community water supplies, only major towns, such as Jamaame, Jilib, Bu'aale, Saakow, Garbahaarey and Buurdhuubo had functional drilled wells (Jobin 1987). While water from drilled wells is relatively free from bacterial contamination, salinity levels were above international standards for acceptable drinking water. Kismaayo draws water from Jubba River and passes it through a nonfunctioning water treatment plant which has been scheduled for rehabilitation. Water intakes for this system are frequently inundated by sea water during low jiilaal river flows and high tides (Jobin 1988). In addition to being unhealthy for domestic use, sea water causes damage to water treatment systems.

Most riverside villages and some large towns, such as Goob Weyn, Baardheere, and Luuq are supplied with domestic water taken directly from the river and most commonly dispensed by donkey cart water vendors in 200-liter barrels. PVOs implement and operate water treatment systems at refugee camps providing reliable supplies of safe water for the large camps. Small villages may have shallow wells drilled by the Water Development Agency, but often pumps are inoperable and hand buckets are used to draw water. Some villages are served by shallow hand-dug wells which are subject to severe contamination and seasonal drying.

Inland from the river, agropastoralists and pastoralists are obliged to rely on scant and temporary surface water, which is often stored in open, hand-dug depressions called *wars*. Humans and livestock share the same contaminated drinking water. As water disappears, humans and animals migrate temporarily to other sites.

Sanitary facilities are virtually unknown beyond simple pit-latrines. Only 12 percent of households reported in-house latrines in the SEBS survey and 92 percent resort to the bush to void wastes. The limited urban facilities are poorly maintained and represent greater human health hazards than using the bush for excreta disposal.

With poor water supply and sanitation systems, valley residents cite gastroenteric problems as frequent household ailments, especially with infants. Nearly 10 percent of infant deaths in Jubba Valley are attributed to diarrhea. There are scattered efforts to improve domestic water supplies, such as a village well-drilling program operated by Swedish Church Relief, who also maintain public health posts in middle Jubba. World Concern, another PVO, operates a health clinic in Jilib in lower Jubba Valley. PVO water systems in upper Jubba benefit some local residents, but they are primarily used for refugees.

Urinary bilharzia is not generally perceived by valley residents as being of significant concern in spite of its common occurrence. Since bilharzia symptoms are more debilitating than life-threatening, it is likely that people have come to tolerate the symptoms and disease as a normal part of life. JESS epidemiology studies clearly demonstrate that urinary bilharzia is common and widespread.

In a JESS study, Klumpp (1988) tested 2,002 children between five and 14 years of age in Jamaame District for presence of *Shistosoma haematobium*, the parasite responsible for urinary bilharzia. Overall prevalence rate was 74.6 percent—the highest rate recorded in Somalia for such a large sample. By village, prevalence rates varied from 46 percent in Jamaame town to 98 percent in a small village surrounded by irrigated cropland. There was slight difference in prevalence between males and females with higher incidence in males. By World Health Organization (WHO) standards, six of 15 sites would be classified as heavy intensity infections with geometric means of egg counts being greater than 50 per 10 ml urine sample (Klumpp 1988). A simultaneous snail vector survey in this area produced no infected *Bulinus abyssinicus*, the intermediate bilharzia host, in Jubba River or dhesheegs. Infected snails were only found in small, temporary roadside pools.

Malaria is perceived by valley residents to be far more common and more serious than most other diseases as nearly 20 percent of the SEBS sample report malaria as the most recent serious illness. This percentage is much higher than would be indicated from blood-testing surveys. It is likely that residents consider any recurring fever as malaria whether it responds to quinine-derivative treatment or not. Since unpasteurized milk is a common dietary item, it is likely that brucellosis (undulant fever) is also common and symptoms of this disease are similar to those of malaria. Slaughter of diseased animals is a common practice which contributes to spread of undulant fever. The Veterinary Laboratory at Kismaayo reported brucellosis antibodies in three percent of cattle tested and five percent of camels. This finding supports a supposition that some valley residents are likely to be confusing undulant fever with malaria.

In a JESS malaria survey, Warsame (1988) found malaria conditions in Jamaame District were slightly more encouraging than bilharzia survey results. Of 1,246 children between two and nine years of age, 180 had palpable spleens. Spleen rates varied between villages with the lowest rate found in Jamaame Town. Blood smear examinations showed infection rates between three percent (Jamaame) to 50.7 percent in a small, riverside village. The dominant parasite species was *Plasmodium falciparum* (always greater than 85.7 percent by village). *P. malariae* was the only other malaria parasite encountered. Only one sample village had malaria at hyperendemic levels.

JESS epidemiology surveys took place in early jiilaal, which is a peak transmission period, although not as high as early xagaa. In July 1988, JESS conducted a survey for the snail vector of urinary bilharzia from Kismaayo to Baardheere. In lower Jubba, 46 likely water contact points for humans were sampled in 25 villages. *Bulinus abyssinicus* were found in 46 percent of sampled sites and 20 percent of these snails were infected with the bilharzia parasite. In upper Jubba, snail incidence was less with only 16 percent of sample sites having bilharzia snails. However, snail infection rates were much higher (35 percent) in this region (Klumpp 1988). Shells of the snail vector were found at the proposed dam site, but no living specimens were collected there.

Only urinary bilharzia is reported from Jubba Valley. Intestinal bilharzia is present in northern Somalia and could possibly spread to Jubba Valley. There is no doubt that this more dangerous form will spread quickly through the valley if both parasites and snail vectors become established. JESS surveys did not find any snail vectors of intestinal bilharzia.

Of greater concern to health officials and valley residents is a recent introduction of a chloroquine-resistant form of *P. falciparum* malaria. Reliable data on prevalence are lacking as only one health post, the MoH laboratory in Jilib, is capable of diagnosing the disease. MoH officials note that more cases of chloroquine-resistant malaria are appearing in Muqdisho, although most cases are coming from outlying regions, including Jubba Valley. The disease is particularly virulent, usually causing death if not treated properly. If this disease follows a course similar to those it has exhibited elsewhere in tropical countries, chloroquine-resistant malaria will become even more prevalent. Unfortunately, government does not have resources to research this disease outside Muqdisho nor is it able to import medicines for prophylaxis and treatment.

Malnutrition is reported to be significant throughout Jubba Valley. Prime indicators are protein deficiencies in children and anemia in women. Limited data on malnutrition make it impossible to predict its extent and severity. UNICEF conducted nutrition surveys on children less than five years of age in Jamaame and Kismaayo districts in 1987 and 1988. Less than two percent of children showed charac-

teristics of severe malnutrition and cases of moderate malnutrition varied from three to 13 percent by village. Over 65 percent showed no evidence of malnutrition. Malnutrition is more common during drought and flood years and these districts experienced both drought and flood in 1987. It is unlikely that the UNICEF study covered pastoral children in their village surveys.

Anemia, especially in pregnant women, is commonplace. Valley women typically do not eat meat and other foods containing iron on a daily or even weekly basis. Further, widespread heiminthic infections contribute to iron deficiencies by selectively taking essential vitamins and minerals from their human hosts. Also, Somali women purposefully restrict food intake during pregnancy to reduce childbirth complications which result from the more severe forms of female circumcision at a time when their diet must provide nutrition for themselves and developing child. A JESS anemia survey was cancelled when trained personnel from the Refugee Health Unit were unable to participate. However, World Concern used JESS hemoglobin spectrophotometers to conduct a limited survey of anemia in pregnant women in a maternity clinic in Jilib.

The World Concern anemia data presented in Figure 5 demonstrate the serious anemic conditions of pregnant Somali women. As medical facilities are better in Jilib than other Jubba Valley villages, anemia is likely to be worse at other sites. The data, subdivided into nonpregnant, first through third trimester and post-partum, show a linear increase in anemia and severity progressing from the first trimester of pregnancy to a 100 percent incidence in post-partum females. Percent of severe anemia increases from zero in first trimester to 25 percent in post-partum. These data were limited by number (99) and geographic location (Jilib) and were not randomly collected. They are presented to illustrate a potentially serious health problem which is likely to exist throughout Jubba Valley and is a problem which could be mitigated with simple health and nutrition education programs.

Cholera, typhoid fever, and hepatitis outbreaks occur with regularity throughout Somalia (Jobin 1988). These outbreaks normally occur at onset of the gu' rains. Highly contaminated pools form in countryside and village streets with enough turbidity to block purifying ultraviolet rays of sunlight. These pathogen-laden "soups" provide excellent media for bacterial growth leading to periodic out-

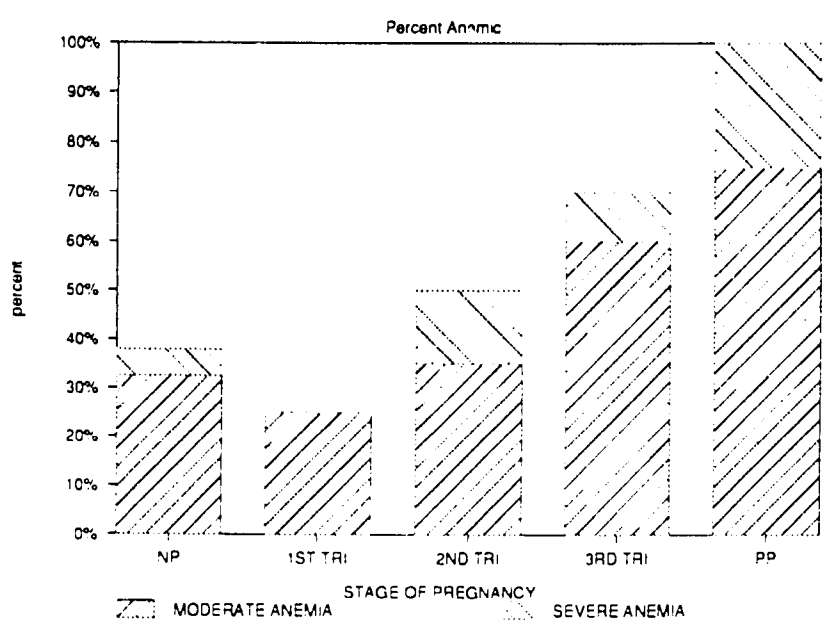


Figure 5. Anemia in Jubba Valley women.

breaks of cholera and typhoid fever. Vermin, especially rats, are favored by widespread water and waste and they provide mechanisms to further spread communicable diseases. As noted previously, street and roadway pools provide habitat for mosquito and snail vectors of disease.

Rift Valley Fever constitutes another threat to Jubba Valley and there is evidence that this disease is encouraged by reservoir filling. This viral disease is transmitted by mosquitos, including many species of *Aedes* spp. and *Culex pipiens* (Benenson 1985). While little is known about this disease, it is apparently associated with sheep and other ruminants and is spread to humans by mosquitos or through handling diseased carcasses. Outbreaks tend to be large and in two instances, they have occurred near filling reservoirs in Egypt and Mauritania. Outbreaks of Rift Valley Fever have occurred recently in countries neighboring Somalia.

Other diseases are of concern. but insufficient data make it impossible to develop reliable health profiles. With existing data, basically for bilharzia and malaria, the overall health assessment is grim. As irrigation expands into middle and upper Jubba, disease will inevitably increase. At present, infection rates in middle and upper Jubba are not as high as in irrigated zones in lower Jubba. As irrigation expands into the upper regions, bilharzia and malaria will increase unless improved health services go beyond development planning and actually become integrated into development projects and programs. Health components aimed at lowering existing disease levels should be routine pre-conditions for any water development project planned for the next two decades in Jubba Valley. Rather than attempting to implement parallel, but separate, projects or programs for agriculture and health, government should build into proposed agricultural projects a fair economic share of providing health services to populations that the projects put at increased risk.

Settlements

Spatially, Jubba Valley urban centers are evenly distributed to provide regional support for rural populations (Table 10). In reality, support roles for these urban centers are poorly developed and each center suffers from a lack of regional and settlement planning. What few areas of support for rural populations existing in urban centers have evolved with little government planning and intervention. Limited government facilities at municipal, district, or regional levels are either in poor shape or nonexistent. In Lower Jubba Region where support facilities and services are best developed, rural populations receive only minimal support from urban centers.

Table 10. URBAN CENTERS IN JUBBA VALLEY (After AHT 1988)

CENTER	LOCATION	POPULATION
Kismaayo	Lower Jubba	80,200
Luuq	Gedo Region	19,000
Baardheere	Gedo Region	17,200
Jilib	Middle Jubba	16,400
Jamaame	Lower Jubba	9,400
Saakow	Middle Jubba	6,800
Bu'aale	Middle Jubba	2,800

As with other valley population estimates, there is a considerable range of estimates for these urban centers. For instance, Watson and Nimmo (1985) estimates Kismaayo's population at 120,000 and Evans, Cullen, and Little (1988) use an estimate of 52,180. Watson and Nimmo (1985) place 58,000 inhabitants in Jilib, and Evans, Cullen, and Little estimate more conservatively at 20,070.

According to AHT (1980), Jubba Valley has, in addition to urban centers listed in Table 10, 12 primary rural centers with greater than 1,000 residents, 45 secondary rural centers (500 to 1,000 population) and 78 tertiary rural centers (inhabitants). Distribution of settlements is strongly influenced by the presence of Jubba River as most towns and villages are within few kilometers of the river. Deshmukh (1989) notes that this dense riparian population concentration places severe stress on woody floodplain and river-dependent vegetation. Unless methods can be devised to divert fuelwood extraction to inland areas, floodplain woody vegetation will succumb to concentrated exploitation. Over-extraction of wood has already surpassed sustainable rates near larger urban areas in lower Jubba and around refugee camps in Gedo Region where large perimeters of complete deforestation can be seen.

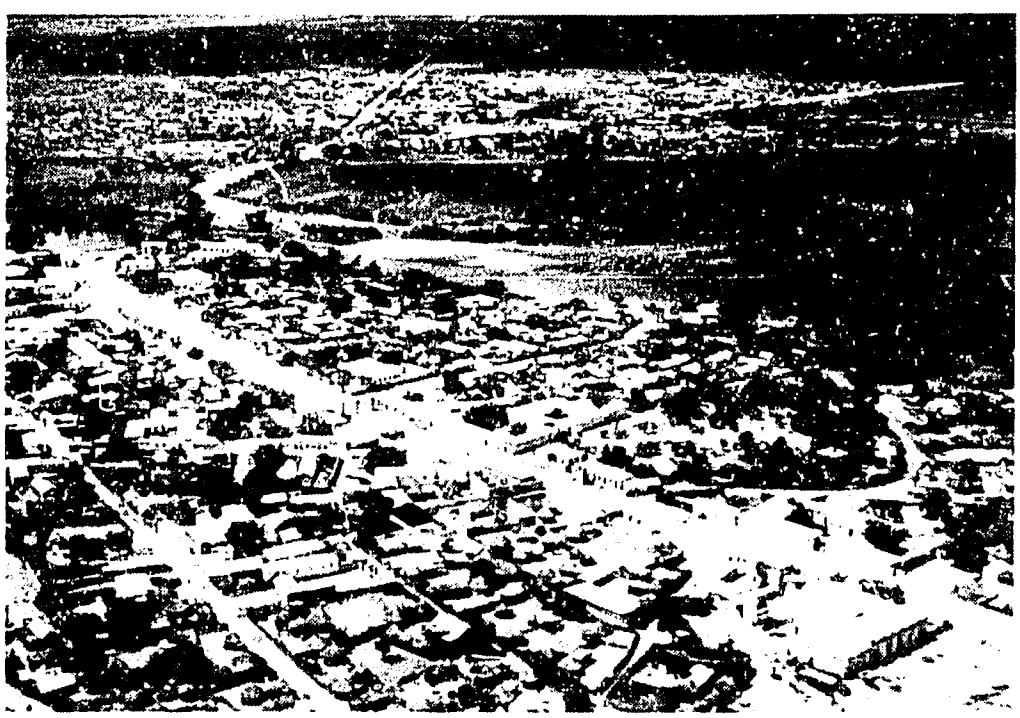
Each urban center has serious problems with water and sanitation systems with the exception of water supply in Saakow and Bu'aale, where there is less population to serve. While Saakow and Bu'aale have adequate wells, pump malfunctions continually plague service. Urban centers have insufficient

health facilities and services. Only Kismaayo has a functional hospital, but with inadequate staff and health care supplies. Bu'aale and Saakow have health posts operated by Swedish Church Relief and World Concern maintains a small health clinic in Jilib. Urban centers in Gedo Region lack even primary health centers.

Public markets in urban centers have variable supplies of goods for sale. JESS market data show that many staple foods are not available for extended periods, even in relatively large markets in Kismaayo, Jilib, and Baardheere. Limited supplies of staple goods give rise to dramatic price fluctuations. Middle Jubba normally experiences high prices during wet seasons when transportation is curtailed by a lack of an all-weather road. Upper and lower Jubba show price increases in late jiilaal when stored grains begin to dwindle.

Larger settlements in Jubba Valley do not provide sources of agricultural inputs normally associated with rural support centers. During the JESS study period, USAID/Somalia supported a study on urban-rural linkages in lower Jubba Valley under auspices of the Settlement and Resource Systems Analysis (SARSA) Cooperative Agreement. JESS and SARSA personnel collaborated on data collection to avoid duplication. JESS believes that study results of lower Jubba can be generalized to Middle Jubba and Gedo Regions, in regard to support functions of urban or village centers.

Evans, Cullen, and Little found that population was not necessarily a good indicator of the number of support functions found in the center. They measured 63 functions, including small stores, clinics, clothing store, telephone, lawyer, bank, and agrochemical supply. The number of functions ranged from a high of 59 in Kismaayo to only three at sites termed "noncentral places". The number and range of urban functions was related to the settlement's hinterland population, physical accessibility, and a location relative to other competing centers, rather than strictly to settlement size.



The town of Baardheere on the east bank of Jubba River will most likely double in size as a result of construction activities at the proposed dam site, just 35 km to the north. (J. Janzen)

The draft master plan gives inadequate coverage to settlement planning, limiting proposed activities to elaborating development plans for all primary and secondary urban centers with priority given to Kismaayo, Jilib, and Baardheere. In an interim report, JESS stressed an importance for settlement planning in Baardheere because two large development planning events will have immediate and extensive repercussions in Baardheere (Tillman 1987a). Completion of a proposed Baardheere-to-Jilib all-weather road will funnel products and people toward Baardheere as the road between Baardheere and Muqdishe is superior to the Jilib-to-Muqdisho roadway. Improving the Baardheere to Muqdisho road for dam construction traffic will exacerbate vehicular movements through Baardheere from Middle Jubba. In addition, constructing a high dam only 35 km from Baardheere will have enormous settlement consequences. The draft master plan does not account for the impacts of dam construction beyond noting that the labor camp is likely to remain as a permanent settlement. However, the plan does not recommend instituting permanency in labor camp construction or make plans for the camp facilities after Baardheere Dam is completed.

JESS recommends that future versions of the master plan include priority for settlement planning at Baardheere as it will be the community which will grow most rapidly in the coming decade as BDP is implemented. In addition, it is urged that the master plan involve the Nairobi-based United Nations Centre for Human Settlements (UNCHS) as soon as possible for an urban settlement planning component. UNCHS maintains an excellent reference facility on rural and urban settlement planning and provides technical assistance to numerous African countries, including activity in Somalia.

Economy

Subsistence Agriculture

Jubba Valley economy is predominantly subsistence agriculture with household economic strategies not oriented to cash or export production systems. SEBS data have been analyzed by regional and socio-ecological production sector. One set of analyses has structured the sample population into socio-ecological sectors (SES) comprising pastoral, riverine agriculture, nonriverine agriculture, and urban populations which then were recombined for whole valley summations. Also, the sample population data were structured by administrative regions, covering Gedo, Middle Jubba, and Lower Jubba regions.

Underlying these analytical components is a recognition that Jubba Valley is evolving economically and socially—changing from historic patterns which more distinctly separated production systems into sedentary agriculture and mobile livestock herders. These groups differed socially and economically and had distinct geographic boundaries determined mostly by tsetse-fly distribution. These distinctions are breaking down through an evolution of agro-pastoralism which combines elements of livestock herding and settled agriculture. Pastoralists are beginning to cultivate plots of land in order to diversify household economic bases. Concurrently, households with predominantly agricultural incomes have started keeping livestock as well as cultivating cropland.

Both tendencies represent risk-aversion or economic diversification strategies aimed at family survival in harsh environments. Recent droughts have been instrumental in prompting pastoralists to become more settled in agriculture and residents are increasingly mixing both systems into agro-pastoral strategies. Urban dwellers diversify as well. Approximately 42 percent of urban households report owning farmland and an equal amount report livestock ownership.

Agro-pastoralism is suited to ecological conditions in Jubba Valley. Livestock are not as dependent on local vagaries of climate, since they can be moved to more favorable locations whereas rainfed crops deteriorate when local rains fail. However, when soil moisture from rainfall or flood is adequate, or even abundant, surplus grain is produced which can be stored for several years in underground pits with relatively little grain loss. It is estimated that more than 100,000 tons of grain may be stored in storage pits in Jubba Valley (World Bank 1985). Menkhaus (1988) reports that British Military Administrators during World War II were aware of both practice and capacity and dispatched soldiers to villages to excavate likely sites for stored grains.

Pastoralists see benefits of allocating some family resources and labor for rainfed cultivation to provide grain for family consumption and crop residues for livestock. Typically, part of the family remains near the cropland while adult males and boys move with livestock to distant grazing grounds. Livestock herding is not labor-intensive as one person can

safely tend many animals. Cultivators can divert a small amount of family labor for livestock herding without economic penalty—often in pooling arrangements within the community or extended family (Janzen 1988). Herds owned by agro-pastoralists are not likely to be as large as transhumant herds nor as wide-ranging in search of forage and water. For example, agro-pastoral households have approximately nine tropical livestock units (TLU) per herd while pastoral household herds average over 55 units (one TLU equals 250 kg live weight). Agro-pastoralist herds have a different mix than pastoral herds, most notably by having fewer camels. In the SEBS sample, only 11 percent of agro-pastoral herds included camels while over 70 percent of pastoral herds had a major camel component. Herd mix and size allows agro-pastoralists to remain close to home so that family herders may return to provide additional farm labor during clearing, planting, or harvesting.

SEBS analyses are a single look at Jubba Valley in transition, which is precisely the objective of baseline studies. It is likely that this trend toward agro-pastoralism will continue, at least until some export-oriented agricultural system takes its place. In a Jubba Valley context, export should not necessarily be conceived as strictly for international sales; any sale of products outside of the valley is an improvement beyond a purely subsistence economy. A fuller discussion of the evolution of agro-pastoralism and its social and economic implications is provided in Volume III, Part A of this report (Craven, Merryman, and Merryman 1989).

Across socio-ecological sectors, SEBS data reveal that farm ownership is as common as would be expected where 90 percent of the population are engaged in agricultural or subsistence labor (Table 11). Plot ownership ranges from 42 percent of urban households to nearly equal rates for riverine and nonriverine families at 93 and 92 percent, respectively. Data support the predicted trend from pastoralism to agro-pastoralism as more than half of pastoral households report farm plot ownership.

Data on mean plot size must be viewed with caution as they are based on respondent self-reporting to questions rather than on measurements. Respondents used local measurements which cannot be precisely converted to metric units. In a reservoir resettlement study, researchers found that farmer estimates of their land under cultivation were often erroneous with up to a sixfold difference between farmer's estimate and measured area. Plot size data show relative differences between socio-ecological sectors.

Table 11. FARM PLOT OWNERSHIP AND MEAN PLOT SIZE

SES TYPE	PERCENT OWNING	MEAN SIZE (ha)
Pastoral	51	4.8
Urban	42	5.9
Riverine	93	6.3
Nonriverine	92	3.6
Total Sample	76	5.4

Urban households are more affluent than rural ones and are able to afford farm plots comparable in size to those of riverine farmers. Riverine farmlands have higher yields than nonriverine land owing to greater soil moisture and periodic soil nutrient enrichment from flooding. These higher yields encourage riverine families to devote more labor to significantly larger plots than their nonriverine counterparts. Nonriverine households are more likely to allocate family resources to livestock keeping rather than increasing farm size. Riverine households are less likely to invest in livestock because of greater tsetse risk near the river. As a result, riverine households are more likely to divert more income and labor toward expanding farm holdings.

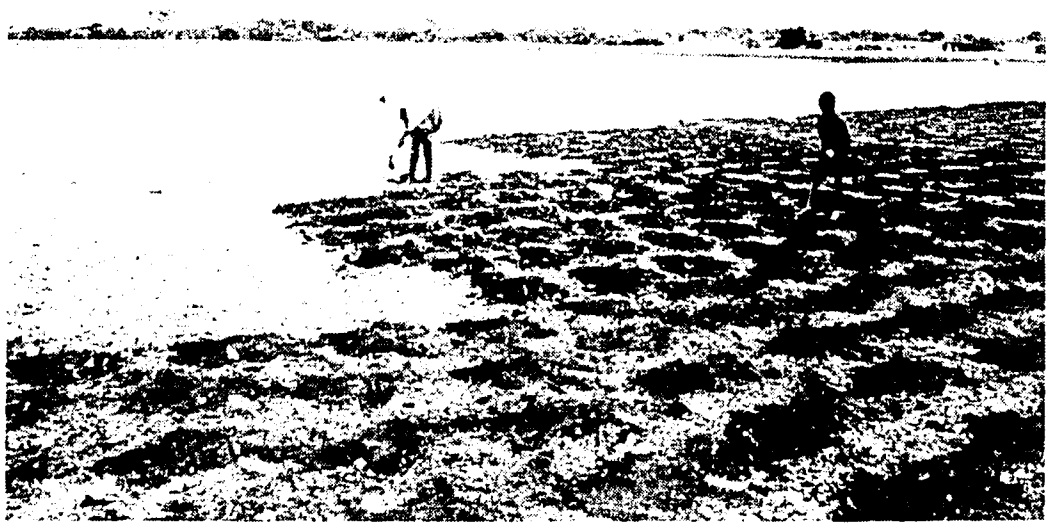
A common subsistence risk-aversion strategy involves multiple plot cultivation. A farmer may have one riverbank plot, one dhesheeg plot for recession agriculture, and an upland site for rainfed cultivation. Each setting has specific agricultural advantages and disadvantages for smallholders. Riverbank soils are normally more fertile with higher soil moisture from flooding and high groundwater levels. Riverbank land is prone to periodic flooding which also provides nutrient enrichment, but with a concomitant potential for crop destruction if floods are poorly timed. For instance, gu' 1987 floods were late and riverbank and dhesheeg crops were approaching maturity when floods arrived. Since Jubba River does not top its banks every year, farmers had already planted shortly after a minor flood peak in April 1987. In late May, a second flood occurred with tremendous and disastrous volume. Farmers in Gedo Region claim that it was the worst flood in the last decade. With increasing deforestation in the upper catchment in

Ethiopia, Jubba River flooding is likely to become more common and less predictable.

Dhesheegs are vulnerable to river floods and heavy local rains, but once flooded, the heavy clay soils retain standing water for extended periods (some greater than two years), thus allowing a relatively safe recession agriculture as water evaporates. Nutrients in dhesheeg soils are comparable to those of riverbanks. Since river flooding is not annual, although frequent, farmers cannot depend each year on production from dhesheegs, but must be in a position in terms of labor and seeds to take advantage when conditions are favorable. Dhesheegs are farmed without floods, but at reduced yields.

Rainfall averages generated from long-term data are of no value to subsistence farmers. In years of good rainfall (amount and temporal distribution), farmers harvest reasonable yields from rainfed plots. As with river flooding, good rainfall is not an annual expectation, but it occurs often enough so that farmers plant rainfed plots when early rains are encouraging. If rains continue, crops will mature to harvest and storage pits are replenished to carry households through years when rainfall and floods are insufficient for rainfed and dhesheeg production. If rains do not continue, the household accepts the crop loss, or perhaps, gets enough stalk growth for livestock fodder. When farmers cultivate all three types, riverbank, and upland areas are planted first at onset of rains, while dhesheeg planting is delayed until danger of flooding is reduced (Besteman and Roth 1988). Planting strategies, in terms of crop selection, are discussed in greater detail by USBR (1987), AHT (1988), and Craven, Merryman, and Merryman (1989).

In theory, farmers gain considerable advantage when cultivating all three plot types. In dry, non-flood years, riverbank plots and stored grains ensure household survival—barring prolonged drought. In wet and/or flood years, surpluses are expected to replenish stores, or to be sold at local markets. Table 12 presents SEBS data on multiple plot ownership. These data do not indicate a pattern of multiple plot



Farmers follow receding waters as they evaporate from a dhesheeg near Caanoole. This farmer opens shallow pits on the drying dhesheeg floor as his son sows sesame. The planting season continues as more area is revealed and sown in a concentric pattern following the receding water level. (P. Dulin)

ownership as less than four percent of any SES claim ownership of three plots and an overwhelming majority own a single plot. Part of this discrepancy between reports and SEBS data may be due to male household heads failing to report plots owned and farmed by wives or working plots which have been borrowed for a season from relatives or friends (Besteman and Roth 1988). Also, respondents were reporting only plots which were in cultivation and did not report plots which were being fallowed. Finally, SEBS sampled in all three regions and found that dhesheeg cultivation is limited to middle Jubba as there are no dhesheeg plots in upper and lower Jubba.

Table 12. MULTIPLE PLOT OWNERSHIP BY SOCIO-ECOLOGICAL SECTOR (percent owning)

	NUMBER OF PLOTS OWNED				
SES	1	2	3	4	>4
Pastoral	78.4	14.4	2.7	0.9	3.6
Urban	87.4	10.4	2.2	-	-
Riverine	73.1	20.6	3.9	1.2	1.2
Nonriverine	73.2	22.8	3.1	0.4	0.4
Total Sample	76.4	18.6	3.2	0.7	1.1

It is possible that multiple plot cultivation is more of a subsistence strategy at community rather than individual household levels. Since community stores are shared in times of need, it is more important that villages have access to all three types of cropland so that at least some farmers will have a crop if conditions are not favorable to all types. This community strategy would make better use of available labor and skills in that individual farmers will not have to travel between three different plots and will not have to master all types of cultivation.

Volume I of the draft master plan provides summaries of rainfed, dhesheeg, and irrigated agriculture in the study area between Baardheere and the coast (AHT 1988). Table 13 summarizes master plan data on rainfed agriculture by district and Table 14 presents estimated crop production and yields by district. No distinction is made between riverbank and upland areas in these tables.

Master planners were keenly interested in dhesheeg and levee agriculture and have collected extensive data on these farming systems. Most recession agriculture takes place in middle Jubba where river

Table 13. RAINFED CROPLAND BY DISTRICT

DISTRICT	CROPPED LAND (ha)	CROP INTENSITY
Baardheere	82,000	140%
Saakow	44,100	125%
Bu'aale	3,900	195%
Jilib	6,500	93%
Jamaame	10,000	53%
Kismaayo	500	53%
Total	147,000	

Source: AHT (1988)

Table 14. RAINFED CROP PRODUCTION BY DISTRICT AND SEASON

District	Crop	Hectares		Production (tons)	
		Gu	Deyr	Gu	Deyr
Baardheere	Sorghum	35,000	38,000	21,000	15,200
	Maize	3,700	800	2,590	320
	Sesame	1,600	1,600	480	320
	Beans	400	400	160	40
Saakow-Bu'aale	Sorghum	22,600	23,600	13,560	9,440
	Maize	1,200	500	720	150
	Sesame	500	500	200	100
	Beans	250	-	100	-
Jilib-Jamaame-Kismaayo	Maize	5,000	-	6,000	-
	Sesame	3,600	-	2,160	-
	Beans	1,000	-	500	-
	Groundnut	300	-	150	-
	Cotton	100	-	40	-

Source: AHT (1988)

meanders are pronounced. Bu'aale District has 5,900 ha of recession agriculture followed by Jilib District with 3,700 ha. Saakow District has less than 2,000 ha in recession farming. Of the 11,400 ha in flood-recession agriculture, 7,000 ha are dhesheegs and 4,400 ha are located on river levees. Estimated crop production from dhesheegs is summarized in Table 15 by season and district.

With river control imposed by Baardheere Dam, dhesheeg agriculture will wane, representing some loss of production from 11,400 ha of relatively rich cropland. Dhesheeg land will not be lost, as it can be farmed without overbank river flooding. Rainwater will still accumulate in dhesheegs, but farmers will be more dependent on local rains than

before. There will be some gains in overall production as crops should not be lost to late floods and farmers can plant early without fear of powerful river floods. Overbank floods can be artificially produced from Baardheere Dam and these could be used to partially fill some dhesheegs if agricultural interests are to be more equally balanced with power generation during dam operation. At least in the period immediately following dam closure, Somalia will not be in a position to utilize full capacity of Baardheere Dam electric power output. During this period, operators may experiment with flood-level discharges for continued dhesheeg flooding. Further, government projects could be initiated to install flood and drainage conduits between the river and dhesheegs so that filling and draining could occur before the river reaches bankfull capacity.

Table 15. DHESHEEG CROP PRODUCTION BY SEASON AND DISTRICT

DISTRICT	CROP	HECTARES		PRODUCTION (tons)	
		Gu	Deyr	Gu	Deyr
	Maize	1,365	425	921	191
Saakow	Sesame	380	1,240	105	341
	Beans	35	125	14	44
	Vegetables	20	-	85	-
	Maize	5,250	1,180	2,625	472
Bu'aale	Sesame	350	4,600	114	1,380
	Sorghum	180	-	32	-
	Beans	60	120	24	48
	Vegetables	60	-	255	-
	Maize	2,660	1,295	2,075	874
Jilib	sesame	220	2,295	99	918
	Beans	670	110	318	50
	Vegetables	-	765		

Source: AHT (1988)

The master plan proposes to implement a dhesheeg pilot project at Saakow, followed by a dhesheeg conversion project based on experiences gained in the pilot effort. Recession agriculture is a sound direction for agricultural research in order to ensure continued flood-recession cultivation until proven irrigation systems have begun to produce.

The master plan study area did not initially include the reservoir zone; therefore, potential agricultural and livestock benefits from the drawdown zone have not been considered by master planners. With a vertical drawdown of 14 to 16 meters, a large part of the reservoir perimeter will alternate submergence and exposure. For instance, the northernmost reservoir point will shift 46 km southward from Luuq when at minimum operating level. This drawdown area has potential for recession agriculture—either for crops or livestock fodder. It may even be possible to graze livestock in the drawdown zone. Scudder (1988) notes that reservoir margins have been successfully utilized for recession agriculture in many African hydropower projects, but that potentials were often overlooked during planning. Most African reservoirs develop luxuriant emergent vegetation in the drawdown area which is excellent livestock forage.

The future reservoir margin will be used by people for agriculture and livestock grazing whether these become planned activities or not. In semiarid environments, subsistence people do not waste water or vegetation resources and some people will use the drawdown zone to their advantage with or without planning. Their productivity could be increased if reservoir management is planned in respect to agricultural production cycles as well as power generation. It is recommended that future master plan versions include planning for reservoir-recession agriculture. It is also recommended that an early pilot project be established to begin recession agricultural trials in the reservoir area.

Irrigated Agriculture

Irrigated agriculture was reported in Jubba Valley by 19th Century European explorers (Menkhaus 1988). During the colonial period, extensive irrigation networks were established in lower Jubba Valley for banana and cotton plantations, reaching a maximum area of slightly over 8,000 ha. Between 1970 and 1985, government set aside more than 25,000 ha for three large-scale irrigation projects. More recently, there has been explosive increases in small-scale ventures using pumps of 20 liters/second (l/s) capacity. AHT (1988) estimated between 380 to 390 pumps were operating in the study area in 1984 and in a 1986 JESS low-level aerial census, 408 small irrigation pumps below Baardheere and 213 similar pumps upstream were counted. During 1987, more than 10 small irrigation pumps per month were added in Luuq District alone (AHT 1988).

Small-scale Irrigation

More than 7,000 ha in Jubba Valley are being irrigated with small diesel pumps. Hand- or animal-powered systems are rare and no wind-powered irrigation pumps remain in operation. Use of small diesel pumps has been encouraged by PVOs and low import taxes. During May 1987, a JESS research boat was used by a PVO to rescue pumps operated by refugees in Luuq District which had been inundated during gu' floods. Refugees were unable to cross the river to remove their flooded pumps. Loss of these pumps would have been a serious blow to the household economy of these refugees.

Small-scale pumps have led to sharecropping arrangements between urban entrepreneurs and landholders. Urban investors supply pumps and fuel while farmers provide land and labor with each taking usually 50 percent of the harvest. Less commonly, pump owners hold both land and pump, hiring labor on a sharecropping basis of approximately one-third share to labor. Some communities form cooperatives to purchase pumps and fuel, systematically moving pumps around to individual plots.

In upper Jubba, irrigated plots are normally planted with vegetables, commonly with onions. With small-scale irrigation, Baardheere District has become the foremost onion-producing area in Somalia. Maize and sesame are also irrigated in upper and lower Jubba. Pumps are not as common in middle Jubba due to difficult wet-season access.

AHT (1988) estimates a 20 percent irrigation efficiency for smallholder systems. This level of efficiency is not likely to improve in the near future as farmers have little irrigation experience and MoA lacks a capacity to provide irrigation extension services. Since most smallnolder pumps are located upstream of Fanoole Barrage, combined smallholder off-take pose serious threats to large-scale projects. With a combined off-take of nearly 15 cumecs, smallholders already have significantly decreased dry-season flows which have adversely affected Juba Sugar Project's irrigation schedules.

Small-scale irrigators are converting floodplain and levees to higher-value crops during the dry seasons. This will increase in intensity after floods are controlled. (J. Janzen)

In the absence of water-use legislation, there are no legal mechanisms to curb upstream off-take or to allocate water on a planned basis.

At current rates of expansion in small-scale ventures, there is danger that these small systems will have a capacity to take all water released by Baardheere Dam when it is completed. Government must promulgate water resource regulations which will allow geographically equitable water allocations in all river sections. Otherwise, smallholders in upper and middle Jubba will have a capacity to deny irrigation water to Juba Sugar, Fanoole Rice, and Mogambo Irrigation projects as well as banana plantations. After dam construction, Jubba River will be like an irrigation canal where the first in line can deny water to tail-end users unless water allocation is regulated. Unregulated water use may not permit adequate flow to prevent seawater intrusions in the estuary which will jeopardize Kismaayo municipal water supplies and increase salinity dangers at lower Jubba banana plantations. Jobin (1988) and AHT (1988) discuss implications of estuarine seawater intrusions in greater detail.

Yield and production estimates of small-scale irrigation in Table 16 show that smallholder irrigation is relatively productive. These data do not include irrigators between Baardheere and the border as this area was not originally included in the master plan study area.

Table 16. YIELD AND PRODUCTION OF SMALL-SCALE IRRIGATION IN JUBBA VALLEY

Crop	Hectares		Yield	Production	
	Gu'	Deyr	(t/ha)	Gu'	Deyr
Onion	1,200	1,400	9.0	10,800	12,600
Tobacco	400	1,000	0.4	160	400
Maize	1,400	1,000	1.6	2,240	1,600
Sesame	1,000	400	0.7	700	280
Fruit/Veg	-	200	10.0	-	2,000

Source: AHT 1988

AHT and others have estimated yields per hectare from the three types of smallholder agriculture. Table 17 is a composite of yield estimates from various sources and averaged over the entire valley. Estimated yields for lower Jubba are higher during gu' than for other regions. However, lower Jubba does not have as successful a deyr season as middle Jubba and Gedo. Should Baardheere Dam eliminate river flooding of dhesheegs, most would revert to primarily rainfed holdings which have higher yields per hectare in gu', but lower yields during deyr. Losses of dhesheeg productivity as a result of dam construction may not be as high as feared based on current yield estimates. However, yields on rainfed land in the floodplain may be higher than is reasonably expected solely from rainfall. In studies of floodplain vegetation, Deshmukh (1989) noted that herbaceous yield is higher than areas in East Africa of equal rainfall, leading to the hypothesis that soil moisture in the floodplain is being supplemented by groundwater from the river. Baardheere Dam will lower groundwater levels during wet seasons which may cause yield reductions of non-irrigated agriculture.

Table 17. SMALLHOLDER AGRICULTURE YIELDS IN JUBBA VALLEY (tons per hectare)

CROP	RAINFED	DHESHEEG	IRRIGATED
Gu'			
Maize	0.75	0.65	1.6
Sesame	0.40	0.35	0.7
Sorghum	0.60	0.18	-
Beans	0.45	0.43	-
Vegetables	-	0.45	10.0
Deyr			
Maize	0.35	0.5	1.6
Sesame	0.20	0.3	0.7
Sorghum	0.40	-	-
Beans	0.10	0.40	-

Source: AHT

Private, Commercial Irrigation

In lower Jubba, below Kamsuuma, 54 banana growers control 8,300 ha in private, commercial irrigation. Of this area, 3,315 ha (including 1,000 ha in fallow) were irrigated in 1987 (AHT 1988). Banana production is organized by Somalfruit, a joint venture between government and Italian investors. Somalfruit provides necessary agricultural inputs, technical services, and credit for cooperators. Somalfruit handles all aspects of export marketing, primarily to Italy and the Middle East.

According to MMP (1987), average banana yield in Jubba Valley is 10 t/ha with as much as a 50 percent rejection rate at Somalfruit processing stations. The same study assumes that yields could be increased to 25 t/ha and the rejection rate reduced to 20 percent with moderate improvements in farming technology. In comparison, Central and South American estates yield between 25 to 30 t/ha. While not stated, another assumption was for a continuous and dependable water supply from Jubba River.

In 1972, Jubba Valley banana exports reached an all-time high with 73,282 tons exported, when bananas accounted for over 60 percent of Somalia's export earnings (Evans, Cullen, and Little 1988). Exports dropped sharply after 1975, falling to 22,708 tons in 1987. In 1970, Somalia held 24 percent of the 300,000-ton Italian banana market, but dropped to six percent by 1984 due to increased competition from Caribbean and Latin American exporters (MMP 1987). Somalfruit is seeking to recapture part of the Italian market and expand Middle Eastern exports.

Currently, banana production in lower Jubba is handicapped by an inability to do full irrigations during low-river flows in jiilaal and groundwater is too saline for banana irrigation. Baardheere Dam will eliminate low dry-season flows, but this gain could be offset by increased upstream off-take. Since banana plantations are at river's end, they are vulnerable to upstream off-take, saline return flows and seawater intrusion. Increased irrigation return flows from small-scale irrigation and large state-owned projects will increase river salinity levels above tolerance levels for bananas. Unless strict water management models are developed and put into practice, banana cultivation in lower Jubba is likely to decrease after closure of Baardheere Dam.

Government-managed Irrigation

Somalia has approximately 15 years of large-scale irrigation experience in Jubba Valley. To date, success for three large-scale projects has been elusive. All have been beset with numerous and serious problems. No project has met design goals in terms of implementation rates, project costs, predicted production levels, employment generation, and anticipated rates of return. All three projects have had serious socioeconomic and environmental impacts on valley populations because social and environmental issues were not considered during project design, loan negotiations and project implementation.

Fanoole Rice Project is a multipurpose venture designed to irrigate 8,300 ha of double-cropped rice, generate four to six MW of hydroelectric power, and construct a rice-processing facility capable of handling project rice production. The project is situated on the east bank of Jubba River between Jilib and Kamsuuma. A 56-km canal conveys irrigation water from a barrage at Fanoole to the cropland. Fanoole Rice is managed by MoA with technical assistance from the People's Republic of China.

Approximately 7,500 ha were expropriated from individual smallholders and several villages. No compensation for land or improvements was made. In 1982, 6,000 ha were cleared, but only 1,500 ha have been brought into production. Instead of double-cropping, one half of the area is cultivated in one wet season and fallowed during the following wet season, so that only 50 percent of the 1,500 ha are in production during any season. Average crop yields are 4.4 t/ha. The project is operated with approximately 260 permanent Somali staff, 400 Chinese engineers and technicians, and 1,000 casual laborers (AHT 1988).

Social costs of implementing Fanoole Rice Project have been and continue to be unjustifiably high. Several villages lost all their agricultural land to the project and are no longer able to allocate farmland to community inhabitants. Individual farmers have options of cultivating land several kilometers away from their housing, taking project wage labor at low rates, or leaving for other areas in Somalia. Local farmers are not allowed to cultivate 6,000 unused hectares under project control.

Bunds constructed to protect project fields and headworks now divert surface flows to smallholdings downstream or toward the opposite bank, creating additional flood hazards for non-project areas. Many of these former fields are no longer usable because of waterlogging.

Juba Sugar Project, situated on the west bank across from Jilib, began in 1976 when GSDR set aside 25,000 ha for project use. Project size was subsequently scaled down and currently, 7,000 ha of sugarcane are under sprinkler and furrow irrigation. Pre-project design goals of 100 t/ha have not been realized, declining from a project high of 89.6 t/ha in 1982 to 61.4 t/ha in 1986. Dry-season water shortages have added to problems of insufficient

spare parts, weak management skills, and a lack of foreign exchange in causing reduced yields.

Juba Sugar is operated by the Ministry of Commerce and Industries with technical management provided by Booker Agriculture International Ltd. A project sugar-processing facility, designed and built for yields of 100 t/ha, is operating at commensurately reduced capacity.

Nearly 1,900 ha taken for the project had been used for subsistence farming prior to expropriation. No compensation for ownership was awarded. Newly erected bunds divert water into adjacent dhesheegs that were previously farmed by smallholders. Displaced farmers now rely on inadequate wage labor for bare subsistence, while unused land is farmed by smallholders with informal permission from project managers.

Mogambo Irrigation Project (MIP) is situated on the west bank downstream from Juba Sugar. Completed in 1986, it has 2,040 ha of surface irrigation and 160 ha under sprinkler irrigation. Mogambo is managed by MoA with foreign technical and management assistance.

Originally, Mogambo was planned for paddy rice and a small amount of sprinkler-irrigated cotton. Rising water tables and secondary soil salinization from rice cultivation caused planners to change direction by incorporating a smallholder mixed-cropping component. As a result, 300 families will be assigned plots on 600 ha of project land while the remainder is to be cultivated by the project. Currently, nearly 600 ha are in rice cultivation and smallholders cultivate an additional 214 ha (Menkhaus 1988). Rice crop losses by birds have been high. Maize, sesame, cowpeas, and mung beans are not as susceptible to bird attacks as rice.

Local villagers lost nearly 1,140 ha of cropland to the project without compensation. Additional dhesheeg land was rendered useless by bund construction. Many villagers had moved to Mogambo after they had been evicted earlier from riverbank land seized for banana plantations. Since 1986, out-migration up to 30 percent has occurred in some villages. Remaining villagers subsist primarily on a diet of boiled unripe bananas, although some dense *Acacia nilotica* woodland has been cleared and planted with maize.

For project smallholdings, outsiders (mostly civil servants from Muqdisho) were given preference for plots. Project management wisely allowed some local residents to participate as the civil servants were not effective farmers and required local guidance in farming techniques. MIP has begun socioeconomic studies to correct earlier injustices and to improve project performance.

Land Tenure

Socioeconomic data gathered from government-managed projects in Jubba Valley reflect a prominent question concerning security of land tenure. Studies worldwide show conclusively that successful agricultural development does not take place when individual households do not enjoy security of tenure. There is a natural reluctance of subsistence farmers to invest precious time and resources for improvements to increase production if there is no assurance that possession of land and transfer to heirs is reasonably guaranteed. Based on evidence collected in JESS studies, security of land tenure in Jubba Valley is not sufficient to foster equitable agricultural development.

Since passage of the Agricultural Land Law of 1975, 17,000 ha of cropland have been taken from small farmers in Jubba Valley and placed in government-managed projects. There are no records of compensation paid or given in other rights for land taken or for any improvements made on the land. Planted crops were destroyed during project land-leveling. Valuable family fruit trees were lost through land-leveling and bund construction. Thousands of people and their villages were rendered landless by legislation and practice. Land-taking at this scale does not foster confidence in security of tenure or in government.

Prior to 1975, rural land rights were governed by traditional methods described in more detail in Besteman and Roth (1988) and Riddell (1988). Since passage of the Agricultural Land Law, all rights to agricultural land in Somalia are transferred to government. This legislation established procedures by which landholders could register agricultural leaseholds of 50-year duration. Under this law, size of plots was limited to 30 ha of irrigable land or 60 ha in dryland areas. Banana plantations and legal cooperatives could register larger amounts, determined on a case-by-case basis by the Minister of Agriculture.

Registered leaseholds may not be bought, sold, subleased, rented, or mortgaged, although rights can be transferred to family members in event of death or illness. Government may revoke or repossess

registrations if plot size exceeds legal limits or if it is used for non-agricultural purposes. If land lies idle for two consecutive years, lease title can revert to government. Uncleared forest, even if managed for wood products, is regarded as idle land under current interpretation and practice. Wasteful and destructive clearing of forest beyond those areas for immediate cultivation has been an unintended result.

Land registration in Somalia is cumbersome and bureaucratic, requiring that each application be reviewed at local, district, regional, and national levels. The Minister of Agriculture must personally approve and sign each application. While official fees are reasonable, various unofficial expediting fees place the process out of reach of subsistence farmers, financially and psychologically, even if they fully understood the bureaucratic aspects. Some farmers think that simply filing an application at district levels completes the process and others believe that tax receipts are registration certificates.

A significant aspect of the Agricultural Land Law is that registrants are not required to demonstrate that land being registered is not currently occupied or used by others. As long as land is unregistered, it is available for registration by any Somali citizen. As a result, farmers are losing land that their families have occupied for decades to registrants who do not reside within the district, region, or valley. Applicants are required to post a public notice of intent to register land, but since valley literacy rates are low, this requirement does not provide protection for many Somalis who are productively occupying unregistered farmland.

With the prospect of numerous development activities, rates of land registration by non-valley residents have been increasing. The government and donors should constrain speculation within equitable limits and provide reasonable guarantees of security of tenure for longtime valley residents who lack the economic and political influence to protect their own interests.

Under the land law, Somalis may register only one plot which is most likely to be riverbank. In the valley, subsistence agriculture is built, in part, on multiple plot cultivation. Reliance on a single plot for survival is an invitation to disaster from either flood or drought, yet Somali farmers can, at best, protect only one parcel through registration.

By 1986, approximately 256,000 ha or three percent of Somalia's arable land area had been registered in 12,561 titles. Most registrations are in Shabeelle and Jubba valleys. In Lower Jubba Region, 501 farms were registered at an average size of 33.8 ha which is less than one percent of the region, but represents 4.8 percent of the land classified as arable by USBR (Classes 1 and 2). In Middle Jubba, 375 farms with an average size of 52.6 ha have been registered, representing 21.2 percent of arable land but less than one percent of total land. Not all registered land is arable, but a tendency to register lands on better soils is apparent.

The rate of registration is increasing—mostly by people who do not live in the valley. In Middle Jubba, the annual rate of registrations went from 17 in 1982 to 247 in 1985 before dropping to approximately 140 in 1986 and 1987. Most of these registrants were civil servants posted to Middle Jubba from Muqdisho.

Security of land tenure in Jubba Valley is insufficient to stimulate agricultural development at rates envisioned in the master plan. A common perception of residents toward the land law is distrust. Tales of outsiders registering and taking occupied farmlands travel from village to village, perhaps amplified by repeated tellings. JESS studies have shown that this form of land-taking is adequately common to merit concern and action by government and donors.

As a part of JuDAS studies and in collaboration with the Land Tenure Center of the University of Wisconsin, Catherine Besteman lived 10 months in Banta, a middle Jubba village, preparing a case study on land-tenure issues (Besteman and Roth 1988). This unique study provides numerous insights on land transactions and tenure security in a contemporary small village remote from mechanisms of central government. In this village, only 15 farms had been registered and only two were registered by village residents. Most land registrations were made by government officials. Since there are so few investment opportunities, Besteman reasons that land speculation is the most promising option for investors. In spite of the land law prohibition of leasehold sales, one investor confided that he had been offered 700,000 SSh for his registered land, but speculated that its value would rise to three million SSh when an all-weather road penetrates the region.

Clearly, tenure security in Jubba Valley does not encourage economic development based on land resources. Government is aware of land law shortcomings as can be seen from the numerous modifications since passage in 1975. In concept, the law was intended to provide tenure security and establish a process for equitable land distribution. In practice, the law has decreased tenure security and aggravated land loss without just compensation. It would be advantageous to government and residents if the registration process were decentralized so that registrants could complete the entire process at district or regional centers. The law should be modified so that registrants have to prove one of three conditions:

- they are long-term occupants of the parcel;
- land is currently unoccupied and unused; or
- compensation for improvements have been paid to persons presently occupying or using the plot.

These pre-registration conditions do not place additional financial or administrative burden on government yet provide a measure of protection to residents using land under customary or traditional rights. The burden of proof of non-occupancy should clearly rest with the potential registrant.

The law should be amended to allow multiple-plot registration while maintaining current size limits in combined holdings. SEBS data show that Jubba Valley farmers do not commonly have holdings in excess of size limits proscribed in the land law. Government must encourage risk-aversion strategies of subsistence households as they are strategies for survival. From its beginning, government has focused on welfare of rural populations in its allocations of scarce financial resources, especially in regard to agricultural development. With simple land law modifications, government can make positive policy interventions which will promote welfare of Jubba Valley residents without incurring national financial penalties.

Livestock

Jubba Valley is a rich pastoral environment. Livestock herding figures prominently in national and valley economic and social systems. Livestock provides livelihood for 50 to 60 percent of Somalia's population (AHT 1988) and 49 percent of the SEBS households reported income from livestock. The national livestock population in 1987 was estimated at 6.3 million camels, 4.4 million cattle, 12 million sheep, and 18.7 million goats. Livestock account for 35 percent of the gross domestic product and more than 80 percent of Somalia's export earnings (AHT 1988). Since 1983, a Saudi Arabia import ban on Somali cattle has severely limited Somalia's livestock exports, declining from U.S. $123 million in 1982 to U.S. $47 million in 1984 (World Bank 1985). Figure 6 shows national and Kismaayo cattle exports.

Livestock Populations

An overwhelming majority of Somalia's livestock are managed in pastoral systems which move livestock in seasonal patterns in search of grazing and water. As a source of perennial water, Jubba River and environs figure prominently in pastoral movements of Southern Somalia. Estimates of livestock using Jubba Valley in 1984 were made for the Southern Rangelands Survey (Watson and Nimmo 1984). These results are summarized in Table 18.

Table 18. JUBBA VALLEY LIVESTOCK BY REGION AND TYPE

REGION	CAMELS	CATTLE	SHEEP	GOATS
Gedo	329,000	231,000	183,000	723,000
Middle Jubba	219,000	383,000	102,000	356,000
Lower Jubba	163,000	823,000	52,000	209,000
Total	711,000	1,437,000	337,000	1,288,000

Source: Watson and Nimmo 1984

In 1986 and 1987, Watson and Nimmo conducted two dry-season and one wet-season aerial censuses for JESS covering the floodplain and river-dependent zone—an area of approximately 34,567 km^2 or roughly 29.5 percent of the Jubba Valley regions. These surveys were conducted during early xagaa, early jiilaal, and late jiilaal. Watson and Nimmo calculated valley livestock in this important zone at nearly 600,000 cattle, 400,000 sheep, nearly 700,000 goats, and 350,000 camels. More than 50 percent of regional livestock populations are concentrated within 30 percent of the area. SEBS data show that 70 percent of valley households report livestock ownership.

Livestock Ownership

SEBS defines pastoral populations as mobile livestock herders; thus, by definition, 100 percent of these SES households own livestock. Nonriverine

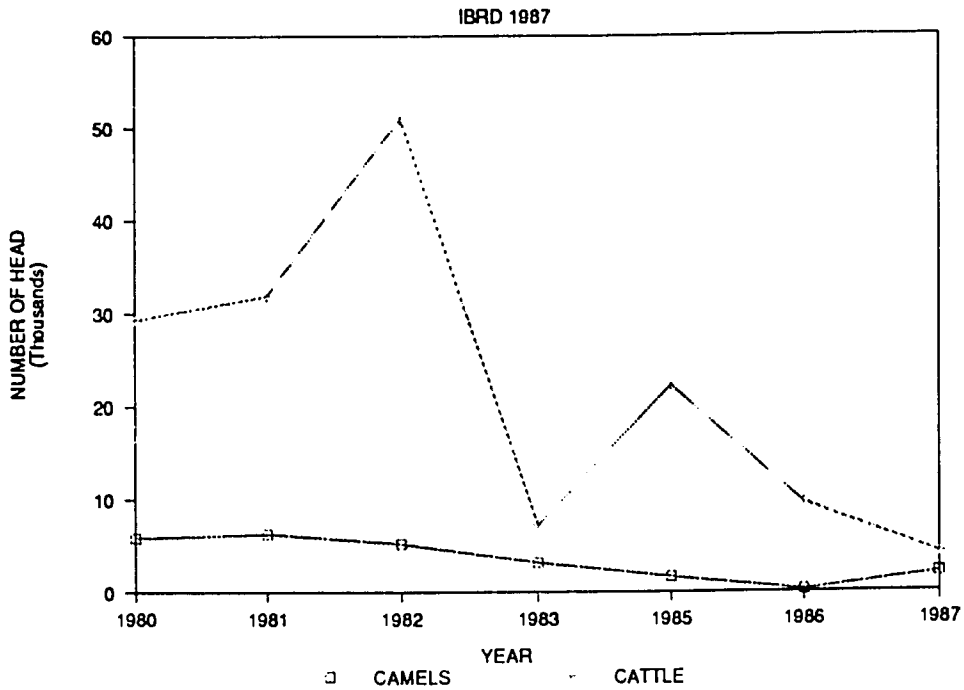


Figure 6. Camel and Cattle exports from Kismaayo.

households, being outside of tsetse zones, are more frequent owners (87.7 percent) than riverine (68.5 percent) and urban households (43.8 percent). Table 19 summarizes percentage of households reporting livestock ownership by type.

Livestock is very important in total numbers, species mix, and breadth of ownership in Jubba Valley. The sector is strongly influenced by ecological, economic, and social constraints. Herd management success is based on ability to increase stock rather than owning or leasing range. At a personal level, most herders believe that large herds increase the probability of surviving a drought with some stock intact. In using this worst-case (drought) management strategy, herders attempt to maximize herd production during years of average or above-average rainfall. In harsh, variable environments, such as Somalia, worst-case management strategies are sound, but often, there is reluctance to evaluate other management options which may become more feasible due to changes in economic, social or environmental conditions. For instance, an alternative option for herders would be to select a smaller but economically viable mixed herd which could be maintained mostly intact during drought because less forage and water are required to maintain herd health.

Table 19. LIVESTOCK OWNERSHIP BY SES AND TYPE[1]

TYPE	URBAN	RIVERINE	NONRIVERINE	PASTORAL
Camels	7.1	18.6	10.8	76.0
Cattle	24.5	50.1	62.5	73.6
Goats	24.5	54.1	38.6	73.1
Sheep	11.3	37.2	21.6	53.4

(1) Percent of households reporting that livestock type

The latter option might be feasible in Somali under two important, but unlikely conditions. Most herders would have to accept this strategy to ensure that range was not used close to, or greater than, its carrying capacity. Overall herd reduction would decrease pressure on woody vegetation and perennial grasses and allow them to be used for drought reserve. Secondly, owners would have to be confident that they would receive commensurately higher prices for larger and healthier animals when they were placed on the market and that there would be fewer export restrictions.

While the smaller size herd may be more environmentally and macroeconomically sound, the current herding practices are not likely to change because of social factors. Large herd ownership is a powerful status symbol and is a means of gaining favors through animal loans to neighbors or family members in need. Livestock ownership increases family resources without having to place money in a bank-

ing system that normally inconveniences and penalizes depositors. In rural Jubba Valley, it is easier and more sensible to invest income into livestock at a local market than to deposit it in regional banks. It is less of a problem to convert livestock into cash or commodities than it is to withdraw money from banks. Livestock is important in bridewealth payments, but becoming less so as Jubba Valley shifts toward a monetized economy.

Livestock owners, whether pastoral, sedentary agricultural, or urban, attempt to increase herd size beyond a level of optimal management or husbandry efficiency as a drought-survival strategy. SEBS livestock data need to be viewed in a context that anticipates heavy livestock mortality in drought years.

Regional patterns of livestock ownership demonstrate Gedo Region's importance as a livestock center (Table 20). Households in Gedo have the highest frequency of ownership with every livestock type. Low rainfall and poor soils in upper Jubba are not conducive for crop production except in floodplain areas, but the region can support moving pastoral herds. Middle Jubba households show the lowest level of livestock ownership resulting from poor regional development and higher incidence of tsetse infestation.

Table 20. LIVESTOCK OWNERSHIP BY REGION AND TYPE

REGION	GEDO	MIDDLE JUBBA	LOWER JUBBA
TYPE	%	%	%
Camels	46.3	9.3	17.7
Cattle	61.7	40.4	46.7
Goats	74.2	26.5	35.1
Sheep	55.6	12.3	15.7

Herd Composition

Herd composition demonstrates risk-aversion strategies based on animal physiology, economics, and environmental factors. Being grazer and browser, camels have a broad environmental tolerance. They are able to go without water for one to three weeks and are capable of browsing high and low woody vegetation. Camels are strong draught animals and can travel great distances. However, they are very intolerant to forms of trypanosomiasis which are transmitted by tsetse and other biting flies.

Goats are also partial browsers, capable of subsisting on thorny *Acacia* bushland vegetation. Due to their small size, water requirements are less and they are more physiologically adapted for body water conservation than are cattle or sheep. Depending on breed, goats are moderately tolerant to trypanosomiasis. The small size and low market value of goats makes them convenient for quick sales to meet cash needs of livestock keepers. Goats also are more likely to produce twins than other livestock which increases their longer-term value.

Cattle and sheep are primarily grazers, requiring herbaceous vegetation either in natural form or as crop residues. Both species require frequent watering, usually every two to three days before physiological stress occurs. Because of difference in dentition and muzzle size, cattle consume coarse and dry forbs and grasses while sheep pluck smaller and more tender plants which are often left by cattle. Cattle are very susceptible to trypanosomiasis.

By using mixed-herd strategies, pastoralists mimic the mixed herds of wild ungulates which dominated Somalia's savannas in earlier times. Each wildlife species had a different ecological niche, particularly in terms of grazing and browsing. Likewise, Jubba Valley's domestic herds show the similar niche diversification as their wild brethren.

SEBS and Watson and Nimmo's data demonstrate a commonality of mixed-herd management. Over 10 percent of the valley's households have herds which include all four livestock types. Single type ownership was relatively rare except with cattle where 15 percent of households reporting livestock owned only cattle. In comparison, single type ownership was 7.7 percent for goats, 1.0 percent for camels, and only 0.6 percent for sheep. Table 21 summarizes herd combinations reported in the SEBS sample.

Livestock Importance

SEBS data clearly show an importance of livestock in the valley's economic and social fabric. Livestock numbers are probably increasing in spite of, or perhaps, because of, dwindling export markets. In a strict economic sense, there is little logic for increasing production at potentially high environmental cost when an ability to market products at fair prices is declining. However, livestock in Jubba Valley cannot be treated in a strictly economic sense as livestock is an integral part of social and subsistence production systems. Pastoral herd manage-

ment is not based on optimal off-take rates for economic gain or genetic improvement, but rather, herds are managed to provide milk products and improve the household's ability to survive drought. Finally, financial opportunities are few in Jubba Valley; consequently, livestock and land are preferred investments for both urban and rural households.

Table 21. HERD COMPOSITION BY SOCIO-ECOLOGICAL SECTOR (percent ownership)

COMBINATION	URBAN	RIVERINE	NONRIVERINE	PASTORAL
All four species	2.8	11.0	10.1	6.8
Cattle only	13.5	8.6	9.6	25.4
Goats only	11.0	7.7	8.2	3.8
Camels only	0.4	0.3	0.3	2.9
Sheep only	1.4	0.6	0.6	-
Cattle/camel	1.4	2.8	2.5	10.5
Cattle/goat	2.5	9.2	8.7	14.4
Cattle/sheep	0.7	2.1	2.0	-
Camel/goat	0.4	0.6	0.6	8.2
Camel/sheep	-	-	-	0.5
Goat/sheep	3.5	7.1	7.0	11.1
Cattle/camel/goat	1.4	2.5	2.3	1.0
Cattle/camel/sheep	-	0.3	0.3	1.0
Cattle/goat/sheep	2.1	16.0	14.6	2.9
Camel/goat/sheep	0.7	2.8	2.5	10.7

In spite of large numbers of livestock using Jubba Valley, future prospects are not viewed optimistically under emerging land-use trends. Each year, more grazing and bushlands are being converted to other uses. As agriculture expands, grazing land diminishes. In some areas, expansion of riverbank agriculture has almost reached a point of exclusion for pastoral herds (Janzen 1988). Conflicts between herders and riverine farmers are increasing in number and severity as herds must be driven across cropland in order to access river watering points. If livestock herding is to remain a viable economic option for Jubba Valley, government needs to take immediate steps to set aside land for access corridors between grazing areas and the river. Janzen (1988) mapped all major livestock watering sites—this information should be used in planning future development projects. Future agricultural projects should include provisions for livestock access to water and integrating crop residues into livestock forage programs. Consideration of livestock is especially critical in planning Lower Jubba projects because livestock access to the river has already been seriously curtailed by existing government-managed projects.

Local Livestock Markets

During 1987, JESS conducted full-year surveys at local livestock markets at Baardheere, Jilib, and Kismaayo. The market at Buurdhuubo was surveyed for eight months. Price data were collected twice per month on livestock type, sex, condition, point of origin, vendor, and sale price. Figures 7 and 8 give a monthly average sale price for male cattle and goats, respectively. It is necessary to point out that prices for male animals are representative of other categories as the degree of fit between male/female, castrated/uncastrated, and lactating/non-lactating was excellent with only slight anomalies due to small sample size in some months. Buurdhuubo data are excluded due to a lack of large animal sales.

Data for some types were discontinuous as they were not offered for sale during some months. Kismaayo prices were not taken at the export market, but at local markets. Bulls and steers were combined as male cattle for the graph, although separate data files for each category remain intact within the data base.

Overall, livestock prices increased during 1987—especially at Kismaayo which peaked during early jiilaal, perhaps reflecting sales when animals are still in good condition. Throughout the year, Kismaayo had consistently higher market prices for all types of livestock than Jilib and Baardheere.

Seasonal price fluctuations fit quite well across all markets except for a dramatic difference in cattle prices between Kismaayo and Baardheere in jiilaal 1988 with a price rise to a year high of 19,500 SSh in Kismaayo while Baardheere average price plunged to a year low of 2,835 SSh. Table 22 summarizes average and maximum price of selected livestock categories surveyed for three markets.

Given its status as the primary livestock market port for Jubba Valley, even local market prices are higher in Kismaayo than at non-port markets with a sole exception for average male goat prices at Baardheere. Kismaayo also accounted for approximately 30,000 head of cattle sold in Kenya in 1987 (Evans, Cullen, and Little 1988). Volume of sales is considerably higher at Kismaayo than Jilib

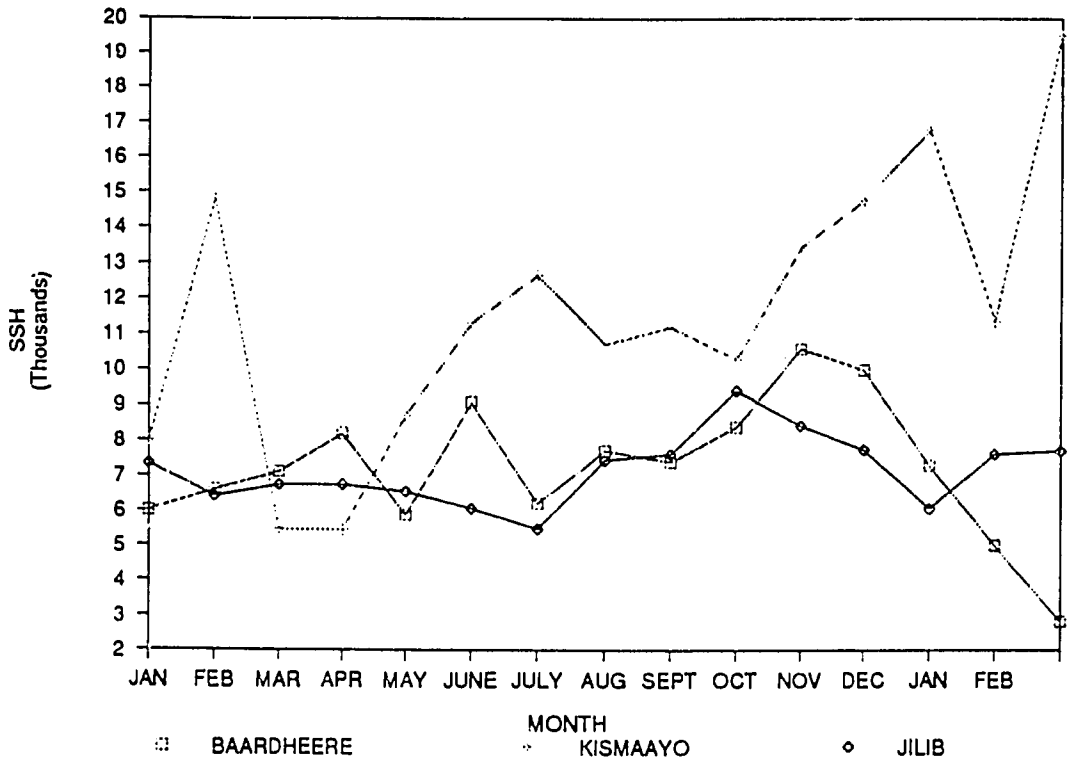


Figure 7. Male cattle prices (1987), for Baardheere, Kismaayo, and Jilib.

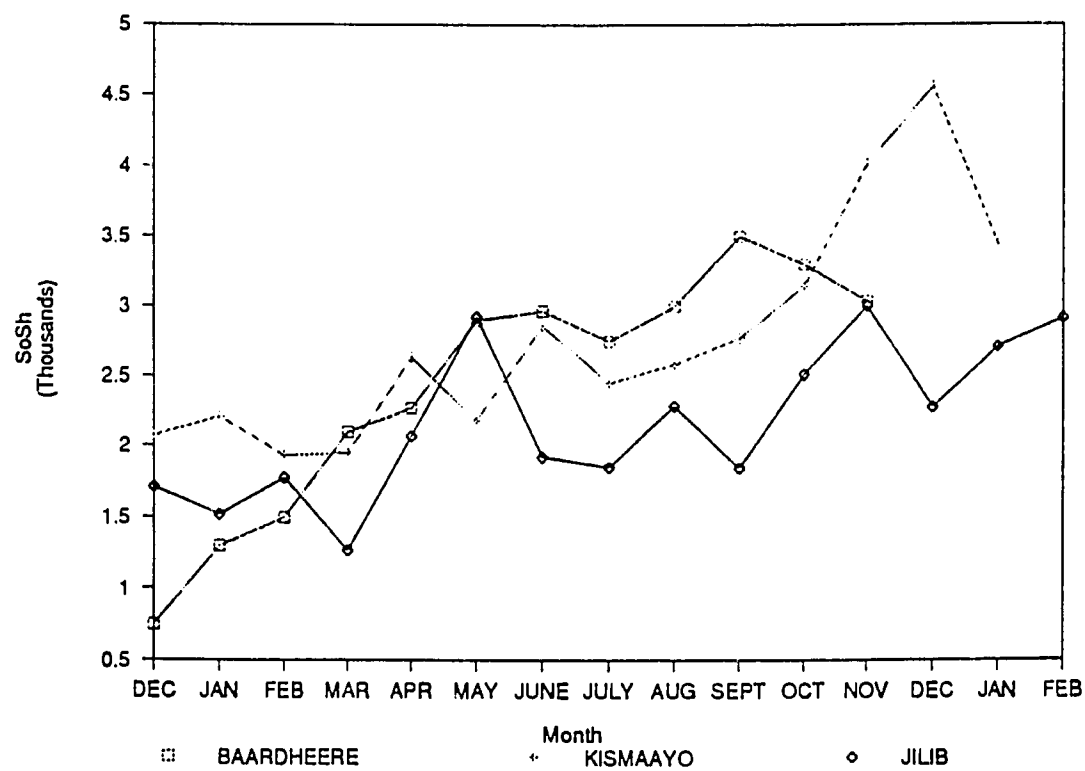


Figure 8. Male goat prices (1987), for Baardheere, Kismaayo, and Jilib.

or Baardheere because of export potential and proximity to Kenya which drives up market prices. The Evans, Cullen, and Little (1988) study estimated the value of livestock and milk products marketed and consumed in the Lower Jubba Region and Jilib District was equal to 3,681.7 million SSh in 1987 which was not a particularly good year for Jubba Valley livestock.

Table 22. LOCAL LIVESTOCK MARKET PRICE SUMMARY - 1987 (Somali Shillings)

	KISMAAYO		BAARDHEERE		JILIB	
Type	Avg	Max	Avg	Max	Avg	Max
CAMELS						
Bull	30,694	46,900	20,340	28,000	13,083	23,500
Castrated	27,009	46,973	19,526	24,290	10,790	12,500
Lactating	20,656	32,565	25,485	33,455	19,900	21,000
Non-Lact	18,137	35,500	12,400	20,000	12,607	16,060
Non-bred	25,612	46,800	10,185	14,000	7,959	7,959
CATTLE						
Bull/steer	13,348	2,600	7,326	14,500	7,438	10,350
Lactating	14,259	25,380	11,190	15,00	10,640	14,185
Non-Lact	8,167	14,208	7,027	14,000	6,640	10,091
Calf (F)	6,120	7,405	4,264	6,000	3,883	5,000
Calf (M)	5,690	7,570	-	-	3,834	4,005
GOATS						
Male	2,578	5,438	2,990	4,700	2,041	4,650
Female	3,039	4,875	2,352	3,500	2,419	4,238
SHEEP						
Male	2,595	5,100	2,436	3,500	3,431	4,368
Female	1,601	2,140	1,900	1,900	1,963	5,500

Export prices are not likely to affect local market prices as the markets are so separate. For export, a complex bi-level arrangement of middlemen, hired by Muqdisho-based traders, travel to the field to purchase male cattle between four and seven years of age in good condition. This type of animal is rarely offered at local markets, so local buyers purchase an animal directly from a herder, then sell it to another middleman who collects livestock for an export agent.

The Kenya market has an impact on the livestock market and prices. Evans, Cullen, and Little (1988) found that prices in towns near the border with Kenya, such as Libooye and Afmadow, have higher prices than Kismaayo. JESS market data show that Kismaayo livestock prices are higher than Baardheere and Jilib, thus it is not likely the Kenyan market significantly influences livestock prices beyond Kismaayo. A crude statistic of relative importance of Jubba Valley livestock markets in 1987 can be derived by multiplying average price by number of sales of selected categories assuming that survey dates were representative of non-survey dates in terms of prices and livestock present for sale. Using this simple indicator, the Kismaayo livestock market was fivefold greater than Baardheere in camel sales and Baardheere market was 2.6 times greater than Jilib. In cattle sales, Kismaayo market was nearly 2.5 greater over Baardheere and five times greater than Jilib market. In goat sales, Kismaayo had a fourfold advantage over Baardheere and Jilib was slightly higher than Baardheere.

Seasonal Livestock Movements

Jubba Valley range cannot support large livestock concentrations in a given area for long periods of time. Either deteriorating vegetation or dwindling sources of water, or both, force herd movements in search of better grazing and water. These movements in, out, and through Jubba Valley have been obvious, at least to pastoralists, for centuries. Further, pastoralists know that these migratory patterns evolved in response to seasonal changes in location of grazing areas and watering points. More recently, anthropologists and geographers have been attempting to understand and quantify these movement patterns in response to needs of development planners.

Most pastoralists move to drier areas during wet seasons and back to wetter areas during dry seasons. In Jubba Valley, this pattern approximates north to south movements parallel to Jubba River on both sides of the river. However, within this general pattern, other factors, notably soil texture and location of watering points, influence directions and routes at micro-levels. There is a danger that planners will not be aware of local pastoral movements and inadvertently compromise resources which are necessary to sustain larger macro-level livestock movements. These local factors must be considered at project design stages to avoid unnecessary taking of resources vital to the livestock sector. The following summary of livestock movements is taken from a JESS pastoral study (Janzen 1988).

Most transhumant herds on both sides of the river move south during jiilaal and, to a much lesser extent, during xagaa, returning north during gu' and

deyr. On the eastern side, movements are from the Bay Region, Luuq, and Diinsoor toward Shabeelle River swamps. Due to a lack of human-made watering points (tubewells and ponds), routes are fairly close to Jubba River. On the western side, livestock move south from Luuq and northeastern Kenya to Afmadow and Dhesheeg Waamo. On the western side, government, donors, and entrepreneurs have constructed numerous watering ponds, perhaps to excess, since many local officials are expressing concern about overgrazing near wells and human-made ponds. This area may be in transition from having water as a limiting factor for livestock to limitations imposed by a lack of grazing. Janzen (1988) notes that these watering sites have significantly increased livestock densities for longer duration which has caused range deterioration. Owing to these artificial water sources, livestock movement is not confined to a narrow river corridor and often extends further west close to the border with Kenya.

Livestock herds have not commonly crossed the river in either direction, although a west-to-east crossing trend may be developing downstream of Baardheere with western side pastoralists moving toward the interriverine swamp area. In the past, traditional socially-imposed grazing controls prohibited herds from crossing Jubba River except in dire emergencies. When rangelands were nationalized by the Agricultural Land Law of 1975, these traditional controls began to break down. However, tradition does not respond rapidly to legislation and river crossings remain relatively rare. The proposed reservoir would not interrupt any long-standing and treasured livestock movement routes. There is no rationale, economic or social, for government to consider implementing a livestock ferry across the proposed reservoir as recommended by Janzen (1988).

At a local level, soil texture is a factor in livestock movements. Pastoralists classify soil according to water retention characteristics, separating sandy and clay soils. Livestock have difficulties on clay soils during wet seasons, either becoming mired or

Pastoralists may encounter conflict with agriculturalists as the banks of the Jubba River are developed for irrigated agriculture. Corridors must be maintained to permit access for livestock watering. (J. Janzen)

falling and being injured. Moist clay soils also contributes to increased risk of hoof rot. As a result, herders move inland toward well-drained sandy soils during wet seasons and head for water-retaining clay soils of floodplains and wetlands for dry seasons. Soil texture considerations and present grazing use by nomadic herds must be factored into designing agricultural development projects.

Of signal importance, particularly east of Jubba River, is a question of river access. The river always has water, even when reduced to stagnant pools during extreme dry periods, thus representing a vital fallback for herders. When all other surface water dries completely, Jubba River is still available as a last source of water. Because of tsetse presence and extensive cultivation near the river, herders are reluctant to water there unless no other options exist. While the threat of tsetse is probably exaggerated by herders, river watering is a last resort option and large thirsty herds are not likely to be deterred by flies or narrow strips of cultivated land.

Conflicts between herders and farmers are increasing in proportion to expanding riverbank cultivation. Janzen (1988) proposes an immediate delineation of livestock corridors up to 200 m wide between the river and grazing areas or migration routes where cultivation would not be allowed. He notes that need for these corridors is more critical on the eastern side. Corridor delineation would create controversy and it is doubtful if it could be enforced. Agricultural interests will note that each 10-km corridor will take 200 ha out of potential cultivation and argue that developing off-river watering points would be more cost-effective. Livestock keepers prefer to water livestock at off-river sites to avoid dangers of tsetse and crocodiles.

Vital dry-season grazing areas, such as interriverine swamps and Dhesheeg Waamo, warrant rudimentary protection at a minimum before productivity dips below levels which can easily be restored. These areas will become even more important as more grazing land is converted to other uses.

Government cannot continue a *laissez-faire* attitude in regards to protecting natural resources needed by livestock. While herders have adapted to loss of grazing and water resources, there is a point of resource loss where this resilience will no longer function. In order to maintain livestock sector vitality in Jubba Valley, three steps need to be taken immediately by government or donors:

- government and donors should cease drilling new tubewells and digging watering catchments between Jubba River and Kenya until it can be determined that this practice will not jeopardize long-term range productivity;
- government, with donor assistance, should delineate and forbid cultivation in livestock corridors connecting dry season grazing areas with major river watering points until substitute watering points can be developed elsewhere; and
- government should seek technical assistance for range improvement projects in the southern rangelands similar to the one developed for the central rangelands, although on a reduced scale.

There are reports that animal husbandry in Jubba Valley has not been fully integrated into crop production systems. It is true that large-scale projects do not make farm by-products available for livestock consumption. However, at informal and small-scale levels, there is a thriving trade in crop residues, either *in situ* or through truck transport of residues to distant holding areas. Trucks dangerously overloaded with crop residues commonly ply Somali roadways during both harvest seasons. In spite of very slender profit margins for collecting and transporting residues to livestock, the trade appears to be healthy. Intervention by well-meaning government or donors could easily upset the delicate economic balance which is working. For the present, it is wise to allow this system to continue without further study or project development. A better focus is to develop policies which encourage use of crop residues from government-managed projects.

Industry

Industrial development in Jubba Valley is weak—an insignificant sector without much promise for improvement in the immediate future. There is a need for rehabilitating what industry is present before planning new enterprises. Based on past performance, industrial ventures should not be considered until after Baardheere Dam is functional.

Limited industry is located between Jilib and Kismaayo and is based on agricultural products, livestock, and fishing. Two rice mills, one at Fanoole and another at Mogambo, are operating below design capacity because neither project has met

planned production goals. Both mills face a prospect of never reaching design capacity before becoming obsolete. A sugar processing facility at Juba Sugar is also operating below design capacity for similar reasons. The sugar facility has been forced to reduce capacity by one-sixth because of equipment failure.

A Somaltex cotton ginnery at Jamaame is no longer operating and the master plan indicates that equipment is too old and worn to justify rehabilitation (AHT 1988). A government-operated meat-processing factory in Kismaayo has become almost inoperable, declining from 16,237 slaughtered animals in 1980 to less than 2,000 in 1987 tp 1988 (Evans, Cullen, and Little 1988). Since 1984, this factory has operated less than three months per year. The plant has been partially rehabilitated to produce canned corned beef for local markets. Donor support for further rehabilitation is pending changes in national economic policies (AHT 1988).

A government tannery at Kismaayo was built with a processing capacity of 125,000 cattle hides and 375,000 goat and sheep skins annually. Current production is less than 25,000 cattle hides and no goat or sheep skins. It was intended that the tannery would be supplied by the Kismaayo Meat Factory, but since that plant is just barely operating, hides and skins must now be procured by the government Hides and Skins Agency (Evans, Cullen, and Little 1988). Prices offered by this agency are one-quarter of prices in Kenya; consequently, Jubba Valley herders prefer that market. All skins processed by the tannery in 1987 were transported from Muqdisho.

One enterprise manufactures plastic bags and wrappers for banana export needs. Somalfruit arranges import of raw materials and provides the sole market. This plant is operating at design levels.

Somali Marine Products maintains a fish processing and refrigeration facility in Kismaayo. It is operating below capacity in spite of foreign technical assistance. Only marine fish are being processed, but the local fishing fleet is not capable of taking full advantage of the rich marine fish and shellfish resource. A foreign company is researching shellfish near Kismaayo in hopes of exporting lobster and shrimp.

Based on these examples, it appears that government cannot sustain larger-scale industry in Jubba Valley. Over U.S. $400 million has been invested for industrial development in lower Jubba which currently employs slightly more than 1,200 people (AHT 1988). Somalia cannot afford to invest U.S. $300,000 for each new industrial job.

Small-scale enterprises are also limited but fare better than larger-scale efforts. AHT estimates 60 maize-sorghum mills and 30 sesame mills for the master plan study area. This number would not appreciably increase within the larger JESS study area. Equipment in these mills is old and dangerous, consisting of one cylinder diesel engines powering exposed belt drives. However, equipment is simple enough to be maintained by local mechanics. There is a small amount of crafts, primarily cottage industries producing woven bags and mats, precious metalwork, rudimentary blacksmith products, and leather work. Craftsmanship is not at a level which generates enthusiasm on international markets. Only 11 percent of SEBS respondents indicated income from crafts and only 23 percent earn household income from business which would include teashops and small kiosk-type vendors.

Clearly, there is little evidence of multiplier effects from large-scale agricultural projects. Benefits to local populations from these projects have not been enough to offset their losses of land and employment. Elsewhere in Africa, towns and villages adjacent to large-scale projects show increasing prosperity following implementation. As household disposable income increased as a result of projects, this income was spent to foster even more growth (Scudder 1988). In Jubba Valley, this increase in household disposable income has not occurred—primarily because each project has become an enclave, relying more on Muqdisho for support than on local communities. Evans, Cullen, and Little (1988) have shown that much of the income generated by banana and livestock commodity systems do not accrue to Jubba Valley, but go to Muqdisho. As long as there is no increase in household incomes, Jubba Valley industrial development will lag or regress.

Commerce

Up to 80 percent of household incomes are spent for food purchases, mainly for sugar, maize, wheat, meat, milk, and oils, leaving very little for other purchases. Urban and herder households account for the bulk of food purchases as rural sedentary households have less income and are more self-sufficient in food production. After investing in farms and livestock, urban households seek small com-

mercial and manufacturing ventures, while rural sedentary families seek small retail business, such as teashops and stalls.

Evans, Cullen, and Little (1988) reported an "intricate web of rural-urban exchange patterns" from their study in lower Jubba. Small town households capture one-quarter of rural and herder household consumption spending. One-fifth of regional consumption spending occurs in the three large towns of the study area: Kismaayo, Jilib, and Jamaame. Only one-third of consumption spending leaves lower Jubba and some of this goes to Middle Jubba for maize purchases. The Evans, Cullen, and Little (1988) analysis suggests that ".... a regional economic growth dynamic would be most effectively fostered by measures that enhance returns to farming, so that small farmers have more to spend, and that facilitate the market center roles of small towns, so as to increase the velocity of the income multiplication process."

Urban and rural centers have not developed a commercial agricultural support structure for tools, fertilizers, biocides, livestock pharmaceuticals, and seeds that is commonly associated with agrarian regional development. Government social and economic policies have not encouraged development of a private sector which could operate small-scale commercial support systems for agriculture. If government removed impediments to small-scale, private-sector commerce, rural support centers would be in a position to support agricultural development. Increased agricultural production would occur under these policies.

Transportation and Communications

A network of primary and secondary roads is vital for successful rural development and normally receives high priority in regional planning. Table 23 shows the current status of Jubba Valley's road transportation system.

Each kilometer of all-weather road (paved + gravel) serves approximately 109 km^2 of the master plan study area. This ratio would be increased if all of Gedo Region were added. Vehicular tracks cannot be included as most become impassable during wet seasons. They are formed by following a set of tire tracks until a wet spot is encountered and a new track is formed.

Three roads connect Jubba Valley with eastern parts of Somalia with a focal point at Muqdisho. The Muqdisho-Jilib-Kismaayo road serves lower Jubba

Table 23. ROAD SYSTEM BY TYPE AND DISTRICT (km)

DISTRICT	PAVED	GRAVEL	VEHICULAR TRACK
Kismaayo	49	8	126
Jamaame	61	28	114
Jilib	46	58	172
Bu'aale	0	0	276
Saakow	0	0	186
Baardheere	0	15	290
Total	156	209	1,164

Source: AHT 1988

and constitutes all the paved roads in the valley except for a short Jamaame access link. From Muqdisho to Jilib, this roadway is in poor shape in spite of rehabilitation in 1985 and further repairs in 1988. These works did not build a proper road bed or drainage and the tarmac surface was insufficient in thickness to withstand heavy truck traffic. Currently, the road surface is dominated by potholes to a point that most traffic uses a parallel track along many sections during dry seasons. Between Jilib and Kismaayo, the older road is in better shape, but is falling into disrepair from a lack of maintenance.

The Muqdisho-to-Baardheere road is paved from Muqdisho to beyond Baydhabo and is in reasonable condition. From the Luuq and Baardheere junction to Baardheere, an all-weather gravel road is in fair condition. Between Baydhabo and Luuq, the link cannot be considered an all-weather road as it is only passable by heavy-duty four-wheel drive vehicles during wet seasons. BDP plans to upgrade the Muqdisho-to-Baardheere road prior to dam construction. At present, the road could not accommodate heavy traffic associated with dam construction.

Gravel roads have been constructed to large-scale projects in lower Jubba. These roads are maintained by project personnel and equipment. In fact, Juba Sugar has spread molasses on the roadway near project housing for dust control. Access between Jilib and Fanoole Barrage is reasonable due to Fanoole Rice Project maintenance.

Between Fanoole Barrage and Baardheere, only a series of bushland tracks are available for dry-season travel. During rains, roadways channel sur-

face water flow into depressions, forming barriers of mud and water. Only slight rains are sufficient to render these tracks useless. Administrative centers at Saakow and Bu'aale are inaccessible during wet seasons.

Air transport facilities are minimal with only one airport at Kismaayo having paved runways. Dirt airstrips are located at Luuq, Baardheere, Buurdhuubo, Saakow, Bu'aale, Jilib, Jamaame, and Juba Sugar Project. Only Kismaayo is serviced by scheduled flights which have been reduced from 280 flights in 1982 to only 52 in 1987 (AHT 1988).

Other than export vessels from Kismaayo (bananas and livestock), there is little sea transportation. There are no coastal vessels plying regular schedules between Kismaayo and other Somali ports. During JESS studies, Kismaayo port was undergoing rehabilitation funded by USAID.

River transport is virtually limited to cross-river ferry traffic. In JESS aerial censuses, 53 cable ferries and three boat ferries were counted on the entire length of Jubba River. Ferries usually consist of old military metal boats attached to metal cables spanning the river. Only 37 other types of boats were observed during the same survey—mostly dugout canoes. River transport of goods is not common even during wet seasons when road transportation is difficult or impossible. In each census, rafts constructed of fuelwood were noted floating downstream toward refugee camps near Luuq.

Telecommunication is through a police radio network with transceivers in regional and district centers. There is direct communications between Jilib, Jamaame, and Kismaayo. Certain enterprises, such as Somali Marine Products, Somalfruit and Juba Sugar, also maintain radio contact with Muqdisho. The Ministry of Agriculture has radio facilities in regional centers.

Education

With only 97 primary and 10 secondary schools, there is little infrastructure for education. Schools that exist are poorly equipped and understaffed. Whenever SEBS teams visited villages, they were told that the school was closed for vacation or the students had been released for farm work.

Koranic schools are common, being located in nearly every village. In the SEBS survey, 69 percent of males and 17 percent of females had received some Koranic training. Adult and women's education programs have existed since 1974, but with limited success. None of five Family Life Education Centers established for women's education is still operating. Post-secondary institutions are absent from Jubba Valley.

Health Facilities

District and Regional centers have hospitals for out-patient care and some in-patient care is possible in Kismaayo. All hospitals are in poor repair and only Kismaayo is able to perform simple surgery. Laboratories are understaffed and poorly equipped.

A primary health care program was initiated in 1982 to provide preventative and curative health care to each district in Somalia. Saakow, Bu'aale, and Jilib have public health centers, but none is in place in the other six districts.

PVOs operate a leprosy hospital near Jilib, public health posts in Saakow and Bu'aale, and an 80-bed tuberculosis hospital in Kismaayo. Government operates a malaria laboratory/clinic at Jilib.

Energy

Installed electric power capacity within the master plan study area is 3.5 MW at discontinuous service. Fanoole Barrage could generate 4.6 MW at stable river flows controlled by Baardheere Dam. At present, the plant cannot operate during high or low flows. Kismaayo recently installed a two-MW thermal plant with assistance from FINNIDA. Some towns are supplied with up to six hours of service from 15 to 250 KVA diesel generators when fuel is available.

IV. EFFECTS OF BAARDHEERE DAM

In Phase II, JESS produced a working paper on pre-construction concerns associated with Baardheere Dam (Tillman 1987a). To a degree, some of those concerns will be reiterated here, but in considerably less detail. Emphasis in this section is placed on the effects of proposed developments deemed most probable and pervading in the valley which will require GSDR and donor attention. This is not to say that other potential impacts should be overlooked. These additional effects are detailed in reports found in JESS Final Report Volume II (Environmental Studies) and Volume III (Socioeconomic Studies) and should be reviewed in conjunction with the discussions in this section.

Many documents have been produced in assessing physical, biological, economic, and social changes which have resulted from constructing high dams in tropical environments. Recent allegations state that no dam produces net benefits because environmental and social costs are excessive (Goldsmith and Hilyard 1984). At the other extreme, virtues of high dams are often extolled in purely financial benefit-cost analyses. Surely, reality lies somewhere in-between.

Discussion is brief, focusing on those changes which are most likely to occur and which may be modified to increase benefit levels or reduce environmental and social costs. Changes are noted in sections dealing with physical, biological, and social contexts, but with as much integration as is allowable without fear of repetition. A macroeconomic analyses was not included in the JESS scope of work.

Baardheere Dam will be 75 m high with an approximate crest length of 500 m with either rockfill or "roll-crete" construction. The resulting reservoir will be 160-km long at maximum operating levels with an estimated surface area of 425 km^2, impounding 3,400 million cubic meters—roughly 55 percent of the average annual flow of Jubba River. The dam will generate 105 MW of electricity through three or four turbines. Bottom outlets are included in dam design to increase discharge flexibility. Two transmission lines will transmit Baardheere power to Muqdisho and Jubba Valley. As can be seen in Table 24, Baardheere Dam is relatively modest by international standards.

Table 24. RESERVOIR DATA FROM AFRICAN COUNTRIES

DAM	COUNTRY	AREA (km^2)	Reservoir VOLUME (mmc)
Akosombo	Ghana	8,482	148,000
Aswan High	Egypt	6,850	164,000
Kariba	Zimbabwe/Zambia	5,500	160,400
Kafue Gorge	Zambia	4,700	160,000
Cabora Bassa	Mozambique	3,800	63,000
Itezhitezhi	Zambia	3,100	56,700
Kossou	Ivory Coast	1,600	n/a
Gebel Aulia	Sudan	1,500	n/a
Kainji	Nigeria	1,260	15,800
Buyo	Ivory Coast	900	n/a
Mtera	Tanzania	610	n/a
Baardheere	Somalia	425	3,400
Massingir	Mozambique	170	2,884
Massinga	Kenya	120	1,560

n/a = data not available *From various sources.*

A. Physical and Land-use Effects

1. Hydrology

Flood Control

After Baardheere Dam is completed, Jubba River will no longer be subject to wildly fluctuating flows. It will be converted into a relatively docile irrigation channel with few characteristics of an uncontrolled African river. Except for extreme floods, discharge will remain below 700 cumecs, thus significantly reducing flood potentials. Local climatic and drainage characteristics of Lower Jubba will continue to produce periodic minor flooding. Current annual flood damage estimates are placed at U.S.$3.2 million based on data collected during 1981 and 1985 floods, a seven-year flood and four-year flood, respectively (MMP 1987). Estimates of flood damage for these two floods were U.S. $8 to 9 million for 1981 and U.S. $3 to 4 million for 1985. Baardheere Dam will prevent this type of flood damage.

Not all overbank flooding is harmful as floods are necessary to recharge groundwater aquifers, wetlands, and dhesheegs. Wetlands, including dhesheegs, adjacent to the river will become reduced in size and have decreased soil moisture for crops and native vegetation. Lack of overbank floods will interrupt floodplain fish spawning.

However, farmers will be able to plant cropland earlier without fear of flood loss. Farmers will be able to experiment with higher value inputs, such as improved seeds and agro-chemicals, with less jeopardy.

Offsetting flood control benefits is a loss of nutrient deposition on floodplain soils. Overall nutrient load in Jubba River will be reduced as sediments are retained in the reservoir and river water will no longer spill over banks to enrich floodplain soils. Soil fertility will decline quite rapidly and farmers will need to purchase fertilizers to maintain current yields.

Fertilizers are not sold in Jubba Valley urban or rural centers. Government will need to encourage development of agricultural support systems in rural centers to offset this loss of natural soil enrichment. There is little latitude for complacency as most crops grown in Jubba Valley have high nutrient demands. Nutrient loss would be partially offset by a more sophisticated practice of crop rotation featuring legumes to replace lost soil nitrogen. Other elements necessary for crop growth will need to be replaced with organic or inorganic fertilizers.

Seawater Intrusion

With a guaranteed jiilaal flow, seawater intrusion will be eliminated unless agricultural off-take exceeds 110-115 cumecs during jiilaal which is not likely to occur within the first decade following closure. It need not occur at all, if water use legislation is enacted and enforced. Without seawater intrusion, Kismaayo will be assured of potable water during jiilaal instead of having water intakes inundated by seawater.

Banana plantations will profit from reduced seawater intrusion. Stable freshwater flows will keep seawater out of the river channel so that banana irrigation can continue, even in late jiilaal. Currently, some banana growers cannot irrigate when low jiilaal flows allow seawater to enter the estuary.

In rivers with biologically productive and expansive estuaries, changes in freshwater flows harm marine and estuarine fish and shellfish populations. Jubba River's estuary is not large and does not support mangrove forest. The estuary is productive, but being so small and poorly vegetated, loss of estuarine fish and shellfish is a minor consequence compared with the rich marine resources. Stable freshwater flows will increase aquatic species so the net loss in biological productivity will not be significant.

Groundwater

Groundwater levels should rise near the reservoir with an improvement in water quality. It remains to be seen if the reservoir contributions can adequately dilute deep deposits of saline groundwater to render it potable. This event does not seem likely in the short term.

Subsurface water storage can be improved by building earthen bunds across seasonal reservoir tributaries during dry seasons. After the reservoir levels top the bunds, freshwater would be trapped as the reservoir recedes. The trapped water would percolate down through sandy deposits to bedrock and could be tapped by shallow wells during dry seasons. These sand reservoirs could be used to water livestock with less threat from tsetse flies and crocodiles.

Downstream effects on groundwater are more difficult to predict because irrigation water must be factored into water balances. Without irrigation, it would be expected that dry-season groundwater tables would be higher after a dam than those before and would be comparably lower during wet seasons. Applications of irrigation water change this tendency and a combined effect of stable river flow and irrigation will lead to rising water tables in the floodplain, especially in lower Jubba.

River Scour and Sedimentation

It is estimated that the reservoir will trap 95 percent of all sediments passing Luuq (ELC 1985). Releases from the dam will be mostly free of suspended solids and will be highly erosive. Two factors will reduce the amount of channel scour. The river gradient below Baardheere is less than a three-meter drop in 10 kilometers which will keep flow velocity quite low. The channel immediately downstream of the dam site consists of bedrock, rock, or boulder-sized togga detritis and resistant fine-grained unconsolidated sediments (Alford 1987). The river channel will deepen between the dam and Baardheere and at meanders, banks will be cut back, producing new meanders. Changes in downstream river morphology will not threaten urban centers. Baardheere is protected by a rocky bluff, although a watering site just upstream may be eroded with some loss of residences. This cutting could be prevented by placing gabions upstream to divert flow away from Baardheere town.

The bridge at Baardheere is in a more precarious position. This bridge is likely to need reinforcement in order to withstand increased river channel erosion. A river gauging station at the bridge will need a new rating curve to be calibrated to the new channel shape.

Reservoir sedimentation is not thought to be a serious problem by consulting engineers (ELC 1984; Electrowatt 1985). Formation of a delta below Luuq could produce a backwater effect that may threaten the town. MNPJVD has commissioned engineering studies on the potential backwater effect near Luuq.

Somalia can do little to control waterborne sediments since most of the catchment area is in Ethiopia. In Somalia, aeolian erosion is a contributor to river sediments. Strong winds around and above Luuq move considerable amounts of sand into the river. A social forestry project directed at shelterbelts and windbreaks near Jubba River would diminish this source of future reservoir sediments.

River-borne sediments have not been studied adequately. Sediment data are based on estimates and a very small number of surface grab samples. A longer-term record of integrated sediment sampling is needed before serious calculations of reservoir sedimentation rates can be made. More data are needed on bedload contribution to sedimentation and this needs to be a longer-term record as well. Better sediment measurements would permit a determination of sediment origins, which would be the first step in preparing an erosion control strategy. These sediment studies would indicate the relative importance of aeolian contributions.

2. Water Quality

Jobin (Volume II) provides a detailed overview of water quality changes which are expected to result from Baardheere Dam. Most significantly, short periods of highly saline water (EC 1,200 µmhos/cm^2) associated with gu' and deyr downstream high flows will be eliminated by Baardheere Dam. Releases from the dam will have EC values below 750 µmhos/cm^2 except for a brief period in early gu' when reservoir density currents will bring water of higher salinity to the penstocks. Irrigation return flows below Fanoole Barrage will elevate EC values above 750 µmhos/cm^2 for much of lower Jubba Valley.

Reservoir Water Quality

There will be salinity variations within the reservoir, but EC values will remain below 600 µmhos/cm^2 and will be under 500 µmhos/cm^2 most of the time. The reservoir may have periods of low dissolved oxygen concentrations at water depths below the light penetration (photic) zone. In the first few years, oxygen depletion caused by decomposing woody land vegetation may create hydrogen sulphide from anaerobic decomposition. This condition is not expected to be excessive or prolonged as little woody vegetation will be inundated relative to water volume.

Reservoir water will be more biologically active than river water due to a decrease in suspended solids which inhibit algal growth. Water clarity will be a function of phytoplankton production rather than suspended solids. Phytoplankton will concentrate in the upper 0.5 m of the reservoir restricting the photic zone to this thickness. Water released through the penstocks will be drawn from below the photic zone and will not have phytoplankton or suspended solids. Water will not have appreciable dissolved oxygen, but it should not be anoxic because of reservoir circulation. Released water should not pose significant danger to downstream fisheries.

No significant contaminants are expected in reservoir water. There is no upstream industrial development and biocide use is negligible. Organic contaminants from Luuq will be quickly decomposed by reservoir biota. It is not expected that sanitary wastes from Luuq will increase appreciably and they should not have significant effects on reservoir water quality. The fate of refugee camps has not been determined yet. If these camps are only moved to a new location at the reservoir's edge, then a potential for bacteriological contamination will become an important consideration as camp wastes would enter the reservoir without treatment.

Downstream Water Quality

Jubba River water quality will progressively deteriorate with downstream distance and time. While dam discharges will generally be below 600 µmhos/cm^2, irrigation return flows will add more saline water. Below Fanoole Rice and Mogambo Irrigation projects, EC values will exceed 750 µmhos/cm^2, which is unacceptable for banana irrigation. As irrigation expands and intensifies, the more unsuitable the water will become for irrigation and human consumption.

Over time, use of biocides and fertilizers will increase and they will run off into Jubba River. Since development is not likely to occur as rapidly in Gedo and Middle Jubba regions, it is anticipated that middle Jubba will maintain better water quality longer than lower Jubba. Growing human populations of middle and lower Jubba with unacceptable sanitary facilities will increase pathogen levels in the river. These contaminants will pose serious health hazards to downstream users, especially Kismaayo, unless the water treatment plant is rehabilitated and maintained properly.

Mitigatory mechanisms exist to counteract deteriorating water quality, but these are unlikely to be in Jubba Valley development scenarios for the near future. USAID's Water and Sanitary Health Project (WASH) has excellent reference materials for mitigation of water supply and sanitation problems which could be used to promote community self-help sanitation projects. World Bank references are also valuable for designing community sanitation projects (Kalbermatten *et al.* 1982). There is a critical need for a comprehensive water supply and sanitation program in Jubba Valley. Government should seek assistance from multiple small donors in a program coordinated by the Ministry of Health, or approach the problem through a sectoral loan from a multilateral lending institution. Moving to solve water supply and sanitation problems is a step toward treating causes of ill-health rather than treating symptoms of disease.

3. Land

Inundation and Floodplain Changes

Baardheere Dam will inundate up to 425 km^2, including some floodplain grazing land. Narrow floodplain strips now in cultivation consist of less than seven percent of the total area. Reservoir drawdown will expose at least 10,000 ha each year and up to 18,000 to 20,000 ha at minimum operating level, which may occur once in every three years. Most of this exposed area will be in upper and middle reservoir zones. The zone near the dam will only expose a narrow strip of steep slopes which should not be used for agriculture or livestock grazing.

Downstream, floodplain will diminish in size, shrinking until it roughly parallels the river from dam to estuary. Vegetation on the existing floodplain fringe will come to resemble dryland communities in terms of production and seasonal activity. Vegetation on the new floodplain will be converted to agricultural crops unless small pockets are set aside for conservation purposes. With reduced flood potentials, settlements will expand toward the river so that villagers will be closer to a water supply and riverbank cropland. Floods will still occur, but at such a low frequency that they will not deter settlement and cultivation as close as possible to river margins.

Irrigation and Recession Agriculture

Converting Jubba River into an irrigation channel will create agricultural benefits. Cropping intensities at all large-scale and private, commercial irrigation areas can be improved with assurance of increased dry-season flows, unless uncontrolled small-group off-take negates gains from Baardheere Dam. Controlled flows will range between 130 and 400 cumecs assuring a supply of irrigation water every month. The amount of irrigation water to be released each year is sufficient to irrigate up to 120,000 ha if water is managed wisely. It is expected that current projects will expand and a new government project at Hombcoy in lower Jubba Valley may be implemented. Small-group irrigation will continue to increase, most likely in excess of current rates. Table 25 presents estimates of increased irrigation potential resulting from dam construction.

Table 25. JUBBA VALLEY IRRIGATION FORECAST (ha)

YEAR	1995	2000	2005
Without Baardheere Dam	22,080	23,080	24,080
With Baardheere Dam			
(a) Expand existing projects	14,750	14,750	14,750
(b) New projects	3,500	20,000	35,000
(c) Banana plantations	4,630	4,630	6,930
(d) Smallholder irrigation	4,130	9,130	14,130
TOTAL	26,980	50,810	70,810
Increase from Dam	4,900	27,730	46,730

Source: Sir Malcom McDonald and Partners, Ltd. 1987

Gains of 27,000 to 47,000 ha of mostly large-scale irrigated agriculture as forecast by MMP will certainly be offset by costs of increased disease. Health implications of this expansion of irrigation are discussed later in the section on social effects of Baardheere Dam.

Reservoir operation proposals have been based on power optimization studies and as such, do not

consider non-generating releases for agriculture, fish, or groundwater recharge. Design specifications were set to prevent discharges greater than 700 cumecs except in rare flood events. If these operation standards are maintained, most of the 11,000 ha of recession agriculture in Jubba Valley will become dependent on rainfall or groundwater rather than river flooding. During seasons of average or better rainfall, some dhesheegs will fill, or partially fill, and recession cultivation will be possible. Since abundant rainfall is not common in Jubba Valley, loss of recession agriculture in poor years could be equal to 7,000 ha.

Dam design does have flexibility to generate controlled overbank floods up to 1,060 cumecs without using the 1,000 cumec spillway. MMP (1987) estimates that for 75 percent of deyr seasons, overbank releases could be made without sacrificing power generation. Most gu' season flows are not adequate to create floods without loss of generating capacity.

In the first few years after closure, Somalia will not be able to utilize full generating capacity of Baardheere. Therefore, controlled floods could be released without economic penalty from lost power generation. If dhesheeg conversion projects constructed artificial conduits between selected dhesheegs and the river, it could be possible to determine if it were feasible to fill and drain dhesheegs without overbank flows.

Areas upstream of Baardheere Dam received scant attention in early master plan drafts. This omission was unfortunate because this area can expect the most dramatic changes in Jubba Valley. At maximum volume, the northern reservoir perimeter will nearly reach Luuq. Approximately seven percent (3,000 ha) of the area to be flooded is floodplain cropland which is a small loss when compared to losses caused by other African dams. Very little forest will be affected as most has already been removed.

During dry seasons, the reservoir will gradually recede, exposing an area of approximately 10,500 ha when it reaches normal operating level (142 masl). An area nearly equal in size would be exposed if the reservoir is drawn down to minimum operating level (128 masl), but this should not occur each year. At minimum level, the northern perimeter will shift from Luuq to a point approximately 46 km downstream providing an area of considerable potential for recession agriculture.

It appears that most of the reservoir zone consists of poor and stony soils which may not be suitable for cultivation, although the soils have not been tested. Mean rainfall below 300 mm per annum is more constraining to agriculture than soil fertility. Creating a reservoir will cause beneficial changes in soil structure and fertility. Sediments will drop during floods when river water, laden with suspended solids, mix with placid reservoir water. Deposition will be greatest at the upper end, primarily in the drawdown zone. Sediments will create a more heterogeneous soil structure and contribute valuable nutrients. Further enrichment will come from plankton, fish, and aquatic bird populations which will proliferate in the eutrophic reservoir. Over time, soils in the drawdown zone will improve appreciably as they have in other African reservoirs. Scudder (1988) reports grazing areas of *Panicum* grasses on the Lake Kariba shoreline which rival historic and rich grazing areas of Kafue Flats floodplain.

Vegetable and cereal crops could be planted in upper drawdown areas, perhaps between 138 and 142 masl, and annual grasses for livestock fodder could be encouraged below 138 masl. Maximal grass production should occur at a fortuitous time for livestock—during late jiilaal as dam operators release reservoir waters to increase storage for gu' floods.

Master planning should include this important agricultural and livestock asset. As reservoir bathymetric data improve and operation schedules become more firm, planners will be able to place time frames for perimeter recession so that crop planting and harvest times can be fixed with more certainty. Subsequent reservoir operation will allow planners to fix specific dates and rates for reservoir releases. Experiences elsewhere in Africa with drawdown agriculture and livestock grazing has produced extensive benefits for local residents (Scudder 1988).

B. Biological Effects

1. Vegetation

Vegetation, especially native species, is an excellent environmental indicator, which visibly demonstrates different soil types and moisture regimes. In part, rainfall isohyets of Jubba Valley

are based on vegetation analysis from aerial photography. Vegetation delineates floodplain from non-floodplain by showing species which require higher soil moisture. As a result, by examining changing vegetation patterns from aerial photography, it will be possible to precisely measure changes in floodplain area as a result of Baardheere Dam. Remote sensing is a vital part of an overall monitoring proposal described in Section VI of this report.

In addition to a direct effect of diminishing Jubba River's floodplain, Baardheere Dam will contribute secondary effects. As settlements and cultivation increase on a floodplain made safer by controlled flows, more clearing of floodplain vegetation will occur. Clearing will be for new cultivation areas and intensified fuelwood extraction. Nearly all native floodplain vegetation will be removed within one decade after dam closure. Loss of floodplain vegetation will have deleterious effects on wildlife, livestock, and humans who rely on hunting and gathering as supplements to household incomes. Increased production of crop residues may compensate for vegetation losses to livestock, but will not offset losses to wildlife and humans dependent on natural vegetation. Numerous medicinals collected from native plants will be lost in converting floodplain wildlands to croplands.

Some floodplain soils will become salinized from intense irrigation and soil waterlogging, especially in lower Jubba. These plots will be abandoned periodically until rainfall can leach a sufficient amount of salts beyond plant root zones. These abandoned areas will support a weak growth of salt-tolerant native species, primarily shrubs and herbaceous vegetation, before the plots are cleared for another cultivation cycle. Since floodwater nutrients will no longer be added, native vegetation will not flourish as before until a woody biomass is established that is capable of capturing nutrients in a relatively closed nutrient cycle. At that point, clearing would be likely to take place for a few more years of cultivation before the land is abandoned once again.

Reservoir zone vegetation will change dramatically as land species will be replaced by aquatic species. Existing woody vegetation will die and decompose, even if only partially submerged. Woody vegetation should be cleared from between the minimum (128 masl) and maximum (144 masl) operating levels. It is not economically feasible to employ clearing contractors for this task as the woody biomass is too sparse, too dispersed, and of too low value for cost-effective clearing. Fuelwood cutters may be enticed to clear wood from this zone if they are granted preference and subsidies for fuelwood sales at the construction camp. Small subsidies in a form of higher prices for fuelwood purchased by the camp would not create a severe economic penalty on construction, yet would return significant health, forestry, fishing, and reservoir operation benefits. Emergent woody vegetation, whether alive or dead, improve aquatic habitats for mosquitos and snails by disrupting wave patterns, decreasing turbidity, and providing points of attachment for breeding and feeding.

There is no economic justification for cutting woody vegetation which would not emerge at minimum operating level. Biomass is not large enough to produce problems with decomposition and production of hydrogen sulfide which is corrosive to turbines. A small amount of woody vegetation below minimum operating level has been found to be beneficial for fishery development as fish have protection from predators and nets.

Wading birds will carry plant propagules to the reservoir— some of which may be undesirable, such as water hyacinth (*Eichhornia* sp.) and water lettuce (*Pistia* sp.). Under certain conditions, these aquatic plants can proliferate rapidly to create vast floating mats of dense vegetation. Their evapotranspiration rates increase water loss to the atmosphere several fold over evaporation loss. With an estimated reservoir evaporation of 34 cumecs or three million cubic meters per day, water losses are already significant. Power generation could be curtailed if aquatic plants doubled or tripled water loss over a large part of the reservoir. JESS limnology studies did not find water hyacinth, although it is known to exist in Jubba Valley in small pockets. Water lettuce was more common and was found in a small tributary in the reservoir region.

Wind and wave patterns and reservoir morphometry are not expected to be conducive to waterweed proliferation. If proliferation is to occur at all, it will be during the initial period of explosive nutrient release and if waterweed growth follows patterns in other tropical reservoirs, it would be short-lived. It is important that a reservoir operation unit monitor waterweed proliferation in the initial years of operation.

During JESS studies, a sedge was discovered which is probably a new species. It is not known if this

species occurs outside the inundation zone, but an effort should be made to determine if this sedge grows elsewhere. It would be simple to salvage this species for transplanting if it is not found at other sites. Unwitting extinction of a species is tragic, but a knowing and uncaring extinction is unforgivable.

The reservoir perimeter will establish new vegetation, that is adapted to higher soil moistures and this could be seriously detrimental to livestock. At present, tsetse fly is not reported above Baardheere because aridity and high soil temperatures are not suitable tsetse habitat (NTTCP 1985). Baardheere Reservoir will increase soil moisture, microclimate humidity, and depress soil temperature—all conditions which favor tsetse fly breeding. Growth of woody vegetation also improves tsetse habitat. JESS studies show that the reservoir zone is an important grazing area during jiilaal, especially for cattle. An invasion of tsetse would force a change in grazing patterns which would produce ripple effects in all grazing areas throughout the southern rangelands of Somalia.

2. Wildlife

Baardheere Dam will not have significant direct effects on wildlife populations with the exception of crocodiles. Wild herbivore biomass in the inundation zone is small, especially when compared to livestock biomass. Some protected ungulates are present, but are capable of moving to adjacent habitat without penalty. Large terrestrial predators are also reported in this area, but only rarely. As with herbivores, predators will move to adjacent range without detrimental effects to their populations. Their numbers are more threatened by livestock herders.

It is not likely that hippos will move into the reservoir in significant numbers until sufficient land vegetation develops to provide forage. If the reservoir perimeter is managed for livestock grazing and recession agriculture, as recommended, hippos will eventually become common, probably to nuisance levels as they are downstream.

With an increase of reservoir fish, crocodiles will quickly fill a predator niche. The middle and upper reservoir zones will provide ideal habitat and crocodile reproductive biology is suited to rapid population increases. Crocodile attacks on humans and livestock will become as commonplace in the reservoir as in downstream areas. Throughout JESS reports, recommendations for crocodile control programs have been repeated. Every study team visiting Jubba Valley returned with accounts of crocodile incidents in which human life and livestock had been lost. JESS does not endorse elimination of these valuable animals, but does recommend a controlled harvest approved by international conservation organizations. Any modest control program implemented would not threaten the long-term existence of crocodiles in Jubba River.

Birds will benefit from Baardheere Dam. Wading and other aquatic birds will quickly colonize this new environment and land birds will also benefit from a new water resource. Increased terrestrial and aquatic productivity in and near the reservoir will bring about commensurate increase of raptors and other birds of prey to further enrich reservoir zone birdlife.

Reptile and amphibian populations will also increase as a direct result of Baardheere Dam. Invertebrates will also increase (both beneficial and detrimental species). As noted previously, tsetse may become established near the reservoir and mosquitos will surely flourish. Jobin (1988) predicts that the reservoir will not provide suitable habitat for bilharzia snails, although the drawdown area may leave small pools which will harbor bilharzia hosts. The biggest increase of invertebrate disease vectors resulting from Baardheere Dam will be in downstream areas where new irrigation will provide highly suitable habitat.

Major effects on wildlife will be secondary—mainly through increased clearing for cultivation in downstream areas. Although natural habitat will be lost in floodplain areas, some wild ungulates will fare well unless poaching counterbalances increases in artificial forage. Large predators will continue a marginal existence as solitary animals or in small hunting groups. These wary animals are able to avoid poaching at current levels of intensity. Rhinos and elephant will completely disappear unless large areas in Bushbush or Shabeelle wetlands are set aside and protected by a disciplined, trained, and well-armed anti-poaching force. There is adequate dryland habitat for wildlife as many wildlife species with viable populations do not depend on Jubba River for water.

3. Fish

River

Fish populations in Jubba River will decline and some species may disappear from the river. Some

species will prosper while others diminish. Overall, fish biomass will decline. While conclusive proof of dhesheeg spawning is lacking, there is strong evidence that some fish species use dhesheegs for spawning or developing larval stages. Dhesheegs provide a rich aquatic environment for fish growth. Much of this fish habitat will be lost once Baardheere Dam is closed.

Fish biomass will not fluctuate as it does in an uncontrolled river. Fish populations suffer heavy mortality in late jiilaal when river flow ceases. Surviving individuals in deeper pools remain to begin a seasonal increase. This population instability will cease as the river will have sizable flow in every season.

It is impossible to predict how Baardheere Dam will affect fishing. Presently, part-time fishermen take advantage of low river volume in jiilaal to extract fish in both river and dhesheegs as this time is also a period when farm labor is not in high demand. Without low flows, fishing or fishing success may be reduced. On the other hand, channel fishing may be enhanced by stable flows. Fishermen do not fish during flood periods which coincide with periods of high farm labor demands. Flood periods make channel fishing unsafe and damage nets. With higher jiilaal flows, fishermen will have to change their techniques since fish will no longer be trapped in shallow pools. These new techniques will be more expensive and if investments are made for new gear, there is a likelihood of it being employed for longer periods of time. It is not expected that river fishing will increase appreciably and commercial fishing is highly unlikely. Baardheere Dam will not change the number of full-time fishermen on Jubba River.

Reservoir

Fish resources lost downstream will be more than compensated by gains in reservoir fish production. For a few years, fish populations will increase rapidly and fish growth rates will be nearly optimal. Subsequently, fish numbers and growth rates will subside while coming into equilibrium with nutrient inputs to the reservoir. While production will not be as high as in initial years after closure, fish yields will remain substantial for a very long time if sedimentation estimates are correct. What remains questionable is Somalia's interest and ability to capitalize on this valuable resource. The recommendation that GSDR grant reservoir fishery concessions to foreign enterprises for five to 10 years is repeated here. Somalia does not have resources or interest in developing a freshwater fishery in Baardheere Reservoir, yet it is an asset that is too valuable to waste. Government could grant import advantages to a private foreign company for fishing boats, gear, and processing facilities. Tax from fish exports could be significant as the reservoir fishery may exceed 2,000 tons annually. GSDR should insist that the concessionaire conduct training for local fishermen and technicians. Equipment imported should remain in Somalia after the concession expires. If this approach to reservoir fishery development is not taken, it is highly probable that the fishery will be vastly underexploited.

C. Social Effects

Baardheere Dam appears to be relatively benign in an environmental context, perhaps capable of bestowing net environmental benefits. In a social context, the dam has potential for causing considerable social harm on a population which has not experienced social and economic advantages. Unless great care is taken in planning and implementing development which is to accompany dam construction, an already disadvantaged population will become even more disadvantaged while development benefits are siphoned off to urban centers.

Three powerful social issues have come to the fore during JESS fieldwork which will require the utmost in cooperation and will of government and donors/lenders for solution. These issues encompass:

- resettlement of dislocated populations;
- health and livelihood; and,
- land tenure.

These issues are complex and intertwined interactions. In development, it is unlikely that one of these problems can be resolved without equal consideration for the others. Each of these topics is addressed elsewhere in this report in descriptions of current valley conditions, but future conditions merit more attention, more discussion, and better answers. Government and donors/lenders must demand even more effort in these areas of concern if the development dictum "*Primum non nocere*" (First do no damage) is to be met and that development in Jubba Valley is equitable.

A fourth major issue, settlement planning, also merits additional effort by government and donors/lenders if undesirable construction camp

conditions are not to be imposed upon Baardheere town. Present master plan drafts do not adequately account for the potential rapid growth of Baardheere once construction begins.

1. Resettlement

Compared to other African dams, the resettlement population is small as approximately 13,000 people living in loosely aggregated communities will need to be resettled outside the reservoir area. Somalia has previous experience with permanent and temporary resettlement of large numbers of refugees in Jubba Valley. Over 100,000 refugees also live in the reservoir area in large camps between Luuq and Buurdhuubo. Some of these camps will be totally inundated and others will be partially covered. Relocation of refugees was not a component of JESS studies as other national and international organizations were better suited to conduct studies on refugee relocation. A basic issue to be resolved is whether to merely relocate refugee camps or attempt a longer-term solution through repatriation and integration into Somali society. Government policy is to work with repatriation and integration, but how this will be factored into short-term solutions for Baardheere Dam remains to be decided.

During JESS studies, MNPJVD commissioned a separate resettlement study for the settled, non-refugee population. This study was performed by Halcrow Fox Associates, Ltd. with collaboration from JESS. Early resettlement proposals centered on translocation of the affected population to government-managed projects in lower Jubba, including Fanoole, Mogambo, and a proposed project at Hombooy. Several factors complicated this proposal and caused MNPJVD to explore another solution. Fanoole and Mogambo did not have adequate land to equitably compensate households for land and assets which would be lost by dam construction. The Hombooy Project is dependent on completion of Baardheere Dam and is not suitable for interim occupancy.

Relocation of the entire population at one site is culturally unacceptable to the people to be resettled. Communities in the reservoir area are culturally distinct, sufficiently so to warrant settling communities or groups of communities separately to avoid social conflict. Since these reservoir communities have evolved traditional rules and roles in geographic isolation, an attempt to blend them into a single harmonious whole is unrealistic.

A current proposal will locate agriculturally-suitable areas of 50 to 100 ha throughout Middle Jubba. Each area will be visited by resettlement community leaders for initial planning and allocating land. Communities with cultural similarities will be moved and settled at specific sites under their own leaders. Each household will receive a registered parcel of land and access to a small irrigation pump. Land clearing is to be done by household labor with assistance from project tractors. A Somali vendor will handle pump contracts and supply maintenance and training for small-scale pump operation. Host populations will be allowed to purchase project pumps at cost in order to improve host community receptivity towards the resettled population. JESS endorses this proposal and recommends that it be implemented by government and donors/lenders. On-the-spot land registration must be a key component to protect this socially vulnerable group against land speculators.

Resettlement is to be financed by a loan separate from, but tied to, the dam construction loan. This second loan will also include health and environmental components associated with the dam. Separating loans is wise, since single loans have not produced satisfactory social and environmental safeguards in other hydropower development projects. When construction cost overruns occur in single loan situations, deficits are covered by subtracting funds from companion components, usually from resettlement, health and environmental protection. With separately administered loans, social and environmental elements cannot be sacrificed for construction add-ons or overruns.

2. Health

The adage "Where water goes, disease will follow" has been tragically demonstrated in water development projects throughout the tropics. Baardheere Dam will increase incidence of waterborne and water-related diseases in Jubba Valley. JESS studies have demonstrated that poor health is commonplace and health facilities are below acceptable levels. Jobin (1988) provides a detailed analysis of JESS health and epidemiology studies which includes work of Klumpp (1988) and Warsame (1988). This summary, based on Jobin's report, will discuss only bilharzia (schistosomiasis), malaria, gastroenteric diseases and river blindness.

Bilharzia

Only urinary bilharzia, caused by *Schistosoma haematobium* and transmitted by the snail *Bulinus*

abyssinicus is reported in Jubba Valley. Intestinal (visceral) bilharzia is present in northern Somalia, but neither the schistosome, nor host snail for visceral bilharzia are reported in Jubba Valley. Incidence of urinary forms is high in Lower Jubba and progressively decreases in upstream regions. Incidence in each region is a function of the amount of irrigation.

The snail host prefers small pools of standing water with depths between 0.5 and 1 meter and containing aquatic vegetation. This type of habitat is almost exclusively human-made in Jubba Valley—usually byproducts of bund and road construction or parts of irrigation drainage systems. Because Lower Jubba has higher rainfall and more irrigation development, bilharzia incidence is much higher than in Middle Jubba and Gedo Region.

Expanding irrigated agriculture from 17,000 ha to 120,000 ha in Jubba Valley will bring about a proportional increase of bilharzia. In addition, Baardheere Dam will change dhesheegs so that snail habitat is increased. With recurrent river flooding, dhesheegs have little habitat suitable for snails because water depth is usually greater than one meter and aquatic vegetation at the margins is either grazed or trampled by livestock. Cultivation also contributes to reduced marginal aquatic vegetation. JESS surveys did not produce significant numbers of bilharzia snails in natural water bodies.

Without river flooding, some dhesheegs will partially fill with rainwater and will be less suitable for livestock watering and agriculture. More water area will be less than one meter deep and will have less turbidity which encourages snails. With favorable dhesheeg habitat and more irrigation canals and drains, bilharzia will increase, exceeding 80 percent in some villages located near irrigation projects, roads, and shallow dhesheegs.

Jobin (1988) predicts that Baardheere Reservoir will not be a favorable habitat for bilharzia snails except at a few sites. Jobin bases this prediction on an analysis of reservoir margin depths, wave patterns, wind direction, and drawdown rates. Small pools remaining in the drawdown zone could harbor snails, but if this area is cropped or grazed, a threat of bilharzia diminishes.

Malaria

Increasing incidence of malaria is a more threatening effect of Baardheere Dam in Gedo Region than incidence of bilharzia because the reservoir will provide suitable habitat for mosquito vectors. A second factor which contributes to malaria risk is a recent, but increasing, appearance of a chloroquine-resistant strain of malaria. Each new irrigation field, canal, and drain adds more mosquito habitat and puts more people at risk. Currently, chloroquine and its derivatives are available, but non-chloroquine medicines are not. It is possible to predict with near certainty that regular and chloroquine-resistant forms of malaria will show significant increases in Jubba Valley following implementation of Baardheere Dam.

Greatest increase will be in Lower Jubba as most of the projected increase in irrigation will occur in that region. Transmission patterns will not fluctuate as widely as they do now. During jiilaal, mosquito populations die back because there are few suitable sites for breeding, except in irrigation canals and small sections of the river. With additional irrigation during jiilaal and regular river flow, mosquitos will breed all year and in higher numbers. Since most settlements are located near mosquito breeding areas, disease transmission is assured.

While greater numbers of people will be infected in Lower Jubba, the greatest change in rate of infection will be near Baardheere and Luuq. With extended dry seasons, standing water is not common in this region, thus mosquito breeding is interrupted for many months each year. With Baardheere Reservoir, breeding will not be interrupted and several thousand hectares of new mosquito breeding habitat will be created.

Gastroenteric Disease

Baardheere Dam may contribute to reducing diarrhea and dysentery by providing a stable dry-season flow. Fewer people will use stagnant river pools for domestic water. More water will be available for drinking and bathing which will reduce diarrhea and dysentery. Reduced salinity will also lessen diarrhea caused by drinking saline water. This effect will be most apparent in lower Jubba, especially near the estuary.

If simple water treatment systems employing slow sand filters (such as those used in refugee camps) could be introduced in villages, then the river could provide a reasonably safe source of domestic water. Sand filter systems can be locally constructed and do not require advanced technology or equipment to be effective. While slow sand filters do not provide pathogen-free water, the improvement over not having any system is significant. Later, simple

chlorination devices can be added to slow sand filters to further improve water quality. With these two simple devices, gastroenteric disease will not be a significant health problem.

River Blindness (Onchocerciasis)

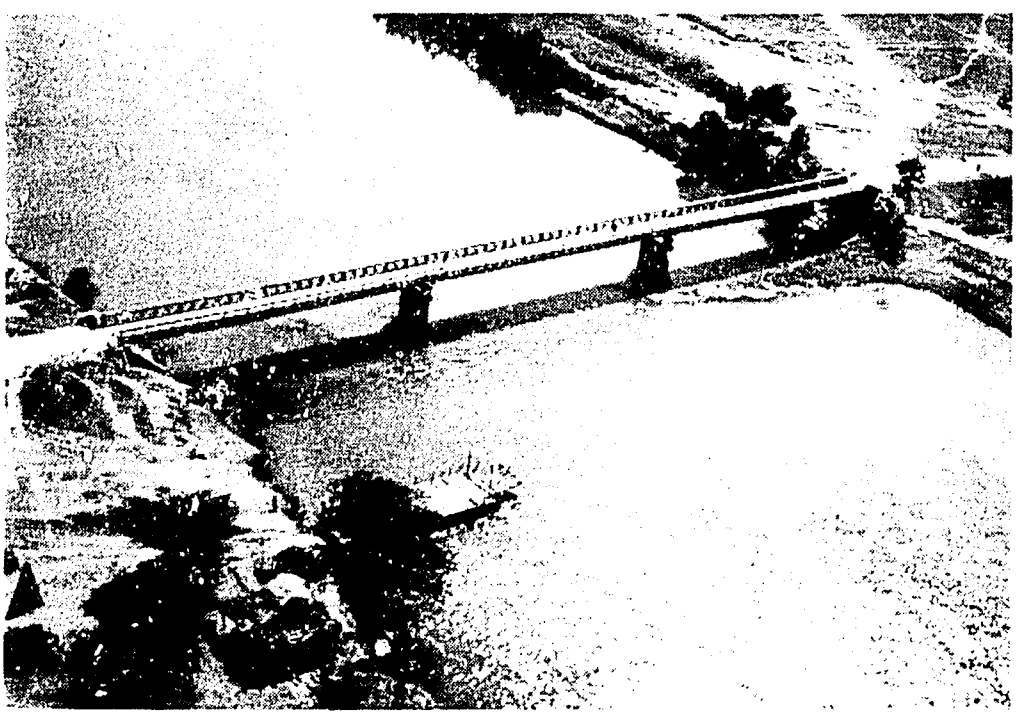
River blindness is not reported in Somalia, although the blackfly vector has been collected in the Shabeelle Valley. Blackfly larvae require oxygenated, flowing water to survive. Because of their low gradients, neither Jubba River nor Shabeelle River provide this type of habitat except in very short sections. However, plunge pools at the base of dams provide suitable habitat for blackflies. Baardheere Dam will create this type of habitat. However, in absence of the vector, it is not likely that river blindness will ever be an important factor at Baardheere. If cases of river blindness appear, blackflies can quickly be located and eliminated by judicious use of insecticides.

3. Land Tenure

With increasing expectation of an all-weather road between Baardheere and Jilib and construction of Baardheere Dam, land pressures in Middle Jubba and parts of Gedo Region will intensify. Whereas the current land law provides a legal mechanism for registering occupied, but unregistered land, land conflicts will become more common and more people will be dispossessed from land held for generations under customary tenure. This type of land speculation adds nothing to the valley economy and causes social disruption.

Since much of this speculation is carried out by non-permanent valley residents, benefits accrue to populations which are not forced to bear social and environmental costs of large development projects. In Jubba Valley, a rural population is being put at a disadvantage to benefit urban speculators. Since many of these registrations are done by civil servants, government is clearly responsible for inequities and must amend the current land law to make it equitable to all.

Land speculation is still at relatively small scale, but data indicate a trend toward more speculation and at accelerated rates. If government and donors/lenders wait until Baardheere Dam is completed and the road becomes active, existing valley



Traditional river crossings and access, such as this one at Buurdhuubo, will be lost to the rising waters of the new reservoir. The reservoir must be circumvented at Baardheere to the south or Luuq to the north, or new ferries must be established for people and livestock. (J. Janzen)

residents will have already lost their rights to land and agricultural production will be severely penalized. Conditions which have emerged in Jubba Valley are in contradiction to the expressed intent of the Agricultural Land Law; consequently, changes are necessary before development proceeds further.

4. Human Settlements

As soon as loan agreements are announced, Baardheere town will receive an influx of people which will lead to a doubling of town population within two years, if experience with other African dams is a reliable guide. Baardheere is ill-equipped to meet needs of the current population without adding burdens of uncontrolled and rapid growth. Municipal water and sanitary systems are nonexistent and medical facilities are lacking. Housing is not adequate and standards will decline further as newcomers take or make whatever is available for housing. Prices for basic domestic items will [illegible] rapidly as demand will outstrip supplies of food and clothing.

Bu'aale, Saakow, and Jilib will experience growth, but at much slower rates than Baardheere. There is a critical need for settlement planning in Jubba Valley and highest priority must go to Baardheere town. Since there is little settlement planning expertise in Somalia, technical assistance will be necessary. While settlement planning takes place, the Ministry of Public Works (MPW) will need to be reinforced in order to implement infrastructural additions which are planned. Regional headquarters at Baardheere will require considerable assistance because demands will come so rapidly. The UN Centre for Human Settlements based in Kenya can provide technical assistance for settlement planning and can assist the MPW in implementing those plans.

Settlement planning at this scale is an ideal donor package. It is a project that will show immediate physical results and should include a settlements training component. Experience gained from a settlement planning project at Baardheere town could be applied to other Jubba Valley growth centers.

There will be future concern about settlements on the reservoir margin. Because of suspected poor soils in this region, settlements are not likely to occur within a short time frame without an agricultural support base. Unless fishing villages are established, there is little economic activity to support large settlements.

Downstream settlements will grow at slower rates because some of their population will move toward Baardheere. With the road and dam, Baardheere will become a commercial hub of Jubba Valley until dam construction is complete—roughly a period of seven years. Even after dam completion, Baardheere will remain an important commercial focus of the valley's economic development.

Traditional river crossing points for both humans and livestock will be lost to the new reservoir, requiring that they circumvent the 160-km lake at Baardheere or Luuq.

V. RECOMMENDATIONS FOR MITIGATION

A. Introduction

Throughout this report, recommendations are integrated with discussions where potential mitigation or compensatory issues were raised. Some recommendations are specific, urging direct action by government or donors, while other suggestions reflect actions which could be taken by individuals or an organization which would improve the quality of life, but are not necessarily at project or program level. The latter recommendations are not of sufficient magnitude or importance to demand immediate attention and are not presented in this chapter.

Busy people take reading shortcuts, often moving to "the bottom line" as quickly as possible. For that reason, major recommendations for mitigation or compensation which have resulted from JESS long-term and consultant reports are offered in this chapter for quick review and are accompanied by a brief discussion. Detailed discussions on these mitigating measures can be found in the original reports. However, it must be noted that all recommendations have not been brought forward in this chapter, since several hundred mitigatory and compensatory recommendations have been generated in the three years of JESS studies by consultants and long-term staff. Many JESS recommendations call for further studies and, in most cases, are not repeated here.

Several recommendations have already been accepted and acted upon by the GSDR or donors/lenders, especially in the areas of resettlement planning and cultural heritage studies. JESS is confident that other recommendations will also be carefully considered by government and donor/lenders when planning development for Jubba Valley.

There has been no effort to present these mitigatory or compensatory measures by priority. Timing of implementation will be governed, in part, by sequences of other development activities or by availability of funding. Establishing mitigatory priorities for development is more a task of a master planning team and developers of Baardheere Dam and the Jubba Valley. Inspection of these mitigatory recommendations will show that they are relatively inexpensive and can be accomplished with existing or expected human and financial resources available to GSDR. In this report, JESS recommendations are organized in issue categories roughly following the report table of contents, so that readers may quickly refer back to the appropriate section for more background information.

B. Physical and Biological Environment

1. Undeveloped Areas

There is very little undisturbed land in Jubba Valley as most is used for agriculture or transhumant livestock grazing. Some undeveloped land is worth preserving, either for scientific reasons or for protection it affords to human systems and settlements. JESS recommends protection for two forest areas and a wetland complex in Southern Somalia as an important part of development.

Barako Madow and Shoonto Forests should be protected immediately and efficiently administered as Forest Reserves under compensatory wildland provisions of loan negotiations for Baardheere Dam.

These two small forest patches between 100 and 150 ha in size contain the only gallery forest remaining in Somalia. Both forests are threatened by more agricultural clearing and therefore, require immediate protection if anything will remain for biological conservation measures of construction loan agreements. Such action will contribute to maintaining biological diversity as well as protecting several endemic species of flora and fauna.

Shabeelle drainage wetlands should be protected from further clearing or drainage. These valuable wetlands should be protected under compensatory wildland provisions in loan agreements for Baardheere Dam.

This extensive series of swamps extending from Sablaale to the Jubba River are valuable for flood control, wildlife habitat, and dry-season livestock grazing. Without these wetland flood buffers to absorb high flows in the Shabeelle River, lower Jubba Valley would receive serious flood damage from Shabeelle as well as Jubba rivers. If these wetlands were drained and converted to agriculture, flooding will occur nearly every year.

Shabeelle wetlands provide viable habitat for large wildlife species, including elephants and rhinos. Loss of these vital wetlands would guarantee the

extirpation of elephant and rhino from Somalia except for a small number of transients from Kenya. These swamps also provide excellent forage and watering sites during jiilaal for livestock herds which migrate from Bay Region and upper Jubba Valley. The Shabeelle wetlands are vital to the livestock economy of Jubba Valley and Somalia.

2. Vegetation

Most vegetation mitigatory recommendations relate to wise use of forest resources. One notable exception is to locate and attempt to preserve a unique species of sedge found in the reservoir zone during JESS terrestrial ecology surveys.

GSDR, with assistance from international conservation organizations, should attempt to locate and transplant a species of sedge collected in the reservoir zone which was previously unknown to science.

This sedge may be found only in Somalia, or possibly only in the reservoir zone. Government must attempt, perhaps through organizations such as IUCN or USAID, to mount a small expedition to verify that this sedge is found elsewhere in Jubba Valley. If it is not found elsewhere, it should be collected in the reservoir zone and transplanted where it can be grown under scientific supervision. Unwitting extinction of a species is tragic, but a knowing and uncaring extirpation is unforgivable.

GSDR should establish a strong community forestry program in Jubba Valley which would include improved nurseries and extension services.

The JESS ecologist and the forestry consultant recommended that even though nurseries and forestry staff are present, additional funding and support are required before a community forestry program could function efficiently.

GSDR should devise methods to divert fuelwood extraction away from population centers to a broader geographic base further from the river.

Jubba Valley forests can supply fuelwood needs of an expanded population if fuelwood extraction could be spread to new areas instead of being concentrated around population centers and large-scale projects.

GSDR should seek a donor who would be willing to fund and administer a project on alternate and more efficient uses of energy for domestic uses in Jubba Valley.

Residents do not use energy efficiently for their domestic activities. Stoves are similar to those used in previous centuries when populations were small in relation to fuelwood availability. USAID has funded several successful projects in Africa, Asia, and Latin America which have introduced energy conservation in cooking, lighting, and pumping. These improvements utilize new and efficient designs as well as other energy sources, including solar and wind energy. Somalia has ample supplies of wind and solar energy waiting to be inexpensively harnessed for domestic uses.

All woody vegetation should be removed from the proposed reservoir margin prior to inundation. At a minimum, woody vegetation should be cleared between minimum and maximum reservoir operating levels (128 and 144 masl).

Aside from ecological and public health arguments on merits of reservoir clearing, Baardheere Dam Project has other considerations relating to woody vegetation. It is imperative that a clearing policy be instituted to prevent wasting wood resources that can be used as construction timber and fuelwood for labor camps.

The Agricultural Land Law of 1975 should be amended so that clearance of woody vegetation without crop cultivation would not be considered in compliance with land improvement requirements. Further, the law should be amended to allow management for forest products as a legitimate land use to maintain leasehold.

The Agricultural Land Law requires that new leaseholders improve the land within two years or have leases revoked. While not specifically stated in the law, removing woody vegetation has been accepted as the most recognizable land improvement. Farmers clear more than they cultivate, or just clear land without actually planting, but retain the leasehold because the land was cleared. Land-clearing without subsequent cultivation has been a common ploy of land speculators. It is a wasteful practice as most woody vegetation is burned *in situ*, rather than used for building materials or fuelwood.

The land law does not recognize forest management as a legitimate land use to retain leasehold. If a farmer selectively cut native vegetation or replanted tree species for future cutting, the leasehold could be revoked under the current interpretation of land law requirements. If Jubba Valley forests are to remain robust and viable, the level of forest manage-

ment must be improved. Before this improvement can be attained, the land law must be modified to include forest use as a legitimate land use.

3. Wildlife

GSDR should seek to institute controlled crocodile harvests on Jubba River by a pre-selected concessionaire with experience in crocodile harvesting in African Rivers. As a part of this recommendation, Government will need to gain an exemption from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Government could enlist the assistance of IUCN in this crocodile control program.

Crocodile population estimates range between 45,000 and 150,000 individuals in Jubba Valley. Crocodiles prey upon humans and livestock with alarming frequency. Crocodile control programs have been recommended by several JESS consultants in limnology, fisheries, wildlife and ornithology based on field visits. JESS wildlife consultants estimated that Jubba River can support an annual sustainable harvest of crocodile skins worth over U.S. $3 million.

Crocodile harvesting is not a task for amateurs; not so much due to the danger of collecting, but because processing of hides requires experience which is not widely available. A poorly-processed hide is nearly worthless while one correctly done can earn up to $200 for a three-meter hide. There are crocodile hunters who have legal concessions on other African Rivers. These concessionaires have experience in harvesting, processing, and international marketing. By following this recommendation, government can earn foreign exchange without a major investment of time or capital.

GSDR should institute a hippopotamus control program through the Wildlife Department of the National Range Agency.

Hippopotamus populations in Jubba Valley are also extensive, and are considered a nuisance. Hippos have fatally attacked humans and inflicted havoc on cultivated fields. At present, farmers enlist the aid of soldiers or bandits to shoot hippos which have damaged fields. At the same time, the Wildlife Department has an anti-poaching directive, and farmers who hunt to supplement family diets frequently have unpleasant experiences as a result of the efforts to protect the hippopotamus. If the Wildlife Department began to assist farmers in hippo control, relations will improve.

Hippo extermination is *not* recommended. However, it is recommended that the hippo population be culled to decrease their densities—especially in areas of high agricultural activity. If this program is instituted, the Wildlife Department should conduct a hippo census every year to determine how many animals should be removed.

4. Fish

GSDR should encourage a small-scale, freshwater fishery extension program which would disseminate information on fishing techniques and fish preparation.

JESS makes a strong nutritional and economic case for a more vibrant freshwater fishery, since Jubba River can produce a sustainable annual yield of 1,600 metric tons with an estimated market value of up to 100 million SSh. The Ministry of Fish and Marine Resources has a freshwater fishery unit which has had success in developing fishing cooperatives with minimal budget allocations. It is recommended that government increase freshwater fisheries budget so that cooperatives can be developed on Jubba River.

While fish are commonly consumed in Jubba Valley, many residents do not have experience with preparing or eating fish, and therefore, are unable to take advantage of a less expensive protein source. Jubba Valley fish protein costs less than one-quarter of protein from meat sources. If government prepared lessons on purchasing, catching, and preparing fish, women's groups, such as SWDO, could take these lessons to Jubba Valley to encourage freshwater fishing and improved family nutrition.

GSDR should seek a partner or partners for developing a fishing concession on Baardheere Reservoir. This concession should be limited to 10 years or less and must include a training component for local fishermen.

All new reservoirs experience rapid growth of fish populations while nutrients from decomposing vegetation are available. These large populations eventually diminish as nutrients wane, usually within 10 years. In experiences in other countries, governments were not prepared to establish fishing infrastructure to adequately take advantage of large fish yields and an ephemeral resource was lost. Somalia does not have freshwater fishing experience or supplies to handle a large reservoir fishery without outside experience.

GSDR should seek private entrepreneurs in other countries who would be willing to bring fishing equipment and fishermen to Somalia to harvest Baardheere fish during the initial years of operation. Government should grant import and export concessions in returns for fees on catch. At the same time, local fishermen should be trained to take over the reduced fishery at the end of the concession period.

GSDR should not commit national financial or technical resources to aquaculture projects in Jubba Valley. Development of aquaculture should be left to private enterprise if it is economically feasible.

During the study period, recommendations for developing aquaculture in Jubba Valley appeared in other studies. Aquaculture is capital intensive and requires technology which is not available in Somalia. In an absence of a proven market for Somali pond-raised fish, JESS recommends that government should not devote capital or human resources to developing aquaculture in Somalia.

C. Socioeconomic Environment

1. Irrigation and Recession Agriculture

It is recommended that GSDR not attempt to implement any government-managed irrigation projects in Jubba Valley until existing projects are improved and the potential of small-scale irrigators' input to agricultural development of the valley is considered.

Juba Sugar, Fanoole Rice, and Mogambo Irrigation projects cannot be judged successful even under the most permissive economic, social, or environmental criteria. Baardheere Dam will lead to stable water flows, thereby removing many water management constraints in these projects. Since government already has such large investments (mostly in foreign exchange) in these projects, it is imperative that these projects are rehabilitated as part of the Baardheere Dam and Jubba Valley development efforts. Small holders could have a significant contribution to economic development and water should be equitably allocated in relation to overall irrigation development.

During the initial years of operation, BDP should experiment with controlled flood releases from Baardheere Dam to enable valley farmers to continue with dhesheeg and flood-recession agriculture. Since power demand will not equal full generating capacity initially, experimental controlled floods will not result in economic penalties for lost power generation.

Over 20,000 ha in Jubba Valley are dependent in some aspect on overbank floods from the river. If Baardheere Dam eliminates these floods, many valley farmers will be seriously penalized until they are able to purchase and install rudimentary irrigations systems. As Scudder (1988) points out, heartland river basins in Africa are more important food producers than expected because of flood-recession cropping. In most African river basin experiences, importance of flood-recession agriculture is habitually underrated in benefit/cost analyses. When flood control is imposed by dam closure, downstream farm families previously dependent on recession cropping begin to experience crop failures and increased malnutrition.

At Baardheere, several years will pass after closure until dam operations reach full generating capacity. During these years, dam managers could release overbank floods at fairly specific times and for measured duration without losing power. These releases will enable valley farmers to continue recession agriculture and permit government to conduct economic feasibility studies of continuing controlled flood releases for agriculture even after power demand exceeds Baardheere's generating capacity.

2. Reservoir Drawdown Zone Agriculture

Future master plans should include considerations of reservoir drawdown zone agriculture.

As much as 10,000 ha of potential cropland could be available for agriculture in the reservoir drawdown zone.

Master plan agricultural studies for this zone were unavailable during JESS fieldwork. It is likely that future drafts of the Jubba Valley master plan will have sections on potential uses of the reservoir drawdown zone.

GSDR should seek a donor willing to sponsor pilot projects for forage production in the reservoir drawdown zone.

It is possible that the reservoir drawdown period may not be long enough to grow many crops, except at upper margins. Most African reservoirs have sufficient drawdown duration to produce a dense growth of grass and herbs which provides excellent forage and fodder for livestock (Scudder 1988). Maximum drawdown at Baardheere will be in jiilaal

which is the time when most Jubba Valley livestock are seeking forage and watering sites. It is likely that grasses and herbs will develop without human intervention in the reservoir drawdown zone, but yields can be improved through forage management practices which can be developed from a pilot project.

3. Nonirrigated Agriculture

GSDR should seek means to improve fertilizer delivery to Jubba Valley before dam closure.

As a result of frequent floods, a large amount of soil nutrients are deposited on croplands adjacent to Jubba River. After Baardheere Dam commences operation, flooding will be reduced or completely cease and nutrients will no longer be deposited on cropland. Even if controlled floods are continued, 95 percent of the suspended solids entering the reservoir will be retained and would not enrich downstream soils. If yields are to be maintained at present levels, farmers will need to apply fertilizers, probably after two years following closure.

Outside of large-scale projects and banana plantations, fertilizer use is virtually unknown in Jubba Valley. Farmers do not apply fertilizers or other chemicals because they are not sold locally. Farmers demonstrate a willingness to pay for agricultural services, such as for labor and tractor hire. It is likely that they will pay for fertilizers and biocides, if they become available and are shown to result in higher yields. At present, there are no mechanisms to effectively import and distribute agricultural inputs to Jubba Valley. GSDR should take steps to ensure future supplies of fertilizer to Jubba Valley.

GSDR should adopt policies to encourage small-scale, private-sector suppliers of agricultural supplies in Jubba Valley support villages.

Jubba Valley villages and urban centers do not provide sufficient support for agricultural development. Farmers are unable to purchase rudimentary farming inputs, such as commercial seeds, fertilizers, biocides, and tools. As a result, most smallholder agricultural practices, except for tractor hire, are virtually unchanged from the last century.

GSDR should adopt policies which would encourage private-sector merchants to operate agricultural support ventures in villages and urban centers in Jubba Valley. The government could continue to handle imports, but should not become involved in distribution or sale at the farm level as the private sector is more effective at this transaction level. Until the agricultural support functions of villages is improved, agriculture will continue to languish.

4. Livestock

GSDR should delineate livestock access corridors as soon as possible to Jubba River or provide off-river watering facilities to replace river watering points.

Cropland is expanding rapidly close to Jubba River making it difficult for herders to gain access for watering livestock without damaging crops. During the long north-south seasonal migrations of livestock, river watering points are crucial to herd and herder survival. During JESS studies, herders and farmers reported an increasing number of conflicts to researchers as well as noted a declining number of watering points available to livestock.

All Jubba Valley economic studies, including JESS, emphasize the economic importance of livestock in regional and national contexts. If this part of the economy is to remain viable, then government must take steps to assure supplies of water to livestock herds through access corridors to the river or through off-river tubewells and watering ponds. The decision between livestock corridors or artificial watering points should be determined by benefit-cost analyses, since livestock corridors of 200 m in width, as recommended by a JESS pastoral expert, will remove 20 ha from crop production for each kilometer of corridor. Off-river watering sites, such as tubewells or water catchment ponds, would avoid dangers of crocodile attacks and drownings.

Agricultural development projects designed for Jubba Valley should always contain components for livestock, such as use of crop residues for feed, watering access, and dry-season movement.

Livestock is a predominant feature in Jubba Valley economic and social systems. Some agricultural projects have been designed solely on a basis of crop production and potential livestock benefits have not been factored into overall plans. When livestock are overlooked, conflicts arise between new farming ventures and traditional use of land by mobile livestock herders. In addition, potentially valuable crop residues are not made available as livestock fodder during difficult dry seasons. Finally, livestock herders claim that traditional watering sites are being

increasingly denied to livestock use by farming interests.

Failure to consider livestock interests in planning agricultural projects increases social conflicts and imposes economic penalties to all groups. Livestock need not be a major consideration in farming projects, but herders should be consulted routinely as a part of community participation exercises in development planning. In most cases, herder requests will be simple and will not add appreciably to the cost of projects.

GSDR and donors should cease drilling tubewells and digging watering tanks on the west side of Jubba River until the effects of existing engineered watering sites can be assessed by range experts.

Between Jubba River and the border with Kenya, the government and some donors have been drilling new tubewells and digging large artificial watering ponds (*wars*). In addition, privately-owned wars are increasing. Some experts and government officials feel that these new watering sites attract larger numbers of livestock which is detrimental to range productivity. The range may be exhibiting symptoms of overgrazing which should be reversed as quickly as possible. It is likely that the private sector will continue to construct new wars, but that rate of increase is not likely to be serious and government need not prohibit this activity. However, drilling efforts should be temporarily halted until a range assessment can be made.

The government should seek donors to fund range improvement projects in the Southern Rangelands.

Very little work in range improvement has been done in the Southern Rangelands. GSDR should request that a donor begin range improvement studies as preliminary to beginning range improvement activities. However, JESS studies have shown that the Southern Rangelands are healthy and do not show overgrazing except in localized areas, usually near market towns or dry-season watering sites.

The government or PVOs should not attempt to improve the informal market system for crop residues through studies or interventions.

Crop residues are collected, transported, and fed to livestock on a routine and systematic basis. Money for collecting, transporting, and the residues exchange hands, yet the final purchase price for the residues is low. The system works because large truckloads of crop residues ply the many tracks and roads of Jubba Valley at frequent intervals. The system has been organized to work well because remuneration is slight and efficiency is necessary to make earnings worth the effort. When outsiders begin to study or tinker with these efficient informal exchange systems, problems usually occur and the systems begin to malfunction. In the crop residue market, it is working well enough not to require fixing.

The government should attempt to improve the use of crop residues as livestock fodder at its irrigation projects.

Crop residues at the three state irrigation projects are not used to feed livestock, nor are livestock permitted to graze fields after harvests. Juba Sugar uses most of its residues or by-products for fuel or products for sale. Fanoole and Mogambo project management do not permit use of residues for livestock feed and this fodder is wasted.

5. Land Tenure

GSDR should decentralize the land registration process.

The land registration process established by the Agricultural Land Law of 1975 is cumbersome, lengthy, and centered in Muqdisho—the least agricultural part of the nation. Applicants must fulfill requirements at a district level involving plot identification and notification of filing. After inspections at a district level, applications are screened by Regional Agricultural Officers and, if approved, sent to Muqdisho. After further screening and bureaucratic processing, successful applications are signed by the Minister of Agriculture. The fate of unsuccessful applications is not clear. In order to increase the probability of success, applicants usually accompany documents throughout the process—a task that simple farmers are not likely to accept.

There are no compelling reasons why the process could not be completed at district or regional levels where parcels and participants are better-known. Land registration has become a difficult topic in Somalia because of a growing number of inequitable land dealings which are legal under the current land law. Decentralization would be one step toward a more equitable land registration process.

New land registrants should be required to show proof that their parcel is currently unoccupied or

show proof that fair compensation has been paid to present occupants.

Currently, land registration applicants can register any land which is not registered, even if the land has been occupied and farmed by others for decades. Some urban dwellers have used this legal oversight to register land which is in full agricultural production. The new registrant evicts the farming family, often offering to hire them on a wage basis to operate the farm. In most cases, cultivation is taken over by wage labor without supervision because the leaseholder continues an urban residence. Farm production drops appreciably, perhaps operating at a loss. The investment is maintained because leaseholders are speculating on an increase in land values resulting from new development projects, such as the road and dam.

The scenario described above is inequitable, but legal. Government should amend the land law so that applicants must prove that the land is unoccupied and not currently in farm production or that the applicant has paid the occupants some compensation for land improvements. Under the law, land may not be bought or sold, but compensation for improvements is permissible.

The Land Law should be amended to allow for multiple plot leases for subsistence farmers.

Under Land Law provisions, only one plot may be registered per person. This provision is fine for large leaseholders, but is inappropriate for subsistence households. A common strategy to diversify farming risk in Jubba Valley is to cultivate multiple plots under different water regimes. This type of farming will seek one plot for river-recession planting, one for dhesheeg, and one upland site totally dependent on rainfall. The land law should provide a legal mechanism to maintain and protect this agricultural system.

The government should make changes in the interpretation of the Land Law to cover recommendations made in the forestry unit in this chapter.

6. Water Legislation

GSDR should promulgate national water-use legislation which will allow government to control river or reservoir off-take.

Water is the limiting factor for agriculture in Somalia. The Baardheere Dam will improve water management so that more land in Jubba Valley can be irrigated, but more land will remain available for irrigation than can be supplied with water. Jubba Valley cannot afford to operate under a policy of "first come, first serve", since the major state-operated ventures are not the first to be served. Unrestricted upstream off-take by smallholders can seriously jeopardize the well-being of all three state projects as well as Jubba Valley banana plantations. It is imperative that government establish some means to arrive at equitable allocations of water between large projects and smallholders and between geographic regions of the valley.

7. Health

A comprehensive health plan for Jubba Valley should be prepared to be implemented over a 25-year time period and to include municipal water supplies, waste treatment facilities, and primary health care posts at district levels.

Jubba Valley health problems cannot be resolved in a piecemeal fashion with several donors defining spheres of interest and operating without integration with any overall plan. In this process, symptoms, not causes, of ill health, are treated, but seemingly without progress. Success is measured by a number of cases treated, not by a reduction in the number of cases reported.

The Ministry of Health with assistance from the World Health Organization should prepare a master plan for better health in Jubba Valley. This plan should include probable costs, realistic time frames for implementation and lists of potential donors/lenders. Without such a plan, one group will attempt to treat malaria in Lower Jubba, another group will furnish prophylaxis for bilharzia in another region, but without any coordination of effort or focused approach to actually change conditions which promotes disease, such as unsanitary water supplies, mosquito breeding sites, or human behavior which encourages disease transmission.

A public health officer should be a member or advisor of the dam operations group.

Bilharzia and malaria may be partially controlled in the reservoir through manipulation of drawdown rates. A public health officer should discuss dam discharge and filling rates with the engineering staff to determine if rates could be modified to eliminate breeding habitat of mosquitos and snails.

Health components should be built into every development project proposed for Jubba Valley. These components should be in agreement with

requirements of the regional health plan recommended above.

It is not difficult to append health components to development projects. Safe water supplies can easily be added to agricultural projects and without major expense. Small health posts can also be added to project administrative units to service staff and project neighbors as a part of a regional primary health care program. For instance, it would be difficult for the Ministry of Health to establish a health post in Jilib District, but two agricultural projects already have posts that are used only for project personnel. These posts can be enlarged and better staffed to handle nonproject populations without a proportional increase in cost.

Development projects have access to foreign exchange for purchase of medical equipment and medicines. The MoH does not have this same access and is dependent on various donors to supply medical supplies. If health components are attached to, and financed by development projects, health conditions in Jubba Valley will improve at a faster rate than if left solely to MoH budgets.

The government should initiate or support a health education program on causes and treatment of anemia aimed primarily at pregnant women.

Common forms of female circumcision result in reduced flexibility in the birth canal in adult women. As a result, women often restrict food intake during pregnancy to limit fetal weight gain. The dieting normally results in anemia which becomes progressively more severe during the course of pregnancy which endangers the life of mother and infant. Often, results of this practice are exacerbated by helminth infections which also contribute to malnutrition and anemia.

A health education program, perhaps conducted by SWDO, will point out dangers of anemia and provide alternate means of controlling fetal weight which will not cause anemia.

8. Resettlement

GSDR should not attempt to resettle the dislocated population in less than four resettlement sites.

The resettlement population is over 13,000 individuals and it is unlikely that there is one site in Jubba Valley which will provide this many people with adequate farmland for agricultural self-sufficiency. While the valley is not densely populated, most of the better farmland has been occupied for decades, if not centuries. Existing irrigation projects do not have adequate space to accept this many people without severe problems.

The resettlement population is not accustomed to living in large settlements and would have difficulty in adjusting to urban or large project styles of life. In addition, there are several culturally distinct components within the resettlement population who are sufficiently different to warrant separate settlements to reduce potential tensions between groups.

It is recommended that the resettlement population be placed in several sites of 50 to 100 ha in size with technical and financial assistance for developing small-group irrigation systems.

JESS socioeconomic studies support expansion of small-group irrigation systems. JESS also recommends multiple site locations for the resettlement population. The two recommendations are combined in this single recommendation which supports both positions.

On-the-spot land registration should be an integral part of the resettlement process.

The resettlement population should not have continuing fears about security of tenure in their new locations. As settlers receive the boundaries of their plot, they should have an automatic application for leasehold. Conditions of the lease may remain as is in the Land Law in that it may not be sold or traded and the land must be used for agriculture within two years.

Resettlement planners should arrange visits by community leaders, including women, of the resettlement population to sites selected for relocation. At the same time, meetings should be arranged between these leaders and leaders of the host communities to discuss problems of mutual concern with and without resettlement planning officials.

Many large resettlement ventures have been limited successes or failures because of a lack of participation of the people being moved. Often resettled populations are merely trucked to new lands where housing may or may not exist and partial land clearing has taken place. If community leaders, including women who do most of the community work, are invited to participate in planning and to visit new sites, a more efficient and effective resettlement process will result. It is likely that community participation will lessen resettlement expense as funds will be spent more judiciously.

It is also important that resettlement leaders meet with host community leaders to head off many future problems. Host communities are often envious of attention lavished on new settlers as they may not appreciate the trauma of forced relocation. Property disputes and other social indicators of friction commonly develop between new settlers and long-time residents. Some of these disputes can be resolved before they become serious if leaders of each group have ample opportunity to air ideas and grievances in joint meetings.

Radio should be more widely used as a means to encourage community participation in resettlement and other development activities.

Newspapers and printed notices are not effective means of communication in Jubba Valley. Printed material does not circulate freely among rural villages and if it did, most people would be unable to read the contents. Literacy in Jubba Valley is sufficiently low to warrant other forms of public communication.

Radios are relatively common, even with pastoral groups. People listen to the radio in social gatherings as well as for solitary enjoyment. Due to its popularity, radio is the best means of urging people to participate in development decision-making. Because of their remote location, radio may be the only effective way to communicate with people in the inundation zone.

9. Baardheere Dam Project

BDP should make immediate arrangement with consulting engineers to begin measurements of total sediments transported into the reservoir zone.

There are no long-term and systematic measurements of suspended solids in Jubba River and there are no data on bed load contributions to sediments. These data are important in forecasting reservoir life and magnitude of delta formation near Luuq. BDP should begin these measurements as soon as possible.

It is recommended that the environmental and socioeconomic monitoring unit within MNPJVD be under the direct supervision of BDP. This monitoring unit should continue to operate within BDP after dam operations begin.

Monitoring units are more likely to be effective if they are located in operating agencies, not direct-line ministries. Operating agencies are normally staffed with technical personnel, more receptive to scientifically valid information. These non-ministerial agencies are also less susceptible to political pressures, thereby creating a more efficient monitoring unit.

While organizations have not become firmly established for building Baardheere Dam, it is likely that BDP will add more technical staff and should take the responsibility for an environmental and socioeconomic monitoring unit which is purely technical in operation.

BDP should develop a simple remote sensing program utilizing aerial video imaging as a part of the environmental and socioeconomic monitoring unit.

Aerial video imaging is less expensive and would be more responsive to the needs of BDP than other forms of remote sensing. The technology is rapidly emerging as new applications are attempted. Even without new gains in technology, aerial video can adequately meet the needs of a sophisticated environmental and socioeconomic monitoring program for Baardheere Dam and Reservoir operations. BDP should seek assistance from the Remote Sensing Centre in Nairobi in establishing this program and for technician training.

BDP should use aerial video imaging to monitor for waterweed proliferation on the reservoir.

Because of reservoir morphometry and prevailing winds, Baardheere Reservoir is not likely to experience extensive problems with waterweed growth, in spite of adequate nutrients. However, this forecast may be in error and BDP should monitor for waterweed buildup which can be corrected before proliferation gets out of hand. Semiannual aerial videos will show points where waterweed has started and if it is likely to become a serious nuisance.

BDP should monitor for hydrogen sulphide and methane buildup near the dam during early years of operation.

As a precaution in protecting people and machinery, BDP should monitor for hydrogen sulphide and methane during early operation. Hydrogen sulphide can corrode metal parts and methane can asphyxiate dam personnel or produce explosions. Both gases result from anaerobic decomposition of vegetation left in the reservoir. If clearing is effective, dangers of gas buildup are reduced, but not eliminated. The dangers decrease as the reservoir matures and vegetation decomposes.

VI. ENVIRONMENTAL AND SOCIOECONOMIC MONITORING

In a predevelopment setting, Jubba Valley exhibits certain environmental conditions that are the result of existing biophysical and agro-ecological phenomena. Superimposed on these conditions is a human population with its varying socioeconomic characteristics of demography, vocation, and land and resource utilization. JESS has conducted a series of baseline studies that were designed to document environmental and socioeconomic conditions before construction of the Baardheere Dam and subsequent development of Jubba Valley. These studies were implemented to predict what impacts—negative and positive—will or could occur as a result of dam construction and subsequent valley development.

With the publication of JESS Final Report, pertinent information and recommendations are conveyed to those responsible for the Baardheere Dam Project and Jubba Valley development in an effort to mitigate especially negative impacts that could irreversibly affect the area's human or ecological resources. Still, JESS could only estimate these impacts based on information gathered during its baseline studies. The actual detection, documentation, and resolution of problems and impacts associated with dam construction and valley development can only occur through a continuous monitoring program. Changes in the existing (predevelopment) situation should be monitored using JESS and other relevant research as a baseline. In theory, monitoring would be continuous over the medium- to long-term, even though certain follow-up research or sampling may be periodic. Depending on the monitoring parameters selected, changes in current environmental and socioeconomic conditions in Jubba Valley could be qualified or quantified, giving MNPJVD "hard" data to use in making decisions that will affect the environmentally sound and socioeconomically efficient operation of Baardheere Dam and development of Jubba Valley.

JESS conducted environmental and socioeconomic baseline studies in Jubba Valley over a three-year period. The meaning of baseline in this case is: "a set of critical observations or data used for comparisons or a control" (Webster's Ninth New Collegiate Dictionary 1988). What must follow, by definition, are additional sets of observations which will be compared with results of the JESS studies in order to detect environmental and socioeconomic changes as they occur, in time to take advantage of evolving beneficial changes or to perceive and mitigate negative effects. Environmental and socioeconomic monitoring can be designed to be complex or simple, costly or inexpensive, depending on the number and kind of variables measured and the degree of precision required. Generally, monitoring for development planning does not require measuring a large number of variables or a high degree of precision because planning agencies cannot afford the high recurring cost associated with data collection and analysis. For instance, it would not be possible for GSDR to completely repeat JESS studies on a regular cycle because of high costs. In preparing this proposed monitoring program, an effort was made to select a limited number of variables which are considered the most vital indicators of environmental and socioeconomic change.

This proposed monitoring program is based on the assumption that there will be a designated government unit charged specifically with environmental and socioeconomic monitoring of Jubba Valley development. MNPJVD has created an *environmental and socioeconomic monitoring unit* (ESMU) within the ministry for this purpose and staffing has begun. At present, MNPJVD is the logical organization to begin staffing and training for ESMU. If Baardheere Dam Project is charged with administration of construction and dam operation, ESMU should be transferred to that organization.

Monitoring units are more successful if they are not involved directly with political agencies, such as line ministries. To be effective, monitoring must be constant and should not vary activities in accordance with political pressures or variable budgets. The monitoring unit should be established within the eventual power authority which derives budgets from sale of power, and is normally outside governmental budgeting decisions.

Power authorities are usually composed of technocrats with hydropower experience and scientific training. As technical staff, they are appreciative of technical information generated by a monitoring unit and are more likely than politicians to utilize

this information for decision making. For these reasons, it is recommended that an environmental and socioeconomic monitoring unit be incorporated into Baardheere Dam Project before and after dam operation. In the following sections, JESS suggests a series of monitoring themes and methods deemed appropriate for GSDR.

A. Remote Sensing as a Monitoring Medium

Monitoring experience in every country has demonstrated the cost-effectiveness of remote sensing techniques (basically satellite imagery and aerial photography). Recent computer applications in geographic data management has further accelerated the utility of remote sensing in resource planning and management. At present, many techniques are too sophisticated and expensive to be endorsed for developing countries. As computer equipment becomes more available and less expensive, the geographic information systems (GIS) will be more appropriate for monitoring and planning in developing countries. However, wisdom dictates that new data bases be created which can ultimately be used in geographically referenced data management systems.

Important environmental and socioeconomic variables for Jubba Valley monitoring are not easily measured by satellite imagery. Satellite imagery is not perceived as a valuable planning tool in Somalia by GSDR or donors/lenders. For instance, USAID funded an expensive land-use study of Jubba Valley using 1978 LANDSAT images. Maps and images from this study were little used due to limitations of scale and applicability of map themes.

Stereo aerial photography has been widely used in Somalia for numerous agricultural and range projects. Cost of this photography is high and increasing in price. During JESS, stereo coverage of a four-kilometer strip at 1:10,000 scale centering on Jubba River cost approximately U.S. $30,000 with additional costs for photointerpretation. These photos are valuable for planning, but costs for new monitoring sets are high.

There is a time lag between planning and completing stereo aerial photography. For example, it took two jiilaal seasons to photograph all of Jubba Valley at 1:30,000 scale in 1983 and 1984 with a commensurate delay in obtaining a complete set of photographs. These photographs have been extremely valuable in providing a map base and photographic baseline for environmental and socioeconomic variables.

An emerging remote-sensing technology utilizing video cameras holds great promise for application in Jubba Valley. Video cameras and tapes are relatively inexpensive and tapes can be edited or used several times if the images are not worth keeping. The cameras can be attached to fixed wing aircraft with simple metal work. Images can be viewed with a video monitor within the aircraft while they are being recorded. Pilot/observers may make verbal records on the tapes to help in precisely defining location of the aircraft during image recording or to add valuable commentary to the visual record. Tapes can be viewed at higher scanning rates immediately after recording to determine image sharpness and to locate missing or poor quality segments. If imagery is missing or of poor quality, the pilot can repeat the necessary segments immediately. Video provides an instant feedback medium for rapid appraisal and analysis.

Standard video cameras may be purchased for less than U. S. $2,000, video cassette player/recorders (VCR) and high-quality television sets sell for under U.S. $500 each. It is recommended that nonstandard video cameras be purchased—those with a shuttered (stop-frame) capability to produce single frame images at an approximate cost of U.S. $5,000. A small inexpensive black and white monitor should be added for on board review during recording.

With shutter capability on the video and pause control on the VCR, 35 mm, 70 mm, and polaroid cameras can be attached to a color monitor to photograph selected images on the aerial tapes. These images can be used for making approximate measurements of structures or land uses in the photograph or to draw rough maps. It is not possible to expect precision of scale or mapping utility from video that is present in still aerial photography, but detection of change using selected environmental and socioeconomic parameters and follow-up decision making does not normally require that degree of precision in photo interpretation.

Other advantages include storage of thousands of potential single images on one small tape which can be duplicated at very low cost. Complete sets of images (tapes) can be copied and sent to remote sensing laboratories or to experts for interpretation at little cost. Tapes can be stored for decades, form-

ing an extremely valuable archival record for future studies. These archive tapes are small and can be stored safely in any reasonably clean and dry room.

Color images can be presented at meetings in a television media that most people know and enjoy. Images can be presented at the normal or higher speed for review, or at slow or pause speed if viewers wish to inspect images in more detail. If more detailed inspections are required, a polaroid camera could be used to photograph the image from the monitor for immediate interpretation.

Aerial video photography is an excellent development planning tool as it permits incredible flexibility. Pilots and observers can change scale instantly by simply shutting off the camera and changing altitude or lenses. Areas of interest can be recorded at larger scale at any time in a monitoring run by lowering aircraft altitude. Resolution is excellent, permitting identification of types of livestock, crops, dwellings, new clearings, or wildlife movements, all as part of a permanent record.

Monitoring in Jubba Valley will require more than remote sensing to be effective. Remote sensing is cost-effective in directing ground studies that are necessary to collect planning information, but it cannot permit detailed investigation of ground work. Through remote sensing, a monitoring team can learn where change is most apparent and rapid in Jubba Valley or where critical resources are being used unwisely. Fieldwork can be directed at these sites for more precise environmental and socioeconomic measurements. It is recommended that environmental and socioeconomic monitoring in Jubba Valley be built upon and integrated with an aerial video remote-sensing program.

B. Environmental Monitoring

1. Rainfall

Rainfall is the most important variable in determining ecosystem processes in semiarid areas, yet Jubba Valley records have poor coverage and are unreliable. Isohyetal maps, assumed to be true measures of rainfall in most development studies, are based more on vegetation patterns from aerial photography than on recordings from rain gauges. JESS recommends that the Food Early Warning System (FEWS) of MoA be charged with establishing a network of rain gauges throughout Jubba Valley. Desired coverage would be one gauge per 500 km^2, or a total of 60 gauges. Gauges should be set at government project headquarters, administrative centers, forest nurseries, health posts, police stations, and local employees trained for more reliable record keeping. Agents from FEWS should visit each recording site once a month to collect and review data. Copies of rainfall data sets should routinely be forwarded to MNPJVD for distribution to other government organizations working in Jubba Valley.

Somalia should also seek to participate in ARTEMIS (Africa Real Time Environmental Monitoring using Imaging Satellites) for precipitation monitoring. This FAO program uses cloud cover, cloud cover duration, and cloud-top temperatures to estimate rainfall over Africa. Data from this program are telemetered to the Regional Remote Sensing Centre in Nairobi and could be disseminated to Somalia as a member supporting nation.

2. Water Quality

It is assumed that the government will continue to monitor water quality at Mareerey. It is also recommended that similar parameters be monitored at other points on Jubba River. At a minimum, another station should be added at Mogambo Irrigation Project, primarily to monitor salinity. If funds allow, stations should be added at Baardheere town or dam site and at Luuq, in that order of priority. Measured parameters need not be extensive or require expensive equipment. Measurements should be taken on air and water temperature, pH, EC25 and turbidity (Secchi Disk). If funds allow, measurements of suspended solids, dissolved oxygen, phosphates, and nitrates should be added to the monitoring program. Measurements of hydrogen sulfide and methane should be made at the dam for corrosion control and possible explosive buildup of methane gas. At the Luuq and Baardheere stations, sedimentation rates should be monitored before and after dam construction.

3. Vegetation

Vegetation will change in Jubba Valley and with JESS baseline studies, remote sensing and ground studies can be used for monitoring. It is recommended that the monitoring unit re-photograph and analyze JESS vegetation monitoring sites at five-year intervals between June and August. This photography can be done with shuttered video cameras. It is important that GDSR develop a capacity to do vegetation analysis from aerial photography, either in NRA or a special Jubba Valley monitoring unit.

JESS collected detailed vegetation data on 90 plots throughout Jubba Valley. These plots have been permanently marked for easy relocation. Future ground studies of these plots would provide an excellent means of determining changes in floodplain and nonfloodplain plant communities as a result of Baardheere Dam and other land-use changes. These changes would have development significance, but are more important in an environmental science perspective. For this reason, JESS does not recommend that studies at these plots be a part of a monitoring program, basically due to cost, but it is recommended that government encourage botanical studies on these plots by interested international environmental organizations.

The rate and type of vegetation growth in the reservoir drawdown zone is an important element in a monitoring program. Vegetation in this area could be easily monitored with aerial video using images from randomly-selected sites and comparing these with imagery from similarly selected sites over time, as well as aerial photographs taken during JESS. Further, smaller-scale images over a larger area could show overall extension and abundance of drawdown vegetation. A limited amount of ground-checking studies could provide more detail on community composition, rates of growth, and above-ground biomass production. During ground studies, soil cores could be taken to determine the amount of sedimentation occurring in the drawdown zone.

It is essential that dam operators monitor growth of aquatic weeds in the reservoir. This task can easily be accomplished as a corollary to vegetation monitoring in the drawdown zone. Video coverage of the entire reservoir can be compared to previous years to determine if aquatic weeds are increasing. Aquatic weed foci will be apparent from video tapes and weed control programs can be developed for these specific sites.

Vegetation of conservation areas, such as Shoonto and Barako Madow can be monitored with aerial video photography. Images of the entire conservation area should be photographed from the video monitor and mapped for more detailed study and inclusion in an archival record of these areas. Incursions or dramatic changes can and should be investigated by ground teams and enforcement personnel.

4. Aerial Censuses

JESS has an excellent baseline for aerial censuses in Jubba Valley. It is recommended that monitoring include complete enumerations of river features at two-year intervals beginning in 1990. It is important that these aerial enumerations be recorded on video tape. Conducting aerial censuses of so many items requires highly skilled observers who are rare throughout the world. At present, one of the most highly experienced aerial census pilots/observers works in Somalia and was the principal in JESS remote-sensing studies. Video imaging allows more time for counting if tapes are played in slow motion or stop action as well as allowing the luxury of numerous reviews. Early tapes could be used to train Somali observers in aerial censusing and imagery analysis.

In this monitoring component, censusing covers both environmental and socioeconomic factors. As is true with all aerial photography, the tapes constitute an important archival record which can be reviewed many years in the future.

It is recommended that JESS strip censuses at 10 percent of the floodplain and three percent of the river-dependent zone be repeated at five- and 10-year intervals, respectively. As with river enumerations, it is important that these censuses be recorded on video tape because this unique censusing experience which is now in Somalia will not be available indefinitely. Strip censuses should be conducted twice in the same year during late jiilaal and mid-xagaa. Original JESS flight lines should be followed as closely as possible.

C. Socioeconomic Monitoring

The socioeconomic monitoring program should focus on a few areas which are most critical to the valley's development and the economic and social well-being of its people (Craven, Merryman, and Merryman 1989). Changes in the following areas should be monitored by the unit:

- health and nutrition;
- range condition, livestock numbers and species mix;
- agricultural land use and crop yields;
- resource access;
- out-migration; and
- resettlement.

1. Health

JESS studies indicate the potential for significant increase in disease, especially for waterborne types. All the elements for explosive increases in malaria and bilharzia are present without any strong deterrent, such as effective health staff and facilities. Clearly, a health monitoring program needs to be established, if only to record or document the expected increases. It is recommended that any health monitoring be performed by the most able unit in Somalia and the only agency mandated to deal with health, which is currently, the Ministry of Health.

It would be unwise to expect a monitoring unit to acquire equipment and medical staff to conduct vector or disease surveys when equipment and staff are already present in MoH and well-trained by WHO. It is unlikely that WHO would agree to train a second set of medical professionals and technicians in Somalia. It is also doubtful that WHO would be willing to supply a monitoring unit with medicines to treat diseases as they do with MoH.

It is recommended that a Jubba Valley monitoring unit work closely with MoH teams to coordinate survey work and to assure MoH of adequate vehicles, fuel, and field pay to complete the required tasks. By controlling payment and allotment of vehicles and fuel, the monitoring unit could be assured of receiving data sets and cooperation of ministry personnel.

Specific health monitoring parameters and schedules are omitted here but can be found in Volume II, Part I of JESS Final Report. Professionals in MoH and the Faculty of Medicine are well aware of what constitutes effective monitoring for bilharzia and malaria, both in terms of disease and vector surveys. There is no question that MoH and the Faculty of Medicine are capable of designing effective health monitoring programs for Jubba Valley. Resources should be provided for these programs by the monitoring unit and Somali expertise should be used.

2. Nutrition

UNICEF has been making height/weight measurements of children in lower Jubba Valley for the past few years. Children are most likely to show first signs of community malnutrition and are used as indicators for the group as a whole. Similar surveys are needed in Middle Jubba and Gedo Region. The monitoring unit should coordinate surveys, by UNICEF and/or the Refugee Health Unit which also has personnel trained in nutrition and anemia testing. It would be unwise to duplicate these experienced people in another agency, so it is not recommended that the monitoring unit develop a capacity to actually conduct field nutrition studies. A more useful role of the monitoring unit would be to coordinate studies in different Jubba Valley regions and handle field logistics for participating agencies, such as providing vehicles, fuel, and field pay. The monitoring unit would perform a valuable service if it were able to secure and administer funding for these surveys from donors. These surveys are relatively inexpensive, if vehicles are already available. Equipment is limited to height boards, scales and hemoglobin spectrophotometers which cost approximately U.S. $600 and will last for many years.

3. Range Condition, Livestock Numbers, and Species Mix

Range and livestock can be monitored with aerial video imaging. These conditions are most critical during jiilaal and early monitoring efforts should focus on this season. Images taken in strips in grazing areas at very low altitude will provide an adequate record of range condition. Ground-truthing will be necessary to determine grass and forb species at selected sites.

Annual jiilaal flights and imaging over floodplain grazing areas will provide a reference index for livestock numbers and species mix. Tapes can be played slowly or action stopped to determine species types. These annual counts will provide a relative, rather than specific, number of livestock present in the valley, but this index will be valuable in project decision making.

Censusing the entire valley for livestock numbers can be done every five years using strip censusing methods similar to those employed by JESS. Total census data will give the annual index counts a means to extrapolate in noncensus years and further verity index validity.

4. Agricultural Land Use

The ESMU can monitor agricultural land-use changes by reviewing aerial video tapes either by total review or selecting random tape segments for mapping or area calculation. Rough maps can be prepared from video tapes showing field patterns for different valley sections. It would be unwise to attempt crop mapping of the entire valley with the limited time and personnel likely to be available to

the ESMU. It will be more effective to select target study areas of "hot spots" of development, such as areas where new fields are being cleared at rapid rates.

Video imaging has sufficient resolution when taken at low altitude to identify crop types. Yearly or seasonal records or maps will show changes in cropping patterns, changes in ownership, and changes in plot size, once interpreters learn key points for observation.

Data could be enhanced through random field checking with measurements of crop yields of fields which have been photographed. In time, video interpreters will be able to estimate crop yields directly from video images. Video tapes should be saved for a video archive of Jubba Valley agriculture. Tapes from one year and one location can be compared with the same or different location of earlier years. Aerial video imaging is a powerful tool for socioeconomic analysis of agricultural or farming systems analyses.

5. Resource Access

Resource access monitoring will be accomplished by ground teams. First, teams will evaluate land registration applications at regional offices. Teams will visit two or three villages where registration is occurring at higher rates to interview households. The team will seek information on land losses due to registration irregularities or other losses of resource use.

It should be kept in mind that video cameras used for aerial imaging can also be used to record activities on the ground or to be used as teaching tools at village levels. MNPJVD has a supply of inverters which allows television sets to be run off vehicle batteries in rural villages.

6. Out-migration

While conducting other monitoring activities, the ESMU ground teams will collect information on out-migration in each village that is visited during the year. The out-migration data will be compared with JESS baseline data to determine if changes in rates are occurring. The out-migration is likely to be correlated with loss of resource access and can indicate to ESMU teams where resource loss may be occurring.

7. Resettlement

It is important that the resettlement population be monitored for at least one decade. These households will require interview teams as well as land-use surveillance through remote sensing. Because of this need for ground verification in resettlement villages, there is opportunity to train ESMU staff in ground-truthing for remote sensing. In effect, resettlement villages will be the ESMU's teaching laboratory where techniques will be learned that can be applied throughout the valley.

Since over one hundred of these households were interviewed by JESS, it is recommended that at least half be interviewed once again in five years using a limited set of parameters from the SEBS questionnaire to determine the extent of changes in their economic and social status.

D. Commentary

The proposed monitoring program is technically feasible, affordable and can be highly effective. It is not possible to provide all the information needed to make perfect development decisions because of inherent limitations of costs, logistics, and human resources in such monitoring programs. The proposed system was designed in the context of the limitations in Somalia and Jubba Valley and should work effectively in that setting.

At the same time, there is full recognition that it is improbable that such a monitoring system will be employed in the near future. Since the entire system rests on a video imaging base, if that part does not occur, there is no system. It is recommended and urged that MNPJVD or BDP take immediate steps to develop a remote-sensing capability based on aerial video imaging.

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Summary Table

JESS Recommendations for Enhancement of Positive Effects and Avoidance or Mitigation of Negative Effects of Proposed Baardheere Dam and Jubba Valley Development.

Aspects of Environmental Concern

Hydrology, Sedimentation and Water Quality

An effective "Jubba Water Use Authority" is urgently needed and should continue to operate during and after construction. The Authority should immediately commission a study to produce a water-use master plan, which would serve as its terms of reference.

During the initial years of operation, BDP should experiment with controlled flood releases torm Baardheere Dam to enable valley farmers to continue with dhesheeg and flood-recession agriculture. Since power demand will not equal full generating capacity initially, experimental controlled floods will not result in economic penalties for lost power generation.

Development of alternative management strategies for the regulation of the reservoir should be based on a reliable forecast model for streamflow inputs. Design and planning should be based on the hydrologic data set prepared by AHT.

Regulation of river flow should allow a base flow of 20-90 cumecs at the ocean during the jiilaal dry season to sustain freshwater recharge of the riverine aquifer and avoid the annual episodes of saltwater intrusion to wells along the river and the Kismaayo water system intakes.

In mixing concrete for dam construction, river water should not be used when it has high concentrations of sulfates and suspended solids, and a special cement should be used to avoid the danger of spalling in the concrete.

Additional meteorological and groundwater studies of the Bale-Ogaden area should be carried out to improve on baselines, and the study area should be expanded to the adjacent Shabeelle Basin in order to improve capacity for predicting inflows to both Somali rivers. BDP should also make immediate arrangements with consulting engineers to begin lower-term measurements of total sediments transported into the reservoir zone.

Monitoring. A study should be conducted to determine annual volume of sediment transported into the reservoir during at least one flood season.

Salinity of irrigation drainage waters should be monitored annually to determine if any of the major projects are returning excessively salty water to the river, to the detriment of downstream users.

Salinity of the water being discharged at the dam should be monitored daily by the dam operations group, to detect saline density currents or other conditions which might result in harmful concentrations of salt reaching the turbines or being released downstream.

It is assumed that the government will continue to monitor water quality at Mareerey. It is also recommended that similar parameters be monitored at other points on Jubba River. At a minimum, another station should be added at Mogambo Irrigation Project, primarily to monitor salinity. If funds allow, stations should be added at Baardheere town or dam site and Luuq, in that order of priority.

GSDR should promulgate national water-use legislation which will allow government to control river or reservoir off-take, and establish equitable allocations of water between large projects and smallholders and between geographic regions of the valley.

BDP should monitor for hydrogen sulphide and methane buildup near the dam during early years of operation, as a precaution in protecting people and machinery.

Limnology

Limnological sampling should be repeated during the low-flow months of January through March, when maximum development of microflora, macrophytes, microfuana, and benthic organisms can be expected to occur in the Jubba River. The JESS study was carried out after a major flood and during high water flow.

Monitoring. The GSDR should establish a fully equipped laboratory for limnological and water quality studies. The training of local limnologists is absolutely essential for successful management of the reservoir. Once other reservoir is formed, it is recommended that seasonal monitoring of phytoplankton growth be carried out. This monitoring should include measurements of primary production, phytoplankton biomass, and species composition. It is also recommended that zooplankton and benthic community production, biomass and species composition be determined regularly, as well as measurements of primary production, standing crop cover and species composition of aquatic macrophytes. Post-impoundment surveys should be conducted regularly to locate new growths of aquatic weeds, particularly the exotic species, which could pose problems in the future.

Fisheries

MNPJVD should provide fisheries administrative training to one of the present staff members, enabling logical interactions with associated government ministries (MFMR) for planning of fisheries development and management in the Jubba Valley. MNPJVD and MRMR should develop a cooperative infrastructure for fisheries development and management in the Jubba River.

GSDR should not commit national financial or technical resources to aquaculture projects in Jubba Valley because it is capital intensive and requires technology which is not available in Somalia. Development of aquaculture should be left to private enterprise if it is to be economically feasible.

Development and extension programs should include encouragement of fish consumption by local villagers, development of local and international freshwater fish markets, and creation of community fishing centers that could provide low-cost fishing gear on a revolving credit basis and would disseminate information on fishing techniques and fish preparation.

The use of fish for malaria control and control of aquatic vegetation would require limitations on the chemicals which would be used in agricultural and health programs. Strict control on mixing and spraying operations would also be required to protect fish in drains and other waterbodies. These controls should be developed as part of an integrated pest management program.

Monitoring. Ongoing fishery assessment surveys and short-term fisheries development programs w/ extension activities should be developed to enable predictions of maximum sustainable yield.

The fish, prawns, and lobsters processed in Kismaayo should be monitored for biocides by the Ministry of Health, using facilities of the Faculty of Chemistry at the National University. If significant concentrations are found, the use of such chemicals in agricultural projects should be reduced.

Vegetational Changes, Forestry and Biological Diversity

GSDR should establish a strong community forestry program in Jubba Valley which would include improved nurseries and extension services.

It is recommended that the forestry component remain the responsibility of NRA, and be coordinated with MNPJVD or a project director as appropriate, and that NRA should be strengthened to carry out this component.

In the district of Luuq, major efforts should continue to be taken to encourage all landowners and householders to plant trees to contribute to their own local needs for wood and other products.

Tree planting should be promoted in all districts, and nurseries and extension activities should be improved throughout the valley.

Cutting of fuelwood and poles for sale in all towns should be regulated sufficiently to spread cutting over a wide enough area to avoid deterioration.

Measures must be taken in advance to ensure that fuelwood is transported to key locations, particularly in towns which will expand rapidly during or after dam construction.

In refugee camps, the responsible authorities should take action to ensure provision of fuel just as they now provide for some other basic necessities, such as food and water, so as to avoid pressure on surrounding woody vegetation.

Barako Madow and Shoonto Forests should be protected immediately and efficiently administered as Forest Reserves under compen-

satory wildland provisions of loan negotiations for Baardheere Dam.

Shabeelle drainage wetlands should be protected from further clearing or drainage. These valuable wetlands should be protected under compensatory wildland provisions in loan agreements for Baardheere Dam.

GSDR, with assistance from international conservation organizations, should attempt to locate and transplant a species of sedge collected in the reservoir zone which was previously unknown to science.

GSDR should seek a donor who would be willing to find and administer a project on alternate and more efficient uses of energy for domestic uses in Jubba Valley to avoid continued over exploitation of fuelwood.

All woody vegetation should be removed from the proposed reservoir margin prior to inundation to prevent wasting wood resources that can be used as construction timber and fuelwood for labor camps. Woody vegetation should be cleared between minimum and maximum reservoir operating levels (128 and 144 masl).

Monitoring. A monitoring system should be established, with the main purpose of environmental-ecological monitoring of habitat changes and trends, and annual productivity of the vegetation.

ESMU should re-photograph and analyze JESS vegetation monitoring sites at five-year intervals between June and August. This photography can be done with shuttered video cameras.

Changes in land use of the floodplain should be monitored and incorporated into decision-making. Technicians and trainers should be trained to interpret and apply monitoring information.

The ESMU can monitor agricultural land-use changes by reviewing aerial video tapes either by total review or selecting random tape segments for mapping or area calculation.

ESMU should select target study areas or "hot spots" of development, such as areas where new fields are being cleared at rapid rates.

Wildlife

Tsetse fly eradication efforts should be restricted to the Jubba and Shabeelle systems and not be attempted in Bushbush area adjacent to the Kenya border, so as not to endanger resident wildlife.

GSDR should institute a controlled harvest program for crocodiles and consideration should be given to their commercial exploitation so that these control costs can be met from the sale of skins.

Public Health and Disease Vectors

The potential incursion of Rift Valley fever virus in herds around the proposed reservoir site should be monitored by an established virology laboratory, arranged through WHO. If the virus appears soon after the reservoir fills, a military quarantine should be established around the dam and reservoir, in combination with a vaccination program. This would probably be needed only for the first few years after the reservoir fills to spillway height.

A public health officer should be a member or advisor of the dam operations group to discuss dam discharge and filling rates with the engineering staff to determine if rates could be modified to eliminate breeding habitat of mosquitos and snails.

The schedule of dam operations should be revised to integrate requirements for fish production, and control of aquatic vegetation and disease vectors. Encouragement of fish populations in the reservoir would reduce malaria risks as well as provide an important source of food.

New agricultural projects should avoid the possibility of snail colonization by careful programs of canal cleaning and maintenance, crop rotations which would allow long-term drying of canals and fields at three- to four-month intervals, and construction of extensive drainage systems.

Each irrigation project should be required to establish and maintain a toxicity treatment unit for the biocides which it uses, and educate its personnel about the early signs of intoxication. An interministry government panel should review all import licenses to control particularly dangerous biocides.

River regulation through constructing the dam, and improving local drainage, filling depressions, and planting eucalyptus trees around towns and villages would be the most practical method of large-scale malaria prevention in the Jubba Valley.

The MNPJVD should require that all new developments include these features.

Pest control in sugarcane, rice, and other crops should be improved by requiring new agricultural projects to develop integrated pest management strategies which utilize cultural, genetic, and biological methods, and minimize application of dangerous biocides.

If public health programs using biocides are implemented in the future, the use of organophosphate compounds should be avoided because of the possible accumulation of multiple exposures by agricultural personnel from both agricultural and health programs.

Programs eradicating tsetse fly, malaria, and bilharzia should be part of development programs for the pastoral population and their livestock. The reservoir area used by livestock-keepers should be included in a possible tsetse-eradication campaign, as well as in programs for the abolition of malaria and bilharzia.

A comprehensive health plan for Jubba Valley should be prepared to be implemented over a 25-year time period and to include municipal water supplies, waste treatment facilities, and primary health care posts at district levels.

Health components should be built into every development project proposed for Jubba Valley. These components should be in agreement with requirements of the regional health plan recommended.

Monitoring. ESMU should oversee supplemental disease control operations around the dam—especially malaria control in very wet years. Funds should be providedto MoH to operate a disease control unit, stationed near the reservoir.

Present plans should be expanded to include financing and planning for a public health program against malaria, bilharzia, and diarrheal diseases. The program should be based on environmental management, public water supplies, community education, and primary health care.

The cost of the public health program should be financed as part of the construction costs of the dam and agricultural developments. Operation and maintenance of the program should be the joint responsibility of the local communities, the development projects, the National Anti-malarial Service, MoH, and the MNPJVD.

Avoidance of flooding in the lower valley for malaria control should be monitored when the dam is in operation and discharge rules should be developed for the dam to avoid mosquito production in the lower valley.

Fanoole Barrage and irrigation system should be monitored annually, around February, for invasion by the snail which transmits intestinal bilharzia, *Biomphalaria pfeifferi*. Emergency assistance from WHO should be requested if this occurs. The new reservoir should also be surveyed for snails annually for at least the first 10 years of operation.

The government should initiate or support a health education program on causes and treatment of anemia aimed at primarily at pregnant women. ESMU should coordinate surveys with UNICEF and/or the Refugee Health Unit which also has personnel trained in nutrition and anemia testing. It is not recommended that the monitoring unit develop a capacity to actually conduct field nutrition studies. Rather the monitoring unit should coordinate studies in different Jubba Valley regions and handle field logistics for participating agencies, such as providing vehicles, fuel, and field pay.

Aspects of Socioeconomic Concern

In-migration and Construction Camps

MNPJVD should develop a settlement program which includes planning for existing and expected agricultural communities. Sites should be selected on the basis of their suitability for agricultural activities and minimal exposure to water-associated diseases. Community water supplies should be developed as the keynotes to determine the location and size of these communities. The plan and organization of the community and its public facilities should reflect the need to protect health at maximum efficiency and low cost. The communities should be assisted in organizing primary health care systems.

Special provisions should be made for fuel and pole supplies for construction camps, so that cutting does not occur in the usual collection areas of towns and villages, and does not cause environmental deterioration.

For the construction camps near the dam, a water treatment system should be built which will also supply water to Baardheere, after sedimentation and filtration. The system should be constructed with enough capacity for the ultimate expected population of Baardheere.

The construction camps should be supplied with a health unit which has responsibility for drainage and sanitation, health education, medical screening, and treatment of personnel. They should also have facilities, personnel, and supplies for treating trauma from construction accidents as well as communicable diseases.

MNPJVD should develop and manage the settlement program in cooperation with local councils of the existing or planned population groups, and the Ministries of Health, Mineral and Water Resources, and Range and Livestock. The location of settlements should be carefully selected to assure their suitability for the communities' agricultural activities and minimize exposure to water-associated diseases. Community water supplies should be developed at the keystone to determine the location and size of these communities.

Monitoring. While conducting other monitoring activities, the ESMU ground teams will collect information on in-migration and migration in each village that is visited during the year. The out-migration data will be compared with JESS baseline data to determine if changes in rates are occurring.

Resettlement

Displaced persons from the inundation zone should be absorbed in the agricultural expansion taking place in the middle Jubba. A study should be required to design the most efficient way to encourage this absorption. Master planners should consider this emphasis in their present agricultural studies.

It is recommended that a workable rehabilitation program for the Buurdhuubo refugee population be put into effect as soon as possible, but not later than 1990.

GSDR should not attempt to resettle the dislocated population in less than four resettlement sites since this population is not accustomed to living in large settlements and to reduce potential tensions between culturally distinct components.

It is recommended that the resettlement population be placed in several sites of 50 to 100 ha in size with technical and financial assistance for developing small-group irrigation systems.

Resettlement planners should arrange visits by community leaders, including women, of the resettlement population to sites selected for relocation. At the same time, meetings should be arranged between these leaders and leaders of the host communities to discuss problems of mutual concern with and without resettlement planning officials.

On-the-spot land registration should be an integral part of the resettlement process so that the resettlement population does not have continuing fears about security of tenure in their new locations.

Radio should be more widely used as a means to encourage community participation in resettlement and other development activities.

Monitoring. The resettlement population should be monitored for at least one decade. These households will require interview teams as well as land-use surveillance through remote sensing. Since over one hundred of these households were interviewed by JESS, it is recommended that at least half be interviewed once again in five years using a limited set of parameters from the SEBS questionnaire to determine the extent of changes in their economic and social status.

Farming Systems

Potential of the reservoir drawdown zone as a productive area for agriculture or livestock production should be assessed and incorporated into land-use planning and dam operating schedules. This should include a set of measures which will maximize the development of usable vegetation biomass on the reservoir drawdown zone.

Agriculture should be expanded gradually by emphasizing development of existing smallholder systems such as dhesheegs and farming cooperatives, rather than large monoculture systems, and by developing integrated pest management programs to avoid ecological and health damage due to agricultural pests, disease vectors, malnutrition, and biocides.

A phased change from assisted dhesheeg farming to pumped irrigation in the area between Saakow and Faroole Barrage should be considered.

Stable agricultural expansion should be assured by avoiding salinization of soil and drainage waters by combining carefully designed crop rotations with provision of a base river flow and with deep drainage systems. The salinity problems could be avoided by using less intensive cropping systems which limit the drainage return rate to about 10 percent of the applied flow.

It is recommended that GSDR not attempt to implement any government-managed irrigation projects in Jubba Valley until existing projects are improved and expanded to the most feasible limits in view of water management constraints.

GSDR should seek means to improve fertilizer delivery to Jubba Valley before dam closure. Fertilizers will be needed to replenish nutrients previously deposited by river flooding.

GSDR should adapt policies to encourage small-scale, private sector suppliers of agricultural supplies in Jubba Valley support villages since farmers are currently unable to purchase rudimentary farming inputs, such as commercial seeds, fertilizers, biocides, and tools.

Agricultural development should take place in such a way that suitable crop residues are available to livestock.

A one-sided expansion of export-oriented crops should be avoided. A spatial pattern of mixed cultivation including sufficient staple crops, e.g. maize, sorghum, and possibly rice, should be the goal to avoid loss of fodder availability for livestock during the dry seasons.

The small amount of land for potential cultivation on the plateaus along the reservoir area should be developed to substitute for the loss of arable land on the river banks of the gorge area. Compensation of the agro-pastoralists with new agricultural land further south along the river in the Middle Jubba Region should be considered.

Pastoralism

In spite of the demand for freedom of movement, it would be advisable to seek appropriate alternatives for the large-scale, dry season immigration of camel herds from the north to the south, since this poses considerable ecological strain and introduces many animal diseases to the southern part of the valley.

A restriction on building new government and private wells and water catchments in the main grazing areas should be considered to limit further increases in the livestock population and resulting degradation of vegetation.

Agricultural development projects designed for Jubba Valley should always contain components for livestock, such as use of crop residues for feed, watering access, and dry-season movement. This should help to avoid conflicts between new farming ventures and traditional land uses by mobile livestock herders.

Maintenance of livestock watering-points along the Jubba River should be and integral part of floodplain development. The possibility of using selected dhesheegs for this purpose should be investigated.

The possibility of diverting postdam flood waters into Dhesheeg Waamo should be investigated to maintain forage and water requirements for livestock in Afmadow District.

The possibility of rehabilitating herbage yields in the river-dependent zone should be investigated. GSDR should seek a donor willing to sponsor pilot projects for forage production in the reservoir drawdown zone.

At those points along the river and reservoir 's shore where traditional watering of livestock is no longer possible, the GSDR should construct watering facilities (e.g., level river banks, troughs, and mechanical facilities for lifting the water).

Principal dhesheegs traditionally used as watering points for livestock, and others which could be used, should be connected to the river by small canals for artificial flooding.

Between new cultivation areas, a sufficient number of corridors of at least several hundred meters in width have to be kept open the facilitate livestock access to the riverbanks thereby avoiding conflicts between pastoralists and farmers over damage to crops and irrigation canals.

A certain number of areas with good grass in the Jubba floodplain and coastal plain should be maintained as livestock fodder reserves for the dry seasons and GSDR should seek donors to fund range improvement activities in the Southern Rangelands.

GSDR and donors should cease drilling tubewells and digging watering tanks on the west side of Jubba River until the effects of existing engineered watering sites can be assessed by range experts. Since new watering sites may attract larger numbers of livestock which is detrimental to range productivity.

At favorable places in the bays surrounding the reservoir, adequate watering facilities in shallow water should be constructed for livestock, and protective measures (e.g. fences) against crocodiles should be built.

Monitoring. Range and livestock should be monitored with aerial video imaging, particularly during jiilaal. Images should be taken in sampling strips in grazing areas at very low altitude and ground-truthing will be necessary to determine grass and forb species at selected sites. Annual jiilaal flights and imaging over floodplain grazing areas will provide a reference index for livestock numbers and species mix.

Censusing the entire valley for livestock numbers should be done every five years using strip censusing methods similar to those employed by JESS. Total census data will give the annual index counts a means to extrapolate in noncensus years and further verify index validity.

Land Tenure

Traditional use and legal claims of the mobile livestock-keepers to areas on the river banks and in the flood plain will have to be considered in future development planning; in case of loss of claims, adequate compensation for the mobile livestock-keepers should be provided.

When distributing agricultural lands along the middle course of the Jubba River, preferential consideration should be given to agropastoralists, and possibly also to pastoralists who are willing to settle.

GSDR should decentralize the land registration process to reduce unnecessary layers of bureaucracy, and ultimately to increase the number of successful applicants.

New land registrants should be required to show proof that their parcel is currently unoccupied or show proof that fair compensation has been paid to present occupants.

The Land Law should be amended to allow for multiple-plot leases for subsistence farmers, enabling them to continue to diversify risk by cultivating under different water regimes.

The Agricultural Land Law of 1975 should be amended so that clearance of woody vegetation without crop cultivation would not be considered in compliance with land improvement requirements. Further, the law should be amended to allow management for forest products as a legitimate land use to maintain leasehold.

Monitoring. Resource access monitoring should be accomplished by ESMU ground teams. Teams will evaluate land registration applications at regional offices then visit tow or three villages where registration is occurring at higher rates to interview households. The team will seek information on land losses due to registration irregularities or other losses of resource use.

Public Services and Infrastructure

One or two ferry crossings should be established across the dam at suitable locations to reduce the impact of the long barrier created by the reservoir between Luuq and Baardheere.

Good all-weather roads along both banks of the Jubba floodplain, with two new bridges at Saakow and Jilib, are needed to develop cash cropping throughout the valley and a generally more intense and technically based agricultural system.

MNPJVD should ensure that provisions for community water supplies of resettlement, new settlements, and expanded communities, be linked directly with construction of the dam and development of the valley. The design capacity for community water supplies should be 100 liters per capita, per day, to ensure reserves enough to minimize deaths due to diarrheal disease as well as risk of bilharzia infections.

Subterranean reservoirs should be created in the "magnet communities" by placing clay dikes across the beds of the ephemeral tributaries or "togga," thus trapping water underground and retaining adequate water for the time when the reservoir has receded.

Community water supplies, using filtered water, should be established on the flat land west of Buurdhuubo, 2-5 km west of the maximum normal operation level (142 masl) of the reservoir, and at

similar locations on the east bank. By careful planning and collaboration with existing and potential residents, "magnet communities" should be created at these sites to draw the expected settlers. It is recommended that the "magnet" sites be developed with access roads, electricity, wide streets with good drainage, and well-spaced community water taps. Domestic herd should be kept between the communities and the reservoir during the night to protect the people from malaria mosquitos.

Baardheere town should be supplied with water from the reservoir by constructing a pipeline from the damsite to a treatment plant, with several distribution taps within the town and to the high ground east of town to encourage development away from the river.

The number of bridges on the middle and lower river should be increased, taking into account the locations of traditional livestock keeper crossing points when planning future bridge construction. It would be advisable to build new bridges at Jilib and Saakow, to at least partly maintain the traditional migration pattern.

Long Term Environmental and Socioeconomic Monitoring Program: Administration and Methods

It is recommended that the Environmental and Socioeconomic Monitoring Unit (ESMU) within MNPJVD be under the direct supervision of BDP. This monitoring unit should continue to operate within BDP after dam operations begin.

The MNPJVD or BDP should take immediate steps to develop a remote-sensing capability based on aerial video imaging as the basis for environmental and socioeconomic monitoring of Jubba Valley.

Somalia should also seek to participate in ARTEMIS (Africa Real Time Environmental Monitoring using Imaging Satellites) for precipitation monitoring.

JESS recommends that the Food Early Warning System (FEWS) of MoA be charged with establishing a network of rain gauges throughout Jubba Valley. Desired coverage would be one gauge per 500 km2, or a total of 60 gauges. Gauges should be set a government project headquarters, administrative centers, forest nurseries, health posts, police stations, and local employees trained for more reliable record keeping. Agents from FEWS should visit each recording site once a month to collect and review data. Copies of rainfall data sets should routinely be forwarded to MNPJVD for distribution to other government organizations working in Jubba Valley.

Source: Compiled from reports presented in JESS Final Report: Volumes I, II, and III.

USAID/Associates in Rural Development, Inc.

Contract No. AFR-0134-C-00-5047-03

Jubba Environmental and Socioeconomic Studies (JESS)

Scope of Work

This appendix contains the original work statement between USAID and ARD to implement JESS, signed on 13 September 1985. Following the original work statement are the texts of two modifications to the original scope–No. 3 effective 12 August 1987 and No. 4, effective 30 May 1988—which altered ARD's contractual responsibilities in adding, reorienting or deleting specific technical studies.

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SECTION C

WORK STATEMENT

1. BACKGROUND

The Juba River Valley is situated in the south-western part of Somalia. It is bordered on the east by the Shabelli River Valley, on the west by the Kenya border, on the north by Ethiopia, and on the south by the Indian Ocean. The Valley has an area of 170,720 km^2 (27% of Somalia's total land area) with about 300 km of coastline. The Juba River flows southward for some 700 kilometers, and discharges into the Indian Ocean just north of Kismayo. The Juba is the only river in Somalia with a perennial flow, with an average annual discharge entering Somalia at about 6000 million cubic meters. Essential to the overall development of the Valley area is construction of the Bardhere dam on the Juba River. The dam would assure some 4000 mcm of water annually for irrigation with flood storage capability to limit flood flows downstream. A site has been selected for the proposed dam located about 35 km upstream from the town of Bardhere. The reservoir created above the dam would extend upstream approximately 200 kilometers, occupying an area of about 550,000 hectares.

The primary emphasis up to the present time has been on engineering for the major structure, the Bardhere dam. However, the World Bank-financed study may identify a viable alternative for interim water storage. If so, the potential impacts of this alternative may need to be assessed as well.

The Valley is the most important area in Somalia for future agricultural development. When fully developed, it is estimated that it will produce enough crops for meeting nearly all the country's food requirements and have amounts left over for export.

The climate is arid with two rainy seasons. Mean annual rainfall in the valley ranges from 500 mm in the hills in the north to 300-400 mm on the alluvial plain. The valley is covered by deciduous forest which becomes very sparse in the north. Along the banks of the river is a gallery forest which reflects the presence of good alluvial soils.

2. GENERAL DESCRIPTION OF THE JUBA DEVELOPMENT ANALYTICAL STUDIES PROJECT (649-0134)

On September 29, 1983, AID signed a grant agreement with the Government of the Somali Democratic Republic (GSDR) to fund the Juba Development Analytical Studies Project. The goal of

the project, in cooperation with IBRD and other bilateral donors, is to create a master plan for Juba Valley development which optimizes resource use. In order to reach this goal, data must be generated for input into the plan, through such activities as a hydrologic study of river flow, siltation rates study, water quality and salinity studies, livestock and agricultural assessments, and detailed soil, social and environmental studies.

The purpose of AID assistance to the GSDR is to provide the necessary information on the last three items in the above listing: (1) land use and soils classification; (2) social effects; and (3) environmental studies. All these studies will be integrated into an overall Master Plan for the Juba Valley.

The project will result in the following outputs:

(a) Classification of soils, and land classification of highest irrigation potential in the Juba and lower Shabelli valleys;

(b) Identification of likely social and environmental impacts of the various options of development; and

(c) Developing the Ministry of Juba Valley Development (MJVD) as an effective coordinative body for master planning in the Valley. This will include long- and short-term training in the U.S. for MJVD technicians in the fields of Agriculture, Environment, Natural Resource Planning, and Soils.

In conjunction with the project, commodity assistance will be provided to the MJVD, including field survey and camping equipment, soil and water analysis equipment, and basic commodities needed for logistical support.

This contract is for the performance of the environmental and sociological assessment (No. [2] above). However, there will be a high degree of coordination between all three of the above components within the project. The team performing the environmental and social assesment under this contract will work closely with the soils/land use team in developing MJVD expertise in all study areas involved.

As this project is primarily field data collection oriented, it is expected that the team will travel widely within the area of the valley. Team members will be functional as well as advisory, and will be required to train MJVD staff in some aspects of environmental/social data gathering and monitoring.

The Contractor will be responsible for progress in the project. AID has a financing, programmatic, advisory, and approval role. However, the Contractor's team will receive day-to-day guidance from the MJVD.

3. MINISTRY OF JUBA VALLEY DEVELOPMENT

The MJVD is primarily responsible for the overall planning and implementation of development projects in the Juba Valley and coordinating various donor-assistance in development efforts regarding the Valley. Newly established, the MJVD hopes to build the necessary expertise and data information base to more effectively determine the development potential of the Valley. The MJVD is currently organized into divisions including the Bardhere Dam Project, Bardhere Cement Plant Project, Department of Planning and Economic Development, Department of Agriculture and Environment, and Department of Financial Administration. A German Advisory Support Team is located in the Department of Planning, which is responsible for coordination of the Juba Valley Master Plan. The Department of Agriculture and Environment has the main responsibility for cooperation with the AID soils/land classification and environmental/sociological studies, including provision of counterparts and logistical support. However, the Contractor will also work very closely with the Somalis and German advisors in the Department of Planning, in order to ensure effective and timely inputs into the master plan. To promote the long range institutional benefits of project activities, the Contractor will help to improve the skills of MJVD counterparts and technical staff through both classroom and on-the-job training.

4. NATIONAL ACADEMY OF SCIENCES (NAS) ADVISORY ROLE

The National Research Council (NRC) of the National Academy of Sciences, and its Board on Sciences and Technology for International Development (BOSTID) will advise the USAID/Somalia and MJVD on the scope, direction, conduct, and outcome of the environmental and sociological assesment. The purpose of the NAS cooperation is to provide AID, MJVD and the Contractor with a forum in which the exchange of information of critical importance to the assesment can take place with an independent, objective group of concerned, authoritative specialists. This information exchange will permit the assesment to be redirected, where necessary, into additional areas of emphasis, to be advanced more effectively, and to have access to a broader range of expertise concerning data acquisition and analysis than would otherwise be possible. During the three year period of the environmental and sociological assesment, BOSTID will organize a series of

workshops involving AID, MJVD, the Contractor, and other knowledgeable individuals. The five workshops will include: A preliminary workshop in Washington, D.C. at the commencement of the study, to discuss the scope of work and potential difficulties and possible sources of information and approaches; three field workshops, to review study progress and suggest modifications, assist with analysis of topical issues, and help identify sources of information or potential specialists who might be required; and a final workshop held in either Washington D.C. or Somalia, to evaluate the outcome of the study and prepare a final report for AID and the GSDR.

5. GENERAL INFORMATION

Since this project cuts across many disciplines and government sectors, the Contractor will be required to coordinate studies and data collection with other government agencies, including the Ministries of Agriculture, Livestock, Forestry and Range, and National Planning, and the Water Development Authority. The Contractor will also have the advantage of reviewing and, in some cases, relying on previous studies and data collection concerning the valley area. Available studies and maps are as follows: A detailed land-use/natural resources survey for Southern Somalia, due to be completed in September 1984; some site-specific studies on the refugee camps; the 1979 AID country environmental profile; 1983 Stephenson/Zalla/Gun report, and the 1984 Dowhan report. Also available are 1:100,000 topographical maps, 1:200,000 landsat interpretation package, and 1:30,000 aerial photography with 1:50,000 mosaics of the valley.

6. CONTRACT REQUIREMENTS

The Contractor shall provide the services necessary to carry out the environmental and sociological assessment of the effects of development in the Juba Valley. Work consists of three phases: (a) preliminary data collection; (b) field data collection and preliminary assessment of the environmental and sociological effects of irrigation and dam development; and (c) final analysis and assessment of the environmental and sociological effects of irrigation and dam development, including a final report consisting of an environmental and social impact statement with procedures on mitigating adverse impacts. All work is to be performed in cooperation with assigned Somali counterpart staff from the MJVD and other Somali agencies and organizations.

The work to be performed shall be carried out by the Contractor in the three aforesaid phases, under the guidelines which follow. At the conclusion of each phase, the Contractor will submit a report to USAID/Somalia and MJVD, which will contain findings of the preceding phase and a detailed work plan for the succeeding phase. Where findings so indicate, the report shall contain feedback and recommendations for redirection or modification of studies. Such recommendations shall include sufficient justification for any deviation for proposed new studies. A rationale for establishing the priorities shall be part of the report. The phases of the project are as follows:

(a) Phase I: Under Phase I, the Contractor shall review available data, literature, existing conditions, ongoing and proposed development activities in the valley, and others outside the valley, which could have impact on the proposed developments in the valley. At the end of this phase, the Contractor shall submit a report which will include the Contractor's findings and recommendations for activities to be undertaken in Phase II, e.g. field surveys to collect baseline data for use in environmental and sociological assessment of proposed and potential development projects. Analytical methods proposed for this study (indicating a balance between qualitative and quantative data collection) will be refined as appropriate at this time. Full consideration shall be given to coordination and compatability with other studies ongoing in the basin. The report shall include a work plan and specify personnel and logistical support needed for phase II work. USAID/Somalia, with concurrence from MJVD, shall approve the Phase I report, and authorize the Contractor to proceed with Phase II.

(b) Phase II: Under Phase II, the Contractor shall collect field data and preliminarily formulate certain anticipated impacts and related mitigating proposals. The workplan for this phase must allow for interim reports timed to provide data and provisional recommendations that might have an impact on the master planning process. The timing and emphasis of these interim reports will be determined in collaboration with USAID/Somalia, MJVD, and other donors.

At the end of this phase, the Contractor shall submit a comprehensive and detailed report, including annexes, of data collected and an outline of the perceived potential environmental/sociological impacts of various development scenarios which will be assessed in detail in Phase III. USAID/Somalia, with concurrence from MJVD, will approve the Phase II report, and authorize the Contractor to proceed with Phase III.

(c) Phase III: Under Phase III, the Contractor shall analyse and assess environmental and sociological impacts of proposed development projects and submit a final report, which shall recommend mitigating and enhancement measures, and contain a plan for continuing with environmental and socioeconomic monitoring to be carried out by MJVD after the contract is completed.

7. SCOPE OF WORK FOR THE JUBA VALLEY ENVIRONMENTAL AND SOCIOLOGICAL ASSESSMENT

(a) Objectives

The objectives of this assessment are to:

(1) Provide the GSDR with timely information to be used in formulating a socially and environmentally sound master plan for the Juba Valley, and to provide the GSDR with guidelines to be used in formulating future projects which are socially and environmentally sound.

(2) Identify and evaluate the interrelated sociological and environmental effects which will be caused by development of the river valley; and to further describe procedures and development activities that will mitigate adverse impacts and enhance beneficial impacts.

(3) Provide the GSDR with a realistic plan for the monitoring of environmental, social, land use, and agricultural parameters of the Juba River Valley so that national development decisions can be made based on sound, current data.

(4) Develop institutional strengths in the MJVD through classroom and on-the-job training.

(b) Assessment Components

(1) Mapping and Status of Valley Development Schemes

(A) The Contractor shall review available data, literature, existing conditions, etc., and shall complete, as required, a detailed environmental/sociological data base map of the study area, including watershed, watershed tributaries, and downstream zones, using the latest information including available baseline data. Note: A soil/land classification of the project area will be conducted under a separate component of the project, resulting in soil base and land use maps and irrigation suitability maps. Detailed land use/natural resources maps are due to be completed under another AID project by September 1984. The environmental/sociological data base map will be at a scale compatible with these maps and will complete and complement, rather than duplicate these maps.

(B) The Contractor shall provide an inventory and descriptions of existing, ongoing, and planned development projects.

(C) The preliminary data collection conducted by the Contractor under Phase I shall include not only existing literature on the valley, but also the rather extensive literature available outside of Somalia on settlement/resettlement, pastoralist/sedentary farmer interactions, and human aspects of dam construction (the Aswan High Dam and the Kariba Dam), etc.

(2) Environmental Investigations

(A) Physical Resources

- Surface Water Quantities (Hydrology): Hydrologic regime of the river system will be altered. The Contractor shall compare hydrographs before and after implementation of the various development options, and describe and estimate water balance, including loss of water through evaporation and other non-project conditions. Deshek conditions shall also be described.

- Surface Water Quality: The Contractor shall describe and measure or estimate, as appropriate, water quality conditions before and after dam development (reservoir and downstream). The Contractor shall also study effects of water storage and irrigation return flows on surface water quality (dissolved minerals, temperature, BOD, pesticide pollution), and describe effects on aquatic biota.

- Ground Water Quality: The Contractor shall describe anticipated effects of development on water quality/quantity in reservoir and downstream, including leakage from reservoir, changes in water table, waterlogging of lands, and contamination of wells.

- Soils: The Contractor shall examine all aspects of soil erosion, modification, and irrigation effects, such as saline buildup, change in pH, waterlogging.

- Geology/Seimology (in Dam Development): The Contractor shall provide information on earthquake hazards or other factors related to structural stability of various development options.

-Sedimentation and Erosion: The Contractor shall describe and estimate sediment load in reservoir, and plans to mitigate this. The Contractor shall also describe effects of sediment load on proposed reservoir uses, and shall describe the estimated future extent of downstream erosion due to scour by water released by the dam.

- Climate: The Contractor shall describe and measure effects of changes in climate due to water impoundment (e.g. changes in humidity affecting insect populations).

(B) Natural Resource Assessments

- Fisheries: The Contractor shall describe expected losses of fish populations due to (a) regulated downstream flow; (b) upstream inundation; (c) decreased nutrient levels downstream from reservoir trapping; and d) migration interruptions. The Contractor shall also describe the expected new fisheries situation in the reservoir, downstream, and the estuartine system at the coast. The Contractor shall investigate possibilities of fish farming and artificial propagation techniques, and plan for fishery production to offset losses due to future habitat alterations.

- Aquatic Biology: The Contractor shall describe present and expected ecological conditions, such as salinity changes, food chain interruptions, and biological productivity. The Contractor shall also describe a program for effectively monitoring all aquatic zone characteristics (chemical, biological, physical), and shall include the likelihood of aquatic weed buildup from still water in reservoirs and irrigation, and regulated flow. The Contractor shall assess the results of increased oxygen content from aeration by turbines and spillways.

- Wildlife: The Contractor shall describe impacts on wildlife populations due to (a) water diversion; (b) increased access through road construction; and (c) increases in agriculture. The Contractor shall also develop a detailed wildlife management plan including (a) establishment of reserves; (b) new wildlife resources created by dam development; (c) salvage and rehabilitation of damaged wildlife habitat; and (d) changes in distribution of livestock and/or nomadic land-use patterns, as well as overall changes in land use. The Contractor shall perform a wildlife inventory.

- Forests: The Contractor shall develop a forestry multiple-use management plan, and shall describe the effects of river impoundment (forest inundation) and downstream effects. The Contractor shall also describe and design a plan for soil and water conservation activity through tree planting and, e.g., agroforestry activities, and shall consider present and future status of forests on the watershed.

-Reservoir Ecology: The Contractor shall describe the anticipated environment in newly-created reservoirs including:

(a) Fishery development, storage, marketing, and regulations.
(b) Use of the reservoir for wildlife propagation.
(c) Physical, chemical, and biological properties of the new water-body (increases in fertilizer/pesticide pollutants).
(d) Problems of stabilizing reservoir banks from wave action.
(e) Health impacts at the reservoir edge.
(f) Effects of surface water fluctuations on shoreline facilities.
(g) Salvage of inundated vegetation.
(h) Problem of algae and vegetation growth in reservoir.

(C) Human Use Values

- Water Supply: The Contractor shall describe the impacts of development on water availability in quality and quantity, and shall assure adequate water supply for downstream communities.

- Aquaculture: The Contractor shall describe potentials for aquaculture development downstream.

- Navigation: The Contractor shall describe any changes in navigation, and shall survey current navigation uses of waterway.

- Flood Control: The Contractor shall describe benefits from dam flood control, including reclamation of lands for agricultural use.

- Mineral Development: The Contractor shall survey and describe potentials for mineral exploration and development.

- Roads: The Contractor shall describe changes and/or additions to current road and access systems.

- Land Use: The Contractor shall describe current land use patterns and anticipated changes, and shall formulate planning guidelines for rational land use mangement, which would optimize human and natural resources.

- Health: The Contractor shall investigate the presence of schistosomiasis-carrying snails, and describe economic measures to build-in control of the spread of habitat. The Contractor shall also survey means of eradication or control of other diseases such as malaria, onchoceriasis, typhoid, cholera.

- Energy: The Contractor shall describe present energy and fuelwood consumption, and describe benefits from future hydropower and reforestation programs.

(3) Sociological Studies

(A) Objectives

The social studies will generate a data base that can assist the GSDR in the formulation of strategies and plans for basin development, which relate to the circumstances, and are responsive to the needs of the populations who live in, or periodically make use of, the Valley's land and water resources. They will provide new information concerning social institutions and patterns of agricultural production and resource management that currently exist in the Valley. Such information is required if Juba Valley development is to lead to social and economic benefits to the affected Somali population, and build upon the considerable skills and strengths of that population. Through data collection and analysis, the Contractor shall address the following topics, which relate to social issues likely to be of concern in the development of the Juba Valley.

- Description of existing water and land-use practices, productive systems, and the socio-political organization of the different occupational groups who make use of Valley resources.

- Assessment of direct, indirect, and short- and/or long-term impacts of specific development activities proposed for the basin, and of differential effects on different categories of people. Special attention shall be paid to the effects of relocation and resettlement on the affected population.

- Critical analysis of steps which might be taken to increase socio-economic benefits to affected groups, and increase participation of local institutions in management of water resources and irrigation. Complementary measures to minimize or mitigate clearly detrimental sociological effects shall also be proposed.

- The studies will provide benchmark information essential as the basis for accurate and meaningful measurement of the socio-economic benefits of Valley development.

- In addition, the studies will recommend procedures for maximum participation of local populations in the planning, monitoring, and evaluation of development activities that will affect them.

(B) Populations to be Studied

The populations to be studied by the Contractor shall include all those who are likely to be directly affected by, or affect the progress of, development of the Valley's water resources. These will include, but not necessarily be limited to:

- Persons to be displaced.

- Valley residents along river.

- People based elsewhere (agropastoralists and pastoralists), who enter the Valley periodically to graze or use water resources, especially during drought.

- People who enter the Valley for wage labor on agricultural schemes,

- Labor pool for dam construction or new irrigation schemes.

(C) Data Collection

Surveys will be undertaken by the Contractor as determined by the outcome of Phase I review of the literature, and of the plans for ongoing data collection efforts by the GSDR and other donors. Samples of each of the populations noted in (B) above shall be included. Household-level surveys shall include basic demographic, nutrition, economic, and social indicators necessary to establish a baseline and to assess potential and eventual actual impacts of valley development interventions.

In addition, data shall be collected by the Contractor on the following specific topics:

- Production and land-use systems in the area, including deshek or inundation farming, small-scale irrigation, large scale irrigation/state farms, dryland farming, agropastoralism (with interaction between cultivators and pastoralists, and interchange between residents of the Valley and those outside), pastoralism (including use of the area by residents of other parts of the country). Estimation of amount of land involved and people supported shall be included.

- Social organization of production in the valley, and relationships outside, including, but not limited to, the role of the family, labor needs, utilization and availability of local labor for productive activities, patron-client, trading, and other relationships.

- Availability of, and access to, productive inputs and government agricultural services, marketing channels, and price structure for major inputs and outputs.

- Local traditional and modern rules and regulations regarding access to land and water resources, with particular reference to their impact on local resource management.

- Local institutions, formal and informal, their organization, functions, and effectiveness, and local decision-making, to include patterns of leadership and the authority structure (religious, traditional, government). Local institutions for cooperation or self-help (water management, pond construction, irrigation canals, range management) are particularly important.

- Availability of social services, existence of local providers, projection of social service needs, any fee-for-service, or similar self-help traditions.

- Estimate of skilled and unskilled labor available for construction, and factors determining availability (incentives, working conditions).

- In order to address the above topics, it is likely that several types of data collection activities will be required (household survey, special surveys, in-depth interviews, compilation of records, etc.).

(D) Analysis

At a minimum, The Contractor shall concentrate analysis of the data collected on the following (the Contractor may include additional areas based on preliminary review):

- Presentation of the demographic and socioeconomic characteristics of relevent population groups who use the Valley's resources. These groups will be the analytical categories for whom impacts and the need for mitigating actions are likely to differ.

- Discussion of likely impacts on the population to be displaced, including refugees, and ways to minimize or alleviate social, economic, and psychological costs of relocation.

- Organization strategies to involve Valley and all residents of Somalia in planning and decision-making for Valley development, and to strengthen local institutions for new management roles regarding water and land resources.

- Likely impacts of the dam and Valley development on the livestock industry and grazing potential of the area, on the agropastoralists and pastoralists using it, and implications for strategies and plans.

- Likely impacts of the dam and Valley development on existing types of crop production in the area, and implications for strategies and plans.

- Likely impacts of migration, urbanization, and economic growth to result from Valley development, and implications for planning, especially for education and social services.

(E) Consultations with Study Populations

The preliminary conclusions of the analysis shall be taken by the Contractor to a number of study sites, and discussed with the populations under study. This will allow feedback on the correctness and adequacy of the data, and insure initial participation of the affected populations in the design and management of their own development.

(4) Public Health Impacts

(A) The Contractor shall investigate and describe the following:

- Expected impact of development and irrigation schemes in altering hazards of water-oriented diseases and parasites in the region, including malaria, dengue fever, schistosomiasis, onchorceriasis, fecal-oral diseases, etc.

- Physical hazards expected to occur during dam construction.

- Environmental and health consequences of increased pesticide/biocide and fertilizer use, and possible accumulations in reservoirs and irrigation ditches.

- Plans for provision of adequate community sanitation facilities in new villages to be located around the development area, both to improve village living conditions, and to minimize pollution of reservoirs and impoundments.

- Other anticipated public health/ sanitation problems.

(5) Nutrition

(A) The Contractor shall describe anticipated effects on nutrition patterns due to altered fishery resources and increased food production.

(B) In order to obtain the background information required to enhance positive food consumption effects and minimize negative food consumption effects in future projects design, the Contractor shall:

- Identify and describe the foods directly or indirectly provided by the river and by other sources, and the consumers of each food or food group.

- Estimate the percentage contribution in calories and in protein of each food to the diet of its consumer, and identify seasonal variations.

(6) Municipal and Industrial Development

(A) The Contractor shall describe all anticipated environmental and social impacts of increased development concentrating on: water supply and waste disposal, surface water contamination, water treatment and distribution systems, and oxygen depletion problems in the river.

(7) Archaeology and Historical Sites/Treasures

(A) The Contractor shall review past data collection efforts and describe measures for assessing archaeological values and/or historical and cultural sites to be inundated, and necessary corrective programs for salvaging or preserving these values. The Contractor shall also prepare a plan necessary for archaeological survey of proposed reservoirs to determine if salvage/preservation programs are needed.

(8) Follow-up and Monitoring

An effective plan shall be developed and described by the Contractor for monitoring the environmental and social impacts through all stages of future development projects in the Valley. Monitoring should cover those parameters that are most sensitive to irrigation/dam development. These include:

(A) Hydrology (Surface and groundwater)

(B) Water Quality

(C) Fisheries

(D) Public Health Hazards

(E) Sociological Surveys

(F) Soil Changes/Modifications

(9) Procedures and Technical Assistance

General procedure for the analysis and assessment by the Contractor shall be:

(A) Under each study component, inventory, examine, and fully describe existing conditions, and establish a sound data base.

(B) Outline and describe in detail the impacts (both negative and positive) of proposed developments (if known) on these existing conditions.

(C) Detail proposed mitigating procedures that will lessen adverse impacts and enhance/increase beneficial impacts.

8. REPORTS

In-addition to the requirements of the clause of this contract entitled "Reports" (AIDAR 752.7026), the Contractor shall submit the following reports (5 copies to each recipient, in English) to the place(s) indicated:

(a) Work Implementation Plan: The Contractor shall prepare a life-of-project implementation plan, and an annual work plan, showing projections of data-gathering and assessment activities in each discipline to be covered (Forestry, Water, Sociology, etc.). The plans shall include projected numbers of staff to be in country and their duties. This report shall be due within one month after the effective date of this contract, and is to be submitted to MJVD and USAID/Somalia, for approval by USAID/Somalia with MJVD concurrence.

(b) Monthly Report: The Contractor shall submit monthly reports to USAID/Somalia and MJVD, which assess activities during the month in each discipline, the status of counterpart participation and training, and which provide a list of personnel in country. The report shall address progress against each item in the current work plan, include a statement of problems encountered and steps being taken to resolve them, and the status of any newly initiated and outstanding procurement or personnel actions.

(c) Daily Logs: When feasible and appropriate (as agreed to by the Contractor and USAID/Somalia), field personnel gathering data will keep daily logs of assessment and surveying activities.

(d) Special Reports: Upon completion of Phase I (compilation of existing data and literature), the Contractor shall prepare a report for USAID/Somalia and the MJVD (as noted in part 6.[a], above), which provides (1) an assessment of available information; and (2) an outline of data collection based upon a determination of the level of field work required to complete the requisite data base. Upon completion of Phase II (preliminary field data collection), the Contractor shall prepare a comprehensive report with annexes on the data collected. The report will be used in discussions with USAID/Somalia, MJVD, and coordinators of the Master Plan for the Juba Vally Development, to determine if sufficient data has been collected in order to formulate the final assessment and plan of action. All reports will be submitted with executive summaries no longer than three pages in length.

(e) Short-Term Specialist Reports: Each of the short-term specialists will submit (1) reports after each field visit; and (2) a final report, with their recommendation and findings, to the Project Coordinator, with copies to the MJVD and USAID/Somalia for inclusion in the final project documents.

(f) Final Report: The Contractor shall prepare a final report (Phase III), detailing all work carried out under the contract in each category. The final report shall include completed annexes of all data collected under the project, including maps and results of laboratory, computer, and other analyses, and an action plan for all approaches for mitigation. This final report will be incorporated into the overall Master Plan for the Juba Valley Development. It shall contain an executive summary of not more than 20 pages, and be submitted first in draft to the MJVD and USAID.

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MODIFICATION 03

Section C, Paragraph 7. Scope of Work for the Juba Valley Environmental and Sociological Assessment, is amended by deleting the following items, in their entirety, from Sub-section (b)(2)(A):

> Surface Water Quantities (Hydrology), Surface Water Quality, Geology/Seismology (in Dam Development) and Climate.

The following item is added to Sub-section (b)(2)(A) in replacement of the above deletion:

> Surface Water Quantities and Quality, Geology/Seismology and Climate
>
> The Contractor will include and refer to in their analysis previously collected data on surface water quantity and quality, geology and seismology and climate.

Section C, Paragraph 7, Sub-section (b)(2)(B) Fisheries, is amended by deleting: "The Contractor shall investigate possibilities of fish farming and artificial propagation techniques, and plan for fishery production to offset losses due to future habitat alterations." and adding in replacement: "The Contractor will compare the resources available in the projected reservoir area with other known successful similar fresh water fisheries in Africa and make recommendation on applicable fisheries management of the impounded area."

Section C, Paragraph 7, Sub-section (b)(2)(B) aquatic Biology, is amended by deleting: "The Contractor shall assess the results of increased oxygen content from aeration by turbines and spillways." and adding in replacement: "Proposed development interventions in the Juba are likely to increase the distribution of hippos and crocodiles. The Contractor shall investigate methods of monitoring and managing these population and should establish for the MJVD what the correct procedures for international marketing of crocodile hides are for the Somali government."

Section C, Paragraph 7, Sub-section (b)(2)(B) Wildlife is amended by inserting "estimate" in place of "describe" in the first sentence; and deleting the second sentence and adding in replacement: "The Contractor (1) shall evaluate the present identified reserve areas (2) conduct a wildlife inventory of the Valley (3) identify sites with the highest potential for natural reserve areas, and suggest a realistic management strategy, in such a way that based on provided information, GSDR can set national wildlife objectives and prepare management plans accordingly."

Section C, Paragraph 7, Sub-section (b)(2)(B) Forests is deleted and the following added in replacement: "Forestry: The Contractor shall collect and (a) analyze the data relevant to harvesting fuelwood from the reservoir area (b) and on production and management of native forests and proposed forest/agroforestry production to meet the development needs of the valley. The Contractor through forestry studies as well as the related botanical studies shall identify species accommodating U.S. interests in preserving international biological diversity."

Section C, Paragraph 7, Sub-section (b)(2)(B) Reservoir Ecology is amended by deleting "(a) Fishery development, storage, marketing and regulation" and "(b) Use of the reservoir for wildlife propogation".

Section C, Paragraph 7, Sub-paragraph (b)(2)(C) Human Use Value is amended by deleting under Navigation: "shall describe any changes in navigation and" and by deleting in its entirety "Mineral Development" of waterway.

Section C, Paragraph 7, Sub-paragraph (b)(5) Nutrition is deleted and the following added in replacement:

"(5) Nutrition

(A) The Contractor shall describe village eating pattern and determine the relative importance of river related produce (fish and food product) in villagers/nomads diet, identifying foods directly or indirectly provided by the river and the consumers of each group.

(B) Collect information on the dependence of settled population on nomad produced milk.

(C) Conduct with the epidemiology team weights and measure of 3-4 year old in select villages as the best indicator of nutritional health to provide gross baseline information."

Section C, Paragraph 7, is amended by deleting Sub-paragraph (b)(6) Municipal and industrial Development and adding the following in replacement:

(6) Municipal and Industrial Development

(A) The Contractor shall describe all anticipated environmental and social impacts of increased development, concentrating in select communities, on the following problems in the river: water supply and waste disposal, surface water contamination, water treatment and distribution systems, and oxygen depletion (as far as turbidity allows).

Section C, Paragraph 7, Sub-paragraph (b)(1) Mapping and Status of Valley Development Schemes, is amended by adding a new Sub-section (D) as follows: "The Contractor will provide for a riverine census of human, livestock and wildlife populations by means of aerial photography. Since it is necessary to sample wet and dry season distribution, aerial censuses must be repeated twice at a minimum."

Section C, Paragraph 7, Sub-paragraph (b)(3)(C) Data Collection is amended by adding a new untitled Sub-section as follows: "The Contractor in conjunction with the Policy Initiatives and Privatization Studies Project, Land Tenure Consultant, will pay particular attention to resource rights and the resolution of land entitlement disputes as well as registration."

Section C, Paragraph 7, Sub-paragraph (b)(4) Public Health Impacts is amended by adding a new Sub-section (B) as follows: "The Contractor will undertake in cooperation with the Somali Ministry of Health a limited epidemiological survey which will include village data collection for malaria, bilharzia and nutritional status (anemia plus height-for-weight measurement). Contractor will survey existing intestinal parasite survey in animals and construct a schoolchildren and livestock fecal study to be carried out by the Ministries of Health and Livestock."

Contract No. AFR-0134-C-00-5047-03

MODIFICATION 04

Section C, WORK STATEMENT, is revised as follows:

(1) Page 14, para 7(b)(2)(A), subpara entitled "Soils," revise to read:

"The Contractor shall address aspects of soil erosion, modification, and irrigation effects, such as saline buildup, change in pH, warerlogging based on the examination conducted by the US Bureau of Reclamation (BUREC)."

(2) Page 15, para 7(b)(2)(A), subpara entitled "Sedimentation and Erosion," is deleted in its entirety.

(3) Page 16, para 7(b)2(B), subpara entitled "Forests," as amended (Modification 03, page 3), delete last sentence of subpara (b).

(4) Page 16, para 7(b)(2)(B), subpara entitled "Reservoir Ecology," delete subparas (d) and (f) in their entireties.

(5) Page 17, para 7(b)(2)(C), subpara entitled "Roads," delete in its entirety.

(6) Page 18, para 7(b)(3)(A), revise first line of first para to delete "Critical analysis of" and substitute therfor "Address".

(7) Page 18, para 7(b)(3)(A), revise first line of third para to delete "will recommend" and substitute therfor "address".

(8) Page 20, para 7(b)(3)(D), second line of third subpara, delete ", including refugees,".

(9) Page 20, para 7(b)(3)(D), fourth subpara, delete in its entirety.

(10) Page 20, para 7(b)(3)(E), delete in its entirety.

(11) Page 21, para 7(b)(4)(A), fourth subpara, delete in its entirety.

(12) Page 21, para 7(b)(4)(B), as amended (Modification 03, page 4), delete "(anemia plus height-for-weight-measurement)".

(13) Page 21, para 7(b)(4)(B), as amended (Modification 03, page 4), delete the last sentence which begins "Contractor will survey existing intestinal parasite survey . . . "

(14) Page 21, para 7(b)(5), entitled "Nutrition," as amended (Modification 03, page 3): delete subpara (c) in its entirety.

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21 July 1989

Mr. Maury Brown
PPC/CDIE/DI
RM 209F, SA18
USAID
Washington, DC 20520

Dear Mr. Brown:

Associates in Rural Development, Inc. (ARD) is extremely pleased to present the **Jubba Environmental and Socioeconomic Studies (JESS) Final Report.** This report represents the culmination of three and one-half years of work (including nearly three years of fieldwork in Somalia) by ARD/JESS long-term staff.

The report is divided into four separate volumes as follows:

Volume I--Executive Report. This volume provides an overview of the existing environment and presents a summary description of the expected effects of the proposed Baardheere Dam and Jubba Valley development.

Volume II--Environmental Studies. This volume presents the report on JESS' long-term Terrestrial Ecology Baseline Studies (TEBS), and eight other pertinent reports prepared by JESS consultants concerning aspects of: land-use surveys, forestry, migrant birds, limnology, fisheries, river hydrology, and water quality and public health.

Volume III--Socioeconomic Studies. This volume presents the report on JESS' long-term Socioeconomic Baseline Studies (SEBS), plus two reports by JESS consultants concerning cultural heritage and pastoralism.

Volume IV--Bibliography. This volume presents a comprehensive bibliography of publications and reports with direct relevances to Somalia and the Jubba Valley, as well as works covering aspects of water development projects throughout Africa and the world.

Distribution of these volumes is extremely restricted due to the limited number of copies in publication. Any questions concerning the reports should be directed to the project sponsor,

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U.S. Agency for International Development/Mogadishu, Somalia, or to APD, Inc. in Burlington, Vermont.

We hope you will find the report interesting and informative.

Sincerely,

George Burrill

George Burrill, Ph.D.
President

Paul Dulin

Paul Dulin
Project Manager

GBPD/sr

enclosures