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

3. The dominant delivery method 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

5. These guidelines apply to all types of irrigation projects and consider the various stages of the water cycle, or the collection, storage, supply and distribution of water to the plot. However, these guidelines do not address the issues that are related to dams and reservoirs, although these facilities are sometimes required to supply irrigation water. Projects involving the construction and operation of dams and reservoirs are discussed in the guidelines for dams and reservoirs

Potential Environmental Impacts

6. 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.

7. 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.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.

8. 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).

9. 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 agriculturallyinduced

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.

10. 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

11. 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

12. 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. 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. 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

13. 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.

14. 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.

Efficiency Irrigation and Improvement of Existing Systems

15. 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.

16. 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

17. 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.

18. These guidelines for assessing the environmental and social impact assessment (ESIA) has been developed to propose mitigation measures for negative impacts

Management and Training

19. 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.

20. 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

21. 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 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.