

CHAPTER 6

IMPACT ON MAN

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6.1 INTRODUCTION

Littoral zones of lakes or lagoons are extremely sensitive land-water fringes and represent the most complex ecotones (see Chapter 5). Especially where distinct zonations such as epi-, supra-, eu-, infralittoral, etc. are developed already, a slight impact may result in profound changes (Kann, 1933, 1986). In this section, however, only the serious and profound changes in the littoral zones, which affect man either by threat to his health or even life or at least to his resources and activities, will be considered.

6.2 MORPHOMETRIC IMPACTS AND IMPACTS BY WATER-MOVEMENT

Lakes held by end-moraines, landslides, glaciers, volcanic ash or peat bogs may last often for a long period and even develop a variety of littoral vegetation. The destruction of such a fragile section of the littoral followed by the sudden eruption of the lake behind it may be released by earthquakes, excessive precipitation, ice- or (and) volcanic or other rock fall into the lake (Löffler, 1988). The most spectacular example of the latter kind was a rock and glacier fall of about 50 million m³ from Mt. Huascarán (Cordillera Blanca, Peru) in 1970 into the lower Lake Yanganuco resulting in the death of about 18,000 people. Sometimes the accelerated growth of a morainic lake by the fast retreat of its glacier may increase the pressure against the end-moraine which finally collapses. Obviously, it is in all these cases listed not an impact from the littoral itself but its labile constitution.

Floods, water-movement from seiches and waves are the most common parameters which may either improve the littoral zonation and its persistence or which exert destruction tendencies on man-made establishments and achievements such as aquatic (paddies) or terrestrial agriculture, roads and settlements or urban areas and different sites of recreation (sailing, boating, etc.). Other serious consequences may involve erosion or silting which often result in dramatic changes in the littoral morphology frequently combined with the alteration of the plant

communities and of the general littoral aspects. Seiche movements and currents have contributed to the fast growth of the large phragmites belt of the shallow Neusiedlersee (Austria-Hungary) since the lake's last desiccation about 120 years ago and have accelerated the siltation of the western part (Löffler, 1979). Therefore, at present, the western shore communities are more or less cut off from the open lake. The shifting of Lop-Nor and sand-dune movements within Lake Chad prior to its rapid shrinking are examples of profound littoral changes in arid zones which can severely influence the traditional life of herdsman, hunters and other socio-economic oriented communities.

Lagoons close to the coast are often subjected to tidal waves which turn fresh or slightly brackish bodies of water into highly saline ones and sometimes to ectogenic meromictic lakes (e.g. Hemmelsdorfer, Hutchinson, 1957). Drastic changes of the macrophytic vegetation will then influence the surrounding inhabitants involved in livestock management.

A more unusual event occurs with the piling up of ice in lakes and the erosional power of these ice flows. Though not a direct impact by the littoral, its shape and slope is responsible for the extent of possible destruction. Ice piles with a height of more than 15 m have been observed in Neusiedlersee and much larger ones are known from other lakes. Their shear force not only smashes solid concrete constructions but may also contribute to the formation of dams along a shore-line. The dam along the eastern shore of Neusiedlersee is most likely the result of such ice flows which occurred during the last several thousands of years. With its main composition of sand and pebbles it is a rather dry structure.

6.3 HYDROLOGICAL IMPACTS

The hydrological influences on the littoral communities are closely related to the water-movement previously mentioned but in large astatic catchment areas additional long-term impacts on the littoral zone, sometimes of irreversible nature, do occur. They are either due to climatic fluctuations or to engineering work devoted to irrigation or diversion of affluents of a lake, a lagoon or a wetland. In semi-arid and arid zones the impacts involved most often concerns salinification and therefore brings about major changes in the vegetation of the littoral zone. Consequently, this means that useful plants, such as *Phragmites spp.*, *Typha spp.*, *Scirpus spp.*, etc. are replaced by a vegetation (if any at all) which may neither be used by man (production of mats, boats, etc. and construction of huts and thatching) nor by domestic stock for food. Dramatic examples of this kind are the Aral Sea, to a lesser extent Lake Niriz in Southern Iran and Lake Hamun at the Iran-Afghan border. With respect to Lake Hamun it should be

mentioned that the traditional "Gaw-Dar" (herdsmen) culture faces its extinction if the vast typha stands should vanish. In all these cases, the surrounding areas are heavily exploited for irrigation. At the same time these are striking examples where a cost-benefit analysis was never undertaken even though it is badly needed. There are, however, also lakes which - due to most recent climatic changes - face a large reduction in area and volume (e.g. Lake Chad in Africa) and consequently their littoral and hence the resources of the dependant human population are heavily affected.

6.4 EUTROPHICATION

With only a few exceptions, eutrophication is almost always induced by man and generally it results at first in not only an increased growth of the littoral vegetation but also a decrease in species. At high nutrient loads, the reduction of submersed macrophytes is a common consequence of the increased growth of epiphytes and filamentous algae. This results in an increase in the phytoplankton growth and a further shading of the macrophytes. Finally, phytoplankton can dominate in such lakes (see Chapter 5). There is, however, a wide variety of scenarios which range from purely aesthetic impacts to serious implications for man's interests. In many alpine lakes, the excessive growth of algae (such as *Cladophora spp.*) may suppress the original littoral zonation of algae (See 6.1 and Kann, 1986). Additional parametres such as the possible increase of tensids may contribute to this phenomenon. More disturbing (particularly in relation to recreation such as swimming, boating) is the accelerated expansion of unwanted submersed macrophytes which in some cases (such as *Elodea canadensis*) are recognized as a nutrient pump, may contribute to further eutrophication. Explosive growth of macrophytes, however, may also occur in relation to the introduction of exotic species. Very little is understood about the growth of the low growing *Characeae* which can suppress large growing macrophytes and at the same time epipelagic algae. Thus the management of *Characeae* in littoral zones used for recreation may become important. Excessive algal blooms (mainly blue-greens) often seriously suppress the growth of submersed macrophytes which in some cases are of economic value for man (e.g. *Myriophyllum sp.* in Indonesia). Expansion of the emergent vegetation contributes to siltation and decreases the area of open water. On the other hand, eutrophic influences of a not yet recognized kind are responsible for the extinction of emergent helophytic vegetation. An example of such a process is the reed belt of the lower part of Lake Constance (Untersee) where phragmites have been vanishing for years. In spite of numerous studies the parametres involved remain unclear. One hypothesis suggests that the allelopathic effect from *Cladophora* is

responsible (Schröder, 1987). Another example of vanishing emergent vegetation concerns *Scirpus tatora* in Puno Bay of Lake Titicaca. It has been estimated that over a four-fold reduction in totora coverage in the inner Puno Bay has been taking place since the mid-1930s. Changes in lake level, channel dredging, harvesting and other factors may partly be responsible for this decrease, but cultural eutrophication intensifying over that period is most likely also involved (Bornejo & Aramayo, 1989). *Scirpus tatora* plays a significant socio-economic role for the native population (e.g. construction of boats, floating islands for aquaculture etc.).

On the other hand, excessive growth of helophytic vegetation may also be extremely undesirable. In many of the lakelets east of Neusiedlersee, well known for their waterfowl, this has become a problem since quite a few species of birds prefer open shore sections. They were abundant when phragmites were controlled by trampling of cattle some decades ago. With the end of cattle farming phragmites quickly started to overgrow the littoral zones.

However, in summarizing the more general aspects one must point out that the possible role of macrophytes (handcraft, thatching, fodder, food for man, fertilizer, biogas, drying up of freshly created polders, accumulation of toxic substances and nutrients, spawning site for fish, etc.) for man is still only tentatively known and therefore - with a few exceptions - the destruction and extinction of littoral macrophytes represents one of the major impacts.

6.5 LITTORAL ZONE POLLUTION

Compared with the marine coastal situation in many parts of the world, littoral zone pollution in lakes is generally of a minor importance. Oil spill, for example, is rather an exception and mainly limited to large lakes. There exist, however, risks of this kind when oil pipelines are transferred close to lake shores as it occurred along the eastern shore of Lake Constance in the mid-1960s. On the other hand, an almost unlimited variety of harmful and toxic substances, such as detergents, pesticides, PCBs, derivatives of asphalt and tar (such as the cancerogenic 3,4-benzopyrene), heavy metals, etc., become dangerous to man in a number of lakes and above all in the littoral zone where most of the resources, often the sustenance for the native population, are concentrated. Therefore, careful handling of the sanitation within given watersheds is of essential importance.

6.6 ACIDIFICATION

In contrast to the oil spill, which is mainly an impact on the marine environment and large rivers used for traffic, acidification concerns almost exclusively lakes within poorly buffered watersheds. The classical examples belong to Scandinavia and the eastern parts of Canada and USA. In some of these lakes an annually drop of 0.02 units of pH has been observed. One consequence is an increase of heavy metals which contributes to the death of fish, zooplankton and other organisms. Cerné Jezero, a small cirque in the Bohemian Mountains of CSR, has been studied since 1871. Already in 1891 a decrease of species of zooplankton was observed and in 1975 the last specimens of *Salvelinus fontinalis* disappeared. The pH dropped from 6 in 1871 to 4.6 about onehundred years later. There is only little information about the littoral zone but it appears that the impact has been much less severe in the area than within the pelagic part of the lake. Macrophytes (such as *Isoetes lacustris*, *Soarganium affine*, *Juncus bulbosus*, *Carex rostrata* and *Glyceria fluitans*) are still present but scarce. It is known, however, from the experimental acidification of small pond ecosystems and from field observations, that increased growth of *Sphagnum spp.*, *Juncus bulbosus* and *Lobelia dortmanna* occurs whereas soft water plants such as *littorella uniflora* are likely to disappear (Gahnström & Andersson, in press). In contrast to the profundal zone of Cerné Jezero (z max. 40 m), where chironomids are at present missing, a variety of species still live in the littoral zone of this lake. Likewise chydorids and copepods are abundant there. Generally, it may be expected that the upper littoral is more resistant to acidification than the rest of a lake. Obviously, the renewal of terrestrial debris and matter is one of the main parametres responsible for this protective influence. There is, however, no doubt that at least the loss of littoral fish species and the increase of heavy metals in the littoral system must be considered as a serious impact on man.

6.7 IMPACT FROM VERTEBRATES

Again, impacts of this kind are mostly induced by man. Exotic species, such as the grass carp (*Ctenopharyngodon idella*) may seriously influence and destroy the phytal region and thus the spawning sites of other fish species. Likewise the introduction of *Lepomis gibbosus* from North America in Central Europe has resulted in a serious depletion of food resources for other fish species of the littoral zone of backwaters of the Danube. Among birds the recent increase of *Fulica atra* in Central Europe has in some places heavily influenced the macrophytic vegetation (e.g. Lunzer Untersee, Austria). On the other hand, the endemic giant coot of Lake Atitlan recently

became extinct after a denivallation of the lake level. Both cases are examples of impacts on the conservation of genetic diversity and on endangered species. Among mammals, the musk-rat (*Ondatra zibethicus*) from North America may be mentioned. It was introduced into Bohemia in 1905 and has since spread over large parts of Europe. Apart from damage to dams and other man-made constructions, it sometimes causes deterioration of littoral zones. Trampling of live-stock (see 6.4) strongly affects the emergent vegetation and the breeding sites of birds. In contrast to horses, (e.g. Camargue in France) cattle feeds only on sprouts of phragmites but avoids fully grown stands.

6.8 HEALTH RISKS

About 80% of all diseases affecting man are due to inadequate water or sanitation which include the effects of drinking contaminated water, water acting as a breeding ground for the carriers of diseases, and diseases caused by the lack of washing water (UNICEF, 1983; Löffler, 1988). Well-known infectious diseases such as typhoid, cholera, dysentery, diarrhoea, certain types of hepatitis, amoebic meningo-encephalitis, etc. are caused by viruses, bacteria and protozoa. In large and deep lakes it is almost exclusively in the littoral zone where such risks occur. But at the same time, this zone offers the easiest access to water for the native population. Likewise, the infection with schistosomiasis, feacioliasis, angyostronylosis, etc. is mainly restricted to the littoral zone in large lakes. Parasites, whose vectors are snails like *Bulinus*, *Biompalaria*, *Thiara*, etc. are lacking in highly alkaline lakes. In the littoral zone of some of the subtropical and tropical lakes venomous snakes may be abundant.

6.9 CONFLICTING SCENARIOS

Recreation - conservation

With respect to conservation and the maintenance of genetic diversity, the loss of lake littoral zones is one of the most significant impacts on man - made by man and particularly by his recreational activities. Almost all of the lakes suitable for swimming, boating, yachting and holiday housing have lost their littoral communities - especially their vegetation - not only in industrial regions but increasingly in developing countries (e.g. Lake Atitlan, Guatemala). The loss of species diversity of littoral bound organisms is increasingly recognized not only by scientists but also by international

organizations and even by local decision-makers. However, the destruction of the littoral ecotones still progresses rapidly.

Traffic, urbanisation and industry - recreation (conservation)

The reclamation of littoral zones by urbanization (e.g. Lausanne, Geneva, Chicago, Milwaukee, Detroit, Toledo, etc.) and by highways of railways is not only a serious impact on conservation and recreation but contributes considerably to the pollution of lakes. Only if a city or industry is concentrated at the outflow area of a lake can the harmful influences to a certain extent be mitigated (e.g. Zürich). Since, in most cases, the existing problems of such a kind have a long tradition (e.g. mule-tracks along lakes which later were turned into roads and highways), improvement of the present situation is unlikely to happen. Even the removal of traffic routes from lake shores is rather costly and therefore very few activities of this kind are at the planning stage or have even taken place (e.g. railway along the eastern shore of Lake Constance).

Agriculture - conservation

Again, reclamation here is the most common impact on valuable littoral zones. Formerly, an outstanding bird sanctuary, the some 100 km² large "Hanság" SE of Neusiedlersee, was drained and at present it is almost exclusively used for terrestrial agriculture. Lake Biwa has lost large portions of its phragmites belt which were replaced by paddies thus decreasing the lake's self-cleaning capacity. Pesticides and fertilizers used in agri- and horticulture additionally jeopardize protective efforts. Similarly, in some countries like Sweden, wetlands and littoral zones are reclaimed for forestry. The adverse but also positive influences by live-stock have already been mentioned in 6.4 and 6.7

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