Balancing the Uses of Wetlands

John Berry

Synopsis

The British Isles, and especially the Scottish Highlands, although small in size when contrasted with continental areas, can provide examples of errors and of successes of techniques for environmental conservation in hydro-electric and other water-use developments. Some U.K. experience in wetland conservation is of general application throughout the world.

The history of water storage works is sketched briefly from some 3,000 years ago to the present time. Ruthless exploitation of water resources for a single purpose, such as power generation, is now being succeeded by multi-purpose planning. The environmental importance of maintaining wetlands is increasingly appreciated. To replace lost wetlands, new water areas can be made: antipodal examples are given from England and from New Zealand.

The initiative of the Government of Guyana is commended for holding an international symposium on “Hydropower and the Environment”. A seminar, to which selected specialists in wetland ecology were invited, is claimed to have ‘lighted a candle’ for wetlands throughout the world.

Introduction

In the Chairman’s Foreword to the first number of the Journal of the Ecological Society, Mr L. G. Rajwade drew attention to the realisation
in recent years that "... Natural Resources like land, trees, water and air..." are not, as previously regarded, "...in such plentiful supply as not to need any particular care or attention with regard to the extent of their use and exploitation." The global importance of Mr Rajwade’s wise counsel is not yet sufficiently appreciated. But, as he indicates, in some countries so much environmental damage has been done that Governments are now giving attention to the advice of voluntary bodies such as the Ecological Society, who have been warning of trouble and offering the help of expert advice.

It has been my personal concern to study, in particular, the ecological consequences of use and misuse of water resources. Over many years I have been involved in hydro-electric and other water storage projects, and in efforts to ameliorate damage which some water schemes have done to freshwater fisheries, agriculture, forestry, wildlife and scenery.

The Setting

When the International Union for Conservation of Nature and Natural Resources met in New Delhi in November, 1969, for the Union’s General Assembly and Technical Meeting, "The Ecological Effects of Water Storage" was a main topic of study and report. Introducing a Paper on Studies of Water Storage in the British United Kingdom (Berry, J. 1970), it was claimed that although it might seem trivial in the vast sub-continent of India to consider studies of water-use in such a small island country, yet "...the United Kingdom and particularly in this context, the Highlands of Scotland, can be regarded as a research laboratory where techniques can be studied and data obtained some of which can be of general application throughout the world. Thus a dam only 70 feet (21 metres) high in Scotland (seemed)... to have parallels in its ecological problems with those of the Idikki Dam... (then)... being constructed in Kerala, about 700 feet (210 metres) high...". Before the I.U.C.N. November meeting in New Delhi, a team of four ecological specialists, each man from a different continent, had been appointed to carry out an inspection and to report to the I.U.C.N., for the Indian Government, on the Periyar Wild Life Sanctuary in Kerala State. In particular the team was charged to recommend the best multiple use of the large reservoir, Lake Periyar, which had been created by a dam on the Periyar River built in 1895. In the Periyar survey it was of relevance to consider experimental use of Scottish hydro-electric reservoirs for wildlife conservation, fisheries, tourism, flood-control and other purposes additional to the generation of electricity (Berry, J & others 1971).

Hydro-Electric Development in Scotland

Although it is about a century since the first hydro-electric scheme in Britain was built in the Scottish Highlands, the country was slow to make further use of this great self-renewing and non-polluting source of power. Some early schemes had made maximum use of the water with ruthless disregard of other interests. Opposition to all hydro developments increased. The strongest opposition arose from fears that irreparable harm would be done to stocks of salmon and trout in lakes and rivers liable to be affected and that beautiful scenery would be irretrievably marred. Apart from aesthetic aspects, this opposition was based upon economic grounds; the netting of salmon and sea-trout was an industry of growing value, and angling, scenery and wildlife are major attractions for tourism which is of financial importance in many rural areas. Such was the strength of the opposition that it seemed impossible for any hydro-power promotion in the Scottish Highlands to receive the necessary Parliamentary approval. At last, in 1943, an Act was passed in the United Kingdom Parliament creating a public utility organisation for the generation and distribution of electricity throughout north and west Scotland and the islands where waterpower could be the main source of supply. The unique importance of this Hydro-Electric Development Act was that, perhaps for the first time in any country, the Act placed on the new Board a statutory duty not only to produce electricity, but to safeguard so far as practicably possible, stocks of fish and scenic amenity in all areas affected by its works. Statutory Advisory Committees were set up for Fisheries and for Amenity, and the Board also appointed specialist advisers and consultants of its own. The recruitment to the Board’s senior headquarters staff of a biologist-environmental conservation specialist, from the outset of the Board’s work in 1944, appears to have been a precedent for environmental study and research at the earliest planning stages of such industrial developments. That the same specialist who was appointed to the Board’s staff in 1944 should still be retained as the Board’s adviser in 1986 is also remarkable.

Water Diversions and Impoundments

To study the effects of water diversions and impoundments and changes caused thereby in the natural flows of rivers, one must go back a long way in time. Dams to collect and retain water are among the oldest engineering structures known, dating back for almost 5,000 years. The oldest dam still in use may be one on the River Orontes in Syria; it is
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air..." are not, as previously regarded, "...in such plentiful supply as
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oldest dam still in use may be one on the River Orontes in Syria; it is
cycles of the model fish lock in operation. "The model fish-lock was considered of special note because it provided an impressive demonstration of practical conservation of a wildlife resource of great economic and recreational value—the Scottish salmon fishery—with development of an industrial resource—water power" (Expo 1971).

**Loss and Replacement of Wetlands**

During recent decades, concern has been increasing in many countries at the loss of wetlands. The term "wetlands" includes some inshore coastal waters and all inland water areas—lakes, rivers, bogs and marshes. At an I.U.C.N. meeting at the Hague, Netherlands, in 1951, attention was drawn to the loss of natural wetlands from 'over-zealous drainage projects', pollution and other causes. In compensation, it was suggested that the environmental value of many water areas, whether natural, or 'man-made lakes', might be greatly increased by ecological management.

The use of natural waters for primary purposes, for irrigation and for power, has been altering their extent and character for many centuries; but during the present century and with accelerating impetus at the present time, two unrelated factors have been changing the distribution and constitution of wetlands, particularly in the industrialised nations. These factors are first, the extraction of sand, clay and gravel for the building trade, and secondly surface excavation of coal and other minerals. Both of these developments may result in massive water pollution and in other less obvious impacts, such as alteration of springs, percolating water, water tables and drainage (Berry, J. 1979). Sand and gravel extraction often takes place from, or near to, a river. Large quantities of water may be required for washing and grading the extracted material and returned to a river densely turbid. The extraction of gravel from a river may be of more than local importance where such gravels are the essential and perhaps restricted spawning grounds of fish, notably of such migratory species as the salmonids. Changes in flow velocities, in scour, in turbidity and in other physical conditions may affect fish directly, but sometimes more importantly indirectly through reduction of flora and invertebrate fauna on which the vertebrates may depend. Some critical effects may not be easy to detect, for example, clay in suspension may pollute water almost invisibly; the colloidal suspension can become lethal to young fish with a change in the alkaline-acid balance,—the 'pH' (Berry, J. 1934).

In urban zones, especially near large cities, the pits left after mineral
extractions are likely to be used for dumping rubbish and sometimes toxic waste. Poisoning of ground water seeping to rivers and lakes can result, sometimes with disastrous limnological consequences. On the other hand, extraction pits can be used to create new wetlands of great scientific and recreational value. Two antipodal examples can be quoted to illustrate such use. Both have been dependent essentially upon ecological study, planning and management.

A Gravel Pit Reserve in England

The first example is the Sevenoaks Gravel Pit Reserve in Kent, England. Extensive extraction of gravel for industrial building left large pits which were flooded. Use of the pits for wild life, instead of filling them in as a dump for disposal of urban and industrial rubbish, was negotiated with the Sand and Ballast Company who owned the site. The Company generously cooperated with the conservationists, using their earth-moving machines to make islands and in other ways to make the site more suitable as a reserve. A wonderful new man-made wetland area has been formed. Some indigenous water and marsh flora was planted, but a rich and remarkable colonisation by plant and animal species took place naturally when the habitat had been made attractive for them. More than thirty species of mammals have been recorded in or near the area now declared a Nature Reserve; it has an interesting population of fish, but outstandingly it has become a bird resort, both for migrants on passage and for species breeding and for others wintering. Perhaps most noteworthy is the reestablishment there in Kent County of breeding and wintering Greylag Geese (Anser anser), previously long extinct as residents in the southeast of England. Scientifically, the Gravel Pit Reserve is valuable for the opportunities it provides for study and research in environmental conservation (Harrison, J. G. 1974). But the particular significance of the Sevenoaks Reserve is its location in the populous conurbation of south London. People who profess no interest in birds, nor in Nature, may be entranced to watch Common Kingfishers (Alcedo atthis), Shovellers (Anas clypeata) and other handsome water birds amid the beauty of flowers and water plants which have replaced the desert of the former gravel pits. To have such an oasis of nature in such a place is cogent propaganda for wildlife conservation. Common Kingfishers, Shovellers and several of the other kinds of birds to be seen at Sevenoaks can be watched also in another urban wildlife oasis far distant from southeast England. It is the remarkable Mula-Mutha Sanctuary within the City of Pune, Maharashtra. The foreword to the 'Bird-Watchers Guide to the Mula-Mutha Sanctuary' admirably sums up the way such places make their popular appeal: "The appreciation of the beautiful and the novel is a characteristic latent in the human species. There is none in whom the seed of this faculty is entirely wanting".

An Artificial Wetland in New Zealand

An example of an impressively successful man-made wetland can be seen on the opposite side of the earth, in the South Island of New Zealand. In the great Otago power development of the Waitaki River system, the Benmore Dam, 110 metres high, flooded some 80 sq. km. of land. Downstream from the Benmore Dam is another great reservoir created by the Aviemore Dam, 56 metres high, and downstream is yet another big reservoir. The chain of man-made lakes has provided a wonderful extent of water for human aquatic recreation and vistas of scenic beauty, but the lakes, Lake Aviemore in particular, inundated an extent of marshes and swamps previously of scientific importance as the breeding grounds of many water birds. Among these was an isolated local population of the Pukeko (Porphyrio melanotus), a large purple Gallinule with singular nesting requirements. Before the Aviemore reservoir was filled, sections of the natural marsh, with clumps of a giant rush in which the Pukekos habitually nested, were removed with big earth-transporters to recreate similar marsh conditions in gravel pits some miles away. Pukekos were caught by night and transported in the dark, with their nests and eggs, to the artificially-made duplicate habitat. Some other species were transferred in a similar manner, and as the reservoir slowly filled, stilts, dotterels, herons, ducks, gulls, and other birds of inundated Aviemore marshes, transferred themselves. Revisiting the Waitaki valley five years later, one found that the man-made habitat had completely replaced the former Aviemore marshes. All the species which had characterised the original marshes and lagoons were now so well established in the transformed gravel pits area that one might think it had always been their natural habitat.

The Waitaki-Aviemore wetland transplants demonstrations the engineering practicability of replacing completely an ecologically important wetland on a very large scale. Of course, the cost was considerable, but it was a comparatively small part of the great over-all cost of the Waitaki power development. Such replacements of important wetlands can be made a condition of approval for industrial development. Specialists in environmental ecology with the necessary expertise and experience for such translocations, are still few in number; however, keen
young ecologists are now getting trained for this work. They should be given every encouragement.

**Changing Water Levels of Natural Lakes**

When large natural lakes are used for water storage without changing by more than some 5% their former water levels, or the periodicities of their level fluctuations, there is unlikely to be significant change in the wetland ecology. But when natural lakes are artificially deepened by a barrage, with prolonged inundation of adjacent ground, marshes or shallows, grave loss of indigenous flora and invertebrate fauna may result. And drawing down the surface level of a natural lake for longer than natural periods, or at unnatural seasons, may cause ecological destruction of the littoral, except where a former water-table can be maintained artificially. This has been achieved successfully by cutting off from the main lake some bays or inlets and ponding them with small dams; by this means the water level at that location remains in a natural condition and does not drop when the water level in the main lake-reservoir is drawn down. It has proved better to maintain some scarce sensitive species by safeguarding a restricted natural habitat in this way, than by attempting translocation. The fact that a sedentary species is rare, or locally restricted in distribution, implies that it is ecologically unadaptable, and must have precisely the right conditions of habitat to which it has become adapted over thousands of years.

Grave environmental harm has been caused by failure to appreciate that the effects of artificial changes in long-established lake levels may extend far from the lake margins. This is notably so when land adjacent to the lake is rather flat and with pervious soils. Such soils may become waterlogged, or desiccated at a critical season, or leached of nutrients. Many other effects of changing water levels artificially have to be considered: Will the thermocline be altered? Will flooded vegetation rot and pollute water discharged from a dam? or will the discharged water be so devoid of oxygen that fish below the dam will suffocate? Should aero-hydraulic guns be used to counteract stratification? Should rotary dispersers be employed to aerate discharged water and to reduce hydrogen sulphide if the discharged water is to be drawn from bottom layers of a deep reservoir? Such considerations may be of critical importance for wetlands dependent upon reservoir water. It is not only the actual reservoirs and associated wetlands which need careful and skilled planning. Whether reservoirs are to be made by altering natural lakes, or by the creation of entirely new water bodies, ecological study and the planning of comprehensive environmental management from the start is necessary if advantage is to be taken of their potential biological value as productive wetlands.

Hitherto, the wetland importance of large new reservoirs has received less attention than this aspect deserves. A commendable exception is the Snowy Mountains Scheme in Australia. Created to retain, for electric power and for irrigation, snow-melt water in a catchment area of more than 5,000 sq.km., the reservoir-lakes have been planned and managed to provide wetlands of great beauty and with rich wild life in a zone which previously lacked any such amenities. Another example of exceptionally good environmental conservation in a major water impoundment development is to be found in the Koyama Catchment Area, in Maharashtra, India, an area of some 890 sq.km. In that development it was essential to clothe very steep barren slopes of the valley in which the great Koyama Lake reservoir was made, to restrict erosion and siltation of the reservoir. The manner in which the afforestation and concomitant wildlife protection has been achieved is indeed noteworthy.

**Acceptance of Comprehensive Water-use Planning**

Comprehensive environmental planning of large water-use projects is becoming a more widely accepted practice; much credit for this should be given to Guyana. In 1976, the Government of Guyana decided to embark on a very large hydro-development of their Upper Mazaruni River. A dam 43 metres high and 435 metres long would flood a vast area of rainforest. “To provide up-to-date information on environmental aspects of hydropower with special reference to agricultural, archaeological, ethnographic, fishery, forestry, health and recreational aspects…” (to quote H.D. Hoyte, Now President of Guyana then Minister of Economic Development & Cooperatives), and to plan the creation of a unique equatorial wetland of great size and habitat diversity, the Government of Guyana, through their Science Research Council, called an International Seminar on “Hydropower and the Environment”. Countries and international agencies which had practical experience of the conservation problems of large water storage schemes were invited to send a leading specialist on some aspect, apart from engineering and construction. The Guyana Seminar was “...the first-ever such to be held”, and as Prime Minister Forbes Burnham “…remarked in his address when he formally declared the Seminar open, it might well be that the major historical significance of the Seminar was that it made it possible for... Guyana to ‘light a candle in the path of other developing...’...”
countries who seek to develop their resources and to advance into the technological age of the last quarter of the 20th century .” (Guyana 1978).

The I.U.C.N.’s International Commission on Ecology, from its creation in 1954, pressed the clamant need for maintaining aquatic habitats and for comprehensive assessment, at the planning stage, of large water-use projects to that end. But it may be claimed that it was the Guyana Seminar which did indeed “light a candle” for wetland conservation in a way which was unique and unprecedented.

In Guyana, a small team of participants in the Seminar was selected from those deemed to have had exceptional experience and to have specialist expertise in some aspect of wetland planning and operation. The team was taken in an airplane to the remote hinterland above the great escarpment where the area to be flooded was surveyed, with jungle landings by helicopter. This was a daunting exercise, but it provided for us, as ecologists, an exceptional opportunity to discuss with engineers and surveyors, in a largely unexplored terrain, the practicability of creating there a unique wetland and wild life reserve, and how to minimise risks of health hazards such as schistosomiasis and vectors for other tropical diseases.

It is to be hoped that in most countries the importance is now appreciated of maintaining or creating wetlands, with realisation of their potential benefits, but also possible dangers, for human population ecology, hence the need for specialist guidance in wetland planning and operation. Yet in many countries, whether already industrialised or developing, politicians and administrators may be helped by reminders and encouragement from men and women versed in ecological science.

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References


