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Volume 1

Defining an Environmental Development Strategy for the Niger Delta

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Volume I

Industry and Energy Operations Division
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DEFINING AN ENVIRONMENTAL DEVELOPMENT STRATEGY FOR THE NIGER DELTA

VOLUME I

CONTENTS

This report has been prepared by Jasdip Singh (Task Manager), David Moffat (Consultant) and Olof Linden (Consultant). It is based on considerable input from Nigerian stakeholders, including Federal and State government agencies, NGOs, communities, academic experts and the private sector. The World Bank team worked closely with the Federal Environmental Protection Agency and the Rivers and Delta State Environmental Protection Agencies. Local consultants prepared background papers on biodiversity (Bruce Powell), pollution (Miriam and Turner Isoun), institutional and legal frameworks (O. Douglas), fisheries (A. J. T. Otobo) and flood erosion (T. K. S. Abam). International consultants prepared background papers on pollution assessment (Palle Grevy) and environmental economics (Michael Linddal). Financial support was provided by the Global Environment Facility (GEF) and the Swedish and Danish Trust Funds. The peer reviewers, Robert Clement-Jones (AFTES) and Marea Hatziolos (ENVLW), provided important inputs. Valuable contributions and comments were provided by Messrs. Jose Sokol (AF4DR), Robert Nooter (Consultant), and Jack Ruitenbeek (Consultant), as well as over 20 Nigerian stakeholders. Ms. Lee Swapp and Ms. Sally Resnick provided secretarial support. Ms. Mary Oakes Smith and Mr. Olivier Lafourcade are the managing Division Chief and Departmental Director, respectively.

Boxes

Figures

Pictures

Tables

Maps

EXECUTIVE SUMMARY

The Niger Delta has been blessed with an abundance of physical and human resources, including the majority of Nigeria's oil and gas deposits, good agricultural land, extensive forests, excellent fisheries, as well as with a well-developed industrial base, a strong banking system, a large labor force, and a vibrant private sector. However, the region's tremendous potential for economic growth and sustainable development remains unfulfilled and its future is threatened by deteriorating economic conditions that are not being addressed by present policies and actions. An urgent need exists to implement mechanisms to protect the life and health of the region's inhabitants and its ecological systems from further deterioration.

Introduction

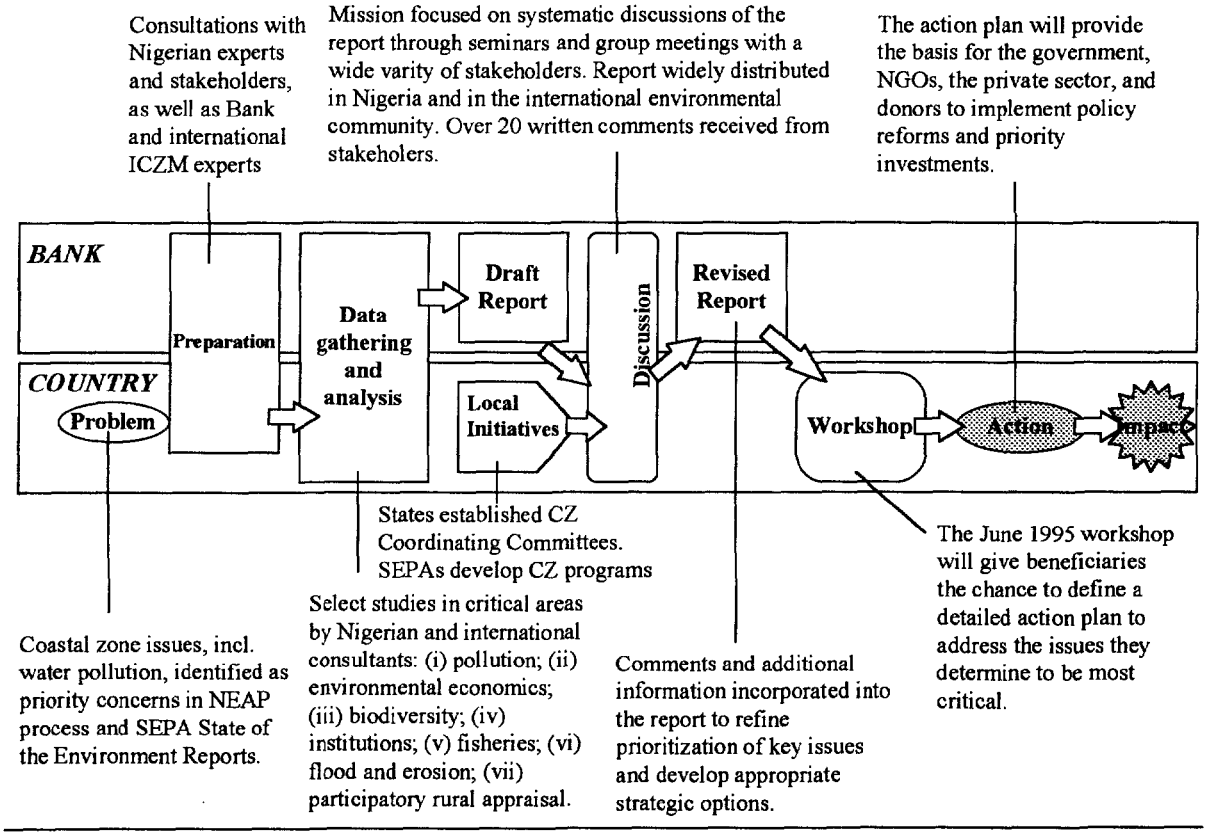
This report examines the major obstacles to sustainable development in the Niger Delta and presents strategic options for overcoming them. Sustainable development will require a balance between accelerated economic growth and environmental protection to ensure that the people of the Niger Delta benefit as much as possible from the exploitation of their resources. The immediate objective of the report is to provide a basis for discussions on how to address the key environmental concerns in the region. The report assesses the full range of environmental issues to identify the priority concerns based on the severity of their health and environmental impacts. The principal constraints to addressing the concerns, including institutional capacity, information, beneficiary consultation, regulatory frameworks, and enforcement, are examined. The report also critically discusses policies issues and options that should be addressed in designing a regional environmental development strategy. The report was developed based on an innovative and highly participatory process which emphasized beneficiary consultation and collaboration to ensure local ownership (Figure I). The next steps in the process are an expanded stakeholder review of the report and the development of a beneficiary action plan to tackle the key environmental issues facing the Niger Delta.

The report is divided into two volumes. Volume I introduces the defining ecological, social and economic characteristics of the region and analyzes the critical environmental and social problems facing the region (Chapters 1, 2 and 3). It also examines the indirect causes which lead to environmental degradation (Chapter 4). An environmental and human health risk assessment framework is utilized to determine priorities among the major environmental issues (Chapter 5). Volume I concludes with a discussion of specific policy and project options to address the priority environmental problems and presents integrated coastal zone management as a model for coordinating development in the region (Chapter 6). Volume II contains statistical tables and annexes with detailed information on issues summarized in Volume I.

Background

The Niger Delta is one of the world's largest wetlands, encompassing over 20,000 km^2 in southeastern Nigeria (Map 1). The Niger River has the ninth largest drainage area of the world's rivers (Table I, Map 2). Being an vast interface between land and water systems, the delta is ecologically very complex. The social systems are equally intricate, comprising 26 language groups in addition to several large urban areas. The states that are the focus of this study, Rivers State and Delta State, include approximately 80 percent of the Niger Delta. The total population of the two states is estimated to be 6.7 million, with 70 percent of inhabitants living in rural communities. Rivers and Delta States together produce about 75 percent of Nigeria's petroleum - equal to over 50 percent of national government revenues.

Figure I
Niger Delta Coastal Zone Sector Work Process



The delta is a vast floodplain built up by the accumulation of sedimentary deposits washed down the Niger and Benue Rivers. It is composed of four ecological zones: coastal barrier islands, mangroves, fresh-water swamp forests, and lowland rainforests. The hydrological boundaries between ecological zones are fluid and depend on seasonal river flows. Nigeria has the third largest mangrove forest in the world and the largest in Africa, over 60 percent of which is located in the Niger Delta (6000 km^2). The fresh-water swamp forests of the delta are considerably larger (11,700 km^2) and the most extensive in west and central Africa. With the high rates of deforestation in the rest of the country, the fresh-water swamp forests will

soon become the largest forest zone in Nigeria. Most of the lowland rainforest is now derived savanna with small areas of intact forest remaining. The barrier island forests are the smallest of the ecological zones in the delta, but are largely intact and have high concentrations of biodiversity.

The high rainfall and river discharge during the rainy season, combined with the low, flat terrain and poorly drained soils, cause widespread flooding and erosion: over 80 percent of the delta is seasonally flooded. During most years, only select elevated areas remain dry. When the flood waters recede, the channels that spread out across the delta leave swamps and pools that drain only poorly, if at all. A dynamic equilibrium between flooding, erosion, and sediment deposition is the defining characteristic of the delta ecosystem. However, construction of dams along the Niger River during the last twenty-five years has disrupted the hydrological balance by significantly modifying water flow regimes and sediment deposition.

Table I: Comparison of the World's Major Rivers

	RIVER	CONTINENT	DRAINAGE AREA (million km^2)	SEDIMENT YIELD (t/km^2)
1	Amazon	S. America	6.15	146
2	Zaire	Africa	3.82	11
3	Mississippi	N. America	3.27	107
4	Nile	Africa	2.96	38
5	La Plata	S. America	2.83	196
6	Yenisei	Europe	2.58	23
7	Lena	Europe	2.50	23
8	Ob	Europe	2.50	42
9	***Niger***	***Africa***	***2.23***	***33***
10	Yangtze	Asia	1.94	531

Source: Mahmood, 1987; Rangeley et al., 1994.

Despite its vast oil reserves, the region remains poor. GNP per capita is below the national average of US$280. Most resource and land use decisions are made by an expanding poor population. Their decisions are being driven by a lack of development, stagnant agricultural productivity, negligible opportunities in urban areas, rapid population growth, and tenuous property rights. The rural population commonly fish or practice subsistence agriculture, supplementing their diet and income with a wide variety of forest products. During floods, which in some areas last for over half the year, drinking water is frequently contaminated. In the dry season, insufficient water is often available to dilute contaminants, which also leads to increased risk of water borne disease. Clearly, water related diseases exert an enormous social and economic toll in the Niger Delta. These problems are exacerbated by the fact that both urban and rural infrastructure is poor - electrification, potable water supply, and sanitation levels are very low. The extensive flooding makes transportation difficult in rural areas.

Determining Environmental Priorities

An evaluation of the major environmental problems facing the Niger Delta indicates that some of the problems are particularly critical. The problems are ranked based on their environmental, human health, and economic significance. The rankings are refined by comparing the costs and benefits of potential interventions. Problems which pose significant environmental or health risks and have high net intervention benefits are assigned the highest priority. The prioritization process utilized in the report represents a first cut based on the limited information available. However, it is an effective filter for determining where policy interventions can be most effectively directed given the limited resources and institutional capacity available in the Niger Delta. Additional analytical research, particularly spatially based information, and continuing systematic stakeholder participation is essential to reach consensus on which issues should be addressed. An initial assessment of priorities determined the ranking presented in Table II.

Table II: Ranking of Environmental Issues

Category	High Priority	Moderate Priority	Lower Priority
Land Resource Degradation	Agricultural land degradation. Flooding (moderate - high).	Coastal erosion. Riverbank erosion.	Sea level rise.
Renewable Resource Degradation	Fisheries depletion. Deforestation. Biodiversity loss. Water hyacinth expansion.	Fisheries habitat degradation.	Mangrove degradation. Nypa palm expansion.
Environmental Pollution	Sewage. Vehicular emissions. Municipal solid wastes. Toxic and hazardous substances.	Oil pollution. Industrial effluents. Industrial air emissions. Industrial solid wastes.	Gas flaring.[1]

Agricultural Land Degradation. Agricultural land degradation is a high overall priority because of the large geographic extent of the problem. Extensive and formerly highly productive areas of the lowland rainforests and fresh-water swamp forests have been affected by soil fertility declines. At current population growth rates, agricultural output will need to double in the next two decades to meet existing subsistence requirements. Since agricultural inputs are generally not available or too expensive for most farmers in the Niger Delta, they resort to cultivating increasingly marginal land and increasing the frequency of cropping on existing plots. Agricultural land degradation's central role in causing deforestation and exhausting soil fertility, with its consequent negative impact on rural development, warrants the high priority. The potential benefits of increasing agricultural productivity and preventing

[1] While the local environmental impact of gas flaring in the Niger Delta is assessed as low, its contribution to the international problem of greenhouse gas emissions is substantial.

expansion into forests through more intensive rather than extensive farming are estimated to be valued at US$30 million in terms of continued supplies of forest products from Rivers State, nearly eight times the cost of appropriate interventions.

Flooding. Flooding induced land degradation is a problem throughout the Niger Delta. The construction of upstream dams and subsequent sedimentation of the reservoirs has created very large annual floods that supply little sediment to the delta. Increased flooding and reduced sediment loads, as well as greater population and farming activities in flood prone areas, has intensified the negative impact of flooding. Direct losses from flooding include large areas of valuable land which cannot be cultivated and the destruction of infrastructure and housing. In addition, flooding substantially degrades the health status of both rural and urban communities by increasing the prevalence of water-related diseases. Offsetting the large benefits of intervening are control costs which are generally very high, resulting in the moderate to high ranking of this problem.

Fisheries Depletion. At present overfishing is of high overall priority because fishing is a critical activity in rural delta communities - 400,000 artisanal fishermen supply 80 percent of the total catch and fish contribute at least 50 percent of per capita animal protein intake. The total annual value of a sustainable harvest is estimated to be N5 billion. The delta, being predominantly a floodplain habitat, is a highly productive waterbody for fisheries and a critical nursery for offshore and upstream ecosystems. The very weak information base prevents an unequivocal conclusion that overfishing is taking place, but all available indicators suggest that coastal fish stocks are overfished: annual catches vary drastically, but are generally declining and catch per effort for both the artisanal and industrial sectors is declining. Since fisheries management is virtually non-existent, but can be highly effective in increasing yields at relatively low cost, the net marginal benefits of improved management by preventing open access and enforcing regulations on fishing methods will be high. Supporting local initiatives in improved fisheries management, equipment, storage, and distribution will probably be another of the most cost-effective management interventions.

Deforestation. Deforestation and forest degradation are large scale problems in two of the four ecozones: fresh-water swamp and barrier island forests. Deforestation in the mangroves has not been significant - an estimated 5-10 percent have been lost. Deforestation is no longer a major issue in lowland rainforests since the forests are already highly degraded. In contrast, the fresh-water swamp and barrier island forests are under great pressure from agricultural and infrastructure expansion, as well as logging. The importance of the remaining fresh-water and barrier island forests is very high for reducing the severity of flooding and erosion and for preserving biodiversity. Timber resources and especially nontimber forest products (NTFPs) are a critical source of income for many rural households - the value of NTFPs in River State alone may exceed US$100 million annually. Consequently, the potential benefits of preserving these future values are high. Intervention actions to strengthen the State Forestry Departments, especially their monitoring and enforcement capabilities, are relatively inexpensive and anticipated to cost well under US$2 million annually.

Biodiversity Loss. The biodiversity significance of the Niger Delta is high from regional and global perspectives. According to the International Union for the Conservation of Nature (IUCN), the Niger Delta is one of the highest conservation priorities on the west coast of Africa. It holds a large number of threatened and endangered species, particularly mammals, that are economically, aesthetically, and scientifically very valuable. For example, the only mammal known to be endemic to Nigeria, Sclater's guenon, is found in the delta. The high value of the biodiversity in the region is being rapidly eroded by hunting, uncontrolled logging, agricultural encroachment and poorly designed development projects. The State Forestry Departments are completely unable to address these threats in protected areas, let alone other biologically rich areas. The benefit of preserving biodiversity in the region is rated as high because of its rich biological resources and the rising international willingness to pay for biodiversity. For example, the international willingness-to-pay for three of the most important conservation areas is estimated to be six times the cost of effective protection. However, even these low costs are far above the existing budgets of the forestry departments.

Water Hyacinth Proliferation. Water hyacinth, an exotic species, has spread from Lagos to Akwa Ibom State in only 7 years. The plant has expanded into most of the fresh water systems of the delta. It has effectively closed many creeks in the delta to water related activities - a critical loss to communities which rely on water transportation and fishing. The high rate of expansion and severe impacts on transportation and fishing mean that the potential benefits of intervention are high. The costs of intervention, however, can still be substantial. Mechanical and manual harvesting techniques have been used to clear water hyacinth, although both are relatively costly and neither is completely effective. Manual harvesting is often socially beneficial because it provides additional income to those who bear the negative impact of water hyacinth (such as fishermen).

Toxic and Hazardous Substances. Toxic and hazardous substances are a priority because of their high potential to impair human health in urban areas. The health risks are greatly magnified by the lack of waste treatment, poor drainage systems, and reliance on surface and shallow groundwater for drinking water. In addition to hazardous emissions from industries, biological wastes from hospitals and medical clinics contribute to an escalating problem of toxic wastes in the Niger Delta. Controlling these wastes will generate moderate long-term benefits to the region in terms of reduced health costs. Although the costs of intervention vary considerably, sound management practices which separate wastes and establish tracking mechanisms are very cost-effective as a starting point. Of moderate cost, but of critical importance, is the construction of a secure hazardous waste disposal facility in the Port Harcourt area.

Sewage. Health risks associated with sewage contaminated water are highly significant and affect a large proportion of the urban population in the region. The health impact is aggravated because no municipal sewage treatment plants operate in the Niger Delta. Organic pollutant levels in Port Harcourt are extremely high compared with cities with sewage treatment facilities. Households and small scale industries produce most of the organic pollutants; medium and large scale industries are much less significant. The high pollutant levels substantially increase the risk of water-related diseases. Current productivity losses

associated with water-borne diseases are estimated to approach US$20 million annually and the potential benefits of improving sewage facilities could approach US$250 million annually. Nigerian and Ghanaian studies have found that consumers are willing to pay for improved water supply from private vendors and are willing to invest in simple sanitation infrastructure. The studies provide support for examining the potential for private sector service provision.

Vehicular Emissions. Estimates of air emissions in Rivers State and Port Harcourt indicate that lead emissions from vehicles are of great concern in urban areas. Of secondary importance are vehicular particulate emissions. The concentration of lead in Nigerian gasoline is one of the highest levels in the world (0.74 mg/l). Lead contributes to mental dysfunction (and potentially death). Children are at greatest risk because they spend a larger proportion of their day close to street level and lead has an especially severe impact on the neurological development of children. Control costs for lead and particulates are relatively low; changes in fuel specifications are often relatively inexpensive, yet are sufficient to achieve acceptable levels of lead (in petrol) and particulates (in diesel). Lack of information on emission levels, fuel consumption, exposure levels, and health impacts is a serious constraint to managing this problem.

Municipal Solid Wastes. Inadequate municipal solid waste management poses a serious health threat to people living in urban areas and some rural communities. Solid wastes clog drainage systems, increasing flooding and water-related diseases. When dumped into nearby water bodies, they reduce water quality, further adding to health risks. Municipal solid waste generation in Port Harcourt (approximately 96,000 tons per year) is an order of magnitude higher than industrial solid waste generation. Neither of the two largest cities, Port Harcourt and Warri, have sanitary landfills; they rely on open dump sites and river dumping. Given the high social costs of improper disposal of municipal solid wastes, the future benefits of intervening are commensurably high. The costs of appropriate management programs, involving sanitary landfills, waste collection, and separation of selected wastes for recycling, are generally moderate in comparison to the benefits.

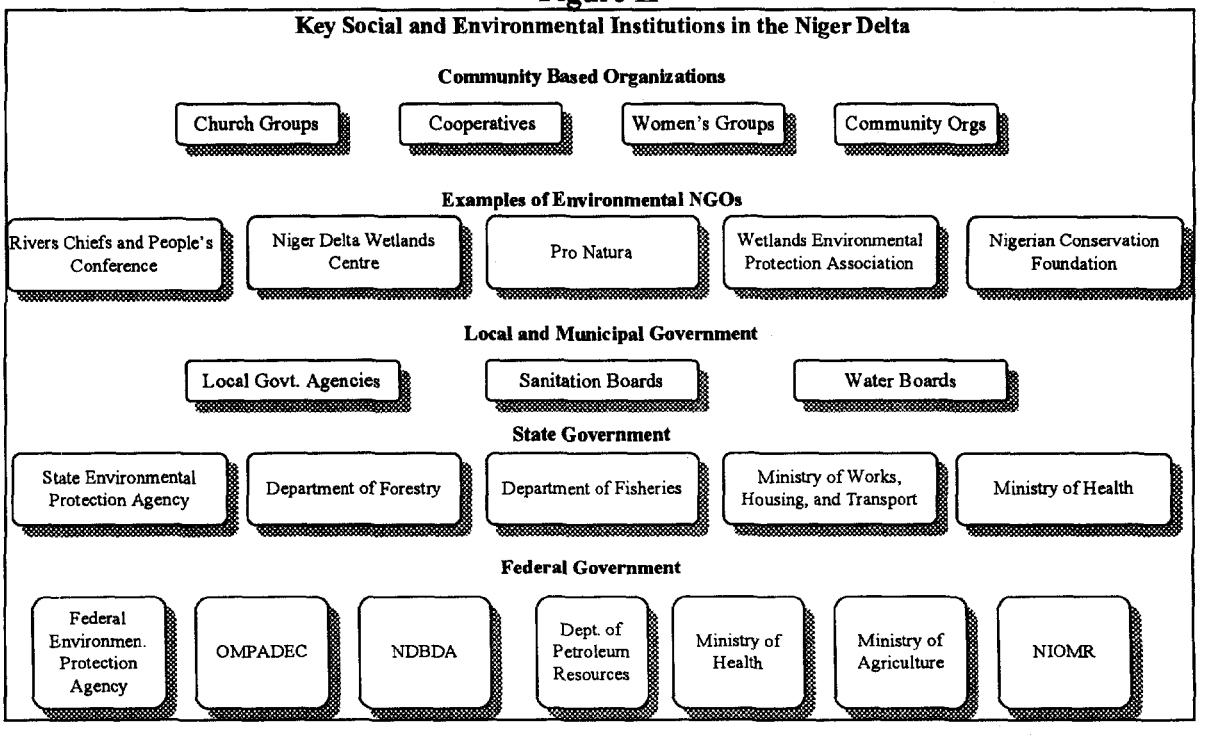
Oil Pollution. The impact of all oil related activities on the environment of the Niger Delta is widespread and substantial (Map 4). Infrastructure development for oil activities causes serious physical alteration of the environment and degradation of natural resources. The indirect impacts of oil development, particularly the effect of a very large influx of people into the region, are also very significant. However, oil pollution, by itself, is only of moderate priority when compared with the full spectrum of environmental problems in the Niger Delta. Research in the delta and from spills and experiments in other tropical areas throughout the world has consistently found that only areas that are directly exposed to large or repeated oil spills or leaks frequently exhibit long-term environmental problems. The impact of oil pollution on human health is not expected to be substantial. Given the low environmental and health impacts, the actual future benefits of reducing oil pollution are low. Nevertheless, the intervention costs of avoiding most incidents of oil pollution are not high and should be included in the normal operating costs of oil companies working in the delta, as is the case in most of the world. The intangible benefits of better relations with riverine communities could be quite high if future pollution were better controlled.

Social Priorities. Of the major social concerns in the Niger Delta, water supply, sanitation, and associated health problems are the greatest priority. Health indicators for the Niger Delta are significantly worse than southern Nigerian averages. Water-related diseases, many of which result from poor sanitation and inadequate water supply, are the most severe health problem facing the region, causing 80 percent of reported illnesses. Malaria is by far the most prevalent disease, followed by diarrhoreal diseases. The State Health Ministries estimate that just 20 to 24 percent of rural communities and 45 to 50 percent of urban communities have access to safe drinking water sources. These figures may be optimistic since none of the public water supply is treated in either state. Studies have found high levels of fecal indicator bacteria from surface water samples and in tap water throughout the region. Only 25 percent and 12 percent of Delta and Rivers State households, respectively, are estimated to use satisfactory sanitation facilities. No municipal wastewater treatment facilities exist in either state. Urban residential wastes are directly discharged to the nearest open drain, water body, or soaked into the ground. When the drainage systems are filled with waste during heavy rainfalls, health risks from water-related diseases are high. During the dry season, clean water is also difficult to find since contaminants are not readily diluted, increasing the prevalence of water-related diseases.

Constraints to an Environmental Development Strategy

Institutional Constraints. The institutional framework for addressing environmental issues is expanding in the Niger Delta in response to government and stakeholder concerns about environmental degradation (Figure II). The Rivers State Environmental Protection Agency has operated for five years and Delta State has nearly completed establishing its own Environmental Protection Agency. A large number of other federal and state agencies also have environmental responsibilities. Although institutions exist with responsibility for mitigating all major environmental problems, severe constraints limit their actual impact. A large problem is that clear divisions of responsibilities often do not exist, leading to inaction or duplication of efforts. For example, six federal and state agencies in each state have flood and erosion control as part of their mandates. However, none of the agencies actually addresses flood and erosion problems and no management plans have been developed. In addition to low levels of institutional cooperation, a client focus and accountability to stakeholders are missing. As a result, community participation in policy and program development is lacking and community based, rather than centralized, programs are rare. The government also has a tendency to create new agencies to address topical problems rather than strengthen existing institutions, whose weakness and neglect led to issues becoming severe problems.

Figure II



Institutional objectives and programs are often inappropriate and even contradictory to achieving environmentally sustainable development. This is particularly a problem for line ministries with specific objectives, such as increasing the number of roads or improving agricultural output, which do not take into account the environmental and social impacts of their activities. Institutional objectives need to be revised to address sectoral needs which are compatible with achieving the common goal of sustainable development. Institutions with broad, cross sectoral mandates often have difficulty setting priorities among their responsibilities. For example, the Rivers State SEPA is required to deal with issues ranging from erosion to hazardous wastes, but has yet to define clearly where it can apply its limited resources most effectively.

Even when institutional objectives are sound and clear priorities are established, financial, personnel, and technical constraints severely limit implementation of programs and enforcement of regulations. Budget allocations to address the key environmental and social concerns are not commensurate with the severity of the problems. For example, the Delta State Ministry of Works receives 40 percent of the state budget for infrastructure development, while the total state health allocation is 8 percent and the forestry allocation is less than one-half of 1 percent. The Rivers State Forestry Department budget was cut from N1 million to N500,000 in 1995 to manage some of the continent's most valuable forests. The solution to the financial constraints may not always require increased state allocations. In some cases institutions should be granted greater flexibility in generating their own sources of revenue or private sector service provision should be encouraged. For example, timber tariffs should be increased and State Fisheries Departments should consider selling fishing licenses to generate funds.

State institutions are generally inadequately staffed to address the critical environmental issues. The Rivers State Forestry Department, for example, has only 13 professional foresters, who require immediate training in natural resource economics, forest management, and conservation to manage and protect state forests effectively. Staff, budget and equipment constraints mean that all institutions are virtually administrative bodies without significant presence in the riverine areas. Most agencies either completely lack field offices or have a few offices that are inadequately staffed and equipped. The impact of the State Ministries of Health, Departments of Forestry, and Environmental Protection Agencies in the riverine areas is very limited because none of the agencies owns water craft.

Lacking sufficient resources and clear priorities, agencies rarely enforce existing regulations. For example, there is no enforcement of environmental sanitation, pollution, forest reserve, or environmental impact assessment regulations. Monitoring is equally undeveloped. The State Forestry Departments have only rough estimates of the quantity of timber extracted from forest reserves and other areas. The State Fisheries Departments have no monitoring capacity and do not collect any fisheries statistics. Overall, institutional constraints have meant that government agencies in general have had little positive impact in the riverine areas.

Information Constraints. For effective enforcement, as well as policy and decision making, environmentally related information collection, analysis, and dissemination needs to be greatly improved. Incomplete information encourages policy makers to emphasize areas with abundant information and ignore more uncertain and complex environmental and social issues. At present, too little is known about Niger Delta ecosystems, resources, and communities to understand the full impact of resource extraction or the full value of resources. For example, Forestry Departments do not conduct forest inventories before allocating timber concessions, and so have only a vague concept of the value of the resources they are allocating. Critical areas for improved information management are: (i) land and forest surveys; (ii) flood and erosion risk assessments; (iii) fishing effort and yield monitoring; (iv) biological inventories; (v) socioeconomic studies of communities; and (vi) pollution risk assessments. Geographic Information Systems (GIS) are especially important for improving the understanding of this highly complex system. For example, the Niger Delta Environmental Survey, which the World Bank is on the steering committee of , should significantly enhance stakeholder understanding of the impact of major economic activities on the delta environment (Box 2.6).

Legislative and Regulatory Constraints. The most important regulatory constraint is the lack of enforcement of existing regulations. For almost all the priority environmental problems, regulations are in place which, if enforced, would significantly reduce environmental degradation. Nonetheless, some modification of the current regulatory framework is necessary to improve the efficiency of environmental protection. For instance, overlapping oil pollution legislation and regulatory frameworks have confused oil companies and negatively impacted oil pollution management. Another major regulatory constraint is the absence of market based incentives. Although Rivers State is promulgating pollution charges, they will have little impact on reducing pollution because charges are not based on marginal effluent. The low energy, water, and waste disposal charges also provide minimal incentive to use resources more efficiently. Positive economic incentives, such as tax credits, grants, or

lines of credit, to encourage firms and individuals to consider the externalities of their actions have not been developed.

Policy Constraints. Policy failures frequently occur either because governments fail to address incomplete markets or intervene in markets to the extent that prices are distorted away from encouraging optimal use of resources. One of the most important policy failures in the Niger Delta is the lack of well defined property rights and their enforcement. Under the Land Use Act of 1978, all land belongs to the Federal Government and is administered by the governor of each State. This policy curtails the traditional rights of local communities, restricts private property rights, and leads to inefficient resource use. The Act and lack of enforcement of communal property rights also encourages government agencies and private companies to ignore communal rights. Tenure insecurity reduces the incentives of producers to invest in the resource and to maximize sustainable benefits. For example, farmers are unlikely to invest in land improvement or switch to longer maturing tree crops if their ownership is uncertain.

Insufficient tenure security has reduced participation and accountability to local communities. Oil companies, parastatals, and government agencies have all failed at various times to communicate adequately with local communities and to respond to their concerns. Since property rights are not always recognized or enforced, institutions are frequently not held accountable to the groups most affected by their actions. Furthermore, without strong property rights and accountability, little incentive exists to ensure adequate stakeholder participation in planning and implementation of activities.

Inadequate policy responses to incomplete markets have social costs in terms of excessive resource use. For example, the severe solid waste problems in urban centers in the delta result partially from individuals and firms deciding that it is in their interests not to pay the full cost of disposal because only a small portion of the environmental and social costs resulting from their actions directly affects them. Policy interventions are required to induce individuals and firms to account for the social costs of their actions through enforcement of regulations and incentives for provision of waste management services.

Prices can be distorted if governments subsidize resource consumption. Low crude oil price netbacks to producers, and low refinery-gate prices to refiners, implicitly provide an incentive for excess consumption of petroleum products. This practice has resulted in what may be one of the most inefficient refinery complexes in the world. Oil exploitation and other economic activities consume excessive amounts of forested land because the compensation rates for damaging forests do not reflect the loss of the wide variety of goods and services provided by those ecosystems - the forest products alone are valued at 50 times the rates paid by the oil companies. Water prices, which are far below the costs of water and wastewater treatment and are frequently not enforced, subsidize consumption and lead to water pollution, over-abstraction of groundwater, and underinvestment in water treatment and distribution.

In January 1995, the Federal Government allowed market determined foreign exchange transactions in autonomous funds. In general, the policy will help to decrease economic

distortions which disrupt the efficient use of resources by reducing government control of foreign exchange. However, studies in neighboring countries have shown that when exchange rates are allowed to float freely, the increase in producer prices exacerbates environmental degradation unless complementary policies are explicitly targeted to prevent it. This issue may be a concern for Nigeria, and the Niger Delta in particular, because forest and fisheries management remains very weak. Inappropriate fiscal policies include the Federal Government setting interest rates at 5 percent above average funding costs, a level far below market rates. Overall, this distortion exacerbates unsustainable practices by not allowing capital to be put towards the most efficient use.

Development of an Integrated Environmental Action Plan

Government institutions as well as other stakeholders in the Niger Delta recognize that environmental degradation is taking an increasing toll on human health and economic productivity. This recognition needs to be translated into action by developing and implementing an Action Plan that addresses the priority environmental issues on the ground. Table III presents the key policy objectives and proposed actions which could form the basis of an Action Plan. Critical decisions need to be taken now to develop an integrated strategy that makes the most effective use of the limited resources in the Niger Delta for improving environmental conditions.

An integrated resource management approach, such as Integrated Coastal Zone Management (ICZM), is necessary to address the broad range of environmental and social issues facing the Niger Delta. Generally accepted ICZM principles which have formed the conceptual basis for successful programs throughout the world include:

- Addressing the priority issues with interventions that have the highest net marginal benefits;
- Developing an appropriate, incentive based, regulatory framework;
- Strengthening sectoral management and induce sectoral institutions to recognize and account for the interconnections between coastal resources and uses;
- Creating institutional arrangements and linkages to coordinate sectoral activities and policies such that they reinforce the goals agreed on for the coastal zone;
- Focusing on proactive environmental planning, impact assessment, and management;
- Minimizing foreclosure of future development options by current activities (maintain flexibility for future resource uses);

- Following the 'polluter pays' principle, whereby firms are required to pay all-or at least a substantial part-of the social costs of their activities;

- Integrating stakeholder participation and ownership throughout the ICZM process;

- Establishing open and effective institutions; and

- Striving to have prices reflect the full cost of goods and services.

Policy Reforms. To achieve sustainable development in the Niger Delta, the Action Plan needs to be based on an appropriate policy framework to deal with the most critical policy failures, including: (i) lack of recognition and enforcement of property rights; (ii) economic policies which fail to encourage markets to reflect the full social and environmental costs of goods and services; and (iii) lack of accountability and participation. The overarching purpose of the policy changes discussed in the report is to provide clear incentives for all stakeholders to work towards environmentally sustainable development in the Niger Delta. On a government level, reform requires that agencies consider their impact on environmental and equity concerns as part of an expanded mandate. At the individual and company level, regulatory reforms need to ensure that externalities become incorporated into private decision making. For communities, reforms need to give them greater incentives and skills to manage resources more sustainably. Policies need to be directed towards the following objectives and action taken to implement them:

(a) reducing negative environmental and social impacts by emphasizing incentive mechanisms;

(b) alleviating poverty in order to reduce poverty induced environmental degradation;

(c) encouraging investment in renewable resources;

(d) increasing resource ownership and management by those affected by degradation;

(e) encouraging a precautionary approach to activities where information is poor or impacts are uncertain; and

(f) increasing the accountability of decision-makers and expanding stakeholder participation in decision-making processes.

Institutional Issues. The implementation of an Action Plan for integrated coastal zone management requires that effective institutions are in place. Many institutions with high levels of skills and resources (both public and private) will be necessary to carry out the wide variety of ICZM responsibilities. In meeting the objectives of the Action Plan, institutional reform is as integral as capacity building to create professional, results orientated, and responsive agencies.

The first step in defining institutional responsibilities should be to determine the comparative advantage and hence the role of the public institutions at all levels operating in the Niger Delta in achieving the objectives of the ICZM Action Plan. The existing government agencies will need to be assessed for their ability to meet potential future roles as implementing, monitoring, and enforcement agencies under the ICZM action plan. Stakeholders will need to identify a lead agency, or agencies, to coordinate and oversee management and implementation of the Action Plan. The roles of the State Coastal Zone Coordinating Committees must also be defined. Based on current responsibilities, resources, and effectiveness, all of the participating institutions must be given clear mandates and assignments of responsibility for implementing the most critical elements of the Action Plan. The most important and difficult institutional issue will be to determine which organizations, public, private, or non-governmental, are best suited to implementing the Action Plan at the community level.

Table III: Agenda for Key Policy Objectives and Proposed Actions[2]

Policy Objective	Major Constraints	Proposed Short Term Actions	Proposed Medium Term Actions
Correct policies and eliminate distortions which exacerbate pollution and result in excessive resource depletion.	Limited understanding of the linkages between environmental degradation and inefficient policies. Lack of incentives to include social and environmental costs in private decision making. Implicit and explicit energy, water, land and waste management subsidies. Inappropriate macroeconomic policies.	Introduce market based incentives by moving towards having prices reflect the full cost of goods and services through reducing inappropriate subsidies, intervening in incomplete markets, providing positive incentives to reduce environmental degradation, and increasing user charges. Achieve and maintain a viable and stable macroeconomic framework.	Enforce resource rights. Strengthen communal resource ownership. Encourage a precautionary approach to activities where information is poor and impacts uncertain by requiring EIAs and additional information gathering.
Monitoring and enforcement of regulations.	Limited resources and information management capacity in agencies to implement monitoring powers. Lack of incentives for aggressive enforcement. Lack of prioritization of issues. Reliance on limited federal or state budget allocations. Slow legal enforcement processes.	Provide technical assistance to SEPAs and ministries to improve priority setting, information management, monitoring, and enforcement. Establish and enforce realistic compliance timetables. Allow agencies to retain enforcement revenue. Move from court settlements to administrative fines.	Adhere to compliance timetables. Establish long term monitoring of key quantitative environmental and development indicators.
Improve the legal and regulatory environment.	Absence of market based incentives. Inadequate recognition of communal resource rights. Uncoordinated government environmental management. Absence of land use zoning, infrastructure, and construction regulations. Insufficient EIA regulations	Introduce market based incentives, including user charges, and discharge fees. Develop land use zoning plans and regulations. Expand legal recognition of communal resource rights. Clearly define roles of agencies with environmental responsibilities. Refine and implement EIA regulations.	Enforce land use zoning regulations.
Increase public understanding of environmental issues and community level mitigation measures.	Limited information publicly available. Lack of emphasis on information dissemination.	NGO and state agency training in environmental education, resource management and conservation, and environmental health. Social marketing of environmental messages through mass media.	Incorporate environmental and health education into school curriculums. Foster and strengthen community extension programs in key areas (land, fisheries and forest management, flood control, waste management, water supply, public health, and family planning). Demonstration projects in communities.

[2] Timetable to be determined at the Niger Delta Coastal Zone Workshop in Port Harcourt.

Policy Objective	Major Constraints	Proposed Short Term Actions	Proposed Medium Term Actions
Reduce the economic and social costs of flooding.	Lack of risk based information. Lack of implementation of flood reduction mandates. Absence of long term and land use planning. Overlapping jurisdictions. Limited resources.	Assess impact of natural hazards and human activities, including upstream dams. Develop land use zoning plan and regulations based on a determination of flood and erosion risk zones. Establish incentives to reduce development in high risk areas. Clearly define institutional responsibilities.	Implement mitigation measures at upstream dams as appropriate. Implement land use zoning regulations. Develop state and community level protection and drainage projects.
Reduce agricultural land degradation.	Limited land tenure security. Lack of land use zoning. Limited availability of intensification inputs and of alternative cropping and cultivation techniques (e.g. soil conservation practices).	Land tenure reform. Develop land use zoning plan and regulations. Capacity building in the Ministries of Agriculture, NGOs, and cooperatives to improve extension programs to small farmers.	Implement land use zoning regulations. Encourage intensification, land management, soil conservation, and agroforestry projects and programs. Create a framework for small farmer credit mechanisms
Foster sustainable high value fisheries management.	Poor data collection and management. Open access to resource. Negligible monitoring and enforcement of regulations. Limited alternative community level economic activities. Inadequate recognition of community resource ownership. Undeveloped fish processing infrastructure.	Capacity building in state ministries for information management, monitoring, and enforcement. Initiate yield and effort monitoring programs. Enforce key regulations. Evaluate applicability of market based incentives. Enforce community resource ownership. Allow agencies to retain enforcement revenue.	Encourage environmentally and socially sustainable aquaculture and alternative livelihood projects. Implement market based incentives, as appropriate. Provide the framework for improved fish processing infrastructure.
Reduce deforestation and loss of biodiversity.	Limited land and tree tenure security. Lack of monitoring and enforcement of regulations. Very limited forest and biodiversity information. Implicit subsidies for forest clearing. Weak public sector commitment to conservation. Lack of protection of sites of high biodiversity.	Enforce land and tree rights. Enforce existing regulations. Develop economic mechanisms to improve resource management and conservation. Conservation and resource management capacity building in state forestry departments, NGOs, and communities. Expand forest and biodiversity information collection and management. Refine and implement EIA regulations. Allow agencies to retain enforcement revenue.	Implement economic mechanisms. Encourage the sustainable development of smallholder timber, agroforestry, and NTFPs programs. Foster integrated conservation and development projects and programs. Upgrade the status of key protected areas and develop new protected areas in valuable ecosystems. Improve timber processing efficiency.
Control expansion of water hyacinth.	Inadequate control programs. No eradication solution available.	Implement available control methods. Establish control and eradication research programs. Initiate utilization pilot program. Adopt models used in other countries (e.g. Cote d'Ivoire).	Foster NGO/community control programs. Develop small scale harvesting programs.
Improve management of municipal wastes: sewage and solid wastes.	Absence of enforcement of regulations. Incomplete regulatory framework. Lack of economic incentives for resource conservation. Insufficient infrastructure. Inadequate waste management investment policies. Limited institutional capacity.	Enforce existing regulations for waste management. Establish effluent standards. Require secondary wastewater treatment in largest urban areas. Develop and implement user charges for water and waste services. Technical assistance and training for relevant state and municipal agencies.	Provide incentives for establishment of effective and efficient waste management and water supply in urban and rural areas. Evaluate and support privatization of select municipal services.

Policy Objective	Major Constraints	Proposed Short Term Actions	Proposed Medium Term Actions
Reduce generation of toxic and hazardous substances (THS).	Limited data on sources. No enforcement of regulations. Lack of market based incentives. Insufficient institutional capacity. State ownership of many of the largest facilities. Lack of technical expertise and knowledge of international best practices in regulatory agencies and waste generators.	Prepare THS emissions inventory. Provide information, technical assistance and training in THS management to SEPAs and targeted facilities. Incorporate incentives into regulatory framework. Establish realistic compliance schedules for major waste generators, including parastatals. Develop reduction, recycling, treatment, and disposal options.	Enforce compliance schedules for major waste generators, including parastatals. Develop hazardous waste tracking system. Provide the framework for the establishment of reduction and recycling programs, secure disposal facilities, and treatment centers.
Reduce emissions from vehicles.	Limited information. High lead concentration in fuel. Incomplete regulatory framework. Limited technical capacity. Limited mass transit. Absence of urban transport planning.	Commission vehicle emission and mass transit studies. Regulate improved fuel formulations. Create incentives for increasing demand for unleaded fuel. Capacity building in SEPAs and vehicle repair shops. Initiate urban transport planning.	Support mass transit initiatives. Support natural gas vehicle fleet development and refinery retrofits. Implement mass transit program, if appropriate. Establish incentive framework for vehicle and repair shop improvements. Implement urban transport plans.
Address key social issues with population emphasis.	Limited recognition of the linkages between population growth, environmental degradation, and reduced economic productivity. Lack of incentives to reduce family size. Limited educational opportunities for women. Limited distribution of contraceptives.	Include population concerns in planning, programs and budgets. Train state agencies, NGOs, and community organizations to disseminate family planning, health, and nutrition information. Strengthen community health clinics. Encourage contraceptive distribution, especially by the private sector. Improve incentives for women's education and for smaller families.	Establish agricultural, NTFPs, and business training and extension services for women. Expand nutrition programs. Provide the framework for improved infrastructure. Increase investment in female education and child survival programs.

1. INTRODUCTION

The Niger Delta is one of the largest deltas in the world. Located in southeastern Nigeria, it covers over 20,000 square kilometers. Rivers and Delta State make up approximately 80 percent of the Niger Delta. The two states produce 75 percent of Nigeria's petroleum, by far the country's largest export. Despite the vast hydrocarbon reserves, the region remains poor and infrastructure is largely undeveloped. Subsistence agriculture and fishing, supplemented by forest products, are the most important sources of livelihood for rural communities. Yet unsustainable exploitation and environmental degradation are increasingly impairing the natural resource base on which the rural communities depend. To assess the critical environmental and social concerns facing the Niger Delta, this report employs an analytical framework that emphasizes the linkages between economic activities and environmental degradation.

A. ECOLOGICAL SETTING

1.1 The Niger Delta is one of the world's largest wetlands, covering over 20,000 km^2 in southeastern Nigeria.[1] The states that are the focus of this study, Rivers State and Delta State, comprise approximately 80 percent of the Niger Delta. Rivers State covers two-thirds of the Niger Delta. Around 75 percent of the state is riverine and regularly inundated with water. In Delta State, the percentage of floodplain drops to about 50 percent and the state includes another 15 to 20 percent of the Niger Delta.

1.2 The Niger Delta receives inputs from a total catchment area of 2.23 million km^2 (the third largest in Africa behind the Zaire and the Nile) and has the fourth largest average annual discharge in Africa: 180 billion m^3 (Rangeley et al. 1994, 4). The delta is a prism that was formed by the accumulation of sedimentary deposits transported by the Niger and Benue Rivers. Within the delta floodplain, the river splits into six major tidal channels and innumerable smaller outlets. Fluvial sediments are deposited throughout the delta with sand and silt suspension during both high and low flood regimes. Construction of dams along the Niger during the last twenty-five years has significantly modified flow regimes and sediment deposition. Tidal currents, which range up to 1.5 m/sec, determine sediment settling patterns near the coast.

1.3 Annual rainfall is very high, ranging from 3000 mm to 4500 mm. Rainfall peaks in July and September. The dry season occurs in December through February. The mean monthly temperature is 27'C and humidity oscillates around 80 percent (Rivers SEPA, 1993, 2).

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[1] The Niger Delta covers a large area of Nigeria and depending on the political, ecological, or hydrological definition of what constitutes the delta, it includes significant portions of Rivers, Delta, Ondo, and Akwa Ibom states. This study concentrates on the riverine and coastal areas of Rivers and Delta state.

1.4 The delta can be roughly categorized into four ecological zones: coastal barrier islands, mangroves, freshwater swamp forests, and lowland rainforests (Table 1.1). The hydrological boundaries between ecological zones are fluid and depend on seasonal river flows. Salinity rises during the dry season when low river flows allow greater salt water intrusion upstream. The high rainfall and river discharge during the rainy season combined with the low, flat terrain and poorly drained soils result in extensive flooding and erosion. Over 80 percent of the delta is seasonally flooded, including all of the swamp forest, except the riverbank levees (The Rivers Chiefs, 1992, 3-1). During most years, only select elevated areas remain dry. The flooding causes severe and extensive riverbank erosion. When the flood waters recede, the channels that spread out across the delta leave swamps and pools that drain only poorly, if at all. This is because sediment deposition blocks the few outlets which might otherwise be available. Through erosion, water accumulation, and sediment deposition, the Niger Delta is constantly reshaped by flooding. A dynamic equilibrium between flooding, erosion and sediment deposition is the defining characteristic of the delta ecosystem. However, since the construction of the Kainji Dam on the Niger River in the late 1960s, peak discharge volumes have declined by approximately 30 percent, disrupting the hydrological balance.

B SOCIAL FEATURES

1.5 In the Niger Delta, an expanding poor rural and urban population makes most resource and land use decisions. Their decisions are being driven by a lack of development, stagnant agricultural productivity, negligible opportunities in urban areas, rapid population growth, and tenuous property rights. Based on the 1991 census, the populations of Rivers and Delta States are estimated to be 3.98 million and 2.57 million, respectively. In both states, approximately 70 percent of the inhabitants live in rural delta communities (Ministry of Health, Rivers State, 1994). The average population density for Rivers State is 1.95 people/ha and for Delta State is 1.38 people/ha (Western Africa Department, 1990, 116). However, the state level statistics are misleading since the wetland ecology of the region restricts habitation to the relatively small area of higher elevation. Thus, densities per habitable area are very high (Map 5).

1.6 **Poverty.** Despite its vast oil reserves, the region remains poor. GNP per capita is below the national average of US$280. Unemployment in Port Harcourt, the capital of Rivers State, is 30 percent and is believed to be equally high in the rural areas of both states. The rural population commonly fish or practice subsistence agriculture, and supplement their diet and income with a wide variety of forest products. Education levels are below the national average and are particularly low for women. While 76 percent of Nigerian children attend primary school, this level drops to 30-40 percent in some parts of the Niger Delta. The poverty level in the Niger Delta is exacerbated by the high cost of living. In the urban areas of Rivers State, the cost of living index is the highest in Nigeria (Rivers State (urban): 783; Lagos (urban): 609) (Canagarajah, Ngwafon, and Thomas, 1994).

1.7 Data on poverty levels in the Niger Delta region do not exist, although some information is available at the state level. However, state averages are of limited use in assessing poverty in the delta because they include the wealthier upland regions thereby

masking the degree of poverty in the riverine and coastal areas (the focus of this study). In addition, most data collection occurred before the creation of Delta State, and the Bendel State figures, which include a large upland area now known as Edo State, further dilute the relevance of the information to the delta. The World Bank study, The Evolution of Poverty and Welfare in Nigeria (1985-1992), found that the percentage of Nigerians living below a poverty line of N395.41 fell from 43 percent to 33 percent between 1985 and 1992 (Canagarajah Ngwafon, and Thomas, 1994). Both Rivers and the former Bendel state poverty levels were consistently below the national average, with Bendel showing significant improvement (1985: 42 percent; 1992: 16 percent)[2] and Rivers not improving as dramatically (1985: 36 percent; 1992: 29 percent). The figures for southern Nigeria, which include the former Bendel State and Rivers State, also dropped significantly (rural: 42 percent to 26 percent; urban: 29 percent to 15 percent). In the rural southeast, which includes the delta region, the proportion of people living beneath the poverty line fell, but poverty severity increased slightly from 0.075 in 1985 to 0.079 in 1992. Although the proportion of people living under the poverty line in Rivers State fell, all indicators of extreme poverty for the state increased, but still remained below the Nigerian average. For example, the percentage of people in extreme poverty (living below a poverty line of N197.71) increased from 3 percent to 7 percent. If data for the Niger Delta region was available, it is expected that poverty indicators would be considerably worse than the state averages because of the poorer socio-economic conditions in the riverine areas compared with the upland areas.

1.8 **Housing and Infrastructure.** Within the riverine areas, most people live on the elevated areas to avoid flooding. Housing conditions are generally poor, with only one-fifth of rural housing considered physically sound (Nest, 1991, 207). During floods, which in some areas last for over half the year, drinking water often becomes contaminated causing high levels of bacterial, viral, and parasitic outbreaks (Linden, 1993, 4). Water borne diseases are also a severe problem during the dry season because water supplies are often inadequate to dilute contaminants. Not surprisingly, water related diseases exert an enormous social and economic toll in the Niger Delta. These problems are exacerbated by the fact that both urban and rural infrastructure is poor - electrification, water supply, and sanitation levels are very low. The State Ministries of Health report that just 20-25 percent of rural communities and 45-50 percent of urban centers have access to safe drinking water. Similarly, adequate sanitation is available only to 25 percent of Delta State and 12 percent of Rivers State residents compared to the national average of 28 percent. No municipal wastewater treatment facilities exist in either state. As a result of the extensive flooding, transportation is difficult in the riverine areas.

1.9 **Social Organization.** The people of the Niger Delta are comprised of distinct ethnic groups. Six major language groups and twenty-six minor language groups exist in River State alone (Alagoa and Tamuno, 1989, 43). In some cases, trading, migration, and cultural links have blurred these distinctions, while in others, oil related boundary conflicts sharpen

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[2] If the data were separated between the Delta and Edo State areas of the former Bendel State, the poverty indicators for Delta would probably be similar to the Rivers State figure because of the similar resource base, environment, and socio-economic conditions.

distinctions (e.g., Ijo/Biseni and Ekpeye/Engenni conflicts) (NDWC, 1995, 1). Women play a very significant role in the social and economic organization of riverine communities. In addition to infant and child care, they contribute at least half of the agricultural labor, operate most of the retail sector, and process virtually all artisanal fish catches. Since a larger proportion of men migrate to urban centers, women also provide continuity to community organizations and structures. The relatively rapid development of oil exploitation has greatly increased immigration into the region, particularly into Port Harcourt. This rapid flux of new populations has significantly disrupted many communities.

1.10 Most communities are led by a council of chiefs who set community policies. Elders advise the chiefs and reinforce their authority. A group of young males usually implement policies and enforce social rules. Women's associations are also common (Alagoa and Tamuno, 1989, 94). With social unrest prevalent in many parts of the delta, these traditional social structures have broken down in many communities and have yet to be replaced by alternative forms of government.

1.11 **Resource Ownership.** Traditionally, families and communities, rather than individuals, held rights to most rural land. Individuals who wished to obtain land could barter with the village chief or council. Today all land is legally vested in the state government. However, individuals, families, and communities continue to engage in land. Women were historically excluded from owning land, however, in most communities this is no longer the case (Alagoa and Tamuno, 1989, 73). The federal government owns all mineral rights - a source of anger for communities in which oil development is going on. Except for timber trees, which are state property, forests are community owned and managed. Communities also control stretches of rivers and creeks.

C. Sectoral Characteristics

1.12 **Industry.** The petroleum sector dominates the Nigerian economy. Since 1973, oil has made up more than 90 percent of total exports and 80 percent of federal government revenue. At the end of 1992, proven reserves of petroleum stood at 17.9 billion barrels, sufficient for 24 more years of production at current levels (around 2 million barrels per day - about 3 percent of world production). Most of Nigeria's oil and gas reserves and production are located in the Niger Delta. Rivers and Delta States together produce about 75 percent of Nigeria's petroleum. Their oil production alone comprised about 56 percent (US$3.9 billion) of estimated national government revenues in 1992. Proven reserves of natural gas amounted to 3.4 trillion m^3 in 1992 (approximately 1000 times the volume of oil reserves). In 1989, Nigeria produced 2,267 mmcfd of natural gas, of which 1,690, or 75 percent, was flared into the atmosphere (ESMAP [Energy Sector Management Assistance Programme], 1993, 45). Most of the gas flaring occurs in the Niger Delta region.

1.13 Since 1979, the Nigerian National Petroleum Company (NNPC) has operated joint venture equity participation agreements with major foreign oil producers. Shell Petroleum Development Company is the largest producer in the country, with about 40 percent of total production (800,000 barrels per day). The other major onshore producers are Agip (150,000 bpd) and Elf (250,000 bpd). The principal offshore producers are Chevron (300,000) and

Mobil (400,000). Chevron has prospecting licenses for onshore areas which may be developed in the future.

1.14 Although petroleum exploration and production are by far the largest industry in the Niger Delta, numerous other subsectors operate there as well. These include steel works, metal fabrication, food processing, rubber and plastics, petroleum refineries, and paint. The Industrial Directory for Rivers State lists over 500 companies, but most employ fewer than 10 people. Only 112 companies employ more than 50 workers (Linden, 1993, 12). Two of the three operating refineries in Nigeria and two petrochemical plants are located in the delta. The Delta Steel facility outside of Warri is the largest steel plant in West Africa. The National Fertilizer Company (NAFCON) fertilizer plant located near Port Harcourt is the only fertilizer plant in southern Nigeria. Other large facilities in the delta include the African Timber and Plywood mill at Sapele and the Delta Glass Industry at Ughelli. In Rivers State, the medium and large scale industries are concentrated on the Trans Amadi industrial estate in Port Harcourt, and include plastics and rubber, food processing, metallurgical, pharmaceutical, and chemical companies.

1.15 **Agriculture.** Agricultural land covers about 278,000 ha in Rivers State (about 16 percent of the state) and employs the largest percentage of the work force in both states. The principal crops are cassava, plantain, and yam. Shifting cultivation is the major form of agriculture, but is less significant in areas benefiting from flood deposited sediments which restore fertility without requiring long fallow periods. Traditionally, communities managed farmlands as common property resources with areas being communally cut down and burned (The Rivers Chiefs, 1992, 69). On average, fields are cultivated for one or two years (two to four crop cycles) and then left fallow for three to five years. Agriculture is concentrated in the lowland rainforest ecozone and the levees of the freshwater forest zone. It is less important, but growing, in the barrier island zone and largely non-existent in the mangroves. Similarly, while smaller numbers of livestock are kept in the mangrove zone, goats, pigs, ducks, and especially chickens are more common in the other ecozones. Livestock is primarily for household consumption and rarely raised commercially.

1.16 Land degradation and flooding are the principal constraints to agriculture in the fresh water forests zone. Agriculture is limited to areas with sufficiently short flooding periods to allow for a complete growing season. Lack of water management makes even rice cultivation difficult and keeps yields low (The Rivers Chiefs, 1992, 68). Agricultural land degradation has forced many farmers to switch from high value and high nutrient demanding crops, like yams and peppers, to less demanding, but less valuable crops, particularly cassava (Linden, 1993, 7, 10).

1.17 **Fishing.** The contiguous coastline of 360 kilometers (larger than the coastlines of many West African countries) and vast areas of wetlands offer major fishing potential which is reflected in the economies of both states. In both states, the artisanal sector, which includes over 400,000 fishermen, is far more significant than the small local industrial fleet. Conflicts between artisanal fishermen and trawlers illegally fishing close to shore are increasing. Available evidence indicates that overfishing is causing a decline in marine and coastal fish stocks, but sound data and maximum sustainable yields are not available. The construction of

dams along the Niger has also reduced fish and shell fish stocks in both the coastal and riverine systems. Industrial fish processing is constrained by very limited capacity for frozen fish storage.

D. Analytical Framework: Environmental Linkages

1.18 The purpose of this paper is to evaluate the environmental issues that constrain environmentally sustainable development in the Niger Delta. To accomplish this objective, the most critical environmental issues are assessed in terms of their: (i) direct and indirect causes, and (ii) direct and indirect impacts on human health, economic activities, and ecological systems. Strategic options for redressing environmental degradation are also presented.

1.19 Linkages between poverty and population growth leading to environmental degradation are evident in both the rural and urban areas of the Niger Delta. In the rural areas, poverty and population growth have directly caused or exacerbated the effects of most of the major environmental concerns: erosion, flooding, agricultural land degradation, fisheries stock depletion, deforestation and forest degradation, and biodiversity loss. Similarly, the overriding urban issues of flooding, municipal solid waste, and sewage are also closely tied to poverty and population growth. The environmental, social, and indirect causes sections (Chapters 2, 3, and 4) present and analyze these linkages.

1.20 One of the aims of this paper is to provide greater understanding of the explicit linkages between economic activity and environmental degradation. Economic analysis, therefore, has been integrated into the report, both in identifying the role of policy failures in environmental degradation, and in the analysis of priorities. In analyzing the priorities, a series of examples has been prepared, drawing as much as possible on information from the Niger Delta, which illustrates a number of the economy-environment linkages through explicit valuations of the economic costs of degradation. It should be recognized that data are, at this juncture, still relatively scarce and the analyses are based on the best available information at the time of completing this report. Appropriately, many of the valuation procedures use estimated values of resources 'at-risk', rather than valuation of resource degradation as a well-established consequence of some well-defined cause.

1.21 In addition to this introduction, the analytical framework is broken down into five additional chapters:

- **Chapter 2 - Environmental Problems and Challenges to Sustainable Development**. This section examines the environmental problems of the region, which are divided into three categories by the type of resource impacts: (1) land resource degradation, (2) renewable resource degradation, and (3) environmental pollution. The chapter emphasizes quantitative information, where available, and environmental-economic linkages. A review of relevant legislation and current responses to environmental degradation is also presented to assess their coverage, successes, and limitations.

- **Chapter 3 - Social Issues and Challenges to Sustainable Development.** With the strong links between poverty and environmental degradation in the region, this chapter discusses the major social constraints to sustainable development, the impact of environmental degradation on human health, and resource use conflicts. A review of relevant legislation and current responses to social issues is also presented to assess their coverage, successes, and limitations.

- **Chapter 4 - The Causes of Environmental Problems.** This section examines the root causes of environmental and social problems using an analytical framework that distinguishes between population changes, resource ownership, market failures, and policy failures.

- **Chapter 5 - Assessing Environmental Priorities.** Given the limited resources available to address the issues presented in the report, this section determines the relative priority of the major environmental problems.

- **Chapter 6 - Strategic Options.** The integrated coastal zone management model is discussed as a useful paradigm for holistically combining sectoral interventions. Specific policy and project options that address the priority environmental problems are reviewed.

2. ENVIRONMENTAL ISSUES AND CHALLENGES TO SUSTAINABLE DEVELOPMENT

The environmental problems of the Niger Delta have been grouped into three categories based on the type of resources affected: land resource degradation, renewable resource degradation, and environmental pollution. These categories are only one of several different alternatives for classifying the problems; however, they provide a suitable framework for improving the understanding of environmental issues, assessing priorities, and developing options for mitigating the problems. Although categories strictly based on media or source type would be more orthodox, they are not suited to wetland ecosystems where it is difficult to differentiate between land and water systems. In addition, the framework presented has the flexibility necessary to better highlight the principal environmental problems. For example, a source based approach would dilute the severity of the biodiversity loss issue. Land resource degradation refers to actions which reduce the amount or quality of land in the region. Renewable resources are classified as a discrete category because of their ability to produce sustained yields if properly managed. The environmental pollution problems are grouped together because they use and frequently stress waste sinks.

A. LAND RESOURCE DEGRADATION

Flooding, Erosion and Land Subsidence

2.1 The Niger River Delta is the largest delta in Africa. It contains about 20,000 km^2 of wetlands within two meters above present sea level (Ibe and Awosika, 1989). Along the ocean coast of the delta there are about 20 barrier islands consisting principally of low sand ridges with a maximum elevation of 1 to 3 meters above mean high tide. The Niger River Delta has been formed by, and continues to be highly influenced by rivers, mainly the Niger and Benue. Over geological time, these rivers have transported sediments to the delta and the sea. High water levels in the rivers during the rainy season flood extensive areas of the delta. Sediments brought to the sea via the rivers have replenished the delta and the coastal islands and have mitigated erosion by the sea. A large portion of the delta is directly influenced by the sea; tidal influences are felt *up to 90 km inland* from the coastline (NDWC, 1995, 3).

2.2 During the last 30 years, the Niger River has been dammed for hydroelectric power and irrigation at several locations and the water flow has been manipulated extensively. The major dam projects on the Niger and its tributaries are at Kainji (1968), Jebba (1983), Goronyo (1984), Bakalori on the Sokoto Rima, and Shiroro (1984) on the Kaduna tributary (Bourn, 1992, 5; NEST). Although no dams have been built on the Benue because of its high sediment load (11×10^6 m^3/yr compared with 4.6×10^6 m^3/yr for the Niger), seven have been proposed on it or on its tributaries (NEST; The Rivers Chiefs, 17). It is estimated that around 70% of the sediment transport via these rivers into the sea has been lost because of the dams (Table 2.1) (Collins and Evans, 1986). Much of the sediment which no longer flows to the

delta has been accumulating behind the dams, especially in the Kainji reservoir. Unconfirmed reports by scientists at the University of Benin in Edo State indicate that the depth of this reservoir has decreased from about 19 m in 1970 to 14 m in 1984 and 9 m in 1991.

2.3 Although information on sediment loads is unavailable for the Niger River, the data on four other large rivers presented in Box 2.1 illustrates the dramatic losses of sediment load that can occur. The smallest loss of sediment yield, which occurred in the Mississippi River, still represents a 40% reduction. On a global level, loss of reservoir capacity is estimated to be 1% of gross capacity per year (Mahmood, 1987, 8). It should be noted that very large regional differences exist. The Yellow River in China carries the highest sediment load in the world, an average annual load of 1,600 million tons with a maximum (in 1933) of 3,900 million tons. It was clear during the planning stage that the construction of dams in the Yellow River would cause drastic changes to the water and sediment regimes. However, technical modifications of the dams and the water use schemes were made with considerable success (Box 2.2).

2.4 The loss of sediment input to the delta via the rivers is exacerbating coastal and river bank erosion (Picture 2.1). In many areas along the coast, the erosion caused by waves, currents and other oceanic processes is estimated to range from tens of meters per year to over 100 m per year (Ibe, 1988 and 1993). Coastal erosion is pronounced in selected areas, particularly Brass, Bonny, and Sangana. Estimates of coastal erosion at Brass are 16-19 meters annually (Oyegun, 1990).

Table 2.1: Sediment Load Estimate for the Niger Delta (10^6 m3/yr)

	Pre-dam	Post-dam
Suspended Sediment	16	4.8
Bedload	0.9	0.27

Allen recorded the pre-dam data in 1965. The post-dam estimate is based on the 70% reduction estimated by Collins and Evan (1986).

2.5 Construction of breakwaters and jetties can also cause coastal recession. For example, at the mouth of the Escravos River, Ogborodo beach has receded by 20 m per year since breakwater construction in the early 1960s (Beak Consultants Ltd, 1994, 5.1). Tidal erosion occurs in the southern parts of the delta as a result of high tides in combination with waves. A number of townships and islands are affected, including Abbonema, Ke and Isaka. Other factors that contribute to coastal erosion are sand and gravel mining, dredging, reclamation of land, as well as oil, gas and water abstraction and the removal of vegetation (mangroves). The cost to the Nigerian economy of coastal erosion along the entire coastline is expected to be approximately US$150 million annually (Western Africa Department, 1990, 109). Since the delta encompasses 60% of Nigeria's coastline, the costs of erosion in the region can be expected to be in the range of US$90 million annually.

Picture 2.1
Example of Coastal Erosion in Rivers State

Box 2.1
Reductions in Sediment Loads as a Consequence of Dam Construction in Major Rivers

River	Before Dam Construction (tons/km^2)	After Dam Construction
Colorado River (N. Am.)	211	0.2
Nile (Africa)	37.5	0.0
Indus (Asia)	434	103
Mississippi (N. Am.)	107	64.2

Source: Mahmood, 1987.

Box 2.2
Mitigation of Sedimentation in Sanmenxia Dam and Other Dams Along the Yellow River, China.

The Sanmenxia Dam was completed in 1960 and is still in operation. The following measures allowed passage of high sediment concentrations.

- lowering of the water table;
- excavating bypass tunnels;
- opening bottom sluices;
- rebuilding of penstocks as conduits; and
- installing low head turbines.

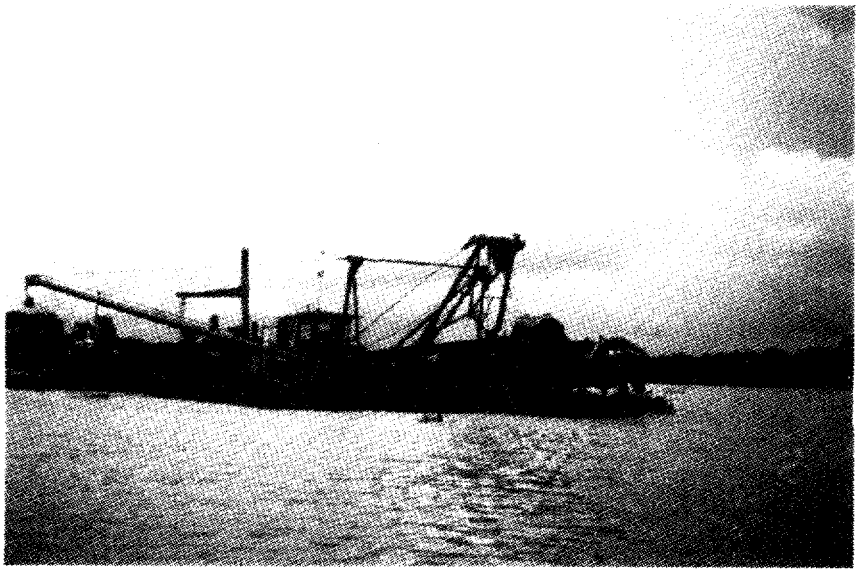
Source: Qishun & Yuqian in Sundborg & Rapp (1986)

2.6 River bank erosion occurs at the end of the annual floods when saturated river bank soils become unstable and collapse into the river. When dry, the soils contract and crack, but remain cohesive. However, when saturated, they are much less cohesive and fall into the rivers as flood waters recede and no longer support them. The affected land is frequently fertile and intensively farmed, such as in Agbere, Odoni, Sabagreiya, and Asamabiri areas.

2.7 Sand mining, which is common in rivers near the glass industries of Warri, increases the rate and extent of riverbank erosion and reduces downstream sediment deposition (Picture 2.2) (Ivbijaro, personal communication, 1994). Communities report that wakes from large vessels also increase the rate of erosion (Osundu, 1994). River water tables may vary as much as ten meters (River Niger) and six to eight meters (Rivers Nun and Forcados) between low water during dry periods and high water during rainy seasons.

2.8 It is estimated that close to 400 ha of land is lost annually to river bank erosion (Abam, 1995). With the present trend, about 40% of the current inhabited land in the delta will be lost within 30 years and about 750,000 people displaced. Since riverbank levees are the most populated areas and are intensively cultivated, riverbank erosion results in the loss of some of the most valuable land in the delta.

Picture 2.2
Sand Dredging Downstream of Yenagoa



2.9 Sheet, rill and gully erosion is most serious primarily outside of the floodplain and in farmlands upstream of the Niger Delta, but the effects are felt also in the delta. It is caused by rain or surface run-off, particularly in areas where shifting cultivation is practiced, and is especially severe in areas too steep for sustainable cultivation. Such areas include many locations in Oyigbo LGA. It can be expected that soil erosion caused by poor upstream agriculture and forestry practices will reduce the impact of the dams decreasing sediment loads. However, no data are available to support this theory.

2.10 A medium term result of the upstream damming of rivers flowing towards delta, is that flooding problems in the lowlands decreased considerably. Scientists at the University of Science and Technology report that dams reduce peak discharge volumes by 30% on average. Before the Kainji Dam came into operation the average yearly discharge at the confluence of Benue and Niger Rivers at Lokoja was 21×10^9 m^3, that is a daily average of 7,000 m^3/s. Immediately following the start of operations at the Kainji Dam an average drop of 20% was observed. The discharge was then constant until 1981 when another drastic drop from 7,000 m^3/sec. to 3,000 m^3/sec (Abam, 1995). With less intensive flooding, low lying areas that were previously inundated became habitable, leading to immigration into these areas. Reportedly, a large proportion of the rural population increase since the construction of the dams have settled in such areas. As a result of the accumulation of silt in the dam, the buffering capacity

of the reservoirs on the river flow has gradually decreased, such that the area flooded is expanding towards the pre-dam level.

Picture 2.3
Flooding in Sangana, Rivers State - July 1994

2.11 The combination of increased flooding and higher population densities in flood prone areas has intensified the human and economic impact of annual flooding (Picture 2.3) (Table 2 - vol. II). In Rivers State three Local Government Areas, SILGA, EKELGA, and ABOLGA, are most severely affected. The new, more severe, flooding regime disrupts the lives of several hundred thousand people. The total area of arable land that can no longer be cultivated owing to annual floods amounts to some 700,000 hectares. The flooding lasts four to five months annually. During those months, river levels may rise up to 8 to 10 meters from their lowest dry season levels. In 1988 alone, 211 villages were inundated partially or wholly for a period of two weeks or more. The water level rose at a rate of 5 to 7 cm per day throughout September 1988 forcing thousands of people to seek shelter at higher elevations, leaving crops and houses to be destroyed (Ministry of Works and Transport, Rivers State Government 1988). Flooding was even more severe in 1994 and caused similar widespread damage.

2.12 Land subsidence has been reported as a possible factor contributing to flooding in the Niger Delta. Several factors, including natural geologic processes and hydrocarbon extraction, may be the cause. Land subsidence can cause: (1) coastal flooding, (2) coastal erosion from increase wave penetration inland, (3) forest inundation, and (4) salt water intrusion.

According to Haq (1993), there is little empirical data on the local subsidence rates in the delta. In the southwestern part of the delta, subsidence rates of 5 mm per year since the last glaciation have been inferred. The extensive oil and water extraction from subsurface layers, and the reduction in the sediment input caused by upstream dams may have accelerated the local subsidence. However, since oil extraction occurs at very deep levels (4,000 - 8,000 m below the surface) it is unlikely that subsidence from that level would be significantly manifested on the surface (Abam, 1995, 13). Ibe (1993) estimated that the delta was subsiding 25 mm per year.

2.13 In neighboring Ondo State, coastal recession of more than 1,200 m between 1972 and 1991 is believed to be related to the dredging of a navigation canal and land subsidence. The navigation canal may allow large waves to reach further inland, increasing erosion. The channel may also be causing salt water intrusion and inundation leading to the destruction of 2,000 ha of inland forests. Oil and gas exploitation from the many wells in the area may be causing land subsidence as host and overburden sediments consolidate (Beak Consultants Ltd., 1994).

2.14 The reduction of the freshwater discharge in the lower delta from upstream dams has increased salt water intrusion into the delta. However, the absence of hydrological data makes quantification and prioritization of the associate problems difficult. Saline levels are highest in January during low river flows and can be significant even 90 km upstream on the Benin River, northeast of Warri, and Port Harcourt on the New Calabar River (Ashton-Jones and Douglas, 1994, 95). The saltwater wedge is penetrating deeply into the delta particularly during the dry seasons. This has reportedly caused drinking water wells to become saline. Dredging of rivers and the extraction of sand and gravel has also increased the risk of saline water penetration into the ground water layers (Abam, 1995). The lowered freshwater input via the rivers has decreased nutrients from land runoff via rivers and streams. This has produced a variety of effects on the flora and fauna of the lower delta, including decreasing fish stocks. The reduction in the input of nutrients as a result of the decreased freshwater discharge has significantly reduced fish catches (Fisheries Section). The potential issue of reduced water supplies is discussed in Box A.1 - vol. II.

2.15 **Regulatory Framework and Institutions.**[1] Flood and erosion control was originally mandated to the Niger Delta Basin Development Authority under the 1987 Decree establishing the Authority. Numerous other agencies include erosion and flood management as part of their mandates, including FEPA, the SEPAs, the State Ministries of Works and Transport, OMPADEC, and the Federal Department of Flood and Erosion. However, none of the agencies significantly addresses flooding or erosion problems. The high cost of control measures and the overlapping jurisdictions have limited mitigation to a small number of community level erosion projects. For example, the Federal Government has recently constructed erosion protection structures in Opobo Town, Brass, Queenstown, Abonnema, and Bonny, and OMPADEC is implementing 25 shoreline protection and reclamation projects (The Rivers Chiefs, 1992, 46). No delta wide flood and erosion management plan exists. The principal constraints to efficacious flood and erosion management are: (i) limited funds; (ii)

[1] See Annex K for additional information

lack of implementation of mandates; (iii) lack of data and no region wide risk assessment; (iv) absence of long term planning; and (v) overlapping jurisdictions.

Impact of Climate Change

2.16 Several studies have reported on global warming and its possible impact on sea level rise in West Africa and Nigeria (see for example Awosika et al. 1990, French et al. 1994, Milliman et al. 1989, Nicholls et al. 1993) (Annex B). The conclusion from these analyses is that the Niger River Delta is particularly sensitive to sea level rise because of its low elevation over extensive areas. The risks of sea level rise are also high because erosion and flooding are already spatially widespread and severe in selected areas. A projected sea level rise of around 1 m per 100 years (The International Panel on Climate Change (IPCC) scenario) would have grave consequences for large parts of the delta. Under this scenario, the sea would transgress the barrier islands and subsequent erosion would destroy much of the mangrove vegetation. Over 18,000 km^2, or 2% of Nigeria's land area, including most of the Niger Delta is at risk (Nicholls et al. 1993). Land loss would primarily be due to the inundation of large areas of wetlands, particularly in the delta area. Economic activities, such as oil exploration and production, agriculture and fisheries would be disrupted. It could force up to 80% of the delta's population to migrate to higher ground. IPCC estimates property damage of approximately US$9 billion as a consequence of a 1m sea level rise over 100 years. Even the most conservative scenario, a sea-level rise of only 0.2 m, would put an area over 2,700 km^2 at risk (Nicholls et al. 1993). It should be emphasized that none of these scenarios indicate an immediate danger, rather they predict a gradual increase of erosion and flooding problems (unless remedial measures are taken). However, extreme weather conditions may be more frequent and severe, causing significantly more damage than might otherwise be anticipated.

Agricultural Land Degradation

2.17 Increasing populations require either more intensive agriculture on existing farms or an expansion of agricultural areas to feed the additional community members. In addition to regional population growth, a heavy influx of farmers into the delta from already degraded upland areas and immigrants attracted by oil development has increased population expansion in the region (NDWC, 1995, 3). Since agricultural inputs are generally not available or too expensive for most farmers in the Niger Delta, they have resorted to cultivating increasingly marginal land and increasing the frequency of cropping on existing plots. This is a common problem throughout sub-Saharan Africa (Cleaver and Schreiber, 1992).

2.18 Evidence of agricultural expansion since the 1960s in the Niger Delta is widespread. In freshwater wetland forests, any new road is quickly followed by farmers establishing plots along the roadside. While farmers used to avoid the backswamps behind the levees, pressure for land has forced communities throughout the freshwater wetland ecozone to invest large amounts of labor in reclaiming small areas of the wetlands as farm plots (e.g., in Ekpeye, Isoko, and Ikwerre). In riverine areas, farmers are clearing prime forests for plantain cash cropping (NDWC, 1995, 2). Typical of the freshwater zone, the levees of the Anyama area

were cleared and farmed by the 1960s. Species unable to move into the freshwater swamps, including elephants and chimpanzees, were driven to extinction (Ashton-Jones and Douglas, 1994, 89). The lowland rainforest areas were cleared even earlier and are still under severe population pressure. In the Ogoni region of the lowland rainforest, cassava, for the first time, is being grown in wet areas during the dry season to offset yield declines on established fields. Farmers are also resorting to cutting down forest shrines to meet the demand for agricultural land (Ashton-Jones and Douglas, 1994, 60). Federal and state governments subsidize extensification, through programs run by National Agricultural Land Development Agency, the School to Land Project, State Ministries of Agriculture, and NDBDA (Powell, 1990, 4).

2.19 Without additional capital inputs, intensification leads to declining yields from reduced soil fertility. Fallow periods shorten resulting in inadequate nutrient replenishment and poor soil structure. This is an unsustainable practice that mines soil fertility. It has been extensively studied in southeastern Nigeria. The studies clearly show that shorter fallow periods without additional inputs are closely tied to soil degradation and yield declines. A survey in neighboring Imo State in 1988 found that fallow periods have declined from a range of 1-9 years to 0-6 years: and are on average far less than the 5-7 years required to restore soil fertility (Goldman in Lal and Okigbo, 1990, 16). In addition to declining fertility, a reduced fallow forces communities to do without, or obtain from forests, products formerly supplied by fallow areas, such as stakes, food, fodder, and medicines.

2.20 Soil degradation induced yield reductions are more severe in the acid infertile soils of southeastern Nigeria than in the western regions of the country (Lal and Okigbo, 1990, 11). Researchers found that under continuous cropping in field trials in southeastern Nigeria yields declined by 65% for maize, 38% for yam, and 25% for cassava after four years (Odurukwe and Orji in Lal and Okigbo, 1990, 11). A study of several hundred farms just north of the delta determined that yields of yam, cocoyam, and cassava fell as fallow periods shortened and soil fertility declined (Armon in Lal and Okigbo, 1990, 14). These studies and others illustrate that in high population density areas of southeastern Nigeria, shortened fallow periods lead to soil degradation and lower yields. In a study of the impact of population pressure on land use around Onitsha, just north of the delta, Okafor found that increasing population pressure was correlated with smaller farms, fragmented fields, and shorter fallow periods. By the mid 1989s, fallow periods averaged only 3 years, a drop of 2.25 years from the mid 1970s and half the length of time required for fertility restoration (1988). Although no studies of agricultural yields or fallow periods have been conducted in the delta, sociological studies have consistently found that communities complain of reduced agricultural production (Ashton-Jones and Douglas, 1994, 10). In addition to anecdotal evidence of declining yields, the variety of crops planted in the delta has fallen. While intercropped systems of yams, maize, cassava, beans, cocoyams are the traditional farm crops, cassava has begun to dominate in many areas because it produces good yields even on soils with low nutrient concentrations, has few major insect pests, does not require staking, and can be grown all year (Daniel-Kalio, 1994). Declining yields combined with population pressure result in a cycle which forces farmers to expand into increasingly marginal areas that offer even lower returns to labor leading to further expansion.

2.21 Intensification, one of the solutions for addressing agricultural land degradation, does not have to involve expensive capital inputs (potential conservation problems with intensification are discussed in Box A.2 - vol. II). The compound farms of eastern Nigeria are cropped continuously for years without loss of yield because of heavy manuring with mulch, household wastes, and animal wastes. Perennial species also accumulate nutrients from deep soil layers which are recycled to shallow rooted species. While appropriate for small plots near houses, such intensive land management cannot be practiced on large plots because of its high labor requirements (Lal and Okigbo, 1990, 15).

2.22 **Erosion and Flooding**. Reduced sedimentation caused by upstream dams is believed to be decreasing agricultural productivity in the freshwater forest zone (see paragraphs 2.1 - 2.8). This problem appears to be most pronounced along the fringes of wetlands, where lower sediment transport retards the restoration of soil fertility because annual flooding may be depositing less silt. Until recently, high silt deposition reduced the need for farmers to resort to shifting cultivation. If sediment deposition is actually declining, the impact on agricultural yields will increase because the wetland fringes are the major area for current agricultural expansion. The impact of reduced sedimentation is compounded by sedimentation of the upstream reservoirs increasing flooding and washing away topsoil in the flood prone areas (David, 1994). Sediment losses within the delta may be partly offset by heavy gully and sheet erosion in upstream states depositing material in the delta. High floods of longer duration threaten crops with waterlogging and force farmers to harvest early. Riverbank erosion in the freshwater forest zone is exacerbated by land pressure which necessitates that farmers cultivate right to the edge of the levees. By converting the natural forests and reducing fallow periods, the soils are much more susceptible to erosion forces.

2.23 In the drier lowland rainforest area, sheet erosion may be a problem, but it has not been studied. Researchers have found that gully erosion is severe in large areas of the lowland ecozone, but is not common in the riverine areas (Lal and Okigbo, 1990, 18). Extensive gully erosion in Oyigbo LGA along the riverbanks has disrupted farming (Dike, 1994). In addition to inadequate soil conservation practices, poor road construction is a principal cause of gully erosion. For example, gully erosion is common along the Port Harcourt-Aba-Enugu road (Fubara in Lal and Okigbo, 1990, 18).

2.24 **The Population and Agriculture Nexus.** Since agricultural expansion continues to degrade large areas of forest, it is critical to understand the ultimate mechanisms driving land conversion. In the case of population growth in rural areas, it expands the labor pool available for both more intensive and more extensive agriculture. However, since labor productivity is probably low in the Niger Delta and inputs are not available to poor farmers, additional labor will have to be absorbed through extensification (which is limited by the relatively small area of arable land), the non-farm rural sector, or the urban sector (Larson, 1994, 681). The non-farm sector in the delta largely consists of fishing, which may already be exceeding the MSY, and activities which require intact forests (NTFPs and hunting). Migration to urban centers has already been very extensive, but is slowing because of the lack of opportunities. Consequently, extensification can be expected to remain critical for assimilating rural labor.

2.25 The population-agricultural nexus and the depletion of other renewable resources are particularly important because of (i) the direct impact on the environment; (ii) resource interconnections; and (iii) damage to the regenerative capacity of ecosystems (Pearce and Turner, 1990, 344). The nexus results in renewable resources being mined: soil fertility and forest products are degraded too rapidly for natural systems to regenerate them. The reiterative nature of the linkages leaves resource bases increasingly vulnerable to further damage because recovery between stresses is not sufficient.

B. Renewable Resource Degradation

Fisheries Exploitation[2]

2.26 **Sector Characteristics**. The preservation of the freshwater swamp and mangrove ecosystems is crucial for the viability of a large coastal and wetland fishery. The annual value of sustainable harvesting of fish in the Niger Delta is estimated at N5 billion (Box 2.3). Fluctuations in captures, decreasing sizes of fish, and observations from fishers give evidence of declining stocks from overexploitation and habitat degradation.

2.27 Fishing is an important component in Nigeria's agricultural sector, comprising about 20% of production (Government of Nigeria, 1992). The present annual catch is estimated to cover about one third to one quarter of the total consumption of fish, 800,000 mt (FAO, 1993). Fish contribute to about 40% of per capita animal protein intake in Nigeria. This figure is considerably higher in coastal areas and along rivers and water bodies. In the delta, a large number of families consume molluscs (periwinkles), oysters, and dry shrimp daily, though these food items are not mentioned in the statistical data (Otobo, 1995).

[2] Statistical records of catches are scarce and unreliable. Few data collectors operate in the region, and they do not have crafts or vehicles which are necessary to cover significant areas to collect data. Hence the fisheries data presented below should be regarded as indicative, rather than accurate.

Box 2.3
Value of Sustainable Management of Fisheries

Total Annual Value of a Sustained Harvest[3]	N5 billion
Net Present Value of a Sustained Harvest	N50 billion
Annual Value per fisherperson	N35,000
Annual Value per Hectare	N2,500

Source: Linddal, 1995.

2.28 The delta, being predominantly a floodplain habitat, is a very productive waterbody for fisheries and a critical nursery for offshore and upstream ecosystems (Powell, 1993, 7). The most important commercial species from marine and brackish waters are croakers (*Pseudolithus spp.*), bonga (*Ethmalosa spp.*), herrings (*Sardinella spp.*), catfish (*Arius spp.*), snappers (*Lutjanus spp.*), mullets (*Liza spp.* and *Mugil spp.*), and shrimps (*Penaeus spp.*). Most important freshwater species include tilapias (*Tilapia spp.*), moonfishes (*Citharinus spp.*), carps (*Labeo spp.*), *Heterobranchus*, *Chrysichthuys nigrodigitatus*, and catfishes (e.g., *Clarias spp.*).

2.29 In addition to finfish, molluscs and crustacean harvesting is widespread and a critical economic activity for many riverine and mangrove communities (aquaculture is not well established - Box 2.4) . In the mangroves, periwinkles are a significant source of income and protein. Periwinkles are an excellent delta resource because they require no preservation for weeks and harvesting requires minimal capital (Powell, 1993, 77). They have been overfished in several areas (Powell et. al., 1987). Clams (such as *Galatea pradoxa*) are equally important to some freshwater swamp communities. Fishermen catch approximately 2,000 tons of shrimps off the coast of Nigeria. The major coastal species are Guinea shrimp (*Parapenaeus longirostris*) and pink shrimp (*Penaeus notialis*). The most important commercial brackish water species are *Namatopalaemon hastatus* (Amadi in Dublin-Green and Tobor, 1992, 16).

[3] The average (shadow) price throughout the year is estimated to be 50 N/kg based on market prices (Table A.8). The total value of a sustained harvest of fish (100,000 tons per annum) is in the order of about 5 billion N. This harvest is from the delta, or species that had part of their life cycle in the delta. With a discount rate of 10 percent and constant prices and harvest level, the total value of the renewable fish resource is 50 billion N. With the estimated annual capture of 700 kg per full time fisher, the annual value of artisanal fishery is estimated at 35,000 N/fisher-year. This is a value comparable with other employment possibilities (valued at about 100 N/day). The value is a *gross* value but since the harvest efforts are assumed to have a low opportunity value, the value is approximated to *net* value. With the total delta (2 million ha) supporting an annual fish production of 100,00 tons valued at N5 billion, the per hectare value is N2,500. Thus, the destruction of one hectare has an opportunity cost for fishing estimated at 2,500 N/ha.

Box 2.4
Aquaculture

Riverine communities have yet to engage actively in aquaculture. Some development agencies have funded research and pilot programs, but the removal of large areas of mangroves for aquaculture, as seen in countries, such as the Philippines, Ecuador, and Indonesia, remains at the proposal stage. If large scale aquaculture does take off in the delta, a large range of environmental problems may be anticipated. Depending on the value of mangroves to local communities and for marine fisheries, the most significant impact can be the outright destruction of mangrove forests. As well as forest loss, inputs required for culture fisheries, including fertilizer, fish feeds, and pesticides can degrade water quality. Commercial fisheries infrastructure often modifies water and sediment flow regimes to the detriment of downstream communities and ecosystems. Culture operations usually rely on natural fish populations for stocking ponds which can decrease both natural populations and capture fisheries that rely on the mangroves and associated species.

A well designed aquaculture program, which minimized its negative environmental impact, would improve the productivity of the delta. This option may not be available if estuarine water quality continues to decline because of other sectoral activities, including oil exploitation, unplanned municipal development and industries. Sufficient areas of mangroves should be preserved between and within the culture to allow for wild stocks of fish and other aquatic life to thrive and reproduce. Areas of intact mangroves would serve as natural filters for waste products from the cultures. Clearly, ecological changes from any major aquaculture developments should be assessed during the planning stage and closely monitored during implementation.

2.30 In both Rivers and Delta State most of the fishery is artisanal (small-scale).This subsector consistently contributes over 80% of the catches (national average). There are about 123,000 full-time and part-time artisanal fishermen in Rivers State and about 282,000 in Delta State. There has been a very significant increase in the number of fishermen during the last decade. Most of the artisanal fishing is carried out from wooden fishing canoes built by local craftsmen. The artisinal fishing is limited to the estuarine and immediate shore areas. Approximately 20% of Nigerian fishing canoes are equipped with outboard-engines, but the percentage of motorization is considerably higher in the coastal areas. An estimated 120 fishing and shrimping trawlers operate in the Niger Delta. In addition a small fleet of larger fishing trawlers operates in the EEZ between 30 and 200 nm from the coast.

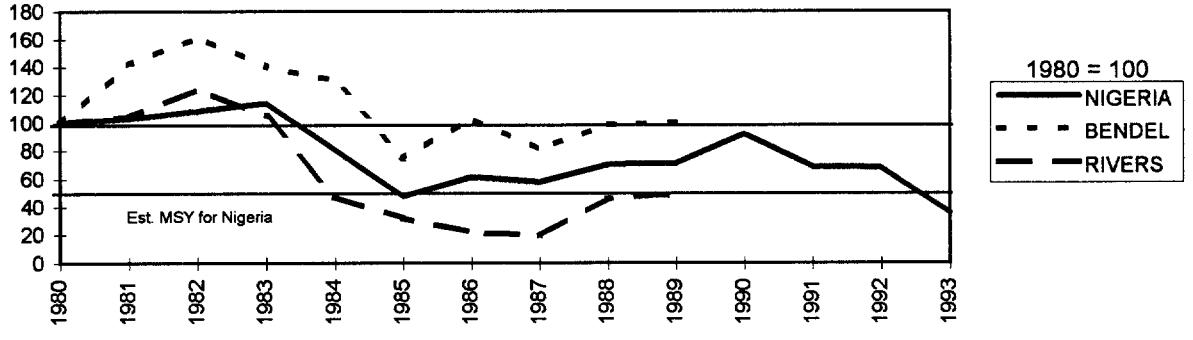
2.31 In Rivers and Delta States, women carry out most fish preservation and trading. It is estimated that over 75% of the fish landed is preserved by traditional smoking methods. The capacity for freezing of fish is very limited and the total storage capacity in Nigeria for frozen fish is reported to be 29,000 tons (November 1992, Government of Nigeria). However, in mid 1994, no large commercial freezing facilities or ice plants were reported to be operating in Port Harcourt. This situation leads to high post-harvest losses and limits fish marketing beyond the immediate landing areas, except for smoked fish.

2.32 **Exploitation and Conflicts with other Sectors**. According to the Director General of the Nigerian Institute for Oceanography and Marine Research (NIOMR), Dr. Tobor, there are

no signs of overfishing in Nigerian waters. However, fisheries experts in the universities and elsewhere believe that overexploitation is a significant problem which is affecting most types of fisheries in the country.[4] Expert consensus exists that the offshore and oceanic stocks of pelagic fishes are not well exploited, mainly because they are out of reach of the artisanal fishery.

2.33 The maximum sustainable yield for the fisheries of Nigeria has been estimated to be about 240,000 mt including coastal and brackish water fishery for finfish and prawns and some 30,000 mt of fish from offshore areas (Table A.4 - vol. II) (Tobor 1990). It should be emphasized that the MSY is difficult to estimate, particularly if catch, effort, and standing stock data are inadequate, which is the case in Nigeria. The official catch figures (Table A.5 - vol. II) have greatly exceeded the estimated MSY for at least 12 of the last 14 years. During several years in the beginning of the 1980s they were more that double the MSY. The catch data from the Federal Department of Fisheries show that the total catches have varied drastically during the period 1980 to 1993 (Federal Department of Fisheries 1993) (Figure 2.1).

FIGURE 2.1
INDEXED OFFICIAL CATCH FIGURES



2.34 The very drastic variations in the catch figures may indicate that the fish stocks are heavily over-exploited. This inference is supported by scientists reporting that certain fish stocks had declined, e.g., sardines, snappers, croakers, and mackerels, and that the average body length of some of the most important commercial fish species have decreased during the last decade. A major problem in riverine areas is overharvesting of juveniles (NDWC, 1995, 5).

2.35 Updated estimates for the fish catches of Rivers State are not available, but official figures from 1980 to 1989 range between 16,469 and 107,469 mt (Table A.5 - vol. II, Figure 2.1). No estimate of the MSY of the fishery in Rivers State is available. However, the very drastic variations in the catches in Rivers State from 86,000 to 107,000 mt in 1980 to 1982,

[4] Mr. Louis Abuah, Director of Fisheries, Asaba, Mrs. C. Iragurina, Ministry of Fisheries, Rivers State, Mr. P. Coates, Natural Conservation Foundation, Prof. Fubara, Dr. Bruce Powell, Rivers State University of Science and Technology, Prof. Austin B.M. Egborge, University of Benin.

decreasing to some 16,000 to 19,000 mt in 1986 to 1987 indicate that catches were well above the carrying capacity of the stocks for several years. The implications of continued fishing at the current levels are uncertain, but a general trend of decreasing catch volumes should be anticipated. A risk of total disappearance of the most valuable fish species also exists. Catch figures for Delta State (formerly Bendel State) are given in Table A.5 - vol. II: declines in catches and increased effort are not as significant as in Rivers State.

2.36 The number of licensed inshore trawlers and the catch per unit effort between 1980 and 1990 for all of Nigeria is shown in Table A.3 - vol. II. It is widely suspected that these figures are less than the actual catches due to more or less systematic errors in the reported figures (Otobo 1995). Nonetheless, the data do illustrate that while the total catch has not changed dramatically between 1984 and 1990, the growth in the fishing fleet has reduced the catch per effort by nearly 60%. An index of fishing effort based on the number of fisherpersons in Rivers and the former Bendel State also shows that catch per effort is declining. Catch per fisherperson fell annually from a high of 1.88 tons in 1983 for both states to 0.7 tons in Rivers State and 1.26 tons in Bendel State in 1989, the last year of available data (Table A.5 - vol. II) (Linddal, 1995, 19).

2.37 Trawling is carried out along the coast and in some of the estuaries. A legal no-trawling zone extends to 5 nm from the shore, however trawlers frequently fish in this zone causing conflicts between artisanal and industrial fishermen to flare up along the coasts of Rivers and Delta States. Damage is caused by the trawlers contributing to excessive fishing in the shallow areas, disturbing the benthic environment, and destroying the fishing gear used by artisanal fishermen. Recently some cases of illegal trawling have been brought to court in Rivers State. Other conflicts that affect the fishing sector are the activities of the oil production industry. In this case, oil spills occasionally taint fish and smear nets and other gear. Fishermen and riverine communities report mortality of fish and shellfish, as well as the destruction of important habitats for spawning and feeding, through, for example, increased turbidity caused by dredging, construction, drilling, and transport. Fishing with destructive fishing methods, including the use of undersized mesh in beach seines, traps, trawls, and gill nets, are also reported as a widespread problem, although no data are available. Several local communities in Rivers State have banned the use of seines with small mesh size.

2.38 **Impact of Habitat Degradation**. The damming of the Niger River has affected the hydrological cycles of the Niger Delta. This manipulation of the hydrological regime has greatly modified sediment transport and nutrient input into the sea, as well as increased salt water intrusion into the delta (see Flooding Section). As a result, fish and shellfish stocks of the coastal areas and particularly the freshwater swamp areas of the delta have been reduced. According to UNEP (1989) the reduction of the freshwater flow is accompanied by a reduction of the nutrient input to the coastal zone, which has led to a highly significant loss in local fish catches in the Niger Delta.

2.39 In the freshwater zone of the Niger Delta, the reduced floods, caused in part by upstream dams storing water during low rainfall years, have decreased the productivity of many ponds and lakes normally stocked by larvae of fish and shellfish during the flood seasons (Otobo 1995). When the floods fail, the next years catches are reduced. Fisherpersons praise

the floods of 1994, the largest in several decades, for the improved catches expected from the stocking of lakes and ponds with fingerlings (Linddal, 1995, 17). An EU study of Oguta Lake at the inland edge of the delta has found that zooplankton and fish have declined after flow reductions caused by upstream dams cut the lake off from Niger River inputs. This reduction has also occurred in marginal swamps which before Kainji dam was completed in 1969 acted as fish nurseries for reproduction and recruitment. The predominant zooplankton feeding fish have almost disappeared (Mass, Nwadiaro, and Dumont, 1992, 169). Research across the border in the Cameroon freshwater swamp forests has found that during the flooding season millions of fish breed on the forest floor. They have a substantial, but unquantified impact on the riverine and coastal fish stocks which constitute a US$5 million annual industry in the region (World Wildlife Fund, 1995). The productivity of such lakes is also affected by road construction and flood control measures which prevent large areas from being flooded, as well as by the use of agro-chemicals. In addition, during the last decade water hyacinth has become much more common in the delta. Their encroachment into many creeks, rivers, ponds and lakes has prevented fishing in these waters.

2.40 Aquatic vegetation, such as floating grass mats and seagrasses, are likely to be affected by the long term change in sediment transport (See the Flooding Section) caused by the construction of hydroelectric dams, canalization and construction in the rivers and estuaries. This may impact different species both negatively and positively. Dredging and movements by boats and vehicles during construction increase sediment loads . This will decrease sunlight reaching the bottom and thereby lower photosynthesis. Indirect effects could occur as a result of decreasing sediment loads from upstream dams reducing nutrient input. Increased canalization may change salinities and degrade drinking water quality. The salinity change may also have a number of ecological effects on the fauna and flora. However, little data or other information of direct relevance to this problem have been found. One effect may be the migration of new, unwanted species, such as water hyacinth, into the disturbed areas.

2.41 Habitats of particular importance for the coastal and estuarine fishery are the mangroves and seagrasses. Sewage and waste disposal, and the cutting of mangroves for fuel have destroyed or degraded mangroves to various degrees near most villages, towns, and cities. Damage has also occurred in the immediate surroundings of oil production sites. However, mangrove degradation is not widespread in the delta (see Oil Pollution and Forest Sections). Although in Rivers State the damage from larger oil spills may be significant, it appears that a very small proportion of the total mangrove area has been substantially affected.

2.42 Dynamiting and the use of poisons for fishing have been reported to be common in a few areas in the Niger Delta. However, this problem does not appear to be widespread. The high cost of pesticides, the most commonly used poison, has reduced the frequency of this destructive practice.

2.43 **Regulatory Framework and Institutions.**[5] The Sea Fisheries and Inland Fisheries Decrees, 1992, control access to fisheries resources. The Decrees include wide provisions for

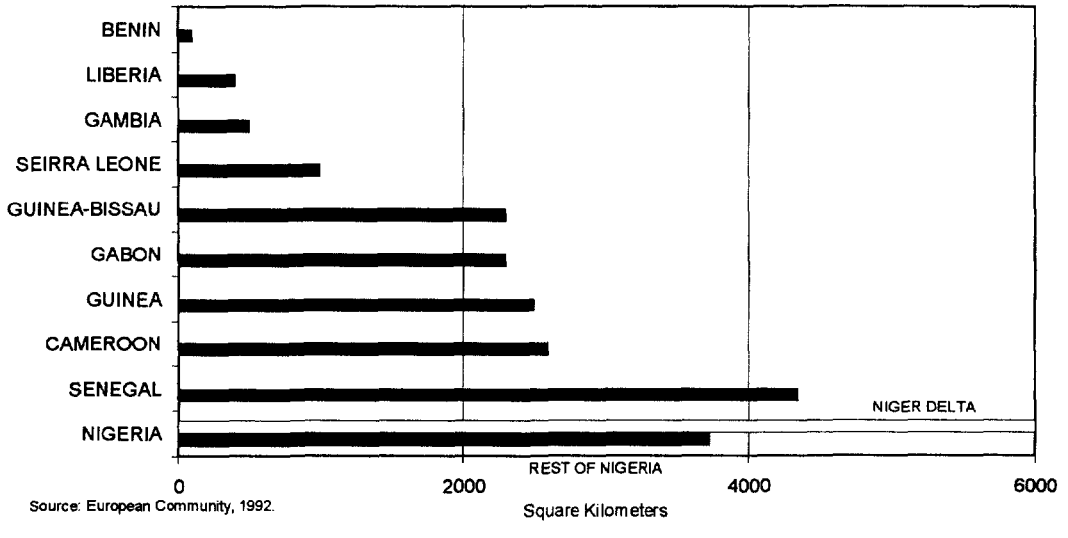
[5] See Annex K for additional information

the regulation of catch species, sizes, net sizes, and fishing zones (Annex J). If enforced, the regulations would provide the basis for efficient exploitation of this resource. Currently, few fishermen register their boats or adhere to fishing regulations. Similarly, international trawlers ignore Nigerian laws. The Inland Decree also requires that the construction of dams, weirs or other fixed barriers ensure the free movement of fish, but this regulation is not enforced. According to NIOMR, enforcement of the five mile artisanal fishing zone has been ineffective because the agencies charged with enforcement, the Federal Department of Fisheries, the Navy, and the Air Force, have not been able to coordinate their operations. While government enforement is completely ineffective, community enforcement of traditional regulations is still agressive in many areas. Neither State Fisheries Department conducts monitoring, enforcement, or data collection. The major constraints facing them are: (i) limited funding; (ii) negligible monitoring and enforcement capacity; (iii) few appropriately trained staff; and (iv) lack of fisheries information.

Forest Exploitation

2.44 **Sector Characteristics.**[6] The FAO estimates that activities in the Niger Delta are eliminating approximately 3.5% of the forest annually. If this rate of deforestation continues, the remaining forests of the region will be eliminated in less than 20 years.

FIGURE 2.2
MANGROVE DISTRIBUTION IN WEST AFRICA



Source: European Community, 1992.

2.45 **Mangroves**. Nigeria has the third largest mangrove forest in the world and the largest in Africa (9,730 km^2) (see Figure 2.2). The majority of it is found in the Niger Delta, estimated to cover between 5,400 km^2 and 6000 km^2 (SECAL in Sayer, Harcourt, and Collins, 1992, 231; Adegbehin and Nwaigbo, 13). According to the FAO 1979 land use survey of the

[6] See Annex C for additional information.

delta, 30% of Rivers State is composed of mangrove forests (5,891 km^2) (Table A.1 - vol. II). Defined by regular salt water inundation, the mangroves form a vegetative band 15 to 45 km wide parallel to the coast. Creeks, which are kept open by tidal action and flooding, flow throughout the forests (The Rivers Chiefs, 1992, 38).

2.46 **Freshwater Swamp Forests.** With the severe deforestation of other forest zones in Nigeria, freshwater swamp forests will soon become the most extensive forest zone in the country (World Conservation Monitoring Centre, 1993, 15). Large areas remain intact because of the high cost of extracting timber, developing plantations, and clearing land for agriculture. These forests cover one third of the land area of Rivers State and 11,700 km^2 of the entire delta (Forestry Department, Rivers State, 1994). The freshwater swamp forests are most extensive in the west and central delta. In the eastern delta, the freshwater forest band is much thinner because of the higher elevations. Seasonal flooding is the dominant ecological influence on the freshwater swamp forest. Flood waters collect in countless swamps and ponds, saturating the soil for at least the rainy season. Standing water evaporates during the dry season in most areas, but permanent swamp forests are common in many areas, such as behind the riverbank levees. The swamp forest zone can be divided into two general ecological groups: (i) riverbank levees which are rarely flooded and have been mostly converted to agriculture, but have the best conditions for tree growth, and (ii) the back swamps which can be inundated with water for most of the year.

2.47 **Lowland Rainforests.** As an ecological zone, the lowland rainforest region covers about 7,400 km^2 of the Niger Delta. Very little lowland rainforest remains and only a few of the forests left are significant in size or species diversity (e.g., proposed Lower Imo Forest Reserve, Ebubu forest, Ikwerre). No literature exists on the original forests (NDWC, 1995, 8). Most areas are in swidden agriculture systems that permit only oil palms and occasional mango trees to remain. As an example, Ogoniland used to be covered with a rainforest, but has been largely converted to degraded bush and farmland. The remaining forest stands in the lowland rainforests are contained in relic shrine forests, which may include only a few individual trees, or are managed by local communities along riverine areas (Hall, 1994, 22). Since the forests no longer exist as a viable ecological zone, but only as small stands and individual trees, they are not described here.

2.48 **Barrier Island Forests**. The smallest of the ecozones in the delta (1,140 km^2), the barrier island, or beach ridge island, forests are freshwater forests found between the coastal beaches and the estuarine mangroves. They typically contain a band of rainforest species growing on the inland side of the beach ridges and freshwater swamp forests created by the high freshwater table (Table 5 - vol. II). The forests are degraded in accessible areas, but large areas of high quality forest with high concentrations of biodiversity remain. For example, the Adoni area is still relatively intact. It has been proposed as a game reserve because of its remnant populations of elephants and sea hippopotami (Biodiversity section) (Hall, 1994, 27). Similarly, the forests around Sangana and in the Olague Forest Reserve along the western coast of Delta State are in good condition.

Picture 2.4
Collection of Mangrove Leaves as Fish Lures

Forest Utilization and Conversion: Non-Timber Forest Products[7]

2.49 **Mangroves.** The mangrove forests are the least disturbed of the forest zones, only an estimated 5-10% has been lost to urban growth, industrial development, and oil activities (Hall, 1994, 26). In addition to fishing which is the most important economic activity, traditional uses of the mangroves include cutting trees for drying racks, fish traps and cages, and fuelwood (Picture 2.4) (Table 8 - vol. II) (Ashton-Jones and Douglas, 1994, 1994, 80). Other important uses are for house and fence construction (Adegbehin and Nwaigbo, 1990, 17). The annual value of NTFPs in the mangroves is estimated at N6.8 million and the annual value of sustainable fishing in the mangroves is estimated at N15 million.[8]

2.50 Mangrove degradation is limited because communities prefer gathering dead wood than cutting live mangrove trees (Leh, 1994). Except near large settlements where most trees have already been removed, these are low intensity activities on a sustainable level. On a

[7] See Annex D for a discussion of the value of NTFPs

[8] With the total delta (2 million ha) supporting an annual fish production of 100,00 tons valued at N5 billion, the per hectare value is N2,500. The estimated value of mangrove production is N2,500*6000ha. The annual value of NTFPs from the mangroves is assumed to be less than the estimated N2,000/ha/yr for the freshwater swamp forest because of much smaller range of products. The estimate of N700 is based on the only study of the value of mangrove NFTPs available (US$33/ha/yr in Indonesia). The estimate annual value of NTFP production is N700*9730ha (adapted from Linddal, 1995).

national level, it is estimated that inhabitants extract 4 million m^3 of mangrove products annually (ESMAP). While no figures are available for the Niger Delta, mangrove utilization is not threatening the resource base or ecological functions. For the states as a whole, woodfuel demand is considerably lower than the estimated sustainable forest yield (see Table 2.2). A major reason keeping the mangroves from being overexploited may be the preference for using kerosene for cooking even in isolated villages (Ashton-Jones and Douglas, 1994, 1994, 166).

2.51 In addition to fuelwood, local communities collect a large variety of other non-timber forest products (NTFPs) such as food (crabs, shrimps), honey, medicine, dyes, thatching, and numerous other household products from the mangroves. Mangrove salt and periwinkles (*Cerithiacea potamidididae*) are both important income sources for local people (Powell, 94-5). Residents also catch monkeys and sitatuangas (NDWC, 1995, 9).

2.52 **Freshwater and Barrier Island Forests.** Forest utilization is second only to agriculture as the most significant economic activity in the freshwater swamp forest zone. Communities have converted virtually all of the riverbank levees to cultivated agriculture (common crops are listed in Table 6 - vol. II). In the beach ridge areas, forest products are a distant second to fishing. Flooding, which restricts land transportation and communication for long periods, increases reliance on the surrounding forests for products because larger markets are difficult to reach (The Rivers Chiefs, 1992, 68-9). As well as being used for the same purposes discussed for mangrove forests, timber trees from these two ecozones are fashioned into canoes and climbers are made into ropes and rattans. Inland and barrier island forests supply more NTFPs because of their higher floral and faunal diversity than mangrove forests. Unlike in the mangroves, collection is highly seasonal (NDWC, 1995, 9).The estimated annual use value of NTFPs in the freshwater zones is N2,000/ha, nearly 3 times the estimated value in the mangroves (Box 2.5).

Box 2.5
Value of Non-Timber Forest Products in the Niger Delta

Estimated minimum average value from the actual use of NTFPs: 2,000 N per ha/year.

This value is based on collection of five specific NTFPs (ogbono, giant snails, bushmeat, raffia products, and spices) and indirect estimates of the value of other household products and medicinal plants (Annex D). It is presumed to be a lower bound because: (i) the potential value of the forest when all available resources are harvested up to the sustainable level would probably be larger;[9] (ii) it is an average value while the use is concentrated around villages; and (iii) other uses of NTFPs may exist.

Source: Linddal, 1995.

2.53 Local communities exploit and cultivate tree crop species, such as raffia palm, oil palm, mango, ogbono (*Irvingia gabonensis*), citrus species, breadfruit, and kola nut (Ashton-Jones and Douglas, 1994, 82) (Table 6 - vol. II). These tree crop products are also important trading commodities. Depending on the season and location the following four NTFPs provide a majority of riverine incomes in the freshwater swamp forest zone: (1) raffia (gin and 'maggots'), (2) swamp cane (*Calamus*), (3) ogbono, and (4) land snails (*Archachatina* spp.) (Powell, 94-95). A similar group of NTFPs (including bushmeat) generate 51.1% of local income in communities in the Korup region of Cameroon adjacent to the Nigerian border (Ruitenbeek, 1990, 19). The importance of NTFPs is similarly high in villages around Cross River National Park (Infield in Drolet, 1991, 216).

Table 2.2: Fuelwood Demand And Supply Balance

REGION/STATE	TOTAL CONSUMPTION (million adt)	SUSTAINABLE YIELD (million adt)	SUPPLY/DEMAND BALANCE (million adt)
Bendel State	4.00	11.30	+7.30
Rivers State	2.50	5.60	+3.10
Southern Average	4.08	4.83	+0.71
National Average	3.25	2.94	-0.31

adt: air dried ton
Source: ESMAP, 1993.

2.54 A greater diversity and abundance of wildlife species is found inland and in the coastal islands than in the mangroves, which are limited to animals that can adapt to their semi-aquatic nature. As a result, bushmeat is a much more important resource of the freshwater and barrier island forests than the mangroves. For example, Isoko farmers in the Niger Delta obtain 36% of their animal protein from bushmeat and most of the rest from fish (Anadu,

[9] Assuming that only half of the area is used intensively for collection of NTFP the potential average value could be 4,000 N/ha.

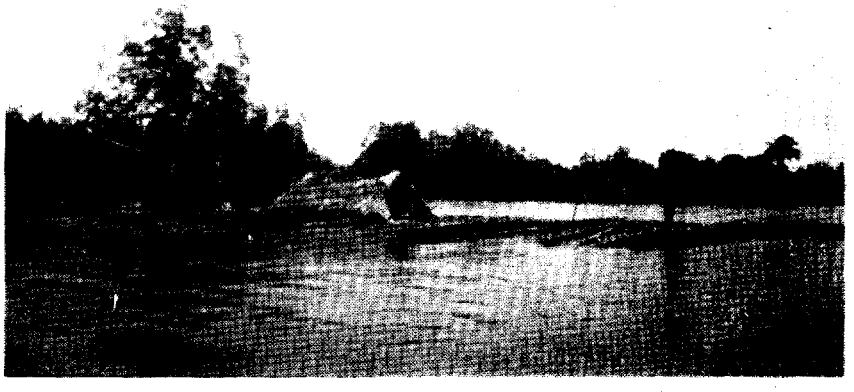
Elamah, and Oates, 1988, 201). Duikers, civets, monkeys, antelopes, turtles, dwarf crocodiles, grasscutters, giant rats, pangolins, squirrels, bush pigs, monitor lizards, water chevrotains, and guinea fowl and other birds are all commonly hunted for food or skins (Ashton-Jones and Douglas, 1994, 167; NDWC, 1995, 9). A species of bullfrog (*Dicroglossus occipitalis*) and tongueless frog (*Xenopus tropicalis*) are also harvested (Powell, 1993, 49). Grey parrots and snakes are hunted for sale as pets or for skins (Powell, 95). Fishing is relatively less important to inland than coastal communities, but it still provides significant income and nutrition.

Forest Utilization and Conversion: Timber Extraction

2.55 **Mangroves.** Timber information for all ecological zones is out of date and of poor quality, making volume and extraction estimates of limited value. Assessing the data and analytical framework of these estimates, Adegbehin and Nwaigbo calculate that Nigeria's mangroves would have a total standing volume of 30 million m^3 and an exploitable volume of 10 million m^3 (1990, 17). This would correspond to a total standing volume of 16.7 million $m.^3$ and exploitable volume of 5.5 million m^3 for the delta. Except for traditional uses, mangrove species are not currently utilized in Nigeria, though they are heavily consumed in Asian countries for chipwood, lumber, poles, and pulp (Synge, 1989, 216). As the country's other wood resources become scarce, commercial exploitation of mangrove resources may increase. Based on a review of mangrove management systems in Asia, it is estimated that sustainable timber management would have an annual value of N1,100 per ha (US$50) depending on the management program (Linddal, 1995, 38).

2.56 **Freshwater Swamp and Barrier Island Forests.** While high value commercial timber species are largely absent from the mangroves, they are well represented in the freshwater and barrier island ecozone (Table 5 - vol. II). The annual value of wood products is estimated to be N500 million, with a per hectare value of N400 (Annex D). A feasibility study of timber resources in the Niger Delta calculated that the standing timber volume of the 18,000 km^2 freshwater swamp forest zone of Nigeria was 32.3 million m^3 in 1980 (Skoup and Co. Ltd., 1980). Following this estimate, the standing volume of the Niger Delta freshwater forests (11,700 km^2) would be 20.8 million m^3, which considering the high levels of exploitation and conversion to agriculture, is probably significantly overestimated.

Picture 2.5
Log Raft Heading Towards the Coast



2.57 Over-harvesting is one of the most critical resource problems of the freshwater swamp forest zone (Powell, 1994, 93; Osemeobo, 1987, 32). It is of less concern for the barrier island forests because of the greater difficulty in extracting the logs from the forests. Though local communities do sell timber for processing, most logging is conducted by contractors who are legally required to pay local communities and the state for felling, but often do not. Chiefs from Ogbojolo, near the Upper Orashi Forest Reserve, stated that outsiders come in, often without permits, to cut *Khaya* spp. (mahogany) and *Mitragyna ciliata* (abura) and do not pay the villagers for the trees (Osundu, 1994). The trees are cut in the dry season and floated out along hand dug ditches in the wet season (Ashton-Jones and Douglas, 1994, 172). The timber operators raft the logs to mills in Delta and Lagos States (Picture 2.5). By rafting the logs, they circumvent the forestry station on the road to Port Harcourt set up to assess timber removal, causing cutting rates to be underestimated and reducing Forestry Department revenue (Powell, 1994). No private sector companies practice forest regeneration in Delta State, and the situation is probably similar in Rivers State (Delta State Forestry Department, 11).

2.58 Historically, timber extraction has been highly selective in the freshwater forests because of the relatively high cost of extraction in the back swamps. The best timber trees have been removed near populated areas and the levees generally have been logged over. The conclusion of the Skoup Forestry Consultants that "the only successful control to exploitation

is not the enforcement of the...Forestry Laws and Regulations..., but that imposed by the very poor and adverse access, which restricts felling and logging to only the favorable season of the year" is still true (1980, 7). As other timber sources in southern Nigeria have been progressively exhausted, the incentives for intensive logging throughout the zone have increased. Exploitation of remote backswamps did not begin until the 1960s when small contractors and local communities began removing the most valuable species. Only since the mid-1980s have commercial loggers begun harvesting in the Taylor Creek Forest Reserve (Werre, 1991, 16). Being more densely populated, logging and agriculture have been most intensive in the forests east of the Niger, with some areas having lost their forests decades ago (Marchant in Oates et al., 484). Consequently, timber contractors have shifted their attention to the western forests of Rivers State. The paucity of good quality timber near traditional logging areas is shown by the fact that the average distance to Delta State sawmills from the log sources has jumped from 30 km in 1990 to 70 km in 1992 (Delta State Forestry Department, 1993, 3). Within Rivers State, the area around the Upper Orashi Forest Reserve south to Okoruba and some beach ridge forests are the most heavily logged (Leh, 1994). If intensive logging continues to increase in the west, its forests will be soon be equally denuded of commercial species as the eastern forests.

Forest Utilization and Conversion: Wood Processing

2.59 Wood processing is not a significant economic activity in Rivers State, but remains important to Delta State. The forestry subsector in Delta State employs 110,000 people and produced N170 million in 1992 (Table 7 - vol. II). Seventy-nine sawmills with a total capacity of 270,000 m^3, as well as two plymills (133,000 m^3) and a particle board mill (21,000 m^3) operate in Delta State. Transmission poles and boat building are also important. Capacity utilization is at 59% for the sawmill industry. The Delta State Forestry Department estimates that old equipment, power shortages, and poor operating practices result in inefficient processing with 60% of each log wasted (1994, 24).

2.60 **Regulatory Framework and Institutions.**[10] Within the delta, the state governments control the forests under reservation and the rights to timber trees outside of reserves (see Annex J for a detailed discussion of the regulatory and institutional situation). The legal status of existing reserves needs to be reviewed and strengthened, especially after Risonpalm's attempt to expand into the Upper Orashi Forest Reserve. The Forestry Departments collect tariffs from logged timber. While the Forestry Department in Rivers State is not able to effectively enforce tariffs, the Delta State Forestry Department claims that about 70 percent of the logging is paid for according to the tariff. The tariff in Delta State is 150 N/tree, and an additional 20 percent (30 N) is paid as royalty to the community for a total revenue of N3 million annually. The tariffs are not in proportion with the stumpage value of a tree. As a result, the tariff gives no incentive to reduce logging, although all kinds of creativity are used for evading it. At the beginning of 1995, Osun State revoked all timber licenses and has begun to take action against illegal logging. Though laudable, this action may increase logging pressure on Niger Delta forests (NDWC, 1995, 9). The major constraints facing the Forestry

[10] See Annex K for additional information

Departments are: (i) weak monitoring and enforcement capacity; (ii) limited funding; (iii) lack of personnel skilled in forest management and conservation; and (iv) lack of forest resource information.

Conversion to Agriculture

2.61 **Mangroves and Lowland Rainforests.** Agriculture has not been significantly developed in the mangrove forest zone. The high salinity levels and acid sulfate organic soils are unsuited to most crops. In lower salinity areas, rice cultivation is expanding. At the other extreme, clearing for agriculture has eliminated most of the forests of the lowland rainforest region. Typical of the lowland rainforest situation, the Ogoniland plain has been almost completely converted to agriculture. Even the few remaining forest shrines are being degraded or removed to make room for crops, primarily cassava, which can tolerate the degraded soil conditions (Ashton-Jones and Douglas, 1994, 18).

2.62 **Freshwater Swamp and Barrier Island Forests.** Conversion to agriculture has been extensive in the freshwater swamp forest zone. Most of the levees are covered with farms right to the riverside. Population pressure has played a major role in the conversion of most of the forests occupying relatively high land to agriculture. Unless trees have direct economic value, they are rarely encountered on the levees of the freshwater forest or in the lowland rainforest ecozones: cultivable land is too scarce a commodity to be left under natural forest. While fallow periods on the levees may have fallen because of farming pressure, the small area suitable for crops and habitation has always kept fallow periods short. The back swamps have been spared because of the high cost of preparing the land for crops. However, the expansion of rice cultivation along the floodplains of the backwater swamps is beginning to disrupt their isolation (Ashton-Jones and Douglas, 1994, 30). Water pollution from fertilizers or pesticides is not anticipated to be a problem except near plantations because of low rates of application. The Federal Government's allocation of fertilizer to Delta State has averaged only 18,000 tons (Oyo, 1994). A study of chlorinated hydrocarbons in Nigerian coastal waters (including the western delta) found levels of pesticides in fish to be far below permissible levels in developed countries and significantly lower than in the coastal zones of other countries (Osibanjo and Bamgbose, n.d.). With the high cost of fertilizer and dwindling government input subsidies, agricultural intensification has declined, but expansion is continuing.

Plantations and Large Scale Agricultural Development

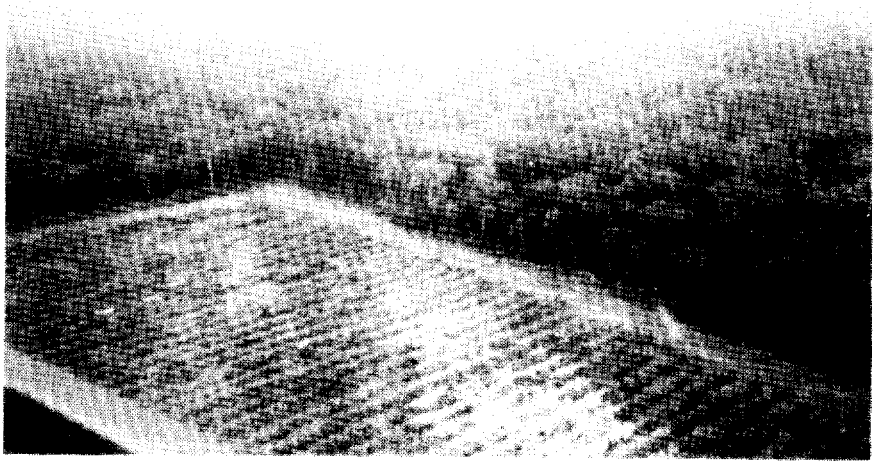
2.63 Risonpalm is one of the largest developers in Rivers State. It has converted over 23,000 ha of forest and small holder farmland into oil palm monocultures. If its full project portfolio is completed, 36,500 ha, or over 2% of the state will be planted in oil palms. Delta State has a similar oil palm plantation program covering 7,000 ha, with proposals for another 20,000 ha, but no expansion is on-going (Ministry of Agriculture, Delta State, 1994b, 1994). If completed as envisioned, which is now unlikely, Risonpalm's activities are expected to permanently alter 78,000 ha either by directly clearing land or by changing the hydrological

regime (Guardian, 1994e, 3). Major plantations are distributed in four locations in the state: Yenagoa, Elele, Ubima, and Bori (see Table 10 - vol. II).

2.64 The primary environmental impact of the projects is the destruction of large areas of forest. Although project locations are mostly secondary and bush-fallow forests, project managers do not discriminate between forest quality and have slated forest reserves and other primary forests for development. Environmental assessments are not conducted.

2.65 Oil palms are a promising development option for upland areas, but not within the wetlands of the delta. There is no clear economic justification for establishing oil palm plantations in the lowlands. A comparative assessment of the economics of oil palm plantations shows upland plantations produce a NPV of 20,000 - 30,000 N per hectare higher than lowland plantations (Annex E). The value of the palm fruit harvest from wild palms in the lowlands can be substantial (2,500 - 5,000 N per ha/year) , almost equal to the value of lowland oil palm plantations without considering the value of the myriad of other uses of forests that are not available in plantations (Linddal, 1995, 9).

Picture 2.6
New Section of the Yenagoa Oil Palm Plantation



2.66 The current focus for Risonpalm is the development of the lowland Yenagoa plantation. The original proposal called for clearing the fully gazetted Upper Orashi Forest

Reserve (9,696 ha) which is one of the most biologically important sites in the delta (Biodiversity section). It would also have disturbed water flow into the Lower Orashi Forest Reserve, located downstream of the project. Outside of the reserve, the project is clearing timber species and valuable tree crops, such as natural oil palms, mangoes, and Ogbono, which are harvested by farmers (Picture 2.6). Managers scaled down the project after community protests caused the European Union to reduce its funding.

2.67 The Niger Delta Basin Development Authority (NDBDA) is the major large scale crop development agency in the delta, concentrating on irrigated rice projects (Annex E). The Authority's plans for new irrigation projects appear to be on a much larger scale than its budget permits (Table 11 - vol. II). Although the Peremabri rice scheme has slowly been implemented, its other projects are at pilot or feasibility stages. In the past the agency ran the irrigated farms, but now restricts its involvement to developing the project and providing services to farmers.

Infrastructure

2.68 Canal and roads are critical for improved transportation and communication in many isolated communities in the Niger Delta. However, their construction has precipitated some of the most extensive environmental degradation in the region. The greatest environmental concerns are not the canals and roads per se, but farmers who establish new plots in the natural forests and loggers who gain better access to the forests. Canals cause more severe logging damage than roads because water transport of logs is more efficient than road transport. As well as agricultural and logging expansion, forest ecosystems are degraded by professional hunters and to a lesser extent by farmers hunting to supplement their diet and income.

2.69 Requiring extensive transportation networks, the oil companies, as well as the government agencies, have greatly contributed to agricultural encroachment by building hundreds of kilometers of roads throughout the freshwater swamp forest zone. Since road construction is one of OMPADEC's primary concerns, its road program is expanding rapidly throughout the region - it is planning to complete a major network for the state within three years (OMPADEC, 11).

2.70 Improved transportation and selective road construction is undoubtedly required for development in the delta, but must recognize ecological differences and minimize its environmental impact. Presently, transportation planning in the delta is haphazard, lacking systematic assessments of community transportation and communication requirements, as well as environmental impact assessments. Funding is a severe constraint for the construction of adequate roads. The Delta State Ministry of Works does not have sufficient funding to complete any of its road projects, usually abandoning them after 3-4 months. Lack of EIAs and funding limit the quality of road construction and damage ecosystems. In the long term, construction of adequate roads would be less expensive than chronically rebuilding poor roads. Current examples of environmental degradation include oil company and OMPADEC roads that block streams and floodplains creating stagnant ponds of water, killing forests, and

flooding fields. For instance, the Shell road leading to its Gbaran field near Yenagoa has created a swamp on one side of the road and dried out the other side, causing dramatic vegetation changes. The linkages between poorly planned infrastructure projects and reduced incomes tied to environmental problems and open access regimes are common in the delta.

2.71 Canal projects are also widespread in the delta, especially in the mangrove forests. Designed to improve transportation between settlements or gain access to oil installations, the canals can have substantial effects on water flow patterns and ecosystems. As with roads, hunters and timber contractors follow the canals into new areas. Canalization has been extensive; between 1980 and 1988, government agencies dredged 100 km in just Rivers State (Awosika, Ojo, and Ajayi, n.d.,70). Recently, however, government canal projects have virtually ceased because of high dredging costs. Government institutions and oil companies have not conducted environmental impact assessments of their canal projects, except for occasional drill slot EIAs (van Dessel and Omuku, 1994, 442). Since slot and canal creation does not adequately consider the impact on local communities and ecosystems, environmental degradation and linked social problems are common. The problems of canal and slot construction include: (i) destroyed fishing grounds and enclosures; (ii) changed salinity leading to forest dieback; (iii) changed water flow patterns, disrupting erosion and sediment deposition; (iv) temporarily increased turbidity and decreased dissolved oxygen from dredging organic soils may reduce fish biomass; (v) dredge spoils eroding during rains, increasing turbidity and potentially, acidity; (vi) temporarily increased biochemical oxygen demand (BOD) from dredged material and houseboat sewage; (vii) reduced farm yields because of dredge spoil run-off acidifying fields[11]; (viii) reduced farm yields because of water logging of fields; (ix) destroyed mangroves and freshwater forests, including valuable timber and tree crop species.

2.72 Long term problems from the changed hydrological regimes are beginning to emerge. For example, the Apoi-Gbanraun canal flooded Gbanraun town, disrupting fishing and the sediment/erosion balance downstream (Powell, 1994, 92). After an oil company constructed a slot to a well near Okoroba in the freshwater swamp forest zone, mangroves began encroaching on the freshwater swamp forests along the canal edge, perhaps because of salinity changes. By leaving dredge spoil on and near farms, the oil company directly reduced the land available for cultivation and changed drainage patterns which water logged additional plots. Fishing enclosures in the path of the dredgers were also destroyed.

2.73 As well as the road network which is largely restricted to the freshwater swamp zone, the operations of the oil companies have destroyed substantial areas of mangroves. For example, since it began operations 30 years ago, Shell Petroleum has removed about 1% of the mangrove forests in Rivers State, and probably a similar percentage of Delta State's mangroves (Table 2.3). Mangrove clearing is especially problematic because of the very slow regeneration rates. Seismic lines only a few meters wide that were cut over a decade ago are still visible by air. In addition to the cleared mangroves, a large number of mature *Rhizophora*

[11] Dredging of acid sulphate soils which are common in the delta results in the sulfides being oxidized creating highly acidic areas along the canal banks which plants are unable to colonize for many years.

spp. trees near flow stations are dead, possibly from oil clogging roots and suffocating the trees. Pipelines, flowlines, and, to a lesser extent, seismic lines fragment forests and open them up for better access for hunters, but unlike roads, do not attract farmers in their wake. The clearance required for some of the lines can be very large: a 6 inch flowline requires that a swath of forest 5 m wide be cut down (van Dessel, 1994). Drilling operations require the construction of slots and in some cases wider transportation canals. Dredge spoils of acid sulfate soil, because of its high acidity when dry, can decrease farm yields and severely disrupt natural regeneration of forest edges. For example, many freshwater tree species and mangroves will not grow in the extremely acidic conditions (down to pH 2) (van Dessel and Omuku, 1994, 439).

Table 2.3: Mangrove Conversion in Rivers State by Shell Petroleum[12]

Seismic Operations	56,400 km of seismic lines	56.4 km^2
Drilling	349 drilling sites	4.5 km^2
Production	700 km of flowlines, 400 km of pipelines, 22 flowstations, 1 terminal	10.5 km^2
Total	1% of Mangroves in Rivers State	71.4 km^2

Source: van Dessel and Omuku, 1994.

Forest Reservation and Conservation

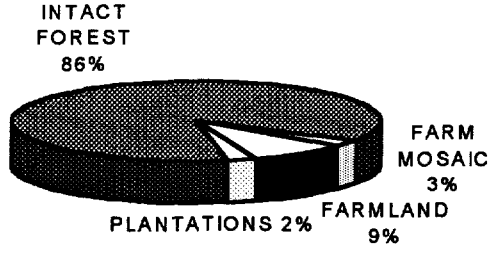
2.74 Gazetted and proposed forest reserves amount to 132,949 ha in Rivers State and 87,676 ha in Delta State, encompassing 7.7% and 4.5% of each state, respectively. However, as Table A.8 - vol. II illustrates, most of the reserves have only been surveyed or proposed and are not yet constituted. Reservation is no guarantee of protection. Reserves are under threat from agricultural encroachment, loggers, and plantations. For example, only concerted community and NGO pressure halted Risonpalm's expansion into the Upper Orashi Forest Reserve. Concessions are awarded for selective logging in the reserves, but logging practices are not monitored. In Rivers State, farms and plantations have already taken over at least 11% of total reserve area, but in specific cases the percentage can be much higher (Figure 2.3 and Table A.8 - vol. II). For instance, the reserves located in the lowland rainforests west of the Niger River are mostly composed of farmland and exotic species plantations (Oates et al.,

[12] This table estimates the area of mangroves cut for oil activities by Shell Petroleum since Shell began operations in the delta in the late 1960s. The total is approximately 1% of the total mangrove area in Rivers State. It does not include: (1) canal construction and canal widening, (2) road building, (3) indirect impacts of changed hydrology, (4) areas covered with dredge spoils; (5) activities in Delta State (Shell's western region); and (6) most importantly, activities of other oil companies, primarily Agip and Elf.

1992, 484). In both states, reservation of mangroves is underrepresented compared with other forest types. For example, while mangroves make up 30% of Rivers State, only 1.6% are reserved. Delta State has proposed reservations covering 4% of its total mangrove forests, but has yet to gazette any areas (Forestry Department, Delta State, 1994; FAO in nare, 60; foriii). However, as the previous sections describe, the mangroves are not yet under substantial development pressure. Of much greater concern is the barrier island ecozone because of population pressure, the smaller area, and the high species diversity. Currently, neither state has gazetted reserves in the island zone. The Rivers State Forestry Department has proposed that 12,400 ha in Adoniland be gazetted as a game reserve, but lacks funding for implementation (Forestry Department, Rivers State, 1994). In the Delta State coastal forest zone, the Olague Forest Reserve is slated to be gazetted in 1995.

Figure 2.3

LAND USE WITHIN RIVERS STATE
FOREST RESERVES



SOURCE: RIVERS STATE FORESTRY DEPARTMENT

2.75 In addition to reserves, an unknown number of communities have forest shrines, sacred forests, or protected areas. Some shrines provide adequate protection to forest resources, but they have not been surveyed or documented (Hall, 1994). In one case, the people of Sangana, who inhabit a beach ridge island near Brass, allow outsiders to fell trees for timber in one of their forests, but reserve the other forest for village hunting and cut down trees only when they are needed for canoes.

Biodiversity and Exotic Species

2.76 **Biodiversity Characteristics**. Biodiversity can be assessed from genetic, taxonomic, or ecosystem perspectives. This report emphasizes the latter two measures because all of the available information falls into those categories and they are sufficient for developing initial biodiversity priorities in the delta. Taxonomic diversity commonly refers to diversity at the species or higher taxonomic level: the variety of life forms existing in an area. The number of endemic species within an area is another critical parameter for determining taxonomic diversity. Ecosystem diversity is the number of habitats or ecological systems within a given

geographic area. In situ conservation of biodiversity requires determining the most important ecosystems and protecting them.

2.77 Being the most extensive and complex lowland forest/aquatic ecosystem in West Africa, the biological diversity of the Niger Delta is of regional and global importance. In its assessment of the coastal regions of eleven West African countries, IUCN ranked the Niger Delta as one of the highest conservation priorities in the region and noted that it was virtually unprotected (IUCN, 1992, 95, 100). The World Bank report, Africa: A Framework for Integrated Coastal Zone Management, also emphasizes the importance of the delta as habitat for a great variety of coastal and estuarine fauna and flora which lacks any marine or coastal protected area (1995). Conservation significance is enhanced because the area is a center of endemism for Africa (Grubb, 1990) and located in the overlap between the upper and lower guinea forest regions. The area has a unique and highly diverse flora and fauna. The Niger Delta and Cross River State region contains 60-80% of all Nigerian plant and animal species (Ashton-Jones and Douglas, 1994, 29). Nigeria has 205 endemic species, the largest number of which are found in the southeast - including the Niger Delta (Brenan in Sayer, Harcourt, and Collins, 1992, 235). The delta is also an important habitat for trans-hemispheric migratory bird species. The region has a richer freshwater fish fauna than any coastal system from Gabon to Senegal (NDWC, 1995, 15). The full significance of the delta's biodiversity remains unknown because new ecological zones and species continue to be uncovered and major groups, such as higher plants and birds, remain unstudied in large areas.

2.78 Within the delta, biological diversity is concentrated in the freshwater and barrier island ecological zones. The extreme hydrological conditions of the mangrove forests limit their biological richness. While the lowland rainforests were historically the most biologically diverse of the delta ecozones, severe deforestation has greatly reduced both the number of species and the variety of ecosystems. However, small areas of intact rainforest still contain important populations of rare and endangered species. The Niger River acts as an important barrier to species movement, such that many species are found only on one side of the river. For mammalian fauna, 33 of the 97 species found in the region only inhabit one side of the river (Happold, 1987, 248). Conservation programs will have to consider this large scale spatial factor in designing protected areas.

Plant Diversity

2.79 Conservation and biodiversity assessments in the Niger Delta have generally overlooked floristic diversity. The delta region is cited as one of the most poorly collected areas of West Africa for plant specimens. However, the data available depicts high endemism compared with most of West Africa (Campbell and Hammond, 1989, 193). No estimates of the total number of plant species or endemics in the region have been made.

Vertebrate Diversity

2.80 Since the barrier island and freshwater forests, as well as some rainforest fragments, have high floristic diversity, animal diversity is also concentrated in those areas. Many animals which are rare or extinct in the rest of the country are still relatively common in the Niger Delta. These include the olive colobus, Nile monitor lizard (*Varanus niliticus*), spotted-necked otter (*Lutra maculicollis*), clawless otter (*Aonyx capensis*) brush-tailed porcupine (*Atherurus africamus*), manatee (*Trichechus senegalensis*), and dwarf crocodile (*Osteolaemus tetraspis*) (Powell, 89; Sayer, Harcourt, and Collins, 1992, 235). Table A.9 - vol. II lists land vertebrates of global and regional concern, which are known or reported from the Niger Delta area. Some the species were not known to occur in Nigeria or east of the Cross River until very recently (e.g., delta red colobus, crested genet, long-nosed mongoose, and black-fronted and ogilby's duikers) (NDWC, 1995, 16). It is anticipated that more discoveries will be made.

2.81 The status of many large species which were once common in the delta, but are now endangered is not known precisely. What is known is that all of them have fallen from being widely distributed in viable populations to becoming classified as vulnerable, threatened, or endangered. Very limited funding for conservation studies means that most current information is anecdotal. For example, little information is available on the surviving populations of pygmy hippopotamus (*Choeropsis liberiensis*), manatees (*Trichechus senegalensis*), and maritime hippopotamus (*Hippopotamus amphibius*). While the pygmy hippo is listed as extinct in the 1994 IUCN Red List of Threatened Animals, communities near the Upper Orashi Forest Reserve report seeing them (Powell, 1993). Leopards are now rare because of hunting for pelts (Sayer, Harcourt, and Collins, 1992, 235). All species of crocodiles (slender-nosed (*Crocodylus cataphractus*), Nile (*C. niloticus*), and dwarf (*Osteolaemus tetraspis*)) are poorly studied, but survival in many areas is known to be precarious. The only Nigerian forest antelope on the 1994 IUCN Red List, Ogilby's Duiker is found in some of the remaining lowland rainforests (NDWC, 1995, 8). Two endemic subspecies of antelope, the Nigerian variety of Bates' dwarf antelope (*Neptragus batesi*) and the black-fronted duiker, are only found in the Niger Delta (NDWC, 1995, 16).

2.82 **Primate Species.** Primates are well represented in the Niger Delta. They also are particularly threatened (as Table A.9 - vol. II illustrates). The only mammal species known to be endemic to Nigeria, Sclater's guenon (*Cercopithecus sclateri*) lives only in the delta and Cross River ecosystems (Happold, 1987, 291; Oates et al., 1992). Sclater's guenon is one of the most poorly studied and most threatened of all African primates; the IUCN/SSC Primate Specialist Group ranks it as highly endangered (Oates et al., 1992, 478). Specimens of the extremely rare Benin genet (*Genetta bini*), which is believed to be endemic to Nigeria, have been collected in the Delta, but the findings need to be confirmed with additional research (Powell, 1993, 26). In addition, more than half of the primate species of conservation concern, including numerous species classified as endangered or threatened, inhabit the region. For example, olive colobus (*Procolobus verus*), red-capped mangabeys (*Cercocebus torquatus*), chimpanzees (*Pan troglodytes*), and white-throated or red-bellied guenons (*Cercopithecus erythrogaster*) are found in the delta (iv, 39; Powell, 88). Once thought to be endemic to the Niger Delta, white-throated guenons have been found in Benin and may live in Togo (Oates,

1994). The olive colobus populations are far from the main geographic range of the species (Sierra Leone to Ghana) and are separated from other populations by about 1000 km (Happold, 1987, 99). Researchers have recently discovered what is probably a new subspecies of the endangered red colobus *(Procolobus badius)*. Many local primate populations have gone extinct or are severely threatened by deforestation and hunting. Within the lowland rainforest, forest monkeys are now only common near communities that view them as sacred and protect the populations (Oates et al., 1992, 484).

2.83 **Fish Species.** The delta has more freshwater fish species (197) than any other coastal system in West Africa (Powell, 1993, 7). Only the eastern half of the Niger Delta has been moderately well studied. Sixteen fish species are endemic to the region and another 29 are near endemics which range further along the coast (NDWC, 1995, 18). Of the 12 new species discovered in Nigeria since 1980, scientists have found 10 of them in the Niger Delta (Powell, 1993, 63). Two groups of freshwater species are locally endangered. The freshwater catfish (probably *Arius gigas*) has disappeared from much of its range - Volta to Niger systems - and is no longer common in the delta. The coastal species, *Arius parkii* and *A. latiscutatus* may also be declining rapidly. Several lake fishes are also disappearing from many lakes: the python-bichir (*Polypterus endlicheri*), the tigerfish (*Hydrocynus brevis*) and the moonfishes (*Citharidium ansorgii* and *C. latus*). Among fish collectors, the delta is world famous for its variety of dwarf cichlids and killifishes (*Fundulopanchax* spp). At least four endemic species of killifishes are present and the delta may be a center of speciation (Powell, 1993, 59-60).

2.84 **Bird Species.** Even though no systematic bird censusing has been conducted anywhere in the Niger Delta (Powell, 1994), over 330 different bird species have been identified (Global Environment Facility, 1992, 1). Some vulnerable species which are rare over much of their ranges remain abundant in the delta, such as the Hammerkop (*Scopus umbretta*) and African grey parrots (*Psittacus erithacus*) (Ashton-Jones and Douglas, 234; Sayer, Harcourt, and Collins, 1992, 232). The threatened and endemic Anambra waxbill (*Estrilda poliopareia*) occurs in the Niger Delta. Pelicans formerly migrated to several coastal islands, but are no longer found in the region (Powell, 1993, 45). The importance of the region for migratory songbirds and waterfowl has not been comprehensively studied, but it is believed to be regionally and globally significant (Global Environment Facility, 1992, 1).

Major Threats to Biodiversity

2.85 The two principal threats to biodiversity are habitat destruction and hunting. Both factors are directly tied to road and canal construction increasing the access of farmers, loggers, and hunters to the forests. Population pressure and agricultural land degradation also exacerbate biodiversity losses as they induce people to extensify agricultural production and emphasize non-farming activities, particularly hunting. For instance, while population growth is not estimated to be high in the Taylor Creek area, the lack of economic opportunities in Port Harcourt has caused an urban-rural migration back into the area that began in the mid 1980s. Many of the migrants have never farmed and find hunting, fishing, and logging more lucrative (Werre, 1992, 16). Incomplete markets are also an indirect cause of biodiversity declines because communities cannot capture the national and international benefits of

biodiversity conservation, so they do not protect biodiversity resources at higher, socially optimal levels.

2.86 Habitat destruction and fragmentation from agricultural encroachment, roads, and logging modify ecosystems in a variety of ways which increase the probability of local extinction. While logging traditionally was less significant than agricultural expansion because it involved small-scale highgrading operations, it is now probably a major threat to intact forests. The rate and extent of logging seems to be increasing rapidly as other sources of timber in southern Nigeria are exhausted. Huge rafts of *Mitragyna* and other species are commonly seen being floated to Lagos. Recent ecology work suggests that logging is removing a substantial part of the food supply of highly valued delta mammals, such as the red colobus monkey (Oates, 1994).

2.87 Hunting for meat and skins remains an important source of income for many rural households. It is unregulated, operating under an open access regime that has depleted wildlife in the region. Exceptions include communities which continue to be able to protect sacred species or enforce traditional hunting rules (closed seasons, harvesting schedules, permissible gear, and restrictions for outsiders) in the face of mounting external threats. However, sacred restrictions usually cover only a single species. The Ogbogolo community, for example, does not shoot pygmy hippos because of the species' spiritual value, but kills 3-6 manatees annually (Osundu, 1994). The Biseni have strong regulations which are frequently updated (NDWC, 1995, 13). Community protection of monitor lizards is breaking down in at least two areas, Odi and Odoni. Crocodile protection is also eroding as communities subject to taboos sell the live animals to Hausa traders to kill. Throughout the region, hunting is most constrained by the cost and availability of guns and ammunition. Biodiversity is also degraded by the trade in endangered species. Traders commonly buy crocodile, snake, and cat skins. Hunters capture and sell grey parrots, which are classified as vulnerable to extinction for Nigeria, but are locally common (Powell, 1993, 95). Within the central axis of the Niger Delta, protection from hunting is most required for elephants (*Loxodonta africana*), pigmy hippos, chimpanzees, pangolins (*Manis* spp.), water chevrotains (*Hyemoschus aquaticus*), and two unidentified bovids. The species most commonly sold are cane-rats, monitor lizards, Maxwell's duikers (*Cephalophus maxwellii*), dwarf crocodiles, monkeys (primarily white-throated and putty-nosed guenons (*Cercropithecus* spp.)), and pigs; many of these species are threatened or endangered (Powell, 1993, 95).

Concentrations and Protection of Biodiversity

2.88 The Federal Government has recently established a national park network covering many natural ecosystems. However the park system fails to include any coastal areas. Considering the severity of anthropogenic disturbance and the rich biological diversity of the coastal zone, especially the Niger Delta, this exclusion significantly reduces the conservation value and ecosystem representation of the national park system. At the state level, a large number of forest and game reserves have been constituted or proposed in both states. However, as made clear in the forest reservation section, state reservation does not equal

protection on the ground: roads, canals, oil developments, hunting, and farming threaten all reserves to varying degrees.

2.89 The central axis of the Niger Delta (Yenagoa, Sagbama, Ekeremor, and Southern Ijo LGAs) contains significant populations of endangered animals and is thought to be the most biologically important large sector of the delta (Powell, 1993, 87-92). The central delta may be a biogeographic island with high forest populations not found anywhere else in Nigeria. It includes extensive intact freshwater, mangrove, and barrier island ecosystems. Although Happold's *Mammals of Nigeria* and the IUCN Elephant Specialist Group Databank state that elephants are no longer present, two or three herds have been observed. Manatees inhabit the tidal zone of the freshwater system. Hippopotamuses live in the barrier island areas, particularly around Kula and on Bonny Island, but are also highly threatened. Preference for a coastal habitat is highly unusual for hippos and increases the importance of protecting the remaining populations. The newly discovered form of the endangered red colobus monkey was recently found in the area.

2.90 It must be stressed that specific foci of biodiversity have been substantially determined by interviews with hunters and short wildlife surveys in areas that are suspected of high diversity. Systematic surveys are rare because of funding constraints. Consequently, more areas of high biodiversity may exist and the known areas with elevated biodiversity discussed below probably hold more vulnerable species than have been recorded to date. The most recent manatee survey in Nigeria was conducted in 1938 and the latest amphibian studies date from the turn of the century (Powell, 1993, 28, 49). A glaring omission is the complete absence of biodiversity studies in Delta State (Ivbijaro, personal communication, 1994). In the case of Sclater's guenon, Oates recommends further survey work in Rivers State to search for additional populations (Oates et al., 1992, 490). Clearly, more comprehensive data collection is needed to catalogue the full range of biodiversity in the delta.

2.91 The following key areas of high biodiversity and hence potential priorities for conservation are described more completely to emphasize their biodiversity significance. Their selection is based on biological richness, degree of threat, ecological sensitivity, and social importance. These criteria in conjunction with others, such as representativeness, population viability analysis, cultural importance, and management feasibility, should form the basis of an analytical framework to determine priority areas for conservation.

2.92 **Upper Orashi Forest Reserve (Constituted).** The Upper Orashi Forest Reserve (97 km^2) is reputed to be the best wildlife area in Rivers State (Powell, 1993, 91). While a few pygmy hippos may exist in other areas, the Upper Orashi population is believed to be the only potentially viable one left in Nigeria (Powell, 1994). It also contains perhaps the last significant population of the endangered yellow-backed duiker (*Cephalophus sylvicultor*) in the Niger Delta. Hunters have reported seeing Jentink's duiker (*Cephalophus jentinki*), which currently is only known to inhabit northwestern West Africa (Ivory Coast to Sierra Leone) and other duikers which are not thought to be present west of Cross River. The endemic and very rare Sclater's guenon is found in the Reserve, along with the endangered white-throated guenon. Other threatened and endangered species include the olive colobus, speckle-throated otter, leopard (*Panthera pardus*) and manatee (Powell, 1994). Since many species have been

discovered in the area without systematic censusing, it is likely that other rare and endangered species remain undiscovered in the Reserve.

2.93 **Ramos-Dodo-Pennington-Digatoro Area.** As discussed in the forestry section, mangroves are not well represented under any protected area rubric. According to Prof. Powell, the former head of the Biodiversity Unit at the University of Science and Technology, the best location for a park that would include substantial mangrove forests, as well as three of the largest beach ridge areas (149, 121, and 52 km^2) and important freshwater swamp forests, would be part of the Ramos-Dodo-Pennington-Digatoro sector (Powell, 1993, 90). The area contains beaches used by sea turtles, forests with leopards and chimpanzees, and red colobus inhabited wetland forests. Elephants may also live in the forests (Powell, 1994).

2.94 **Adoni Game Reserve (Proposed).** The Adoni Game Reserve (124 km^2) was proposed in 1988 principally to protect the large elephant population on the island. It contains mangroves and 80 km^2 of barrier island wetland forests. Local communities report considerable commercial timber harvesting which is destroying wildlife habitat (Starwoods Nigeria Ltd. 1988, 7). Elephants are the most significant species known to exist in relatively large numbers in the reserve. Numerous other threatened and endangered species have been reported anecdotally in the area, but a wildlife survey is required to determine the species composition of the reserve. Conflicts between elephants and human communities are common. The Forestry Department is required to shoot rogue elephants found trampling crops or threatening the lives of villagers (Starwoods Nigeria Ltd., 1988, 24).

2.95 **Taylor Creek Forest Reserve (Proposed).** Although mammal densities in Taylor Creek (219 km^2) are high for southeastern Nigeria, it has become less important as a reservoir of biodiversity because of extensive development (Werre, 1992, 1-21). A DFFRI road, three oil fields, several pipelines, and logging have directly fragmented the freshwater forest and led to increased hunting within the reserve. More roads and pipelines are proposed. A preliminary survey conducted in 1991 found that the reserve contained numerous threatened species: vulnerable - white-collared mangabey, chimpanzee, West African manatee, and African elephant; rare - olive colobus; endangered - white throated guenon. The area is especially important for manatees and its remnant elephants. The number of bird populations is also high. The survey concluded that the reserve is under intense pressure because the resource demands of the local human population exceed the carrying capacity of the area.

2.96 **Apoi Creek Forest Reserve (Proposed and Surveyed).** This forest reserve may hold important populations of endangered and rare species, such as the red colobus monkeys. However, even less is known about biodiversity in the area than in the other reserves discussed. A thorough field survey and remote sensing imagery are required at Apoi and the other sites to accurately determine conservation priorities (Oates, 1994).

2.97 **Other Areas with Potential for High Biodiversity.** The following areas have a high potential for wildlife diversity. In some cases, they have not been degraded because difficult topography hinders timber extraction:

- Ogbusuwari-Kunou area;
- Forests between Kolo Creek and the lower Orashi River;
- Forest patches containing Sclater's guenon along Rivers-Imo border near Oguta;
- Freshwater forests along mangrove ecotone between Norgbene and Oyeregbene (red colubus, leopards, and manatees);
- Bonny Island (hippos);
- Community protected crocodile lakes in several locations in the delta;
- Proposed Olague Forest Reserve in the western coastal forests of Delta State north of Escravos;
- Proposed Uremere-Yorki Forest Reserve in the western coastal forests of Delta State north of Forcados (hippos);
- High forests between Ekeremor and Sagbama Creek;
- Forest between the Nun-Forcados bifurcation; and
- Opukushi forest at the border of Delta and Rivers State.

2.98 **Regulatory Framework and Institutions.**[13] The current Endangered Species Decree updates earlier wildlife legislation and lists 90 rare and threatened fauna for protection, many of which inhabit the Niger Delta. Vulnerable flora are not similarly listed. The laws focus on species protection and hunting regulations, neglecting to consider habitat conservation or ecosystem-level management. The Decree also needs to be reviewed in light of the new species being found (Oates, 1994). The State Forestry Departments are charged with biodiversity conservation. However, lack of biodiversity information, no staff ecologists, and insufficient personnel and resources to regulate hunting and deforestation, means that biodiversity protection does not occur on the ground in the Niger Delta (Annex J).

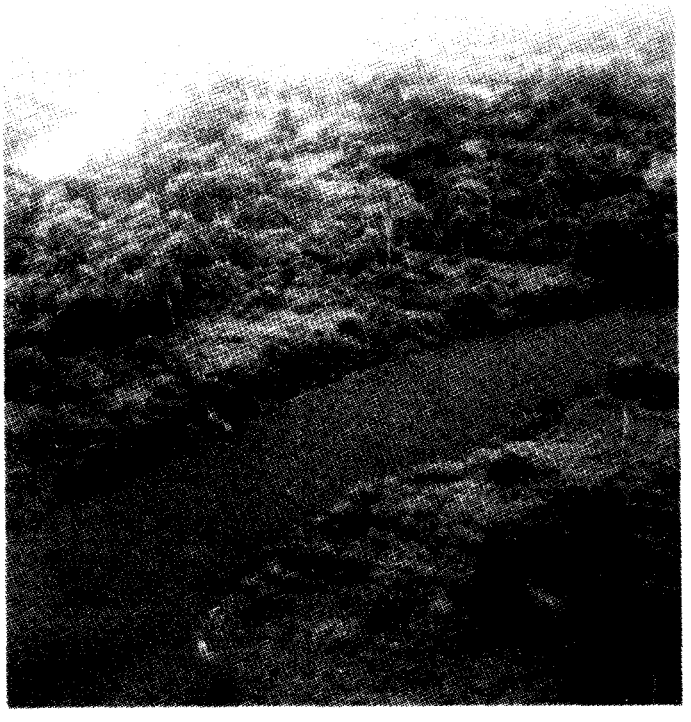
Major Exotic Species[14]

2.99 **Nypa Palm**. Nypa palm *(Nypa fruticans)* was introduced to Calabar in 1906 (Adegbehin, and Nwaigbo, 1990, 15). It is common only in the mangroves of the eastern delta. Compared with water hyacinth, nypa palm has expanded very slowly: spreading from Calabar to the Bonny area over the past eighty-five years.

[13] See Annex K for additional information

[14] Exotic species are discussed in greater detail in Annex F.

Picture 2.7
Water Hyacinth Completely Covering a Stream



2.100 **Water Hyacinth**. Between its introduction in 1984 and 1991, Water hyacinth *(Eichhornia crassipes)* expanded over 800 km from Lagos to Akwa Ibom State (Epelle and Farri in Egborge, 1993b, 2). Remote sensing imagery from those years confirms the general absence of the plants in 1984 and their abundance in 1991 (Eedy, 1994). It is a serious problem in ten LGAs in Rivers State (Rivers SEPA, 1993, 12). Using a defensive expenditure approach, the World Bank report, Towards the Development of an Environmental Action Plan for Nigeria, estimated that water hyacinth control would cost US$50 million annually and that the species negatively effects about 5 million people (Western Africa Department. 1990, 39). Since the delta includes over half of the southern freshwater systems, it will incur the majority of these costs. The major problem with water hyacinth is that as it encroaches on open water, rivers become very difficult to navigate (Pictures 2.7 and 2.8). Fishing is further impeded because the plant becomes entangled in fishermen's nets. Other potential problems are the infestation of irrigated fields, fish ponds, and irrigation channels, as well as being a breeding habitat for mosquitoes (Western Africa Department, 1990, 16). When populations

die off in the dry season, decomposition of the plants and associated bacterial growth causes very high BOD which significantly decreases water quality (Hatziolos, 1995).

Picture 2.8
Water Hyancinth

2.101 If current rates of expansion continue, the species can be expected to cover large portions of the freshwater streams and rivers in the delta within the next 3 to 5 years. Some streams and ponds in the western delta are already completely blanketed. Of the two major exotics, nypa palm and water hyacinth, the latter is considered to be much more of a threat to local communities because of its rapid expansion rate and its impact on navigation and fishing activities.

2.102 **Regulatory Framework and Institutions.**[15] Water hyacinth control has not been well organized or effective in Nigeria. The Federal Government and Delta State have established water hyacinth control committees, but with little result. All levels of government and the oil companies, especially Shell Petroleum, have spent over US$1 million to control water hyacinth and other aquatic weeds since 1989 (Egborge, 1993b, 10). The federal government aborted a pilot biological control program because of poor planning and management. In some

[15] See Annex K for additional information

areas, workers have installed bamboo barriers to halt its expansion. The critical obstacles to controlling water hyacinth spread are: (i) limited understanding of water hyacinth ecology; (ii) lack of a coordinated control effort; (iii) absence of support for community based programs; (iv) no harvesting or utilization program; and (v) limited funding.

C. Environmental Pollution

Water Contamination

2.103 **Pollution from Oil Activities**. From extraction in the Niger Delta to arrival at a terminal or refinery, a number of potential pollution outlets from the oil stream can be identified. The outlets can be categorized as air emissions, water effluents, and waste generation.

Air emissions mainly originate from:
- Gas flaring in relation to gas and crude oil separation

Water effluents mainly originate from:
- Separation of production water and oil
- Spillage of oil

Waste generation mainly originates from:
- Hazardous sludge from separation of crude oil and water
- Drilling sludge
- Household waste, scrap and worn out equipment

2.104 This section focuses on water pollution from effluents and wastes. In addition to pollution issues, infrastructure development for oil activities causes substantial physical impact on the environment; this issue is discussed both below and in the renewable resource section. Emissions from gas flaring are discussed in the air pollution section.

2.105 Probably no other aspect of environmental contamination has been as carefully studied as petroleum hydrocarbon pollution, particularly its impact on the marine environment. Worldwide research spending on petroleum hydrocarbon contamination reached over one billion dollars annually from the early 1970s to the late 1980s. Several very comprehensive reviews of the results of this research have been published by various international and national organizations. Two important summary reports are *Oil in the Sea, Inputs, Fates and Effects* by the US National Research Council (National Academy Press 1985) and *Impact of Oil in the Marine Environment* produced by a variety of United Nations (UN) organizations, including the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP/UNEP 1980). In addition, intensive studies have been conducted after major oil spills, such as those following the Argo Merchant in Massachusetts (1976), the Amoco Cadiz in Brittany (1978), the Exxon Valdez in Alaska (1989) and the oil spills in the Persian Gulf following the Gulf War (1991). The amount of information summarized and analyzed in these

reports is very extensive and has significantly modified scientific opinion about the environmental impact of oil compared to other anthropogenic substances. Furthermore, advances in chemical and biological analytical methods have greatly increased the understanding of the environmental fate and effects of petroleum hydrocarbons in different organisms and ecosystems.

2.106 The improved analytical methods and large body of evidence consistently show that crude oils and many refined products have a comparatively low immediate toxicity to most groups of organisms and ecosystems compared with a large number of other harmful substances. Studies of actual oil spills and other cases of chronic exposure to petroleum hydrocarbons, including refineries and oil terminals, have shown that oil contamination has not caused evident irrevocable damage to marine resources, such as fish or invertebrates, anywhere in the world (Ocean Sciences Board, US National Research Council, 1985). Under normal tropical and subtropical conditions, the weathering and microbial processes contribute to a rapid degradation, particularly of acutely toxic substances in the oil. Within 36 to 48 hours most of these substances have been eliminated. Many of the physical properties of the oil will remain, however, and may cause environmental consequences particularly in plants in the tidal zone, such as mangroves (Box A.3 - vol. II). In addition, under anoxic conditions petroleum hydrocarbons may be preserved almost intact for long periods of time.

2.107 Separation of oil and water either takes place in the delta or at a terminal. An output from all separation of water and crude oil is heavy hazardous sludge. Together the two Shell terminals at Bonny and Forcados handle around 45% of the yearly total crude oil production in Nigeria (Grevy, 1995, 15). All separation of water and crude oil from Shell in Rivers State takes place at Bonny terminal (Picture 2.9). Sludge from separation of oil and water represents a problem at Bonny terminal. At Forcados, the Shell terminal in Delta State, hazardous sludge is disposed of in a swamp neighbouring the terminal area. Several projects for creating a non hazardous sludge for safe disposal have been established without result. Some separation of water and crude oil in Delta State takes place at the Shell installation at Ughelli. Evaluated from concentrations of oil in discharged wastewater at Ughelli, the separation process is much less effective than at the terminals. Other companies are separating oil and water in the delta with less environmentally appropriate facilities which are said to include separation in soil basins (Grevy, 1995, 14).

2.108 In Table A.11 - vol. II average concentrations of oil in discharged water is shown together with total amounts for the three Shell discharge points: Bonny and Forcados Terminals and Ughelli water separation station. From the data, it appears that separation of oil and water by Shell at all discharge points in 1994 meets the effluent standard of 20 ppm. Assuming that the production of oil by Shell in Rivers and Delta States represents 40% of the total production in Nigeria, and that the total amount produced by all companies in the delta represents 80% of Nigerian oil, then the total outlet of oil with production water and after separation amounts to at least 710 tons/year. Most probably this figure is too small as other companies are said to use less appropriate techniques.

Picture 2.9
The Bonny Petroleum Terminal

2.109 Ibiebele (1986) reported concentrations of dissolved petroleum hydrocarbons in wastewater from refineries and oil-exporting terminals in the Niger River Delta between the years 1980 to 1983. The concentrations ranged from 11.2 to 53.9 mg per l. A 1993 SPDC environmental impact study also found an average hydrocarbon content of 62.7 mg/l in Oloma Creek, near the terminal (Resigner Industries, 1993). These figures are high and indicate poor or no treatment of effluents. These studies conflict with information from Shell which indicates that the oil content in production water discharged at Bonny Terminal has averaged 7.8 mg/l (Table A.11 - vol. II). Oil water separation at flow stations (storm water) and terminals (production water) is done using API separators and TPF holding basin facilities. However, in the oil industry, API separators are not considered suitable in situations requiring better performance than 50 mg/l (van Dessel, personal communication, 1995).

2.110 Each year in Rivers and Delta States around 2,300 m^3 of oil is spilt in 300 separate incidences (Table A.12 - vol. II). To estimate spill volumes, it has been necessary to choose different sources of information as there is no correspondence between figures given by NNPC and Shell. This figure does not include the large number of very small spills that occur daily. Hence the actual number of spills as well as the total quantity of lost oil is likely to be considerably higher. In addition, Nigerian oil is a very light crude oil which might indicate an evaporation loss close to 50% within 48 hours. Even with a quick turn out most incidents will be underestimated with respect to volumes spilled. Oil leaks and spills, as well as poor waste

management, are also reported to be common around offshore oil platforms. Many of the vessels which operate with the drilling platforms are in poor condition and would not be considered seaworthy in other oil producing areas (World Wildlife Fund, 1995). However, no data quantifying the extent of this problem are available.

2.111 Compared to incidences of oil spills for the period 1976-1985 (Ikorukpo 1986; Ekweozor, 1989), the number of recorded spills has not changed in the 1990s. Excluding two major accidents at Forcados Terminal and Apoi North 20 in 1979 and 1980 of 570,000 and 280,000 barrels (Ikporupko, 1983), the quantities being spilled today also do not differ significantly from the early 1980s. The only positive aspect in this comparison is that the oil production today is higher than in the early 1980s (Grevy, 1995, 21).

2.112 According to Agip, clean-up costs average N28 per barrel including repair of the pipeline (Linddal, 1995, 69). Thus, average annual clean up costs for all spills in the delta are only N409,000. While the cost per barrel for cleaning up after a spill is probably low, this figure is particularly small.

2.113 The effect of oil pollution on aquatic fauna is very uneven among species and ecosystems. A sensitivity index for ecosystems exposed to oil contamination has been developed for Nigeria (Gunderlach, 1981). The index indicates that sheltered tidal flats and sheltered salt-marshes and mangroves represent the most sensitive areas, but it also indicates that clean up at these locations is extremely difficult. While freshwater swamp fauna is vulnerable to oil pollution, freshwater swamp trees rarely die from oiling (NDWC, 1995, 22).

2.114 Oil spills have been reported to cause mortality of bivalves such as oysters and fish kills (Powell, 1994). Subsurface and floating macrophytes are quickly killed by direct oiling. In some cases, spills have contaminated and killed several hectares of mangrove swamp. The more severe cases of mortality have usually been caused by diesel oil; crude oils are considerably less toxic to marine life. Fishermen report that some fish, such as surface feeding clupeids, avoid oil slick areas, while tilapias and mullets congregate above oiled mudflats to feed on associated algal blooms. Sub-lethal impacts on fish, such as endocrine disruption, reduced fertility and fecundity, and disease, have not been studied in the delta, but communities have reported fish tainting. Oil persistance may be relatively high in poorly-flushed tide dominated systems, peat soil areas, and under anoxic conditions (NDWC, 1995, 21-22).

2.115 One scientific study assessed the impact of an oil spillage in the Bonny Estuary (Snowden & Ekweozor, 1987). The spill, consisting of 250 barrels of crude oil, contaminated an area up to 6 km away from the site of the spill. At the spill site there was a near total elimination of the littoral fauna and a highly significant mortality of oysters. In addition, mangroves became partly contaminated and the seedlings of the mangroves died in a 500 m^2 area. However, no mature mangrove trees died and the recovery was well underway 5 months after the spill. Crabs were not significantly affected even at the spill site. Fagbami et al. (1986) reported that an area of freshwater and mangrove vegetation as large as 200 km^2 around the Tsekelewu oil field was damaged to different degrees. The authors conclude that increasing salt concentrations in the soils, especially during high tides, caused the damage. A very large

spill occurred following the Funiwa 5 blow-out in 1980. The quantity of the spill was over 400,000 barrels, and extensive, but short-term mortality was caused among crabs, oysters and winkles. The long term impact on amphipods, some shrimps, and welks was more significant. Fish returned within a few weeks (NDWC, 1995, 22). Some of the affected mangroves died and complete recovery from the spill took at least 10 years (Ekekwe 1983, UNEP 1989)

2.116 Ekweozor (1989) reviewed the available research on the environmental impact of oil spills in the Niger Delta. Based on this review and the experience from similar areas influenced by oil industry activities (Table A.13, Box A.3 - vol. II), it can be assumed that most spills in the delta release relatively small amounts of oil and that the damage in most cases is primarily confined to the already industrialized areas surrounding the oil installations or their immediate vicinity. While there is no scientific evidence of any widespread contamination by petroleum hydrocarbons in the environment of Rivers or Delta States, the information base is limited. The initiation of the Niger Delta environmental survey is a very significant step towards improving the information available on the environmental impact of oil development and other economic activities in the delta (Box 2.6).

Box 2.6
Niger Delta Environmental Survey

The World Bank has joined the steering committee of an intensive environmental sensitivity study of the Niger Delta. Initiated and funded principally by the Shell Petroleum Development Company of Nigeria, the study is the first ever attempt to systematically gather data to determine the current and future environmental impact from all major economic activities in the region. The study is expected to cost US$3.5 million and take 2 years to complete. Critical to the legitimacy of the study is the fact that it will be strictly independent from Shell and will be composed of key stakeholders and representatives from international development and environmental organizations. GIS and remote sensing based, the study will build upon an earlier phase which assessed the environmental impact of oil spills. Shell conceived of the program in response to strong pressure from its parent, Shell International, which is concerned about growing negative publicity surrounding the environmental and social effects of its activities in the Niger Delta. To avoid duplication, the Shell study will be coordinated with relevant aspects of the land use survey being conducted for all of Nigeria under the Environmental Management Project. The information obtained in the study will be available to the government of Nigeria at large and other stakeholders.

2.117 The volume of oil from spills is only 3 times as high as from production water separation from crude oil at oil outlets. The environmental impact is expected to be less serious because spills occur all over the delta, but are rarely large or do not chronically occur in the same location. In contrast, constant discharge of oil contaminated production water at a few locations prevents natural ecosystem rehabilitation in small areas.

2.118 Obviously oil industry operations in the delta involve a large number of activities that may cause environmental effects in addition to oil spills. Oil activity infrastructure development in the delta appears to cause more severe and more extensive environmental

impacts than oil pollution (see Forestry and Biodiversity Sections). The impacts from the presence of large numbers of people that are involved in various activities could degrade the environment, particularly if the handling of garbage, wastes and sewage is not done with care. Currently, waste treatment in the field is primitive; burial, burning in the flare, and injection into the crude oil are practiced (van Dessel, 1995). During the drilling period of the Seibu-1 oil well, 256 m^3 of domestic waste was generated. As an isolated source of waste generation this is not much, but assuming around 3-4,000 drillings in Delta and Rivers State during the last 25 years, the amount of waste from one single activity represents more than 1 million m^3 in total. A specific problem with waste generation may be related to seismic oil exploration in swamp and mangrove areas. All equipment for such activities are hand carried by crews of up to 1200 men moving through not easily accessible pristine areas (van Dessel and Omokum 1994).

2.119 The turbidity and siltation caused by digging and dredging to clear vegetation at drilling sites is one of the most important short term environmental problems resulting from the exploration and production of oil in the aquatic ecosystems of the delta. The suspended material (clay, sand, silt, organic matter, etc.) will decrease the primary productivity of the rivers and water-bodies by reducing the light available to algae and aquatic plants. The siltation also may negatively effect the benthic fauna. Anoxic conditions may result from the increased input of organic material and the drop in primary productivity.

2.120 Drilling fluids are released from exploratory drilling. The drilling fluids used in Nigeria are relatively harmless; no oil based muds are used, and few hazardous or heavy metal components are added (van Dessel, 1995). However poor control of drilling waste in combination with the large quantities can create environmental problems, eg. from the use of hypersaline muds for horizontal wells in fresh/brackish water or land environments. Approximately 7 million m^3 of drilling wastes has been disposed of in the two states. An average well, calculated from these figures, gives rise to around 2,500 m^3 of drilling mud and cuttings.[16] Even if the ecological impact from chemical components in drilling muds are considered less hazardous, the physical impact of such amounts must locally be a problem which is not easily managed.

2.121 **Oil Company Response to Environmental Degradation.** To manage ecological issues, the oil companies have set up environmental divisions. Shell, for instance, has environmental divisions stationed at its Niger Delta headquarters in Port Harcourt and Warri. The oil companies commission environmental impact assessments of all their major projects, which are usually performed by the environmental consulting units of local universities. The quality of this work is reported to be highly variable. Field work is usually limited to two weeks, which is completely inadequate to understand an area considering the absence of other studies. Shell is currently conducting a mangrove regeneration experiment to learn how to accelerate rehabilitation of degraded sites.

[16] Up to 1994 more than 1250 wells had been drilled by Shell (East) in Rivers State (van Desse. and Omuku, 1994), which might indicate a total number of drilled wells in Delta and Rivers State of around 4000. Assuming that at least 3000 wells with an average depth of 3000 m have been established a total amount of cuttings and drilling muds.

2.122 Although the oil companies have generally developed adequate environmental policies, implementation has lagged. A combination of factors explain the difference between policy and practice: (i) difficult terrain, (ii) poor enforcement of environmental regulations, (iii) operating practices that do not meet international standards, (iv) community animosity, (v) limited funding, and (vi) lack of commitment. For waste disposal, oil companies have strong policies and programs to establish secure landfills and high temperature incinerators, but implementation has not followed. Company officials, NGOs, and state environmental experts all reported that oil spill clean ups are slow and inadequate. Spill responses have not improved over the past three years. On the other hand, some oil companies have implemented several positive changes. For instance, seismic lines have been reduced from a 5m wide swath to 1m and greater care is taken not to damage large trees. However, reports of crews ignoring the policy are still made (NDWC, 1995, 35). To reduce the risk of flowline and pipeline breaks, Shell has instituted a policy of replacing all lines every 15 to 20 years. To minimize forest clearance, replacement lines are sited beside the old lines (van Dessel and Omuku, 1994, 440).

2.123 **Regulatory Framework and Institutions.**[17] Oil companies in Nigeria are under federal jurisdiction. The federal government is both a partner in all oil activities, through NNPC, and is required by federal law to enforce environmental compliance of oil operations through the Department of Petroleum Resources. This situation has resulted in the government inadequately regulating oil pollution while at the same time, being party to much of the oil related environmental problems of the delta. The jurisdictions of other environmental regulatory agencies (FEPA and SEPAs) over oil pollution issues is unclear. Although they consider regulation of oil pollution to be part of their mandates, their legal justification for doing so has not been defined. In any event, none of the agencies has the technical expertise or equipment necessary to effectively regulate the industry (see Annex J for agency level discussions). The major constraints impeding reduced oil pollution are: (i) the conflict of interest for the federal government - being both a partner in oil activities and the regulatory body; (ii) no requirement for community participation in planning and development of oil activities; (iii) very limited ability of regulatory institutions to monitor pollution; (iv) low compensation rates for damage to property; and (v) lack of enforcement of environmental regulations.

2.124 **Industrial Pollution.**[18] Although the petroleum industry is by far the largest industrial subsector in the Niger Delta, a wide variety of other industries operate in the Niger Delta. The Industrial Directory for Rivers State which was last updated in 1988 lists over 500 companies, but most of them employ fewer than 10 people. Only 112 companies employ more than 50 workers (Linden, 1993, 12). In addition to the industries discussed in detail in Annex H, other large facilities in the delta include the African Timber and Plywood mill at Sapele and the Delta Glass Industry at Ughelli. Many of medium and large scale industries are concentrated on the Trans Amadi industrial estate in Port Harcourt. This section calculates pollution based on actual production figures from 80 manufacturing industries in Port Harcourt (Tables A.16-

[17] See Annex K for additional information

[18] Additional information on industrial pollution in Nigeria can be found in the World Bank report, Nigeria - Strategic Options for Redressing Industrial Pollution. The report concentrates on four states, including Rivers State, but does not extensively discuss Delta State.

18 - vol. II). Additional information on industrial pollution has also been incorporated into the analysis. Data from Delta State was generally insufficient to assess pollution levels (Table A.19 - vol. II).

2.125 In the two states, industrial facilities are concentrated in the major centers, particularly Port Harcourt. The low levels of industrialization in the rural areas of the delta confine environmental degradation primarily to a local scale: industrial pollution is not a region wide threat to the delta. A study of chlorinated hydrocarbon concentrations found that levels of PCBs in coastal Nigerian fish, an indicator of regional industrial pollution, were far below developed country standards and generally lower than in coastal areas in other regions of the world (Osibanjo and Bamgbose, n.d.). The few studies that have been carried out on the levels of heavy metals in algae and fish from the Niger Delta have not shown any elevated levels of any type of metal pollution. This may not be surprising as there are few significant industrial activities in the area that could release large quantities of heavy metals. However, it should be pointed out that there is an almost total lack of quantitative data and of adequate time series data (Ndiokwere, 1984; Sadik 1990). Notwithstanding the regional emphasis of this report, industrial pollution can cause significant health and economic impacts, especially in urban areas. For example, industrial effluents reduce economic productivity by causing eutrophication of waterbodies, which may reduce fish catches and render water unsafe. Pollution of groundwater may force communities and industries to find more expensive, alternative sources. In the delta, the ties between industrial pollution and impaired human health and economic productivity are generally limited to the local vicinity of the facilities. Four industries (steel works, food processing, petroleum refining, and fertilizer manufacturing) are discussed in greater detail because they generate the largest quantities of wastewater.

2.126 ***Steel works.*** Able to produce 1 million tons of steel annually, the government owned Delta Steel plant located near Warri is the largest steel plant in West Africa. However, capacity utilization did not exceed 20% between 1986 and 1991 (Western Africa Department. 1994d, 62). Wastewater from steel facilities tends to be high in suspended solids, metals, acids, oil and greases, and dissolved iron. Iron and steel producers in Nigeria, including the Delta Steel facility, have difficulty complying with effluent limits for suspended solids, phenols, ammonia, and cyanide. Heavy metal and organic pollutants also contaminate receiving water bodies.

2.127 ***Food Processing.*** Rivers State has at least 14 food processing firms; most process fish or refine oil and produce associated products (Table A.14 - vol. II). Although this group of industries is very diverse, all dispose of large amounts of organic wastes which cause oxygen depletion, turbidity (suspended solids), unsanitary conditions and sometimes abnormal pH. Most food processing industries process up to one third of the raw materials as inedible food parts which are discharged as putrescible waste. Food processing plants generate over 50% of BOD_5 and suspended solid effluents in Port Harcourt. While the environmental impact of food processing wastes in the Niger Delta has not been studied, reports on such facilities in other parts of the country show a consistent pattern of discharges greatly above the FEPA limits. BOD_5 and temperature levels are often extremely high. Similarly, dissolved

oxygen commonly drops to zero near outfalls (Ogedengbe, Fapohunda, and Gotau, 1984, 58-60).

2.128 ***Petroleum Refineries and Petrochemical Facilities.*** Three of the four Nigerian refineries are located in the Niger Delta at Warri and Port Harcourt (two). The newest Port Harcourt refinery was commissioned in 1989 and is capable of producing 150,000 bpd. The older Port Harcourt refinery has been shut down for repairs since 1989 (ESMAP, 23). The Port Harcourt refinery generates very large amounts of hazardous sludge, but is not estimated to contribute substantial wastewater except for oil and nitrogen compound discharges. Other parameters of concern are COD, heavy metals, phenols, and sulfides, but they could not be calculated. Except for the new Port Harcourt refinery, which is operated by a foreign company, Nigerian refineries are very inefficient compared with their developed country counterparts. For example, the operating costs for the Warri refinery were US$22 per ton while a typical Western European refinery would costs US$13 per ton to operate. The high energy consumption of the Nigerian plants causes most of the inefficiency: the Warri refinery uses up 11% of crude throughput just to operate (West African Department, 1989, 17). Marginal pollution output would decline dramatically if the refineries were simply more efficient.

2.129 ***Fertilizers.*** The National Fertilizer Company of Nigeria (NAFCON) facility, located in Onne near Port Harcourt, is one of only two fertilizer plants in the country. It produces urea, ammonia, and compound fertilizers, like NPK. Output averages just over a million tons annually, and capacity utilization is over 95% (NAFCON, 1990, 7). Effluent treatment systems are reported to function only intermittently (Isoun, 1994). NAFCON generates approximately 50% of total nitrogen and virtually all total phosphorus industrial effluent in Port Harcourt. Seven major spills of what was reported to be urea in 1992 killed large numbers of fish in the immediate area surrounding the outlet. The number of major spills dropped to two in 1993 (Rivers SEPA, 1994, 17).

2.130 **Regulatory Framework and Institutions.**[19] Of the different types of environmental legislation, the federal framework for controlling industrial pollution is perhaps the most comprehensive (Annex J). It creates a complete monitoring, enforcement, and legal prosecution process. Current legislation began with the Federal Environmental Protection Agency Decree, 1988. The Decree establishes penalties for discharging hazardous wastes into any media and prohibits indiscriminate disposal of waste into waterbodies. The Act was followed by the 1991 National Environmental Protection Regulations, which require that every industry installs abatement equipment, restricts releases of toxic substances, and obtains permits from FEPA for storage, treatment, and transportation of toxic wastes. Environmental impact assessments are now mandatory for new large industrial developments. The key constraints of the existing regulatory framework are: (i) lack of enforcement; (ii) overlapping responsibilities, especially between federal and state environmental protection agencies; and (iii) no market based incentives (pollution charges, appropriate user and input pricing, pollution abatement subsidies, etc.).

[19] See Annex K for additional information

2.131 In addition to Federal legislation that FEPA must implement, regional agencies (OMPADEC, NDBDA), the State Ministries of Works, and the SEPAs have their own, often conflicting, pollution legislation to implement (Annex J). The division of responsibilities between the various agencies is not yet discrete. While FEPA's policy is to only enforce regulations in states that cannot do so themselves, the reality in the delta is that all of the agencies are too poorly equipped and staffed to manage industrial pollution. The principal institutional constraints to comprehensive enforcement of pollution regulations at all levels are: (i) limited funding; (ii) weak monitoring and enforcement capacity; and (iii) few appropriately trained staff.

2.132 **Urban Wastewater**. No municipal sewage treatment plants operate in the Niger Delta. Consequently, households, commercial establishments, and industries discharge wastes directly into open drains. Many of the drains are unlined, blocked with solid wastes, or broken. Untreated urban wastewater transported via sewage systems or drains into aquatic ecosystems consist primarily of organic matter, including nutrients. High organic and nutrient inputs over large areas can result in eutrophication: increasing blooms of microscopic algae and fast growing epiphytic algae and bacteria, as well as depleted oxygen levels. This process may increase the stocks of herbivorous fish, such as tillapias, but often decreases the populations of other commercial species. In Port Harcourt, dissolved oxygen levels in some rivers are very low and no longer able to support even herbivorous fish. High density areas of the city also have elevated levels of total solids, chloride and turbidity (Ayotamuno and Akor, 1994, 30). In addition to organic matter and nutrients, urban wastewater also contains industrial effluents and household pesticides released into common drainage or sewage systems. Water supplies in Port Harcourt are frequently degraded from the common practice of laying the water pipes directly in open drains or near soak away pits, and building shallow wells near poorly maintained drains. In all cases, water contamination is believed to be common (Ayotamuno and Akor, 1994, 31).

2.133 Since land use planning remains theoretical in the delta, small scale industries (SSIs) are found throughout residential areas. They are included as part of the urban wastewater assessment because distinguishing between the household and small scale industry waste streams is extremely difficult. SSIs may not only threaten the health of workers and families who often live on premises, but also reduce the quality of life of surrounding households. Most small industries in Port Harcourt have service functions occupied within repair and maintenance, or involve craftsmen in fields such as carpentry, shoe making, furniture, clothing, and electronics (Manufacturers Association of Nigeria, 1994). Other SSIs are involved in wholesale, transportation, hotel, restaurant, and office based activities producing mostly organic and paper wastes. Most of the pollution from such activities contributes to the general pollution at a level corresponding to household waste generation and septic effluents. Oil and grease from repair and maintenance is expected to be higher than household levels, equalling the amounts being spilled from major enterprises. Small enterprises with considerable environmental impact, such as tanneries, dyeing facilities, slaughterhouses, and some minor food processing industries, have not been identified in Port Harcourt.

2.134 **Other Sources of Pollution.** Nutrients are released via land runoff from agricultural areas and through various sewage outlets into the marine environment. Nutrients, by

themselves, are not considered toxic substances, but large quantities may cause acute depletion of oxygen which may kill fish and other aquatic animals. UNEP (1989) stated that releases of fertilizers from agricultural land into coastal lagoons in Nigeria were extremely high and frequently caused eutrophication phenomena. However, since the UNEP report was released, fertilizer use in the Niger Delta has declined dramatically. Eutrophication from fertilizers, therefore, may no longer be a significant environmental problem. In addition, as mentioned earlier, the damming of the rivers has decreased nutrient transport into the delta and estuaries.

2.135 **Summary.** From the information available, water pollution does not appear to be a major regional environmental problem. The information pertaining to oil pollution in the Niger Delta and similar ecosystems in other areas of the world indicates that its impact is localised and long term damage is generally limited to the immediate surroundings of large oil installations which are subjected to continuous discharges. Data indicates that total oil industry losses in Rivers State are less than the combined oil effluents from industries and households in Port Harcourt (Table 2.4). On an area basis, the oil industry spills and production losses are an order of magnitude smaller than the estimated industrial and household discharges. With industry concentrated in a few major centers and the low levels of household wastes generated in rural areas compared with ecosystem thresholds, industrial and household wastewater discharges are not expected to cause regional environmental impacts.

2.136 On the other hand, the amounts of eutrofying components (BOD_5, nitrogen, and phosphorous) (and associated pathogens) per square kilometer in Port Harcourt are extremely high compared with urban centers with sewage treatment facilities. These high levels represent a considerable health hazard to people who rely on surface and shallow ground water supplies for drinking and bathing. The Port Harcourt data should be representative of the other large centers in the Niger Delta and generate concern regarding the lack of sewage treatment. Other than phosphorous which is generated by NAFCON, domestic and SSI sources of eutrofying components are a significantly higher percentage of total discharges than industrial sources: BOD_5- 66%; suspended solids - 82%; and total nitrogen - 89% (Table 2.4). Hazardous industrial wastewater levels were generally not estimated, but may cause considerable health impacts in urban centers, particularly because of the lack of waste treatment, poor drainage systems, and reliance on surface and shallow ground water for drinking water. The assessment clearly indicates that interventions to reduce water pollution should focus on reducing effluent from households and small industries in urban areas.

Table 2.4: Estimates of Total Effluents in Rivers State and Port Harcourt

	BOD_5		SS		Oil		Nitrogen		Phosphorous	
	tons/yr	tons/ km^2/yr	tons/yr	tons/ km^2/yr	tons/yr	tons/ km^2/yr	tons/yr	tons/ km^2/yr	tons/ yr	tons/ km^2/yr
Oil Spills and Prod. Discharges Rivers State[20]					2,898	0.2				
Medium and Large Scale Industries Pt. Harcourt	4,374	16.1	3,448	12.7	2,343	8.6	362	1.3	836	3.1
Households and Small Industries Pt. Harcourt	8,331	30.6	15,300	56.3	2,343	8.6	2,806	10.3	340	1.3

Note: Port Harcourt LGA = 272 km^2. Rivers State area is 18,754 km^2.

Air Pollution

2.137 **Gas Flaring**. Oil production generates gas which continues to be flared in the production fields. Gas flaring is a wasteful emission of greenhouse gases that increases global warming (Picture 2.10). Nigeria currently (June 1993) flares more gas than any other country in the world (Escravos Gas Project 1993). In 1989, Nigeria flared off 617 billion cubic feet of associated gas, in the process releasing about 30 million tons of CO_2 (Table 2.5) (ESMAP, 46). However, considering the low combustion efficiency of Nigerian flares (80%) a large portion of the gas is vented mainly as methane. In 1994, the total emission of CO_2 from gas flaring in Nigeria amounts to an estimated 35 million tons/year and around 12 million tons/year of methane from Delta and Rivers State. Based on the much higher global warming potential of methane (64 vs. 1 for CO_2) the significance of the Nigerian gas flares is even more considerable. The World Bank and the GEF have proposed a flared gas reduction project for oil fields offshore of Delta State (Box 2.7) (Annex I).

[20] Oil Production oil discharges average 1,525 tons/year (Grevy, 1995) and spills average 1,571 m^3/year or 1373 tons per year.

Table 2.5: Flaring of Natural Gas in Major Producing Countries (% of gross production in 1991[a])

USA	0.6
Holland	0.0
Britain	4.3
Ex-USSR	1.5
Mexico	5.0
OPEC Countries	
Nigeria[b]	*76.0*
Libya	21.0
Saudi Arabia	20.0
Iran	19.0
Algeria	4.0
OPEC Total	18.0
World Total	4.8

Source: Escravos Staff Appraisal Report, 1993.

2.138 Emissions from gas flaring are difficult to evaluate as very little is known about flame temperatures. The flares are said to be operating at temperatures between 1300-1400°C, that may be the case in the center of flares, but combustion is at lower temperatures in most of the flame.[21] In the immediate environment of the flare, gas flaring causes noise, elevated temperatures, and NOx, SO2, VOC, and soot (particulates) (Annex I and Table 19 - vol II). Speculations are widespread that gas flaring may have contributed to acidification of soils and the corrosion of metal roofs. However, no evidence of acidification causing such damage has been found. With Nigerian petroleum having some of the lowest sulfur levels in the world and NO_x generation during flaring being insignificant, it is extremely unlikely that gas flaring is causing acid rain. (van Dessel, 1994). Site specific measurements of SO_2 and N-oxides related to gas flaring have been undertaken[22] and do not indicate that the two parameters are emitted to an extent where dry and wet depositions cause serious acidification effects. No acidic rainwater pH values have been measured near gas flares (Grevy, 1995, 25). The noise and increased temperatures are local problems in the immediate surroundings of the flares. The release of soot may be a problem in some cases as it smells and may cause oil-like surface contamination. The toxicity, however, is likely to be very low. With better management of flaring (higher temperatures) the problem with fallout of soot could be avoided.

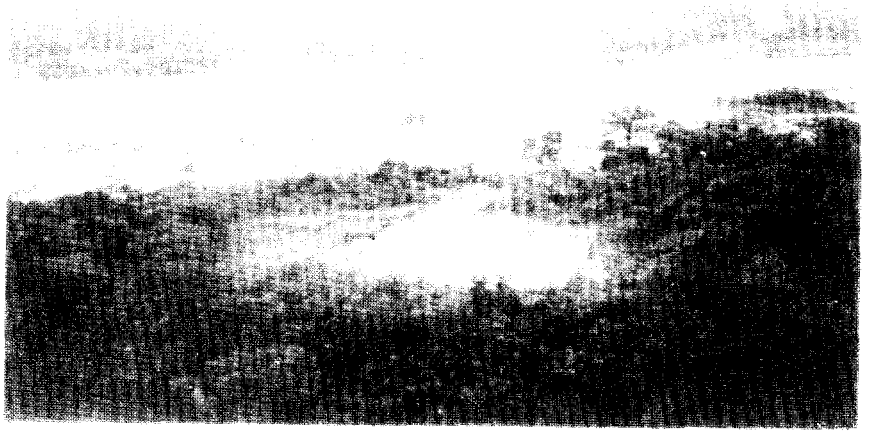
[a] Production of associated and non-associated gas.

[b] About 88% of the associated gas is flared.

[21] The seven different flares inspected by World Banik missions were clearly orange and sooting, indicating a much lower temperature and only a partial combustion of gaseous components.

[22] E.g: *Environmental impact study around the gas flare of the Bonny Flow Station.* Renseigner industries Ltd. for The Shell Petroleum Development Company of Nigeria, 1993; University of Calabar Flared Gas Study for The Shell Petroleum Development Company of Nigeria.

Picture 2.10
Gas Flaring



Box 2.7
Escravos - Flared Gas Reduction Project.

The proposed project is designed to reduce gas flaring from two oil fields operated by Chevron Nigeria Ltd. offshore of Delta State. It would be supported by a US$100 million IBRD loan and a US$25 million GEF grant. The unflared associated gas would be separated into two streams: (1) the 'dry' gas component will be transported by pipeline to the Lagos area for electricity generation and industrial use; (2) the liquefied petroleum gas (LPG) component would be piped to an LPG tanker for export. The proposed project also includes a technical assistance program to assist NNPC and the Federal Ministry of Petroleum and Mineral Resources with policy formulation and training in natural gas economics, technology, and management. As important as its direct reductions in gas flaring, project has already induced the government to modify its natural gas policy framework to include much stronger fiscal incentives to conserve gas resources, produce exportable LPG, and reduce the effect on global warming (World Bank, 1994a). Implementation of the project depends on an improved macroeconomic framework in Nigeria.

2.139 **Regulatory Framework.** To reduce gas flaring and conserve gas resources, the government promulgated the Associated Gas Reinjection Decree, 1979, which required companies to stop flaring by 1984. When it became obvious that flaring would continue, the Decree was changed to fixing a 2 kobo (US$0.0009) penalty for each thousand cubic feet of

gas flared, but this has not proved to be an incentive to induce companies to reduce flaring (World Bank, 1994a, 7).

2.140 **Industrial Emissions**. Localized air pollution problems of particular concern are particulates (e.g., cement kiln dust), nitrogen compounds (especially from the fertilizer plant), multiple pollutants from the NNPC refineries, and emissions from steel production.[23] In addition to industry specific pollution, industrial furnaces, boilers, and thousands of private electrical generators contribute to air pollution (Adegbulugbe and Dayo, 17). This section reviews the major air polluting industries.[24]

2.141 ***Steel works.*** Particulate matter and sulfur dioxide levels are the steel industry's principal air emission problems, but a wide variety of additional pollutants are also generated (FEPA, 1991, 37). Air emissions from the Delta Steel facility deposit metals in downwind areas. Soil levels of cadmium, chromium, and lead 250m from the pellet plant were all about 7.5 times background levels. Nickel concentrations were measured as 140 ppm; over 30 times background levels. The mean metal concentrations of nearby cultivated crops were also found to be elevated. Epidemiological studies on the surrounding communities would have to be conducted to determine the health effects from exposure to metals from the facility. Air emissions, including metals from the Delta Steel plant, may represent a case where air pollution imposes a significant health risk to local communities (Ndiokwere and Ezihe, 1990).

2.142 ***Petroleum Refineries and Petrochemical Facilities.*** Air emissions are the most significant causes of environmental degradation from refineries. The major air pollutants emitted by refineries and petrochemical facilities are sulfur oxides, nitrogen oxides, particulates, carbon monoxide, and hydrocarbons. The refineries are estimated to generate virtually all the industrial NOx emissions and 25% of the industrial particulate emissions in the Port Harcourt area. A study of metal concentrations near the Warri refinery found elevated level in both soils and plants. Concentrations ranged from 3 times background for chromium (44 ppm), 4 times for lead (20 ppm), 4 times for zinc (119 ppm), 6 times for copper (43 ppm), to 7 times for nickel (7 ppm) and cadmium (44 ppm). Plant levels were similarly elevated. The combination of metals and other air pollutants from the refinery complex may result in air pollution, as well as wastewater, degrading human and ecosystem health (Ndiokwere and Ezihe, 1990).

2.143 ***Cement***. A cement facility operates in Warri, Delta State and a cement packaging plant is located in Port Harcourt. Water pollution is not a major concern from cement plants, but they do create tremendous amounts of dust. In developed countries, well established control equipment is used to keep emissions to acceptable levels. It is not known how many Nigerian cement factories operate such equipment. However, the Bendel Cement Company in

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[23] Power generation and power consumption is an outstanding issue which has not been considered in this overall estimate of industrial and household pollution. It was not possible to obtain information on power generation and distribution from NEPA (The National Electrical Power Authority). Missing information on power production in the industry and fuel consumption in households in Port Harcourt is reflected in small amounts of N-oxides and NM VOC in air emissions and makes comparisons with impacts from traffic and oil production difficult.

[24] Annex I includes additional information on other industries.

Delta State has been cited as emitting very high particulate levels (NEST, 1991, 126). The Rivers State plant (Eagle Cement Factory) is located in a moderately populated area of Port Harcourt and may increase respiratory problems in neighboring communities.

2.144 ***Other Industries.*** Fumes from metallurgical plants can be hazardous to workers and to communities located nearby (FEPA, 1991, 37). Communities near the NAFCON fertilizer plant have complained of choking gases coming from the plant, which could be from nitrogen compound releases (Council of Chiefs, 1994).

0.145 **Vehicular Emissions**. The major pollutants from traffic exhaust are particulates, nitrogen-oxides (N-oxides), non-methane volatile organic components (NM VOC), carbon monoxide (CO), sulphur dioxide (SO_2), polyaromatic hydrocarbons (PAHs) and lead. For this report pollution loads from exhaust emissions have been assessed for particulates, N-oxides, NM VOC and lead. SO_2 has not been considered because no information is available on sulphur levels in fuel, except for statements by both NNPC and Shell that sulphur contents are very low. For CO and PAHs, no general tools exist to make overall assessments. Exhaust emissions for Nigeria, Rivers State and Port Harcourt are presented in Table A.15 - vol. II. The estimates are considered to be lower bound figures because the analysis does not consider the poor condition of the vehicle fleet or the impact of traffic jams (Annex G).

2.146 Health impacts from even heavily polluting traffic are difficult to recognise and diagnose in developing countries except for injuries caused by vehicle accidents. More obvious, acute health problems often overshadow chronic health effects from exposure to traffic if precise diagnoses or expensive analyses are not performed.

2.147 The most critical health risks from traffic are accidents followed by lead, particulates, sulfur, and NO_x emissions. People who spend a lot of time near urban roads, like taxi and bus drivers, street vendors, traffic wardens, and police officers are particularly at risk of being exposed to harmful levels of these pollutants. Particulates, including sulfur, contribute to chronic and potentially debilitating respiratory illnesses, while lead can cause mental dysfunction and potentially death. Investigations have shown that children are much more sensitive to lead poisoning than adults. Children spending a great deal of time near streets show significantly higher blood lead levels than adults. Mental retardation in children in many developed countries has also been linked to lead from traffic. NO_2 may lead to increased susceptibility to respiratory pathogens. Environmental work in other countries has shown that control costs for reducing lead and particulates from vehicles are relatively low. Most countries use fuel with much lower levels of particulates (in diesel) and lead (in gasoline).

2.148 Particular emphasis in this section is given to lead emissions because of their severe impact on human health and the high lead levels of Nigerian gasoline. Gasoline in Nigeria contains 0.74 g lead/l or 1.0 kg lead/t, one of the highest concentrations in the world. In comparison, the lead content in Sweden is 0.15 g/l and in Japan it is 0.31 g/l. The most recent EU standard is 0.15 g/l.

2.149 With respect to exhaust hazards, specific studies have been conducted with traffic wardens in Lagos, the most traffic exposed category of inhabitants in Nigeria (Ogunsula et al., 1994a, 1994b). Blood lead levels in the traffic wardens were found to be significantly higher than those in normal subjects with lead levels increasing with age. Compared to other highly exposed populations in Africa, the Middle-East, and Europe, lead levels in Nigeria were not especially high, as shown in Table 2.6. However, pulmonary functions for traffic wardens as a consequence of exposure to traffic particulates were significantly reduced.

Table 2.6 Blood Lead Levels With Traffic Exposed Personnel in Selected Countries

Location	Average lead level, µg/l
Lund, Sweden	12.3
Hokkaido, Japan	9.6
Ahmedabad, India	34.5
Teheran, Iran	29.5
Cairo, Egypt	29.2
Lagos, Nigeria	18.1
Ife, Nigeria	10.2

Note: The World Health Organisation recommends an exposure limit of 40 µg/l for men and 30 µg/l for reproductive women. A blood lead of 80 µg/l is usually associated with serious complications.

2.150 **Summary.** From the analysis above and the air emissions estimates summarised in table 2.7, several preliminary conclusions can be made. First, there are no major region-wide air pollution problems in the Niger Delta. Although VOC emissions (largely methane) from the region are very high, they do not have a significant regional impact (however, the contribution to global warming is substantial). The information available on the NOx and SO_2 emissions from gas flaring indicates that they do not cause regional acid precipitation. Vehicle emissions also do not represent a health hazard at a regional level. Emissions estimates from industry on a regional level could not be made, but are not anticipated to be significant because of the moderate level of industrial activity and its concentration in only a few locations, particularly the Trans Amadi industrial estate in Port Harcourt.

2.151 Air pollution problems are concentrated in large urban centers and near large individual industrial facilities. Data collected from Port Harcourt, which should be representative of the other large centers in the delta, indicated that lead pollution is the most significant problem because of the very high emission levels and the high risk to mental development of children. Particulate emissions from industries, and to a much lesser extent from vehicles, are another critical air pollution concern. Comparative risk analysis studies in numerous developing countries have similarly determined lead and particulates to represent the most significant health risks from air emissions (Sessions, 1995). Of secondary concern are

VOC emissions from households and small industries, as well as NOx and VOC emissions from vehicles and larger industries.

Table 2.7: Estimates of air emissions in Rivers State and Port Harcourt

	Lead		Particulates		N-oxides		SO_2		VOC	
	tons/yr	kg/km²/yr	tons/yr	tons/km²/yr	tons/yr	tons/km²/yr	tons/yr	tons/km²/yr	tons/yr	tons/km²/yr
Medium and Large Scale Industries Pt. Harcourt			10,496	38.6	779	2.9			292	1.1
Small ind. and households Pt. Harcourt									3,750	13.8
Vehicles Pt. Harcourt	54	199	304	1.1	345	1.2			1,326	4.9
Vehicles Rivers State	253	14	1,461	<0.1	1656	<0.1			6,260	0.3
Gas Flaring Rivers State			2590	<0.1	103,562	6	19,624	1	25,900,000	315

Note: Lead emissions per area are measured in kg/km²/yr. No energy production emissions have been included for households or industries.(refer to Annex G for methodologies).Port Harcourt Local Government Area = 272 km². Rivers State area is 18,754 km².

Solid Wastes and Sludge

2.152 **Industrial Wastes**. Industries in Port Harcourt generate only 15% of the total solid and sludge waste streams, but virtually all of the hazardous waste - most of which is generated by the refinery (Table 2.8). According to the Director of the Port Harcourt Environmental Sanitation Authority neither hazardous nor industrial wastes are separated from municipal solid wastes before disposal in the municipal waste dumps. Waste disposal in the other municipal centers is equally inadequate. Most companies have waste containers, but collection is infrequent, resulting in solid wastes clogging nearby drains and creating health hazards. Poor management of industrial sludges is expected to cause considerable environmental degradation, including irreversible impacts in small areas (Grevy, 1995, 73). The steel, refinery, metallurgy, and food processing industries are highlighted because they produce large quantities of solid wastes or particularly hazardous solid wastes.[25]

2.153 ***Steel.*** The steel industry produces the largest quantities of solid and hazardous wastes in Nigeria, of which the Delta Steel facility is the largest single contributor (Western Africa Department, 1994c, 18). It is estimated to generate 45,000 tons of non-hazardous solid waste, 2,100 tons of hazardous solid waste, and 3,200 tons of hazardous sludge annually. These amounts are considerable in comparison with the waste generated by all industries surveyed in Port Harcourt (Table 2.8). The major solid wastes from steel rolling and finishing are steel scrap, scarfing residues, and refractory materials, most of which can be recycled back into the

[25] Additional industry specific information is presented in Annex H.

manufacturing process (World Bank, 1988, 152). Solid wastes from the byproduct coke operations include sludges and impure recovered byproducts (World Bank, 1988, 137-8).

2.154 ***Petroleum Refineries.*** The new Port Harcourt refinery is estimated to produce over 90% of the hazardous sludge generated in Port Harcourt. The ability of the refinery to manage the hazardous sludge is not known. At the refinery in Warri, sludge is simply being disposed of in a neighbouring swamp. The refineries do not generate large amounts of solid wastes.

2.155 ***Metallurgy.*** Metallurgy is the second highest producer of hazardous wastes in Port Harcourt and in Nigeria, as a whole. Solid wastes from metallurgy plants are frequently contaminated with metals. On the other hand, recycling is well established in this industry, with metal wastes being extensively recycled. Auchi reported that the metallurgy industry has the second highest partial and complete reprocessing of wastes of all Nigerian industries, 50% and 19% respectively (Auchi in Math and Robinson, 1991, 483).

2.156 ***Food Processing.*** Although it generates very little hazardous waste, the food processing industry is the largest producer of industrial solid waste in Port Harcourt and second largest producer of solid wastes in the country. The palm oil industry, one of the largest in the Niger Delta, produces substantial amounts of solid waste - one-quarter of every palm fruit bunch is discarded. Open dumping and burning of solid wastes remain common practice. On the other hand, recycling, such as animal feed made from spent grains and soap made from lipid residues, occurs throughout the industry (Auchi in Math and Robinson, 1991, 484).

2.157 **Municipal Solid Wastes.** In rural communities solid waste disposal is often not a significant problem because of extensive recycling practices and the small volume of waste produced compared with the assimilative capacity of the surrounding ecosystem. Wastes are usually composted, buried, or thrown into the nearest water body. Organic wastes, such as oil palm wastes and plant peelings, litter river banks around settlements (Akinluyi and Odeyemi, 1984, 39-40). In Rivers State organized waste management in local government areas is limited to under-funded task forces that attempt to run the monthly sanitation day clean ups. In some areas of Delta State, solid waste management is more sophisticated. Communities construct walled cement platforms for waste collection from which council workers or private contractors either incinerate wastes or haul them to dumps outside of populated areas.

2.158 In contrast to the rural situation, high population densities, poverty, and inadequate infrastructure lead to a considerable solid waste problem in urban areas. Annual municipal solid waste generation in Port Harcourt amounts to 125,000 -160,000 tons (Grevy, 1995, 61; Amachree, 1993).

2.159 No safe disposal sites have ever been established in Port Harcourt. Wastes are disposed in at least 6 open dump sites located at Igurutu, Mile 3, Uboloma, Elelenmo, Rumuokoro and Reclamation Road (Map 2). The latter is situated in a wetland area where waste is used for land reclamation. No ground water monitoring is conducted at any of the sites (Ohichuku, 1994). Some urban areas in Delta State have engineered landfills, but none monitor or collect leacheates. The official disposal site for Warri is a stretch of a nearby river

(Ashton-Jones and Douglas, 1994, 176). Solid waste collection in Port Harcourt is largely limited to private contractors as only one of forty municipal waste collection vehicles is functioning (Ohichuku, 1994). The uncollected solid wastes accumulate, blocking drainage systems. Obstructed drains amplify flooding and expose residents to considerable health risks.

2.160 **Summary.** In Port Harcourt, households and small industries generate the largest quantities of non-hazardous wastes - they exceed industrial outputs by more than one order of magnitude (Table 2.8). However, industries are estimated to generate essentially all of the hazardous waste and sludge, with the refinery producing the largest amount of hazardous material. The total amounts and amounts per square kilometer of solid and sludge wastes are similar to cities in other developing countries. While the calculations only include data from Port Harcourt, the analysis and conclusions are anticipated to be relevant to other cities because of the similar economic and social composition of the other large urban centers.

Table 2.8: Estimated Total Solid Waste and Sludge Generation from Industry and Households in the Port Harcourt area (tons/year)

	Putrescible waste	Non-hazardous waste	Hazardous waste	Non hazardous sludge	Hazardous sludge
Medium and Large Scale Industries	6,495	1,796	127	990	13,617
Households and Small Industries	95,625	31,875			
Total (Round figures)	102,000	33,700	125	1,000	13,600

2.161 Since municipal solid waste generation is much larger than industrial solid waste generation, solid waste management programs should focus on addressing municipal wastes. The lack of safe disposal sites for hazardous sludge and waste originating from industrial activities is another clear priority. It is difficult to introduce treatment facilities concentrating hazardous components if no safe disposal options exist. Establishment of safe disposal sites for disposal of industrial waste should be considered as one of the first steps in a long term strategy for sewage, sludge and waste handling in Port Harcourt (Grevy, 1995, 61).

3. SOCIAL ISSUES AND CHALLENGES TO SUSTAINABLE DEVELOPMENT

The Niger Delta continues to sustain high population growth and, as a result of oil development, absorb large-scale immigration, particularly in urban areas. Given the limited area of dryland, population densities per habitable area are very high. The most critical social issues that require improvement are inadequate water supply and sanitation which result in poor standards of health. Health indicators in the Niger Delta are significantly worse than southern Nigerian averages. Water-related diseases, many of which result from poor sanitation and inadequate water supply, are the most severe health problem facing the region. Housing and infrastructure are deficient in many areas. Urban infrastructure is unable to cope with existing demand and will be further strained by projected population increases. In rural areas, inadequate clean water, sanitation, transportation, and electricity impair health and impede development in most communities.

A. DEMOGRAPHIC CHANGE

3.1 The most important demographic concern facing the Niger Delta is the high population growth rate combined with severe habitable land constraints. According to the 1991 census, Rivers State has 3.98 million inhabitants and Delta State has 2.57 million. Rivers is slightly more urbanized than Delta, with 31 percent versus 25 percent of its population living in urban areas. Population growth rates in both states are estimated to be around 3 percent (Ministry of Health, Rivers State, 1994). Since oil development began in the 1960s, immigration into the region has greatly increased. Until recently, migration followed the common developing country pattern of young people leaving their rural villages to search for work in larger urban centers, in this case Lagos and Port Harcourt. However, outmigration has slowed because unemployment is very high in the cities (Osundu, 1994). Limited prospects in urban areas have convinced many young people to remain in their villages.

3.2 The population densities for Rivers State and the former Bendel State are estimated to be 1.95 and 1.38 people/ha, respectively (Western Africa Department 1990, 116). However, state level data masks the very high population densities on habitable land in the riverine and coastal areas. With habitation largely restricted to the levees along the river banks in the freshwater swamp zone, the population density on habitable areas equals or exceeds the highest rural population densities found in Nigeria's most densely populated states, Akwa Ibom and Imo States (6.18 and 7.12 people/ha). The coastal beach ridge islands, another area of high ground, are nearly as densely populated as the freshwater zone. Within the mangrove region, populations densities are low because little land is habitable. Communities there build their houses on platforms above the high tide mark. Large towns, such as Nembe, are built on sand fill that radiates from a small core of high ground (Ashton-Jones and Douglas. 1994, 158).

B. HUMAN HEALTH

3.3 **General.** Health indicators for the Niger Delta States are lower than for the country as a whole and particularly low in comparison with the southeastern region. The major health concern in the delta is water-related disease - the state health ministries estimate that such diseases cause 80 percent of illnesses in the region. A study of the six major causes of death in Nigeria (measles, malaria, pneumonia, tetanus, dysentery, and tuberculosis) determined that the coastal area, including the Niger Delta, constituted a zone of disproportionately high fatality rates from these diseases (Egunjobi, 1993). It is important to note that the vast majority of health problems go unreported and most sicknesses are self-treated or treated by local herbalists. The Delta State Ministry of Health estimates that 80 percent of water-related disease sufferers do not go to a health center. The health statistics for 1991 from Delta State only include the 659 deaths which occurred in government hospitals which account for just 1.3 percent of the expected deaths in the state (Linddal, 1995, 79).

3.4 Adequate nutrition, particularly for children and pregnant women, is essential to human resource development. Childhood malnutrition increases infant mortality, reduces mental capacity, degrades quality of life, and restricts economic productivity. It also reduces the body's ability to cope with environmental stresses. While no data is available for the Niger Delta, Nigeria has a substantially higher level of malnutrition than many other developing countries. For example, 43 percent of Nigerian children are chronically malnourished compared with 30 percent in Ghana, Zimbabwe, and Brazil (Western Africa Department. 1993b, table 3.1). Environmental degradation is linked to nutrition problems. Poor sanitation and water contamination cause high incidences of diarrhea and other water related diseases which result in lower nutritional status. The reduced nutritional status causes a negative feedback loop which increases the duration and incidents of diarrhea and other illnesses. Over the long term, increased population pressure and unaddressed agricultural land degradation could impair the diets of Niger Delta inhabitants in general.

3.5 Immunization is the primary method of reducing childhood illness and infant mortality. By reducing the probability of illness, immunization decreases the impact of environmental stresses that impair health, including water contamination, food contamination, and air pollution. In the delta, immunization programs have been curtailed because of reduced funding. For instance, Delta State was able to immunize 80 percent of children in 1990, but less than 40 percent in 1993 (Ministry of Health, Delta State, 1994). Rivers State had an even more significant reduction, from 85 percent in 1989 to 15 percent in 1991 (Kue, 1992).

3.6 **Regulatory Framework and Institutions.** Health and sanitation are largely state concerns. Legislation covering health and sanitation include the Federal Government's Public Health Act and State Environmental Sanitation Edicts. The Edicts address sanitation issues such as waste disposal, sewage, water supply, pest control, and pollution. They also provide a legal framework for environmental management, with special emphasis on water quality and domestic and small scale industrial wastes and pollution. Specific state agencies, such as the Ministries of Health, SEPAs, and the Sanitation and Water Boards in both states, are charged with enforcing relevant sections of the Edicts. The Health Ministries are also responsible for improving the public health situation in their respective states.

3.7 The Health Ministries of both states allocate the highest percentage of their limited resources to controlling epidemics and immunizing children - neither state focuses on preventative environmental health (Annex J). Attempts to provide health care and teach basic sanitation in community health clinics in the Local Government Areas (LGAs) have been made, but were largely unsuccessful, especially in the riverine areas. For example, in early 1990s, the Rivers State Ministry trained two dozen community health workers in each of the LGAs , but only 5 or 6 remain active today (Joe, 1994). To increase chances for success, clinics must be staffed by properly trained personnel and incentives introduced to encourage them to remain in the rural areas. Additionally, infrastructure should be improved and medical equipment supplied. Efforts to encourage rural households to boil their drinking water is problematic because of the high cost of fuel and cultural aversion to the taste (Joe, 1994). In the old Bendel State, the Ministry of Health ran a pit latrine construction program that was moderately successful until funding ended in 1991. The major limitations facing the health agencies are: (i) limited funding; (ii) lack of emphasis on preventative environmental health and sanitation; (iii) few appropriately trained staff; and (iv) inability to consistently provide health care in riverine areas.

3.8 **Water-related Diseases.** Water-related diseases are the most critical health problem in the Niger Delta and the health issue most closely linked with environmental degradation. Although few water quality studies exist, the data available on water-related diseases and waste management practices illustrate that water contamination and associated disease is a problem throughout the Niger Delta. Water-related disease represents at least 80 percent of all illnesses in Delta and Rivers States (Figure 3.1).[1] In contrast, the limited national data show that the two principal water-related diseases, malaria and dysentery, account for only 26 percent of all cases of disease in the country (Egunjobi, Layi, 1993, 1267). Poor sanitation and lack of clean water are the primary reasons why feces transmitted diseases are endemic in developing countries. The Niger Delta region is no exception.

3.9 Although water is ubiquitous in the delta, potable water is difficult to find, especially during the dry season, when contaminants are not easily flushed out of the slow moving rivers and tides push the contaminants back upstream (Ashton-Jones, and Douglas. 1994, 31). In addition, 30 percent of the Niger Delta is located in brackish or salt water ecosystems. The high water table and flooding further aggravate water quality problems by increasing feces and waste contact with water and creating pools of stagnant water. Water-borne disease outbreaks are concentrated during the dry season because of water shortages or river flow and flushing rates. Households are forced to consume septic water supplies, as bacteria are not sufficiently diluted (del min, 1994). Bathing, eating contaminated seafood, and drinking contaminated water are the major exposure pathways leading to illness from water-borne infectious diseases. Inadequate waste disposal and water supplies indirectly retard economic growth because of lost human productivity. Children and poor households are particularly susceptible to water-related diseases.

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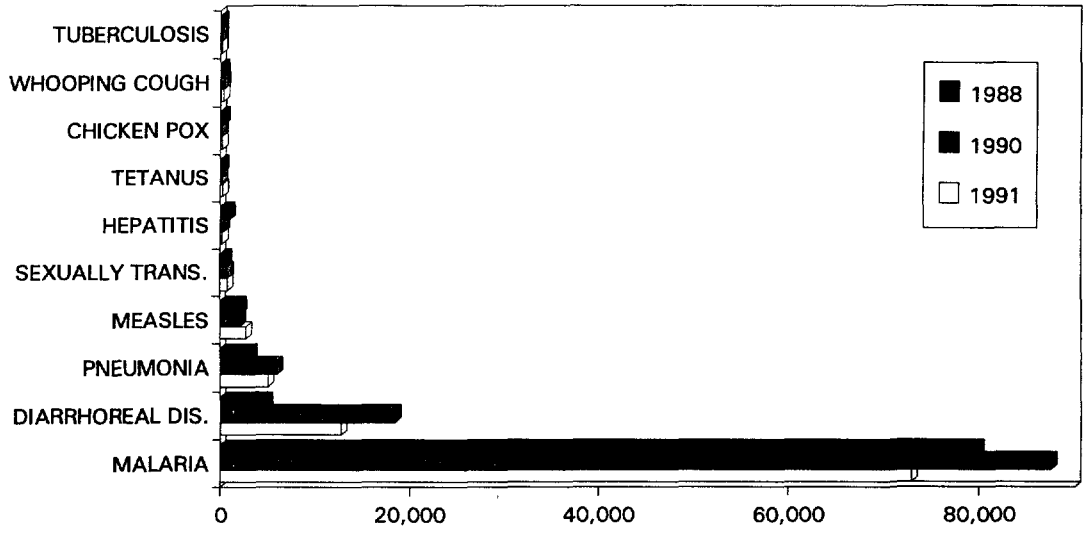
[1] The term water-related disease is used rather than water-borne because many of these diseases are not strictly water-borne but, like malaria, yellow fever, and onchocerciasis, their vectors require a water habitat during their life cycles.

3.10 The Delta State Ministry of Health estimates that 150,000 people contract water-related diseases every year. In Rivers State, health authorities report an increase in morbidity and mortality rates from gastro-enteritis since the late 1980s (Harry, 1994). The morbidity data for River State indicate the overwhelming importance of water-related diseases (Figure 3.1). Malaria is by far the most common cause of morbidity at Rivers State medical centers, followed by diarrhoreal diseases (dysentery, typhoid, and cholera). Cholera has been reported in Rivers State since 1971 (Olof Linden, 1993, 12). Data from government hospitals in Delta State presents similar findings. Malaria is the most prevalent disease, followed by diarrhoreal diseases. Respiratory diseases also cause a large number of illnesses. In addition, many cases of illness are not diagnosed in Delta State, including those arising from environmental hazards as well as other factors which health care practitioners are not able to diagnose (Grevy, 1995, 53). The Delta State Ministry believes that in addition to malaria, which virtually everyone contracts during their lifetime, two other water-related diseases, cholera and yellow fever are the most severe health problems facing the state (Box 3.1). Although guinea worm is common in five LGAs in Delta State and three LGAs in Rivers State, its control represents one of the few successful health programs in the delta. The Global 2000 program to eradicate the disease has reduced the number of reported cases in Delta State to only 50 in 1993 (Ministry of Health, Delta State, 1994). Registered cases of guinea worm in Rivers State also fell from 550 in 1990 to 98 in 1993 (Ministry of Health, Rivers State, 1994).

Figure 3.1

10 LEADING CAUSES OF DISEASES IN RIVERS STATE (MORBIDITY)



Diarrhoreal diseases include dysentry, cholera, and typhoid.

Source: General hospitals, health centres, dispensaries, and Public Health Department.

3.11 In a study of 27 water sampling stations throughout the Rivers State section of the delta, researchers found that over 85 percent of the samples contained total coliform counts above 40 coliforms per 100. Coliform bacteria, when found at such high levels, indicate fecal

contamination. The researchers also found *Escherichia coli* biotype 1, *Streptococcus faecalis*, and *Clostridium perfringens* in over 75 percent of the samples (Akinluyi and Odeyemi, 1984). While low levels of coliform bacteria can be naturally occurring in water and soil, the other three bacteria and the high levels of coliform found are unambiguous indicators of fecal pollution. Water containing any of these bacteria is considered unsafe for human consumption (Feachem et al, 1983, 53-55). The presence of high fecal indicator bacteria levels spread over such a wide area in the delta graphically illustrate the severe water contamination problems of the region.

Box 3.1
Recent Epidemics in Delta State

1991: An epidemic of yellow fever is estimated to have afflicted 50,000 people and killed 5,000 to 7,000 in Delta State.

1992: 10,000 people in Delta State are estimated to have contracted cholera during a three month epidemic at the end of 1992.

1993: Between October and December, Delta State communities reported 30 cases of cerebral spinal meningitis.

Source: Public Health Department, Delta State Ministry of Health.

3.12 **Other Stresses to Human Health.** Available evidence does not show AIDS related illnesses to be a major health issue in the region. Rivers State reported 30 cases of AIDS in 1993. Delta State reported 10 cases of AIDS in 1993, up from 1 in 1990 (Ministry of Health, Delta State, 1994). No data on the number of HIV positive persons are available. The Ministry of Health for Delta State reported that the number of tuberculosis cases has been increasing recently (Omen, 1994). The incidence of tuberculosis is also rising in Rivers State (Isoun, 1994).

3.13 In addition to exacerbating the water related diseases discussed in the preceding section, water pollution from industries and agriculture can cause chronic and acute toxicity (see industrial pollution sections). Of particular concern are industries producing hazardous wastes such as the steel, metal fabrication and finishing, textiles, pharmaceuticals, oil refining, and paint industries (Annex H). Since facilities producing these products are generally concentrated in large centers, particularly Port Harcourt, health risks from hazardous waste are expected to be concentrated there. Human risk assessments for industrial pollution have not been conducted in the delta region. The studies that have been conducted on metal concentrations in West African waters and fish have found them to be well within acceptable levels (Biney, 1991; Sadik, 1990, Ndiokwere, 1984). The amounts of pesticide used in the delta are very small and not yet a cause of concern except, perhaps, to applicators. An

exception may be users of water bodies downstream of oil palm plantations, which over the past decade have intensively applied pesticides.

3.14 Insufficient information exists on air pollution in the Niger Delta to accurately determine the health impacts and social costs. At a minimum, a baseline inventory of ambient pollution levels is required. On a regional level, vehicular emissions are believed to create the greatest health risks. These include respiratory problems from particulates and smog, and lead contamination (estimates of the health benefits of reduced particulate emissions are presented in Box 5.11). Communities near oil production flow stations complain of a variety of respiratory ailments that they associate with gas flaring, but no studies are available to document these claims. Large industrial facilities, such as the refineries and the fertilizer plant, cause localized air pollution which may impact communities downwind. Occupational exposure to air pollution, especially from small and cottage industries, is believed to cause chronic health problems. Since many of these small industries are located in residential areas, the pollution may also impair the health of nearby residents.

3.15 A single study related to health effects has been identified for some of the big industries in Rivers State and Port Harcourt area (Ayotamuno, 1993). At Onne, Eleme, Okrika and Ogu, communities where NAFCON and the NNPC refineries are located, 38-60 percent of respondents complained of regular stomach upsets, up to 29 percent complained of eye irritation and 62-78 percent were dissatisfied with the quality of well water. In Trans Amadi Estate, the industrial heart of Rivers state, only 15 percent of those surveyed complained of regular stomach upset. This is surprising as they live in an area expected to have the highest industrial health impact, whereas those surveyed in Onne, Eleme, Okrika and Ogu live in less densely populated rural areas and are expected to have fewer health problems resulting from industrial growth. One explanation may rest on life quality expectations of the different communities.

3.16 Incomplete research on health statistics and ambient pollution levels makes an accurate assessment of the potential gains from investments in environmental improvements very difficult. However, there is little doubt that investments in environmental facilities (water, sanitation and waste management) particularly in urban areas, such as Port Harcourt, would generate substantial welfare improvements. In all likelihood, a comprehensive economic assessment would also reveal substantial gains in health improvements and identify capital to be the major constraint for achieving them.

C. HOUSING

3.17 Housing and infrastructure are deficient in much of the Niger Delta. The link between health problems and poor housing is very strong. By increasing the intensity and frequency of environmental stresses, such as rain and temperature fluctuations, poor housing conditions significantly reduce the body's ability to resist disease. Studies of housing conditions in Bendel and Rivers States in the early 1980s determined that only about 20 percent of rural houses were physically sound and that about 40 percent required major repairs to meet basic housing standards, with urban houses in slightly better condition (NEST, 1991, 207). Although the

data are over a decade old, the deteriorating economic situation makes it unlikely that housing conditions have improved in the 1990s.

3.18 The poorest urban housing conditions are in the waterfront slums of Port Harcourt, which have a population of approximately 550,000. The lack of urban planning in the delta is particularly acute in these communities. Households pile up mud to extend the riverbank on which they build poorly designed houses. Since the reclaimed land is not properly compacted, bank failure frequently collapses houses into the river. Annual flooding causes considerable hardship in the communities because the reclaimed land is rarely high enough to remain dry even during minor flooding. Fire is also a constant hazard. For example, a fire in October 1993 destroyed 150 waterfront houses (Ayotamuno, 1993). These areas have no electricity, water supply, or sanitation infrastructure. Nearby creeks serve as the solid waste dump, water supply, and toilet (Arene, Ukpeibo, and Nwanze. 1989, 296).

3.19 The materials used in the construction of housing in the region are generally adequate, however, they are often not to properly maintained. Roofs are typically constructed with corrugated metal sheets or thatching. Most houses in southeastern Nigeria have cement (59 percent) or earth floors (39 percent) (Federal Office of Statistics, 1992). The percentage of earth floors is higher in rural and riverine communities. If the structure leaks during rains, earthen floors can become muddy and unsanitary.

3.20 The high frequency of flooding during the rainy season requires that many families in low lying areas and coastal barrier islands construct their houses on stilts to keep the floor above average flood levels. Mangrove fishing communities have to construct virtually all of their buildings on poles to compensate for tides, as well as flooding. Erosion problems also aggravate poor housing conditions. In some villages, houses perch precariously over the river's edge and are swept away during floods or heavy rains (Douglas, 1994).

D. INFRASTRUCTURE

3.21 **Overview.** Adequate infrastructure is essential in breaking the nexus of environmental degradation, poverty, and poor human health. The most pressing infrastructure deficiencies are access to potable water and adequate sanitation. Insufficient water and sanitation infrastructure in both urban and rural areas are direct causes of water-related disease, which is the most significant health issue in the region. While line ministries and development organizations are developing substantial transportation and power programs, effective water supply and sanitation efforts have yet to be initiated.

3.22 Port Harcourt, the largest urban center in the delta, does not have the infrastructure necessary to cope with its rapid expansion. Containing only 75,634 people in 1952, the population tripled during the oil boom of the 1970s, and is now estimated to be over 1 million. Housing and infrastructure construction in Port Harcourt has lagged far behind immigration. Smaller centers, such as Warri, Yenagoa, and Ughelli, also continue to grow at rates which exceed current infrastructure capacity.

3.23 Outside of Port Harcourt and other large centers, public services are even less common. Most communities have experienced at least one development project (typically boreholes, community health clinics, or electrification), but benefits usually last for only a few years before lack of funding or maintenance render equipment inoperable. Several private companies provide infrastructure services to surrounding communities to augment limited municipal services. For example, Asaba Textile Mill, NAFCON, and Eagle Cement supply water to surrounding residents (Grevy, 1995, 55). Lack of community services is the rule, rather than the exception in riverine communities. As an example, in Ogoni and Botem-Tai villages, southeast of Port Harcourt, no public services, such as electricity, telephones, pipe-borne water, or health services, are available, while 96 oil installations, a fertilizer plant, two refineries, and a petrochemical plant operate nearby (*Cultural Survival Quarterly,* 1993, 3; *Wall Street Journal*, 1994, 1).

3.24 **Regulatory Framework and Institutions.** The state governments have expanded on the federal Town and Country Planning Law with their own decrees and planning boards covering water supply, land use zoning, waste management, transportation, and sewage. While simple, these land use regulations, if enforced, would improve considerably the health of urban communities. However, lack of enforcement has meant they have had little impact.

3.25 Outside the major urban centers, the Ministries of Works and Transport are responsible for waste disposal, but have little impact on the ground. In the urban centers, the municipal sanitation and water boards are responsible for water supply and waste management. The poor state of domestic solid and liquid waste management in urban areas includes inoperable collection vehicles, no sanitary landfills, no wastewater treatment facilities (Chapter 2). Urban municipal water supply is also undeveloped; in Rivers State, only 50 percent of urban residents have access to pipe borne water, none of which is treated (Federal Office of Statistics, 1991). OMPADEC is currently implementing a large portfolio of infrastructure investments, emphasizing road construction. The major institutional constraints to more effective provision of infrastructure are: (i) capital constraints; (ii) lack of enforcement of land use and sanitation regulations; (iii) no incentive framework for improved services; and (iv) lack of emphasis on maintenance.

3.26 **Water Supply**. Access to safe water is generally inadequate in both states. This is a direct consequence of poor sanitation and waste management practices, and negligible water supply infrastructure. The State Health Ministries estimate that just 20 to 24 percent of rural communities and 45 to 50 percent of urban communities have access to safe drinking water sources (Ministry of Health, Delta State 1994; Ministry of Health, Rivers State, 1994). The estimates are corroborated by the General Household Survey which found that all rural respondents in Rivers States obtained their drinking water from streams, which have a higher risk of contamination than groundwater sources (Figure 3.2). Similarly, Delta State residents in the riverine areas use surface water, while upland denizens tend to rely on boreholes (Ministry of Works, Delta State, 1994). In some fishing camps along the mangrove section of the Bonny River, residents have to spend every third or fourth day to obtain freshwater at the nearest source (NDWC, 1995, 4). The Rivers State Water Board has developed 38 borehole projects, but only eight continue to operate (Dinyai, 1994). In both states, OMPADEC has provided equipment, but no maintenance for borehole projects (OMPADEC *Quarterly*

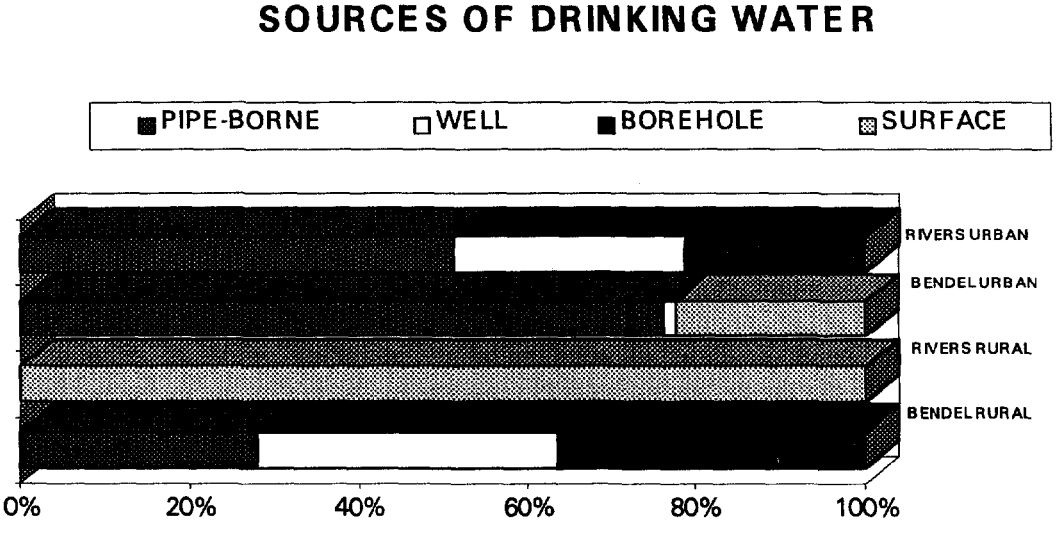
Report. October, 1993). Villages often prefer better tasting river water over borehole water which is often colored and tainted with iron or other substances.

3.27 Pipe-borne water in urban areas is available to 56 percent of Rivers State and 78 percent of the former Bendel state inhabitants (Federal Office of Statistics, 1991). According to the Water Boards of both States, none of the public water supply is treated (Dinyai, 1994). New pipes need to be laid in most urban areas because they were constructed over 40 years ago and are susceptible to leaking. (Ayotamono, 1994). The Rivers State Water Board has begun replacing the existing water pipe network in Port Harcourt (Rivers SEPA, 1993, 14).

3.28 Data on water supply in Port Harcourt indicates that the annual withdrawal capacity (84 l/person/day for 850,000 people) is sufficient to supply domestic demand (Grevy, 1995, 56). However, water supply studies and observations of a ubiquitous lack of tap water in densely populated areas contradict these estimates. A study of water supply problems in Diobu, Port Harcourt, found that broken pipes and chronic electrical shortages which hampered sub-pumping capacity were the major factors limiting water supply (Ayotamuno, 1994). Investigations on maintenance and supply capacities in the network indicate that pipelines and other facilities need maintenance or renewal, particularly in densely populated areas of Port Harcourt.

3.29 Water quality is not easily assessed because of very limited data. Generally, bacteriological tests are not performed at the consumer level, but some measurements indicate the presence of coliform bacteria in tap water (Ayotamuno, 1994). Coliforms and other bacteria indicating fecal contamination also have been found in surface waters in locations throughout Rivers State (Akinluyi and Odeyemi, 1984).

Figure 3.2

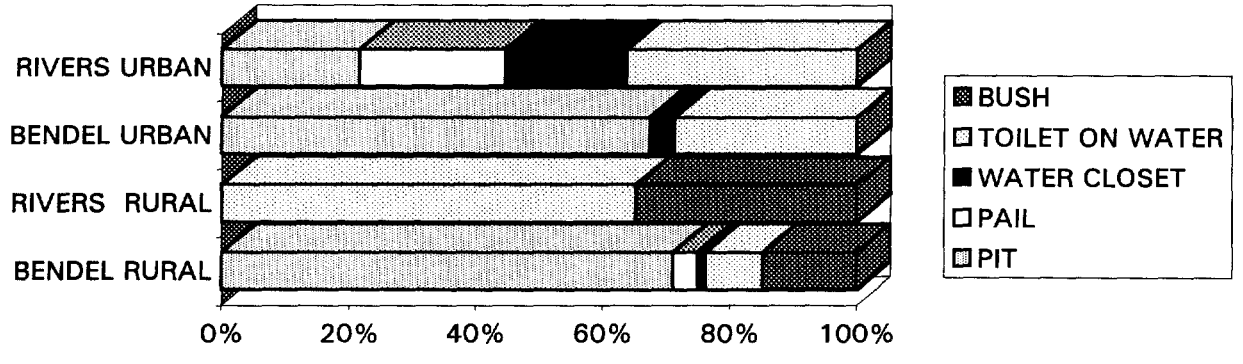


Bendel data used because Delta State data are not yet available. Source: General Household Survey, 1991.

3.28 **Sanitation.** Adequate toilet facilities are rare in Niger Delta communities. In the past, low population densities limited the magnitude and extent of problems associated with traditional sanitation practices, but expanding populations have overwhelmed their efficacy and exceeded waste assimilation thresholds. In stagnant areas, water becomes septic from human excrement and household waste dumping (Akinluyi, and Odeyemi. 1984, 40). Only 25 percent and 12 percent of Delta and Rivers State households respectively are estimated to use satisfactory sanitation facilities (Ministry of Health, Rivers State, 1994). The Rivers State percentage is less than half the Nigerian average (28 percent) (World Bank, 1992a). In rural Rivers State, nearly two thirds of households use toilets constructed over water bodies; usually the same water bodies that are used for bathing and drinking water (Picture 3.3) (Figure 3.3) (Federal Office of Statistics, 1991). In some cases, the public toilet and bath house are the same building. In the rural areas of the former Bendel state, the use of such toilets in rural areas drops to 9 percent primarily because of the lower percentage of riverine area. However, the percentage is probably considerably higher in the riverine areas of Delta State. Even in the urban areas in both states, toilet buildings over water bodies are still used by approximately 30 percent of the population (Federal Office of Statistics, 1991). Unfortunately, instead of recommending simple latrines which could be constructed on dry areas, local authorities continue to advocate construction of toilet buildings over water (Ashton-Jones, and Douglas. 1994, 176).

FIGURE 3.3

TOILET FACILITIES IN THE NIGER DELTA



Source: General Household Survey, 1991.

3.29 Pit latrines, while preferable to toilets built over water, are difficult to construct in the brackish and freshwater ecozones because of the high water table (Ashton-Jones and Douglas,1994, 176). The greater proportion of dry land allowed more frequent construction of pit latrines in the former Bendel State and explains why they constitute nearly 70 percent of toilet facilities, compared with only 17 percent in River State.[2] While potentially an

[2] Since the former Bendel state contained both upland Edo State and partly riverine Delta State, the Bendel statistics are skewed towards upland data. If data were available for Delta State, it would be more similar to that of Rivers State (rivhealth, 1994). This scenario is true for both infrastructure and health statistics.

improvement over direct discharge into the nearest water body, poorly maintained pit latrines can overflow in the rainy season increasing the risk of water-borne diseases.

3.30 No municipal wastewater treatment facilities exist in either state (Ohichuku, 1994; Ministry of Works, Delta State, 1994). Urban residential wastes are directly discharged to the nearest open drain, water body, or soaked into the ground (Box 3.2). In the rainy season the runoff capacity of the drainage system is insufficient causing flooding in densely populated areas such as Diebu and Township in Port Harcourt. In Map 3 the most prominent drains have been shown with indication of areas with risk of flooding during the rainy season. When the drainage systems are filled with waste during heavy rainfalls the environment is intolerable and hazards from water related diseases are high. Although Rivers State authorities are improving drainage in Port Harcourt, without construction of wastewater treatment plants, this action may further degrade water quality in adjacent water bodies.

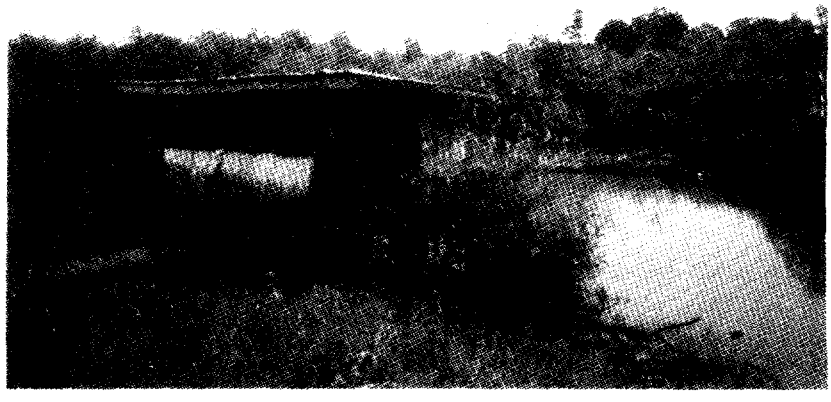
3.31 Poor sanitation greatly increases water pollution problems. Together they are one of the major causes of infectious diseases in the Niger Delta. There is a direct link between poor sanitation contaminating water supplies and creating breeding grounds for pathogens and their vectors. When sanitation and water supplies are improved, the incidences of diseases such as cholera, shistosomiasis, dysentery, diarrhea, and guinea worm will fall. Improved latrine facilities in the rural areas and a major overhaul of sanitation infrastructure in the urban areas are vital for the region to significantly improve health standards.

E. TRANSPORTATION

3.32 Within the Niger Delta, transportation is often difficult and expensive, especially in the flood season. Water transport is the most common form of transportation. Many of the large towns are not connected by roads. Water transport is particularly critical in the wet season when flooding severely interferes with land transport. However, even in the dry season, less than 20 percent of the delta is accessible by road. The climate and the hydrological regime make road construction and maintenance prohibitively expensive, with bridges and culverts essential. The expense of road construction has greatly constrained economic activities in large areas of the delta: it is a major reason why the mangroves are largely undisturbed. This may change, however, as the major emphasis of OMPADEC's development program throughout the LGAs in the delta is road construction. Environmental impact assessments are essential to ensure that road development takes into account potential environmental effects. As roads are cut through the delta, forest habitats are fragmented and aquatic ecosystems may be disrupted.

3.33 Transportation for the local population is expensive. A return trip between many riverine communities and Port Harcourt costs as much as a the monthly salary of a government worker. Although an important global producer of oil, the Niger Delta has almost no rural retail petroleum outlets. To obtain fuel for generators and outboard engines, inhabitants usually have to travel to Port Harcourt where they purchase large quantities of fuel for community distribution. Considered hoarding, the practice is illegal, but is often the only way to distribute petrol (Douglas, 1994).

Picture 3.1
Toilet Building Over a River



F. HOUSEHOLD ENERGY

3.34 Fuelwood is the most common source of energy in rural communities, but is secondary to kerosene and natural gas in urban areas (Ministry of Health, Delta State 1994). According to ESMAP estimates, consumption levels for fuelwood in both Rivers and the former Bendel State are considerably lower than the sustainable yield; in contrast to the national average which faces a deficit (Table 2.5). Thus on a regional level, fuelwood availability is not a concern for residents of the Niger Delta states. Household electrification levels are not known for the Niger Delta, but are believed to be considerably lower than the national average of 41 percent (World Bank, 1994d). OMPADEC has established some electrification projects and has proposed numerous others.

G. CURRENT AND POTENTIAL RESOURCE CONFLICTS

3.35 Conflicts between stakeholders over resource rights and uses are endemic in the region. The most frequent and serious conflicts have pitted local communities against oil companies. Other large development activities have also angered communities to the point of hostility. The issues can be explained by three underlying themes: (1) distribution of benefits and costs, (2) accountability, and (3) resources rights. The third theme is discussed in Chapter 4 and links closely with the other two. Without well defined and enforceable resource rights, institutions are not accountable to the local communities and do not have to be concerned about the distribution of benefits and costs to them.

Box 3.2
Nembe - Sanitation and Infrastructure in the Mangrove Ecological Zone

A large town on the Nun River, Nembe, typifies the water contamination problems of riverine communities. Inadequate sanitation results in the creek between the two islands of the town being filled with sewage. At high tide, low lying areas of the town flood with human refuse. Potable water is available from only one borehole. When the borehole generator fails, inhabitants must obtain their water from decrepit and foul brackish-water wells. Electricity is available for one hour each day, only long enough to allow the generator to pump water from the borehole.

Source: Ashton-Jones and Douglas, 1994.

3.36 **Oil Activities.** Of the resources available in the Niger Delta, oil is by far the most valuable to the national economy. However, the benefits to the Niger Delta region are less obvious. Oil development can degrade the environment, impair human health, and precipitate social disruptions. While oil activities have undoubtedly caused significant and extensive environmental degradation in the region, the near universal belief of delta residents that oil activities are the sole cause of environmental problems is exaggerated. Nevertheless, viewed in its social context, simply because local communities perceive oil activity problems and especially oil pollution to be greater than they actually are does not make the issue less severe: it just makes it more difficult to solve. The most recent federal government attempt to redress the social impacts of oil development is the creation of the Oil Mineral Producing Areas Development Commission (OMPADEC) (Box 3.3).

Box 3.3
OMPADEC

Established by the federal government in 1992 to improve on the ineffective 1.5 percent fund to assist the development of oil producing areas, OMPADEC is designed to distribute 3 percent of government oil revenues back to oil producing Local Government Areas (LGAs).[3] In 1993, OMPADEC's budget amounted to approximately N1.9 billion (US$95 million). In proportion to their oil production, Rivers State receives about 40 percent and Delta State receives about 35 percent of OMPADEC's allocations. Given its substantial funding and direct accountability to the Presidency, OMPADEC is probably the strongest government institution in the region. In just 2 years, OMPADEC has achieved significant results on the ground in the form of infrastructure projects. While it has made significant process in infrastructure development, the Commission has several major constraints which must be overcome for it to become an appropriate regional development agency, including:

- No environmentally sustainable development emphasis;
- Lack of implementation of its ecological mandate;
- No long term planning;
- No provision of maintenance and services;
- Lack of environmental policies, expertise, and project assessment; and
- Poor dialogue with other institutions and communities.

3.37 Most stakeholders have concluded that oil companies are the major environmental culprit because their activities are highly visible and create highly visible local ecological impacts. Many residents assign a direct cause and effect relationship between oil development and declines in fisheries and agricultural productivity because both phenomena began at roughly the same time. However, the timing may be largely coincidental and other factors such as population increases and migration, as well as the construction of upstream dams, are more significant causes of the productivity declines. Communities in the Niger Delta recognize that whereas many families continue to live in squalor, other Nigerians and foreigners are being enriched by the petroleum resources exploited in the Niger Delta. Communities also resent the fact that immigrants into the region get the bulk of oil company employment. Residents feel justified taking what compensation they can obtain from the oil companies because they view the companies as having unlimited sources of money and causing environmental damage without creating local benefits (Annex M evaluates the compensation programs and discusses the problem of pipeline sabotage). Since they obtain few benefits from oil development and are required to shoulder the environmental and social costs of exploration

[3] See Annex K for supplementary information on OMPADEC.

and extraction, it is not surprising that they overstate the environmental problems caused by oil activities.

3.38 The attitudes of the oil companies have increased friction between rural people and the oil companies. Generally, they have preferred to ignore the local communities. When they have had to deal with villages, companies usually communicate with the most obvious leader, a local chief or politically powerful person, who may have very tenuous ties to the community, rather than making an effort to determine who represents the villages. Though oil companies have attempted to assist communities near oil installations, most of their projects have had little impact (see below Social Initiatives of the Oil Companies).

3.39 Two surveys to determine the public's perception of the oil industry were conducted in the early 1980s. In the first study, a researcher examined the views of two small communities near the Forcados oil terminal (Ikporukpo, 1983). Over 60 percent of the respondents from one village, Ogulagha, felt that oil activities benefited their community, while in another village, Odimodi, only 10 percent felt their community benefited. The large difference between the two villages highlights a major concern of many communities that more politically powerful riverine communities and individuals benefit from oil activities or compensation while the vast majority receive nothing. In this case, Ogulagha, part of the residential area of Forcados, benefited from additional municipal services and infrastructure arising from oil development, which were not provided to Odimodi.

3.40 An American consulting firm conducted a second survey in 1983 covering a much larger geographical area. They questioned inhabitants of 47 communities in southern Nigeria and 10 northern communities regarding their attitude towards oil operations (Research Planning Institute. 1985, VI). Of the southerners interviewed, 71 percent believed that oil pollution was a problem, with those living in the freshwater swamp region and parts of the mangrove ecozone being most concerned about the pollution. Seventy-three percent of southern respondents reported that the oil companies have done nothing for their area, while only 8 percent stated that they had benefited from infrastructure development.

3.41 The two studies show that in contrast to the tremendous national benefits of oil production, southerners, especially those from the Niger Delta, considered it more of a burden than an advantage. However, it can also be concluded that those who benefit from oil activities, i.e., the residents of Ogulagha, tend to view them as less damaging.

3.42 **Conflicts over Oil Activities.** The conflicts between oil companies and communities are not recent occurrences confined to a small number of villages. Instead, they are flash points of region-wide expressions of long term frustration at what inhabitants feel is inequitable distribution of oil income and costs. Protests began in the late 1970s after a series of large oil spills. The situation has become severe in some communities, notably Ogoniland. Oil companies have been shut out of some of their fields and have to be accompanied by armed guards in others. Military police and troops, originally in response to Shell's request for assistance, have violently suppressed protests in Ogoniland. The Ogoni incidents are the most severe and best publicized of the oil conflicts. However, other areas have also become centers of social unrest. In 1993 alone, Agip had problems with Rivers State communities at its

Obrikom-Obiafu gas re-injection plant and Tebibada, Obama and Clough Creek flow stations (Adams, 1993, 34).

3.43 Although social disruptions must be expected in areas where traditional communities interact with modern resource extraction activities, the social unrest prevalent in the Niger Delta is not evident in many other oil producing regions of the world.

3.44 **Social Initiatives of the Oil Companies.** In addition to government mandated compensation programs and government revenue allocation programs, the oil companies have developed their own community projects. Annually, the oil companies estimate that together they spend US$30 million on community development (Anderson, 1994). Their projects emphasize infrastructure, but rarely include maintenance or service components. Although largely unintentional, road construction designed primarily for company use is perhaps the most common community development activity because road access is unrestricted. Between only 1982 and 1984, the oil companies renovated or constructed 726 km of roads in the delta, which made up 63 percent of the value of their community development projects (Research Planning Institute. 1985, VI-40). Since 1985, Shell reported spending more than US$2 million on community projects in Ogoniland, primarily for road improvement, water projects, classroom construction, and school equipment. In addition to its community level projects, Shell operates an agricultural station near Warri which is attempting to improve cassava yields of farmers in the delta. Direct employment of local people includes, for example, 20-50 percent of seismic crews (van Dessel and Omuku, 1994, 438). Inspite of the large investments, the impact of the oil company investments on improving the quality of life in the delta has been minimal.

3.45 **Oil Palm Plantations.** This section presents an overview of resource conflicts associated with oil palm plantation projects. The nexus of oil palm plantations causing environmental degradation and reducing local income in the riverine areas is clear. It has also precipitated social conflict. Risonpalm, a state government parastatal, is the major oil palm company in the region. It has developed 23,000 ha of palm plantations and plans to establish an additional 13,000 ha. The Delta State program is smaller, with 7,000 ha planted and 13,000 additional hectares proposed.

3.46 Risonpalm does not follow a systematic program of communication with local communities. For example, written agreements are not obtained from communities before land appropriation, and community meetings are seldom called. The company justifies this approach on the Land Act of 1978 which vests rights to all state land in the government. The company pays compensation for its appropriations, but at levels even lower than the oil activity rates. Communities, seeing the ecological and economic losses sustained by some villages bordering oil palm plantations, have begun disrupting new Risonpalm operations. Their actions are analogous to community activities against oil companies. For example, at the Bori highland plantation, Risonpalm was forced to suspend the clearing of land after communities threatened its employees and property. (Guardian, 30 June 1994). In March 1995, problems between Risonpalm and communities arond the Ubima plantation led to Risonpalm calling in the Internal Security Forces which occupied and disrupted village activities for three weeks (Sunray, 22 April 1995). State property rights offer little protection

against land confiscation. Until community and NGO protests halted its expansion, Risonpalm had planned to replace the Upper Orashi Forest Reserve with a monoculture of oil palms. The State Forestry Department was unable to protect this biologically rich area in the face of the parastatal's development plans.

3.47 To reduce community problems, Risonpalm and the Niger Delta Basin Development Authority have recently begun stressing smallholder development projects instead of large nucleus estates, but communities have yet to readily embrace the small-holder programs.

3.48 **Potential Future Conflicts: Mangrove and Fresh-water Ecozone.** Two future resource developments, rice cultivation and aquaculture, may cause social problems directly by disrupting traditional societies and indirectly by increasing environmental degradation in the mangrove forests. Culture fisheries have a more restricted geographical environmental impact than capture fisheries, but being more intensive, the local ecological damage tends to be more severe. By destroying parts of the ecosystem, aquaculture and rice culture may reduce the value of the ecosystem to traditional users, including fisherfolk. Fish grown in aquaculture systems tend to be too expensive for local communities to purchase and will mostly be produced for export. Fish exports from the area could reduce the fish biomass available to local residents, reducing their protein intake. A conscious effort must be made to cultivate species for local as well as export markets. Decreased water quality, which could result from fish culture or rice projects, can stress human health both directly and through the consumption of contaminated food. Extensive rice production would reduce both mangrove and marine fisheries. Rice projects may also impair human health through water contamination and the creation of ideal microhabitats for snail hosts of human schistosome parasites (NDWC, 1995, 27).

3.49 Several studies in Asian countries have often found that large scale shrimp mariculture projects not only do not benefit local communities, but also can lead to greater impoverishment. Alternatively, when local communities fully integrate into the development projects, they generally benefit substantially (Burroughs, 1994). If mangrove development follows the customary route of lack of accountability to local communities, it can be anticipated that they will have very limited input into project development and implementation. It is also likely that their traditional ownership systems over mangroves and creeks will be ignored. As the resource base available to riverine people is converted to rice or aquaculture projects, it can be expected that income distribution will become more inequitable as less of the income may be available to rural communities despite the fact that these areas become more productive (Kulleseid et al., 1994, 10). In a study of aquaculture projects in Bataan, the Philippines, socio-economists found that the poorest households were the most adversely affected because of reduced aquatic areas and mangroves open to their harvesting (Edwards, 1982, 41).

4. THE INDIRECT CAUSES OF ENVIRONMENTAL ISSUES

To develop sound strategic options, it is critical to understand the underlying, or indirect causes, as well as the direct causes of environmental problems. Environmental degradation at the interface of two ecological systems such as coastal zone areas, results from complex relationships between indirect and direct causes. This chapter unravels these relationships by presenting the key indirect causes of degradation and determining how they interact and relate to the direct causes. The indirect causes are categorized into three major areas: (i) population growth and distribution, (ii) resource ownership, and (iii) policy failures.

A. ANALYTICAL PERSPECTIVE

4.1 This section evaluates the ultimate causes for environmental issues in the delta and builds on the environmental degradation and underdevelopment linkages described in the rest of the report. Environmental degradation, particularly at the interface of two ecological systems such as coastal zone areas, is often a result of complex interrelationships of indirect and direct causes. While the direct causes of environmental damage, like oil pollution and deforestation, are evident and discussed in the environmental problems section, this chapter examines the indirect causes that have led to the environmental and social problems of the Niger Delta. The indirect causes have been categorized as follows (Table 4.1):

- Population growth and distribution
- Resource ownership
- Policy failures

Table 4.1: Major Causes of Environmental Degradation

Problem Type	Problem	Direct Causes	Indirect Causes
Land Resource Degradation			
	Erosion - coastal	Sediment loss. Infrastructure construction.	Upstream dams. Population pressure. Weak enforcement. Natural and human induced land subsidence. Sea level rise.

Problem Type	Problem	Direct Causes	Indirect Causes
	Erosion - riverbank	Heavy rainfall. Unsustainable farming. Sediment loss.	Upstream dams. Population pressure. Weak enforcement. Natural and human induced land subsidence. Sea level rise.
	Flooding	Heavy rainfall. Agricultural expansion. Reduced upstream water retention.	Population pressure. Upstream dams. Natural and human induced land subsidence. Sea level rise.
	Sea Level Rise	Climate change.	International air emissions.
	Agricultural Land Degradation	Unsustainable farming. Decreased sedimentation. Excessive flooding Increased erosion.	Population pressure. Upstream dams. Lack of inputs.
Renewable Resource Degradation			
	Fisheries - stock depletion	Fishing techniques. Fishing intensity. Post harvest losses.	Population pressure. Weak enforcement. Open access (limited). Post harvest losses.
	- habitat degradation	Trawling. Pollution. Oil activities. Nutrient loss.	Weak enforcement. Open access. Upstream dams.
	Forestry - deforestation, degradation	Agricultural expansion. Infrastructure expansion. Indiscriminate logging.	Population pressure. Weak enforcement. Infrastructure expansion. Open access (limited). Incomplete markets.
	Biodiversity Loss	Hunting. Habitat loss.	Population pressure. Infrastructure expansion. Weak enforcement. Open access (limited). Incomplete markets.
	Exotic Species Expansion - (1) water hyacinth, (2) Nypa palm	Introduction (1,2). Forest degradation (2).	Weak enforcement. Open access.
Environmental Resource Degradation	Water Contamination		
	- oil	Inadequate wastewater management. Spills and leaks.	Weak enforcement. Incomplete markets.

Problem Type	Problem	Direct Causes	Indirect Causes
	- industrial	Inadequate wastewater management.	Weak enforcement. Open access. Incomplete markets. Subsidies.
	- - toxic and hazardous substances	inadequate waste management. inadequate urban infrastructure.	Weak enforcement. Open access. Incomplete markets.
	-other	Inadequate sewage treatment.	Population pressure. Weak enforcement. Open access. Incomplete markets.
	Air Pollution - gas flaring, industrial, vehicular	Industrial pollution. Vehicular emissions.	Weak enforcement. Open access. Incomplete markets. Subsidies.
	Solid Wastes - industrial, municipal	Inadequate waste management. Inadequate urban infrastructure.	Population pressure. Weak enforcement. Open access. Incomplete markets.

B. INDIRECT CAUSES

Population Growth and Distribution

4.2 At first glance, the Niger Delta does not appear to have a population density problem. However, as the social issues chapter points out, very little land in the delta is suitable for habitation or farming. All three of the wetland ecosystems, fresh-water, barrier island, and mangrove forests, are at least as densely populated as any area in Nigeria (Ashton-Jones and Douglas. 1994, 26). Urban areas, particularly Port Harcourt, are under pressure as they continue to attract large numbers of young people from throughout the region, even though the prospects for economic advancement are very limited. Between the 1963 and 1991 censuses, the population of Rivers State increased by 2.7 percent annually. The population of the two states is estimated now to be growing at 3 percent per year. At this rate, the population will double in two decades. Even without considering migration into the region, this increase will severely tax the already densely populated habitable areas of the Niger Delta. Since large scale oil development started in the 1960s, immigration has been very high, as people have been drawn to the region with the hope of direct or indirect employment in oil related actities.

4.3 Population growth is not inherently a problem. It can be accommodated if agricultural production is shifted to more efficient and intensive production systems and if urban areas are able to provide services to expanding populations (Western Africa Department, 1994a, 33). However, neither of these situations is evident in the delta. Instead, the information points to

current population densities already disrupting natural, economic, and social systems. For example, the population of urban centers greatly exceed the capacity of infrastructure to provide adequate social services. This has led to poor health conditions and lower economic productivity. In rural areas, negligible agricultural intensification has resulted in degraded land, forest, and wildlife resources without improved socioeconomic conditions in communities. The natural capital of at least three ecological zones (freshwater, barrier island, and lowland forests) is being exhausted to meet the needs of a growing population, relegating communities to greater impoverishment in the future.

Resource Ownership Issues

4.4 The lack of well defined property rights is a primary cause of environmental degradation in the Niger Delta. As well as being clearly defined, property rights also must be respected and enforced. Without tenure security, resources are over-used or over-developed, leading to environmental degradation and rural impoverishment.

4.5 Under the Land Use Act No. 6 of 1978, all land legally belongs to the federal government and is administered by the military administrator of each state. This legislation attenuates the traditional rights of the local communities and has led to inefficient resource use. Since local communities have very limited rights under the Land Use Act, governments, parastatals, and private companies often ignore communal rights to resources or inadequately compensate communities for taking or damaging their resources. Without complete title to their land, communities and individuals are unlikely to manage it for maximum sustainable benefits. Instead, inhabitants place greater emphasis on managing the land for uses they control, such as agriculture, over resources which they have less control, such as timber, thereby leading to inefficient use of land. Tenure insecurity also reduces the incentive of producers to invest in the resource. For example, farmers are unlikely to invest in land improvement if their ownership of the land is uncertain. Other resources, such as coastal fisheries and newly opened hunting areas, are inherently open access. In both cases, too rapid depletion and underinvestment in the resource occurs.

4.6 Open access regimes may require government regulation to maximize welfare benefits from resources and protect nonmarket values, such as biodiversity, which are not considered in individual behavior. Privatization of the common property resource is another efficient solution, but one which can reduce equitable distribution. Community resource management is more equitable than privatization and can be equally effective if it is sufficiently strong to restrict access. From an efficiency perspective, the critical factors are whether the property rights are well defined and defensible, not the identity of the resource owner.

4.7 Ambiguous resource rights to petroleum resources are a major factor leading to the violent clashes between police and communities. Although the Petroleum Act explicitly vests all rights to petroleum resources in the federal government, communities believe that since they manage the resources above ground, they also have rights to underground resources. Previous programs to pay communities for the right to extract oil failed and have been supplanted by OMPADEC

4.8 The transfer of community rights to the government can also create problems. For example, forest reservation in the delta has often done little to protect forests and may have disrupted communal tenure systems that were more effective or could have been bolstered rather than cast aside. Communities have become wary of transferring their property rights to the government even for such ostensibly good programs as forest reservations. For example, the community of Sangana did not accept Forestry Department overtures in 1994 to turn their community managed forest into a forest reserve. The States also have rights to timber trees outside of reserves. In theory, state control is supposed to improve resource management, but the Department lacks the necessary resources to effectively manage timber extraction and without rights to the trees, communities have lost a major incentive for long term timber management.

4.9 **Communal Tenure Systems.** In comparison with legal decrees, communal ownership is complex, and sometimes conflicting and ambiguous. Private holdings without formal title, but with community recognition, are common. However, they are frequently bypassed by private and state organizations. Under pressure from development, tenuous legal standing, and loosened community ties, communal tenure systems are eroding. In addition to land tenure, traditional ownership can extend to creeks near sedentary communities or near their migratory fishing camps. In some communities during the flooding season, anyone is allowed to fish under an open access regime. For the rest of the year, however, owners of the creeks impose a fee (Resource Inventory and Management Ltd. 1992, 1992, 4).

4.10 Limited recognition and weak enforcement of traditional ownership of resources, combined with poor information on the value of the resources often result in local communities obtaining very little income from extraction. Villages have difficulty keeping 'foreign' loggers from highgrading their forests. The logging companies, many without official permits, simply take whatever trees they wish. Generally unable to restrict logging on their own, the communities receive no assistance from the under-funded Forestry Departments, which are administrative bodies that have almost no field presence (Leh, 1994). To save their forests, two communities (Foropa and Akpede-Biseni) have banned outside loggers (Powell, 1993, 93). Since communities and the state officers frequently have limited information on the economic value of their trees, they are often sold at enormous discounts. They tend to view the forests as "bush" and convert it to other uses in the name of development (Ashton-Jones and Douglas. 1994, 171). In contrast, logging contractors and timber companies, who appreciate the value of timber in the remaining forests, compete for stands and concessions, particularly in forest reserves. In one case, an international rubber company was able to purchase a forest containing standing timber estimated to be worth N21 million (US$800,00) for N40,000 (US$1,600) to establish a rubber plantation (Ashton-Jones and Douglas. 1994, 171).

Policy Failures

4.11 Policy failures often occur because governments fail to address market failures. Governments do not intervene in the market system when required to make individuals and firms incorporate externalities in their decisions. Alternatively, government intervention can

create policy failures by intervening in markets to distort incentives away from achieving the optimal use of resources. Both failures are common in the Niger Delta.

4.12 **Lack of Enforcement of Property Rights and Regulations.** Clear resource rights are of little use if they cannot be defended. When the government does decide to recognize property rights and manage resources more sustainably, as in the case of timber permits, forest reserves, flooding and erosion control, and fisheries legislation, they often lack the capacity to enforce their decisions. Environmental systems and their services are even more difficult to manage than resources with explicit owners because of their biological complexity and the increased difficulty of excluding users. For example, aquatic waste sinks have waste thresholds which vary by pollutant and season. It is also very difficult, even in developed countries, to regulate non-point and small sources of water pollution.

4.13 **Inadequate Policy Responses to Incomplete Markets.** Inadequate policy responses to markets which are not competitive, insufficient, or do not exist are policy failures. Many of the benefits provided by natural systems are not incorporated into the prices paid for goods and services from that system. For example, wetlands, such as the delta, act as natural biological filters of pollutants, but projects to convert wetlands rarely consider such nonmarket services (Figure 4.1). Socially optimal exploitation of resources requires that market prices incorporate the full environmental and social costs (and benefits) of goods and services. If prices do not include such negative externalities, resources, whether they are renewable resources, such as timber, fish, and waste sinks, or non-renewable, such as oil, will be exploited too rapidly and underinvested in. In the delta, land prices and rents do not reflect the goods and services the land provides, resulting in excessive consumption of land by private firms and parastatals. The severe solid waste problems in urban centers in the delta result partially from individuals and firms deciding that it is in their interests not to pay the full cost of disposal because only a small portion of the environmental and social costs resulting from their actions affect them. Even if private markets offered waste removal at the full financial costs, it would remain in their interest to 'free ride' by receiving the social and environmental benefits of others reducing their waste without doing so themselves. Policy interventions are required to induce individuals and firms to account for the social costs of their actions through enforcement of regulations and incentives for provision of waste management services. Imperfect information and non-competitive markets can also lead to market failures. For example, the forestry departments do not conduct forest inventories before granting concessions (imperfect information) and do not hold competitive bidding or auctions (non-competitive markets).

Figure 4.1: Relationship Between the Location and Type of Mangrove Goods and Services and their Economic Valuation

		LOCATION OF GOODS AND SERVICES	
		On-site	**Off-site**
VALUATION OF GOODS & SERVICES	**MARKETED**	**1** Usually included in an economic analysis (e.g., poles charcoal, woodchips, mangrove crabs)	**2** May be included (e.g., fish or shellfish caught in adjacent waters)
	NONMARKETED	**3** Seldom included (e.g., medicinal uses of mangrove, domestic fuelwood, food in times of famine, nursery area for juvenile fish, feeding ground for estuarine fish and shrimp, viewing and studying wildlife)	**4** Usually ignored (e.g., nutrient flows to estuaries, buffer to storm damage)

Source: Developed by Dixon and Burbridge and reported in Hamilton and Snedaker, 1984.

4.14 **Economic Policy Failures**. Prices can be distorted if governments subsidize resource consumption. For example, subsidized petroleum prices in Nigeria reduce the social benefit of the resource by encouraging excessive consumption. Until 1994, domestic petroleum prices were far below world prices. In 1992, Nigeria had the lowest priced gasoline in the world: 4 cents per liter or 13 percent of the European average (Western Africa Department, 1994d, 19). This policy resulted in excessive resource extraction and has degraded natural areas, increased economic costs through health impacts, and reduced foreign exchange earnings. It also created a parallel domestic market from which between 8 and 20 percent of refinery production was smuggled into neighboring countries (Western Africa Department. 1994d, 57). To reduce the social costs of petroleum subsidies, price increases must be gradually instituted with a full realization of their social repercussions. In October 1994, the federal government reduced the fuel subsidy significantly as petroleum prices were increased to N11 per liter (US$0.50). This increase is a major step towards full cost pricing of petroleum.

4.15 Another example of over-consumption as a result of inappropriate pricing policy occurs within the petroleum industry itself. Low crude oil price netbacks to producers, and low refinery-gate prices to refiners, implicitly provide an incentive for excess consumption of petroleum products. As noted previously, this practice has resulted in what may be one of the most inefficient refinery complexes in the world, with the own-use of energy at times double what it is in more efficient refineries. From an environmental perspective, this has a number of direct consequences. First, it causes greater pollution from effluents and emissions associated with the higher levels of energy consumption. Second, it provides a disincentive to producers (and refiners) to limit both accidental spills (from normal operations) and deliberate upsets (from sabotage). Finally, the low compensation rates for damage caused by oil and other activities are another clear example of fixed prices resulting in pollution, environmental

damage, and excessive consumption of land. The rates not only do not account for the present value of communities losing economic trees and crop damage lasting more than one year, but also ignore the indirect impact on ecosystem services, such as biodiversity losses and the disruption of fish breeding grounds (Annex M). While oil companies pay an average of N1000/ha in compensation for oil spill damage to community resources, using an estimated annual land rent of forest land of 5,000 N/ha from sustainable forest management and production of NTFP (Chapter 2), the price should at least be 50,000 N (land value at 10 percent) or 50 times larger (Linddal, 1995).

4.16 Water is a classic example of improper pricing leading to inappropriate use. Water is, in fact, an open access good and generally available free of charge to industry and domestic users. Where this has arisen elsewhere, it has resulted in environmental problems such as water pollution, over-abstraction of groundwater, and inappropriate diversion of surface waters for water-intensive cropping. In the delta region, this under-pricing of water may become a problem in areas of future aquaculture and rice expansion: both involve water intensive technologies. In areas where water is provided freely these forms of production, are in effect, subsidized; where such production occurs in coastal mangrove ecosystems, there is an implicit subsidy to clear these ecosystems for other uses. While not necessarily a concern at present, future expansion into aquaculture and rice may exacerbate this pricing distortion.

Poor management of petroleum resources has lead to 'Dutch Disease' in Nigeria. In this case, Dutch disease is the result of the very rapid increase in petroleum output causing an appreciation of the real effective exchange rate because of an rise in domestic prices relative to the prices of imported goods. The five-fold rise of the real effective exchange rate in Nigeria caused the profitability of traded goods to fall relative to non-traded goods. When oil revenues fell between 1980 and 1986, the economy had not developed a production structure which was capable of paying for the new, higher level of imports. Dutch disease exacerbated poverty in rural communities by constricting agricultural production and increased income disparities in urban areas. While the environmental impacts of Dutch disease have not be studied, they can be expected to include reduced access to agricultural inputs leading to land degradation and expansion of agriculture into forested areas. In addition, the lack of economic development based on appropriate investment of oil revenues has limited the ability of Nigeria to invest in environmental management and to invest in more efficient production processes which would consume less resources and produce less waste.

4.17 Under the Structural Adjustment Program (SAP), the price of imported goods relative to domestic inputs increased, giving a strong incentive for the local sourcing of inputs. This may have increased environmental degradation in the delta from greater pollution levels and expanded resource exploitation. Conversely, improved economic productivity may have increased local incomes, intensified agriculture and soil conservation practices, and increased expenditures on health (Box 4.1). In 1986, marketing boards for agricultural goods, including palm oil and rubber, were abolished as part of the SAP process (Western Africa Department, 1994d, 15). Since world market prices have been higher than the monopoly prices, this action increased the cultivation of these two tree crops which are important in the delta. As a result of these two policy changes and other factors, agricultural production for the country increased at an annual rate of 3.8 percent since 1986. Of the more important Niger Delta

crops, palm kernel production expanded by 276 percent, rubber production by 123 percent, and cassava production by 163 percent for the entire country between 1986 and 1992. Since only nominal amounts of agricultural inputs are available in the Niger Delta, most of the crop increases from the region would have come from expanding the cultivated area, not from intensification.

4.18 In January 1995, the Federal Government allowed market determined foreign exchange transactions in autonomous funds (proceeds of non-oil exports and other foreign exchange). However, official foreign exchange receipts continue to be converted at the fixed rate of N22 to the dollar. While the autonomous funds policy reduces the fixed market effect of artificially increasing the price of Nigeria's exports and decreasing the cost of imported goods, the environmental impact of such actions are not known. The policy may increase growth in sectors which require large amounts of foreign exchange, particularly manufacturing. It may also increase agricultural production, as Nigerian agricultural products become more attractive internationally. Growth in the agricultural sector may increase the rate of agricultural expansion into forested regions. The new policy may raise the cost of imported inputs required for intensification, such as some fertilizers, farm equipment, and pesticides, which could also result in agricultural expansion. However, in general, the policy will help to decrease economic distortions which disrupt the efficient use of resources by reducing government control of foreign exchange. Studies in neighboring countries have shown that, when exchange rates were allowed to float freely under structural adjustment, the increase in producer prices would exacerbate environmental degradation unless complementary policies were explicitly targeted to preventing it. In Ghana's forest sector, for example, increased forestry product prices were offset by stricter controls on forest management practices and little incremental degradation was detected; similar price increases in the fishery sector, however, are blamed for an increase in non-sustainable fishing because no effort was directed to managing the fisheries (Acquah and Wilkins, 1994). In Nigeria, and in the delta region in particular, little institutional support has been directed towards either fisheries or forestry management after the initial SAP. One might also expect, therefore, that some net negative impact on the resource has resulted. The Federal Government sets interest rates at 5 percent above average funding costs, which is far below market levels. However, commercial and merchant bank breaches of this regulation were widespread. The interest rate distortions result in funds being lent to those with significant collateral and powerful connections. Overall, this distortion exacerbates unsustainable practices by not allowing capital to be put towards the most efficient use.

Box 4.1
Macroeconomic Adjustment and Environmental Quality

A growing body of research in sub-Saharan Africa deals with the linkages between macroeconomic adjustment and environmental quality. Perhaps its most striking conclusion is that, to date, no generalizations can be made regarding the relationships.

The generally positive linkages are those where macroeconomic adjustment increases economic and material efficiency, thereby reducing wastes. In addition, macroeconomic policies can increase income, which is in turn reinvested in environmental infrastructure such as sewage treatment or clean water provision. Macroeconomic adjustment may also directly benefit the poor, who might otherwise exert increasing pressures on environmental resources.

Most of the negative linkages, by contrast, come about because of sectoral distortions where environmental quality issues are not adequately addressed, or because of distribution effects on certain individuals. For example, economic growth in many countries has increased material output and investment in economic infrastructure; environmental degradation has often gone hand-in-hand with this when pollution control measures were not implemented concurrently, or when environmental impacts of construction (such as erosion) were not properly mitigated. Regarding distribution impacts, some have argued that the macroeconomic adjustment programs in Nigeria created untenable circumstances for many people in the larger cities; these often moved into the country-side, placing additional pressures on the forest and agricultural land base. In many of these circumstances, however, the negative impacts of macroeconomic adjustment were further exacerbated by policy failures at the sectoral level.

Sources: Rock and O'Keefe, 1994; Cromwell and Winpenny, 1993; Munasinghe, Cruz and Warford, 1993; Triffen, Mortimore and Gichuki, 1994.

4.19 **Tax Policy.** Resource extraction and industrial production are often subsidized leading to resource depletion and non-optimal pollution levels. The Nigerian government offers substantial tax incentives for both oil and gas development. As these induce resource exploitation such that the present value of marginal prices over time are equal, resource consumption will be efficient. However, if the incentives subsidize extraction, the reserves will be removed too rapidly in the short term meaning that future supplies and income will be used to subsidize current consumption.

4.20 Under SAP, the corporate income tax was reduced from 45 to 40 percent for large firms and down to 20 percent for smaller firms engaged in manufacturing, mining, or agriculture (Western Africa Department, 1994d, 15). If small firms actually pay taxes, this change would provide an incentive for their proliferation. If the number of small firms increases in the delta, enforcement of environmental regulations will become more difficult because small firms and farms are particularly difficult to regulate. Capital allowances have also been increased for manufacturing, construction, agriculture, and transport (Western Africa Department, 1994d, 16); all of which could add to environmental degradation in the region. The tax system does not intervene to address environmental externalities.

4.21 **International Trade Policy.** The Federal Government bans the export of raw palm kernels, palm oil, cassava, rice, yam, beans, and timber (Western Africa Department, 1994d, 14, 69). While the bans reduce economic efficiency, their environmental and social impact are unknown. Presumably the bans were introduced to encourage value added processing in Nigeria because without the regulations, domestic producers could not afford to pay as much for the raw resources as foreign competitors. Under the bans, indigenous firms do not have to compete against foreign companies, so the resources are sold below market rates reducing the incentive to expand timber and agricultural production. In Costa Rica, for example, domestic prices for logs fell to between 20 and 60 percent of international prices after a log export ban. Under a log export ban, with a less efficient domestic processing industry, the demand for logs is lower and less logging will occur than if there were international processing competition. Consequently, the area of unmanaged (and biologically rich) forest will be higher with a log export ban than without one. Conversely, lower prices will reduce incentives for forest management, decreasing the area of managed forests (von Amsberg, 1994, 14-5). Thus, while log export bans encourage inefficient processing and logging, they decrease logging pressures on unmanaged forests and increase the area of unmanaged forest compared with other land uses. Similarly, with reduced agricultural prices from the bans, less land will be converted to agriculture. However, to the extent that the export bans are successful in promoting local industry, they will increase industrial pollution in the region. Consequently, the overall impact of the export bans on the environment of the Niger Delta is not known. If the market prices of the goods included environmental externalities, which they do not, then the welfare impact of banning raw exports will be negative since resources will be extracted at suboptimal rates.

4.22 Under the Structural Adjustment Program, all export licensing was abolished except for several exceptions including nature conservation (Western Africa Department. 1994d, 14). While the policy is laudable, whether implementation has been effective in reducing the export of endangered species is unknown.

4.23 **Oversimplification of Issues and Solutions**. Environmental systems are functionally and structurally complex. This is especially true of deltas which integrate land and water systems. Not only is the Niger Delta complex, but as numerous researchers have pointed out, it is not well understood (Bourn, 1992, 11). The intricate social systems of the hundreds of riverine communities are equally poorly known. General policies that ignore complex details are often appropriate at the central planning levels, but they need to be adapted to local conditions before implementation (Ascher, 1990, 164). By ignoring complexity, policies are frequently poorly matched for the communities and ecosystems they are intending to benefit or modify. A cascade of unanticipated side effects result. For instance, the assumption that road construction is required throughout the delta does not differentiate between dryland areas and mangroves, which would be better served by water based transportation.

4.24 Since government agencies and parastatals have specific mandates to address a select range of issues, they have little incentive to balance other concerns, such as environmental or distribution issues, which only make their work more complex (Ascher, 1990, 175). It is much easier for them to present their accomplishments in simple quantitative form, such as the number of boreholes sunk or kilometers of road constructed, than to depict how their activities take into account ecological and social complexities. On a project level, social and

environmental impact assessments can provide the necessary information to maximize the net benefits from policy decisions. On a regional level, the State Coastal Zone Committees are expected to become fora ensuring that activities in the delta consider the complex interrelationships that constitute the Niger Delta.

4.25 **Incomplete Information.** Incomplete information leads to inappropriate policies, lost income, oversimplification and poor participation. In addition to prices which do not reflect the full costs of goods and services, the information available to community decision makers may not be sufficient to obtain even the local market price of a resource. As discussed in the social conflict section, local communities frequently do not know the market value of timber being harvested by outsiders. They often have little choice, but to accept whatever payments are offered to them. In the case of government officials, they allocate timber concessions without conducting forest inventories. As a result, they only have a vague concept of the value of the resources they are selling.

4.26 Attempts to improve community participation in development activities are hampered by poor information and education (Annex K). Environmental and health information is often not available to poor urban and rural households. Poor education levels may mean that information dissemination programs are not appropriate for their target audiences. Since a lack of information makes it difficult for planners to know about specific conditions in areas and the majority of people are not highly educated, participation quickly becomes limited to the most articulate and well connected individuals (Ascher, 1990, 165). Perhaps most importantly, incomplete information frequently drives policy makers to emphasize areas with abundant information and ignore more uncertain and complex social and environmental issues.

4.27 **Lack of Accountability and Local Participation**. Local concerns and initiatives rarely filter up to decision makers of their own accord (Ascher, 1990, 163). At the same time, when property rights are not well respected or implementing agencies are not accountable to local communities, governments, development agencies, and private firms often exclude, or fail to include, the groups most affected by their actions. This policy failure is endemic in the Niger Delta; oil companies, parastatals, government agencies, and development organizations have all succumbed to it. Without a dialogue with local communities, priority setting and subsequent actions may be inappropriate and even detrimental. Even perceptions of negative impacts which may not be significant in reality can be avoided through comprehensive participation (Ascher, 1990, 59). Lowering community perception of the damage of oil pollution would have certainly reduced tensions in the delta.

4.28 Participation is not easy to establish. With only a simplified understanding of local communities and an unwillingness to delve further into their social structures, incomplete participation exercises are destined to include only politically connected individuals who often cannot be considered suitable representatives for community interests. This problem has ensnared the attempts of oil companies and oil plantation developers to improve community participation in their activities in the delta.

4.29 **Communication between Stakeholders**. While the lack of inclusion of community interests in policy making is the most obvious communication failure, communication between

even relatively powerful stakeholders can be very limited. Government agencies, particularly at the federal level, frequently do not discuss programs and projects with state and local authorities. Communication breakdowns can lead to implementation delays, inappropriate actions, and project duplication. Within the delta, better communication between parastatals and the forestry department would have averted at a much earlier stage threats to the Upper Orashi Forest Reserve. Lack of communication between the oil companies and OMPADEC has resulted in duplicate projects in Rivers State (OMPADEC, 1994, 4). The establishment of the State Coastal Zone Committees are expected to substantially enhance dialogue between the major stakeholders.

4.30 **Distributional Equity**. Distributional equity is defined as the number of people affected by policies and their relative income levels. The issue of equity is closely tied to accountability - if institutions are not held accountable for the impact of their actions on local people, they have little incentive to consider the issue of the distribution of costs and benefits. Local communities have only nominally benefited from the extraction of many resources, by far the most important of which is oil. Consequently, development is bypassing them even as the resource base declines. To try to capture more of the producer's surplus from oil activities, people sabotage flowlines to receive compensation. The relatively low income share going to the vast majority of people means that they are not effective mass consumers or a well educated and healthy workforce. Inequitable distribution and concomitant lack of development increase population pressures because poorer parents are more likely to view children as economic assets rather than burdens (Sen, 1994). Distributional inequity has exacerbated economic stagnation, increased resentment of oil operations, and helped create the perception that oil is the source of all ailments. Most importantly, it has led to violence against oil companies, the state, and other communities.

5. ASSESSING ENVIRONMENTAL PRIORITIES

Establishing priorities is the first step in managing environmental problems. This chapter presents an initial ranking of the major problems based on their environmental, human health, and economic significance. The potential future benefits and costs of addressing each issue are evaluated to ensure that the problems assigned higher priorities are those where intervention would achieve the highest net marginal benefit. In addition to the analytical component, the prioritization approach employed includes an ongoing process of systematic stakeholder participation to reach beneficiary consensus on the issues they feel are most important. The assessment has identified nine key problems: (1) fisheries depletion, (2) deforestation, (3) biodiversity loss, (4) water hyacinth expansion, (5) sewage, (6) vehicular emissions, (7) municipal solid wastes, (8), hazardous substances, and (9) agricultural land degradation.

A. PRIMARY CRITERIA FOR RANKING PRIORITIES[1]

5.1 To rank the environmental issues of the Niger Delta, an analytical framework focusing on their environmental, human health, and economic significance has been developed. The aim of the priority assessment process is to evaluate and rank the magnitude of relative risks from environmental issues based on the best available information. The priority setting process can be broken down into two facets: risk analysis and risk management. The current significance rankings represent the risk analysis component of the assessment. They ask the question 'What are the risks associated with different problem areas?' While information constraints limit the analysis to orders of magnitude, it provides an important initial step for determining potential areas for intervention and where further information gathering and analysis is needed. For the environmental significance, long term, large scale and severely disruptive environmental problems are ranked higher than short term, local, and moderately disruptive anthropogenic activities. Health significance is similarly ranked, with stressors that impact large populations or cause substantial direct health impacts ranked higher than those with smaller scale or indirect health effects. The effect on economic productivity is included in the evaluation for both health and environment.

5.2 The analysis also incorporates a risk management component which asks 'What options can be found to reduce the risks identified in the risk analysis?' This aspect of the prioritization process is substantially developed in the report through comparing the potential

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[1] The ranking criteria are loosely based on the matrix developed in the World Bank report, "Sierra Leone: Initial Assessment of Environmental Problems". It also draws from earlier ranking frameworks presented in "Democratic Republic of Sao Tome and Principe: Country Economic Memorandum and Key Elements of an Environmental Strategy" and "Guinea-Bissau: Towards a Strategic Agenda for Environmental Management". Similar ordinal rankings for determining environmental priorities haves been undertaken for Nigeria as a whole, and for the Philippines, Thailand, Indonesia, Chile, and Uganda. It also benefits from the methodology developed in the EPA report, "A Guidebook to Comparing Risks and Setting Environmental Priorities".

future costs and benefits of intervention. It also requires intensive stakeholder participation to reach consensus on the priority areas for interventions, since the problems identified may not exactly match the beneficiaries' priorities. For example, available scientific evidence may indicate that certain environmental problems are not of highest concern relative to other issues (e.g., oil pollution and gas flaring); however, this may conflict with perceptions held by local communities. With such issues, participation is critical for reaching consensus on which issues stakeholders determine most important to address. The continuing dialogue and beneficiary workshops are essential for incorporating community concerns into the priority assessment process and developing an Action Plan to redress the key problems.

5.3 Potential future environmental benefits are an estimate of the present value of all future benefits of mitigating the problem. Consequently, interventions with short term benefits (e.g., within five years) are ranked higher than interventions which require longer periods for benefits to manifested themselves (e.g., more than five years). The benefits are compared with the present value of intervention costs to derive an estimate of the net present value of addressing the issue. This methodology places highest priority on issues that have high environmental or health significance and large net intervention benefits. As such, it attempts to ensure that the highest marginal benefits of mitigation are achieved per mitigation cost.

5.4 In establishing the overall priorities, equal weight is given to each of the criteria. Depending on the magnitude of the issue it is given a rating of High (3), Moderate (2), or Low (1) for each criterion. The overall priority assessment follows this ranking as well. To determine the overall priority, the sum of rankings of the environmental and health parameters are added to the net intervention benefits (benefits - costs). From this calculation, the overall priority (OP) is rated as High ($OP \geq 5$), Moderate ($2 < OP < 5$), or Low ($OP \leqq 2$). A Low ranking does not mean that the problem is unimportant, only that it is less significant problem than the higher ranked issues.[2] The ranking provides a critical initial step for formulating policies and programs to address the most important environmental problems. Given the weak information base, the framework and the priorities should be refined as additional information and values are incorporated. This analytical framework is a foundation for developing future investment activities in the Niger Delta.

B. PRELIMINARY RANKING

5.5 A preliminary ranking of the various environmental problems is presented in Table 5.1. It is important to recall that, in designating 'high, moderate and low' priorities, these should be construed as *relative* rankings. Limited financial and human resources require that such priorities be established to ensure that funds are cost-effectively applied to those problems where they are most likely to be successful. The rationale for each of the designated rankings follows.

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[2] For example, while nypa palm expansion and gas flaring are ranked as low, they are more significant than issues such as noise pollution and radioactive substances which are not included among the major environmental problems.

C. LAND RESOURCE DEGRADATION

5.6 **Erosion, Flooding, and Sea Level Rise.** Land degradation through erosion and flooding is a persistent problem in the Niger Delta. Direct losses (from farm productivity loss as riverbanks are eroded) and indirect losses (from declines in fishery productivity because of changes in hydrological conditions), are difficult to estimate, but experience elsewhere in the world (Box 5.1) and in neighboring regions, provides an indication of the potential magnitude of this problem in coastal areas. In neighboring Cross River State, a study of forest protection illustrated that riverbank erosion costs along the Cross River and fish productivity losses associated with changes in water regimes in a coastal mangrove fishery would approach US$16 million annually. This area covers approximately 200,000 ha and is inhabited by about 40,000 people. The higher population levels in the Niger Delta region, suggest that erosion and flooding will also result in substantial economic losses. The social costs of flooding are particularly high because of the vast areas of the region that are regularly inundated. Flooding severely impacts the farming activities and health status of riverine communities. Offsetting this, however, control costs for limiting the impacts are also substantial. They typically require large infrastructure investments, or significant on-going costs (e.g., dredging reservoirs and building sediment bypass channels). Such recurring measures are typically not viable alternatives, and a general response to erosion and flooding is one of adjustment: flood damage is repaired where possible, or people move to higher ground. Community based riverbank protection measures are estimated to cost N1,000 per m of protected bank (Linddal, 1995). Given these high costs, the overall priority for erosion, as shown in Table 5.1, is 'moderate'. Of the two types of erosion, riverbank erosion is of greater concern because of the higher value of the land lost and the risk to a larger population. Flooding is rated as a more important overall priority (moderate-high) than erosion because it has greater social effects.

5.7 Currently, sea level rise is not causing significant environmental or health problems. However, medium and long term impacts may be substantial depending on the severity of global warming and its impact on sea levels. With the low current significance of problems associated with sea level rise and the uncertain magnitude of future impacts, the intervention benefits are moderate and lower than the high costs of intervention. Furthermore, some of the actions that can be taken to reduce flooding and erosion will also mitigate the impact of sea level rise.

Table 5.1: Priority of Major Environmental Problems

Problem Type	Problem or Source	Current Environmental Significance	Current Health Significance	Potential Intervention Benefits	Intervention Costs	Overall Priority
Land Resource Degradation	**Erosion**					
	- coastal	High	Low	High	High	Moderate
	- riverbank	High	Low	High	High	Moderate
	Flooding	Low	High	High	High	**Mod. - High**
	Sea Level Rise	Low	Low	Moderate	High	Low
	Agric. Land Degradation	High	Moderate	High	Moderate	**High**
Renewable Resource Degradation	**Fisheries**					
	- stock depletion	Low	Moderate	High	Low	**High**
	- habitat degradation	Moderate	Moderate	Moderate	Moderate	Moderate
	Forestry					
	- deforestation	High	Moderate	High	Low	**High**
	- mangrove degradation	Low	Low	Low	Low	Low
	- fresh-water forest degrad.	High	Low	High	Low	**High**
	- barrier island for. degrad.	High	Low	High	Low	**High**
	Biodiversity Loss	High	Moderate	High	Low	**High**
	Exotic Species					
	- Nypa Palm	Low	Low	Low	Moderate	Low
	- Water Hyacinth	Moderate	Moderate	High	Moderate	**High**
Environmental Pollution	**Water Contamination**					
	- oil[3]	Low	Low	Moderate	Low	Moderate
	- industrial	Low	Moderate	Moderate	Moderate	Moderate
	- toxic & haz. substances.	Moderate	Moderate	Moderate	Low	**High**
	- sewage	Moderate	High	High	Moderate	**High**
	Air Pollution					
	- gas flaring	Low	Low	Low	High	Low
	- industrial	Low	Moderate	Moderate	Low	Moderate
	- vehicular	Low	High	Moderate	Moderate	**High**
	Solid Wastes					
	- industrial	Low	Moderate	Moderate	Moderate	Moderate
	- municipal	Moderate	High	High	Moderate	**High**

[3] Water contamination from oil activities includes only oil pollution and other aquatic impacts. Other significant concerns associated with oil activities, including deforestation, forest degradation, loss of biodiversity, gas flaring emission, and solid wastes are incorporated into other categories.

Box 5.1
Examples of the Economic Impacts of Erosion and Flooding in Coastal Areas

Two cases illustrate comparative examples of potential costs of erosion and flooding.

In the Niger Delta, estimates of subsidence show that parts of the area may be sinking by as much as 25 millimeters annually (Ibe, 1993). Over a period of a decade, this would result in a total subsidence of 25 cm. This is of the same order of magnitude as Bangkok, which has been named the "sinking city" because over-abstraction of groundwater, coastal erosion, and upstream changes on Chao Phraya River have on average resulted in annual subsidence of about 5 cm over the past decade; during one three year period subsidence in some parts of the city approached 12 cm/yr. The economic and environmental impacts of this have been staggering. The economic costs, in terms of higher infrastructure maintenance costs, higher water treatment costs, and lost agricultural output have been estimated to approach US$500 million in some years (Lonergan, et. al., 1993).

In the Niger Delta, dams have been cited as a major indirect cause of erosion. The impacts of dams on downstream coastal areas, in terms of changed hydrological regimes, is also evident in a number of large dam projects around the world. The inland Narmada Valley dam projects in India, for example, are estimated to impose a downstream cost of US$2,200 to US$3,500 million on low-lying coastal areas as a result of fishery impacts, changes in water regime, and salinization. (Ruitenbeek and Cartier, 1994).

5.8 **Agricultural Land Degradation.** Agricultural land degradation is a high overall priority because of the large geographic extent of the problem - extensive and formerly highly productive areas of the lowland rainforests and fresh-water swamp forests are affected. Although agricultural productivity studies have not been conducted in the delta, evaluations of yields in surrounding areas, the switch to cassava in many areas of the delta, and sociological studies of Niger Delta communities all provide evidence that land degradation is very significant and pervasive. Its central role in causing deforestation and exhausting soil fertility warrants the high environmental ranking. By reducing the agricultural returns to labor, land degradation exacerbates rural poverty leading to poorer household health. In addition, the potential benefits of increased agricultural productivity through more intensive rather than extensive farming are high compared with the moderate costs of soil conservation measures, extension services, and increased fertilization (Box 5.2). As discussed above, attempts to increase sediment flow rates to pre-dam levels, which would also reduce soil degradation in some areas, is a high cost proposition and - for the most part - logistically not feasible given the volumes of sediment that would need to be transported.

Box 5.2
Benefits and Costs of Intensification in Rivers State

At the current population growth rate of about 3 percent annually, population pressure in the Delta will require a doubling of the agricultural output in the region over the next two decades to meet subsistence requirements. Land degradation, from general soil fertility loss as well as erosion, is exacerbating the problems associated with higher population pressures.

Meeting the increased food requirements of the region will present a substantial burden on the region's environmental resources if land is not properly managed. Essentially, a doubling in agricultural output can be achieved either through doubling productivity, or through doubling the land under cultivation. Experience in other wet isolated regions of West Africa has shown that agricultural yield can readily double by applying selected inputs such as fertilizers, extension services, and improved varieties of farm crops. These measures typically cost on the order of US$20/ha annually; improving agricultural yields on the 200,000 ha of farmland under cultivation in Rivers State are therefore estimated to cost roughly US$4 million annually. By contrast, expanding into forest areas will decrease forest yields, as well as associated non-timber forest products from those forest and mangrove areas. As an illustration, a doubling of land under cropping would require at least an additional 140,000 ha of land (this is based on an assumed current use of 80 percent of the land classified as intensive farmland). In comparison, the current total forest reserve area within Rivers State is 136,000 ha, some of which is already dedicated to agricultural production. In summary, extensive expansion necessary to meet increased demand would involve the loss of all of the forest reserve in the area. Even at relatively low forest productivity levels (US$200/ha/yr), this translates to a loss of almost US$30 million annually.

D. RENEWABLE RESOURCE DEGRADATION

5.9 **Fisheries.** At present overfishing is of high overall priority because fishing is such a critical economic activity in the delta. A large proportion of the delta's population depend on fish and shellfish as their principal source of protein and income. In addition, aquaculture and off-shore industrial fishing will not be able to replace artisanal capture fishery in the delta because (i) production will be more costly, and will tend to be exported; (ii) the species may not be appreciated by indigenous consumers; (iii) aquaculture may have negative environmental consequences that decrease artisanal fisheries productivity; and (iv) the potential off-shore production is limited. The very weak information base prevents us from concluding unequivocally that overfishing is taking place, but all available indicators suggest that coastal fish stocks are overfished. Since fisheries management is virtually non-existent, but can be highly effective in increasing yields at relatively low cost, the net marginal benefits of improved management will be high (Box 5.3). The principal instruments of intervention, enforcement of fishing regulations and systematic monitoring of fishing effort and yield, are not expensive if they are applied to the coastal regions (more expensive stock assessments may be helpful for some species, but experience elsewhere suggests that they are a surprisingly unreliable basis for fisheries management in many developing countries). Intervention costs would increase considerably as monitoring and enforcement are expanded to freshwater fisheries. By stabilizing fish yields closer to the MSY through improved regulations,

monitoring, and enforcement, rural development and health conditions may be substantially enhanced. A key difficulty with all enforcement, however, is the potential for corruption; addressing this problem is beyond the scope of a simple fisheries management policy and requires country-wide reforms. It does suggest, however, that supporting local initiatives will probably be one of the most cost-effective management interventions.

5.10 Degradation of fisheries habitat is of moderate importance because on a regional level, habitat destruction does not have a significant environmental or health impact: the coastal and mangrove ecosystems are not under substantial stress. However, it is important to ensure the continued viability of the freshwater swamp forests as a fisheries nursery. Overall, the present value of future benefits of mitigating fisheries habitat destruction is only moderate and roughly equivalent to the moderate intervention costs.

Box 5.3
Precautionary Policies and the Costs of Fishery Over-harvesting

More governments are employing 'precautionary' policies of fishery management after fisheries collapses in many parts of the world have shown that the economic costs associated with such losses can be substantial. Such policies can take many forms: refugia that designate 'no-fishing' zones; restricted quota systems; and removal of subsidies that implicitly reward increased fishing effort.

In Canada, for example, the cost of the recent closures in the Atlantic cod fishery have been estimated to exceed US$1 billion annually. Similar collapses in the Baltic sea fishery have affected the livelihoods of hundreds of thousands of families. In developing countries, the impacts can be even more pronounced: improper management of a crustacean fishery in Eastern Indonesia threatens a US$40 million a year mangrove-dependent resource. In West Africa, a recent World Bank (1993) review of fishery rents in Sao Tome and Principe suggests that as much as 95 percent of the value of the fishery is not being captured by local policies, and that continued over-fishing threatens a US$20 million a year resource. Conservation initiatives in Tanzania are also now being targeted to increased local participation with a view to reducing over-exploitation and keeping intact an important artisanal fishery. In all of these cases, precautionary policies that protect both the economic and environmental importance of the fisheries are being promoted.

5.11 **Deforestation and Forest Degradation.** Deforestation and degradation are large scale problems in two of the four ecozones: fresh-water swamp and barrier island forests. Deforestation and forest degradation in the mangroves are localized and insignificant compared to the vast areas of intact mangroves. Deforestation of the lowland rainforests is largely complete, so it is no longer a large scale issue in this ecological zone. Within the freshwater swamp and beach ridge forests, deforestation is more localized, but causes more intensive damage than degradation which is widespread in both zones. Since land development projects are concentrated in the fresh-water forests, deforestation is a more critical threat to the fresh-water forests than the barrier island forests. However, both forests are under great pressure from infrastructure and agricultural expansion, as well as logging. The importance of

the remaining fresh-water and barrier island forests is very high for reducing the severity of flooding and erosion and for preserving biodiversity. Timber resources and especially NTFPs are a critical source of income for many rural households, even in areas relatively far removed from the forest zone (Infield, 1990; Ruitenbeek, 1989, 1992). Based on these studies in Nigeria and Cameroon, the value of selected NTFPs in River State alone may exceed US$100 million annually (from gathering of forest products, hunting and trapping, and manufacture of goods from forest products). Consequently, the potential benefits of preserving these future values are high. Intervention actions to strengthen the State Forestry Departments, especially their monitoring and enforcement capabilities, are relatively inexpensive. Experience in other West African countries indicates that incremental expenditures of US$5/ha/yr are often adequate to ensure effective management of forest reserves; in the case of River State this translates to well under US$1 million annually.

5.12 **Biodiversity.** The biodiversity significance of the Niger Delta is high. It holds a large number of threatened and endangered species, particularly mammals, that are economically, aesthetically, and scientifically very valuable. The high value of the biodiversity in the region is being rapidly eroded by hunting, uncontrolled logging, agricultural encroachment and poorly designed development projects. For instance, agricultural expansion has almost eliminated the biodiversity of the lowland rainforests. Biodiversity is of moderate significance to human health. Its value is to improve food and health security through increasing the diversity of medicinal and food plants available in rural communities. Prospecting for pharmaceutical use for plant species has yet to develop in Nigeria, but is growing in other West African countries. The benefit of preserving biodiversity in the region is rated as high because of its rich biological resources and the rising international willingness to pay for biodiversity, as illustrated by pharmaceutical prospecting, Global Environment Facility (GEF) projects, debt-for-nature swaps, and increased tropical conservation funding in general (Box 5.4). For example, the international willingness-to-pay for some of the high priority areas identified in Chapter 2 (44,000 ha comprising the Upper Orashi Forest Reserve, Adoni Game Reserve, and Taylor Creek Forest Reserve) could approach US$1.5 million annually, based on typical international conservation expenditures in the region. By contrast, the cost of biodiversity protection is low; protecting these same areas effectively could equate to an annual cost of about US$250,000 on the basis of typical management costs for West African conservation areas.

Box 5.4
International Willingness to Pay for Tropical Forests

The international transfers by donors to various rainforest projects have been found to range from US$20 to 2,100 per km^2 annually, i.e., from two cents to US$2.1 annually per ha. The values are proxies for an international willingness-to-pay for the existence value of rainforest. With a willingness to transfer US$1-2 per ha annually, the international non-use value of the Niger delta could be US$200,000 - 700,000 annually (4-5 million N). In a study from Indonesia, the existence value was estimated to be US$15/ha/yr for mangroves and up to US$30/ha/yr for tropical rainforests based on an analysis of 1987-90 foreign funding for biodiversity projects. These values make the Niger delta forest reserves annual preservation value equal to US$3.0 to 10.5 million.

These international benefits alone would exceed the preservation costs. The estimated expenditures for effective management of parks and reserves from an Indonesian study varied between US$1.80 to 8.00 per ha.[4] The cost of managing the forest reserves in the Niger delta is thus between US$450,000 and 2.8 million annually. The costs in Nigeria are probably at the lower end and some are already covered by the present employment of forest officers. However, even the lower estimate is well above the potential of the forestry departments at present.

Source: Ruitenbeek in Linddal, 1995.

5.13 **Exotic Species.** The control of nypa palm is of low overall priority because it covers a moderately sized area and is not rapidly expanding. As a result, its impact on human health through reduced fish catches is low. In addition, the species has many uses which could be exploited in Nigeria. The future benefits of intervention are estimated to be lower than the moderate costs of controlling the palm and replanting areas with mangrove species. As noted earlier, such replanting has had mixed success, and the cost-effectiveness of replanting is questionable.

5.14 Water hyacinth represents a much more significant environmental threat and is ranked as a high overall priority (Box 5.5). It has a moderate to high environmental significance because the species is expanding rapidly and can increase eutrophication. While insufficient information is available to judge its impact on water quality, the health impact is not expected to be substantial. Potential benefits of intervention are high because water hyacinth is spreading quickly and can severely affect transportation and fishing. Moreover, some of the uses for harvested water hyacinth (agricultural mulch, biogas production) themselves have economic value (Box A.4 - vol. II). The costs of intervention, however, can still be substantial (although they are judged to be moderate in comparison to the potential benefits). Both mechanical and manual harvesting techniques have been used to clear water hyacinth, although neither of these methods are generally 100 percent effective. Mechanical harvesting tends to be more costly than manual harvesting, but slightly more effective (Box 5.6). Manual harvesting is often socially beneficial because it provides additional income to those who bear the impacts of water hyacinth (such as fishermen). Also, where the hyacinth has an economic

[4] World Bank, 1994b, op.cit.

use, benefits flow directly to the local community. Pending global technical solutions which halt rather than control its spread, the expansion of water hyacinth should be addressed.

Box 5.5
Economic Impacts of Water Hyacinth

Water hyacinth has been found to be a problem in many of the world's major waterways, and various estimates have been made of both its direct economic impact and on the costs of controlling it. Control costs have been the most elusive, primarily because no permanent solutions have been found. The benefits of controlling water hyacinth, however, are quite clear from a number of cases investigated in other parts of the world.

On Lake Victoria in East Africa, transportation costs have increased by 10-20 percent because of interference with ferry navigation; many near-shore fisheries have entirely disappeared because of the weed (World Bank, 1994 [Energy Sector Study]). In Thailand, Lonergan *et. al.* (1994) report that water hyacinth proliferation contributed to a loss of up to 75 percent in the aquatic biodiversity of the lower Chao Phraya River Basin. In the Philippines, hyacinth threatens a US$150 million/yr fishery in the Laguna Lake and Manila Bay area near Metro Manila, and also contributes to higher transport costs and lost amenity (World Bank, 1993b).

E. ENVIRONMENTAL POLLUTION

Water Contamination

5.15 **Oil Pollution**. Oil pollution, contrary to common perception, is only of moderate priority when compared with the full spectrum of environmental problems in the Niger Delta. The environmental and health significance of oil pollution is low on a regional level. Only areas that are directly exposed to large or repeated oil spills or leaks will have more long-term environmental problems. Given the low environmental and health ranking, the actual future benefits of reducing pollution are low. Nevertheless, the intervention costs of avoiding most incidents of oil pollution are not high and should be included in the normal operating costs of oil companies working in the delta, as is the case in most of the world. Surveys of environmental compliance costs in developing countries generally suggest that such costs are of the order of 5 percent of total full-cycle costs of exploration, development and production; although they can approach 10 percent in environmentally sensitive areas close to coral reefs and mangroves (Clark, 1991). These control costs include contingency measures for spills, as well as adequate treatment facilities for treating produced water. It is recognized that because of the reported high incidence of sabotage, the costs may be higher in this region. The intangible benefits of better relations with riverine communities could be quite high if future pollution were better controlled.

Box 5.6
Estimated Costs of Mechanical Harvesting of Water Hyacinth

The cost of controlling the water hyacinth mechanically in Nigeria is substantial. Assuming the band of water hyacinth along a river bank is 5 m wide, then 10 m of riverbank can be cleared daily by two men. The clearing includes recovery of the debris that is placed on land for decomposition. Clearing of one ha (about a stretch of 2 km of the river bank) will take 200 days. With a payment of 100 N/man.day and 50 N/day for the rental of a canoe, the cost per ha is 50,000 N or 25 N per meter of riverbank. The direct and indirect benefits from clearing the water hyacinth include improved transportation and potentially improved water quality, fisheries and aquatic biodiversity, as well as local employment is a positive feature. Trials would be required for assessing the costs and benefits of clearing water hyacinth.

Adapted from Linddal, 1995.

5.16 **Industrial Effluents.** Water contamination from industrial sources is a moderate priority for future environmental management in the Niger Delta. While Rivers State is one of the most industrialized states in Nigeria and wastewater treatment is almost non-existent in both states, the environmental and health significance is not high because of the small spatial scale of the effects: both ecosystems and human health are impaired, but the effects are concentrated around the industrial facilities. As industrialization is not expected to expand rapidly in the foreseable future, the intervention benefits of addressing pollution are moderate. While the marginal costs of pollution abatement vary widely across industries and plants, joint treatment options and pollution intervention strategies can keep costs within a low to moderate range. Industrial surveys conducted by the USEPA typically show that incremental abatement costs would be less than 3 percent of the value of industrial output for pollution abatement in industries of the type situated in the Niger Delta. Also, experience elsewhere shows that investment in such technologies will generally pay out directly in terms of better process efficiency in material management, better energy efficiency, fewer process upsets, and improved labor productivity (Box 5.7).

5.17 **Toxic and Hazardous Substances (THS).** Toxic and hazardous substances are highlighted because of their potential impact on human health and the international emphasis on reducing them. Toxic and hazardous substances involve a wide range of substances that can be severely damaging both to ecosystems and human health. Solvents, paints, dyes and lubricants are all substances that are commonly disposed of in water sources or into solid waste landfills, yet they can (in large quantities) degrade soils, foul water courses, and kill renewable aquatic resources. In addition to these common substances, toxic heavy metals from industry, biological wastes from hospitals and medical clinics, and 'intractable' wastes that cannot be broken down into inert compounds, all contribute to an escalating problem of toxic wastes in developing countries. The wide international membership to the Basel Convention, which restricts and regulates the international transport of THS, reinforces the need for countries and regions to start paying attention to the THS stream. Controlling these wastes will therefore generate moderate long-term benefits to the Niger Delta. The costs of intervention vary considerably, depending on the methods employed. 'Cradle-to-grave'

management of THS completely within the region itself can be very expensive and is probably inappropriate for the volumes of waste generated in the Niger Delta. Treatment facilities are also expensive: a feasibility study for a treatment facility for THS in Indonesia found that a basic minimum facility would cost around US$20 million. As a starting point, sound management practices which separate wastes and establish tracking mechanisms, such as standard labeling and inventory methods are very low cost and have the additional advantage of improving environmental awareness among participants. Because such low cost solutions are available, the overall priority for implementing some form of intervention for THS is regarded as 'high.'

Box 5.7
Environmental Accounting: Some Lessons from the Philippines

Attribution of costs to the impacts of environmental degradation allow policy-makers in developing countries to set intervention priorities. Some of the more sophisticated techniques of resource and environmental accounting allow the impacts of such interventions to be traced through all parts of the economy, so that a wide variety of economic costs and benefits are reflected, including those associated with improved health, greater energy efficiency, and improved material use.

Recent work by the US-funded Environmental and Natural Resource Accounting Project (ENRAP) in the Philippines illustrates the applicability of these techniques.
Through appropriate interventions, it was estimated that the total economic benefits associated with pollution reduction are as follows (million pesos/year):

Benefits of Reduced Air Pollution	3 316.9
Costs of Air Pollution Abatement	2 793.2
Benefits of Reduced Water Pollution	14 348.8
Costs of Water Pollution Abatement	14 232.4

Based on these figures, the work encourages that a high priority be placed on reducing water pollution in selected sectors with high benefit-cost ratios; these include in particular industrial sectors such as mining, quarrying and manufacturing.

Source: delos Angeles, Peskin, and Bennagen, 1994.

5.18 **Sewage.** Health risks associated with sewage contaminated water are highly significant and affect a large proportion of the population. Improper sewage transport and disposal are directly tied with many diseases that reduce the productivity and quality of life of people in the Niger Delta. In addition to increasing the spread of pathogens, the decomposition of domestic wastes may deplete oxygen in aquatic ecosystems. This action can result in species composition shifts, including reduced commercial fish stocks. The environmental concerns are, however, moderate and much less significant than the human health issues. Current productivity losses associated with water-borne diseases alone are estimated to approach US$20 million annually. This estimate excludes costs associated with

increased infant mortality. Experience in Indonesia suggests that a willingness-to-pay for improving health conditions may exceed productivity losses by a factor of 10. This implies that, in the Niger Delta, the potential benefits of improving sewage facilities could approach US$250 million annually. Economic analysis of the benefits of reduced water contamination indicates that a 50 percent reduction in mortality from water contamination would save at least N60 million (US$2.7 million) annually in Port Harcourt alone - the prevention of epidemics could make the savings much higher (Box 5.8). Nigerian and Ghanaian studies have found that consumers are willing to pay for improved water supply from private vendors and are willing to invest in simple sanitation infrastructure (Box 5.9). The studies provide evidence that consumers believe that the benefits of safe water supplies outweigh the higher cost of privately supplied water. Although no cost estimates are available for a comprehensive urban and rural sanitation project, it is anticipated that costs of such services are generally much lower than such benefits.

Box 5.8
Consumer Willingness to Pay for Potable Water and Sanitation

A study from Nsukka district in Anambra State (Nigeria) revealed that consumers were willing to pay for purchasing water from private vendors instead of paying flat rate user fees for potable water. The reason was a distrust in the quality and reliability of publicly supplied water. The bad quality and lack of reliable supply is due to poor maintenance following an insufficient cost recovery. The private delivery of water is a defensive expenditure, but the consumers' willingness-to-pay for a reliable water supply was a result of the poor standard of the public water supply.

Another study from Onitsha (also in Anambra state but just across the river Niger from Asaba) showed that the willingness for households to pay for improved water services is rather high. 8,000 out of 100,000 households were connected to the piped water systems and the rest got water from vendors. The price paid to vendors was almost twice the operational and maintenance costs of potable water, i.e., the publicly supplied water would be operating within the indicated willingness-to-pay for water, but the problem was again the lack of cost recovery.

A study from Ghana shows the willingness-to-pay for improved sanitation. The study from Kumasi revealed that households had a willingness-to-pay for water closets and ventilated improved pit latrines, but a public subsidy was still required for the installation of the facility. The lump-sum subsidy would amount to US$16 for a building with 45 households to US$203 for a building with only one household. The requirement of a lump-sum subsidy is a result of the social benefits from the reduction of external costs.

Source: Whittington, Okorafor, and McPhail, 1990; Whittington, Lauria and Mu, 1991; Whittington et al., 1991.

Box 5.9
Estimating Health Benefits from Improved Sewerage Systems in Port Harcourt

Investments in sewerage systems and waste management is important in urban areas, particularly Port Harcourt. Assuming an investment in these facilities will result in a reduction of the diarrheal causes of death by 100 individuals annually valued at 400,000 N per individual, the facilities would save N 40 million per year.[5] Capitalized at 10 percent, it is a benefit totaling 4 billion N. This figure represents an absolute minimum value of the potential gain from saving 100 premature deaths.

An extrapolation of the Mexican mortality estimate of 32.8 per 100,000 from water contamination to Port Harcourt equals about 300 deaths in Port Harcourt, with an estimated cost of 120 million N annually. Another gain from improved water supply and sanitation is the reduced risk of epidemic diseases. An outbreak every decade causing 1,000 premature deaths results in an additional cost of 400 million N per epidemic. The concern for premature mortality induced by environmental pollution is not an attempt to assess the total costs of health damage, but only the cost that eventually can be avoided.

Linddal, 1995.

Air Pollution

5.19 **Gas Flaring.** Gas flaring, although extensive and highly significant from the international perspective of greenhouse gas emissions, is of low environmental and health significance in the Niger Delta region. Any negative effects are confined to the immediate vicinity of the flares, and the direct intervention benefits associated with lower environmental or human health for delta communities are therefore low. In other parts of the world, for instance in the North Sea region, associated gas from oil fields is either (i) reinjected into magazines, (ii) utilised in power or heat generation or (iii) used as feed stock in the petrochemical industry (Annex I). Past analyses of gas recovery options in Nigeria have generally demonstrated that, purely from a local perspective, efforts to recover the gas (and liquefy it for export or bottle it for domestic consumption) are at best marginal. However, given that Nigeria flares some of the largest quantities of gas in the world, the intervention benefits internationally of reducing this component of global warming, while uncertain, could be quite large in comparison to the costs of intervention. Some of this amount could conceivably be paid to Nigeria in the form of direct transfers or subsidies to reduce the amount flared (Box 5.10). Depending on global warming model parameters and especially the costs considered in the models, the marginal international benefits from reducing carbon emissions range from less than one quarter of this marginal cost to several times it (Nordhaus, 1991; Winpenny, 1990, 217).

5.20 ***Industrial Emissions.*** As with industrial effluent, air emissions from industries are ranked as a moderate overall priority. The location of most industry in urban areas keeps the environmental significance ranking low. Health impacts are more pronounced because of the

[5] See Annex M for additional information on the health costs of environmental degradation.

urban concentration of both industry and large populations. In addition to urban pollution, several large scale facilities operating in rural areas are believed to affect downwind ecosystems, human health, and economic productivity. As industrial growth is not rapid, intervention benefits are moderate. For many industries, the costs of abating air emissions are less than for wastewater, hence intervention costs are expected to be low to moderate for the majority of industries. There are, however, some exceptions to this of relevance to the Niger Delta. Steel mills and refineries can have substantial emission control costs if emissions involve high levels of sulfur and/or particulates. It is expected that some of the complaints relating to respiratory problems in the vicinities of these plants may be associated with these pollutants. Controlling these pollutants might involve major retrofits to the older facilities, which would in turn result in relatively high costs.

Box 5.10
International Willingness to Pay for Reduced Global Warming

Various estimates have been undertaken of the amount that the international community would have to be willing to pay to obtain carbon reductions. These estimates generally fall over a wide range; the lowest estimates available are generally on the order of US$3/t of equivalent carbon reduction, while the upper estimates approach US$100/t (Nordhaus, 1991; Winpenny, 1990, 217). In the case of Nigeria, one study estimated the incremental control cost for reducing carbon emissions to be around US$15/t of avoided carbon emissions (ESMAP, 1993, 46). Based on more detailed analysis, the Escravos Flared Gas Reduction Project calculated that reducing carbon emissions would cost only US$5.44/ton. Both estimates are based on production of associated gas to reduce its flaring. The Escravos Flared Gas Reduction Project estimated the global benefits of reducing gas flaring to be US$25/t of avoided carbon emissions. If these control costs are significantly less than control costs elsewhere in the world, Nigeria may be able to obtain a subsidy to reduce these emissions. Industrialized countries investing in reduced gas flaring in Nigeria could obtain CO2 credits which could enable them to meet emissions reductions at less cost than in developed countries. In fact, the cost per ton of carbon reduced of US$5.44 is already considerably less than existing carbon taxes in European countries (US$6.10 - 45) and would fall if the Escravos pilot project were replicated in additional areas (World Bank, 1994a, 48, 53, 54).

5.21 **Vehicular Emissions.** Vehicular emissions are expected to be of greater significance than industrial air emissions, primarily because they are more widespread and some of the pollutants are inherently more dangerous to human health. In general, the pollutants of potential concern include volatile organic compounds (VOCs), NOx, sulphur, particulates, and lead. None of these are expected to have a significant environmental impact on a regional level within the delta, given that total traffic is still relatively light. However, estimates of air emissions in Rivers State and Port Harcourt indicated that lead emissions from vehicles are of great concern in urban areas. Of secondary importance are industrial and vehicular particulate emissions in cities. The concentration of lead in Nigerian gasoline is one of the highest levels in the world (0.74 mg/l). Particulates contribute to chronic (and potentially debilitating) respiratory illnesses, while lead contributes to kidney problems and mental dysfunction (and potentially death) (Box 5.11). Children are at greater risk of exposure because they spend a larger proportion of their day close to street level. Lead also has a more severe neurological

impact on the developing brains of children than on developed adult brains. Work elsewhere has demonstrated that control costs for these pollutants are relatively low (compared to controlling VOCs and NOx). Changes in fuel specifications are often relatively inexpensive, yet are sufficient to achieve acceptable levels of particulates (in diesel) and lead (in petrol). For example, Nigeria would incur little immediate financial cost by lowing its lead content to less than 0.20 mg/l. A serious implementation constraint, however, is simply the lack of information available related to these pollutants.

Box 5.11
Estimating the Benefits of Reduced Particulate Emissions

A reduction of airborne particulate matter (PM10) from vehicles is estimated to result in health gains of 112 million N annually in Port Harcourt. With a target of reducing the ambient level of PM10 by 10 mg/m^3; the health effect is 134 avoided pre-mature deaths (400,000 N each, i.e., a total of 53.6 million N) and 580,000 saved working days[6] (100 N each, i.e., a total of 58 million N).[7] Since only the health improvement of reduced particle matter is taken into account, the value is a lower bound on the health benefits, but it avoids double counting from including other pollutants. The estimation, although rough, reveals the magnitude of the potential health benefits. The method presented here and described in Annex L makes possible an assessment of the benefits from various environmental control policies. For accurate application, it requires improved data quality and coverage.

Linddal, 1995.

Solid Wastes

5.22 **Industrial Wastes.** Industrial solid wastes are a moderate priority because of the limited geographic distribution of industry. While industrial solid waste management is completely inadequate in both states, it does not pose a large scale or long term threat to the environment. However, the human health impact is more significant because of the urban focus of most industries and the ties between inadequate solid waste disposal and increased risk of disease. Future intervention benefits will improve the health and economic productivity of urban communities and are estimated to be moderate. Possible intervention actions are moderately expensive, requiring industrial landfills and waste collection programs; there may also be economically viable opportunities for waste recycling within industrial estates.

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[6] Two RRAD are assumed to cause the loss of one working day.

[7] PM10 is converted to TSP by a factor of 1.82 (Ostro, op.cit.). The space for the ambient pollution in Port Harcourt is assumed to be 75 mio. m^3, i.e. the urban area is estimated at 5 km * 5 km and the urban pollution is up to 3 m above ground. The concentration of 1 mg/m^3 is thus equal to 1.37 kg TSP, or equivalent to the emission of 1,900 vehicle km. If the TSP contribute to the ambient pollution for one week the daily reduction in vehicle km must be 270.

5.23 **Municipal Solid Wastes.** Inadequate municipal solid waste management poses a serious health threat to people living in urban areas and some rural communities. Solid wastes clog drainage systems, increasing flooding and water-related diseases. If dumped into nearby water bodies, they can also reduce water quality, further increasing health risks. Poor solid waste management also lowers economic productivity. Environmental impacts are low because the waste problem is geographically limited in both terrestrial and aquatic ecosystems. Given the high social costs of improper disposal of municipal solid wastes, the future benefits are commensurably high. The costs of appropriate management programs, involving sanitary landfills, waste collection, and separation of selected wastes for recycling, are generally moderate in comparison to the benefits. Experience in areas of Indonesia and Pakistan, for example, shows that such benefits readily exceed costs by an order of magnitude; where benefits are translated into improved health, improved industrial efficiency, and greater amenity (World Bank, 1994).

F. SUMMARY OF PRIORITIES

5.24 Based on the above, it is clear that the highest priorities in the Niger Delta are associated with renewable resource degradation. In addition, some environmental pollution issues are also of high priority because of the potentially high human health impacts. Of the land resource degradation areas, only agricultural land degradation has the highest overall priority. Other problems are generally less urgent because of low to moderate environmental and human health impacts.

Highest Priority Problems

Renewable Resource Degradation:

- fisheries depletion
- deforestation
- biodiversity loss
- water hyacinth proliferation

Environmental Pollution

- water contamination from sewage
- vehicular emissions
- municipal solid wastes
- toxic and hazardous substances

Land Resource Degradation

- agricultural land degradation
- flooding (moderate to high)

6. STRATEGIC OPTIONS - INTEGRATED ENVIRONMENTAL MANAGEMENT AND DEVELOPMENT

Current trends will increase environmental degradation in the Niger Delta if no action is taken to address the priority environmental concerns. The trends, including population growth and excessively rapid extraction of renewable resources, are difficult to reverse, but they are also not inevitable. This chapter presents integrated coastal zone management (ICZM) as a methodology for reversing the trends and moving towards environmentally sustainable development. The types of strategic options and specific interventions for addressing the key environmental concerns within an ICZM framework are discussed. In addition to specific interventions, policy reforms necessary to create a policy framework appropriate for sustainable development are highlighted.

A. THE CONSEQUENCES OF NO ACTION

6.1 Environmental degradation is a major cause of economic productivity losses and poor human health in the Niger Delta. Trends that are under way will increase the impact of environmental degradation if no action is taken to reverse the key environmental concerns. Based on current population growth rates, including urban growth forecast to be between 4-7 percent, the World Bank report, Africa: A Framework for Integrated Coastal Zone Management, anticipates that the coastal corridor along the Gulf of Guinea, including the Niger Delta, will exceed its environmental and development carrying capacity long before 2025. Within the Niger Delta, if no action is taken the priority environmental problems identified in chapter 5 will become more severe, and the links between population growth, poverty, and ecological degradation will become more explicit.

6.2 At the current population growth rate in the delta of about 3 percent annually, population pressure will require that agricultural output double to meet subsistence requirements. If intensification is not increased to match increasing food demands, agricultural land degradation from unsustainable agricultural practices, as well as deforestation from agricultural expansion, will lead to rural economic decline and poorer diets. The trends indicate that reduced fisheries and forest resources will no longer be able to support the thousands of households that rely on them for subsistence and income. Unmanaged sewage, solid wastes, and vehicle emissions will continue to erode living conditions, productivity, and health in urban areas. The social conflicts over resource rights and utilization which have marred the delta are likely to escalate. In sum, the Niger Delta will become an increasingly hostile environment for human habitation, with declining income levels and increasingly poor health conditions.

6.3 These trends are not easy to reverse, but they are also not inevitable. Prompt action, based on a correct diagnosis of the critical problems and a sound strategy for dealing with them, can put the Niger Delta on a path towards long term human development and ecological protection. This chapter presents Integrated Coastal Zone Management (ICZM) as a potential methodology for achieving environmentally sustainable development. The types of strategic

choices that are available for addressing the key issues and the specific actions that can be taken to begin the process of accelerating sustainable development in the Niger Delta are set forth.

B. Conceptual Policy Framework: Integrated Coastal Zone Management

6.4 An integrated resource management approach is required to address the broad range of social and environmental issues in the Niger Delta and to move the region towards sustainable development. Integrated coastal zone management (ICZM) is a process that is being used in other developing countries to deal with similarly complex coastal resource issues (Table 6.1). ICZM is a holistic planning and coordinating process suited to ensuring that the large economic and social benefits from coastal resources in the Niger Delta are managed to maximize social welfare and not dissipated by destructive practices or inappropriate use. ICZM has two fundamental objectives: (i) to promote sustainable utilization of coastal resources, and (ii) to restore and maintain the integrity of coastal ecosystems. Related objectives include reducing user conflicts over coastal resources and fostering equitable distribution of benefits among stakeholders. It is an ecologically and socially based approach to environmental management that is a significant departure from traditional sectoral approaches which have proven unable to deal with the complexity that characterizes coastal zone problems. Instead of being a rigid formula for coastal resource management, ICZM is, most importantly, a way of holistically viewing a region and its resources.

Key Principles of Integrated Coastal Zone Management

6.5 Generally accepted ICZM principles which have formed the conceptual basis for successful programs throughout the world include:

- Address the priority issues with interventions that have the highest net marginal benefits;
- Develop an appropriate, incentive based, regulatory framework;
- Strengthen sectoral management and induce sectoral institutions to recognize and account for the interconnections between coastal resources and uses;
- Create institutional arrangements and linkages to coordinate sectoral activities and policies such that they reinforce the goals agreed on for the coastal zone;
- Focus on proactive environmental planning, impact assessment, and management;
- Minimize foreclosure of future development options by current activities (maintain flexibility for future resource uses);

- Follow the 'polluter pays' principle, whereby firms are required to pay all-or at least a substantial part-of the social costs of their activities;

- Integrate stakeholder participation and ownership throughout the ICZM process;

- Establish open and effective institutions; and

- Strive to have prices reflect the full cost of goods and services.

Critical Actions for Initiating a ICZM Strategy

6.6 To accomplish its purposes, ICZM requires several actions to be taken at the national and regional level, including the following:

- Establishment of an appropriate policy framework to support coastal resource management and environmental conservation;

- The collection of data and technical information of relevance to the coastal zone;

- An understanding of the resource management and environmental objectives among the various stakeholders, including local communities;

- Development of an Action Plan to correct past environmental degradation, to modify ongoing activities that are environmentally harmful, and to establish a system for reviewing and implementing new coastal zone development projects; and

- Development of an effective institutional structure to implement the Action Plan, initiate future programs, and to oversee environmental monitoring of the coastal zone on a permanent basis.

Table 6.1: The Status of National ICZM Programs

Country	Research/ baseline data available	CZM authority identified and plan for coordination available	Sectoral plans or site specific plans exist	ICZM planning and implementation in progress	Evaluation and feedback	Experiences so far
Bangladesh	Yes, large data gathering effort, particularly on mangroves and fisheries	No	Yes for mangrove management	No	No	None
China	Yes, large data gathering effort	Coastal/Marine Management Agency under State Oceanography Administration, No National Plan	Yes, sector plan for fisheries in Chosan and regional plans in Hainan and Xiamen	Yes in fisheries and Hainan and Xiamen regional efforts	None	Limited
Ecuador	Yes	Yes, a National Commission for interagency collaboration has been established. No national plan, but five special area management plans have been developed	Yes, five special area management plans exist. Specific policies address mangrove management, tourism, aquaculture, etc.	Yes	Yes, ongoing	Generally very good
Ivory Coast	Some	No	No	No	No	None
Kenya	Yes, particularly from areas around Mombasa, Kilifi and Gazi	National Parks and Wildlife Service (KNPWS)	Yes, being implemented through KNPWS in some areas	Yes, conservation and pollution areas	Ongoing	Limited, enforcement is a major problem
Mauritius	Yes, extensive data gathering completed	No, discussions ongoing	Yes for some tourist areas such as in Southwest and Northwest	Not yet	No	None, coordination is a major problem

Country	Research/ baseline data available	CZM authority identified and plan for coordination available	Sectoral plans or site specific plans exist	ICZM planning and implementation in progress	Evaluation and feedback	Experiences so far
Mozambique	Some from Inhacca, and geological, fisheries, and mangrove data	No	Yes, under development in some areas, such as Inhacca, and some sectors, such as mussel harvesting	Yes, initiating planning	Not yet	None
Seychelles	Yes, some on corals and fisheries	No	Yes, draft plans exist for Victoria and Beau Vallon	In progress for these areas	Not yet	Limited
Sri Lanka	Yes for some areas along the West and Southwest coast	Coast Conservation Department	Yes for Hikkaduwa and being drafted for Puttalam	Yes, for Hikkaduwa and Puttalam	Yes, ongoing	Limited, but growing, enforcement a problem
Tanzania	Yes from various areas, Rufiji, Mafia, Tanga Kundichi	Not on a National level, but being developed, particularly Zanzibar	Yes for several areas, Tanga, Kunduchi, Mafia, Zanzibar	Yes in Tanga, Kundichi and Mafia	Considerable experience within several institutions	Limited, but growing, enforcement a problem.

Source: World Coast Conference 1993 Proceedings; UNEP, Guidelines for Integrated Coastal Zone Management of Coastal and Marine Areas with special reference to the Mediterranean Basin, 1994; The World Bank, Africa: A Framework for Integrated Coastal Zone Management, 1995; Proceedings of the Arusha Workshop on Integrated Coastal Zone Management in Eastern Africa including Island States, 1995.

C. POLICY REFORMS

6.7 To achieve sustainable development in the Niger Delta, an appropriate policy framework, as well as specific projects and programs, must be instituted. Otherwise enhancements will be localized and drop off when funding ends. The most critical policy failure in the Niger Delta is the lack of effective and uniform enforcement of property rights and regulations (Chapter 4). Without secure resource rights and enforcement of regulations, individuals, firms, and government agencies have little incentive to modify their behavior to manage resources efficiently and consider social and environmental externalities. Institutions must recognize and respect the various forms of traditional ownership. For example, several communities in the delta sustainably manage and protect communally owned water bodies and forests (Box 6.1). Through recognition, traditional ownership systems become eligible for management enhancement, such as agricultural extension services, training, and micro credit programs. Examples of effective farming empowerment programs, participatory natural resource management, and integrated conservation and development programs from throughout Africa are described in Boxes 6.2, 6.3, and 6.4. Non-traditional tenure systems must also be enforced, supported, and strengthened. Economic policy failures, which distort markets from including the full costs of goods and services in prices, are another major policy limitation. Sound policies require accurate information; however, information gathering, management, and sharing are very weak in the Niger Delta. Closely tied to the absence of

Box 6.1
Community Protected and Managed Aquatic Areas in the Niger Delta

Local communities protect aquatic ecosystems in the central axis of the Niger Delta on a variety of different levels. Three communities protect aquatic areas from all forms of exploitation:

Channel Systems
- Orashi River at the Akissa sacred forest
- Akete-tua-owei Creek downstream of Oyeregbene

Lakes and Ponds
- The Igbedi lake at Akakoyoto

Partial protection is afforded in many other lakes where communal tenure systems remain intact. Numerous lakes are only fished every seventh year and 22 harbor protected crocodile populations. In at least two areas, the sanctuaries extend to surrounding terrestrial ecosystems:

- The Biseni wetland reserve at Sabiyo
- The Oporoma reserve at Boupere.

These successful community managed aquatic and terrestrial ecosystems may provide a model for improving local management of other aquatic and terrestrial systems and should be considered for conservation and development support.

Source: Powell, 1993, 8.

strong property rights is the lack of accountability and local participation in decision-making. When public and private institutions are not accountable to the communities they impact and do not establish a systematic dialogue with them, activities may be inappropriate and even detrimental. Communication between institutional stakeholders, including government agencies, is also undeveloped in the region and leads to project duplication, poor regulations, inappropriate activities, and implementation delays. Policies which exacerbate poverty and inequitable distribution of wealth and resources in the delta retard development of the region and force households to degrade their environment to meet short term requirements.

Box 6.2
Empowering Farmers in Africa - Case Studies

Empowering farmers to give them greater control over their resources and organization is considered a critical component for poverty alleviation. Successful empowerment programs from Cameroon and Mali are discussed.

Cameroon. In 1989, the government significantly cut back its direct interventions in farmer cooperatives and undertook significant legislative, regulatory, and institutional reform. Donors established a support fund for cooperative institutional strengthening, training, and improved cooperative services. The goal of reduced state supervision has been met by: (i) an information campaign through seminars and brochures to act as a practical guide and clarify legislation and regulations; and (ii) mandatory registration of cooperatives. The program found that the best approach is to encourage existing community based organizations. Only modest resources were used to develop the empowerment program, but the initial results include building viable local economic institutions which may offer economies of scale, reduced rural-urban migration, and much greater dialogue between farmers and the state in determining rural development policy and actions.

Mali. As in Cameroon, crises in the late 1980s have led the government to reduce its intervention in farmer organizations. Highlights of the reform program include creating: (i) savings and loan associations, (ii) producers' union, (iii) management support centers, and (iv) local investment funds. The concept behind the reforms is to strengthen the independence and impact of inter-village farmer organizations. For example, the 1,500 Village Associations of South Mali collect cotton, distribute inputs, determine credit arrangements, and implement economic and social investments. Financial sustainability of the new institutions is ensured by creating funds which are maintained and replenished. The local investment funds and management support centers have stimulated private sector development in management support, transportation, construction, technical studies, and service delivery.

Source: Africa Region. 1995. Findings. No. 33.

6.8 Policies need to be shifted towards:

(a) reducing negative environmental and social impacts by emphasizing pricing and market mechanisms;

(b) alleviating poverty to decrease poverty induced environmental degradation;

(c) encouraging investment in renewable resources;

(d) increasing resource ownership and management by those affected by degradation (including higher capture of rents by local communities from resource use by state and private organizations);

(e) encouraging a precautionary approach to activities where information is poor or impacts are uncertain; and

(f) increasing the accountability of decision-makers and expanding stakeholder participation in decision-making processes.

Box 6.3
Participatory Natural Resource Management in Burkina Faso

Burkina Faso has developed a participatory approach to mitigating land allocation problems and environmental degradation through community management. Based on the community *terriors*, the program has followed several key steps towards implementation:

- Community organized natural resource management committees, comprised of a wide variety of stakeholders, are established to allocate resources and communicate with adjacent communities and the government.
- Technical advisors help the communities prepare resource management plans which include (i) community objectives, (ii) environmental assessment, (iii) appropriate technological options, (iv) protection of critical natural resources, and (v) community income generating activities.
- The government and the community agree to the plan and respective responsibilities.
- The committees monitor implementation of the plan.

The program has led to better resource management and is being expanded to other Sahelian countries, including Mali and Niger.

Source: World Development Report, 1992.

6.9 The overarching purpose of the policy changes is to provide clear incentives for all stakeholders to work towards environmentally sustainable development in the Niger Delta. The farther an organization's policies and programs are from this goal, the greater will be the required shifts. On a government level, reform requires that government agencies consider their impact on environmental and equity concerns as part of an expanded mandate. At the individual and company level, regulatory reforms need to ensure that externalities become incorporated into private decision making. For communities, reforms must give them greater

incentives and skills to manage resources more sustainably. The strategic options discussed below present concrete mechanisms for the required policy shifts.

Box 6.4
Integrated Conservation and Local Development Case Studies

Burundi: Rumonge, Vyanda, and Kigwena Reserves. This project, run by the government and Catholic Relief Services has increased protection of the three reserves and has created alternative sources of income, employment, and wood products for surrounding communities with a total population of 3,000 inhabiting an area of 100 km^2. Before the project, none of the reserves were protected; now six guards patrol provide partial protection. Community development involves an agroforestry extension program, which also includes conservation education, and ecotourism development. Learning from similar integrated conservation and development programs in the country, this program had significant short term success in improving conservation and agroforestry extension. Managers are currently emphasizing revenue generating activities to ensure long term sustainability after external support ends

Madagascar: Beza Mahafaly Special Reserve Area. This small reserve (6 km^2) was established in a sacred forest local people sought to protect. The goal of the project was to give communities an incentive to support conservation. This was accomplished by making an agreement with local villages describing their obligations and the benefits they would receive. The entire population of the valley (2,000) participated in the decision to create the reserve. Development benefits include road and irrigation canal repair, school construction and maintenance, and agricultural extension. Forest guards are hired from local villages and are well protecting the park. The reserve has become a model for integrated conservation development projects in Madagascar and the rest of Africa. Key factors in its success are: (i) complete absence of government services before the project; (ii) ten year relationship between expatriates and local communities before project initiation; (iii) effective dialogue with government agencies; (iv) small size; (v) stable agricultural systems; and (vi) abundance of fuelwood outside of the reserve.

Zambia: South Luangwa National Park. This protected area covers nearly 15,000 km^2. The national park is complemented with a game management area set up for local development. The principals activities in the management area are wildlife harvesting, safari hunting, and subsistence hunting. The critical factor for success is a policy change that allowed communities to keep the revenue from safari hunting. They also benefit from income and employment in the wildlife harvesting program. Income from the programs supports the funding of local guards. The program is very strongly supported by local communities and has drastically reduced poaching.

Source: Wells and Brandon, 1992.

D. Environmental Information Systems and Exchange

6.10 For effective policy and decision making, more environmentally related information must be collected, analyzed, and disseminated. In many cases, too little is known about Niger

Delta ecosystems and communities to understand and predict the impacts of various development projects and policies, or estimate the value of many of the resources of the region. In other cases, the information exists, but is not available to policy or decision makers. Spatially based information is most critical because it would vastly improve the understanding of the regional impact of different activities on the delta environment. Improved information is particularly essential in the following areas:

- Land use surveys: the national land use survey being prepared as part of the Environmental Management Project will substantially contribute land use information on the Niger Delta, but may have to be augmented by more precise regional surveys, including the Niger Delta Environmental Survey (Chapter 3);
- Flood and erosion risk assessment and long term hydrological monitoring;
- Forest inventories;
- Fishing efforts and yield, and perhaps fish stock assessments;
- Biological inventories in areas with high biodiversity;
- Water hyacinth ecology;
- Vehicular emissions risk assessment (including water transport);
- Socio-economic studies of rural and urban communities, including assessments of how villages interact with their natural environment; and
- Industrial pollution inventories and risk assessments.

6.11 Baseline information gathering should be updated with regular monitoring of key environmental and social indicators to determine how well the coastal zone management program is working and where improvements need to be made. Having relevant quantitative indicators that are assessed right from program development are critical for evaluating the impact of specific interventions. The areas of monitoring will depend on the intervention foci of the ICZM strategy (examples are presented in box 6.5).

Box 6.5
Examples of Potential Indicators for Assessing the Impact of an ICZM Program

Pollution

- Quantity of toxic substances released
- Air quality indicators (e.g. ozone, NO_x, SO_2, particulates, lead)
- Number and size of emissions violations
- Number and size of oil spills
- Value of losses to oil pollution
- Basic water quality parameters (BOD, hydrocarbons, nutrients, coliform, heavy metals)

Biodiversity and Forestry

- Number, range, and population viability of indicator species
- Intact forest area in each ecological zone
- Percentage of forest under sustainable management
- Percentage of actual protected forest in each ecozone
- Annual area deforested
- Species composition and abundance of coastal fisheries; size class distributions

Urban Issues

- Percentage of population with access to adequate sanitation
- Percentage of population with access to safe drinking water
- Number of cases of water related diseases
- Percentage of population with adequate housing
- Annual municipal waste generation

6.12 Successful information management requires not only data collection, but also information exchange. Strong information exchange will help mitigate two of the major underlying causes of degradation: the lack of accountability and limited local participation. Accountability will improve as the information base and decision making process become more open and transparent. Participation will also increase because stakeholders will be better informed of new policies, projects, and programs. At present, government agencies, private firms, and communities have little incentive to share information. The State Coastal Zone Coordinating Committees are expected to greatly improve information exchange between these disparate groups.

6.13 Centralized or decentralized approaches can be used for environmental information management. Under the centralized model, a single institution performs and manages all information activities. The major advantages of this approach are that data collection may be more systematic and better coordinated; new technologies are also easier to adopt. The second model develops an information network which exploits the comparative information gathering advantages of different organizations and their information requirements. The

network is complemented with incentives for free exchange and open access to information. Given the importance of information sharing and difficulty of setting up a central information institution for the delta, a network linking sectoral agencies and NGOs may be the best option. Information exchange can initially be improved by conducting inter-organizational meetings and forums and publishing agency reports, similar to the annual State of the Environment reports put out by the Rivers State Environmental Protection Agency. As electronic information becomes more widespread, a computer information network that emphasizes map based information should be developed. Since OMPADEC is already developing a GIS program, it may be the natural hub for such an information network. Alternatively, as the coordinating bodies for sustainable development in the states, the State Coastal Zone Committees could manage both a paper document resource center and a electronic information hub for the region.

E. Development and Initiation of an Action Plan

6.14 The following actions need to be taken for effective development and initiation of an Action Plan:

- Development of specific goals and policies required to achieve them. As far as possible, goals should be expressed quantitatively to improve monitoring and evaluation effectiveness. This is achieved through:
    - Consensus among the major stakeholders on which of the priority issues they feel are most urgent to address.
    - Evaluating strategic options for addressing the key priorities, including new economic development possibilities, and identify the options with the highest net marginal benefits for further analysis and implementation.
- Identification of a lead agency which will oversee and coordinate the ICZM strategy and assessment of institutional strengthening required in the lead agency.
- Definition of the role of the State Coastal Zone Coordinating Committees.
- Assessment of the capacities of existing institutions to advance the ICZM program, particularly as it relates to addressing community-level issues. Develop specific recommendations for institutional strengthening that reflect the most pressing requirements of the ICZM Action Plan. The institutions must be given clear ICZM responsibilities and be held accountable for them and to their clients.

- Establishment of the timetable, approach, costs, and division of labor for the ICZM program and subcomponents.

- Review and refinement of existing regulations and consideration of new regulations.

- Identification of areas and methods of additional information collection.

- Design of appropriate monitoring and evaluation systems to measure goal attainment.

- Development of the process for ensuring public participation throughout the ICZM process and fora for conflict resolution.

- Eventually, the Action Plan needs to be integrated into the regional and state level development plans for the Niger Delta.

F. INSTITUTIONAL ISSUES

6.15 The initiation and implementation of an Action Plan for integrated coastal zone management requires that effective institutions are in place. The skills and resources of many institutions (both public and private) are necessary to carry out the wide variety of ICZM responsibilities. In meeting the objectives of the Action Plan, institutional reform is as integral as capacity building. Reform and institution strengthening must be directed to creating professional, results orientated, and responsive agencies.

6.16 The first step in defining institutional jurisdictions should be to determine the comparative advantage and hence the role of the public institutions at all levels operating in the Niger Delta to meeting the objectives of the ICZM Action Plan. For regional or state level ICZM, the actions of the public sector must be directed towards two critical areas:

- establishing regulatory frameworks which protect the environment and encourage sustainable development; and

- ensuring the delivery of efficient, effective, and equitable public services (health, education, infrastructure etc.).

6.17 Stakeholders will need to identify a lead agency, or agencies, to coordinate and oversee management and implementation of the Action Plan. Experience from other programs throughout the world has shown that the lead agency is best positioned in a powerful institution which has substantial responsibility for economic planning, land use policy, or physical planning. Line agencies have also become successful lead agencies, but may cause organizational rivalries and result in insufficient emphasis on other sector issues. Criteria for

selection of the agency should be based on: its organizational mandate, financial resources and management skills, experience in integrated planning, rating with other institutions, and ability to interact with local communities. The agency should be an autonomous unit with control over budget and staffing. It should comprise a core unit of professional staff with key skills for coastal zone management. The unit should be staffed with full-time permanent professionals to ensure continuity of staffing and implementation.

6.18 The roles of the State Coastal Zone Coordinating Committees must also be defined. In other ICZM programs, coordinating committees provide a critical forum for stakeholder participation in the ICZM process. They also oversee monitoring of the program and conduct periodic evaluations to ensure the goals of the program are being met and are on schedule. Technical assistance to sectoral institutions which are not used to considering issues beyond their narrow sectoral mandates is another important function. Finally, the committees often facilitate dialogue to reduce agency rivalries and clarify responsibilities. With their broad based stakeholder representation and direct responsibility to the State Governors, the State Coordinating Committees are well positioned to play a major role in ICZM in the Niger Delta.

6.19 The existing state sectoral agencies will need to be assessed in terms of their ability to meet their current obligations and potential future roles as sectoral implementing, monitoring, and enforcement agencies under the ICZM Action Plan. Based on current responsibilities, resources, and effectiveness, institutions must be given clear mandates to implement the most critical requirements of the Action Plan. Municipal agencies will similarly need to be evaluated and augmented to perform or regulate critical public services. The most important and difficult area of institutional assessment will be to determine which organizations, public, private, or non-governmental are best suited to implement the objectives of the Action Plan in the riverine communities. Institutional strengthening should be tailored to meet the most critical new responsibilities of the organizations.

6.20 The first step in reforming public agencies is to ensure that institutional goals are modified to incorporate the key principles of ICZM, particularly: (i) to take into consideration the interconnections between coastal resources and uses; (ii) to develop an appropriate, incentive based, regulatory framework; (iii) to focus on proactive environmental planning, impact assessment, and management; and (iv) to emphasize stakeholder participation and ownership. Helping the public sector carry out its functions efficiently under the Action Plan involves making it more professional through the adoption of appropriate management techniques. This includes approaches such as results orientated management, client focused service delivery, improved personnel management, and utilization of alternative approaches to direct government production of services (e.g., contracting out; utilization of indigenous and informal institutions). It is also essential to strengthen accountability to clients and stakeholders and uphold the rule of law, especially resource ownership.

G. Strategic Options

6.21 The options for redressing environmental degradation in the Niger Delta discussed in this section are presented as *possible* interventions which should be evaluated more closely and considered for inclusion in the Action Plan. They are discussed primarily to stimulate

debate on how to address environmental degradation, rather than to advocate specific projects and policies which must be implemented. Through the process of examining these options, it is anticipated that other alternatives which are more appropriate for the delta will be developed as well. Information collection and management options are not described because they are discussed in the environmental information systems section above. The options emphasize addressing the nexus of rural and urban poverty and environmental degradation. The ultimate goal of the strategic options review process is to determine the most effective and efficient policies, programs, and projects for mitigating the priority environmental issues confronting communities in the Niger Delta.

Types of Strategic Options

6.22 A variety of types of options can be utilized to address different facets of the environmental problems facing the delta. Depending on the scope of the intended impact, the types of options can be designed to manage problems at the regional and state or community level. These include the following:

(a) **Legislative and Regulatory.** This category includes choices that change or add to the laws and regulations affecting stakeholder actions. Regulatory reforms need to emphasize efficient solutions to environmental problems by stressing **market based incentives** where appropriate. One particularly effective regulatory device is **land use zoning** which attempts to make the best use of land resources by limiting the range of activities in specific areas based on environmental and social concerns (see Annex O). Another important regulatory program is the requirement for **Environmental Impact Assessments** which examine the potential impacts both on and off-site before allowing new developments to proceed.

(b) **Institutional Solutions.** On the regional and state level, institutional options should concentrate on capacity building in critical areas to quickly improve the ability of existing institutions to implement their environmental mandates by focusing on the priority problems. It is equally important to get other major agencies to reduce negative environmental impacts of their activities. On the community level, NGOs and community organizations need assistance to develop expertise in mitigating local environmental and social concerns.

(c) **Investment Projects.** Some problems will require the use of specific investment projects to carry out the physical work that may be required to repair the damage that has been done in the past or to create works that would prevent future degradation.

(d) **Social Development.** In addition to infrastructure investments, social development in rural and urban areas willl need to be fostered through community level programs aimed at the provision of basic services and improved income generating opportunities. Avenues for reinvestingrevenues from resource exploitation into improved social welfare and environmental

management need to be established. Alternative livelyhood and other income generating projects are required in areas where natural resources are unsustainably exploited.

(e) **Education.** Whether through regional/state or local programs, education initiatives need to change behavior at the community level. Education plays a crucial role in obtaining local understanding and mitigation of environmental degradation and in facilitating their adoption of more sustainable and higher income generating activities.

Options Targeted To Erosion[1] and Flooding

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS	Require upstream dams to mimic natural flow regimes.	
REGULATORY REFORMS	Land use zoning. EIAs.	
- including economic mechanisms	Incentives to limit construction in high risk areas. Performance bonds for activities that are directly responsible for erosion and flooding.	Incentives to induce communities to move from flood and erosion prone areas. Incentives for improved housing.
INSTITUTIONAL REFORMS	Increased emphasis on erosion and flooding management, watershed management and land use zoning by regional and municipal organizations.	
DIRECT PROJECTS	Protection projects. Reservoir dredging. Riverbank and shore buffer zones. Drainage projects. Flood early warning system.	Community shore and riverbank protection projects. Community drainage programs.
EDUCATION PROGRAMS	Erosion and flooding reduction extension service. Environmental health education.	Enhance erosion management awareness.

[1] Although the priority section did not rank erosion as a high overall priority because of the high cost of most interventions, it is included in the strategic options section because it causes very significant environmental and human health impacts which should be considered for mitigation. In addition, solutions for erosion problems are often closely tied to flood management solutions.

6.23 Flooding and coastal and riverbank erosion impair social and economic development in large areas of the Niger Delta. However, most project level interventions, such as shore and riverbank protection projects and reservoir dredging, are high cost engineering options. In addition, by modifying sediment transport in the delta, protection measures may cause additional problems which are more severe that the erosion they are designed to address. Clearly, these large scale engineering projects need to be viewed with a watershed management perspective and will require thorough EIAs before development. In addition to dredging upstream reservoirs, especially Kainji, integrated sediment management programs could dramatically slow further sediment build up behind the dams (Morris, 1994). The first step in an integrated management program is to reduce sediment inflow into the reservoir. Watershed management, stressing erosion control, is the most effective means of reducing sediment flows to the dams. Techniques include conserving soil on agricultural land, increasing the forested area, creating forest buffer strips along riparian zones, and reducing erosion from construction sites and infrastructure. Upstream sediment traps can be used to temporarily reduce sediment inflow while the longer term land use options are being developed. The second step to lower sediment inflow is to decrease the reservoir's trapping efficiency by routing the sediments. This option can involve engineering solutions, like creating sediment bypass routes around the storage pool or reconstruction of the dam to permit sediments to flow out the bottom of the dam (very expensive). The simplest solution is to allow sediment laden flood waters to be released rather than confined by the reservoir. However, this technique can have substantial effects on downstream ecosystems which must be evaluated. On the community level, projects could provide villages and towns with technical assistance and materials to develop their own drainage and shore and riverbank protection programs which do not require large scale engineering solutions. In fact, a small number of communities have already built flood and erosion protection embankments for houses and fields (The Rivers Chiefs, 1992, 38). Spoils from canal dredging could be used as material for shoring up erosion prone areas and increasing the land area of riverine villages, instead of the current practice of dumping the spoils beside the channels which damages forests and farm land (Abam, 1994). These village projects could serve as a model for a more extensive community based program which would greatly increase community participation and promote local, long term maintenance of the protection structures.

6.24 Land use zoning regulations which direct development away from erosion and flood susceptible areas will be an essential component of any water management program. Regulations should establish riverbank and shore buffer zones in high risk areas to reduce the social and economic hardship imposed by flooding and erosion. All interventions, whether direct or indirect, should be preceded by a study to inventory areas vulnerable to flooding and erosion, classified by degree of threat. EIAs should also be required for developments which have a high potential to exacerbate flooding or erosion. Performance bonds for such activities are an economic mechanism that could be used to prevent them. Other market based incentives include risk or insurance charges for building in hazardous areas and financial concessions to move out of such areas.

6.25 Regional organizations, such as the Niger Delta Basin Development Authority and OMPADEC, will need to direct resources towards erosion and flood control and land use zoning. The upstream River Basin Development Authorities and NEPA, which operates the

hydroelectric facilities, will have to adjust their activities to take into account the downstream impacts of inappropriate land uses and reservoir management. Municipal and state agencies will also have to implement erosion and flood prevention and control programs. At all levels, training and education will be required to increase understanding of activities that exacerbate water management problems and methods of preventing and controlling flooding and erosion. Education options need to concentrate on environmental health education to provide information necessary to get households to reduce the health problems associated with flooding. A land management extension service emanating from the regional or state institutions which focused on flooding and erosion could catalyze communities to develop their own erosion control projects.

Options Targeted To Agricultural Land Degradation

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS	Land tenure reform.	
REGULATORY REFORMS	Land use zoning. EIAs. Recognize and enforce private and communal property ownership.	Strengthen communal property ownership.
- including economic mechanisms	Remove implicit subsidies for extensification. Support intensification and agroforestry.	Provide a framework for small and micro credit mechanisms for intensification and agroforestry.
INSTITUTIONAL REFORMS	Capacity building in the Ministries of Agriculture: - soil conservation - land management - land use data collection and management. Improve land use zoning in relevant agencies.	Foster NGOs and cooperative soil conservation and extension programs.
DIRECT PROJECTS	Intensification projects and programs. Soil conservation projects and programs.	Agroforestry and intensification projects. Soil conservation projects. Smallholder wetland rice cultivation projects.
EDUCATION PROGRAMS	Extension services.	Develop locally based land management and soil conservation programs.

6.26 Agricultural land degradation is imposing significant economic costs on local communities throughout the delta. An increasing population that requires greater yields from

an already intensely used land resource base is the principal cause of the degradation. This section presents a variety of potential programs and policies at the state and local levels that could be brought together to lessen degradation.

6.27 Soil conservation and agroforestry programs coupled with intensification are potential direct projects to address these problems. Intensification could take the form of increased use of fertilizers, improved cultivation techniques, (small scale) mechanization, animal traction, higher yield varieties, and improved intercropping. Smallholder wetland rice cultivation may also be an attractive option for development in swamp forest areas that are under intense population pressure. Support for the expansion of agroforestry, particularly compound farming, may be especially promising since tree crops are well adapted to agroecological conditions in much of the delta. In some cases, tree crop farms have become degraded and could substantially benefit from rehabilitation or conversion to agroforestry systems with trees interspersed in arable crops (Lal and Okigbo, 1990, 24). Less intensive options include active management of fallow land, increased use of a greater variety of perennial species, and greater use of crop residues and household wastes as fertilizers (Lal and Okigbo, 1990, ii). Low cost, community-based programs should be emphasized because they address the direct concerns of the farming households and do not require large amounts of credit. The mix of programs selected for sites should only be developed after conducting site-specific community, environmental, and agroecological assessments.

6.28 To be able to address the agricultural land degradation problems, the Ministries of Agriculture will have to be strengthened, particularly in the areas of land management, soil conservation, agroforestry, and land use data collection and management. Programs to incorporate practical and low cost land conservation techniques should be tailored to NGOs, cooperatives, and other farming community organizations. In both types of institution building, education, in the form of training of extension staff and community agencies, will be critical to reach the farm level.

6.29 On the legislative and regulatory fronts, land tenure reform is required to give farmers and other land users incentives to manage their resources efficiently and sustainably. In addition to recognizing and enforcing private property rights, the government needs to strengthen its recognition and enforcement of communal property rights. Environmental impacts assessments should be required for developments, such as oil installations and large scale plantations, which have a high potential for damaging valuable farm land, as well as ecological systems in general. If enforced, land use zoning would be particularly effective in protecting areas susceptible to erosion or flooding that require comprehensive soil conservation regimes or would be best converted to non-agricultural uses.

Options Targeted To Fisheries Stock Depletion

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS	Marine protected areas. Regional agreements between countries and states regarding regulations.	
REGULATORY REFORMS	Enforce existing regulations. Enforce community resource ownership. Total catch limits.	Support community resource ownership.
- including economic mechanisms	Individual tradable quotas for marine fishing.	
INSTITUTIONAL REFORMS	Capacity building and prioritization of state fisheries departments towards: - improved monitoring and enforcement - fisheries management and economics training - improved fisheries data collection and management.	
DIRECT PROJECTS	Environmentally and socially sustainable aquaculture. Improved fish processing infrastructure (refrigeration, processing, and transport).	Community based aquaculture. Improved community based fish processing infrastructure. Alternative livelihood projects for communities in overfished areas.
EDUCATION PROGRAMS	Environmental education, especially in coastal communities.	Information campaigns among fishermen on fisheries and the environment, and sustainable aquaculture.

6.30 The depletion of fisheries stocks is threatening the economic activities and health of coastal communities. Policies and projects are required to reduce fishing efforts to match the maximum sustainable yields of commercial species. Regional and state level projects should emphasize the development of environmentally sustainable aquaculture and improved fish processing infrastructure. Both of these types of projects need to be developed at the community level to ensure that they directly benefit from development. In areas that have been overfished or have a high risk of overfishing, the potential for alternative livelihood projects that train and fund some households to switch to non-fishing activities needs to be explored

and funded. For example, sustainable, community managed periwinkle (mangrove ecozone) and clam (freshwater ecozone) harvesting could be developed.

6.31 Although the legislative framework governing fisheries exploitation is generally sound, it might benefit from establishing marine protected areas which could act as refugia to increase stocks of commercial and rare species. In addition, fisheries management along the West African coast would improve if regional agreements which coordinate regulations, monitoring, and enforcement programs are created. The two fundamental regulatory reforms that are necessary both involve enforcement: (i) enforcement of existing regulations, and (ii) enforcement of community resource ownership. Supplementary regulatory improvements include establishing total catch limits and individual tradable quotas. To support the necessary enforcement improvements, the state fisheries departments need to have much stronger monitoring and enforcement programs, which requires field stations. Fisheries data collection and management must also be enhanced. Finally, training in fisheries economics and management is required to give fisheries officers a better understanding of how the resource can be exploited most efficiently. To improve awareness of the ecology of fish and aquatic systems in general environmental education programs should be developed, especially in coastal communities. These communities should be the focus of information campaigns that emphasize the linkages between sustainable fisheries and environmental care. Training in small scale aquaculture and fisheries processing techniques would also be beneficial.

Options Targeted To Forest Degradation, Deforestation, and Loss of Biodiversity

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS	Land and tree tenure reform. Endangered habitat and ecosystem management legislation.	
REGULATORY REFORMS	Sound concession and royalty programs. Enforce existing regulations. EIAs. Land use zoning. Hunting permit system and sanctions. Enforce CITES.	Support community resource ownership.
- including economic mechanisms	Concession auctions. Include conservation costs in project development.	Provide a framework for small and micro credit mechanisms. Incentives for tree planting. Conservation royalties.
INSTITUTIONAL REFORMS	Capacity building of state forestry departments: - improve monitoring, enforcement, and revenue collection - forest management, forest economics, and conservation training - improve forest resource data collection and management. Improve land use zoning capabilities of relevant agencies.	Capacity building of NGOs and communities: - training in conservation and silviculture - develop community monitoring, enforcement, and revenue collection programs.
DIRECT PROJECTS	Forest reserve support Smallholder timber and NTFPs programs. Upgrade select reserves to higher protected area status. New protected areas. Alternative sustainable product development. Establish buffer zones around protected areas. Improve timber processing efficiency.	Agroforestry projects and programs. Integrated conservation and development projects and programs. Alternative sustainable product development. Domesticated game projects and programs.
EDUCATION PROGRAMS	Environmental education in schools.	Conservation clubs.

6.32 Other than in the largely intact mangroves, deforestation and forest degradation are disrupting ecosystems and the communities that rely on them in large areas of the Niger Delta. While some of the indirect causes cannot be addressed through regional or sector interventions, a large number of policies and programs at the regional and local levels can improve resource conservation and management.

6.33 Direct projects should be designed to protect and manage the remaining large forest stands, as well as fostering community based forestry and afforestation programs. On the regional level, the forest reservation system needs to be improved by supporting the management of current reserves and establishing new reserves in critical areas. In addition to more reserves and improved reserve management, local concerns and values must be incorporated into the reservation process for it to be successful. Integrated development projects which reduce community pressure on reserves by providing alternative income sources in buffer zones or nearby areas are one alternative. Other options include continuing and even increasing community resource utilization that does not conflict with conservation goals. For example, community logging or non-timber forest products (NTFPs) collection may be an effective way to enhance community development and improve forest management. The high demand for wood products makes efficient use of wood inputs critical. Improved wood processing efficiency would reduce forest resource waste and have substantial cost savings.

6.34 Agroforestry programs and projects could be used to increase tree coverage and reduce forest degradation from small scale timber extraction and non-timber forest products collection. The agroforestry system selected must take into account existing land uses and strive for compatibility with farming practices. The forestry departments could develop agroforestry smallholder and community programs based on particularly valuable timber species or NTFPs. A small and micro credit mechanisms framework may be necessary to encourage rural communities to plant trees and manage forests.

6.35 For forest management to improve on a regional level, the forestry departments in both states must be strengthened. Capacity building is required specifically to improve monitoring and enforcement of regulations and concession conditions. Field offices and vehicles, especially boats, are essential for effective regulation. To offset their small state budget allocations, the departments must concentrate on revenue generation. Before the departments can effectively manage their resources, they must have a much better knowledge of the resources under their jurisdiction. This requires systematic and comprehensive forest resource data collection and management which are now done in an ad hoc fashion, at best. Government agency development could be complemented by promoting NGO and community organizations that focus on silviculture and conservation training. Community monitoring, enforcement, and revenue collection programs would also be very valuable for enforcing community rights over forests, and freeing department resources for other tasks. Most importantly, it would give communities strong incentives to manage their forests for long term benefits. Education programs and conservation clubs would also increase community understanding of the importance and value of their forests.

6.36 Legislative reforms that increase local rights over land, and in this case trees, are important for sustainable and efficient use of resources. As long as communities do not have legal land tenure and the state has ownership of timber trees, local people will not have strong incentives for forest management since the benefits of proper silviculture require many years before they are realized. Regulatory modifications should stress sound concession and royalty programs which include market based incentives, such as concession auction and higher royalties, to ensure that the state and communities receive a greater share of forestry rents. As important, existing regulations need to be enforced either directly by the forestry departments or by community foresters and councils. Land use zoning and better environmental impact assessments would also reduce the risk of incompatible land uses and projects degrading or destroying forests.

6.37 Many of the policies and direct interventions used to address forest degradation described above also support biodiversity. The next two paragraphs emphasize areas which have a biodiversity focus that lie outside the scope of the forestry strategic options. Direct projects should focus on upgrading the most biologically important reserves to higher protected area status as part of integrated conservation and development projects which meet the needs of local communities. Ecosystems which are not well represented in the reserve system, such as mangrove forests and the western barrier islands, should also be protected. Community and forestry department domesticated game programs could also help reduce hunting pressure on threatened species and increase rural incomes. Programs should begin with relatively easily managed species, especially snails and bees, before attempting more sophisticated programs involving mammals. Longer fallow periods and allowing larger areas of secondary forest to establish would also increase the populations of bushmeat species. Fostering activities which promote the export of sustainably harvested products, such as aquarium fish, *Ogbono* seeds, bullfrogs (*Dicroglossus occipitalis*) and timber, should be examined. Since little is know about the biology of the delta ecosystems, systematic biological inventories should be conducted and incorporated into precautionary land use planning.

6.38 Conservation capacity building and training at both the state ministry and community levels should be the focus of institution building programs. On the legislative side, in addition to land tenure reform, laws need to incorporate endangered habitat and ecosystem management concepts. The states should explore instituting hunting permit and sanction programs to keep hunting at sustainable levels and reduce the pressure on threatened species. Stronger support of community resource ownership would reduce open access regimes which permit excessive hunting and habitat degradation. Economic mechanisms which influence private behavior to consider the social costs of biodiversity losses, including incorporating conservation costs into projects, paying conservation royalties to the state or communities, and develop a framework for credit mechanisms for NTFPs production, should be reviewed.

Options Targeted To Water Hyacinth

Options	Regional/State Level	Community level
LEGISLATIVE REFORMS REGULATORY REFORMS		
- including economic mechanisms		
INSTITUTIONAL REFORMS	Research program. Coordination of control programs.	Foster NGO/community control programs.
DIRECT PROJECTS	Harvesting programs. Biological control pilot program. Utilization pilot project.	Small scale harvesting projects.
EDUCATION PROGRAMS	Include in environmental education programs.	Control and management awareness programs.

6.39 Water hyacinth is a major and rapidly expanding problem for riverine communities which rely on water transportation and fishing. Currently, no solutions which halt rather than control its spread are available. A decision will have to be made whether to wait for the development of methods to stop the spread or use existing control to slow its proliferation. To control water hyacinth expansion, direct projects will have to concentrate on harvesting programs in priority areas (e.g., flood plain lakes). While mechanical harvesting is most efficient, community based programs may be more appropriate because they can be maintained by local people after project funding ends and provide income to fishing households which are most affected by the species. Research programs to better understand the ecology of the species and constraints to its expansion should be developed. Biological control programs should also be explored. One innovative option would be to develop biological control pilot programs using manatees, an endangered species, which are reported to consume water hyacinth plants - which are part of the diet of American manatees (Lowe in Powell, 1993, 28). The East African countries bordering Lake Victoria have introduced a hyacinth eating weevil species, which successfully controlled the plant in trials (Wachira, 1994). State or community level projects to determine economically attractive uses of water hyacinth (agricultural mulch, biogas production) should be developed to see if some advantages can be gained from this scourge. On the institutional level, the federal government water hyacinth control committee could be strengthened and better coordinated with state programs. Community or NGO control programs could also be developed.

Options Targeted To Municipal Wastes: Sewage and Solid Waste

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS		
REGULATORY REFORMS	Enforce existing wastewater and solid waste regulations Establish effluent standards. Require secondary treatment in urban areas. Land use zoning.	
- including economic mechanisms	User charges for water, sanitation, and solid waste services.	Provide a framework for small and micro credit mechanisms.
INSTITUTIONAL REFORMS	Capacity building of state: - Ministries of Works - Environmental Protection Agencies - Water Boards - Sanitation Boards - Ministries of Health (increased emphasis on preventing water related diseases). Evaluate private sector provision of services.	Increased emphasis on community health clinics. Support and develop village health committees, traditional bed attendants, and NGO community health groups.
DIRECT PROJECTS	Sewage treatment plants. Drainage and sewage systems. Public toilets. Solid waste reduction, recycling, collection and safe disposal. Improved water supply.	Latrine construction. Borehole construction. Solid waste reduction, recycling, collection and safe disposal. Improved water supply.
EDUCATION PROGRAMS	Disseminate health information. Environmental health education programs for schools.	Environmental health education programs for communities.

6.40 Sewage contaminated water and unmanaged solid wastes degrade the health of a large proportion of the people living in the Niger Delta. Direct projects to reduce the health toll from domestic wastewater involve upgrading the inadequate sanitation and water supply infrastructure. Awareness and distribution of simple technology, such as hand pumps and above ground treatment tanks, should be pursued. Solid waste management projects need to improve waste recycling, collection, and disposal in sanitary landfills. Source reduction options should also be explored. For urban areas, sanitation infrastructure should include

sewage treatment plants, drainage and sewage systems, and public toilets. Sewage treatment plants and associated sewage systems should initially be constructed to reduce municipal wastewater discharges from the largest urban centers (Port Harcourt and Warri) and then phased in for smaller cities. Safe water supplies, distributed either by tanker trucks or pipes, are also required in urban areas - pipes need to repaired or replaced in many urban areas. In riverine areas, borehole construction may be necessary in areas with contaminated surface water supplies. Latrines for rural communities should be built to replace toilet buildings overhanging waterbodies and the pail system. Improved rural solid waste management using composting and locating village dumps away from waterbodies to reduce the common practice of throwing wastes into adjacent streams and rivers is required in some areas. These advances combined with additional boreholes in selected areas will significantly improve water supplies. Rural water and sanitation programs will require a framework for small and micro credit mechanisms, as well as training.

6.41 The most critical regulatory action is to enforce the existing wastewater and solid waste regulations - without enforcement, pollution levels will not fall. While no legislative reforms are proposed, three regulatory modifications should be instituted. First, national or state level municipal effluent standards need to be promulgated. Second, secondary treatment of municipal wastewater must be required in urban areas to provide a regulatory incentive for sewage treatment. Third, urban land use plans and associated regulations need to be developed. In addition to providing a framework for funding mechanisms for sewage, water supply, and solid waste infrastructure, market based incentives to generate revenue for their operation and reduce waste generation such as user and input charges need to be assessed. Rent capture from resource extraction in the region through OMPADEC and other agencies could also be directed to water and sanitation programs in rural and urban communities.

6.42 Institutional reforms at the state level need to focus on enhancing the capacity of the water boards, sanitation boards, and environmental agencies to design, implement, and maintain adequate wastewater, solid waste, and water supply systems. The ministries of health need to redirect more of their resources towards preventing water related diseases. Given their minimal budgets, additional resources for environmental health issues will have to be obtained. Much of the expanded emphasis on environmental health needs to be channeled to community health clinics in rural and urban areas. The development of NGO community health groups should also be fostered. Community health programs need to include environmental health education as part of the school curriculum and community outreach programs.

Options Targeted To Toxic and Hazardous Substances

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS		
REGULATORY REFORMS	Enforce existing hazardous waste, EIA, and land use zoning regulations.	
- including economic mechanisms	Increase input charges to THS generating processes. THS emissions charge system. Develop deposit-refund system. User charges for hazardous waste management services.	
INSTITUTIONAL REFORMS	Capacity building of state: - Environmental Protection Agencies - Sanitation Boards	Community and NGO informal emissions monitoring programs.
DIRECT PROJECTS	Hazardous waste tracking system. Develop source reduction, recycling, and disposal (landfills, incinerators, and solidification) alternatives. Treatment facility and transportation system. Reduce hazardous sludge output.	Improve plant-level process management. Foster the development of credit mechanisms for industries.
EDUCATION PROGRAMS	Disseminate hazardous materials information to industries and associations.	

6.43 Of the industrial pollution concerns, toxic and hazardous substances should be a priority because of their potential to adversely impact human health and the availability of effective low-cost solutions. Options to reduce hazardous sludge generation, particularly from the refineries, are a priority because available information indicates that very large amounts are produced and management practices are inadequate. Cost effective options which have been successfully employed in other developing countries focus on improved management practices. For example, hazardous waste tracking and information management systems help industries and government agencies to better understand and monitor THS generation, transactions, and disposal. Companies need information and training on how to reduce their use and generation of THS. A framework for credit mechanisms may be required to support the installation of specific abatement equipment or more efficient manufacturing equipment. On a regional or state level, regulatory agencies need to review source reduction, recycling, treatment, and disposal alternatives to determine the most appropriate cost-effective program.

As far as possible, emphasis should be placed on pollution prevention, such as source reduction, reuse, and recycling. However, regardless of how extensive the pollution prevention program is, disposal of the remaining THS will still be necessary.

6.44 The most critical regulatory issue is enforcement of existing regulations. At the same time enforcement begins, regulatory agencies should develop incentive based mechanisms to strengthen the regulatory framework. The principal market based incentives to consider are (i) increasing THS input charges; (ii) developing a marginal emissions charge program; (iii) establishing a deposit-refund system for hazardous materials; and (iv) establishing user charges that cover the full costs of hazardous waste management. User charges will be important for ensuring that the regulatory institutions have the financial resources to meet their enforcement and THS management obligations. The institutions will also require capacity building in the form of: THS information management, enforcement, and operation of treatment, transport, and disposal services. Community and NGO informal emissions monitoring programs, which have proved effective in specific cases in other developing countries, should be explored. The Port Harcourt office of the Manufacturers Association of Nigeria has expressed a strong interest in industrial environmental management training and working with the regulatory agencies.

Options Targeted To Vehicular Emissions

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS	Legislate improved fuel formulations and phase out leaded fuel. Require natural gas vehicles.	
REGULATORY REFORMS	Fuel specifications.	
- including economic mechanisms	Price differential between leaded and unleaded fuel. Increased fuel prices. Support natural gas vehicles.	Provide the framework for small and micro credit mechanisms for vehicle improvement or purchase, as well as repair shop improvements.
INSTITUTIONAL REFORMS	Capacity building of State Environmental Protection Agencies: - develop vehicle inspection and maintenance programs.	
DIRECT PROJECTS	Support urban mass transit programs. Retrofitting refineries. Convert government fleets to natural gas.	
EDUCATION PROGRAMS	Education programs focusing on the health and environmental benefits of emissions reductions. Training repair personnel to perform emission reducing vehicle maintenance and upgrades.	

6.45 Over the long term, the region and the nation should consider converting to natural gas as the principal vehicle fuel since the gas being flared is an excellent fuel for both gasoline and diesel vehicles. The conversion would greatly reduce SOx, NOx, and particulate emissions. Conversion costs are around US$2000 per engine in North America and Europe. Half of the existing vehicle fleet could be converted over a ten year period as a natural gas distribution system is developed in the country. Clearly, such an ambitious program would require extensive funding mechanisms to cover natural gas production and distribution, as well as vehicle conversion.

6.46 In the short and medium term, strategic options to reduce vehicle emissions should concentrate on supporting mass transit in urban areas and on improving fuel formulations of existing fuels. The most important action is to lower lead emissions. This can be achieved

through greater use of mass transit vehicles and by reducing lead levels in gasoline, which are among the highest in the world. Several developing countries have already removed lead or plan to do so in the near future (e.g., India, Brazil, and Mexico). Nigeria could immediately lower the lead content to 0.010 to 0.020 percent without significant economic cost. Sodium and potassium salts would be suitable lubricant substitutes. To improve diesel emissions in the short term, sulfur levels should be reduced to 0.2 to 0.3 percent which will reduce particulate emissions by 20 to 50 percent. Five years after the initial reduction, sulfur levels could be further lowered to 0.05 percent. To lower polycyclic aromatic hydrocarbon (PAH) levels, refinery modifications which have been undertaken throughout the world could be completed in Nigeria in 5 years. Nitrogen release reductions of 40 to 50 percent would require engine modifications over a period of 4 to 5 years. If water transport vehicles are determined to contribute significant amounts of contaminants, they should be included in appropriate emissions reductions programs, including fuel reformulation and financial mechanism frameworks for repair shop improvements and engine improvements or purchase.

6.47 To meet short term vehicle emission goals, the federal government will have to legislate improved fuel formulations and implement a phase out program for leaded fuel. Economic incentives will be particularly important for reducing this type of environmental degradation. Specific actions include (1) creating a price differential between leaded and unleaded fuels, (2) raising fuel prices, (3) supporting refinery retrofits, (4) developing a framework for small and micro credit mechanisms for vehicle improvements or purchase, as well as vehicle repair shops. The State Environmental Protection Agencies, who should lead this initiative, need to develop vehicle inspection programs. Education programs will be required to train vehicle repair shop personnel to perform vehicle maintenance and upgrades which reduce emissions. Other education programs should empower people with the knowledge of how lower emissions increase health and environmental benefits. Retrofitting the refineries and supporting the conversion of government vehicle fleets to natural gas should be developed as direct projects.

Options In The Social Sector: Focus on Population Growth

Options	Regional/State Level	Community Level
LEGISLATIVE REFORMS REGULATORY REFORMS		
- including economic mechanisms	Incentives for day care services. Maternity benefits. Incentives for the education of women. Incentives for private sector contraceptive distribution.	Initiate the framework for small and micro credit programs emphasizing women.
INSTITUTIONAL REFORMS	Train state agencies to develop programs for women, especially in health and education. Ensure population concerns are incorporated into planning, programs, and budgets.	Train community-based institutions to disseminate population, family planning, health and nutrition information. Improve skills of traditional birth attendants and community health workers.
DIRECT PROJECTS	Programs to improve productivity and income of women in agriculture, NTFPs & industry. Infant and child nutrition programs. Wider distribution of contraceptives. Improved infrastructure.	Programs to improve productivity and income of women in agriculture, NTFPs & industry. Infant and child immunization and nutrition programs. Child survival programs. Wider distribution of contraceptives. Community health programs. Improved infrastructure.
EDUCATION PROGRAMS	Disseminate family planning and health information. Agricultural and business training and extension services designed for women. Expanding women's education.	Disseminate family planning and health information. NGO led agricultural and business training and extension services designed for women.

6.48 Although many of the options discussed above directly or indirectly improve social conditions for communities (e.g., water supply, sanitation, and preventative health education), additional social sector interventions that are outside the direct scope of environmental interventions may also be required for sustainable development, particularly to slow

population growth.[2] Moreover, while two of the indirect causes of environmental degradation, resource ownership and policy failures, are addressed by many of the strategic options, population growth is not directly tackled.

6.49 Since population growth is an indirect cause of many of the environmental problems in the region, strategic options to address it are discussed in this section. The principal direct mechanism for reducing population growth is family planning. Family planning programs should include a significant education component through formal and informal mechanisms which disseminate information on maternal and child care and nutrition, as well as population and family planning. Economic mechanisms to slow population expansion include maternity benefits for smaller families (e.g., up to four children) and company day care programs. Small credit programs in the industrial and agricultural sectors would help expand economic opportunities for women. Incentives need to be reviewed for establishing private sector and community based family planning, particularly contraceptive distribution. Such schemes have been undertaken with market women and other community groups in neighboring Ondo State. Social marketing campaigns could be extended beyond family planning to cover child and maternal health care.

6.50 To reduce population growth, development and income generating activities must emphasize the advancement of women. Increased opportunities for female employment in industry and agriculture would reduce the incentives for large families. For example, female extension officers, support for women's farming groups, and extension programs covering 'women's crops' and food processing have been introduced by the Agricultural Development Projects. The concept of integrated conservation and development projects discussed under the forestry and biodiversity options, could be progressively expanded to other areas to assist the development of women focused industries based on sustainable extraction and processing of resources.

6.51 In addition to water-related disease strategic options discussed above, the community health and family planning programs are central to slowing population growth. Research in sub-Saharan Africa has found that cost-effective packages of basic health care services delivered through networks of local health centers and small referral hospitals can meet 90 percent of demands for health services and reduce premature mortality by 30 percent. From a population focus, the goal is to encourage fewer, more widely spaced births of healthier children. Programs would have to be designed for specific communities, but would usually involve (i) maternal and child health services, (ii) sexually transmitted disease control, (iii) school health, (iv) treatment of common diseases, (v) education and communication programs (World Bank, 1994c). The nutritional status of women and children should also be improved through, for example, better infant feeding practices, increasing nutrient intake by pregnant and nursing women, improving nutrition education, and increasing the use of locally available protein rich foods.

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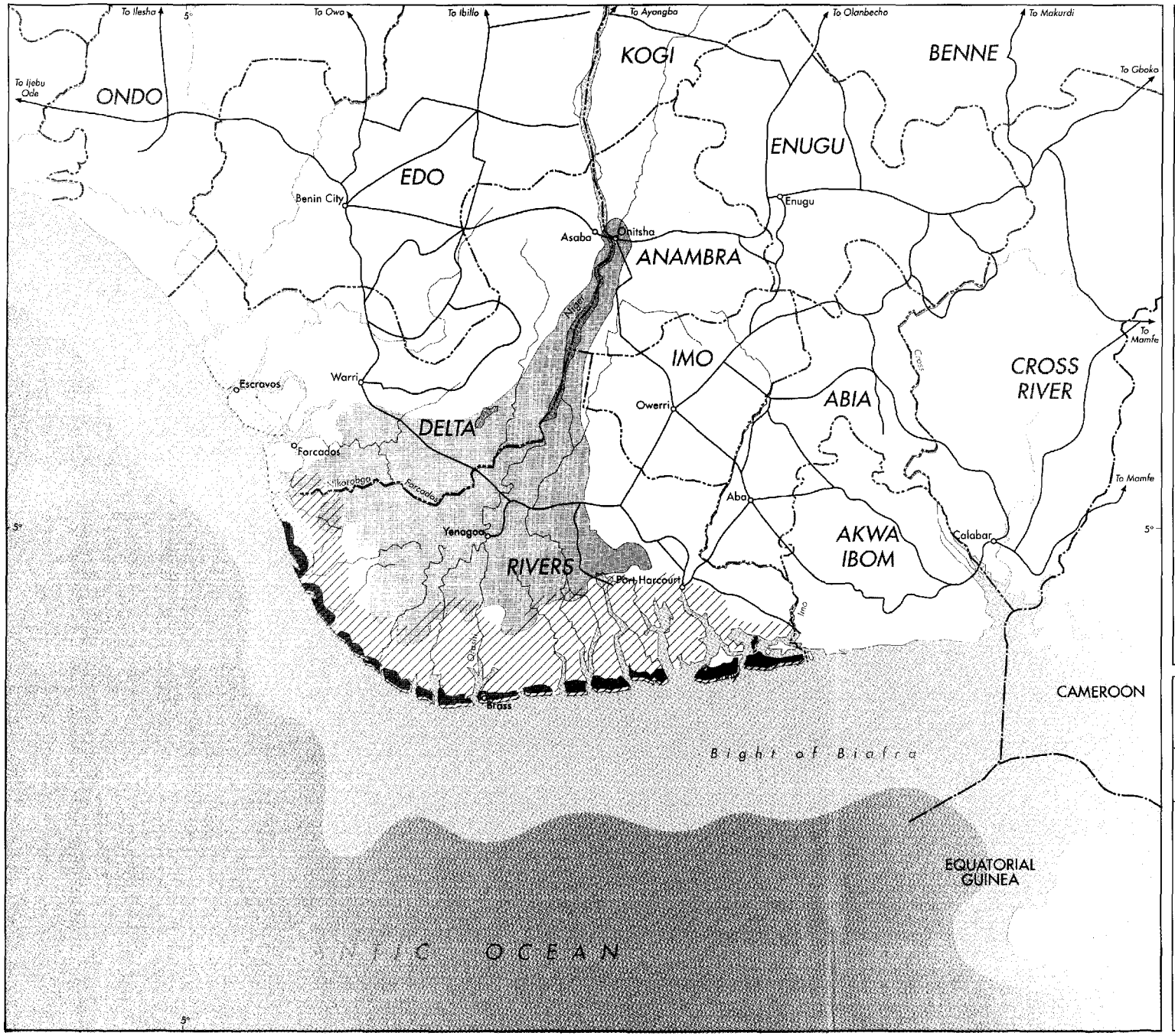
[2] The population strategic options are adapted from the World Bank report, "Nigeria: Implementing the National Policy on Population".

6.52 As well as family planning and health education, basic education must be expanded throughout the delta. With better health and education, individuals will lead more productive lives and will not as frequently resort to degrading natural areas to meet subsistence requirements. From a population perspective, expanded educational and career opportunities are most important for women. Incentives need to be implemented to induce parents to send their daughters to school and for women to enroll in technical and vocational programs. Alternatives for educating women in migratory fishing communities should also be explored.

6.53 Under institutional strengthening, state agencies need to redress their limited emphasis on women's programs and projects. Training and technical assistance to community health workers and traditional birth attendants is required, but must be directly relevant to community health concerns. Government agencies must begin to incorporate population considerations into their planning, programs, and budgets.

6.54 Infrastructure projects which provide electricity and water, or improve transportation and housing, are required in many riverine and urban communities to improve health conditions and expand economic opportunities. However, infrastructure development must consider environmental implications to ensure that the net benefits of development are maximized.

IBRD 26885



NIGERIA
VEGETATION ZONES OF THE NIGER DELTA

ECOLOGICAL ZONES:
- FRESH WATER SWAMP
- BRACKISH WATER SWAMPS/MANGROVES
- COASTAL BARRIER ISLANDS

FOREST AREAS:
- MANGROVE FOREST
- COASTAL RAIN FORESTS

- CONTINENTAL SHELF
- WATER DEPTH GREATER THAN 200 METERS
- RIVERS
- MAIN ROADS
- SELECTED CITIES
- STATE BOUNDARIES
- INTERNATIONAL BOUNDARIES

0 20 40 60 80 100 MILES
0 40 80 120 160 KILOMETERS

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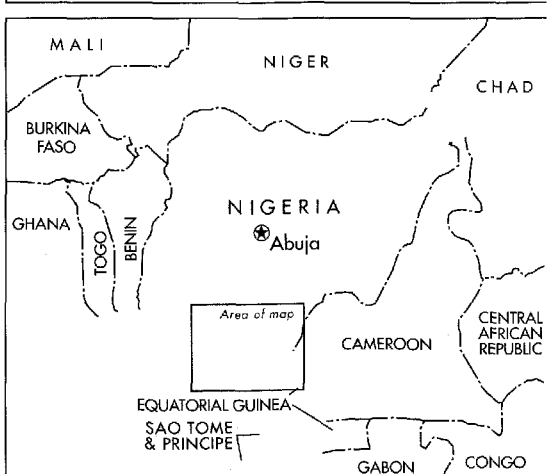

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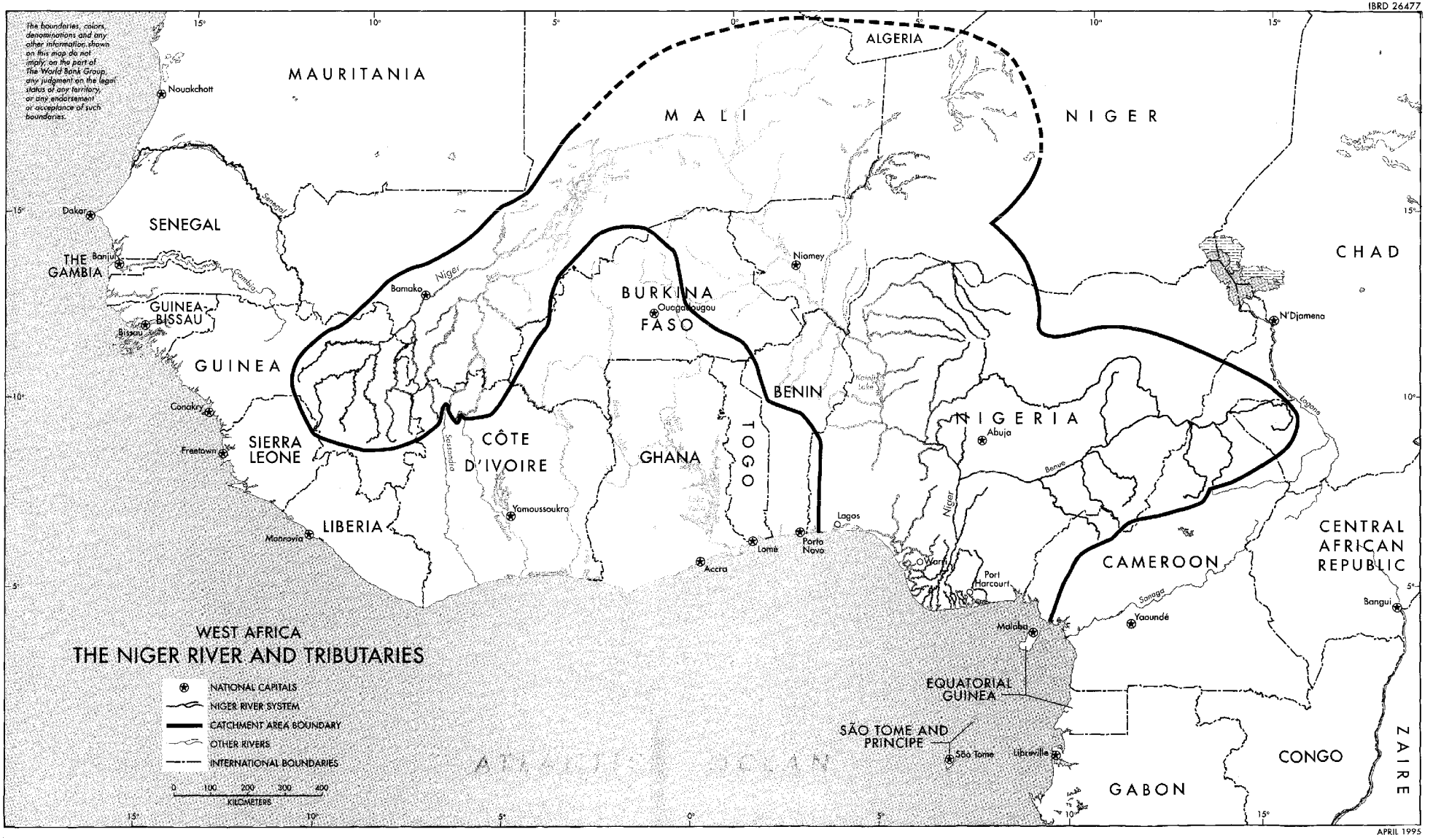
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MAURITANIA
Nouakchott
ALGERIA
MALI
NIGER
SENEGAL
Dakar
Senegal
THE GAMBIA
Banjul
Gambia
Bamako
Niger
Niamey
BURKINA FASO
Ouagadougou
CHAD
N'Djamena
GUINEA-BISSAU
Bissau
GUINEA
Conakry
SIERRA LEONE
Freetown
Sassandra
CÔTE D'IVOIRE
Yamoussoukro
GHANA
TOGO
BENIN
Volta
Lagos
Porto Novo
Lomé
Accra
NIGERIA
Abuja
Kainji Lake
Lagone
Benue
Niger
Warri
Port Harcourt
LIBERIA
Monrovia
CAMEROON
Sanaga
Yaoundé
Malabo
CENTRAL AFRICAN REPUBLIC
Bangui
EQUATORIAL GUINEA
SÃO TOME AND PRINCIPE
São Tome
Libreville
GABON
CONGO
ZAIRE
ATLANTIC OCEAN
WEST AFRICA
THE NIGER RIVER AND TRIBUTARIES
NATIONAL CAPITALS
NIGER RIVER SYSTEM
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INTERNATIONAL BOUNDARIES
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KILOMETERS
APRIL 1995

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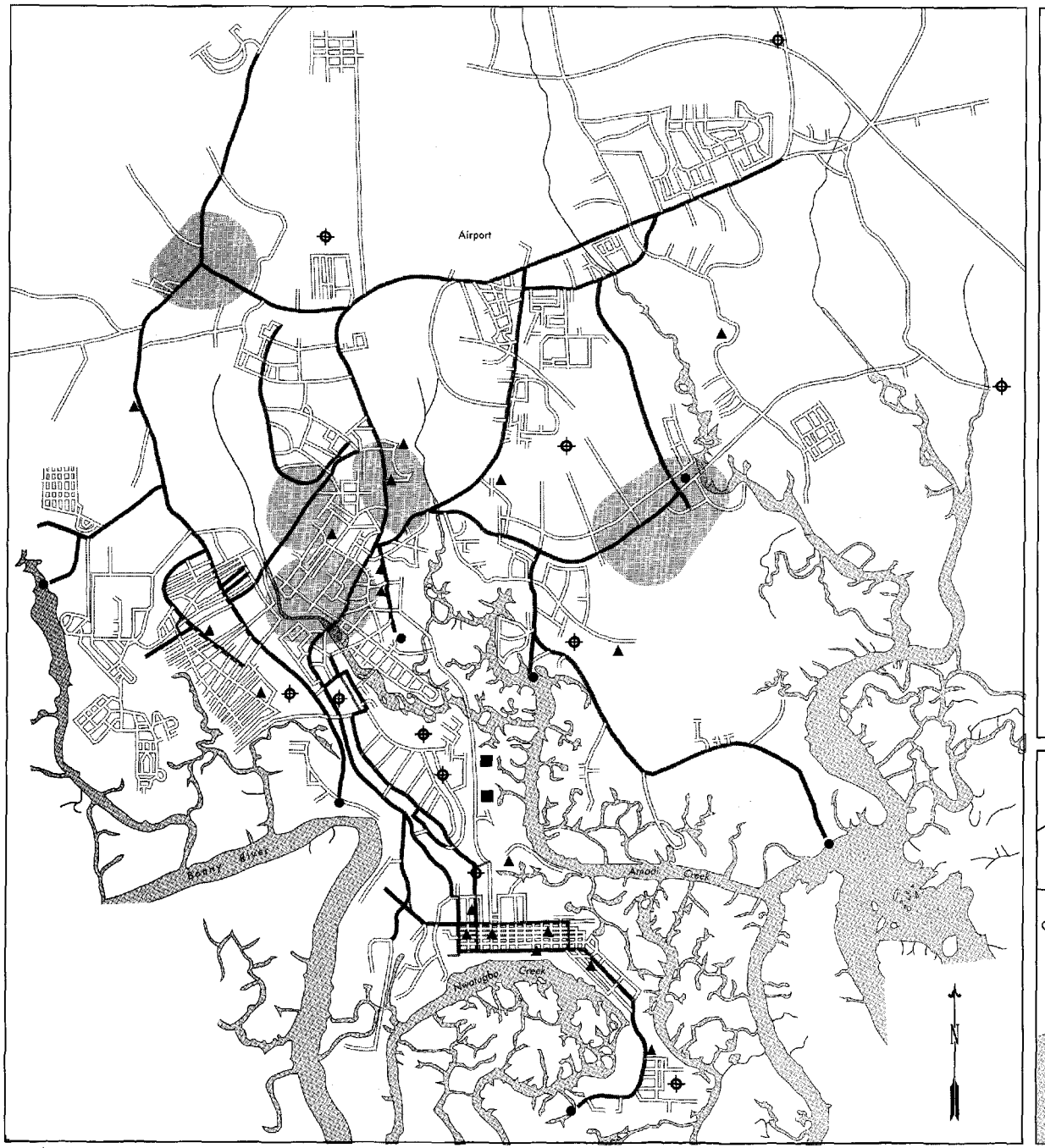
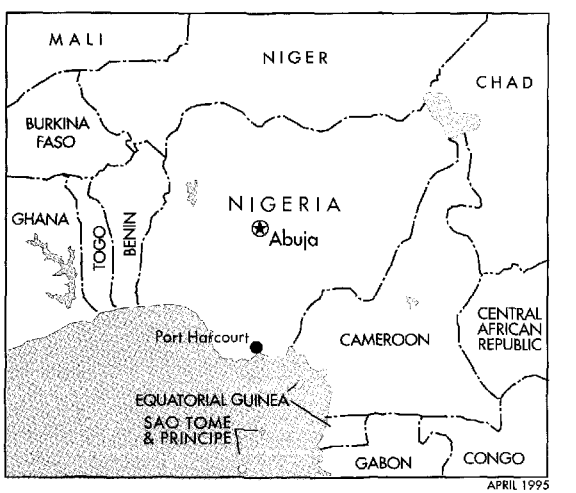


NIGERIA
PORT HARCOURT
INFRASTRUCTURE AND FLOODING ZONES

- DRAINAGE SYSTEMS
- DRAINAGE DISCHARGE POINTS
- FLOODING ZONES
- MAJOR WATER STATIONS
- NEIGHBORHOOD WATER SCHEMES
- SOLID WASTE DISPOSAL SITES
- MAIN ROADS
- INTERNATIONAL BOUNDARIES

0 1 2 3 4
KILOMETERS

The boundaries, colors, denominations and any other information shown on this map do not imply, on the part of The World Bank Group, any judgment on the legal status of any territory, or any endorsement or acceptance of such boundaries.



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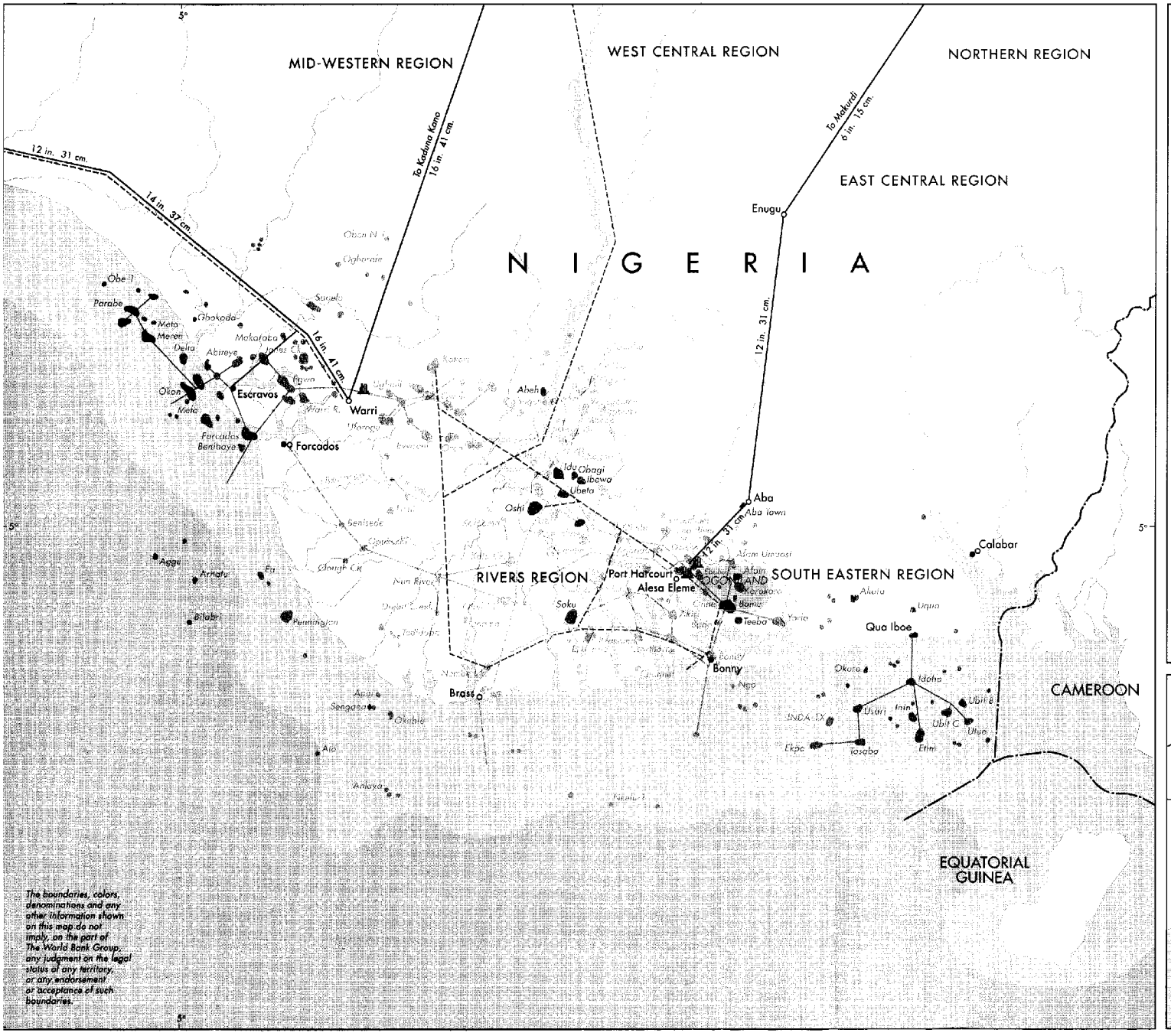
IBRD 25717R

NIGERIA
DISTRIBUTION OF OIL AND GAS FIELDS AND RELATED INFRASTRUCTURE IN THE NIGER DELTA, 1991



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- OIL FIELDS
- GAS FIELDS

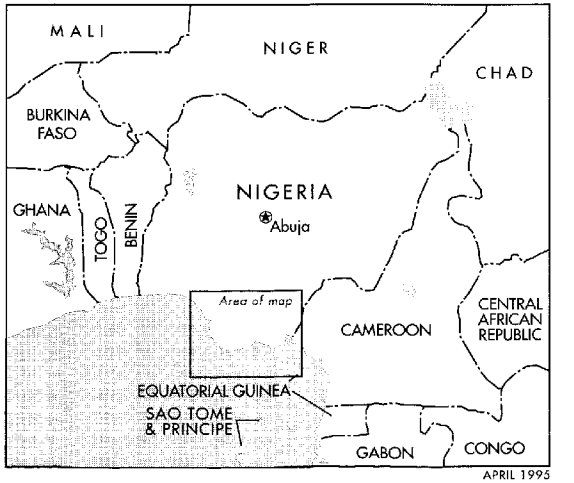
EXISTING PIPELINES:
- CRUDE OIL
- NATURAL GAS
- PRODUCT

PIPELINES PLANNED OR UNDER CONST.:
- CRUDE OIL
- NATURAL GAS

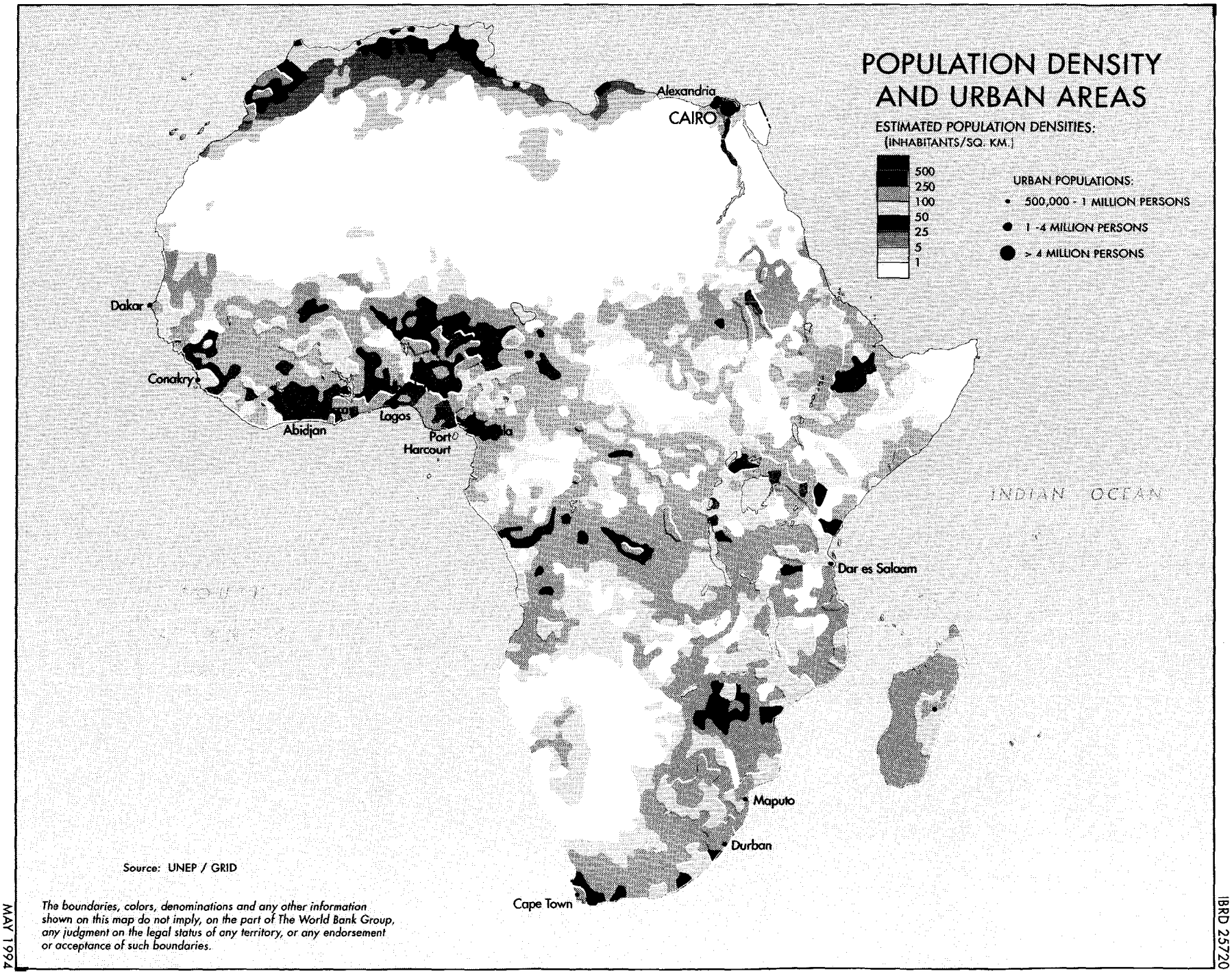
- REFINERIES IN OPERATION
- TANKER TERMINALS
- OGONILAND
- SELECTED CITIES
- CONTINENTAL SHELF
- WATER DEPTH GREATER THAN 200 METERS
- INTERNATIONAL BOUNDARIES

Sources: International Tanker Owners Pollution Federation LTD, 1994.
Fearnleys World Bulk Trade, 1990.
International Chamber of Shipping, 1994.
International Petroleum Encyclopedia, 1991, vol. 24.

0 20 40 60 80 100 MILES
0 40 80 120 160 KILOMETERS



APRIL 1995


POPULATION DENSITY
AND URBAN AREAS
ESTIMATED POPULATION DENSITIES:
(INHABITANTS/SQ. KM.)
500
250
100
50
25
5
1
URBAN POPULATIONS:
500,000 - 1 MILLION PERSONS
1 -4 MILLION PERSONS
> 4 MILLION PERSONS
Alexandria
CAIRO
Dakar
Conakry
Abidjan
Lagos
Port Harcourt
INDIAN OCEAN
Dar es Salaam
Maputo
Durban
Cape Town
Source: UNEP / GRID
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MAY 1994
IBRD 25720

Map 4