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Ecology Of Wet-Lands With Particular Reference
To Asian Pacific Region

By

R S Ambasht
ECOLOGY OF WET-LANDS WITH PARTICULAR REFERENCE TO ASIAN PACIFIC REGION

BY

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Wetlands are defined somewhat differently by different people, but there is a general consensus that all such lands which are saturated with water or covered with shallow water (upto a maximum depth of five metres) for at least a few months in a year are regarded as a wetland. Thus all the riparian lands, flood plains, shallow seasonal rivers, rivulets, streams, shallow lakes and extensive margins of deep lakes and dams, ponds, pools, puddles, swamps, peats, lagoons, and continental shelf (bearing mangroves) and paddy fields are parts of the wetland ecosystem. These constitute one of the most important segments of the biosphere upon which man and most other organisms depend for their sustenance. Out of the $510 \times 10^6 \text{km}^2$ of global surface area the oceans occupy 361 and land $149 \times 10^6 \text{km}^2$. Swamps, marshlands, shallow lakes, rivers and periodically inundated riparian lands, paddy fields are all included in wetlands. They are extremely rich in biological diversity i.e. they harbour a large number of plant and animal species ranging from lush growth of algae, aquatic fungi, numerous liverworts and mosses, aquatic pteridophytes, submerged, rooted, free floating macrophytes, numerous microscopic decomposer as well as pathogenic bacteria.
protozoons, molluscs, fishes, and birds. These ecosystems are usually highly productive. Whittaker (1970) has estimated that swamps and marshes have a very high primary production rate of $10^{-4}$ tons ha$^{-1}$ yr$^{-1}$ and account for a global production of $0.4 \times 10^{10}$ ton yr$^{-1}$ and support a biomass of about $2.4 \times 10^{10}$ tons. Such a high rate of productive efficiency is matched only by certain tropical forests and high energy and fertilizer subsidised agricultural ecosystems. Man has always depended on wetlands such as the river, lakes, ponds, lowlands for his day-to-day domestic and irrigation needs of water, fish and for raising wetland crops, particularly rice. Human culture has evolved on the margins of rivers and other waterbodies. In the Asian-Pacific regions, wetlands are particularly important as rice is the principal food of the densest segment of human population living in this region. It may be of interest to divide our subject matter into:

i) Global water storages and hydrological cycle,

ii) Aquatic ecosystem-structure and functioning, and man made problems of the wetland environment, and

iii) The management aspects and highlight important ecological aspects.

1) Global water storages and hydrological cycle:

A number of estimations about the distribution and movement of water on a worldwide scale have been given by different scientists from time to time, important among which are by Hutchinson (1957) and L'vovitch (1979). The total volume of freshwater is estimated to be $28,380.2 \times 10^3$ km$^3$ or 1.92 percent.
of the total water of this earth, which is $14,58,703 \times 10^3 \text{km}^3$.

From among the freshwater stock 84.566% is in the form of ice on mountain tops and the two poles, and 14.094% in the active groundwater. A very little fraction of the total freshwater is in lakes (0.987%), soil (0.299%), rivers (0.004%), and in the atmosphere as vapour (0.049%). Although, the freshwaters of the wetlands appear to be an insignificantly small fraction yet, they are the most important source of water for all the life on the land and they cycle rapidly. The largest water storages have a slow turnover rate and a long residence time such as the world oceans have 3,000 yr., deep groundwater 5,000 yr., ice caps or glaciers 8,000 yr., and active groundwater 330 yr. but, the wetlands have a turnover rate of few days, months, or one to five years only i.e. the water is in a very rapid state of movement or recharging. Hydrological cycle is primarily powered by solar energy. The oceans supply 84% and land 16% of the total evaporation to the atmosphere while, on precipitation the oceans receive 77% and the land 23% of the rainfall. Thus, the land receives an additional 7% moisture in the form of clouds from the sea through wind which, it returns every year by surface and subsurface runoff (rivers, and underground flows). Ten days is the average residence time of water molecule in the atmosphere, and if at a given time all the atmospheric moisture is made to precipitate it will equal to 2.5 cm of rainfall (and the global average rainfall is 85.7 cm). Atmospheric water vapour and clouds have a very significant controlling effect on the temperature regime as in its total absence the night temperature would fall
down to much below the freezing level even in the warmest tropics. There is very little that we can do about the global hydrological cycle, but much undesirable effects on water quality and quantity on localized places are taking place. The technology of artificial rain making has been developed but it is costly and should not be normally resorted to as it almost amounts to stealing the legitimate rain of another place. Destruction of vegetation in watershed areas have resulted into increased conversion of rainfall into streamflow. In absence of plant cover, the rain beats the soil, selectively deposits the finest soil particles - clay on the surface which blocks infiltration resulting into lateral runoff. Water carries with it the most fertile and nutrient rich part of soil with it to streams, rivers and to sea. In the process of rapid runoff of an increased quantum of water and in absence of adequate vegetation, gullies are formed. Fertile land bearing forests are converted into wasted ravinous lands. Presently, dams, embankments and dams receiving the and carrying capacity are reduced, resulting into flooding of the surrounding villages, cities, croplands and forests. Further, in absence of adequate infiltration, the soil becomes dry quickly and drought conditions prevail later. Thus, wetlands and watershed lands need careful management to reduce the unpredictable but inevitable floods and droughts.

ii) Structure, Function and Problems of Wetland Ecosystem:

Wetland Ecosystem or ecological system is the assemblage of variety of aquatic, amphibious and terrestrial green plants as primary producers, animals as secondary producers or consumers,
microscopic bacteria and fungi as decomposers or reducers of dead organic matter on the one hand and non-living components like soil-mud, water, nutrient elements, light and temperature regimes fluctuating with depth and diurnally and seasonally on the other. These components interact and influence each other in such a way that almost a self sustained and self regulated structural and functional entity is formed. Such entities or ecosystems have formed and reached to natural balanced states in course of long time. Man needs the resources of wetland for a number of purposes such as, water for drinking, cooking, washing, bathing, other domestic and residential needs, irrigation of crop fields, industrial uses for washing, coal washeries, solvent, slurry, boilers for steam engines, coolants, etc. Man also non-consumptively uses rivers and stream and dam water for navigation, transports (floatation) of logs, generation of hydroelectric power, recreation and aquatic sports. Then the products of wetlands such as crops of rice, water chestnut, some other coarse grains eaten by tribal and poor villagers, lotus flowers and seeds of Eleuryale ferox ("Makhana" - a dry fruit), rest of the game birds also abound wetlands and play their roles in food chains and links between different wetlands. In quest of all these and many other needs of water and products of wetlands, man has been increasingly exploiting these ecosystems to the extent of destroying it at many places. Further, wetlands are indiscriminately being used as dumping place of all kinds of wastes, pollutants, sewage and effluents from factories. No other
kind of ecosystem has received the onslaught of ecological disturbance and pollution to even half as much extent as the rivers, lakes and low-lying lands. They have been treated as the 'sinks' of all kinds of harmful and toxic wastes. These have caused a variety of harmful effects on the resource quality. Well known phenomena of biological magnification of toxic chemicals like DDT are reported from several places in the Asian Pacific region. DDT sprayed to control mosquitoes and other pests, even though applied in innocently low levels, gets accumulated in the body of phytoplankton and macrophytes in thousand times more concentrated form. The twig inserts and fishes eating these plants further concentrate the harmful chemical by another few thousand times. The process is repeated at next trophic or feeding level and the DDT concentration reaches highly toxic level by the time it reaches the top level of food chain involving man and fish eating birds. Similarly, mercury accumulation in form of methyl mercury have resulted into mass scale human deaths on prolonged consumption of fishes from such polluted wetlands. Minamata disease of the Asian Pacific in Japan is the well known example. Besides, biological magnification, there are numerous other instances of ecological back lashes or boomerangs from wetlands. Indiscriminate application of pesticides to control aquatic weeds and pests at one place have reached non-target and useful resources and killed the fishes or affected human health indirectly through infected water and food. Water needs of man are too numerous and too well known to be listed here. But his first need is for his own body metabolism which is 2 to 3 litres per person per day which
drinks and obtains from food (containing water). But, his other needs are very high. A modern city dweller in India requires about 50 to 100 litres per day for his domestic and residential needs and his counterpart in large cities of highly developed countries consumes 500-700 litres. Production of one Kg. of wheat requires about 500 litres of water (mostly transpired out to air by the plant) and for 1 Kg. of rice the requirement is about 1500 to 2000 litres. It is estimated that the water intake of grass taken by a cow to produce 1 litre of milk is about 4000 litres. Industrial products like paper, synthetic fibres for cloth, steel, cement etc. require several hundred or thousand times water of the finished product.

Different kinds of wetlands have somewhat different kinds of ecological problems. Rivers have the problems of frequent floods, excessive siltation, nutrient enrichment, point source pollution of sewage, reduced dissolved oxygen, high BOD, high incidence of pathogenic bacteria, excess of toxic metals and certain chemicals like chlorides (from fertilizer factories), phosphates (from detergents), etc.

There are extensive wetlands in the Asian Pacific, South and South East Asian countries. In the Indian subcontinent, the main river basins are of Indus, Ganga and Brahmputra in the north, Narmada in the central and Godavari, Krishna and Kaveri in the south. There are extensive lakes in the Kashmir, Alipatter, Nilnag in the high mountains and Manasbal, Wular and Dal in the valley. Bhakra is a very large man-made reservoir (by damming the middle Sutlej river) 168 km². In the Gangetic basins the
Alluvial plains have numerous big and small lakes and rivers Ganga, Yamuna, Ramganga, Gomati, Sone, Kosi, Gandak, etc. A series of big and small dams are situated in this region. Bengal and Bangla Desh can be classed entirely as a wetland. The extensive flood plains of Ganga and its tributaries and River Padma in Bangladesh yield richest crops of jute, rice and high yield of fishes, and the extensive Sundarbans bearing one of the best mangrove forests of the world are in this belt. The coastal brackish water wetland of Chilka- a lagoon like opening of the Bay of Bengal in Orissa has a unique combination of low salinity and high fish yield. This lake is also experiencing widespread pollution, disturbance and degradation. Further South, Godawari and Krishna watersheds have also numerous inland large dammed wetlands like Nagarjuna Sagar (286 km$^2$ surface area) and lake Gorewada, Ambarasi Pulicat are also facing ecological problems of pollution. Kaveri watershed also has a number of tributaries and man-made dams like Krishnaraja Sagar (on Krishna river), Bhawanisagar (on Bhawani and Bryar rivers), Amarawathy reservoir and natural lakes and ponds throughout the Tamil Nadu and Kerala.

Thailand, Malaysia and Indonesia are almost entirely wetlands except the mountainous regions due to excessive rainfall and preponderance of rivers, lakes, swamps and marshes. In Malaysia the important wetlands studied are Gombak River in the West Coast, Subang Lake badly polluted presently by oil palm and rubber industries, River Pahang basin in the Central peninsula with extensive swamps of Tasek Bera, Tasek Chini surrounded by
rainforests. Malaysian wetlands are very rich in fish production, with over 250 freshwater fish species occurring there. Very similar is the situation of wetlands in Vietnam, Kampuchea, Thailand and Laos, where unlike Indian subcontinent, there is much less seasonal temperature difference. Mekong River basin, extending over 795000 km$^2$, originating in Tibet-Sikliang plateau flows to South-East through China enters Burma, Vietnam, Laos and Thailand. Water is plentiful in this region. The Great Lake of Kampuchea is 110 km long and 30 km wide with average depth of 0.7 metre and volume of $2 \times 10^9$ m$^3$. Its drainage area is 90000 km$^2$. It is very rich in algal flora and fishes provide 50-75% of the animal protein needs of the people. Lower Mekong basin yields over 300,000 tons fish per year. Fish preponderance is delicately regulated by flowing river water where spawning takes place and from where fish fingerlings migrate to lentic regions. Indonesia has nearly 3000 islands many of which have very little human population. Jawa is the most densely populated island. There are many water laks such as Ranu Lamangan, Bali and Sumata are also very rich in wetlands and there are numerous studies on Indonesian wetlands in recent years. Important ones are Toba in Sumatra, Pasir, Pakis, Bedali in Jawa, Bratan and Batur in Bali, etc. The Philippines lake Lanao is regarded as a very ancient formation, about $5.5 \times 10^6$ years old (with a surface area of 357 km$^2$), and L. Mainit has a surface area of 141 km$^2$.

(iii) Management Problems:

Due to limitation of space and time, the conservation and management aspects of wetlands of Varanasi region comprising the
ponds, watershed areas, and the riparian corridors of the river Ganga and Gomati floodplains are being taken up in this paper. The general features as illustrated by a number of colour slides are clarified to illustrate the nature of vegetation, biotic influences, erosion of soil, gully formations, reduced infiltration of water, increased runoff, and heavy loss of nutrients due to anthropogenic forces. These also illustrates the nature of physico-chemical changes in the water quality and the consequent loss of biotic resources. A series of experiments and field studies by the author and his students (B.D. Tripathi, K.R. Verma, K.N. Misra, R.P. Singh, M.P. Singh, Shardendu, Md. Sikandar, A.K. Srivastava, Shankar, N.K. Srivastava, and Kumar) on the effluent discharge into river Ganga, water pollution of Ganga and Rihand rivers, ecology of two very big shallow lakes (Gujar and Surha), and soil, water, and nutrient conservation by the riparian herbs on the river Ganga and Gomati banks and by the herbaceous communities of a watershed land in Chakia forests. The data are illustrated through a series of tables.