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Biodiversity and wetlands

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Abstract

The implications of the Biodiversity Convention of the UNCED Conference in Rio are discussed in terms of the obligations of participating states. The importance of biodiversity is outlined with special reference to wetland ecosystems. The values of wetlands and wetland biodiversity are discussed and a possible classification strategy for their conservation and wise use is suggested.

Introduction

Since the UNCED Conference in Rio de Janeiro in June 1992, where world leaders discussed Planet Earth and the influence and impact of mankind upon it, much has been written and said about the four main topics: Climate Change, Forest Principles, Sustainable Development and Biodiversity. At the Plenary Session in Rio on 14th June, a global partnership for sustainable development – known as Agenda 21 – was adopted. This was a consensus of agreement between participating nations to produce realistic targets to redress the balance between mankind and the natural environment within the twenty-first century. In other words there is a realization that the quality of the global environment is in serious decline.

Care must be taken that the euphoria born at the Rio conference is not allowed to degenerate into a series of platitudes in which words like 'biodiversity' and 'sustainable development' become political words of convenience rather than words of true meaning.

Definition of biodiversity

In order to be able to consider 'Biodiversity and wetlands', first it is necessary to have a clear idea of the meaning of biodiversity, its attributes and values. At the Convention it was defined thus:

'Biological diversity means the variability among living organsism 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.'

Note, biodiversity does not just refer to the biological diversity of species and the protection of threatened species but covers the whole spectrum of the natural environment. A working definition might be:

'The diversity of plants, animals and micro-organisms; their assemblages, habitats, ecosystems and natural areas, the mosaic of which constitute the landscape which gives richness to the natural environment.'

Both definitions bring out the significance of

scale, from strains of microbes to entire ecosystems and landscapes. The variability within species is equally as significant as the diversity of species within habitats. Assemblages of organisms which typify natural habitats and ecosystems are integral to the biological diversity of a region.

Importance of biodiversity

At the Rio conference, some 156 nations signed the Convention on Biological Diversity. Mongolia had the distinction of being the 30th country to ratify the convention, the statutory number required to make the convention international law. Alongside chapter 15 of Agenda 21, which addresses the need to improve the conservation of biological diversity and the sustainable use of biological resources, there is now a global forum for action.

Actions of human beings have degraded the natural environment and diminished biological diversity. Statistics suggest, for example, that half of all extant species may become extinct within the next 100 to 300 years (Wright *et al.* 1993). Generally, extinctions of taxa seem to be greater in an island environment than on a continent, probably because organisms have less area to hide or migrate on an island (WCMC 1992). It is pertinent to note that 66% of the continental extinctions are aquatic taxa. This highlights the exceptional sensitivity of the wetland and freshwater ecosystems to external pressures, for they behave as 'biogeographical islands'. The rate of habitat loss is even greater than species extinctions. In the USA some 54% of their original wetlands have been lost. The statistics for Europe are thought to be even greater whilst in New Zealand over 90% of their wetlands have been destroyed since the onset of European settlements (Dugan 1990). Data are less available for developing countries but a few examples may provide some indications of loss. In the Philippines around 67% of the mangrove forests have been lost over the last 60 years or so whilst in Senegal, 90% of the production from floodplains are expected to be lost by early next century (Dugan 1990). Scott and Poole (1989) found that of the 734 wetland sites studied in Asia, only 107 are not under threat.

At the other end of the scale, at the molecular dimension, there is the reduction of the total genetic resource due to animal and plant extinctions. Whereas extinctions of species is a natural process of evolution the *rate* of loss has dramatically increased over the last two-hundred years or so. The earth's diversity is the pool from which individuals are created and evolution, through 'survival of the fittest' proceeds. If the total genetic resource declines, then the ability of taxa to adapt to changing conditions through genetic diversity declines accordingly and populations may not survive.

Why is Biodiversity so important? There is a range of reasons including precautionary, moral, indicative, aesthetic and economic arguments (HMSO 1994).

Precautionary argument

The precautionary argument accepts that our knowledge is insufficient to make definitive judgement on how much loss of biological diversity can be sustained without irretrievable damage. Until our knowledge is sufficient it is wisest to conserve biodiversity and use the natural environment on a sustainable basis. The argument can be used at a number of different levels. On the global scale, imagine Planet Earth to be one colossal living organism, a concept developed in the Gaia philosophy. The ecosystems: the forests, wetlands prairies, uplands and oceans are the life of the planet which interact with land, air and water to sustain its natural health. The inter-dependence and successful functioning of ecosystems is critical to the planet as a whole. The photosynthetic activity and carbon fixation of living plants, for example, is crucial to the CO_2 balance in the atmosphere; a major gas in the global warming equation. In the wetland context, how much carbon is fixed globally in wetlands; what is their contribution to the CO_2 balance and how does wetland degradation affect the balance? Parallel arguments can be used for the effects of industialization and pollution of the air, land and sea on natural habitats. In freshwater systems the effects of pollution can be very sinister as the source may be diffuse, many hundreds of kilo-

metres devorced from the area of impact, and it may accrue for decades. If forests, wetlands and other ecosystems continue to be degraded at the current rate, when will the critical stage be reached beyond which an ever-increasing downward, uncontrollable spiral of environmental imbalance occurs?

A more utilitarian argument is the commercial value of plants and animals. Breeders draw upon gene and gene combinations from the wild-type genetic pool for a particular quality of individual. It is interesting to remember that a number of food-crops originated in wetlands and the wild-type genetic diversity has enabled the breeding of very successful commercial crops. Rice growing, oil palms and tilapia fish-farming are prime examples. Biotechnologists search for 'medical plants' and, through gene implantations and manipulations, create a panacea of organisms for commerical exploitation. Whilst, probably, only a relatively small number of genetic resources will be of direct commercial benefit to mankind, the precautionary approach argues that the risk of losing the valuable genes from the pool cannot be takne, and genetic resources must be conserved.

Moral and indicative arguments

The moral argument supports the view that mankind is a steward of the natural environment who should look after and improve it; and hand it into the next generation with pride. With industrial progress and modern technologies there is the ability to destroy or conserve nature. With this power goes the responsibility to act wisely. The indicative argument for the conservation of biodiversity places a value on the ability of biodiversity to provide an indicator or barometer of the 'healthiness' of an environment. If external conditions change, say through pollution, then organsisms adversely sensitive to the change will decline in numbers and diversity whilst others, opportunists, may invade the territory. The species diversity provide stability to the ecosystem. A change in biodiversity is often the first indicator that the environment is changing. Eutrophication of rivers and lakes, for example, is often identified by changes in phytoplankton, zooplankton and invertebrate community composition long before fish kills are observed. By long-term biodiversity survey and monitoring programmes changes which proceed through natural evolution can be separated from those attributed to human interference. Indeed, in the United Kingdom the National Rivers Authority uses a benthic macro-invertebrate index for the measurement of river water quality and English Nature, the statutory government advisor on conservation in England, has developed an index of waterplant assemblages to classify rivers according to their quality.

Aesthetic and cultural arguments

Aesthetic and cultural arguments are largely emotional; *i.e.* that the biodiversity of landscapes and natural ecosystems, and the species they support, can provide solace and a feeling of 'homeliness'. The pleasures gained are of direct therapeutic value but cannot be priced. Some tribes in Africa consider the clay from particular wetlands as sacred and use it to smear over the body during circumcision ceremonies – a practice which is fundamental to their cultural heritage. There are many, many other example of wetlands as part of a cultural heritage, but how do you price this value?

Moral, aesthetic and cultural arguments have other dimensions which have to be taken into consideration; that is, the priority placed on these values compared with the immediate and real needs of the land for other purposes. This is particularly pertinent, but not confined, to the developing world where national debts, poverty and population growth place enormous pressure on the natural environment. Conservation of biodiversity is a long-term strategy which may appear to be a luxury a government cannot afford when the short-term non-renewable exploitation of resources can produce demonstrable relief. The 'reclamation' of wetlands by canalization and drainage is an obvious target area for utilization as the land can often provide very worth-while, short-term benefits. Agenda 21's philosophy of global partnership through the redistribution of technologies and wealth to areas of need should be able to help

achieve a balance between the short-term need for non-sustainable use and the long-term desire for conservation.

Economic arguments

Biological diversity constitutes a capital asset with enormous potential for yielding sustainable benefits, but it is proving very difficult to quantify its value. Certain attributes can be allocated a price which reflects its commercial value. This may be the value of a habitat as a tourist attraction, of a forest for sustainable wood production, or a species for direct commercial exploitation. The functional values of an ecosystem – a wetland for water storage and maintenance of higher atmospheric humidity; a mangrove swamp as a nursery for fish stock; or a floodplain grassland for protection against soil erosion, is much more difficult to price. Often the true and full functional value of an ecosystem is chronically underpriced as only a small proportion of all its functions is considered 'commericial'. A wetland may be priced according to its commerically-exploitable timber whist its 'hidden' values of providing water for the rural community and reeds for seasonal cropping may be ignored.

There is a plethora of values for biodiversity which defy any sensible pricing scheme. It is a sad reflection of our times that values have to be reduced to monetary terms: what price a national heritage? However, the monetary approach is likely to prevail and it is prudent for wetland socio/economists to attempt to devise a rough and ready working model. Much can be learnt from the cost/benefit analysis by Barbier *et al.* (1991) for the Hadejia-Jama'are floodplain, Nigeria, for the year 1989–90. The analysis demonstrates that when all the known benefits and dis-benefits are logged, it is commercially better to manage the wetland on a sustainable and culturally acceptable basis (which caters for local people and semi-nomadic pasturalists) than by intensive water management schemes for cash crops.

Our knowledge on biodiversity, functioning and uses of wetlands is very elementary and values attributed to wetlands can only be rough and ready approximations. However, the rates of loss of wetlands are so acute that one cannot await full, scientifically more accurate, evalutions.

Values of wetlands

In any cost-benefit analysis and pricing scheme the first step is to tabulate all the known values for the natural resource under investigation. Often, it is helpful to ask the question 'of value to whom?' Clearly, the value of an ecosystem to the inhabitants thereof, might be very different from its value to mankind. The anthropogenic interpretation of value is looking at the problem from only one side. Values of wetlands have been outlined in a number of publications (Denny 1985; Dugan 1990; Claridge 1991; Finlayson and Moser 1991; Davies and Claridge 1993; Whigham *et al.* 1993; Aksornkoae 1993). The value of each is intimately tied up with the culture and needs of the people who exploit it and will be dependent to a degree upon its location. Some excellent local evaluations for the wetlands of south-east Asia have been undertaken by the Asian Wetland Bureau (Othman 1990; Yahya 1990; Said 1990; Khan 1990).

It may be helpful to consider values briefly under four main headings viz: Global, Functional, Habitat and Anthropogenic Values (Denny 1991).

Global values

Global values include those of widespread significance such as the contribution of wetlands to the mosaic of ecosystems which maintain global diversity and their special value as an ecotone between dry land and the open water. Over large continents such as Africa, the lakes and waterways provide refugia for organisms and, because of geological and geographical barriers and climatic zones, they may become isolated into centres of endemism. The fish population of Lake Malawi and the distribution of Podostemaceae (water-

plants whose species are often restricted to particular waterfalls) are good examples.

Functional values

There is a long list of functional values of wetlands. The more obvious ones include: the ability of wetlands to ameliorate the forces of floodwaters and their use in flood control management; wetlands for water supply and groundwater replenishment; the effects of wetlands on micro-climates, especially the cooling effects from evapotranspiration and the increase in the humidity of the air, etc. The ability of wetlands to purify water has long been appreciated and the use of natural and constructed wetlands for wastewater treatment is one of the most-promising clean-up bio-technologies, especially for less developed countries.

Habitat values

The habitat values of wetlands are more conspicuous than most. Wetlands not only provide habitats for some of the rarest flora and fauna but attract spectacular wildlife diversity. However, the provision of exacting habitats for the multiplicity of ordinary organisms, and common species with a narrow distribution range, is just as important. The different assemblages of taxa which provide diversity of species throughout their natural ranges and variability between and within wetland habitats is vital. But the association between the habitat characteristics and the flora and fauna therein is fragile. Wildlife is often associated with wetlands of particular characteristics. Game animals, for example may be adapted to a particular flooding regime. If this is interfered with, say by placing a dam across a river, and by so doing changing the natural flooding cycles of the floodplain, then the game and fish populations may be eradicated.

Anthropogenic values

Anthropogenic values have been touched upon throughout the text and specifically refer to the values of wetlands to mankind. They can be separated conveniently into two categories: **extrinsic** and **intrinsic** values. Extrinsic values refer mainly to governments and private organizations who exploit the wetlands for major commerical purposes. This may include, peat cutting, timber collection, rice schemes and agriculture as well as tourism, water supply and fisheries. Intrinsic values, on the other hand, are those which are of direct value to the people who live around and in the wetlands, especially those whose whole lives and customs are intimately linked with the wetland functions. They rely upon the wetland for their everyday needs for, food, water, building material and trade. To these people the value of the wetland is a priceless commodity.

Conclusions and the way forward

It has been argued that global diversity *per se* has important functions and values which demands its conservation. The Convention on Biodiversity and Agenda 21 provide the mechanism by which this goal can be pursued through sustainable development.

Wetlands support very valuable pools for biodiversity and genetic resources. However, they are under particular threat through destructions of the ecosystems and loss of species. Indeed, the extinction of species in wetlands is higher than for any other ecosystem, due, probably, to the biogeographical isolation of wetlands in the larger continents and their tendency to behave as biological islands.

In order to conserve wetlands and their biodiversity it is important for a nation to define its **'critical environmental capital'** (English Nature 1992). That is, those elements of the environment for which loss would be critical on a global, national or local level. This is the **'Natural Capital Stock'** of the nation. The natural capital stock is not tradeable and must maintain its value on a sustainable basis. This does not mean that these areas or ecosystems have to be preserved as museum pieces. Changes can occur but the stock is protected against overall degradation. Thus, an integrated

management plan for a wetland may provide for a number of local and commercial activities as long as the integrity and values of that wetland are retained.

A key element in the concept of a critical environmental capital is the appreciation and accurate determination of carrying capacity. As mankind is the main moderator of the resource, either directly or indirectly through his activities, then the size of the human population and the pressures its activities impose on each ecosystem must be assessed. In this way an optimal population size for a country in balance with its natural resources can be projected. If the carrying capacity is exceeded, then the environment suffers accordingly and discussions on moral, aeshetic and cultural values become largely academic. UNCED and Agenda 21 address these issues but it would be naive to think that solutions will be easy.

To conserve the biodiversity of wetlands a sustainable development strategy, in which wetlands are classified according to their values is needed. The classification could take the following form: An Environmental Capital Index for each wetland could be prepared taking into consideration the global, national and local values of the wetlands. Wetlands could then be placed into one of three categories according to their Index, *viz*:

(i) *Natural Capital Stock*. The category with the highest Index constitutes the Natural Capital Stock of the nation and thus, has the highest conservation requirements.

(ii) *Natural Exploitable Stock*. This category will normally contain the largest proportion of wetlands. The important functions and values of these wetlands will be retained but others, deemed non-essential, can be allowed to degenerate.

(iii) *Natural Replaceable Stock*. This is the lowest category containing those wetlands of minimum value which can be destroyed. In order to retain the total wetland resource of the nation a policy of 'no net loss', pioneered by the United States of America, should be adopted. Thus, if a wetland is destroyed, another of similar area should be created. The biodiversity and functional values of the newly-created wetland may not be the same but, with time, it will develop its own characteristics and values.

Because of the total value of wetlands to the global environment, the precautionary argument demands that all judgements and assessment veer towards protecting the habitats until knowledge may suggest otherwise.

Having categorized the wetlands it is important to develop management plans appropriate to their needs. The carrying capacity of all compartments of the wetlands including, fisheries, grazing, cropping, seasonal agriculture, tourism, wildlife, etc. must be assessed for the sustainable utilization of the wetland. Objectives and targets need to be set to optimize the uses of the wetland for particular functions and a programme of survey and monitoring needs to be established to audit the management plan. If the targets are not attained, then modifications to the plan can be made before irretrievable damage occurs.

A flow chart highlighting the various steps for the conservation and wise use of wetlands should contain the following elements:

1. Create a *Wetland Inventory* for the nation.
2. Assess the *Values* of the wetlands in terms of biodiversity, functional and anthropogenic values.
3. *Classify* each wetland in terms of an *Environmental Capital Index.*
4. Group the wetlands into one of three categories:
   Natural Capital Stock
   Natural Exploitable Stock
   Natural Replaceable Stock.
5. Develop *Management Plans* appropriate to the category of wetland and its Environmental Capital Index and to the carrying capacities of each compartment of the wetland. Set objectives and targets for wise management.
6. Establish a *Survey and Monitoring* programme for the wetland and *Audit* the results to ensure the objectives and targets are attained.
7. *Moderate* the management plan if necessary, to attain objectives.

8. Abide by the principle of *Sustainable Development.*

If this procedure is followed then wetland biodiversity can be conserved and a strategy for the wise use of wetlands can be emplaced.

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