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A STUDY OF IMPACT OF DAMS ON BIODIVERSITY

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Abstract:
Dams alter the ecosystems and biodiversity of rivers. In the old industrialized countries, development now is towards the decommissioning of dams rather than the construction of new ones, but in many developing countries exploitation of rivers is proceeding at a fast rate.

Introduction:

The United Nations Convention on Biological Diversity (UNEP, 1992) defines biodiversity as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Article 2). Biodiversity is the totality of genes, species, and ecosystems in a region. The wealth of life on earth today is the product of hundreds of millions of years of evolutionary history. Over the course of time, human cultures have emerged and adapted to the local environment, discovering, using, and altering local biological resources. Biodiversity can be divided into three hierarchical categories that describe quite different aspects of living systems that scientists measure in different ways.

Dam construction has a long tradition in India. With the development of modern engineering, the construction of dams took a quantum leap. As early as 1897 the Periyar Dam was constructed in South India, 54 m above the foundation level. Other high dams were the Wilson Dam (82m, 1926) and Mettur Dam (70m, 1934). After Independence, there was rapid growth in dam building. The Koyna (103m) completed in 1961, was the first dam above 100 m in height. 226m high Bakra Dam was commissioned in 1963. From fewer than 300 large dams existing at the time of Independence, the number of dams constructed and under construction has risen to 4291 in 2000.

It is recognized that large dams directly or indirectly transform the nature and productivity of riparian, estuarine and coastal ecosystems. This will have a direct bearing on the biological diversity that is encompassed in these ecosystems. The ecosystems, the reservoirs of biodiversity, not only provide the biomass, food and economic sustenance to the local communities, but also play crucial roles of carbon sequestration, water regime management, soil erosion prevention and regional ecological balance.

Genetic diversity

Genetic diversity refers to the variation of genes within species. Roughly speaking, genetic diversity concerns the information represented by genes in the DNA of individual plants and animals. This covers distinct populations of the same species (such as the thousands of traditional rice varieties in India) or genetic variation within a population (which

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is very high among Indian rhinos, for example, and low among Asiatic Lion).

Species diversity

Species diversity refers to the variety of species within a region. The number of species in a region -- its "species richness" -- is one often-used measure, but a more precise measurement, "taxonomic diversity," also considers the relationship of species to each other. For example, an island with two species of birds and one species of lizard has greater taxonomic diversity than an island with three species of birds but no lizards. Thus, even though there may be more species of beetles on earth than all other species combined, they do not account for the greater part of species diversity because they are so closely related. Similarly, many more species live on land than in the sea, but terrestrial species are more closely related to each other than ocean species are, so diversity is higher in marine ecosystems than a strict count of species would suggest.

Species diversity and classification

Species diversity refers to the variety of living organisms on earth and has been variously estimated to be between 5 and 50 million or more, though only about 1.4 million have actually been described. Biologists classify life on earth into a widely accepted hierarchical system that reflects evolutionary relationships among organisms. In ascending order, the main categories or taxa, of living things are:

1. Species
2. Genus
3. Family
4. Order
5. Class
6. Phylum
7. Kingdom

Humans, for example, are classified as follows: Animalia (Kingdom), Chordata (Phylum), Mammalia (Class), Primates (Order), Hominidae (Family), Homo (Genus), sapiens (Species). These last two designations, together referred to as the Latin binomial, are used to identify an organism, and distinguish it from any other.

In general, the higher the category ranking of an organism, the more ancient the evolutionary divergence. Thus, with Homo sapiens, it was more recently that the species became established than the genus, and more recently that the genus evolved than did the family (Hominidae), and so on up to the Kingdom level.

Most biologists recognize five kingdoms of organisms:Prokaryotae (bacteria)
Protoctista (includes algae and protozoans) Fungi (mushrooms, molds, and lichens) Animalia (animals), and
Plantae (plants)

Ecosystem diversity

Ecosystem diversity refers to diversity at a supra-species level, namely, at the community level. This covers the variety of communities' of organisms within particular habitats as well as the physical conditions under which they live. Ecosystem diversity is harder to measure than species or genetic diversity because the "boundaries" of communities -- associations of

species -- and ecosystems are elusive. Nevertheless, as long as a consistent set of criteria is used to define communities and ecosystems, their number and distribution can be measured. Until now, such schemes have been applied mainly at national and sub-national levels, though some coarse global classifications have been made. Besides ecosystem diversity, many other expressions of biodiversity can be important. These include:

- The relative abundance of species,
- The age structure of populations,
- The pattern of communities in a region,
- Changes in community composition and structure over time, and ecological processes as predation, parasitism, and mutualism.

More generally, to meet specific management or policy goals, it is often important to examine not only compositional diversity genes, species, and ecosystems, but also diversity in ecosystem structure and function.

The environmental impacts of dams vary considerably depending on the size of the dam, the characteristics of the reservoir, and site specificity such as topography, river flow, climate, ecology and land use. The objective of this review paper is not to review the range of environmental impacts associated with large dam projects but is limited to the impacts on biodiversity.

The creation of a reservoir (impoundment area), as well as the existence of a large body of water, affects the local environment. The most important impacts are outlined in the **Box** below.

Impacts of Large Dams on the Environment

Impacts due to the presence of a dam and reservoir:

1. Creation of static water body that replaces a free flowing river
2. Inundation of valleys that submerge agricultural land, forests, habitations
3. Accelerated sedimentation due to altered land use pattern
4. Changes in downstream morphology of riverbed and banks, delta, estuary and coastline due to altered sediment load.
5. Changes in downstream water quality: effects on river temperature, nutrient load, dissolved gases, concentration of metals and minerals.
6. Reduction of biodiversity due to the blocking of the movement of organisms and because of changes 1, 2, 3, 4, 5 and 6.

impacts due to the pattern of dam operation:

1. Changes in downstream hydrology – change in total flows; change in seasonal timing of flows; short-term fluctuations in flow; and change in extreme high andlow flows.
2. Changes in downstream morphology caused by altered flow pattern.
3. Changes in downstream water quality caused by altered flow pattern.
4. Reduction in riverine/riparian/floodplain habitat diversity, especially, because of elimination of floods.

When reservoirs are created, large areas of forests and land, including agricultural lands, are flooded. Such areas often include wetlands, which are important wildlife habitats, and low-lying flood plains, which are often fertile croplands. Flooding of forestland also means the loss of species and habitat diversity. The biodiversity impacts of dams can be broadly

classified into 5 categories:

- ✓ Impact on aquatic ecosystems
- ✓ Impact on terrestrial ecosystems
- ✓ Impact on agricultural biodiversity
- ✓ Impact on micro climate; and
- ✓ Impact on ecosystem services

Impact on aquatic ecosystems and biodiversity

Reservoir creation will have many effects on water quality, including:

- Reduction in oxygen content and gas release (methane, sulphuretted hydrogen). Anaerobic decomposition of inundated vegetation consumes large amounts of oxygen and produces noxious gases that are toxic to aquatic life.
- Slow water flow can lead to thermal stratification, with warm water on top and cold water underneath. Since the cold water is not exposed to the surface, it loses oxygen and becomes uninhabitable for fish.
- Habitats for fish that feed / spawn in the river bottom, and for invertebrates such as insects, mollusks and crustaceans, are reduced or destroyed by intense flooding and depletion of riverbed gravel.
- Construction activities, including the diversion of the river through a tunnel, cause major disturbances and have adverse impacts on the aquatic ecosystem. In many cases, vulnerable species, with either limited distribution or low tolerance, become extinct even before the dam is completed.

Impacts on agricultural biodiversity

Reservoirs often submerge productive agricultural land. This will have an associated social and economic cost but will also adversely affect agricultural biodiversity. Endemic species of cultivable plants, domestic fauna and gene pools might be irrevocably lost, before their full potential is realized. A host of birds, insects, mammals and reptiles that are dependent on agricultural ecosystems also are negatively impacted in the process. In many cases, traditional crop varieties and methods of cultivation might disappear because of the submergence of agricultural lands. The EIA reports in India have so far ignored this component of biodiversity and concentrated more on the "wild" biodiversity – that too in a narrow sense of larger and charismatic wildlife forms.

Impacts on micro climate

The existence of a reservoir and the resultant changes in temperature and humidity can negatively impact the biodiversity of a region, which otherwise might be naturally adapted to a warmer and dryer climate.

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