Indicative list of environmental factors to be monitored

(Excerpts from "Volume II Sectoral Guidelines" in *World Bank Environmental Assessment SourceBook* (Electronic version)[1]

Monitoring Related To Dams and Water Retention Facilities

Factors to be monitored for dams and water retention facilities 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) 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

Monitoring Related to Fisheries Activities

Factors to be monitored for fisheries activities include:

Capture Fisheries

- water quality (including pollution and oil spills)
- fish stocks (population size and structure)
- fish landings

[1] The following excerpts were derived from a search on the *keyword*: 'monitoring' under the electronic version of the *World Bank Environmental Sourcebook: Volume II Sectoral Guidelines*. 1991.

- conformance by fishermen to regulations on equipment use, fishing areas, catch, fishing seasons
- presence of any discarded materials causing "ghost-fishing"
- 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)

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

Fish 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

Monitoring for Planning for Floodplain Management

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
- 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

Monitoring Forestry Projects

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.

Logging. The following factors should be monitored for logging:

- 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

Reforestation and plantation. The following factors should be monitored under reforestation and plantation:

- 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

Monitoring Irrigation Projects

Factors to be monitored for an irrigation system 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 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
- fish population and species

Monitoring Livestock Projects

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

Monitoring Road Construction

Monitoring of the impacts of road construction will consist of looking at the following:

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

Monitoring Tourism Development[1]

Monitoring plans should include baseline data and periodic review of objectives to determine if plans are being realized. Typical profiles can be developed for protected and ecologically sensitive areas such as beaches, wetlands, reefs; water quality and sediment loading in all water bodies; erosion and sedimentation impacts associated with infrastructure development such as roads, ports, harbors, marinas, hotels, shopping centers and the like; impacts associated with recreational activities such as reef diving, spear fishing, use of all-terrain vehicles, and access to areas previously denied; degree of staging/phasing of development and any observed impacts; demands on transportation and other infrastructure such as water supply, wastewater treatment and solid waste disposal capacity, and the observed system responses; effects on local and regional society and economy.

[1] *World Bank Environmental Assessment Sourcebook: Volume II - Sectoral Guidelines*. 1991 , p..227, para. 21.