Environmental Assessment Sourcebook 1999

CHAPTER 8

AGRICULTURE AND RURAL DEVELOPMENT

Agriculture has been the Bank's largest lending sector for many years, and related environmental concerns are of proportionate signicance. For Task Managers, this chapter of the Sourcebook outlines major environmental impacts of common types of projects, while recognizing that every project has its own peculiarities and that the best procedure involves use of all resources available, particularly the expertise in appropriate technical departments.

As emphasized in the Sourcebook, the Bank views environmental assessment as an opportunity to identify early in the project cycle problems that become costly if they appear unexpectedly later. The guidance offered is a direction to proceed in. Not all environmental problems discussed in connection with one type of project will be found in the same project. And not all problems can be solved in one loan, especially when they transcend the limits of the project, as is the case with institutional weaknesses at sectoral or national levels. In agricultural projects, as in other sectors, task managers and governments will design more efficient and sustainable projects through the process of environmental assessment, and the procedures they develop will replace these early guidelines. In this way, increasingly flexible and cost effective measures will result to the benefit of everyone involved.

There are three classes of environmental concerns related to agricultural development. First are impacts from new land clearance or reclamation for any agricultural development. Second are impacts from intensification of production on existing agricultural land. Third are questions related to the sustainability of the agricultural developments.

LAND CLEARANCE OR RECLAMATION. Whenever new lands are brought into agricultural production for the first time, there are major initial impacts, and some of these are irreversible: loss of the natural resource cleared or reclaimed (e.g., forest, wetland, mangrove); soil erosion; declining soil productivity; extinctions of species; loss of wildlife habitat; reduction in environmental services provided by existing ecosystems; and loss to forest dwellers or other vulnerable ethnic minorities who depend on the ecosystem that was removed. These impacts are dealt with in other Sourcebook sections, especially Chapters 2 and 3. In addition to these initial impacts, the method of clearing the land has great bearing on the subsequent success or failure of the project.

INTENSIFICATION. More conventional environmental problems with agriculture arise from intensification of production on existing agricultural land: soil compaction by heavy machinery, accelerated erosion, harmful impacts from overuse of fertilizers and biocides ("Integrated Pest Management and Use of Agrochemicals"), and soil salinization and improper drainage from irrigation schemes ("Irrigation and Drainage").

SUSTAINABILITY. The crucial agricultural issue of sustainability, as mandated by OD 4.01 and by OMS 2.36, is amplified in Annex 1-5 of Chapter 1. Determining sustainability requires an evaluation of the economic, social, and ecological costs of long-term continuation of the project: are they acceptable, and can they be sustained in relation to outputs? Sustainability is discussed throughout Chapter 8. :

MANAGEMENT OF AGRICULTURE PRODUCTION

General Issues

1. In most circumstances, agricultural projects which are technically sound and sustainable will also be environmentally sound and sustainable. The exceptions to this principle are projects which result in the conversion of natural areas of ecological importance wildlands, mangroves, tidal marshes, tropical forests, etc.and projects in which indirect impacts such as induced development or uncontrolled hunting or logging in newly accessible wildlands are not prevented. In these latter cases, good agricultural practice cannot alone prevent environmental impact. Proper planning, environmental assessment, and mitigation will be necesary. For the Task Manager, then, the task of promoting compliance with the Bank's policies and objectives through EA involves:

(a) Seeing that the decision to convert a natural area to agricultural use is an environmentally acceptable one, and that the alternatives have been evaluated where there are environmental questions.

(b) Ascertaining that indirect impacts have been fully examined and taken into account in planning for project implementation and mitigation.

(c) Ensuring that good agricultural practices are followed in the design and implementation of projects in the sector.

2. It is not the purpose of the Sourcebook to define good agricultural practices. Information and guidance in that area is readily available from the Technical Departments. Instead, this chapter is intended to alert TMs to circumstances which may prevent application of good agricultural practice despite the intentions of the Bank and the project sponsors and to issues that may arise in environmental review of agricultural projects that fall into (a) or (b) above. Most of the questions to be considered are addressed elsewhere in the Sourcebook; cross-references are provided here.

3. Sustainable agriculture minimizes soil loss and maintains productivity through use of organic and inorganic inputs in balance with outputs. It takes into account land capability as a fundamental factor in any agricultural investment decisions. It recognizes that agricultural diversification is a key to the functioning of balanced upland farming systems and that external factors, such as road construction to improve market access may be critical in implementing diversification. (Sustainability is discussed in more detail in Annex 1-5 of Chapter 1.)

Agricultural Practices and Environmental Management

4. Soil conservation and cultivation practices intended to maintain productivity also minimize environmental damage from loss of vegetative cover, increased runoff, soil erosion and siltation. Judicious use of chemicals, both fertilizers and pesticides, is expedient for economic reasons and will either minimize or prevent the eutrophication, groundwater contamination, nitrate accumulation, and evolution of pesticide resistance in non-target species which can result from excessive or indiscriminating applications. Following guidelines for application rates and techniques is usually adequate to protect the environment, except where the substance is used is inappropriate for toxicological, biological reasons (see "Integrated Pest Management and Use of Agrochemical" section). Recycling of manure and other wastes is common practice and is environmentally protective.

5. Good agricultural practice is likely to be used when it has been defined for the type of project, is managed at the project's scale of operation, advertised and explained to operators, and encouraged through inspection and incentives or sanctions. Practices should be proven to be practical, sensible, and profitable to the farmer, since he or she is ultimately the one who will decide if it should be used or not. This argues for strong links between the farmer and research. TMs should be alert to conditions that will prevent one or more of the above from occurring. Common impediments are listed below.

. National or sectoral policies that lead to short-term, minimum-cost exploitation of agricultural, forest, or fishery resources and penalize sustainable, higher-cost or slower payout operations.

. Lack of land tenure or other sense of ownership and thus feeling of responsibility for the natural resource.

. Practices being required for loans or credits involve struc tures or equipment beyond the means of the owners in small-scale operations.

. Shift to intensive production techniques, such as animal feedlots, without accompanying technical assistance in areas such as waste management.

. Lack of well-developed extension service or other outreach institutional structure for education and technical assistance.

. Lack of attention to the differential access of male and female farmers to technologies and inputs.

. Lack of environmental standards applicable to the sector, especially to intensive operations such as feedlots, fish farms, and processing plants.

. Lack of capacity for field inspections to monitor adherence to standards and any required practices, such as for stream-bank buffer zones, reforestation, waste handling;

. Lack of legal basis for enforcement action in cases of environmental damage or violation of requirements.

. Lack of developed, alternative practices that are acceptable to farmers.

. Weak or non-existent provisions for dialogue between farmers and agricultural researchers.

6. Most of these questions fall within the "institutional" dimension of EA. They are critical to project success, because of the very fact that, unlike industrial or infrastructure loans or credits, where many of the significant impacts are avoided through design changes or "hardware", so many agricultural sector operations proceed with the provision that there are potential impacts but that they will be avoided or mitigated merely by good practice. If the capacity to promote, implement and, where necessary, enforce good practice is flawed, adverse impacts can be anticipated.

Environmental Impacts

7. It is useful to divide agricultural projects into two categories: lowland, irrigated agriculture and upland, rainfed agriculture. Each has its own set of potential environmental problems. Impacts of agrochemicals and irrigation are primary concerns in the lowlands and are discussed in more detail in the sections on "Irrigation and Drainage" and "Integrated Pest Management and Use of Agrochemicals." In the uplands, problems of erosion, loss of soil fertility, improper land use and watershed management are more likely to be encountered. Sections on "Land and Water Resource Management," "Arid and Semi-Arid Lands" and "Forestry" are pertinent. Sustainability in agriculture will minimize soil and nutrient loss, and balance inputs with harvests, and strengthen the links between the farmer, extension and research. Environmental prudence, sustainability, and relevant technologies will be fostered by improving the links between farmer and research.

Major Impacts

8. The main environmental impact to be aware of is the irreversible loss of habitats. It is most critical when it is "wildland," but even degraded habitats, e.g., urban wetlands, perform valuable services. Such loss reduces economically valuable environmental services and accelerates extinctions and loss of wildlife. This loss can occur from two main causes: first, access roads that reach the project area; and second, clearing natural habitat for planting and processing of crops. Access roads leading into the project area or near habitat may facilitate unplanned settlements and destruction of that habitat. Loss of socio-economic services can result in increased pressure or conversion of other lands. If grasslands are converted, for

example, graziers will have to graze their herds elsewhere. Indigenous peoples are particularly vulnerable. Similarly, when clearing new lands for the production or processing of crops, if the new land is wildland or other habitat, and especially if it is critical habitat such as tropical forests, (see "Wildlands" section), preventive measures, precautions and policies should be used for any guidance sought. The environmental and social impacts on the conversion of habitat types are discussed in Chapters 2 and 3.

Lesser Impacts

9. The lesser impacts are largely reversible and preventable. On occasion, however, they can be severe. The lesser impacts fall into only three categories:

(1) Agro-chemical runoff contaminating water and ground water ("Management of Agriculture Production: General Issues" section); (2) Pesticide concerns ("Integrated Pest Management and Use of Agrochemicals" section); and

(3) Effluent disposal from crop processing ("Pulp, Paper and Timber Processing" and "Agroindustry" sections).

Prevention or mitigation of these impacts is relatively easy and should be standard procedure. They are discussed in the indicated sections, and in Goodland and others 1985.

Land Clearance Methods

10. The way in which new land is cleared for cultivation greatly influences subsequent agricultural success. For example, clearing tropical forest with heavy bulldozers or big chains decreases the thin layer of fertile topsoil, exposes infertile subsoil, and accelerates erosion. This issue is amplified in the sections on "Cross-Sectoral Issues" and "New Land Settlement" in Chapters 2 and 3.

Fuelwood

11. If fuelwood harvested from the wild is used in processing plants or for curing the crop, then that can be a major impact. (For further discussion, see "Natural Forest Management" section.) All fuelwood needed by such projects should come from fuelwood plantations planted near the processing plant as part of the project, and should not be harvested from the wild. The environmental assessment should ascertain if crop residues are used for fuel instead of having their nutrients and organic matter recycled to the crops.

Crop-Specific Impacts

12. Coffee, cotton, cocoa, oil palm, sugar and tea: apart from the major impacts from conversion of wildlands noted above, the environmental impacts accrue from processing mainly disposal of highly polluting washing watersas amplified in the "Agroindustry" section. The main point here is that most effluents can be profitably recycled. This is especially true for sugar factories, rubber and oil palm mill effluents which are valuable sources of the nutrients needed by the growing crop. Any crop residues, such as bagasse or cacao husks, not used for process steam also should be recycled to the extent possible as stock feed or cardboard, hardboard, or digested for fuel gas and fertilizer, etc., rather than being dumped in the nearest creek as was formerly common. Coffee and tea curing and sugar factories and other processing may consume fuelwood as mentioned in paragraph 10 above. Smoke from burning cane fields before harvest is an impact, but properly handled, it should cause more of a nuisance than an environmental problem. Cotton requires more pesticides than most other crops; this becomes a significant potential problem deserving special management.

Tobacco Production

13. Historically, the Bank has ceased to invest directly in tobacco production projects. Furthermore, Bank investments in tobacco, as components of rural development projects, have become almost negligible. Very small-scale tobacco may still be grown in mixed family farms as a minor crop in rural development supported by the Bank. These trends are expected to continue. The EA of projects containing tobacco production will identify the many impacts to such an extent that even tobacco components will decrease. The main considerations for the EA are:

(1) There is no safe level of use; tobacco products damage the health of the consumer and inquilines.

(2) Since tobacco is so profitable, the Bank, as lender of last resort, increasingly prefers not to use scarce resources for the purpose of competing with the private sector.

(3) The Bank can achieve much more development, specifically in the area of health, by encouraging a reduction in the consumption of tobacco products, by not investing in tobacco production, whether for domestic consumption or for export, than by promoting possible short-term producer profits.

(4) Much tobacco is cured using wood harvested from the wild. Such projects should routinely include sustainable woodlots. If the project cannot bear the costs of the needed woodlot, the EA will point out the major irreversible wildland conversion impacts which are not preventable in such cases, that the project itself will be in jeopardy (see "Wildlands" section).

On the other hand, the Bank is willing to invest substantially in promoting alternative crops for tobacco, in campaigns to reduce tobacco consumption, and in fire prevention.

Livestock

14. Although the Bank has no formal livestock policy, the main impacts are the same irreversibles noted above: access roads facilitating destruction of habitat, and the conversion of habitat for pasture. This is especially serious in the ranches created in moist tropical forest in Latin America, as well as being unsustainable in the short term. EA's for ranches to be created from tropical forest, will point to the major irreversible and unavoidable environmental costs.

15. Ranches in natural range routinely need constant monitoring of carrying capacity to prevent overgrazing in the dry years. Domestic cattle are so dependent on drinking liquid water every day that overgrazing is difficult to prevent around water sources. Therefore, the potential for using non-domestic livestock should be addressed during preparation. These do not need liquid water every day, do not suffer from tsetse and other insects as cattle do; hence, there is no need for biocides. Since they eat a much wider range of vegetation, as well as browse, they can produce more offtake than cattle over the medium and long term.

16. Partly because the Bank is concerned with poverty alleviation, it has not financed many livestock ranching projects recently, and this trend may continue. Grain can feed many more people than cattle can on the same area. The Bank's current emphasis is on more intensive peri-urban dairy projects, including stallfeeding, rather than the resource-wasteful extensive beef projects. (See "Livestock and Rangeland Management" section for more information on livestock projects.) : 17. The lesser preventable and reversible impacts are the same as above: pesticide concerns, and processing effluents from slaughterhouses.

Fisheries

18. Freshwater fisheries normally have little environmental impact; on the contrary, they are usually highly benign, especially fishponds down slope from the household, which recycles household wastes and sewage leachate to great advantage. Highly concentrated aquaculture operations can pose a potential water pollution problem. In general, the Bank should do more to promote the fish potential in all relevant water projects, especially in reservoirs (see "Dams and Reservoirs" section).

19. The Bank has so few marine fishery projects that they are not a major problem. Sustainability should routinely be ensured by monitoring stocks and adjusting catch rates. Sea grass beds should be protected from damage by trawlers and draggers.

20. The major impact in shrimp projects is irreversible habitat conversion, especially of mangroves and other coastal wildlands and wetlands (see "Coastal Zone Management" section).

Social Impacts and Human Health

21. Involuntary resettlement occasioned by agricultural projects, especially irrigation reservoirs, is arguably their major impact. The complex issues surrounding involuntary resettlement have not historically been well handled in Bank-assisted projects; therefore, the Bank has issued detailed policies and guidance in this arena. This is especially so for indigenous peoples (see Chapter 3 for further discussion of "Involuntary Resettlement" and "Indigenous Peoples"). All agricultural projects should address how land is currently utilized within the farming systems, within the local economy, and as a source of nutrition, especially in poor crop years. When land is converted, the project should explicitly plan for substitutions or replacing these lost services, both for equity reasons and to avoid increasing pressure on other areas.

22. Fisheries, livestock development, and irrigation projects can have a negative impact on women's livelihoods and status when interventions increase women's burden without providing them additional assets or income. When mechanized fisheries activities (including shrimp) are introduced, women often lose labor opportunities because they lack new skills and access to marketing.

23. The main risks to human health are outlined for water-borne diseases in the section on "Dams and Reservoirs;" for risks from pesticide use, see the section on "Integrated Pest Management." Health risks resulting from processing cotton, such as byssinosis, are discussed in the "Public Health and Safety" section.

INTEGRATED PEST MANAGEMENT AND USE OF AGROCHEMICALS

1. Insects, weeds, pathogens and other pests1/ are a fact of agricultural life. They thrive on a concentrated and reliable food source and unfortunately, the measures commonly used to raise productivity of crops (e.g., monoculture with high-yielding varieties, multiple cropping with reduction or elimination of fallow periods, use of fertilizers, etc.) create an even more favorable environment for pests. Therefore, knowledgeable management of pest problems is required in any effective agro-system. The Bank's support of the integrated pest management (IPM) approach in its agricultural lending operations is perhaps best discussed in historical perspective.

2. The introduction of chemical pesticides2/ in the 1940s was widely regarded as a revolution in agriculture. They were relatively inexpensive and highly effective, and it became common practice to spray fields regularly throughout the season as a preventive measure even if there were no visible attack. Experience since then, however, has shown this approach not only to be environmentally damaging but also ineffective in the long term. Where pesticides have been used indiscriminately in this way, pest species have become resistent and difficult or impossible to control. In some cases, resistance in important disease vectors (e.g., malarial mosquitoes) has resulted or new agricultural pests have emerged. For example, all mite pests were created by pesticides since there were no mite pests before pesticides were used. Out of this experience, crop protection specialists devised a more diversified and sustainable approach, IPM, which is based on three fundamental principles: (a) To the extent possible, reliance is placed on using nonchemical measures to keep pest populations low. For example, breeding and cultural practices are used to make the environment less hospitable to pests and to keep the crop healthy and resistant or tolerant to attack. This may include the introduction of non-indigenous pathogens or natural enemies.

(b) The goal is to manage pests, not to eradicate them. Populations of important pest species are monitored and control interventions are made only as necessary.3/

(c) When pesticides4/ have to be used, they are selected and applied in such a way as to minimize adverse effects on beneficial organisms, humans and the environment. OD 4.02 provides comprehensive guidelines for the selection and use of pesticides.

3. Within these basic principles, approaches may vary depending on the crops or pests involved. The level of control necessary may also vary considerably, particularly for fruit and vegetable crops where cosmetic damage may significantly decrease market value.

Relationship to Bank Investments

4. Bank investments are to be designed according to the principles of environmentally sound and economically sustainable pest management as set forth in OD 4.02: "Agricultural Pest Management."5/ Pesticides may be one component of an agricultural pest management strategy in the context of an IPM program.

5. Such justifiable practice, however, requires special knowledge of the particular substances being used, and how they are stored and applied. It is important to remember that pesticides are, for the most part, toxic compounds that are dispersed in the environment and handled by large numbers of people. They vary greatly in degree of hazard to humans and the environment and in margin of safety for misuse. :

6. Misuse can cause severe illness or death, contamination of soil and water, harm to livestock and wildlife, and even reduction or elimination of the natural enemies of the pests. Therefore, control and supervision of pesticide use will continue to be of critical concern in Bank projects.

7. The required level of evaluation of pesticide aspects will be determined by the task manager (TM) and the Regional Environment Division (RED) early in the project cycle. Factors that should trigger close attention during project preparation, appraisal and supervision, include: (a) significant financing or use of pesticides; (b) introduction or promotion of pesticide use in areas where they are currently little used; (c) introduction or expansion of crops (such as cotton, vegetables or rice) in which pesticide use is often high; (d) use of pesticide that is judged to present a significant hazard to health or the environment; or (e) questions concerning the likely return on investment in pest management.

8. For projects where none of these factors apply, it will usually be sufficient to pass these guidelines to the Borrower and provide assurance in the legal document that the guidelines will be followed. Bank policy clearly states that its requirements on pesticide selection and use are to be applied for any Bank-financed investment or adjustment operation under which pesticides may be procured, whether or not Bank funds are used for this purpose directly.

9. While pesticides are an easily recognized issue in agricultural projects where crop production is a goal, they are often overlooked where they are used in the reduction of post-harvest losses. Various types of pests (including molds) cause considerable losses in quality and quantity of stored foods worldwide and in developing countries the problem is often exacerbated by climatic conditions and lack of appropriate storage facilities. Produce in bulk storage is usually fumigated or treated with dilute insecticide dusts. Fumigation can be extremely hazardous to humans, requiring specialized equipment and training, and can leave potentially dangerous residues on the food.

Bank Experience

10. Crop protection is an integral part of agricultural development and the Bank's approach has been to promote recognized "best practice" at the time. Consistent with this history, the Bank currently supports preparing a pest management plan for any agricultural development program, taking into account economic, environmental, and health and safety factors. Fundamental to this plan is an IPM program. In an IPM program, pesticides are used as a last resort. The Bank supports development and dissemination of IPM

methods through research, extension and training, as well as through promoting supportive policy in the borrowing country.

11. The identification and preparation of any agricultural development project should cover anticipated pest problems and proposed pest management measures to determine: (a) the extent to which current practices are consistent with IPM; (b) problems and opportunities for improvement; and (c) the resultant strategy. The project and related operations (such as agricultural research or extension projects or sectoral loans) should be designed complementarily to fill gaps in knowledge, infrastructure and human resources, or to promote policy reform to facilitate the use of IPM.

Bank Policy, Procedures, and Guidelines

12. The Bank's policy on pesticides is stated in OPN 11.01: "Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and Their Procurement when Financed by the Bank" (March 1985). In preparation is OD 4.02: "Agricultural Pest Management." It provides guidance to staff on current Bank policies regarding use of the IPM approach in Bank agricultural lending operations and procedures for implementation of this policy. OD 4.02 is the guidelines for implementation of an IPM program, and it sets forth comprehensive guidance for the selection and use of pesticides.

13. Guidance on policies and procedures for procurement of pesticides will be provided in a Technical Note to be issued in conjunction with OD 11.01: "Procurement." The pesticide procurement guidelines address: (a) types of pesticides for which procurement should be prohibited or restricted; (b) specifications for product quality, packaging and labelling; (c) preparation of bidding documents; (d) qualification of bidders and after-sales service; and (e) evaluation of bids taking into account effectiveness, cost and human and environmental hazards.

14. Many pesticides are powerful and hazardous toxins which pose major risks (e.g., health damage to humans, creation of pest resistance, death of non-target species such as birds). Therefore, the EA should scrutinize the selection of pesticides with special care. Since it is impossible to be categorical, the Bank refrains from listing banned pesticides. However, the EA team and the TM should avoid broad spectrum persistent pesticides, and move towards IPM and the more modern less risky pesticides such as Bthuringiensis. All pesticides selected should be justified in the EA report.

Guidance for Environmental Assessments

15. IPM does not necessarily involve sophisticated informationgathering and decision-making procedures. It can be introduced at any level of agricultural development, for example, through variations in such basic crop management practices as planting times, crop spacing and residue disposal. A useful beginning can be made with relatively little specialized information or management requirements. However, the effectiveness of any IPM program will be strengthened by the following:

(a) An understanding of the interactions between the elements of the local agro-ecosystem (e.g., crops, pests, beneficial organisms, the abiotic environment, etc.) and of any disruptions that may arise from overuse or misuse of pesticides.

(b) The development, with farmer involvement,6/ of a pest management plan using practical methods to reduce pest levels (including methods related to the total crop production system as well as those targeted specifically for pest control).

(c) The establishment of realistic economic and action threshold levels for key pests (see footnote 2).

(d) The development of practical systems for monitoring pest populations or infestation levels (either collectively or by individual farmers) and of whatever support structures are necessary to sustain them.

(e) The existence (or promotion) of farmer education concerning the principles and practices of IPM.

(f) The availability of appropriate materials and equipment, including establishment of insectaries to facilitate biological pest control where appropriate.

(g) Social and/or economic policy support that gives the farmer both incentive and opportunity to minimize pest management costs and increase productivity on a sustainable basis.

16. Similarly, research on crop protection/pest management methods does not necessarily have to be sophisticated, but it should be comprehensive. In addition to testing the efficacy (and environmental and toxicological characteristics) of pesticides, a complete research plan should include:

(a) Basic studies of the agro-ecosystem, including biology and life cycles of crops, pests and beneficial organisms and interactions among them (e.g., identification and classification of pests and natural enemies and evaluation of the impact of indigenous natural enemies on pest populations).

(b) Development and improvement of pest-resistant crop varieties.

(c) Examination of cultural practices for reducing pest populations (e.g., crop rotations, intercropping, timing of planting and irrigation, crop hygiene, land preparation, plant spacing, etc.).

(d) Investigation of biological control methods, such as release of indigenous or introduced natural enemies, microbial pesticides, pheromones, repellents, etc.

(e) Identification of pesticides and techniques of pesticide use with minimal impact on beneficial organisms, humans and the environment.7/

(f) Determination of the actual impacts of different pests and population levels on crop yield and quality.

(g) Review of traditional pest management practices of local farmers, as these often have a sound biological basis.8/

17. Research carried out with the active participation of the intended beneficiaries is more likely to result in technologies that are practical under local field and socioeconomic conditions and thus to be adopted by the intended users. Therefore, an essential element of all pest management research supported by the Bank should be an integration of farmers and field workers into planning and implementation and an emphasis on trials in farmers' fields. The agricultural extension service should provide a useful link between farmers and researchers for these field trials.

18. Project support for IPM research can include: (a) technical assistance to evaluate and help develop pest management plans or research programs in specific areas; (b) training fellowships for researchers and technicians; (c) improving research facilities; and (d) grants for specific research projects and institutional strengthening. The Regional Environment Division can assist in identifying appropriate consultants or training institutions.

Training and Extension

19. The IPM approach should be the central focus of education and training related to crop protection at all levels: government policy makers, major buyers of crops, agricultural schools and colleges, pesticide suppliers, extension workers, farmers, etc. Education in IPM for farmers is particularly important because, in many countries, the farmers' primary alternative sources of information and advice on such matters are the pesticide sales representatives or commercial middlemen who have little or no knowledge of the technical aspects of their safe use, and have strong incentive to emphasize benefits over risks.

20. The important role of natural enemies in controlling pest populations must be emphasized. Many farmers have no understanding of this concept nor of its underlying principles (e.g., many do not distinguish at all between beneficial and harmful insects). Not surprisingly, many farmers do not distinguish between the various pesticides (believing that any product is good for any pest in any crop), nor do they recognize the importance of using the correct dose at the right time. Because pesticides are often sold secondor thirdhand in remote rural areas, farmers may purchase products with no reliable information on what they are or how to use them. Extension workers should be prepared to advise farmers on the proper handling and use of pesticides, and on the hazards they pose to the farmersand to their families and livestock.

21. Training should therefore include a thorough understanding of pesticides: their effects and limitations, their associated health and environmental hazards, and requirements for safe and effective use and handling. In addition to conventional extension channels, a variety of methods and media should be used (e.g., radio, television, movies, illustrated pamphlets and comic books, etc.) to circumvent illiteracy and get the widest possible dispersion of information.

22. Special training, information and educational materials relating to IPM and pesticides should also be given to:

(a) Shopkeepers, vendors, farmers' groups or agricultural cooperatives involved in sale or distribution of pesticides, to ensure that all understand the toxic nature of the pesticides they are dispensing.

(b) Doctors, community health clinics and women's groups (particularly on symptoms and treatment of pesticide poisoning).

(c) Staff of credit institutions, to help them understand the economic advantages of IPM and to encourage them not to impose loan conditions that promote dependence on chemical pesticides or the use of very hazardous materials.

(d) School teachers and pupils (and their parents) in rural areas.

Policy Framework

23. While research, education and supply channels can provide the tools necessary for rational and cost-effective pest management, farmers must also have incentives to apply it. Therefore, in evaluating the crop protection component of a project, it is important to examine the economic policy framework and incentive structure and, if necessary, to propose measures to correct them. Clearly, when pesticide use is encouraged by subsidies from the government or donor agencies or by market requirements, the incentive for limiting their use is reduced.

Monitoring, Evaluation, and Supervision

24. Monitoring and evaluating progress on development and implementation of IPM programs is difficult because the scientific base may take a long time to develop, and also because farmers may not immediately adopt the technology offered. Often, therefore, progress must be measured initially just by correct processes being established: appropriate types of research and training programs (with adequate staffing and support) going on; strong linkages in place between research and extension; etc. Improvements relating to policy or infrastructure (e.g., the removal of pesticide subsidies), to safety of pesticide use and human exposure, and to environmental contamination (e.g., surface or ground water, wildlife) also should be tracked and evaluated. Again, market competitiveness is a major factor for the farmer and any successful IPM program will address that concern effectively.

25. When an IPM program is introduced in an area where pesticide use has been high, a reduction in pesticide application within a few years is probably a good indicator of successful implementation. A

system of pest population monitoring should be established early in the project and linkage made between the results of such monitoring and control intervention decisions.

26. Where the necessary technical or institutional capability for such monitoring and supervision does not exist locally, provision to develop them should be planned. Formal or informal cooperation with local nongovernmental organizations (NGOs) should be sought. Where appropriate, Bank supervision should be readily available, including involvement by technical experts (local or international).

Contents of the Staff Appraisal Report (SAR)

27. The SAR for an agricultural loan should indicate how these guidelines have been followed in project preparation and how implementation will be evaluated and supervised. It should describe as fully as possible the anticipated pest problems and current pest management practices. Where these are not consistent with IPM principles, the SAR should include a schedule of the steps to be taken in the proposed projects to bring them in line. Areas of conflict should be discussed (e.g., malaria vs. swamp, drainage vs. use of insecticides). Pesticides selected should be explicitly justified in the SAR, together with training, monitoring, precautions, and other preventive measures to reduce environmental risks.

28. Similarly, the SAR should address current practices and problems, and propose measures for improvement regarding pesticide selection, use and disposal. Aspects to consider include:

(a) Existing or anticipated pest problems. Information on specific crop/pest targets should be provided to aid in identifying available IPM technologies that have been developed in other areas and may be adapted to local conditions. Information on pests that pose a public-health threat locally and control programs already in operation should also be provided, as these can influence agricultural pest management options.

(b) Proposed pest management plans and methods.

(c) Current institutional framework for crop protection (e.g., is pest management the responsibility of a government or company service or of individual farmers? are pesticides supplied by the government or through private commercial channels? are pesticides subsidized by the government? does market demand for a particular product quality encourage pesticide use?).

(d) The existing institutional structure and capacity for:

(i) dealing with pest problems (including diagnosis of pests and monitoring of population levels, impacts in the field and exchange of information on a regional basis);

(ii) applied research for development and testing, with farmer involvement, of pest management technologies (including biological control, intercropping, improved cultural practices and development of resistant varieties);

(iii) extension of pest management information and new technologies, and training of farmers; and

(iv) provision of services and inputs, and measures for cost-recovery for any services or inputs (including presence or absence of subsidies) provided by the public sector.

(e) Any aquatic or other important environmental resources in the proposed project area that may raise special concerns regarding pesticide use or other aspects of pest management (e.g., underlying aquifers used for domestic water supply, downstream commercial or natural fisheries or breeding grounds for aquatic species, adjacent natural parks or reserves, presence of endangered species that may be adversely affected).

(f) Legislation, regulations and enforcement capability relating to crop protection and to importation or use of pesticides. This includes: regulations concerning application procedures, training for application

personnel, and application instructions accompanying products (fertilizers, fungicides, pesticides, etc.); and the capacity for reliable assessment of pesticide toxicity, human pesticide exposure and pesticide residues in foods and the environment.

(g) Technology packages extended to farmers for increasing agricultural production (usually including improved seeds, fertilizers, pesticides, cultural practices, etc.). IPM does not lend itself to standard packages; but in most cases, introduction of these packages has a significant impact on the pest situation, and vice-versa. Therefore, they must be evaluated with respect to their potential impact both on the agro-ecosystem and on prospects for adoption of an IPM approach.

AGROINDUSTRY

1. Agroindustry involves a diverse array of industries which process raw agricultural products. The main agroindustry subsectors include agriculture (and horticulture), forestry, fisheries and shellfisheries. This section reviews the following industries: cotton ginning, palm oil, tea and coffee, tanneries, slaughterhouses and wool scouring. Other agroindustries are reviewed under sections on "Food Processing," and "Pulp, Paper, and Timber Processing."

Potential Environmental Impacts

2. The major adverse impacts associated with agroindustry result from water and air pollution, disposal of solid wastes, and changes in land use. ("Solid Waste Collection and Disposal Systems" and "Wastewater Collection, Treatment, Reuse, and Disposal Systems" are discussed in more detail in Chapter 9.)

3. Wastewater streams vary with the type and size of the agroindustrial operation. Effluents typically have high biochemical oxygen demand (BOD), chemical oxygen demand (COD), and suspended and dissolved solids. Other contaminants such as pesticide residues, complex oils, alkaline or acidic compounds, and other organic constituents may also be present in wastewater. Discharges from feedlots, tanneries and slaughterhouses can be potential sources of disease among humans and animals.

4. Air emissions from agroindustrial operations commonly include particulate matter, sulphur di-oxides, nitrous oxides, hydrocarbons, and other organic compounds. Noxious and nuisance odors are often associated with agroindustries.

5. Land resources may be adversely affected by inappropriate storage of raw materials and disposal of solid waste at the facility property or on off-site disposal areas.

6. The production of raw materials to supply these agroindustries can have negative environmental effects through intensified agricultural activity. Conversion of forest lands to agriculture has the potential for causing the most profound environmental and social impacts. The nature and degree of the impact will depend upon existing land use practices, the quantity of raw materials needed by the agroindustry, the production system chosen, and land and water management systems. Potential environmental impacts from intensified agricultural use include increased erosion, contamination of surface and groundwater from agricultural inputs (e.g., fertilizers, pesticides), changes in physical and chemical characteristics of the soil, and impacts on wildlife and native vegetation. Potential social impacts include decreased access to resources (e.g., traditional cropping and grazing areas, water resources, forest products), displacement of people, and social disruptions. (For further discussion of the potential negative environmental impacts asssociated with agroindustry projects and recommended measures to avoid or mitigate them, see Table 8.1 in Volume II, page 25.) Not all the impacts, however, are necessarily negative. Planting of tree crops on degraded lands, for example, can have a positive environmental effect. The agroindustry can introduce more efficient agricultural practices into an area, stimulate markets for products and provide jobs for local people.

7. Indirect effects of the installation of a large agroindustry include the development of transportation facilities for delivering the products to markets and uncontrolled migration into the area of people looking for land or jobs.

8. The individual agroindustries and their main sources of pollution and potential health hazards are discussed in this section.

Palm Oil Industry

9. Palm oil is extracted from the outer pulpy portion of the oil palm fruit by a series of operations. The fruit is loosened in the bunches by steam sterilization. Strippers then separate the leaves and the empty bunches from the fruit. From the strippers, the fruit is conveyed to the digesters where it is heated and pulped. Free oil is drained from the digested pulp, then the pulp is squeezed and centrifuged to extract the remaining crude oil. The liquid is screened and clarified to produce purified oil. The extraction residues containing broken nuts and shells are further processed in a current of air to separate palm kernels from the shells. The palm kernels are dried, bagged, and stored for subsequent oil extraction, generally carried out at a different location.

10. Palm oil processing produces substantial quantities of solid wastes in the form of leaves, empty bunches, fibers, shells, and extraction residues. The bunch stalks contain significant quantities of recoverable nutrients and can create a major nuisance and disposal problem. Fibers, shells, and other solid residues are normally burned as fuel to produce steam. Uncontrolled burning of waste solids and release of air used to winnow the shell from the kernels contribute to air pollution.

11. Liquid wastes principally originate from sterilizers and oil clarification. The major pollutants are BOD, total suspended solids (TSS), COD, oil and grease (O/G), and organic nitrogen and ash.

Slaughterhouses

12. A simple slaughterhouse operation involves livestock holding pens, slaughtering, blood removal, hide removal or hog dehairing, evisceration, trimming and butchering for market. The main product of the operation is fresh meat as whole, half or quarter carcasses, or smaller meat cuts. The blood, hides, hair, and viscera are subject to further processing.

13. The main sources of pollutants are liquid effluents carrying varying amounts of solids. Odor from putrescible substances and organic decomposition is the only air pollutant but presents a continuous source of nuisance.

14. The most significant pollutants in the wastewater from slaughter houses are: BOD (biochemical oxygen demand), TSS, O/G and fecal coliform bacteria. Solid wastes are normally screened and reprocessed or disposed of in a landfill.

15. The main safety hazards associated with slaughterhouses are cuts and abrasions from knives and cutting tools, falls on slippery floors, burns and scalds from hot water and steam, injuries from lifting, electrical shock from improper use of electric tools or defective electrical insulation. The main health hazard potential is from animal diseases, such as brucellosis, anthrax, acute and chronic respiratory syndrome, skin diseases, erysipelas, glanders, tularemia and Q-fever.

Tea and Coffee Production

16. Tea leaves are processed to yield either green or black tea. The manufacturing of black tea starts with the "withering" of the leaves either by natural drying or by hot air. Withering is followed by rolling to press out the juices and beating to break up the leaves. The broken leaves are sifted and fermented to achieve the final product quality. The fermented tea is dried, graded and sorted for packaging. Green tea is prepared by

heating the leaves either in hot pans or by steam. The leaves are rolled, fired and rerolled to achieve the desired quality.

17. Tea production may result in some gaseous wastes from the drying operation. These emissions are considered to be unimportant in comparison with the discharges from coal or oil fed boilers used to produce heat. Liquid wastes from cleanup operations are also considered to be insignificant.

18. Freshly picked coffee cherries are processed initially either by the dry method or the wet method. The dry process is used for Robusta coffee and for much of the Arabica coffee in Brazil and Ethiopia. The coffee cherry is sun-dried and then milled to remove in one process the outer skin, dried mucilage, the parchment and the silverskin layers. The milling process is undertaken in large installations. The waste products may be used for fuel, and also have on occasion been used for livestock feed.

19. On the other hand, the wet process, used to prepare higher quality Arabica coffee can seriously pollute. The ripe cherries are first washed to remove light fruit and rubbish, then pulped to remove the outer skin and some of the underlying mucilage. The freshly pulped beans are then fermented in tanks. This enzymatic process breaks down the remaining layers of mucilage into an effluent that can cause a serious pollution problem if discharged directly into streams or rivers. After a final wash the coffee, now called "parchment", is dried in the sun or artificially. The parchment coffee is then hulled to remove the parchment and silverskin layers to yield the internationally traded "clean" or "green" coffee beans.

20. The wet process requires a large volume of water and can cause serious pollution problems. Water economy can be achieved through recycling much of the flow, which also concentrates the enzyme content of the water used for pulping and this speeds up fermentation. Water used for final washing can be returned directly to rivers, but other effluent should pass through seepage pits.

21. Health hazards from the final stages of preparing tea and coffee for the market may include irritation of bronchial passages and lungs from exposure to fine tea or coffee dust, and asthma from hypersensitivity to tea fluff.

Tanneries

22. Tanning is the process of converting animal hides into leather. The hides are dehaired, tanned by reacting with tanning agents, dyed and finished to produce finished leather. The four processes involved in tanning hides are: beamhouse, tanhouse, retanning and finishing.

23. In the beamhouse, hides are processed by degreasing, fleshing and dehairing in order to prepare them for the tanning operation. Wastewaters contain dirt, salt, blood, manure, oil, and grease, flesh, hair, etc. Much of the solids is recovered and sold to rendering plants. The waste is characterized by high alkalinity, sulfide, nitrogen, BOD, COD, dissolved and suspended solids, and oil and grease.

24. The purpose of the tanning process is to produce durable material which is not subject to degradation by physical or biological mechanisms. Prior to tanning the hides are subjected to bating and pickling, both of which produce wastewaters high in acids and salts. Tanning is accomplished by leeching the hides with chrome, vegetable tannin, alum, metal salts or formaldehyde. Wastewaters from the operation are substantial. The spent chromium tanning solution is relatively low in BOD, COD and TSS, but can contain significant concentrations of chromium, a toxic metal. On the other hand, vegetable tanning solution is high in both BOD and color.

25. Retan, color and fat liquor operations constitute the third major step in the tanning operation. The three operations are usually performed in one drum and involve addition of tanning solution (retan), dyes, and oils to replace natural oils of the hides (fat liquor). The process generates high-strength, low-volume discharges containing oil and color.

26. Finishing operations include drying, coating, staking, seeding, pasting and washing. The last two operation generate high-strength, low-volume wastewaters.

27. The tanning process generates significant airborne particulate matter and hydrogen sulfide discharges. Other gaseous emissions occur from ammonia stripping and utility boilers. The process also generates solid wastes in the form of fleshing, sanding dust, hide trimmings, sludges, greases, etc., which are normally recovered and sold to rendering plants. Hair is sold as a separate by-product.

28. The main health hazard, aside from accidents, is dermatitis from contact with chemicals and hides. Other health risks result from exposure to excessive dusts, toxic chemicals, noise and anthrax.

Wool Scouring

29. Wool scouring is a wet process used to remove natural and acquired impurities from the fibers. The process uses soap alkali or non-ionic detergents to scour the woollen fibers. As a final step the fibers are rinsed and dried.

30. Part of the water used in the process is recycled and the rest is discharged. The discharged effluent contains wool grease, urine, faeces, sweat, blood and other impurities which makes the wool scouring effluent one of the strongest industrial wastes in terms of BOD. The raw effluent is also high in oil and grease and may contain sulfur, phenols and pesticides.

Cotton Ginning

31. Modern cotton ginning is a continuous process spanning the unloading of raw cotton to baling of processed cotton fibers. Ginning of cotton produces large quantities of solid wastes in the form of cottonseeds (which may used in animal feed) and gin trash, and releases air pollutants in the form of cotton dust and lint. To minimize the source of pink bollworm in gin waste, movement and disposal of cottonseed and trash may be tightly regulated in certain countries. Where regulations permit, cottonseed is sent to oil mills for extraction of oil. Gin trash may be disposed of by composting, fumigation, sterilization and incineration. In some countries open burning is practiced which creates nuisance, air pollution and odor problems.

32. The main health related issue in cotton ginning involves cotton dust. Exposure to excessive levels of cotton dust leads to byssinosis, a serious respiratory disease. Excessive noise can also be a problem in this industry.

Special Issues

Environmental Effects of the Production of Raw Materials

33. As already discussed, conversion of large areas of natural vegetation to crop or livestock production, or the intensification of agriculture have potential negative environmental and social impacts. These factors must be considered in decisions on whether to finance a proposed project and on siting. Following are some examples relating to the agroindustries considered.

34. One of the most obvious and well-publicized examples of resource degradation arising from livestock production is deforestation in the Amazon basin; large areas of the moist tropical lowland forests have been converted to pasture for cattle raising. Large-scale clearing has long-term impacts because of the system's inability to recover from loss of nutrients and ecological disruption.

35. Planting of large plantations of oil palms also is linked with cutting of tropical forests, particularly in Southeast Asia. Conversion of the natural forest to another forest crop is less disruptive ecologically than

conversion to an annual crop, yet still poses the risk of species loss and the problems arising from monocultures and agricultural production in general.

36. Large-scale cotton cultivation is becoming controversial in some areas because of its serious environmental impacts. The rapid growth of cotton production in parts of West Africa, for example, is linked with deforestation, erosion and declining soil fertility. Cotton often is grown in ecologically poorer areas which have higher susceptibility to degradation. Soil exhaustion was less evident in traditional systems in West Africa which provided for a long fallow period. Under more intensive systems the fallow period has been shortened or eliminated.

Facility Siting

37. Site location plays an important role in determining the environmental impact of wastewater discharges and solid waste disposal and the costs and methods used for pollution control. The capacity of a site to absorb waste will depend on the quality and quantity of waste and the ambient conditions. Many agroindustries, such as slaughterhouses and tanneries, which are heavy waste producers and polluters, should not be located in environmentally sensitive areas or at locations where their wastes (after proper treatment) cannot be assimilated without environmental degradation. Conversely, food producing agroindustries should not be sited in areas heavily affected by industrial discharges because of the risk of food contamination. 38. Facility siting is a highly complex and often time consuming process involving developers, special interest groups, politicians and local and national authorities. Developing countries are becoming more sophisticated in facility siting programs. Local regulations must be factored into the selection of an appropriate site for the proposed agroindustry.

Residue Utilization

39. The generation of residues and their potential use or sale depends on the raw materials, the production processes, output specifications, the cost of raw materials and products, the regulations affecting product quality and use, and the constraints, if any, imposed on residue discharge or disposal. The residues may be liquid, gas or solid or a combination of the three. Using, recycling or commercializing residues have two advantages: increasing the productivity and thus the economic performance of the industry, and reducing wastes which are potential sources of pollution.

40. A review of options for residue utilization should be included during project preparation. The following commodities and their by-products are good candidates for such a review:

. palm oil residues for nutrient recovery and fuel . palm kernels for oil and animal feed . slaughterhouse by-products for rendering and animal feed additives . cotton seeds for oil, animal feed additives, and fuel . animal oil for cosmetics . animal by-products (including hair) and wastes

Existing Pollution Regulations

41. A number of countries and the World Bank have established effluent guidelines for many sectors of agroindustry. Contaminants which are regulated under U.S. Environmental Protection Agency (EPA) standards, for example, include pH, TSS, BOD, COD, and heavy metals. Standards for oil and grease, fecal coliform, and ammonia have also been established for slaughterhouses and seafood processing industries.

42. Regulations vary by country and industry type and are highly subjective. In countries having no regulations, World Bank guidelines should be followed; where regulations do exist, the more stringent standards should apply.

43. Air quality standards exist for particulates, sulfur dioxides, and some organic compounds in many developed countries; fewer ambient standards exist in developing countries.

Project Alternatives

44. The main areas where alternatives exist for decreasing the potential for negative environmental impacts are in facility siting and operation.

Siting

45. Selection of a site for an agroindustrial facility is dependent on a number of economic, ecologic and sociopolitical concerns. Regardless of the product manufactured or processed, an environmentally ideal site is one which satisfies the following criteria:

. availability of local land and water resources adequate to supply the required quality and quantity of raw materials without causing unacceptable environmental impact (e.g., clearing of primary forests, wetlands or critical wildlife habitat; and intensification of agriculture which will result in loss of soil fertility, increased erosion, etc.);

. sufficient land area to provide planned and expanded facilities for storage of raw materials, processing and waste disposal;

. minimal displacement of people and houses;

. minimal conflicts with higher valued land uses such as agriculture, especially in marginal land areas where prime agricultural land may be at a premium.

. proximity to receiving waters capable of handling effluent discharge without significant impact on the biophysical and aquatic environment.

. easy access to social and physical infrastructures such as skilled labor pool, support industries, transportation network, energy supply, raw materials and potential market areas.

. adequate distance from tourist or recreational areas, office buildings and housing complexes to minimize the impacts of odors, noise, and pollutants.

. minimal construction and operational impact of the facilities on rare, threatened or endangered species, their habitats, or other sensitive ecosystems.

Operation of the Facility

46. Agroindustrial operations employ a variety of processes and equipment. The type of product processed and the size of the operation determines the type of equipment used, the quality and the quantity of the effluent or waste produced, and thereby the need for pollution control equipment. The various options for pollution control equipment should be examined in light of their effectiveness at minimizing pollution. The type of equipment used in pollution abatement cannot be specified for all possible agroindustries. Generally, pollution control measures employ the following processes:

(a) Water Pollution

. lagoons . neutralization . sedimentation . filtration . flocculation . activated sludge treatment . spray irrigation

(b) Air Pollution

. electrostatic precipitators and baghouses . activated charcoal filtration . scrubbing with sodium hypochlorite (for odor control) . compost filters to reduce nuisance from odors

Management and Training

47. The need for management and training pervades all aspects of agroindustrial projects in developing countries. The technical capabilities of industry personnel and government officials responsible for monitoring pollution abatement performance frequently needs strengthening. The number of in-country consultants qualified to prepare detailed environmental assessments (EAs) is usually small and many of these are academics who lack project or industrial experience.

48. The issue of environmental management for development projects is complex. Many countries have just begun work on developing screening and review procedures for projects, compiling environmental databases, and matching and adapting to local priorities and requirements the multitude of environmental regulations and technical guidelines now on the market. Many central and provincial governments do not have trained staff, adequate budgets, or adequate natural resource databases to keep pace with the numbers of projects being offered by development agencies to host governments.

49. Use of an Environmental Management Plan during project implementation offers one way to establish ground rules for environmental protection and provide guidance to the host country managers. At a minimum, the plan should focus on mitigative measures and the means for their implementation. These measures should be incorporated into the work plans of the project office and other associated government agencies.

50. Training may be needed among the following groups.

(a) Government professional staff: in design and evaluation of EAs; collection, analysis and interpretation of pollution and related health data; plant safety and health procedures for key agroindustries; inspection and enforcement procedures.

(b) Industry employees: in environmental issues relevent to their operation; government regulations; evaluation of pollution data, treatment options and operational data; air and water pollution control options; operation and maintenance of the specific equipment used at their facility; plant safety, sanitation and health procedures.

(c) Local professionals not associated with government and industry: in providing adequate consulting services and/or independent review for EAs and pollution abatement.

51. All of the above people should be provided with some means of keeping abreast of developing technology so as to incorporate the best and most cost effective pollution abatement systems.

Monitoring

52. Air and liquid effluent and solid waste management must be monitored to determine if the project is adhering to the environmental standards and practices agreed upon. The following factors should be monitored for any given agroindustrial facility:

. Waste streams and gaseous and particulate emissions for appropriate parameters. Where a particular discharge is consistently above the established emissions limits or the standard for the industry, corrective action should be taken. These actions could involve process or equipment modification, upgrading, and housekeeping changes.

. Quality of receiving water downstream and air downwind of the plant.

. Effects of solid waste management practices on soils, groundwater and surface water resources.

. Implementation of health and safety plan by periodic site inspections to assure that training protocols and personal protective equipment such as dust masks are being employed in the work place. Standard industry practices should be used. Documentation and records should reflect periodic review and corrective actions taken.

53. An important factor in the abatement of pollution in agroindustrial development projects is the simultaneous strengthening of both in-plant and government monitoring capabilities. It should not be assumed that industrial facilities in the developing countries will develop and undertake air and water monitoring programs and install treatment technologies without effective government surveillance and legal and regulatory enforcement. Likewise, improved monitoring does not result in the reduction of wastewater discharges or air emissions unless the technical capability to comply with the effluent standards is also improved. To operate a successful monitoring program, it may be necessary to introduce sampling equipment and laboratory protocols (or the analytical laboratory) to the host country.

Footnotes

1/ "Pests" refers to all animals, plants and micro-organisms which have a negative impact on agricultural production.

2/ The term pesticide is used here as it is better known than the more precise generic term biocide (literally: chemical killers of life). The term pesticide suggests that pests can be distinguished from non-pests, that pesticides will not kill non-pests, and that pests are wholly undesirable.

3/ The common statistical models used are the economic threshold level (ETL) and the action threshold level (ATL). The ETL is established through crop-loss assessment of the value of the crop, the amount of damage it can tolerate at each growth stage without significant effect on yield and market value, and the cost of crop-production measures. The ATL is the pest population at which control action should be taken to prevent its reaching the ETL. Use of appropriate ATLs minimizes the frequency of pesticide application.

4/ "Pesticides" include insecticides, acaricides, herbicides, arboricides, rodenticides, fungicides, muticides, molluscicides, nematicides, etc., and also plant growth regulators (e.g., hormones and generically engineered compounds).

5/ These draft guidelines deal only with agriculture (including forestry). Regarding control of disease vectors, see "Guidelines for the Use, Selection and Specification of Pesticides in Public Health Programs" (September 29, 1987), filed with OPN 11.01.

6/ "Farmer involvement" means involvement of the people (often women) doing the work.

7/ For discussion of criteria to be used to determine which pesticides should be restricted (e.g., acute mammalian toxicity, environmental persistence, chronic health effects, toxicity to non-target organisms, etc.), see the World Health Organization's WHO Recommended Classification of Pesticides by Hazard.

8/ Sometimes, however, such practices are based on misperception of the importance of highly visible pests or may no longer be effective due to changing conditions. Also, natural compounds may have been developed that are extremely toxic. An attempt should be made to identify the substances and to control their use.

DAMS AND RESERVOIRS

1. Projects for building dams and their associated reservoirs are usually planned for one or more of the following purposes: hydroelectric power, irrigation, domestic and industrial water supply, and flood control. ("Hydroelectric Projects" are discussed in Chapter 10; information on "Irrigation and Drainage" projects appears later in this chapter.)

Potential Environmental Impacts

2. Large dam projects cause irreversible environmental changes over a wide geographic area and thus have the potential for significant impacts. Criticism of such projects has grown in the last decade. Severe critics claim that because benefits from dams are outweighed by their social, environmental and economic costs, the construction of large dams is unjustifiable. Others contend that in some cases environmental and social costs can be avoided or reduced to an acceptable level by carefully assessing potential problems and implementing cost-effective corrective measures.

3. The area of influence of a dam project extends from the upper limits of the catchment of the reservoir to as far downstream as the estuary, coast and off-shore zone. It includes the watershed and river valley below the dam. While there are direct environmental impacts associated with the construction of the dam (e.g., dust, erosion, borrow and disposal problems), the greatest impacts result from the impoundment of water, flooding of land to form the reservoir and alteration of water flow downstream. These effects have direct impacts on soils, vegetation, wildlife and wildlands, fisheries, climate and especially the human populations in the area.

4. The dam's indirect effects, which on occasion may be worse than the direct effects, include those associated with the building, maintenance and functioning of the dam (e.g., access roads, construction camps, power transmission lines) and the development of agricultural, industrial or municipal activities made possible by the dam.

5. In addition to the direct and indirect effects of dam construction on the environment, the effects of the environment on the dam must be considered. (See Table 8.2 at the end of the "Dams and Reservoirs" section for examples.) The major environmental factors affecting the functioning and life span of the dam are those caused by land, water and other resource use in the catchment above the reservoir (e.g., agriculture, settlement, forest clearing) which may result in increased siltation and changes in water quality in the reservoir and river downstream.

6. The benefits of a dam project are flood control and the provision of a more reliable and higher quality water supply for irrigation, domestic and industrial use. Dams may also provide an alternative to activities with potential for greater adverse impacts. Hydropower, for example, provides an alternative to coal-fired thermal power or to nuclear power. Intensification of agriculture locally through irrigation can reduce pressure on uncleared forest lands, intact wildlife habitat, and areas unsuitable for agriculture elsewhere. In addition, dams create a reservoir fishery and the possibilities for agricultural production on the reservoir drawdown area, which in some cases can more than compensate for losses in these sectors due to dam construction.

Special Issues

Hydrologic and Limnological Effects

7. Damming the river and creating a lake-like environment profoundly changes the hydrology and limnology of the river system. Dramatic changes occur in the timing of flow, quality, quantity and use of water, aquatic biota, and sedimentation in the river basin.

8. The decomposition of organic matter (e.g., trees) on the flooded lands enriches the nutrients in the reservoir. Fertilizers used upstream add to the nutrients accumulating and recycling in the reservoir. This not only supports reservoir fisheries, it also stimulates the growth of aquatic weeds, such as water lettuce and water hyacinth. Weeds and algal mats can be expensive nuisances when they clog dam outflows and irrigation canals, damage fisheries, curtail recreation, increase water treatment costs, impair navigation and substantially increase water loss through transpiration.

9. If the inundated land is heavily wooded and not sufficiently cleared prior to flooding, decomposition will deplete oxygen levels in the water. This affects aquatic life, and may result in large fish kills. Products of anaerobic decomposition include hydrogen sulfide, which corrodes dam turbines and is noxious to aquatic organisms, and methane, which is a greenhouse gas. The main gas produced, carbon dioxide, also exacerbates greenhouse risks.

10. Suspended particles carried by the river settle in the reservoir, limiting its storage capacity and lifetime and robbing downstream waters of sediment. Many agricultural areas on floodplains have always depended on nutrient-rich silt to sustain productivity. As sediment is no longer deposited on the floodplain downstream, the loss of nutrients must be compensated by fertilizer inputs to maintain agricultural productivity. The release of relatively sediment-free waters can result in the scouring of the downstream riverbeds. Sedimentation in the reservoir, however, provides higher quality water downstream for irrigation, industry and human consumption.

11. Additional effects of changes in the hydrology of the river basin include altered levels of the water table both above and below the reservoir and salinization problems which have direct ecological impacts and affect downstream water users.

Social Issues

12. The benefits of dams often accrue to urban dwellers, agricultural interests and others living some distance away from the dam, but less so or not at all to those who bear the heaviest environmental and social costs of the dam constructionnamely the inhabitants of area inundated by the reservoir, and those living on the floodplain. Reservoir filling results in the involuntary relocation of hundreds of thousands (in some projects), causing profound social readjustment not only for them but for those already living in the resettlement areas (see "Involuntary Resettlement" section). For those remaining in the river basin, access to water, land and biotic resources often is restricted. Artisanal riverine fisheries and traditional floodplain (recession) agriculture are disrupted by changes in stream flow and reduced silt deposition. Floodplains of many tropical rivers are vast areas of great importance for human and animal populations; when the floodplains shrink, land use must change or populations are forced to move. Water-related diseases (e.g., malaria, schistosomiasis, onchocerciasis, encephalitis) often increase in reservoir and irrigation projects.

13. Social and environmental problems arise from the controlled and uncontrolled influx of other people into the area, such as construction workers, seasonal laborers for agriculture and other daminduced activities, and rural people who take advantage of increased access to the area provided by roads, transmission lines or improved river navigation (see "Induced Development" and "New Land Settlement" sections in Chapter 3). The consequences are health problems, overburdened public services, competition for resources, social conflicts, and negative environmental impacts on the watershed, reservoir and downstream river basin.

Fisheries and Wildlife

14. As mentioned, riverine fisheries usually decline due to changes in river flow, deterioration of water quality, water temperature changes, loss of spawning grounds and barriers to fish migration. A reservoir fishery, sometimes more productive than the previous riverine fishery, however, is created.

15. In rivers with biologically productive estuaries, both marine and estuarine fish and shellfish suffer from changes in water flow and quality. Changes in freshwater flows and thus the salinity balance in an estuary will alter species distribution and breeding patterns of fish. Changes in nutrient levels and a decrease in the quality of the river water can also have profound impacts on the productivity of an estuary. These changes can also have major effects on marine species which feed or spend part of their life cycle in the estuary, or are influenced by water quality changes in the coastal areas.

16. The greatest impact on wildlife will come from loss of habitat resulting from reservoir filling and land use changes in the watershed. Migratory patterns of wildlife may be disrupted by the reservoir and associated

developments. Poaching and eradication of species considered to be agricultural pests have a more selective effect. Aquatic fauna, including waterfowl, reptiles and amphibians can increase because of the reservoir.

Seismic Threat

17. Large reservoirs may alter tectonic activity. Though the probability that they will induce seismicity is difficult to predict, the full destructive potential of earthquakes, resulting in landslides, damage to dam infrastructure, and possible dam failure must be considered.

Watershed Management

18. Increased pressure on upland areas above the dam is a common phenomenon caused by the resettlement of people from the inundated areas and by the uncontrolled influx of newcomers into the watershed. On-site environmental deterioration as well as a decrease in water quality and increase in sedimentation rates in the reservoir result from clearing of forest land for agriculture, grazing pressures, use of agricultural chemicals, and tree cutting for timber or fuelwood. Similarly, land use in the watershed of the lower river basin affects the quality and quantity of water entering the river. It is therefore essential that dam projects be planned and managed in the context of overall river basin and regional development plans, including both the upland catchment areas above the dam and floodplain, and watershed areas downstream.

Project Alternatives

19. A variety of alternatives, such as the following, exist for the design and management of dam projects:

. avoid or postpone the need for dam construction altogether by reducing demand for water or energy by conservation measures, efficiency improvements, fuel substitution, or restrictions on regional growth;

. avoid construction of a dam whose primary purpose is for irrigation by expanding and/or intensifying agriculture on the river's floodplain or outside the watershed;

. investigate possibilities for siting the project on an already dammed river by diversifying the functions of that dam;

. site the proposed dam on the river where it will minimize the negative and social impacts;

. adjust dam height, inundation area, dam design, and operational procedures to minimize negative environmental impacts;

. install several small dams instead of a single large one.

Management and Training

20. Responsibility for management of the dam project should be vested in a river basin authority or other centralized entity, which will:

. collect baseline data . build and manage the dam . produce a water-use master plan with management strategies for regulation of the reservoir . approve permit requests for major withdrawals and wastewater discharges . coordinate disease vector control . plan for municipal water supplies and water treatment facilities

Intersectoral cooperation should be ensured at both the policy and field levels with government ministries responsible for agriculture, fisheries, forestry, range and livestock, health, wildlife, tourism, municipal and industrial planning, and transportation.

21. Environmental and socioeconomic units should be established within the river basin authority and on the project site. The units should be staffed by professionals in physical (e.g., pollution control), biological (e.g., disease vector control), and social (e.g., involuntary resettlement) disciplines.

22. Guidance for the river basin authority can be provided by an advisory panel of international environmental specialists to advise on environmental aspects of the project and on training and management needs.

23. Training should be provided where needed to assure that the above mentioned disciplines are adequately represented.

Monitoring

24. Factors to be monitored should include:

. rainfall . stored water volume in the reservoir . annual volume of sediment transported into reservoir . water quality at dam discharge and at various points along the river (such as, salinity, pH, temperature, electrical conductivity, turbidity, dissolved oxygen, suspended solids, phosphates, nitrates) . hydrogen sulfide and methane generation behind dam . limnological sampling of microflora, microfauna, aquatic weeds and benthic organisms . fisheries assessment surveys (species, populations. etc.) in the river and reservoir . wildlife (species, distribution, numbers) . vegetation changes (cover, species composition, growth rates, biomass. e.) in the upper watershed, reservoir drawdown zone, and downstream areas . increases in erosion in the watershed . impacts on wildlands, species or plant communities of special ecological significance . public health and disease vectors . in and out-migration of people to area . changes in economic and social status of resettlement populations and people remaining in the river basin

FISHERIES

1. The major types of fisheries fall under two categories: capture fisheries and culture fisheries (i.e., aquaculture and mariculture).

2. Capture fisheries harvest wild stock. The major methods are: (a) actively seizing fish or shellfish in a net (seine, trawl) or trap; (b) tangling fish in a net (gill, drift or trammel); and (c) catching them with hook and line (anglers, longliners). Capture fisheries operate in marine, fresh and brackish waters and range from large commercial concerns to small-scale artisanal fisheries. Marine fisheries include offshore and near-shore operations. Inland fisheries include those on rivers, lakes, reservoirs and estuarine areas.

3. Culture fisheries (marine, brackish and fresh water, ranching, etc.) involve management of resources to increase fishery production beyond that which is normally available from wild stock. Fish farming achieves higher concentrations of fish or shellfish by raising them in ponds; containing them in naturally productive areas by using cages, pens or nets; providing substrates for the attachment of nonmotile animals (e.g., oysters); or adding fish or shellfish to natural habitats (e.g., reef seeding, clam grow-out areas).

Potential Environmental Impacts

4. Since the Second World War, strong and sustained demand for fish for human consumption and livestock feed has put increasing pressure on fishery resources. The increase in world catch from 20 million tons in 1950 to over 90 million tons in 1990 has been made possible by technological innovations, deployment of distant-water fishing vessels, and exploitation of new oceanic stocks and shoaling pelagic species. The rate of increase of total world landings, however, has decreased since the 1960s, and the present biological potential for fish production has been estimated at 100 million tons. Total demand for fish for human consumption and for fish meal is increasing faster than the increase in supply, and is expected to exceed 100 million tons by the year 2000. Only limited increases can be expected in marine catches, which account for

80% of total fishery production, because the majority of commercial stocks appear to be fully or overexploited. Yields from freshwater capture fisheries, which supply 10% of total production, are unlikely to expand much, as they too have reached their biological limits in many areas. Fish farming has the greatest potential to increase fishery production, but it is associated with many environmental problems.

5. As demand is approaching production limits, many fishery resources are deteriorating. Overexploitation is depleting certain stocks, and other human activities are affecting fishery productivity and aquaculture potential in fresh, brackish and saltwater systems. These impacts affect traditional and commercial fishery operations as well as recreational and related water-based tourism. Pollution from industrial, urban and agricultural areas, land use in watersheds and water management affecting river flows and sediment loads, and coastal development all are having negative impacts on fisheries (see Table 8.3 at the end of this section for further discussion). The direct impacts on the environment by capture and aquaculture operations, as well as external environmental impacts on the fishery resources are examined in this section.

Capture Fisheries

6. The major direct negative environmental impact of capture fisheries is overexploitation. Overfishing not only degrades the target fish population by changing its population size and structure, but affects other species linked to it in the food chain. Non-target species are also inadvertently harmed or killed by the use of certain fishing equipment and practices that do not catch the desired species exclusively or that are harmful to habitats. Trawling is of special concern because dragging nets across the bottom can damage benthic communities. Accidental damage to coral reef by anchors and divers can be significant. Lost or discarded fishing nets, traps and other fishing gear entangle and subsequently kill fish needlessly (i.e., "ghostfishing"). Although almost universally prohibited, explosives and poison are still used by some fishermen. Not only are many of the fish that are indiscriminately killed, wasted, but these practices may destroy habitats (e.g., coral reefs). Finally, the risk of oil and fuel pollution from accidental spills increases with intensified fishing activity.

7. Fisheries are subject to a wide variety of environmental impacts caused by human activities. Man's impact on the condition of the oceans, which still are in reasonably good condition, is limited. Substantial man-induced resource degradation is evident, however, in freshwater and coastal systems.

8. The effects of inland water resource management and land use are apparent both locally and downstream, often all the way to coastal ecosystems. Land use changes in the watershed, such as clearing of forests and increased agricultural activity, often will affect the quantity and quality of water entering surface waters which in turn have an impact on aquatic populations. The construction of dams and reservoirs, irrigation schemes, and flood control measures interrupt the pattern of seasonal flooding necessary to many fish for breeding and growth, change seasonal flow patterns, alter water quality, and disrupt or destroy fish habitats. (See the following sections for more information: "Dams and Reservoirs"; "Flood Protection" and "Irrigation and Drainage.") Losses to riverine and floodplain fisheries caused by dam construction, however, can be compensated, at least in part, by the reservoir fishery which is created.

9. Pollution of river, lake and marine waters by sewage, industrial effluent, acid rain and agricultural chemicals can reduce the survival rate of aquatic organisms, contaminate fish and shellfish, and create human health problems. Eutrophication from nutrient-rich inputs, such as fertilizer runoff, domestic detergents and untreated sewage effluent, can lead to mass fish mortality or gradual decline in fish populations, changes in species composition, and algal and phytoplankton blooms which foul nets and may be toxic to humans. Another source of pollution is non-biodegradable debris (e.g., plastic materials), which is increasing in quantity and becoming a serious hazard to fish which ingest the material or are entrapped by it.

10. Coastal ecosystems, including estuaries, mangrove swamps, seagrass beds, salt marshes and coral reefs are highly productive fishery habitats and play important protective roles against waves and high tides from the sea and flooding and sedimentation from the land. Many areas are being damaged or destroyed by the

effects of accelerated settlement and economic development on the coastal fringe. Coastal development activities often affect runoff and cause silting and sedimentation of breeding grounds, coastal fishing areas and coral reefs. Dredging, land reclamation, drainage of wetlands and destruction of mangroves can directly or indirectly destroy important breeding and nursery grounds for fish. Oil pollution from offshore oil exploitation and naval traffic can foul nets, taint or kill fish, and spoil aquatic habitats.

Culture Fisheries

11. Aquaculture and mariculture projects, by manipulating natural systems, inherently have more significant possible environmental impacts than capture fisheries. Pond culture should receive attention.

12. The most obvious effect is the clearing of land and establishment of the ponds. This can be most destructive in coastal areas, such as in mangrove swamps and other wetlands which are particularly sensitive to disruption. The worth of these areas' production and protection functions is frequently undervalued and the importance of these areas to local economies underestimated. Extensive systems which involve large areas of ponds managed with minimal inputs are particularly destructive by virtue of the extent of land converted to ponds. Fish ponds established in inland areas are often established on flat, marginal agricultural lands of lower economic or ecological value. Nonetheless, ponds constructed on these lands may conflict with traditional uses of the land (e.g., seasonal grazing, livestock watering) which are of critical importance to local residents.

13. Fish ponds may have both positive and negative effects on local hydrologic conditions by altering water flow and affecting groundwater recharge. Ponds located in a natural stream channel, for example, can help reduce flooding in the immediate area, serve as a trap for sediments carried in runoff, and through seepage, raise local soil moisture. If located in an area subject to flooding, water diverted from the ponds by dikes could cause flooding elsewhere.

14. Water management in the areas affected by fish ponds is crucial, as fish ponds can reduce the water supplies available for competing demands, such as for irrigation, domestic or industrial use. Traditional drinking water supplies and washing areas can be disturbed when streams are diverted to aquaculture ponds. Local groundwater can be depleted by withdrawals for ponds. In general, the establishment of aquaculture ponds which draw on scarce ground or surface water supplies, particularly in arid areas, should be avoided except where fish production can be integrated with other water use (e.g., reusing pond water for irrigation, cage culture, in irrigation canals).

15. Pond drainage water can pollute nearby aquatic environments. The extent of pollution will depend on the quality of the pond water as well as characteristics of the receiving waters. The type and intensity of pond managementfrequency of water exchange, inputs of fertilizer and chemicalswill determine the quality of water in the ponds. Pond water is almost always more nutrient-rich than surrounding waters, but will be more so if fertilizers and feeds have been added to the pond to increase fish productivity. Chemicals used in the ponds (i.e., for pond sterilization, weed, insect and disease control, water quality regulation, and control of undesirable fish) can also contaminate local waters. The quality of the receiving waters at the time of release from the ponds, and their dilution and dispersion capabilities will determine the effect of pond effluent on the nearby aquatic environment.

16. Ponds often are stocked with larvae and juveniles captured locally. This can deplete wild populations of fish, and erode capture fishery operations in the area.

17. Other potential negative impacts of fish pond aquaculture arise from the use of exotics: negative impacts on the wild native species from the spread of disease and parasites by the exotic species or from escape of pond fish to the wild. Selective breeding also has a potential long-term impact by reducing genetic diversity within fish populations.

18. Lastly, ponds can increase the incidence of human disease in an area by providing habitats for water-borne or water-related disease vectors such as snails (schistosomiasis) and mosquitos (malaria, dengue and other arboviruses).

19. Although fish farming operations that involve raising fish in nets or cages have few potential negative impacts, they can cause problems if practiced too intensively. The concentration of pens may increase to such an extent that navigation is hampered, water circulation restricted, and water quality decreased. Similarly, rafts or pilings installed for the cultivation of nonmotile animals can cause navigational hazards.

20. The external impacts on aquaculture are similar to those affecting capture fisheries. These include agricultural, industrial, municipal or transportation activities that decrease water quantity, degrade water quality, and increase sediment loads in supply waters. Drainage from irrigated fields or runoff from other agricultural areas containing fertilizers and pesticides will also affect fish pond water quality.

Processing and Transport

21. The indirect impacts of fishery projects result from the processing and transport of fish and shellfish (see "Food Processing" section). The effluent from fish processing plants is high in organic matter (offal and blood), oil and grease, bacteria, nitrogen and suspended solids. Discharge of the effluent into waters that cannot adequately dilute and disperse the waste can result in anaerobic conditions and fish kills; increased turbidity which affects corals, seagrasses and other organisms settling out of solids which smother bottom dwelling organisms; oil and grease that cause ecological and aesthetic problems; and contamination of fish and shellfish.

22. Fish processing, which often requires large volumes of water, can compete with other demands on the water supply.

23. The processing and transport of fish in a large fisheries project may require substantial infrastructure development, including roads, port and harbor facilities, and power and water supplies (for icing and refrigeration. etc.). Such developments have their own attendant impacts and are discussed in more detail in the following sections: "Rural Roads"; "Electric Power Transmission Systems"; "Roads and Highways" and "Port and Harbor Facilities."

Special Issues

Socioeconomic Issues

24. The development of all fisheries must be concerned as much with proper management of the fish resource as with improving the welfare of, or avoiding negative socioeconomic impacts on, fishermen, fish farmers, people involved in marketing and seafood consumers. While fisheries development can have beneficial effects on human nutrition in an area, the growth of commercial fisheries which export fish to external markets may reduce the quality or quantity of fish available for local consumption by competing with local fishermen and destroying or degrading aquatic habitats. Traditional lifestyles, patterns of resource use and subsistence economies may be disrupted or subverted by the introduction of cash economies in rural development fisheries schemes. Finally, human health risks are posed by contaminated or spoiled seafood, or as can be the case with fish ponds, by creating a habitat for vectors of water-borne or water-related diseases.

25. Integrating both technical aspects and socioeconomic needs of fishing communities requires that the community actively participates in planning and execution of development activities. This improves the possibility that the fishery resource will be properly managed, as traditional methods often are found to be based on sustainable practices. It will also help assure that fishery resources are shared equitably between large and small-scale producers. Attention should be paid to ensuring that benefits accrue fairly to different

social groups and that middlemen do not erode fishermen's earnings. Also, to the extent possible, local labor should be given preference over imported labor.

Pond Fish Farming

26. Although in theory a promising enterprise, pond fish farming has had a high rate of failure. The most common causes of failure are poor siting and improper pond management. Poor siting can lead to problems with soil, water supply, drainage, and conflicting land use practices. The most important issue in management is flushing or exchange of pond water which must be done frequently enough to prevent the deterioration of water quality in the pond.

27. These factors are especially important for ponds located on coastal wetlands, whose previously waterlogged soils (if rich in pyrite and organic matter) can form acidic conditions when exposed to air or highly oxygenated water. Production decreases when the pond water becomes acidic or its quality deteriorates in other ways. In extensive areas of coastal wetlands (e.g., mangroves, tidal marshes) where the impression is that land is "unused" and therefore available, more land may be cleared for ponds when the existing ones become unproductive. The cycle begins again in a syndrome called "shifting aquaculture". Such pond operations not only are uneconomical, but economically unjustifiable, for the productivity of the ponds often proves to be lower than that of the natural ecosystem which has been lost.

28. Institutional factors also affect the success rate of pond fish farming projects. The private sector has been proven to be more successful than governments in this area. Where fish farming is judged to be economically feasible, efforts should be made to encourage private enterprises to invest.

Introduction of Exotics

29. The introduction of exotic species for fish farming or capture fisheries is a controversial practice. Not only have introductions or transplantations been less successful than anticipated, but they may have a net negative effect. Introducing exotics into new environments almost always poses the risk of competition with and predation on the indigenous species. Although exotics are introduced to increase fisheries productivity, they may be responsible for a net loss in fishery production by reducing populations of native species. In addition, exotics have the potential for introducing diseases and parasites into the local aquatic environment. In general, the introduction of exotics should not be advocated for capture fisheries, and should be done only with extreme care and only after precautions are in place in fish farming operations.

Project Alternatives

30. The main alternative to launching a new fisheries project is to improve the efficiency of existing fishery operations. In some places post-harvest losses due to spoilage are very high, particularly in traditional/artisanal and small-scale fisheries located in remote rural areas without infrastructure facilities for handling, processing, storage and marketing of the catch. In addition to reducing post-harvest losses, measures can be taken to salvage fish now discarded and intensify use of all fish by developing new products and expanding markets.

31. An alternative to pond aquaculture in coastal areas is to develop ways of utilizing the natural productivity of the intact ecosystems (e.g., mangroves, salt grass marshes) instead of converting them to pond production. Intensive aquaculture (e.g., oysters, mussels, clams, scallops) using the natural environment account for more than 50 percent of total production in volume (not in value). This type of approach may prove very valuable where pond aquaculture is a too sophisticated technology.

32. Within a given project there are a number of options for its design and implementation which can reduce ecological, social and economic problems. They are as follows:

(a) Culture Fisheries

. Procedures and techniques: native vs. exotic species; stocking from wild or hatchery organisms; extent of use of fertilizers, feeds and chemicals; harvest methods such as seining and pond draining; marketing methods; selling fresh vs. preserving; preservation methods such as icing, freezing, drying, salting, and smoking. : . Siting: location, design, and size.

(b) Capture Fisheries

. Procedures and techniques: number and size of boats; fishing methods and equipment used; catch goals; fishing areas; marketing methods; preservation practices.

Management and Training

33. Most coastal governments have formulated fisheries policies and development plans, but achievement of successful fisheries development is difficult. This is due to the following factors:

. it is difficult to predict the size of various fish stocks targeted by capture fisheries due to natural fluxes in population size;

. sound management of the resource requires reliable statistics on fishery stocks and catches over time, involves expensive scientific programs, and requires effective enforcement of plans and regulations;

. there are many conflicting demands on freshwater and coastal aquatic environments which must be balanced by governments;

. land and resource practices outside of the jurisdiction of government fisheries agencies have profound effects on the fishery resources;

. coordination between governments and local communities is often weak, and where national government policies conflict with local views, needs and customs, the policies are difficult, if not impossible, to enforce;

. collaboration between governments in the management of stocks which cross national boundaries is difficult; and

. national governments are unprepared to take over the authority and complex responsibilities outlined by the Law of the Sea legislation, and other laws protecting individual species.

34. Multidisciplinary approaches essential for planning the optimal use of inland water, coastal or near-shore habitats, choice of technology, prevention of pollution, and reduction of conflicts with other sectors such as agriculture and industry, will require integrated planning. Coordination with other line agencies, local water pollution control agencies, and the appropriate agencies responsible for conservation of critical coastal ecosystems is essential. Intersectoral approaches should be explored at the earliest possible stage in project preparation to identify potential issues and conflicts so that mitigagation strategies can be proposed. It may be impossible to satisfy the interests of all parties involved under a national fisheries law or government venture agreements. Negotiations must be conducted on a continuing basis. It is essential that an institutional environment be fostered in which competing interest groups may reach mutually acceptable and enforceable compromises.

35. Knowledge of existing law and socioeconomic norms which regulate individual and community property and use rights to fishing grounds within a project area are fundamental to project design. National fisheries laws and joint venture agreements for fisheries should contain provisions that would help achieve resource management objectives and protect the environment. Any or all of the following detailed provisions would best be determined at the time of project design: number and size of boats, authorized fishing areas, catch

quotas, fishing methods, and catch limits. In some instances, new regulations may be needed to protect habitats or community rights of access to certain fishing grounds.

36. Appropriate project design for fisheries that factors sound management and development of the resource require a range of skills in biology, ecology, economics, law, and engineering. Many of these skills are lacking in developing countries, requiring sufficient institutional support, both at the local fishermen level and within the government agency responsible for the sector. Provision of skills through technical advisory services, technical and managerial training to develop capacities at all levels, and pilot or research components to determine appropriate management of the stocks or pond culture in question may be required.

Monitoring

37. Factors to be monitored include:

(c) Capture Fisheries

. water quality (including pollution and oil spills) . fish stocks (population size and structure) . fish landings . conformance by fishermen to regulations on equipment use, fishing areas, catch, fishing seasons . presence of any discarded materials causing "ghostfishing" . effects of land use or water management on water quality and fishery resources . condition of non-fish species, especially indicator species (those most susceptible to changes in water quality) . contamination of fish or shellfish or presence of conditions which could lead to contamination (e.g., red tide, oil spills) . condition of coastal zone habitats (mangroves, sea grass beds, coral reefs)

(d) Culture Fisheries

. water quality in fish ponds or water bodies containing traps, nets or attachment substrates for nonmotile organisms . water quality of fish pond effluent . water quality and quantity of fish pond receiving waters . hydrologic effects of fish ponds . effect of aquaculture on local capture fisheries (population size and structure, health condition) . presence of fish diseases or parasites . contamination of fish or shellfish . increase in water-borne or water-related disease vectors or human disease attributable to fish pond establishment

(e) Processing

. water quality of influent to and effluent from fish processing plants . changes in commercial and non-commercial (especially indicator) species down-stream of processing plants

FLOOD PROTECTION

1. Flood protection includes both structural and non-structural means to provide protection from floods or reduce the risks of flooding. Structural flood control measures include dams and reservoirs, river channel modifications, dikes and levees, overflow basins, floodways and drainage works. Non-structural measures include regulation of floodplain uses through zoning, floodplain regulations, building and sanitary ordinances, and regulation of land use in watershed areas.

Potential Environmental Impacts

2. Except for unusually severe flooding, ecosystems, and in many areas, human communities, are adapted to and rely on periodic inundation of the land. Flooding usually becomes a problem only when natural events or human activities increase flooding intensity or frequency, or man invades flood-prone areas with structures and developments that need to be protected.

3. The major potential environmental impacts of structural flood control measures arise from the elimination of the natural pattern of flooding and the benefits flooding confers. Floodplains are productive environments because flooding makes them so; flooding recharges soil moisture and replenishes the rich alluvial soils with flood deposits of silt. In arid areas flooding may be the only source of natural irrigation and soil enrichment. Reduction or elimination of flooding has the potential for impoverishing floodplain (recession) agriculture, natural vegetation, wildlife and livestock populations on the floodplain, and floodplain and riverine fisheries which are adapted to the natural flood cycles. To maintain the productivity level of the natural systems, compensatory measures have to be taken, such as fertilization or irrigation of agricultural lands, rangeland improvement, or intensified fisheries management and production systems. In addition, when channelization measures reduce the frequency of flooding, the sediments entering the river systems from watershed areas upstream will be passed to the mouth of the river unless overflow areas are present downstream. Increased sediment loads in the river can cause physical changes through sedimentation and altered water flows in the estuary, delta or nearshore coastal areas, and affect rich fisheries supported by these ecosystems. Coral reefs, particularly sensitive to increased sediment outflow from rivers, can be irreparably damaged. (A list of flood control measures is provided in Table 8.4 at the end of this section).

4. The function of dams and reservoirs in flood control is to reduce the peak flows entering a flood prone area. Reservoir operation for flood control is distinctly different than that for hydroelectric or irrigation use. Rather than maintaining high water levels for increased head or sustained water supply for irrigation, flood control operation requires that water levels be kept drawn down deliberately prior to and during the flood season in order to maintain the capacity to store any incoming floodwater. The eventual release of water, however, may pose problems. Instead of being flooded to a greater depth for a shorter period of time, some lands may be inundated to a much shallower depth but for a considerably longer period. This may not be compatible with existing agricultural systems. The environmental effects of dams and reservoirs, covered in detail in the preceding section, will not be discussed further here.

5. Structural flood control measures such as levees and channel improvements increase the capacity of a stream by increasing the size of the channel, increasing the velocity of flow, or achieving both simultaneously. Modification of the channel includes dredging to make it wider or deeper, clearing it of vegetation and other debris, smoothing the channel bed and walls, or straightening the channel, all of which help increase the rate at which water is passed through the system, thus preventing flooding. Straightening the channel by eliminating meanders also helps reduce the risk that water will breach the river bank on the outside of curves where the current is most rapid and water rises highest.

6. Channel modification can provoke a number of negative environmental impacts. Any measure that increases the velocity of flow increases the erosive capacity of the water. Problems of erosion and sedimentation can arise both on-site and downstream. Paving the channels reduces or eliminates all factors that retard flow, but the practice poses many aesthetic and ecological problems, including a reduction of groundwater recharge and disruption of aquatic populalations. Channel smoothing and clearing as well as dredging also have a great impact on aquatic organisms and fisheries by disrupting their habitats. Disposal of dredging spoils can create another set of problems. Although channel improvement can alleviate flooding problems in the treatment area, flood peaks are likely to increase downstream, thus simply transferring the problem elsewhere.

7. Artificial levees, improved natural levees and dikes increase channel capacity and contain all but exceptionally high floodwater in the channel. As with channel improvement measures, however, these structures tend to pass floodwater on to downstream areas which in turn suffer or are forced to spend public funds to implement flood control measures themselves. Dikes built on the floodplain to exclude water from certain areas affect the hydrology of the area, and can have impacts on wildlife and livestock habitat and movement.

8. Overflow basins usually are swampy areas between river levees and valley sides. Artificial basins, into which floodwater is diverted, can also be constructed. On-site detention basins, or small impoundments,

used most often near urban areas to intercept and collect runoff before it reaches the stream channel, are also effective in reducing peak flows. The basins have a positive impact in recharging groundwater aquifers and settling suspended sediments which would flow into the channel. They can, however, provide habitats for disease vectors.

9. Floodways (also called high-flow diversions or spillways) are natural or man-made bypass channels or conduits that redirect waters around or away from urban centers or areas of high population density. Further downstream the water can be re-diverted into the river from which it originated.

10. Flood-control structures are costly to build. They also give a false sense of security because people think that the risk of flooding has been eliminated rather than diminished. This may encourage them to increase development on the floodplain with disastrous results in the event of an unusually high flood or if control structures fail.

11. In addition to the impacts of flood control structures on the environment, the environmentally-related factors affecting flood control should be considered. Not only do infrastructure or other developments on a floodplain expose themselves to risk (depending on their vulnerabilities), but they increase the risk of loss or damage to neighbors or others in downstream communities. Buildings, for example, can increase flood heights and velocities by obstructing the flood flow, reducing floodplain storage capacity, and increasing runoff.

12. Natural events such as fires, windblows or changes in a river's course, affect flood flows. Human activities in the watershed, such as cutting of trees in forestry activities or in clearing for agriculture generally will increase run-off, as will hillside agriculture without adequate terracing or planting on the contour. Paving land in the watershed and on the floodplain will also increase run-off, and installing storm drainage systems will increase the quantity and rate at which rainwaters enter the river system.

Special Issues

Non-Structural Measures or Regulation of Floodplain Use

13. Non-structural flood control measures aim to prohibit or regulate development on the floodplain or watershed areas or floodproof existing structures, to reduce the potential for loss from flooding. As true of any preventative measures, these are less costly than treatment (i.e., installing structural flood control measures). Nonstructural flood control measures are essentially environmentally beneficial in that they do not attempt to regulate the natural flooding pattern of a river. The current philosophy among many planners and policy makers is that it is better to maintain undeveloped floodplains as natural overflow areas. Where existing development on a floodplain exists, however, non-structural flood control must be used in conjunction with structural measures.

14. Zoning is an effective means of controlling floodplain developpment. Zoning the land for such things as agriculture, parks and conservation areas is compatible with floodplain protection, and prevention of land uses which are vulnerable to flood damage. As wetlands have a natural function in flood control, zoning to prohibit activities in wetlands that will reduce their storage flood capability is particularly important.

15. Regulations in zoning ordinances can prohibit or specify the types and function of structures that can be built on the floodway and flood plain to minimize flood risk. For example, the disposal of sewage, toxic and other harmful materials can be prohibited, floodproofing of structures required, and construction of buildings and private roads, that may exacerbate the effects of floods, not allowed.

16. Sanitary ordinances and building ordinances can make further specifications on floodplain management. Sanitary ordinances reduce the risk of health problems which could arise from contamination of water supplies when sewage disposal systems are disrupted by flooding. The ordinances can prohibit the installation of soil absorption systems (e.g., septic tanks, absorption fields, etc.) or require that a permit be

obtained prior to installation. Building ordinances can specify structural requirements of new buildings to reduce their vulnerability to flooding, reduce health and safety hazards to occupants (e.g., regulations on electrical wiring and floor elevations), and minimize the extent that the building will impede flow of floodwaters.

17. The ability to apply non-structural flood control measures implies control of land use, and thus is an institutional issue. Nonstructural measures can be only as effective as the government is capable of designing and enforcing sound land use.

18. Finally, various actions can be taken which will help decrease or delay runoff and increased infiltration, and thus reduce the risk of flooding. These include watershed management activities (e.g., increasing vegetative cover, particularly on slopes, improving agricultural practices, implementing gully erosion control measures, etc.), planting of vegetation along river banks to help contain and reduce flooding, and protection of, or restriction of, use of wetlands which have a natural flood control effect.

Social Issues

19. The primary social issue related to flood protection is the unequal distribution of benefits received and costs incurred for the populations affected by flood control measures. In cases where traditional uses of the floodplain for fisheries, agriculture or livestock herding dependent on the natural flooding cycles are disrupted by flood control measures designed to protect other communities (often urban), the rural dwellers frequently are not adequately compensated for the losses incurred.

20. Floodplain dwellers also are those most affected by increased flooding due to changes in land use by others upstream, yet they generally have the least power to enact change or to compel government to intervene on their behalf.

Determination of Floodplain Extent and Frequency of Flooding

21. In order to evaluate flood risk, the probability of floods of various magnitudes on a site must be calculated. The following information is needed:

. the annual peak discharge (maximum rate of flow in a given year) of the river at the site; . the recurrence interval of various peak discharges (the average interval of time at which the peak is likely to occur); and . the peak stage or water-surface elevation (or physical limits of inundation) for each particular discharge.

22. As statistical data on peak discharges (a record of a minimum of 10 years is needed) and the extent of inundation with various discharges are often unavailable, historical information from local residents, local records, and geologic analysis of alluvial deposits can be gathered to help determine the periodicity and extent of flooding in an area. Maps then can be drawn up showing areas that are susceptible to flooding. These maps are useful for developing land use plans and regulations for the area.

Project Alternatives

23. Two options may exist for minimizing structural measures which are disruptive environmentally:

. revise operations of existing dams and reservoirs upstream to provide at least partial alleviation of flood risk; and . use non-structural means, to the extent possible, to reduce flooding risk.

24. When flooding intensity and frequency increases due to maninduced changes in the watershed, non-structural solutions (e.g., revegetating cleared areas, contouring and terracing, tree planting along river levees, reducing access to the area to reduce population influx) can be emphasized. Where flood control is needed to protect existing structures, there may be no alternative but to installing structural protection

measures. In this case, the options lie only in the choice of measures, their installation and management to minimize negative environmental impact.

Management and Training

25. The public authority over watersheds and floodplains is divided hierarchically between local, regional and central government, may be shared among government units of equal rank but responsible for different jurisdictions through which the river flows, and finally may be diffused among various functional or operational agencies. The more diffused the administrative structure, the more difficult it will be to achieve the necessary coordination between the technical disciplines and between functions and policies.

26. The adoption of a comprehensive approach to water management calls for a wide variety of professional skills in the planning and policymaking process. In addition to inputs from engineers, economists, and land use planners, contributions are needed from various natural scientists (e.g., geographers, agriculturalists, foresters, livestock and range experts, fisheries experts, ecologists) and social scientists. The involvement of such a large number of specialists poses a challenge for the organization of flood control management.

27. The government unit(s) responsible for flood control must have the planning and regulatory capability to:

. determine the causes, frequency and extent of flooding . determine the actual or potential effect of various types of development on flood levels . plan, install or implement required structural and non-structural means for flood control . implement a flood warning system . determine areas that are flood prone and take measures to prevent developments that will create a flooding risk . monitor changes that alter flooding risk and also the effects of flood control measures . coordinate plans and activities with other agencies responsible for activities in the watershed

28. Where these capabilities are weak, training in technical, administrative, regulatory and community development skills is needed.

29. As already discussed, the ability to apply non-structural measures is largely an institutional issue. The government agencies responsible for flood control must design control measures, particularly non-structural ones, that are appropriate to local conditions. The successful adoption of flood abatement measures often hinges on the interest and support of local communities, and their ability and willingness to change patterns of land and resource use. A public information campaign may also be a necessary part of a flood control program. In remote areas where the government's influence is weak, local level action can be stimulated by working with traditional power structures and community organizations to encourage necessary change. The government must foster increased coordination and cooperation with these groups when the links are weak.

Monitoring

30. Factors which influence the quantity of water entering and being withdrawn from the river, the land's capacity to absorb floodwater, and the potential damage from floods must be monitored in order to carry out proper planning for floodplain management. Direct and indirect impacts of flood control works should also be closely followed. Data to be collected in routine monitoring should include:

. quantity, intensity, timing and geographical distribution of rainfall and snowmelt . storm patterns . soil moisture conditions at various times of the year . stream discharge (including records of annual peak discharge) . storage, diversion and regulation of stream flows . changes in drainage and other factors that affect stormwater runoff . sediment content of the river water . sedimentation problems in downstream areas . changes in the river course and riverbed . demographic changes in the floodplain and watershed areas . rural and urban land uses (controlled and uncontrolled land use change on the floodplain and watersheds of the river) . socioeconomic impacts resulting from the project (including changes to pre-project agricultural,

pastoral, fishing practices) . effects of flood control measures on riverine, estuaries or near-shore marine fisheries . effects of flood control measures on floodplain vegetation . effects of flood control measures on wildlands, wildlife habitats and wildlife populations

NATURAL FOREST MANAGEMENT

1. Natural forest management can have several different goals: production of timber and other forest products, watershed protection, and conservation of biological diversity. The focus here will be on projects or project components involved with timber exploitation and the environmental impacts of logging, but management for other products and various agro/sylvo/pastoral systems will also be discussed briefly. The impacts of processing, conservation management, and plantations and reforestation are examined in the following sections of the Sourcebook: "Pulp, Paper, and Timber Processing"; "Wildlands"; and "Plantation Development/Reforestation."

Potential Environmental Impacts

2. Proper management of natural forests can and should support sustainable production of a range of wood and non-wood products, preserve the forests' capacity to render environmental services, conserve biological diversity, and provide livelihoods for various people (including indigenous forest dwellers or tribal peoples who represent endangered cultural assets). Many forest types can provide a continuous supply of timber and other commercial products indefinitely if managed properly. Maintaining an area under forest cover controls erosion, stabilizes slopes, moderates streamflows, protects aquatic environments, maintains soil fertility, preserves wildlife habitat, and provides non-wood forest products important to local economies and households. Sustained harvest of forest products can provide the economic incentive to help prevent conversion of that forest to more destructive land uses and relieve pressure on other forests which are best left undisturbed or under low-impact resource use.

3. If badly managed, however, or cleared for conversion to other land uses, such as agriculture and cattle ranching, a forest can be degraded to secondary forest growth, scrub or wasteland. Poor forest management can increase erosion and siltation of water bodies, disrupt hydrology resulting in increased flooding, water shortages and degradation of aquatic ecosystems, diminish genetic resources, and intensify socio-economic problems. (See Table 8.5 at the end of this section for a list of all potential impacts and recommended mitigating measures.) The most dramatic impacts arise from clearcutting forests, while the impacts of other activities disrupting ecological processes or changing the character of the forest are subtle yet significant. Large-scale clearing can be a direct or indirect result of forestry (i.e., timber extraction, construction of logging roads) and non-forestry activities, such as infrastructure development (e.g., dams and roads), resettlement programs, and agricultural projects (crops and livestock). Less dramatic impacts can result from low intensity forest land and resource use, including: selective harvesting of various tree species, agroforestry, small-scale livestock operations, fuelwood cutting and collection of other forest products. These activities may not radically alter the quantity of vegetation, or vegetation cover, but can change the quality of the forest by affecting species distribution and composition and ecological processes.

Timber Harvesting

4. The Bank leaves the decision of timber harvesting to others. Specifically, the Bank does not finance logging in tropical forests. The new policy is expected in May 1991. The major direct impacts of timber harvesting result from both the effects of reducing vegetative cover and the physical impacts of logging operations. The degree of impact will be determined by site conditions (e.g., soil, topography, rainfall), ecological characteristics (e.g., forest type, stand density, wildlife species and numbers present), and harvesting and extraction methods. The following discussion of impacts is necessarily only general in scope.

5. Timber harvesting directly impacts water resources. Surface runoff increases after harvesting, leading to larger and more rapid storm surges in rivers. Decreased infiltration and groundwater recharge, and increased

evaporation and storm runoff in the wet seasons affects baseflow and thus lowers streamflow in drier periods. Increased erosion increases sedimentation in rivers and lakes. Stream crossings for logging operations cause direct sediment increases. Felling trees that shade riparian areas increases water temperature. Floating logs down the river for transport, and improper disposal of slash increases the quantity of organic matter entering a stream will alter water quality and can cause oxygen depletion and problems with eutrophication. Fuels, lubricants, pesticides and other substances used in forestry operations can pollute surface and ground waters.

6. Logging also affects climate and air quality. The main localized air quality problems associated with logging operations are dust and smoke. In semi-arid or seasonally dry areas transportation equipment can generate unhealthy quantities of dust, and the soils, exposed after removal of trees and burning, are more susceptible to wind erosion. Smoke from slash burning can cause severe air pollution problems. The accumulation of slash after logging also increases fire. Removal of vegetation results in localized micro-climate changes, and large scale logging operations modify regional temperature, humidity and air circulation patterns. Deforestation, by increasing levels of atmospheric carbon dioxide, a greenhouse gas, significantly contributes to global warming (see "Atmospheric Pollution" section).

7. Land form, slope orientation and grade, and logging practices determine the extent of environmental damage caused by harvesting. Erosion, soil degradation, slope stability and increases in soil temperature are primary concerns in logging operations. The potential for declines in soil fertility after logging is greatest in moist tropical forests whose soils are characteristically nutrient-poor and highly leached. Nutrients are maintained in the intact system by rapid cycling between the vegetation and soil. Dead organic matter is rapidly decomposed and the nutrients taken up quickly by vegetation and soil organisms. Uncontrolled or clearcut logging disrupts this process by removing biomass in which most of its nutrients are stored, and by disturbing soil micro-organisms. Clearing of vegetation cover, thus exposing soils to direct sunlight and higher temperatures, changes populations of micro-organisms and alters decomposition and nutrient transfer. Poorly located or constructed roads on slopes cause land slips, landslides, erosion and sedimentation.

8. The long-term sustainability of tropical timber harvesting is controversial. Deterioration of harvesting sites caused by nutrient depletion and soil degradation (from removal of vegetation and impacts on soil structure and fertility) may not be detectable for hundreds of years in long rotation harvesting systems, so assessing the risk in most existing (selective) harvesting systems is very uncertain. The International Tropical Timber Organization (ITTO) concludes that sustainability is achieved on less than one percent of managed tropical forests. The 1990 Tropical Forest Action Plan (TFAP) review has recommended that forestry projects be halted until sustainability becomes achievable.

9. Harvesting imposes wider ranging impacts on the vegetation than simply the removal of target trees. In the process of logging, other trees and vegetation on the site are damaged or destroyed by falling trees, skidders and other vehicles. The number of non-target trees lost can be higher than that of harvested trees, particularly in selective harvesting systems. Selective removal of the best trees can lead to genetic erosion of the species in the area. If specimens are not left on the site as seed trees, or the seed trees do not survive the shock of forest disturbance, regeneration of the species is jeopardized. If a cut is large, regrowth will not restore the character of the original forest, at least for a long time. This is particularly true in moist tropical forests where natural regeneration of certain species is problematic. In diverse forests where interspecific relationships are complex, the removal of some species, even if carried out with low-impact selective harvesting, can have negative impacts on several other species ecologically linked to them. If harvesting creates large gaps in the canopy, windblows can destroy large areas of natural vegetation.

10. Logging in mangrove swamps can be particularly destructive both to the forest itself, which is a finely balanced system sensitive to change, and on adjacent areas protected by the swamp. Mangroves are highly productive coastal ecosystems which offer physical protection to the land from the sea, and protection of in-shore waters from negative impacts from the land (e.g., increased fresh water flow, increased siltation). Timber harvesting in mangrove swamps can be sustainable; but if it is not managed properly, it can result in

the destruction of the swamp itself, which is valuable for its wood, fish, crab and shellfish production, and its protective functions.

11. Logging affects wildlife by the destruction of habitat, cutting up of migration corridors, increased poaching pressures, problems of noise and pollution, and hydrologic changes affecting aquatic systems. Again, the impacts can be magnified in moist tropical areas where habitat disruption can set off a ripple effect ultimately affecting a large number of species.

Logging Camps and Logging Roads

12. Construction of logging camps creates a number of environmental problems common to any construction activity, and social problems common to any project involving an influx of population, often of different ethnic, social or economic group from one another and from the local population. The fact that logging of natural forests takes place in remote rural areas where the native population have been isolated from outside forces, heightens the impact.

13. Logging roads create some direct impacts (see "Rural Roads" section), but more important are the indirect effects of such roads. When roads penetrate into remote areas, uncontrolled in-migration of people in search of land for farming or other resources is almost inevitably stimulated. The resulting land use changes often are unsustainable due to the intensity of land use or land uses inappropriate to the environment. Increases in population overload existing infrastructure and social services, such as housing, schools and health facilities, and may cause conflicts over land and resource use rights, racial tensions, and a range of other social problems (see "New Land Settlement" section in Chapter 3).

Management of Secondary Forests

14. Secondary forests, those resulting from cut-over primary forest, could be managed for production and thus reduce pressure on natural forests. These forests generally have better access from population centers than remote areas of natural forest, and may be as productive as plantations without the initial investments. Bringing these forest areas into production can be easier and less environmentally destructive than logging natural forest stands and may be as economically rewarding. Managing secondary forests should be explored as an alternative to harvesting areas that have not been disturbed.

Management for Non-Wood Forest Products

15. Non-wood products represent a largely ignored commercial resource that can generate revenues exceeding those from timber products with a lower capital investment. Latex, oil-seeds, resins, fruit and rattan are non-wood products with well developed markets of high value. Nuts, tannin, medicines, fibers and other "minor forest products", often important in local economies and for household use, may be developed for larger commercial markets. Developing production systems, markets and marketing mechanisms is often difficult; but when successful, it offers a means of sustainable forest utilization with reasonable economic returns and low environmental impact. Loss of the potential of obtaining non-wood products should be considered an opportunity cost of logging natural forests. A potential problem of managing for non-wood products is that once markets are established, demand may rise faster than supply, resulting in the destruction of the resource.

Sustainable Agricultural/Livestock Management

16. Shifting cultivation (also called slash-and-burn or forest fallow) is an ancient form of land use practiced in both moist and semi-arid forest areas. It is a sustainable practice with minimal negative impact on the forest ecosystem if the clearings are small and widely dispersed, and the fallow period between cultivation long enough so that the land can recover. If the fallow periods are too short, a consequence of increased population pressure, the sites deteriorate. Other systems, such as taungya, in which agricultural crops are

grown in association with trees until the trees dominate the site, are also successful. Such systems require a stable population so that cultivation does not become intensified to an unsustainable, destructive level.

17. Attempts to integrate forestry with livestock have very mixed results. The quality of the site and intensity of development are critical. Livestock pressure must be low enough that the forest resource is not unacceptably degraded. Clearing tropical forest for cattle ranching in the moist tropical lowland forests, such as in Central and South America, has had disastrous effects, and overgrazing in semi-arid forest areas is a common problem. (See also "Livestock and Rangeland Management.")

External Impacts

18. A number of external forces can result in the deterioration or destruction of the forest ecosystem. These include the flooding of land behind a dam to form a reservoir (see the section on "Dams and Reservoirs"), clearing of forest lands for cattle ranching (see "Livestock and Rangeland Management" section), intensive slash-and-burn agriculture, and conversion to commercial agriculture (e.g., rubber, oil palm, coffee, rice and cacao).

Special Issues

Moist Tropical Lowland Forests

19. The rapid deterioration, if not outright destruction, of many areas of moist tropical lowland forest, which are characterized by high species diversity and ecological complexity, and the difficulties in managing them sustainably are issues of concern worldwide. While conservation of these unique forest areas by establishing parks and reserves is potentially the best way to protect their biological diversity, ecological processes, and the lifestyles of indigenous forest dwellers, only limited areas can be protected in this way. Economic pressures and population growth are intensifying once-sustainable land-uses (e.g., shifting agriculture) to unsustainable and destructive levels, motivating clearcutting logging operations, and driving the conversion of forest lands for large-scale agriculture and cattle ranching, which generally prove to be unsustainable and permanently damage the forest ecosystem. Management of natural forests for sustainable production of timber and other products to yield important financial returns is one of the most suitable ways to protect forests from conversion to other production-oriented activities while conserving much of their environmental values.

20. The two critical issues in moist tropical forest management for timber production are: (a) the development of sustainable timber management systems, and (b) the implementation of these systems in such a way that the other values of the forest are not reduced to unacceptable levels. In theory, moist tropical forests can provide a continuous supply of forest products indefinitely. In reality, however, few systems exist which have proven to be sustainable or which apply to most of these forest areas. Most of the existing sustainable forest management systems apply to natural forests of a limited number of species. Because of this and economic pressures forcing the generation of quick income from the forest, at present only a very small proportion of tropical moist lowland forests under commercial timber exploitation are managed in a sustainable manner.

21. The most suitable forest management system in moist tropical lowland forests of high species diversity is selective harvesting in which only a small number of trees are extracted per hectare. If done carefully, with minimal damage to the soil and surrounding vegetation, environmental damage can be limited. Impacts on the forest's biological diversity and capacity to provide environmental services are minimized because large spaces in the forest are not created, as is the case with clearcutting. 0

Social Issues

22. Almost all initiatives that have an impact on natural forestswhether it be commercial logging, forest-based processing industries, conversion to other uses, other developments (e.g., mining, dam construction,

irrigation, industrial development), or closure of forest areas for rehabilitation or conservationraise important social issues. Development projects which clear forest areas for other uses can displace people or reduce their access to forest resources on which their livelihoods depend. Commercial logging can destroy resources locally important to subsistence economies and can open up areas to uncontrolled settlement, causing further environmental degradation and social conflict. Similarly, closure of forest areas for rehabilitation or conservation can reduce the income of surrounding populations by depriving them of important foodstuffs or income-generating products. Such closure can lead to greater degradation of adjacent forest areas by people seeking to find substitutes for the resources to which they have lost access. If pressures on the closed area are too great, the conservation or rehabilitation efforts may be unsuccessful.

23. Forest dwellers have considerable knowledge about the qualities, potential utilization, and sustainability of the local flora, fauna, and geologic resources based often on centuries of use. In uplands and arid and semi-arid areas where sources of fodder are often limited, management of forests and local systems of livestock production are usually closely linked; farmers often adopt mixed subsistence strategies in which livestock production based on forest use plays a major role. In the Himalayan region, the productivity of upland agriculture depends heavily on compost and mulching material collected from the forests. Hunting and gathering as well as subsistence slash-and-burn agriculture have been practiced sustainably in moist tropical forest areas for hundreds of years. Artisanal floodplain fisheries are important to populations in many lowland forest areas. The social organization of traditional groups generally is highly adapted to the demands of particular production systems. Both the technical and managerial knowledge of these resources can be very useful to technical specialists seeking to intensify or modify production in that or a similar area, i.e., adapting agricultural recommendations to areas presently under shifting cultivation, or developing forest management and utilization models for forest lands to be rehabilitated. When forest-dwelling groups are displaced, their indigenous technical knowledge of forest management and utilization is often lost. Careful assessment, including a realistic economic analysis, should be made before assuming that present uses of a forest overgrazing land should be abandoned for something "better".

24. Land tenure issues are almost always of concern in forestry projects. There are often overlapping rights for forest lands, which include state-recognized as well as customary tenure and/or systems of concessionary use rights to products. In the case of forest-dwelling ethnic minorities, there may be strong customary rights to forest lands that may be constitutionally valid despite subsequent transfer of authority over these lands to government. In many societies, rights to land and trees may be held separately, with specific rules for different species. Forest-dwelling groups often have complex tenure rules for forests and products. For example, rights to fruitbearing trees may be separate from those permitting individuals to put forest land to other uses, including shifting cultivation. Traditional tenure systems may be more appropriate to the management of fragile lands than state-promoted options.

25. Closure of forest areas or restricting access and use of resources affects various population groups differently. For example, landless livestock owners may be most harmed economically by closure of areas, since they, unlike landed farmers, cannot obtain substitute fodder from their own land. Women may have a much greater work burden because of the need to travel further to find substitute resources; yet this burden may not be identified by local people as a problem because of women's lower status in society. Migratory graziers may have their herding routes affected or be forced to overgraze other lands outside the project area which are still available to them, with negative impacts both for those lands and the sedentary groups dependent on them.

26. Planners increasingly are exploring ways to integrate the needs of local people into conservation and forest rehabilitation initiatives through promotion of common property resource management or systems of joint government/user management. It is important to document the existing local management systems, including those which have broken down under increased pressure. In areas of unique biological diversity, other measures have included the creation of buffer zone programs which generate alternatives for the people traditionally dependent on the area to be preserved or the design of conservation systems that allow for controlled utilization of the protected area by local people. A project in Mexico has upheld traditional rights to forests and provided technical support to cooperatives for wood processing industries. The

forestry plan for Papua New Guinea has a similar proposal for tribes with traditional forest ownership rights. A Bank project in Nepal involves the extensive rehabilitation of hill forests by strengthening the rights of local user groups to undertake protection and controlled utilization in consultation with local foresters.

Improved Wood Processing Technologies

27. Expansion of the utilization of forest products can help intensify forest management. Many species are not used for lack of processing and marketing infrastructure. In tropical forests of high species diversity, individuals of marketable species are often scattered widely over a large area, making harvesting difficult and often uneconomical. Logging may also be uneconomical in forests less diverse but in remote areas or of low stocking density. If new products from other species, a wide range of size classes were possible from improvement of processing or development of new markets, a greater proportion of the forest growth could be used. Not only is there a huge scope for developing new products, but conservation of existing supplies (e.g., developing more efficient veneers, wafer board and particle board and through utilization of logging wastes and waste recycling in processing plants) may help balance supply with demand and take pressure off natural forests. The benefits of these approaches are obvious, but so are the dangers. Increased use of a wider range of species may lead to more intensive exploitation of the forests, and if sustainable management systems are not first well developed, could result in large scale clearing or "mining" of the forest resource.

Project Alternatives

28. Alternatives to management of primary (and secondary) forest management for timber, non-wood forest products and extensive, low-impact agriculture and livestock production include:

. reduction of demand for wood through conservation, improved wood stoves and alternative fuels; . more efficient veneers, wafer board, particle board, use of waste wood and waste recycling; . increased use of forest species through expansion of processing technologies, and product and market development; . plantation development to increase production of wood forest products; . community forestry programs and tree planting by individual land owners for the production of wood products; . development of eco-tourism as a sustainable economic use of tropical forests; . encouragement of in-country processing to gain value-added benefits rather than promoting policies which maximize short-term timber harvesting; . full use of trees destroyed (and often wasted) by forest clearing for non-forestry activities (e.g., dams and reservoirs, road building, industrial and urban development, etc.); and . intensification of agricultural and tree plantation production on fertile soils or areas already cleared before opening up new forest areas to development.

Management and Training

29. Countries with large areas of natural forest should evaluate their forest resources and develop policies and plans that will protect areas important for their biological resources, watershed functions and cultural resources, and allow for sustainable production of timber and other forest products and for low-impact, sustainable agricultural production (agroforestry and livestock) in the intact forest. In addition, forestry institutions must plan and manage plantations, fuelwood production systems, agricultural activities on degraded forest lands, and community forestry efforts ("Plantation Development/Reforestation" projects are discussed in the next section).

30. The fate of forests depends only in small part on forestry policy. Forestry policy must be integrated and compatible with policies of other sectors that can affect forest landssettlement, agriculture, energy, industry, trade, infrastructure development and conservationand national economic, financial and social policies. Forests are also affected by international factors, chief among them are trade, aid and debt.

31. Driven by the need for income and foreign exchange, government forestry policies in some countries are founded on the principle of maximizing short-term monetary output from the sector. Shortsighted economic assumptions result in over-exploitation of resources, logging in unsuitable areas or improper forest management practices. Many tropical countries with large forest resources have granted harvesting rights

to concessionaires for rent, royalty or tax payments representing only a small fraction of the net commercial value of the wood. The problems are compounded by the awarding of short-term leases which impel concessionaires to begin harvesting at once and to clearcut, and by royalty systems inducing loggers to harvest only the trees of highest quality (while in the process damaging or destroying a great many others). There are often no regulations or enforcement of regulations concerning reforestation or minimizing negative environmental impacts from logging. The economic, fiscal, environmental and social costs of these practices can be enormous, with large losses of potential government revenues from forestry and sacrifice of rich biological resources.

32. Trade policies also fuel tropical deforestation. Industrial countries often are permitted to import logs from tropical countries duty-free or with low tariff rates. This acts to discourage them from developing their own timber supplies. In addition, raw logs are often exported from tropical countries. This represents a lost economic opportunity by forfeiting value-added benefits by processing the logs to lumber, poles, railroad ties, plywood, veneer or other products.

33. Forestry projects are dependent on long-term stable institutions that plan, manage and supervise activities. In many developing countries, however, forestry departments need strengthening; they are of low priority and suffer from a lack of trained personnel, shortage of operating funds, and weak research, extension and monitoring capabilities. Forestry training institutions are often absent or neglected. Forestry data generally is limited. Foresters, traditionally trained to protect forest reserves and manage them for industrial production, are often not prepared to manage forest stands for non-industrial use or deal with the socioeconomic aspects of forest management.

34. Government forestry institutions must have the capability to:

. establish forestry policy . coordinate with central government agencies responsible for other sectors and national policies which will affect forest resources . prepare forest management plans . undertake forest inventories and silvicultural research . regulate and tax exports and establish markets for forest products . designate, finance and oversee the management of parks and preserves . develop training, extension and public awareness-raising programs . plan transportation and other infrastructure related to forestry operations . ensure that population groups and local communities are adequately represented, and incorporate them into decision-making processes . promote appropriate technologies which stimulate local economies in the region and employ local labor . coordinate and cooperate with non-governmental organizations: 35. To increase the technical depth of and planning and management expertise of forestry staff, training may be needed in the following areas: (a) policy, regulation, marketing, economics, management, organization, accounting, personnel, contracts, evaluation, reporting, and conflict resolution; (b) technical skills in mapping, biological surveys and inventories, forest sciences, forest management, forest engineering, and environmental impact assessment; and (c) research, education and extension.: 5

Monitoring

36. Monitoring in forestry projects is extremely important to determine that management plans are being followed and that the forest stand treatments are achieving the desired results. Monitoring should ensure that:

. loggers, harvesters and road builders adhere to conditions set forth in their contracts designed to minimize environmental impacts; . harvesting and transportation do not create unanticipated environmental problems (monitoring of soil erosion, soil fertility, stream water quality, groundwater level, vegetation and wildlife changes); . changes in species and site conditions are identified and stand treatment prescriptions are altered as appropriate; . only designated areas are accessed and only the specified species and volumes are harvested; . natural regeneration after harvesting occurs as predicted (rate of cover restoration, rate of regeneration of various species); . objectives of the overall development project are being met and infrastructure to regulate and manage the project is adequate; . no unpredicted socioeconomic impacts occur and if so adequate steps are taken to mitigate them, and that a mechanism exists for community

organizations to monitor and evaluate the project and voice their concerns on a regular basis; . financial distributions are legal and according to contracts and these are adjusted in the event that social services are over-burdened or costs exceed predicted values.

37. Frequency of monitoring is dependent on site conditions, size and complexity of the project. Actual harvesting should be monitored at least weekly by a trained forester. A standard procedure for log inventory should be continuous, and regular auditing of revenues should be done by an impartial company. A periodic reassessment of environmental impacts should be done, with recalculation of costs and benefits and appropriate changes in the management plan should be made.

38. In addition, changes external to forestry operations that affect the forestry resources must be monitored. This includes environmental affects of other development activities and natural events as well as demographic changes in forest areas.

PLANTATION DEVELOPMENT/REFORESTATION

1. This category includes projects and project components which plant trees for production or for environmental protection. Forestry products include lumber, pulpwood, poles, fruit, forage, fibers and fuel. The scale of production ranges from large commercial plantations to community woodlots, to individual farmer plantings around houses or farm fields. Protection-oriented activities include planting trees for slope stabilization, sand dune fixation, shelter belts, various agroforestry systems, living fences and shade trees.

Potential Environmental Impacts

2. Plantations, reforestation on degraded lands, and social forestry plantings have a number of positive impacts resulting from goods produced and environmental services rendered.

3. Plantations offer the best alternative to logging natural forests as a means of satisfying demand for timber and other wood products. Plantations for timber production generally use faster growing species, and are easier to access and harvest than natural forests producing more uniform, marketable products. Similarly, communityoriented plantations for production of fuelwood and forage located near settlements can both facilitate users' access to these goods and at the same time help alleviate pressure on local vegetation leading to overcutting and overgrazing. Generally established on lands unsuitable or marginal for agriculture (e.g., on existing forest lands or on degraded areas), tree plantations represent a beneficial and productive land use which does not compete with uses of higher productivity.

4. Reforestation provides a range of environmental benefits and services. Reestablishing or increasing tree cover can increase soil fertility by improving moisture retention, soil structure, and nutrient content (by decreasing leaching, providing green manure, and adding nitrogen if nitrogen-fixing species are used). Where shortages of fuelwood have caused the use of animal dung for fuel instead of fertilizer for agricultural fields, fuelwood production indirectly will help maintain soil fertility. Tree planting stabilizes soils by reducing water and wind erosion on slopes, in adjacent agricultural fields, and on unconsolidated soils such as sand dunes.

5. Establishing tree cover on bare or degraded lands helps reduce rapid runoff of rainwater, thus regulating stream flow and improving water quality by reducing sediment inputs into surface waters. Cooler temperatures and moderated wet and dry cycles under trees provide a favorable microclimate for soil microorganisms and wildlife, and can help prevent soil laterization. Plantations have a moderating effect on winds and help settle dust and other particulates out of the air. Incorporating trees into agricultural systems can improve crop yields, by virtue of their positive effects on the soil and climate. Finally, the increased vegetation cover established by large scale plantation development and tree planting projects represents a carbon sink, a short-term answer to global warming caused by carbon dioxide build-up in the atmosphere.

6. Large commercial plantations have the potential for causing negative environmental impacts of considerable scope and magnitude. The worst impacts occur where natural forests are cleared for plantation establishment. Apart from systems practicing enrichment plantings or underplanting, the ground identified for a plantation generally is prepared by clearing competing vegetation. The negative impacts of site preparation includes not only the loss of existing vegetation and the ecologic, economic and social values it may have, but also environmental problems associated with land clearance: increased erosion, disruption of the hydrologic cycle, compaction of the soil, loss of nutrients, and a resulting decline in soil fertility. Although destructive, many of these impacts can be shortlived; the site starts to recover once vegetation cover is reestablished by replanting. (These impacts are summarized in Table 8.6 at the end of the "Plantation Development/Reforestation" section.)

7. Plantations are man-made forests whose trees are treated essentially as long rotation agricultural crops. As such, many of the negative environmental impacts inherent in agriculture are present in plantation forestry. The degree of impact depends in large part on site conditions prior to planting, site preparation techniques, the species planted, treatments during the rotation, length of rotation, and harvesting methods. Reforestation and afforestation activities, particularly in drier regions, can deplete soil moisture, lower water tables, and affect base-flow into streams.

8. Like any agricultural crop, plantations of fast growing, short rotation trees can deplete soil nutrients and decrease site fertility by repeated removal of biomass and disturbance of the soil. Although this also can be true of long rotation species, the effects are less obvious. Soil compaction and damage occur during site clearing (removal of vegetation through physical means or burning), mechanical site preparation and harvesting. Erosion can occur in plantations with incomplete canopy closure or limited undergrowth. Accumulation of leaf litter under plantations increases the risk of fire and decreases rainwater infiltration, and the dominance of one or two species in the leaf litter can change chemical and biological characteristics of the soil. Leaf litter of coniferous (e.g., pine) plantations can acidify the soil. 8

9. Some species are allelopathic, producing toxins which inhibit seed germination of other species. Irrigated plantations can compete with other demands for water and cause other environmental and social impacts common in irrigation projects (see "Irrigation and Drainage" in the next section). The return water from irrigated plantations in semi-arid areas may be saline, rendering it less useful for other purposes and degrading the quality of surface waters into which it feeds. Chemicals (pesticides and biocides) used to control insect pests and diseases, and fuel and oil used in forestry equipment can pollute surface and ground water and can be a direct health hazard for those that use them.

10. The indirect impacts of large commercial plantations include those resulting from road building for wood transport (see "Rural Roads" section) and from wood processing industries (see "Pulp, Paper, and Timber Processing" section in Chapter 10).

11. Tree planting as part of a social forestry program can take various forms, including village or community woodlots, planting on government owned land or along rights of way, and planting around agricultural fields, along streams and beside houses. There are few negative environmental impacts associated with such plantings. The trees provide useful products, and environmental and aesthetic benefits. The common problems occurring in these activities are social in nature (see discussion below).

12. Tree planting for protection purposese.g., shelter belts, windbreaks, slope stabilization, erosion control, watershed management, stream bank protection, sand dune fixation also are beneficial in essence, carried out for the purpose of providing environmental protection and services. If problems arise they are most likely to be social (e.g., land and resource tenure issues).

Special Issues

Use of Exotics

13. Plantations and conservation plantings are often established with exotic rather than native species. This is done because (a) the exotics chosen are faster growing than the native species or have more desirable characteristics for its end-use; (b) seed of the exotics is readily available through commercial sources; or (c) the growth and end-use characteristics of the exotic species are better known than those of the native species. Using exotics in an area for the first time always carries a risk. While the use of exotics has been very successful in many places, it has caused problems or unrealistically high expectations in others. An exotic introduced into a new environment does not always do as well as anticipated. This can be due to unsuitable site conditions at the margins of the species' ecological tolerance (i.e., rainfall, temperature); attacks of pests or diseases (sometimes devastating) to which the species has little or no resistance; and inadequate site preparation, planting and subsequent plantation maintenance.

14. Native species, although often more slow growing than exotics, generally have a longer-term viability; genetically selected and refined over the centuries, they are adapted to the ambient conditions and are thus better able to survive local climatic extremes and outbreaks of pests and disease. There have been cases where "slowgrowing" native scrubland vegetation has been cleared at considerable financial and social cost and replaced with plantations of "fastgrowing" exotics, which ultimately had lower productivity than the cleared native vegetation or than was justified by the costs. There have also been cases where the unpredictability of the species' performance in a new environment has resulted in the opposite phenomenon: overproduction. Exotics can become weeds, spreading from the planting site over the landscape, taking over in areas they are not wanted and becoming almost impossible to eradicate.

15. An exotic species (and various provenances of that species) should be well tested before it is used extensively in a new area. Particularly in protection plantings where rapid establishment and maintenance of forest cover are critical, fast-growing exotics should be interspersed with native species, which although may be slower growing, are more reliable on the long-term. Much more research is needed on the botanical and ecological characteristics and end uses of the many little-known tropical species. Much information can be gained through local peoples who are knowledgeable about the native vegetation.

16. An additional problem is that an exotic may not be acceptable locally for the end use for which it was planted (e.g., polewood, firewood). A species used widely in one place for fuelwood, for example, may not be suitable in another with different foods and cooking requirements. People's perceptions about the qualities of wood and other forest products can be culturally based and strongly imbedded. Prejudices against a species, for whatever reason, may die hard. Before a species is introduced into an area, its local acceptability must be tested.

Socioeconomic Issues

17. The socioeconomic benefits of large commercial plantations include employment generation (more jobs than in natural forest management but less than in agriculture) and often some improvements in local infrastructure and social services. As with timber harvesting operations in natural forests (see "Natural Forest Management" section), however, these have negative aspects, particularly in remote areas. These are problems related to the labor force brought in from the outside (overloading existing local infrastructure and social services, social and perhaps racial tensions, increased health problems, etc.); increased monetization of the economy; and, if the plantations result in the construction of roads, problems with unplanned population influxes and societal changes stemming from greater exposure to the outside world.

18. Local reforestation efforts, such as community woodlots and plantings around homesteads, can have many direct benefits for individuals and communities. Fuelwood projects can greatly reduce the time and effort involved in gathering fuel for cooking, making this time available for other activities. Planting for forage production can improve access to and availability of livestock feed which is particularly important in drier periods. Significant income can be derived from sales of wood, fruit, nuts, fibers or other products from the trees. The timing of tree cutting is somewhat flexible so it can be done to coincide with favorable market conditions or a time when the wood or cash is needed most. Community woodlots can provide short term employment for landless and poorer people in the community, mainly at the stages of plantation

establishment and harvesting. The relatively low labor and capital requirements of trees between the time they are planted and harvested are advantages to farmers planting trees on their own land. Because trees can be grown on marginal land unsuitable for farming or on small areas of unused land, they do not compete with other more valuable land uses.

19. Sizable plantings, either privately owned plantations for commercial timber production, community plantations for production of fuelwood or other products, or large scale protection plantings (e.g., watershed management and sand dune stabilization) can pose problems related to land tenure, and land and resource use rights. Programs planting on communal land often overlook or are unaware of the traditional rights of land use or right-of-way. Even protection plantings on degraded lands can cause social conflict. Even if land is degraded (and perhaps causing it), local people may be using it for fuelwood or fodder cutting, livestock grazing, or as a route for themselves and livestock. Planting trees on this land and restricting people's access to it, even if it is in theory to benefit these people, will cause local hardship if a suitable alternative is not provided in compensation.

20. A common mistake of plantation and reforestation projects is to overlook the diversity of wild foodstuffs (mushrooms, roots and tubers, greens, fruits and honey, nuts, condiments, edible oils, etc.) found in forests, grasslands, and uncultivated scrub areas along roads or near cultivated fields -and collected and marketed mostly by women. Particularly in arid and semi-arid areas, these foodstuffs can be key elements in household nutrition or as income earners in times of drought. Wild foodstuffs tend to be considered food of lower status as economies become more monetized and urbanized, or people more formally educated. The opportunity to increase the production and utilization of such products and the positive impact on food security is generally overlooked, even in plantation forestry projects that profess poverty alleviation and sustainability objectives. An environmental assessment needs to collect data on the availability and use of such foodstuffs over time by specific ethnic and economic groups in the project area and bring this information to the attention of planners.

21. Not only existing uses of resources, but future possibilities to generate a wider range of products, are overlooked. A common mistake in plantation projects that seek to take pressure off forest reserves is to focus plantation production on too-limited a range of products for local needs, with the result that people continue to exploit the forest areas. Production of raw materials for local income-generating enterprises is seldom attempted in large-scale Bank projects, because it is perceived as requiring too much institutional development to coordinate the needs of dispersed enterprises and therefore of low economic returns.

22. Ownership of the trees and the land on which they are grown is often a problem. In many countries all trees, planted or natural, officially belong to the government, which is a disincentive for reforestation. Also, planting on what is thought to be communally owned land, but which is in fact land to which certain people have rights, means that the products designed to be for the benefit of community members will be claimed by a limited number of people, often not the most needy.

23. A number of socioeconomic problems arise in "social forestry" projects because of the relative newness of these types of activities. Often neither forestry personnel nor local people are well versed in the skills required. Participatory social forestry activities must involve rural peoples in organized activities for producing and managing their trees or forest stands for their own benefit. Their participation cannot be assumed; the benefits and costs of participation must be clear to them and the obtainment of those benefits due them unencumbered. A profound behavioral change is called for in switching from the traditional gathering of fuelwood and other forest goods from natural forests to the cultivation of trees themselves.

24. Forestry personnel, generally trained in natural forest management and often charged with guarding forest stands from the people, often lack the confidence of the rural people as well as skills in communication and social systems analysis needed for the social forestry job. As a result many problems arise. Species are frequently planted because of seed availability and not end use or site suitability. Once plantations are established people do not know how to care for them, when to thin and harvest, or what to do with the trees when they are harvested. Plantations initially intended for one purpose may eventually be

used for another purpose, or not used at all because there has been no clear plan for their use. Often people who have spent generations cutting down trees to increase agricultural land do not understand the benefits of forestry projects that take land out of agriculture. Equipment for harvesting and transporting trees is often lacking.

25. Finally, there are a number of economic risks associated with plantation forestry. Markets for forest products are volatile, or may disappear during the long life of a single rotation. Political and economic conditions may change, which will alter priorities and allocation of funds. Fire, insects and disease can destroy an entire tree crop. If the market drops because of low demand, increased transportation costs, or flooded markets, there can be a net loss. Enthusiasm in a forestry project whose tangible benefits will not materialize for a relatively long time (a minimum of 3 years), will be dampened by the short-term needs of people.

Project Alternatives

26. The following alternatives to plantation forestry exist: (a) devising management systems for natural forest or shrubland as an alternative to clearing for plantations whose direct costs (establishment and maintenance) and indirect costs (opportunity costs of precluding other land and resource uses) may not be justified; (b) increasing efforts to conserve wood resources (e.g., by promoting more efficient woodstoves, more efficient veneers, particle board, etc., and use of waste wood and recycling), and to promote alternative fuels (e.g., natural gas) as effective alternatives to fuelwood plantations; and (c) where tree planting is being considered for stabilization of slopes or land rehabilitation and improvement, protection of the land by fencing or guarding (to prevent livestock grazing and encourage colonization by native species) as an effective and inexpensive alternative to tree planting.

Management and Training

27. Whether a private plantation of cash crop trees, a community woodlot project or a large-scale commercial plantation, institutional support and training throughout the process is important. (For a discussion on general issues concerning forestry institutions, see the "Natural Forest Management" section.) Typical management support will include:

. project planning, implementation and evaluation . work planning, budgeting and financial management, personnel management . development of community education and extension programs . procurement of seed and equipment . handling of land tenure issues and enlistment of support of local communities and political leaders . development of markets and local processing capabilities

28. Technical support and training may be needed in:

. site assessment and mapping . selection of species . management of propagation material (seed: purchase or collection, storage and handling vegetative material [i.e., cuttings]: collection and handling) . nursery operations . planting methods and timing . management techniques, such as thinning, coppicing, fertilizing, irrigating, monitoring insects and disease, weeding, and protection against livestock damage and poaching . collection of growth and yield data to evaluate stand performance . harvesting and transportation . operation of equipment . development of end uses for the wood and by-products of the plantation operation . marketing procedures

29. Forestry personnel must have a range of new skills to be able to support social forestry efforts. These include:

. identification of specific groups which could be involved in tree planting . communication and extension skills . technical knowledge about establishment and management of trees suited to various social forestry activities . land and resource tenure issues

Monitoring

30. The following factors should be monitored:

. environmental impacts of site preparation and replanting quality of planting stock . growth rates of the plantation . weed problems . presence of pests and disease . management treatments: if being done properly and according to schedule . protection of the stands . market trends . distribution of revenues and benefits from the plantations . changes in costs and benefits as conditions change . recalculation of costs and benefits as conditions change . pressure on agriculture, land tenure, natural forests . environmental impacts of harvesting . long-term viability of the plantation from ecological, economic and managerial standpoints

WATERSHED DEVELOPMENT

1. Watershed development projects are based on the premise that hydrologic units are appropriate for conceptualizing strategies and planning investments. They display a complete range of intersectoral linkages. Failure to approach planning on a watershed-wide basis can lead to incorrect priorities, illogical sequencing of interventions, and interference between separate activities in different sectors or even in the same sector. The emphasis in watershed development has generally been on agriculture and forestry projects, but should extend to any intervention involving land uses which affects the hydrologic cycle. Many watershed projects have concentrated on the technical aspects of investments to correct problems caused by deforestation, declining soil fertility and productivity, erosion and sedimentation, and flooding and drought. A recent review of such projects in Asia has shown that political, social, economic and institutional issues must be addressed as well to ensure success.

Potential Environment Impacts

2. Watershed development projects or project components are undertaken for purposes which are consistent with sound environmental management. They are unlikely to fall into Category A or even B and thus do not require a formal EA. Consequently, they are not discussed further in the Sourcebook. The user is invited to read the section on "Land and Water Resource Management" in Chapter 2 for more information on the watershed approach to environmental planning and management.

IRRIGATION AND DRAINAGE

1. Irrigation and drainage projects manage water supplies for the purpose of agricultural production. There is a wide variety of irrigation types depending upon the source of water (surface or groundwater), means of water storage, conveyance and distribution systems, and methods of delivery (field application).

2. Large scale utilization of surface water (predominantly rivers) for irrigation has long been practiced, in some countries for thousands of years, and still accounts for the major public sector investments in irrigation. Large scale irrigation projects using groundwater are recent phenomena of the last thirty years. They are found mainly on the great alluvial basins of Pakistan, India and China where the tube-wells tapping into the groundwater are often used in conjunction with surface water irrigation systems.

3. The dominant delivery method (up to 95 percent worldwide) is surface irrigation (flood or furrow irrigation) in which water is distributed over the irrigated area by gravity in overland flow. The other systems are sprinkler and drip (trickle) irrigation. Sprinkler irrigation involves spraying water droplets over the land surface in simulation of rain. In drip irrigation water is released in drops or a light stream through holes in plastic tubing laid on or buried below the surface of the soil. Although they are relatively new technologies requiring higher initial investment and more intensive management than surface irrigation, sprinkler and drip irrigation show great potential for maximizing the efficiency of water use and reducing irrigation related environmental problems.

4. Irrigation projects can include the following facilities and infrastructure: (a) dams, watershed and reservoirs; (b) diversion and intake facilities; (c) wells, pumping stations, canals, ditches and pipelines for the conveyance of water (including drainage); and (d) distribution systems for sprinkle and drip irrigation.

Potential Environmental Impacts

5. The potential negative environmental impacts of most large irrigation projects include: waterlogging and salinization of soils, increased incidence of water-borne and water-related diseases, resettlement or changes in the lifestyle of local populations, and increases of agricultural pests and diseases resulting from the elimination of dry season die-back and the creation of a more humid microclimate. The expansion and intensification of agriculture made possible by irrigation has the potential for causing increased erosion; pollution of surface and groundwater from agricultural biocides; deterioration of water quality; and increased nutrient levels in the irrigation and drainage water resulting in algal blooms, proliferation of aquatic weeds and eutrophication in irrigation canals and downstream waterways (for a summary of all potential impacts, see Table 8.7 at the end of this section for a summary of all potential impacts). Increased quantities of agricultural chemicals are usually required in irrigated lands to keep production levels up; fertilizer must be used to compensate for high growth rate and loss of nutrients through leaching, and pesticides to control the greater numbers of crop pests and diseases.

6. Large irrigation projects which impound or divert river waters have the potential to cause major environmental disturbances resulting from changes in the hydrology and limnology of river basins. (The effects of water impoundment are discussed in the section on "Dams and Reservoirs.") Reducing the river flow changes floodplain land use and ecology, disrupts riverine and estuarine fisheries, and causes salt water intrusion up the river and into the groundwater of adjacent lands. Diversion and loss of water through irrigation reduces the water supply for downstream users, including municipalities, industries and agriculturalists. A reduction in a river's base flow also decreases the dilution of municipal and industrial wastes added downstream, posing pollution and health hazards. The deterioration of water quality below an irrigation project can render the water unfit for other users, harm aquatic species, and, because of high nutrient content, result in aquatic weed growth that clogs waterways and has health, navigation and ecological consequences.

7. The potential direct negative environmental impacts of the use of groundwater supplies for irrigation arise from overtapping groundwater supplies (withdrawing water in excess of the rate of recharge). This results in the lowering of the water table, land subsidence, decreased water quality, and saltwater intrusion (in coastal areas).

8. A number of external environmental factors influence irrigation projects. Upstream land use will affect the quality of water entering the irrigation area, particularly the sediment content (e.g., from agriculturally-induced erosion) and chemical composition (e.g., from agricultural and industrial pollutants). Use of river waters with a large sediment load may result in canal clogging. Over time, cleaning the canals and depositing the sediment on cropland, or simply irrigating with water of high sediment content can raise the land level to such a height that irrigation is impaired.

9. The obvious benefits conferred by irrigation are those resulting from increased production of food. In addition, concentration and intensification of production on a smaller area can protect forests or wildlands from being converted to agriculture. Increased vegetative cover for a greater portion of the year helps reduce soil erosion, as does land preparation (e.g., land levelling and contouring). Some health benefits result from improved hygiene and a decrease in the incidence of certain diseases. Irrigation projects can also moderate flooding downstream.

Special Issues

Waterlogging and Salinization

10. Waterlogging and salinization of soils are common problems associated with surface irrigation. On a global basis it has been estimated that annually irrigation takes out of production as much land as it puts in because of soil deterioration, principally salinization. Waterlogging results primarily from inadequate drainage and overirrigation, and to a lesser extent from seepage from canals and ditches. Salinity problems, naturally more acute in arid and semi-arid areas which have more rapid surface evaporation and saline soils, are exacerbated by irrigation. Waterlogging concentrates salts, drawn up from lower in the soil profile, in the plants' rooting zone. Alkalization (the buildup of sodium in soils) is a particularly detrimental form of salinization which is difficult to rectify. While soils in arid and semi-arid zones have a natural tendency toward salinization, many of soil-related problems could be minimized by installing adequate drainage systems. Drainage is a critical element of irrigation projects that too often is poorly planned and managed. Waterlogging and salinization can also be reduced or minimized by using sprinkler or drip irrigation which apply water more precisely and can more easily limit quantities to no more than the crop needs.

Social Issues

11. Social disruption is inevitable in large irrigation projects covering vast areas. Local people dislocated by the irrigation project face the classic resettlement problems: a decrease in the standard of living, increased health problems, social conflicts, and deterioration of natural resources in the resettlement area (see "Involuntary Resettlement" section). The people remaining in the area will likely have to change their land use practices and agricultural patterns. Those moving into the area to benefit from the irrigation scheme similarly will have to adapt to new conditions (see "New Land Settlement" section). The local people often find that they have less access to water, land and vegetation resources as a result of the project. Conflicting demands on the water resources and inequalities in distribution can easily occur both in the project area and downstream. All these factors -changing agricultural practices, increasing population density, and altering the distribution of wealth -can have a profound influence on traditional social patterns.

12. An increase, sometimes extraordinary, of water-borne or water-related diseases commonly is associated with the introduction of irrigation. The diseases most often linked with irrigation are schistosomiasis, malaria and onchocerciasis, whose vectors proliferate in the irrigation waters. Other irrigation-related health risks include those associated with increased use of agrochemicals, deterioration of water quality, and increased population pressure in the area (see "Public Health and Safety" section).

13. The reuse of wastewater for irrigation has the potential of transmitting communicable diseases (mainly helminthic, and to a lesser extent bacterial and viral). The population groups at risk include agricultural workers, consumers of produce (and meat) from the wastewater-irrigated fields, and people living nearby. Sprinkler irrigation poses an additional risk through the potential dispersal of pathogens through the air. These risks vary according to the extent of treatment given to the wastewater prior to reuse.

Irrigation Efficiency and Improvement of Existing Systems

14. Inefficient use of water (i.e., overwatering) not only wastes water which could go to other users and avoid ecological impacts downstream, but results in land deterioration through waterlogging, salinization and leaching, and decreased crop productivity. Maximizing the efficiency of water use, therefore, should be of primary concern to all irrigation projects.

15. As already stated, large areas of irrigated land has gone out of production because of soil deterioration. It may be cost effective and certainly beneficial environmentally to invest in land restoration rather than in increasing the area in irrigation.

Project Alternatives

16. A variety of alternatives to a proposed irrigation project, its design, and management exist. They are as follows: (a) improve the efficiency of existing projects and restore degraded crop lands to use rather than establishing a new irrigation project; (b) develop smallscale, individually owned irrigation systems as an

alternative to large, publicly owned and managed schemes; (c) develop irrigation systems using groundwater resources which have less potential for causing environmental damage than surface water systems; (d) develop, where possible, irrigation systems using surface and groundwaters conjointly to increase the flexibility of water supply and minimize negative hydrological impacts; (e) use sprinkler or drip irrigation as alternatives to surface irrigation to decrease the risk of waterlogging, salinization, erosion and inefficient water use; (f) site the irrigation project on the site where negative social and environmental impacts are minimized; and (g) use treated wastewater, where appropriate, to make more water available to other users or reduce the environmental impacts of withdrawing water from surface and groundwater supplies.

Management and Training

17. Institutional factors are often cited as the cause of failure of large scale public irrigation schemes. Operation of all control facilities from the water source to individual farms requires almost constant management. Careful water management is essential to the quantity, timing, controllability, and predictability of water delivered to the users, all of which will determine the success of the project. Training of a cadre of managers to provide the needed services is required if they are not available or lack necessary technical and managerial skills.

18. Planning and implementation of an irrigation project must be done with the cooperation and collaboration of engineers, soil scientists, hydrologists, public health specialists, social scientists and economists. An operations plan, outlining the operating rules and water distribution goals, should be developed prior to the design of the physical infrastructure and guide the subsequent project management.

Monitoring

19. Factors to be monitored should include: climate (wind, temperature, rainfall, etc.); stream discharge above the irrigation project and below at various points; nutrient content of discharge water; flow and water levels at critical points in the irrigation system; water 0

table elevations in project area and downstream; water quality of project inflows and return flows; quality of groundwater in project area; water salinity levels in coastal wells; physical and chemical properties of soil in irrigation area; agricultural acreage in production; cropping intensity; crop yield per unit of land and water; erosion/sedimentation rates in project area; relation between water demand and supply of users (equitability of distribution); condition of distribution and drainage canals (siltation, presence of weeds, condition of linings); upstream watershed management (agricultural extent and practices, industrial activity); incidence of disease and presence of disease vectors; health condition of project populations; changes in natural vegetation in the project area and on the floodplain downstream; changes in wildlife populations in the project area and on the floodplain downstream; and fish population and species.

LIVESTOCK AND RANGELAND MANAGEMENT

1. The World Bank finances livestock development projects or project components targeting the improvement of rangeland condition and productivity; the health and productivity of livestock (including cattle, sheep, goats, camels, buffalo, oxen and swine) for meat, milk, hides and fiber; and the welfare of herders. Rangelands include grasslands, open forest (and in some places cleared areas of closed forests), shrublands, and deserts that support domestic ruminants and wild herbivores. The targets of assistance range in scale from large commercial ranching to subsistence mixed-farming or traditional pastoral systems. In both large and small scale operations, the production systems can vary in intensity, with the more intensely managed systems feeding harvested natural or cultivated feed to penned animals, and the more extensive systems relying exclusively on grazing of natural vegetation.

2. The emphasis here will be primarily on small and medium scale livestock operations practicing less intensive management systems (free grazing), with more limited reference to large commercial enterprises

(less common in Bank lending) and systems that stall feed animals (which have fewer potential environmental problems than free grazing management systems). Processing of meat and other livestock products is covered in the "Agroindustry" section.

3. Projects involving other uses of rangeland are possible. Wildlife conservation, water catchment, tourism, recreation, hunting, mining and oil exploration are examples.

Potential Environmental Impacts

4. Livestock grazing is a productive land use in areas unsuited to agricultural cropping. Generally practiced in arid or semi-arid lands where rainfall is sparse and unpredictable in time and space, extensive livestock production, particularly pastoralism, is an appropriate and sustainable form of land use that is much less risky than cropping. Grazing and rangeland vegetation are co-adapted; both undergrazing and overgrazing, resulting in the growth of woody plants and large, unpalatable grasses, reduce the productive potential of an area. Grazing also helps maintain soil fertility and physical soil characteristics by deposition of animal dung. And, the germination of certain plants is enhanced or made possible when seed is passed through the digestive tract of animals. Livestock production, therefore, represents a system of land management in marginal areas that can maximize food production with minimal input while maintaining the productivity of the ecosystem.

5. Negative environmental impacts of livestock grazing, however, arise from overgrazing and result from various range management practices. External impacts on the rangelands include development activities (e.g., agriculture, water resource development, settlement programs, mining, etc.) which reduce or eliminate grazing on the land or degrade range resources.

6. The major potential negative environmental impact of livestock production (see Table 8.8 at the end of this section) is overgrazing or overuse (e.g., excess harvesting) of fodder and forage resources leading to degradation of the vegetation, increased soil erosion, and deterioration of soil fertility and soil structure. Overgrazing is a consequence of overstocking the land so that the number and type of animals exceed the area's carrying capacity. Overgrazing results in the decrease of favored fodder species and the increase of unpalatable, weedy species. It increases soil erosion, indirectly by decreasing vegetative cover, and directly by loosening the soil and making it subject to water and wind erosion. Livestock paths scar hillsides and trigger an erosional process that may result in gully formation. Grazing also degrades the structure of the soil by pulverizing it and compacting the surface, thus lowering the soil's infiltration capacity. Rangeland management techniques to reduce grazing pressure include altering the timing, length or succession of use by livestock on particular land areas, and regulating the numbers, species and movement of animals. The most common ways of controlling animal pressure are through the use of rotational grazing, deferred grazing and strategic placement of water points and salt. Organized marketing of range products and development of dry season grazing areas and grazing reserves are the other useful management techniques.

7. Increasing livestock production on rangelands or introducing animal husbandry into areas may have negative impacts on wildlife populations. Competition for vegetation and water resources may increase, and livestock owners may kill wildlife for food or to eliminate them as pests (i.e., predators on livestock species). Livestock and wildlife have coexisted successfully in many places, utilizing different resources and thus avoiding excessive competition. In some areas wildlife ranching has shown greater potential than livestock production, and may be considered as an alternative for meat, hides and skin production. Tourism and controlled hunting are other alternatives to consider.

8. Vegetation depletion and increased soil erosion often occur around water points where animals congregate. Increasing the number of water points, locating them strategically, and closing them at certain times of the year can limit resource destruction. Poor planing, placement, management and control of water holes, however, can compound problems and aggravate the severity of droughts. The drilling of deep wells can also result in severe land degradation around the boreholes by lowering the watertable and thus

affecting local vegetation. The dual use of water points for livestock watering and human water supply has obvious negative health implications.

9. Rangeland management techniques to increase the productivity of the rangeland include: mechanical and physical work on the soil or vegetation (e.g., land contouring and other soil and water conservation techniques, bush clearing); planting, seeding or re-seeding with selected species and varieties; burning the vegetation; fertilization with manure or chemicals and pest control efforts. Soil and water conservation measures and seeding of vegetation can decrease soil erosion, while bush clearing and burning, if not carefully carried out may increase erosion. Not only does site productivity decline with increased erosion, but water bodies suffer from increased levels of sediment input.

10. Burning is the oldest practice used by man to manipulate range vegetation for livestock grazing. Burning is done to control undesirable brush and tall weeds, destroy old, unpalatable grass tussocks, and favor the growth of fresh, more digestible and nutritious grasses. Fire increases forage yield and palatability of grasses and forbs. Haphazard or accidental burning, however, can be harmful or disastrous for the vegetation and soils, and can lead to increased levels of soil erosion.

11. Use of chemicals for fertilization of pasture or for pest or disease control can have negative environmental impacts. Chemical fertilization is prohibitively expensive and thus rarely practiced in most developing countries. Where used, however, it can cause water pollution problems, as can fertilization with organic materials. Use of chemicals as herbicides or for disease control (e.g., for reduction of the tsetse fly population to control trypanosomiasis) is more common and can have negative effects on wildlife, water supplies (surface and ground waters) and vegetation.

12. Livestock improvement includes improved veterinary care, disease treatment and control, and breeding or other stock improvement techniques. Increases in livestock populations resulting from these efforts must be done in conjunction with range management and grazing control in order to avoid problems from increased pressure on the range resource leading to overgrazing. Selective breeding has the long-term negative potential of decreasing the natural genetic variability of livestock populations and thus reducing their resistance to disease and flexibility to adjust to climatic change.

13. Some projects provide supplemental feeding assistance during times of drought to maintain livestock herds. Care must be taken with such subsidized feeding programs that the food assistance is continued until range resources have adequately recovered from the drought. A misconception is that once the rains start again livestock feeding programs can be discontinued, but, in fact, there is a lag time between the time the rains start and the range is ready to accommodate high grazing pressure again. A great deal of damage can be done to grasslands by turning the livestock out too early.

Special Issues

Livestock Production in Moist Tropical Forests

14. Clearing of moist tropical lowland forest lands or using land already cleared for other reasons for livestock production has proven to be an unsustainable practice with disastrous environmental impacts. Clearing of large areas of forest land in Amazonia and subsequent conversion to cattle production, has degraded the land irreparably and rendered it useless for other purposes. Large-Scale cattle ranching in these areas is highly unsuitable and should be discouraged.

Social and Cultural Issues

15. Rangeland management systems and socio-economic patterns and conditions are intimately linked. A decline in rangeland productivity will through natural (e.g., climatic) or humanly driven forces, will have negative impacts on family income, health, and the distribution of scarce resources between people. Conversely, socio-economic factors such as labor availability, distribution of tasks within families, land use

and resource rights, property ownership patterns, and market conditions affect how the range and livestock resources are managed.

16. Many rangeland areas are in a state of transition. The most important social and economic changes in these areas include: (a) increased involvement in wage-labor markets; (b) transformations of indigenous tenure systems and organizations; (c) encroachment of dryland agriculture and irrigation into rangelands; (d) increased involvement of pastoralists in commodity markets; (e) increased sedentarization and settlement that is often encouraged by state and donor policies and programs; and (f) fluctuating terms of trade for pastoral produce. In terms of their potential effects on the physical environment, the most important variables to identify are income and welfare levels, labor availability, and land/population ratios. Changes in these are likely to affect how physical resources are managed, as are changes in people's traditional access to resources.

17. The key social issues which must be considered before developing any livestock or rangeland management project are spacial and temporal dimensions of rangeland economics; resource tenure and local management; property rights, distribution, and welfare; and labor availability.

18. Livestock production systems in rangeland areas are land extensive. The mobility of human populations in rangelands tends to increase in relation to aridity, with the most mobile populations residing in arid and semi-desert zones. It is critical, therefore, to identify the physical expanse and ecosystem types that livestock exploit over a full "drought-to-drought" cycle (7-10 year period), particularly the lands and water resources that are critical to the survival of the overall production system. Loss of access to lands due to agricultural encroachment (either by outsiders or the herders themselves), settlement projects, the creation of national parks, and other activities will reduce land available to extensive rangeland production and decrease land/population ratios. Critical dry-season areas diverted to non-range use can be particularly detrimental to the livestock herders. Finally, reduced mobility due to physical barriers (e.g., fences, settlements) or government policies favoring sedentarization and settlement will affect the flexibility necessary for optimizing the use of the range resource.

19. In areas where rangeland is a common property resource, most local communities have (or had) either formal or informal institutions for regulating access to pasture, water and other resources. The use of communal land was often based on land ownership or user rights over various ecological zones with nomadic production systems. Government policies to settle nomads, the desire of the population to become sedentary, or appropriation of land for irrigation schemes or other development projects have reduced the total land area and ecological distribution to the point of radically changing social structures and production systems. These changes either preclude livestock production or require increased imports for animals. Government policies on subsidies, taxes and product price fixing have often favored crops over livestock with the resulting misuse of lands with little or no economical crop production potential. This has further exacerbated the impact on social and cultural systems. It is critical to identify both these traditional local rules for regulating access to resources (and how these rules have changed over time) and the government policies and programs influencing local tenure practice. The local organizations and individuals responsible for overseeing tenure regulations, and the class, age and gender characteristics of these organizations, should be examined. Not only should these entities be involved in the design of a project, but equal consideration should be given to those which will be affected, particularly when their concerns are not adequately represented by the controlling bodies. The pros and cons of altering property ownership patterns (e.g., shifting from a system of common property resources to private land ownership) must be carefully weighed in light of local social patterns.

20. It is essential to understand existing local livestock ownership patterns in designing a rangeland management project. Livestock ownership in most rangelands is highly skewed, often with 10 percent of herders controlling up to 50 percent of livestock units with large segments (frequently 20 to 30 percent of households) owning little or no livestock or other property. It is dangerous to try to adjust livestock numbers to correspond to the carrying capacity of the range without first understanding property ownership dynamics and the number of animals per household necessary to support the household and

maintain an economically-viable system. The danger is that if the number of animals per household is limited (rather than the number of household units involved in livestock production) to reduce grazing pressure, the number may be reduced to an uneconomic management unit, thus forcing the poorest households out of production.

21. Income distribution and intrahousehold property rights (e.g., those based on gender and age) are also frequently skewed. In addition to information on the general distribution of property and income among and within households, the following factors must be understood: the extent to which management and ownership of property are vested in the same unit (e.g., wealthy segments of the populations, from either within or outside the community, acting as absentee owners, and hiring local herders to tend their animals); the extent to which certain categories of property (e.g., goats and sheep) or sources of income (e.g., income from milk sales) are controlled by women and if development activities have eroded the income-earning activities of women; and the extent to which certain types of resource management and production activities can be distinguished by wealth or income category.

22. Since rangeland production systems generally are carried out in areas of low population density, they often suffer from labor shortages. Lack of labor affects herd movement, mobility, and certain conservation and resource management techniques. The issues to be assessed include: diversification of the local production system (the degree that mixed cropping, wage labor opportunities and other nonfarm activities affect the availability of labor for livestock production); the extent to which engagement in nonfarm activities by males increases the workload of women; and the extent to which labor shortages and low incomes affect local management strategies and are associated with disruptive resource management practices.

23. In areas which are more densely populated, with limited range resources, or in ecologically sensitive areas such as mountainous lands, restriction of livestock movement may be encouraged to limit environmental degradation by shifting to a system of stall feeding animals. While this may be environmentally more sound, access rights to forage and fodder resources may be unequitable, or the concentration of ownership of land on which livestock feed can be grown may preclude the involvement of the poorer and landless in such a scheme. Such factors must be taken into consideration in project design.

Project Alternatives

24. There are few alternatives to livestock production in rangelands as it is generally the most suitable land use available for the climatic conditions. One possibility, although limited to certain areas and circumstances, is wildlife ranching. Management of wildlife as a sustainable system potentially can increase the productivity of the land in terms of meat, hides, skins and other products while minimizing environmental destruction. This success of such a system, however, depends on numerous variables, not the least of which is marketing. Wildlife-based tourism, recreation, controlled hunting, and rainfed dryland farming are other alternatives.

25. The greatest scope for alternatives lies within the livestock management system itself. As already discussed, choices in variables include the following: species of animal(s) for production; intensity of production; rangeland improvement activities; sprinkler irrigation; livestock improvement activities; transport and processing arrangements; and control of marketing functions.

Management and Training

26. Government policies and programs designed to increase livestock production often affect the range resource and welfare of producers negatively and promote economic inefficiencies and social inequities. Livestock policies have often worked counter to development assistance in livestock production. Policies, programs and legislation should be reviewed for their social and environmental impacts. Producer groups which can provide services, represent the individual producers, and facilitate marketing may need to be established or strengthened.

27. Government policies (e.g., on livestock prices and import and export controls) are often aimed at keeping consumer prices for livestock products low. Then to compensate the producers, governments offer subsidies allowing producers to purchase inputs below their real value, provide free services or offer subsidized credit. This creates an artificially bolstered system which may lead to inefficiencies, inequities (favoring the large over the small producers), investment distortions, and the degradation of range resources through inappropriate land use. It also tends to favor capital intensive operations using feed concentrates over forage-based systems.

28. In many places government services are inadequate. In others, some services are excessive and stifle private sector initiatives which could provide the services more efficiently. The governments of most countries are involved in livestock processing, marketing, supplying of inputs, extension of technical services, and programs in animal health and genetic improvement. The delivery of these services is often poor.

29. Government research and extension services are often lacking. They commonly focus on intensive, import-dependent production systems which are not financially viable for the majority of livestock producers. Extension services are often hampered by inefficiencies, lack of funds, and inadequately trained extension agents.

30. Traditional social structures are breaking down and are not being replaced by producer organizations to monitor use of common lands. Legislation defining land ownership and user rights, particularly on common lands, is often weak or unenforced. The lack of producer organizations hinder marketing and the gap is filled by middlemen who siphon off the majority of profits. Producer groups can establish and regulate land use patterns, livestock management systems and livestock numbers; provide services now provided by the government; and represent the livestock producers when working to influence government policies and research priorities.

31. Training is often needed to bolster government personnel's technical, managerial and extension skills. Common training needs are in range ecology and management, livestock production systems, veteriveterinary sciences, agricultural economics, extension techniques, research and management skills.

32. Research should be tailored to producers' needs, particularly in pasture and range production. Research is needed on developing technological packages suitable for the small-scale producers with low labor input. Other research needs include that on farm forestry which integrates livestock and agricultural cropping with tree growing patterns, and practices of pastoralists to investigate their ecological and economic viabilities.

Monitoring

33. Factors to be monitored in a livestock project should include:

. range condition (assessment of present state of health of the range in relation to its potential) . range trend (direction of change of range condition) . availability of and access to natural fodder and forage, cultivated fodder, and imported feedstuffs (in stallfed animals) . numbers and types of animals . seasonal distribution and movement of animals . condition of the livestock (weight, presence of disease, other health indices) . condition of the soil (i.e., signs of increased erosion, compaction, decreased fertility, etc.) . water points (location, condition, and intensity of use, and condition of vegetation around the water points) . market conditions (changes in price, development of alternative markets, etc.) . changes in economic indices of livestock producers (e.g., income levels and health) . changes in social organization . external land use changes and demographic changes which have impacts on the range resource and livestock producers . changes in wildlife populations and habitat due to livestock production

RURAL ROADS

1. Rural roads connect villages and smaller population centers such as regional market towns, and comprise tertiary, feeder and penetration roads. They usually are unpaved or only lightly paved, are narrower and have tighter curves and steeper grades than highways. They may be all-weather or only seasonal and often include fords or ferries rather than bridges. Highways, whether paved or unpaved, which traverse rural regions are treated in the "Roads and Highways" section of Chapter 9.

2. Rural road construction, improvement or rehabilitation can be undertaken as a transportation sector loan or as a subcomponent of another project such as in agriculture, forestry or rural development. When they are subcomponents, they may be difficult to detect in project documents and even the borrower may not know where they will be geographically. Projects which develop location-specific resources far from existing roads (e.g., mineral deposits, timber resources, hydropower installations, or tourism sites) will entail construction of access routes. These roads may have to be paved when the transport of heavy loads is involved.

Potential Environmental Impacts

3. Environmental impacts include: direct impacts at the road construction site and in the immediate environs of the right of way and indirect impacts in the adjoining region. This larger area of influence of a rural road is the area of induced economic, social or environmental effects, whether planned or spontaneous, which are consequences of increased physical access and lower transportation costs. These indirect impacts often greatly exceeds the direct impacts.

4. Air and water pollution and noise, generally associated with highways, are not major problems in rural roads because traffic density is low. Dust raised from the road and blown by vehicles can pose a health hazard and damage vegetation along the side of the road. If the road is paved, some water pollution can occur from chemicals carried away in runoff. Other possible sources of water pollution are chemicals applied along the roadside or on the right-of-way for the control of weeds or dust.

5. The major direct environmental impact associated with rural roads is erosion. Construction in the rainy season, or improper construction methods which leave soils exposed unnecessarily, can cause significant erosion. Improper drainage from roads in areas of high precipitation can ruin roads and have adverse impacts on adjacent lands, most pronounced in steep areas. Even in low rainfall areas, if the drainage system is improperly designed, a short but intense rain can erode large swathes downslope of the drainage ditches. Large-Scale destruction also can occur through slips and landslides in steep areas. Damaging to land and vegetation resources, erosion also causes serious sedimentation and siltation problems in nearby surface waters. With their greater potential for causing environmental problems, roads built in steep, humid zones will require higher standards and costs than roads on plains. (For further discussion see Table 8.9 at the end of this section.)

6. The design of roadways can also determine the effect of the road on its surroundings, for example, in large wetland areas (e.g., tidal flats, lagoons or inland deltas). Roads built on raised embankments which interfere with cross drainage and on causeways which do not adequately allow for movement of water can permanently impair the biological cycles and productivity of the wetland ecosystems. Similarly, roads can cause flooding of adjacent areas by blocking the flow of water and by increasing runoff.

7. Some roads constructed by private industries (e.g., for mining, ranching, logging) may be later formalized and converted to public roads, due to local petitioning and pressure on ministries of public works. The routes of such roads, however, may not serve public needs or be compatible with land use capabilities. Road rehabilitation projects may have to be launched to remedy the problems of such ill planned roads. Some logging roads built to gain access to steep lands in humid regions (e.g., Malaysia) have permanently damaged relatively large portions of such lands.

8. The construction of penetration roads into remote areas triggers migration into adjacent lands and induces land uses and resource exploitation patterns that are extremely difficult to manage or control (see

sections on "Induced Development" and "New Land Settlement" in Chapter 3). Roads intended to open up moist tropical forest lands to settlement, for example, in Kalimantan or the Transamazonica in the Amazon Basin, have almost invariably triggered spontaneous migration into the area and resulted in a sequence of uncontrollable events characterized by wasteful logging methods, invasion of tribal lands and conversion of land to farming of short cycle crops which is unsustainable. Outcomes have included severe disruption of indigenous peoples, conversion of forest to pasture land, invasion of weedy species and land degradation resulting in eventual abandonment of the area. Preventing or mitigating unwanted changes where there are no alternatives to road construction may require a long-term companion development effort.

Special Issues

Road Siting

9. Siting of a road is the most critical decision in road construction. It will largely determine the type and magnitude of environmental and social impacts that will result from road construction. Alignments through lands of indigenous peoples, critical wildlands and wildlife habitat, lands unsuited to probable land use changes that will occur by both planned and unplanned development stimulated by the road, and locations where there are potential natural hazards, should be avoided. Once the area for the road is chosen, care must be taken to avoid constructing it on steep slopes, unstable soils and places where runoff and drainage will be problematic. Decisions on road siting frequently involve rapid screening and appraisal of many proposed locations and road specifications, and should involve a wide range of line agencies and levels of organization. Siting involves the collection of data on the climate, soil, geology, topography, hydrology, biology/ ecology, and social factors (land and resource use patterns, local economy, class and economic structure, local administrative or power structures) of the sites proposed for construction. Remote sensing information sources and qualified interpreters are particularly useful for these functions.

Road Maintenance

10. Designing rural roads projects poses several special problems. Maintenance costs are habitually underestimated and maintenance routines deficient, especially on low volume roads (e.g., roads through lightly populated regions, extensive ranching areas or widely separated settlements). Adequate road maintenance can be costly but is essential to avoid environmental and socio-economic problems. Overloading of freight vehicles is a chronic problem that should be taken into account in road design and maintenance. To the extent possible, road maintenance should be supported technically and financially (at least at first) by the central government, but carried out by local authorities and the community.

Social Impacts

11. The construction of a rural road can confer a host of benefits on the local populations. These include: improved access to markets; increased government services, such as electricity, potable water, extension services, credit systems, health services and education; stimulation of agroindustries; and greater employment opportunities, at least in the short term. Although all positive contributions to rural development, these benefits often are not evenly distributed among population groups and may exaggerate socio-economic disparities. The larger, wealthier landowners generally have better access to services than the poorer peoples.

12. The introduction of rural roads leads to increased land values and more intensive land use, especially for land adjacent to the road. The result is often increased rents, or shifts in ownership or rights of resource use from the poorer to wealthier classes. Land located back from the road may decline in value.

13. Changes in agriculture are often characterized by intensification of production and shifts from subsistence to cash crops. Dependence on cash crops to the exclusion of subsistence crops can have negative effects on local nutrition levels. Roads, by encouraging mobility of people and goods, can also facilitate the spread of pests and disease.

14. Unempowered ethnic minorities, who previously have lived in geographic and political isolation from the rest of the country, often receive little or no benefit from penetration roads. In fact, the construction of a road into their lands can be devastating to these people. In some areas, for example Amazonia, roads have resulted in dispossession of indigenous peoples' lands, malnutrition, decimation of their numbers through the introduction of diseases, cultural disintegration, and a host of other social and economic problems. (See "Indigenous Peoples" section in Chapter 3.)

Project Alternatives

15. There are few alternatives that fulfill the same functions as rural roads. Water transport is a viable alternative in regions with navigable rivers and streams, but such proposals frequently have been rejected. Narrow gauge railways are alternatives for transporting mineral ores. Under some circumstances, air transport may be a viable alternative when all the financial, social and environmental costs of the road are calculated.

Management and Training

16. The planning, construction and maintenance of a road involves a variety of line agencies and levels of organization (national, regional and local), including the central government, planning and financing ministries, one or more operating ministries, the executing unit, private contractors, nongovernmental agencies and local community groups. Input from a variety of agencies will be necessary at the planning stage, and should begin at the point when road investments are first considered and their contribution to rural development discussed. Coordination in project preparation may consist of agency cross-checking of location of the road and construction facilities, setting up an interagency planning committee or coordinating council, or incorporating agency criteria and/or staff views in the pre-screening process.

17. Vertical linkages must also be well developed, ensuring that the project is linked equally well to its sources of political and financial support in the central government, and to the local communities to be affected by the road. It is essential to incorporate these communities in the planning process. Building and maintaining rural roads involve the local communities and populations as much as possible, with the eventual goal that they will be able to assume primary responsibility for the road. A poor track record in turning road maintenance over to rural communities is often attributed to the top-down approach of most public works departments and limited public participation in the planning and construction of the roads.

18. The executing agency may specify in contracts to the construction firm mitigating actions and supervisory/monitoring actions to be taken. Environmental protection and monitoring offices may be located within transportation ministries but are more likely to be located in another ministry, e.g., an environmental protection bureau. Personnel may lack experience; equipment, vehicles, and operational budgets may be inadequate; and standards may be weak or vague. It may be necessary to develop pragmatically defined standards, such as for erosion-control measures, and to create a special capability and capacity to plan and execute a monitoring plan.

19. Training may be required for all levels of personnel to ensure that road construction is carried out properly and with the least possible negative environmental and social impacts. Training may be targeted at the following people: road construction engineers and technicians in road construction design technology and methods; crew chiefs and site supervisors in construction techniques; unskilled local labor in road construction; and local agency personnel, local authorities and/or representatives of community organizations who will be responsible for road maintenance.

Monitoring of Construction Impacts

20. Monitoring of the impacts of road construction will consist of looking at the following: (a) the "performance" of the installation after construction; (b) erosion during and after construction; (c) the

installation of erosion control and drainage works to ensure that it is adequately done; and (d) verification that proper waste disposal at the construction is carried out (cut and fill material, used oil, human waste, trash, debris, etc.).

21. A monitoring plan should be drawn up, on the basis of chosen mitigating measures and assignment of responsibilities for their implementation. The monitoring of immediate and longer term indirect impacts and their mitigation will fall within the jurisdiction of regional development authorities and ministries, (e.g., agriculture, forestry) according to the nature and scope of development that is induced by, or planned in parallel with, rural road construction. If planned and integral to the development loan, the corresponding sections in the Sourcebook will indicate the kind of monitoring needed.

If not integral to a road construction loan, certain impacts may be sufficiently important to justify a companion planning and development exercise, with its own monitoring functions.

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ANNEX 8-1

Sample Terms of Reference (TOR) An Environmental Assessment of Agroindustry

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) Outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project.

(a) Characteristics of the processing plant(s): location, general layout, size, capacity and life-span.

(b) Preconstruction and construction activities of plant(s) as well as any marine terminals, deepwater ports, pipelines, or roads required.

(c) Operation and maintenance activities, including:

. Handling operations for raw materials and the form in which they are to be introduced into the facility process, as well as the off-loading, conveying, pretreatment, and storage operations. Whenever possible, information should be supplied on the source and quantities of the pollutants likely to be produced during each operation.

. Types of processing operations. For example, process control measures should be specified, as variations in the process may result in different amounts and quality of polluting substances being released to the environment.

. Waste disposal and pollutioncontrol measures categorized by continuous, batch, intermittent and emergency (spills, accidents), especially waste minimization (source reduction or recycling) schemes.

. Transportation requirements and extent to which facilities are owned, operated or supported by the proposed agroindustry. Transportation requirements for raw materials (e.g., live animals, vegetables and fruits, plant residues) should be evaluated.

(d) Supply source for raw materials and the extent to which this source is owned, operated or supported by the proposed agroindustry.

8. Task 2. Description of the Environment.

(b) Biological environment: fauna, including aquatic organisms (particularly fish); ecologically important or sensitive habitats, including parks or preserves, significant natural, cultural or historic sites, etc.; any biological factors likely to influence the supply of raw materials to the facility (e.g., pests).

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Special studies may be necessary to obtain the following information:

(a) Effluent studies to define the extent of potential pollutant loading to receiving waters and to develop alternatives for providing appropriate levels of treatment. The quality and quantity of potential effluents and

water pollutants -processing waters, cooling waters, sanitary waters, leachates from solid waste disposal areas, stormwater runoff -should be determined. Chemical characterization depends on the food products being produced, but at a minimum should include: temperature, pH, total suspended solids (TSS), oil and grease biological oxygen demand (BOD), and chemical oxygen demand (COD). Sanitary wastewater and waters from slaughterhouses should be characterized for nitrates and fecal coliform.

(b) The quality and quantity of air emissions, including sulfur dioxide, carbon dioxide, nitrous oxides, toxic pollutants and particulate matter.

(c) The quality and quantity of solid wastes and the potential impacts from their disposal.

(d) Potential noise levels from the facility.

(e) The potential impacts from transportation should be assessed. When the plant is to be sited in a remote or sparsely populated area, the impacts from planned and unplanned in-migration into the area. This should include effects on the natural resources of the area (e.g., clearing of forests for agriculture) and socio-economic impacts (see Chapter 7).

(f) The effects of facility development on aesthetics and visual quality.

(g) Ability of the community or government to provide emergency response services for accidental release of dangerous chemicals (in most instances agroindustries pose no significant threat of this), and availability of medical facilities and trained personnel to respond to medical emergencies.

(h) Raw material handling and waste disposal specifications (to minimize the potential for disease transmission, especially in slaughterhouses and tanneries).

(i) Potential for unplanned development to result from project and the possible environmental and socio-economic effects of this.

17. Consulting Team. Members of the team might consist of people with the following specializations: environmental impact assessment; sanitary engineering for the evaluation of air and water quality, estimation of potential pollution problems from the processing plant and planning for water and air pollution control systems; acquatic ecology; plant ecology, wildlife and conservation ecology (if there is potential for negative impacts on important species or habitats); rural sociology; agronomy/livestock management, as appropriate for assessment of the impact ofthe production system for raw materials.

ANNEX 8-2

Sample Terms of Reference (TOR) An Environmental Assessment of Dams and Reservoirs

Note: Paragraph numbers correspond to those in the Sample Terms of Reference Outline (TOR) in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: general layout, size and capacity (dam and reservoir specifications, location of outlets, etc.), and life-span of the dam and reservoir.

8. Task 2. Description of the Environment. Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area, including watershed, site of the dam and reservoir and downstream areas, especially floodplain, biological environment (particularly fish resources).

10. Task 4. Determination of the Potential Impacts of and Impacts on the Proposed Project. Potential impacts to be assessed include:

(a) Social and ecological effects of reservoir inundation (loss of agricultural, forestry and grazing land, population resettlement, effects on wildlife and wildlands, etc.).

(b) Effects on the hydrology and water quality of the river (and where relevant, the estuarine, coastal and marine resources).

(c) Effects on river fisheries and potential for creating a reservoir fisheries resource.

(d) Impacts of altering river flow regimes on the ecology of the floodplain, and the economic activities/land use on the floodplain (agriculture, livestock production, etc.).

(e) Impact of altering water supply on urban, industrial, and rural users.

(f) Potential environmental and social impacts by planned and unplanned (spontaneous) in-migration into the area.

(g) Potential for increased incidence of water-borne and water-related diseases.

(h) Impact on terrestrial and aquatic wildlife, by creation of the reservoir, disruption of migration routes, alteration of floodplain ecology, and population impacts.

(i) Effect of existing and predicted land use in the watershed on the functioning and longevity of the dam and reservoir.

17. Consulting Team. Members of the team should consist of people with the following specializations: environmental planning and management; hydrology; terrestrial ecology (plant ecology, forestry and wildlife); acquatic ecology and fisheries; watershed management; soil science and geology (where relevant); public health, particularly speciality in water borne and water-related diseases; rural sociology.

ANNEX 8-3

Sample Terms of Reference (TOR) An Environmental Assessment of Flood Protection

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) Outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: scheme's general design, capacity and degree of protection for various flood levels.

8. Task 2. Description of the Environment. Assemble, evaluate and present baseline data on the environmental characteristics of the study area, including watershed areas, the sites of flood control structures and floodplain areas.

(a) Physical environment: surface and groundwater hydrology (annual peak discharge, recurrenceintervals of various peak discharges, and peak stages for various discharges).

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Particular attention should be paid to the following aspects:

(a) Effects of the flood control dam: direct environmental impacts of the dam construction and reservoir inundation; effects on fisheries resource (creation of a reservoir fisheries, loss of downstream fisheries); effects on water quantity and quality; effects on floodplain ecology.

(b) Effects of flood control structures and measures (e.g., levees, dikes and channelization measures) on: aquatic ecology, particularly fish resources; hydrology, including groundwater recharge, and water quality; plant and animal ecology of the floodplain.

(c) Socio-economic impacts on populations in inundation area and downstream (floodplain dwellers, urban population, etc.) through: land use changes; impacts on water-related economic activities (e.g., fisheries, transportation, etc.); health effects (e.g., increased incidence of water-borne and waterrelated diseases).

17. Consulting Team. Members of the team should consist of people with the following specializations: environmental planning and management; fisheries and/or aquatic ecology; hydrology, watershed management and forestry (for upstream effects); terrestrial ecology and wildlife ecology, etc. (for impacts in the inundation area and on the floodplain); rural sociology.

ANNEX 8-4

Sample Terms of Reference (TOR) An Environmental Assessment of Fisheries

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) Outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: construction activities (e.g., port and harbor facilities, roads, fish processing plants, etc.); operation and maintenance involved in fishing and fish processing activities.

8. Task 2. Description of the Environment. Assemble, evaluate and present baseline data on the environmental characteristics of the study area. Include information on any changes anticipated before the project commences.

(a) Physical environment: geology, topography and soils (for aquaculture projects); climate and meteorology; hydrology, water quality; coastal and oceanic parameters.

(b) Biological environment: flora (aquaculture and freshwater capture projects); fauna (fish stock assessment -target fish and bait fish, and for aquaculture, fingerlings); rare or endangered species (plant and animal); ecologically important or sensitive habitats, such as mangroves and presence of parks or preserves, and significant natural, cultural or historic sites, etc.; non-target species of commercial importance.

(c) Socio-cultural environment (include both present and projected where appropriate): population; land and water use; fishing rights; control over fishing rights; community structure; employment and availability of labor; role of fisheries in the local economy; public health; distribution of income, goods and services; marketing/use patterns of local fisheries presence of producer organizations; customs, aspirations and attitudes (including traditional gender roles, e.g., role of women in fisheries); cultural properties; tribal peoples and/or other culturally or economically marginal groups; other planned development activities.

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Among the issues to be investigated are the following:

(a) Potential for overfishing (e.g., of target, bait and nontarget species; in capture fisheries).

(b) Type of fishing equipment currently in use and proposed for the project. Vessels, nets, catch limits proposed should be reviewed to avoid overexploitation of fish stocks, harvest of non-target species, or deterioration/destruction of habitat (e.g., seagrass beds, coral reefs, etc.; capture fisheries).

(c) Impacts of construction and operation of fish ponds on local hydrology (surface and groundwater), water quality, vegetation and wildlife (aquaculture).

(d) Relationship/interaction between industrial/commercial fisheries and artisanal, small-scale fisheries; social and economic effects of increased fishing on local markets, local nutrition levels, income of local fisherfolk).

(e) Impacts of construction and operation of port and harbor facilities (e.g., destruction of local wildlife habitat, coastal erosion, sediment loading of local water bodies, water pollution, overtapping of fresh water supplies for processing requirements, solid waste disposal problems, etc.).

(f) Pollution from fish processing facilities.

(g) Pollution from fishing or collection ships.

(h) Extent of external threats to fishery resource from pollution and deterioration of fish habitat from agricultural, industrial or municipal sources.

17. Consulting Team. Members of the team should consist of people with the following specializations:

Capture Fisheries: fisheries biology, rural sociology;

Aquaculture: aquaculture, terrestrial ecology (soil science, plant ecology, wildlife ecology, and for fish pond projects), rural sociologist; and

Fish Processing: wastewater/pollution management specialist, environmental impact assessment (with experience in port and harbor facilities and fish processing plants).

ANNEX 8-5

Sample Terms of Reference (TOR) An Environmental Assessment of Natural Forest Management

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: location; general design and extent of activities; construction activities (e.g., roads, sawmills, etc.); forestry operations and forest products processing.

8. Task 2. Description of the Environment.

(a) Physical environment: topography (specifying the watershed function of the proposed project site); climate and meteorology; surface and groundwater hydrology; estuarine, coastal and oceanic parameters (where relevant).

(c) Socio-economic environment: the presence of tribal peoples and/or other culturally or economically marginal groups; land and resource use; system of land tenure and resource use rights; employment and labor availability; extent of use of non-market forest products; existing and planned development activities, particularly water developments (dams, irrigation systems for which the project area serves as a watershed).

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Among the areas requiring particular attention are the following:

(a) Siting: impacts on important flora and fauna (particularly threatened and endangered species); impacts on important habitats for ecosystems.

(b) Operation and management of forestry activities: short term and long term effects of logging on forest structure and biodiversity (species composition of vegetation and wildlife), including effects of the logging

method on the capability of the natural forest species to regenerate naturally (sustainability of production); direct environmental effects of logging on the soil, non-target vegetation, hydrology, and local surface water quality, etc. (sustainability of environmental services); long term effects of logging through loss of nutrients from the system, hydrologic changes, disruption of wildlife habitat, etc.; effects of use of pesticides/herbicides; effects on existing uses of the forest (for agriculture, grazing, harvesting of wood and nonwood forest products); social and economic effects of logging camps and road construction teams.

(c) Transport and processing: effects of logging roads (direct effects through erosion, disruptionof wildlife) as well as induced effects of increased population influx; negative effects of construction of processing plant and processing operations (particularly pollution).

17. Consulting Team. Members of the team should consist of people with the following specializations: forestry (harvesting and extraction); forest ecology; wildlife management; hydrology; watershed management; rural sociology.

ANNEX 8-6

Sample Terms of Reference (TOR) An Environmental Assessment of Plantation Development/Reforestation

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: construction activities (e.g., roads, sawmills, etc.); operation and maintenance activities in forestry and forest products processing.

8. Task 2. Description of the Environment.

(a) Physical environment: topography (specifying the watershed function of the proposed project site); surface and ground water hydrology.

(c) Socio-economic environment: the presence of tribal peoples and/or other culturally or economically marginal groups; system of land tenure and resource use rights; availability of potential labor force and need to bring in outside laborers; cultural characteristics, customs, aspirations and attitudes, including existing uses of trees and experience with tree planting and management.

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Among the areas requiring particular attention are the following:

(a) Siting: disruption of traditional access to and uses of the land and resources; negative effects on important flora and fauna resources.

(b) Plantation establishment and management: effects of site preparation; clearing existing vegetation, using mechanical means and burning, etc.; use of pesticides/herbicides; quantification (when possible) of positive and negative shortterm and long-term environmental effects of establishing plantations/tree planting (including on soil fertility, soil erosion rates, hydrology, wildlife, etc.); positive and negative social effects of plantation/reforestation activities (increased or decreased accessibility of fuelwood, fodder and forage resources, increased employment opportunities, etc.); social and economic effects of importing laborers from outside.

(c) Transport and processing: potential effects of logging roads (direct effects through erosion, disruption of wildlife) as well as induced effects of increased population influx; problems associated with construction and operation of processing facility (especially pollution).

17. Consulting Team. Members of the team should consist of people with the following specializations: environmental assessment; forestry (plantation, harvesting and extraction); forest ecology; wildlife management; hydrology; watershed management; rural sociology.

ANNEX 8-7

Sample Terms of Reference (TOR) An Environmental Assessment of Irrigation and Drainage

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: general design and extent of irrigation and drainageworks (specifications of dam and reservoir, size of command area, etc.); size of catchment area; operation and maintenance of irrigation works.

8. Task 2. Description of the Environment.

(c) Socio-economic environment: land use (including current crops and cropping patterns); land tenure and land titling; present water supply and water uses (including current distribution of water resources if irrigation systems already exist in area); control over allocation of resource use rights.

10. Task 4. Determination of the Potential Impacts of and Impacts on the Proposed Project. Potential impacts to be assessed include:

(a) Project Location: resettlement of people; loss of forest land; loss of agricultural land (cropping and grazing); impact on flora and fauna; impact on historic and cultural sites; effects on water resources outside and inside command area.

(b) Project Design: disruption of hydrology; drainage problems; design of dams and other structures; crossings for people and animals.

(c) Construction Works: soil erosion; construction spoils (disposal of); sanitary conditions and health risks associated with construction camp and workers coming into area; social and cultural conflicts between inported workers and local people.

(d) Project Operation: pollution by agrochemicals; impacts on soils (waterlogging, salinization, etc.); changes in ground water levels inside and outside command area; changes in surface water quality and risks of eutrophication; incidence of water-borne and water-related diseases.

17. Consulting Team. Members of the team should consist of people with the following specializations: environmental impact assessment (with extensive experience in irrigation); rural sociology.

Depending on the baseline data needed and the mitigating measures proposed, the team may also include some of the following disciplines: agronomy; hydrology; terrestrial ecology (plant, forestry and wildlife as appropriate to the ecology of the irrigation site and adjacent areas); aquatic ecology and fisheries; soil science.

ANNEX 8-8

Sample Terms of Reference (TOR) An Environmental Assessment of Livestock and Rangeland Management

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: type and extent of livestock/rangeland activities; construction activities (e.g., processing facilities).

8. Task 2. Description of the Environment.

(a) Physical environment: soils (including signs of and susceptibility to erosion); surface and groundwater hydrology (particularly information on waterpoints or water availability for livestock -location, condition and existing uses of water points and potential for developingalternative points).

(b) Biological environment: flora (natural vegetation, as well as range condition and trend, degree of degradation of vegetation around waterpoints, carrying capacity of the land for livestock, etc.); fauna (livestock: size, composition and condition of herds, seasonal distribution and movement of livestock animals; wildlife (species: numbers, habitat requirements, migratory routes, interaction with livestock, etc.); livestock health and presence of any biological factors that would potentially affect livestock numbers or health (e.g., disease vectors, noxious plants); ecologically important or sensitive habitats, including parks or preserves, significant natural, cultural or historic sites, etc.

(c) Socio-economic environment (include both present and projected where appropriate): land use, including competing demands for the rangeland and water resources; land tenure (including rights to grazing lands and water resources); control over allocation of grazing and water use rights; intensity and timing of use of waterpoints; marketing/use of livestock and livestock products; presence of producer organizations; customs, aspirations and attitudes(including traditional gender roles).

10. Task 4. Determination of the Potential Impacts of the Proposed Project. Among the issues to be investigated are the following:

(a) Effect of the project on the numbers of livestock, range condition and trend, range carrying capacity and range ecosystem.

(b) Where mechanical site improvement and burning of vegetation is called for, effect on soil, flora, fauna and hydrology.

(c) Where use of pesticides/herbicides are called for, potential for pollution, negative health impacts and negative effects on flora and fauna.

(d) Impact on the quality and quantity of water resources (surface and ground).

(e) Impact of project activities on other resource users (non-target pastoralists, agriculturalists, wildlife).

(f) Social and economic effects of the proposed project on the livestock owners or hired herders directly involved, distribution of benefits between different sectors of the society and genders, and effects on non-target populations.

17. Consulting Team. Members of the team should consist of people with the following specializations: rangeland ecology; soil science; wildlife and/or plant ecology, as appropriate; hydrology; rural sociology.

ANNEX 8-9

Sample Terms of Reference (TOR) An Environmental Assessment of Rural Roads

Note: Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) outline in Annex 1-3; additional paragraphs are not numbered

7. Task 1. Description of the Proposed Project: location of roads; type of roads and expected volume of use; construction activities.

8. Task 2. Description of the Environment.

(b) Biological environment (of road site and potential area of influence of the road); ecologicallyimportant or sensitive habitats, including parks or preserves; significant natural, cultural or historic sites, etc.

10. Task 4. Determination of the Potential Impacts of the Proposed Project. The engineering plans should reflect "best practice" in road alignment and construction to ensure that potential negative environmental impacts are minimized (e.g., through measures to prevent soil erosion risk, to ensure proper drainage, and provide for waste disposal such as of cut and fill material, used oil, etc.). The EA should verify that this is the case.

The EA should focus on the potential for negative environmental and social impacts caused by planned and unplanned (spontaneous) in-migration of people: clearing of forest lands for agriculture; increased pressure on fuelwood, fodder and water resources; social disruptions and conflicts; threat to wildlands and important wildlife species, etc.

17. Consulting Team. Members of the team should consist of people with the following specializations: rural sociology; human geography; terrestrial ecology (wildlife, plant and conservation ecology).