Lake Constance

Experience and Lessons Learned Brief

*Marion Hammerl**, Lake Constance Foundation, Konstanz, Germany, marionhammerl@yahoo.com
Udo Gattenloehner, Global Nature Fund, Radolfzell, Germany

* Corresponding author

Preface

This Experience and Lessons Learned Brief was prepared by the Lake Constance Foundation (Bodensee-Stiftung), a private environmental organization. The sections concerning contributions to unsustainable lake use, constraints to sustainable management of the lake and lessons learned are reflections from the point of view of an environmental organization. Our statements agree with the Lake Constance Environmental Council (Umweltrat Bodensee) and its 18 regional member organizations. National and regional administrations and the international commissions, as the "officials" responsible for governance and management, might have another opinion concerning some aspects covered in this paper.

1. Description

Lake Constance (Figure 1) lies just to the north of the Alps at 395 m above sea level. It is called Bodensee in German. It has a surface area of 571.5 km², is 254 m deep and has a volume of 48.5 km³. As a natural ecosystem, Lake Constance is a representative and significant natural habitat for plants and animals in Central Europe. Nature preserves such as the Wollmatinger Ried and Vorarlberg's Rhine delta enjoy international prominence. Some basic morphometric information is presented in Table 1.

Figure 1. The Lake Constance Basin.

Lake Constance has German, Austrian and Swiss shorelines. The Principality of Liechtenstein is also located in the lake basin. This international settlement and industrial region is inhabited by over 3 million people. Over 500 people/km² live along the shoreline of the lake.

1.1 Physical and Limnological Data

Lake Constance is the second largest pre-Alpine European lake by area and volume after Lake Geneva. The lake basin is situated in the Molasse basin of the northern Alpine foreland and was mainly formed by water and ice activity during the last Quaternary glaciation period more than 15,000 years before present. The catchment area of Lake Constance is about 11,500 km² and covers the territories of three European countries: Germany (28%), Switzerland with Liechtenstein (48%) and Austria (24%).

Lake Constance is traditionally divided into Lower Lake Constance and Upper Lake Constance. More than 90% of the water flow originates from the Alps by the three inflows Alpenrhein, Bregenzerach and Dornbirnerach in the eastern part of the Upper Lake.

Lake Constance is oriented from northwest to southeast and the water body is strongly influenced by wind activity. It is a low-phosphorus, mesotrophic, hard-water lake with calcite precipitation due to biogenically induced increase of the pH. Electrical conductivity of the water typically ranges between 260 and 300 µS/cm.

1.2 Wildlife and Habitats

As a natural ecosystem, Lake Constance is one of the most representative and important wetland habitats for plants and animals in Central Europe. Lake Constance has particular significance as a resting and wintering area for approximately 250,000 water birds and is the most important inland body of water for water fowl in Germany, Switzerland and Austria. During autumn and winter, the maximum number of individuals of given species is as follows: great-crested grebe (*Podiceps cristatus*) (12,700), gadwall (*Anas strepera*) (12,600), red-crested pochard (*Netta rufina*) (20,400), pochard (Aythya *ferina*) (80,000), tufted duck (*Aythya fuligula*) (116,000), and coot (*Fulica atra*) (77,600).

Table 1. Morphometric Data of Lake Constance Basin.

	Upper Lake	Lower Lake	Total
Altitude (m asl) at middle water level	395.33	395.11	
Surface area of water (km²)	500	71.5	571.5
Volume (10^6 m³)	47.678	0.808	48.486
Maximum depth (m)	253.3	46	
Mean depth (m)	101	13	85
Mean range of annual water level fluctuation (m)	1.50	1.48	
Length of shoreline (km)	186	87	273
Mean outflow (10^9 m³/yr)	11.1	11.7	11.7
Residence time (yr)	4.3	0.07	
Catchment area (km²)	10,919	568	11,487

The occurrence of more than 350 bird species in Central Europe is only possible in a region of favorable geographical position. The location of the lake at the northern edge of the Alps especially favors the occurrence of numerous migratory birds. Some Alpine birds such as wallcreeper (*Tichodroma muraria*) and crag martin (*Ptyonoprogne rupestris*) breed in the Lake Constance region or are guests such as golden eagle (*Aquila chrysaetos*), Alpine accentor (*Prunella collaris*) and ring ouzel (*Turdus torquatus*).

The most important precondition for a bird life rich in species at Lake Constance is its topographical and ecological diversity. The Lake Constance area is a geographical plant-specific contact zone with a wide range of floristic specialties. Apart from Mediterranean plants, Alpine and even steppe flora from the East are found at Lake Constance.

Unlike other large lakes in the foothills of the Alps, the water level of Lake Constance is not regulated artificially. Plant species of the lake shore are especially well adapted to the natural average change of 2 m between the winter low water and the summer high water level. The endemic *Myosotis rehsteineri* grow on gravelly soil in society with *Deschampsia littoralis*, shoreweed (*Littorella uniflora*) and creeping spearwort (*Ranunculus reptans*).

1.3 Tourism and Recreation

Tourism is among the most significant economic values in the German portion of the Lake Constance region. There are approximately 10 million overnight stays, generating around €350 million gross turnover per year and approximately 15,000 full-time jobs. About 27 million day-visitors (vacationers plus day guests) come to the region each year, mainly in the months of July to mid-September.

During the past years, the Lake Constance region had a slight increase in overnight stays; on average, guests stay 5.5 days compared to an average of 3.2 days in other parts of Germany. These visitors are undertaking outings above average in number and in length; their average length is 8.7 hours (the German average is 8 hours) and the average number of kilometers traveled to come to tourist site is 91, compared to the German average of 70 km. Eighty-five percent of these vacation and recreational trips are undertaken by car.

1.4 Shoreline Construction

In addition to the settlements and the transportation infrastructure, there are also recreational facilities, shoreline fortifications/protective structures and excavations for sand and gravel. Today, 42% of the Lake Constance shoreline in the

Federal State of Baden-Württemberg is built up with quays or walled embankments. Fourteen percent of the shoreline outside of protected areas is made up of weekend houses, private bathing areas, public parks or recreation facilities. Over 15% of the settlements are constructed less than 50 m from the shore. A quarter of the Baden-Württemberg shoreline is taken up by buoys or fields of buoys, jetties or harbors. The harbors for recreational boats, jetties, beaches and shoreline walkways are associated with embankments and shoreline constructions and result in severe impacts on nature. They alter the direction of the current, lead to erosion and sedimentation, inhibit the capacity of the shallow water zones to cleanse themselves, and destroy the habitats of the fish populations.

1.5 Agriculture

The part of the Lake Constance landscape, which traditionally was cultivated in a natural way, is even today dominated by agriculture. About 433,000 ha of the Lake Constance area are being used for agriculture. Most lands are used as green fields and pasture land which make up 76% (330,000 ha). Crops are grown on 16.4% (71,000 ha) and 6.9% (30,000 ha) is taken up by so called special cultures. In order of importance these are: fruit plantations, hop, vegetables, and vines. The total agriculturally used area was only reduced by 5% in the past two decades.

Lake Constance is the biggest cultivation area for pomaceous fruit in Germany, whose cultivation increased by 10% during the past 10 years, compared to a decrease of 7% in other tree fruit cultivations. Apples are the main fruit cultivated. About 1,600 fruit growers cultivate about 7,400 hectares. Yearly about 220,000 tons of pomaceous fruits are produced for the fruit trade. Overall, 20% of the pomaceous fruit production in Germany comes from around Lake Constance. Ninety percent of the land is cultivated according to integrated production, with 5% following to organic farming principles. Organic farming has been practiced for a long time at Lake Constance. The number of registered organic farms in Baden-Württemberg's Lake Constance region (Bodenseekreis, Konstanz und Ravensburg districts) is nearly twice as high as in the rest of Germany (4.6% compared to 2.4%). In the small country of the Principality of Liechtenstein, the level of organic farms has even reached a level of 21%.

The number of agricultural businesses around Lake Constance has decreased steadily in recent decades. Currently there are still approximately 24,000 farms in the Lake Constance region. The competition among farms has lead to an overall increase in farm size. The average size of a farm is currently 17.8 ha. The general conditions are quite difficult for the fruit growers because during the past 10 years the manufacturers' prices have fallen continuously.

1.6 Drinking Water

The supply of drinking water to 320 towns and communities with a total of approximately 4 million inhabitants is a significant economic value of the lake. Supply is the responsibility of the non-profit Lake Constance Water Supply Authority (BWW), a communal institution with 177 members. The water is pumped from the Überlingen part of the lake and distributed through a 1,700 km long network of pipes to users.

The members pay a single initial contribution as well as costs for support, operation and administration according to the quantity of water they use. In 2001, water consumption amounted to roughly 130 million m^3. Profits from the electricity the BWW produces are used to reduce the price of water, which has been decreasing steadily for years, and is at present about 35 cents per m^3. In 2001, BWW invested over €7 million in new buildings in order to improve supply facilities. A total investment of €84.8 million is planned up to the year 2006, which will be financed by the rates paid by towns and communities.

1.7 Services and Industry

Industry operates at a high level of technological efficiency in the Lake Constance area. One of the key success factors of this efficiency is historic: the technology branches of aviation and automotive have formed the traditional backbone of the economy of the northern lake region for more than 100 years. The world famous zeppelin is inseparably linked to the Lake Constance area. Technological efficiency also directly depends on the high qualifications of the staff employed in the research and development departments. Lake Constance has the second highest rate of highly qualified technology staff in Germany and the Lake Constance-Upper Swabia region is ranked number four in Germany by the German Patents Atlas. The Friedrichshafen area is the strongest economic region on the lake and is also national leader in the fields of patent registrations and work productivity. Technological leadership is not only based on the main sectors of automotive supply and aerospace but also on telecommunications and electronics.

1.8 Energy Consumption

Up to now, over 60% of the energy required by industry, trade and private households in the Lake Constance area has been supplied by nuclear power stations. The Solar Complex Potential Study for Renewable Energy Sources in the Konstanz District has been carried out for the western area of Lake Constance. The study concluded it would be possible to supply the area (excluding traffic) with renewable energies generated in the region, on the basis of further increases in efficiency and extensive use of the existing potential, providing that energy consumption is reduced or energy efficiency improved by a factor of 2 to 3. The study demonstrated the following potential markets for renewable energy sources:

- In the region there are approximately 2.5 million m^2 of roof space available which would be appropriate for the generation of a yearly average of circa 135 million kWh by means of solar cells (135 GWh);

- Solarthermic power generation on 50% of the available and appropriate surfaces would create energy amounting to around 150 million kWh (150 GWh) yearly;
- The potential for hydroelectric power generation in the region of the Aach by Radolfzell and by Stockacher amounts to 35,000 MWh per year (35 GWh);
- Wind power generation: Potential areas around 800 ha, i.e. 40 optimally located sites generating 140,000 MWh (140 GWh) yearly;
- With wood biomass alone, 185 million kWh of end-use power could be generated yearly (185 GWh);
- Using biogas from manure and slurry 26 GWh of electric power and 31 GWh useable heat could be generated in the region;
- The energy contained within the plant oils currently harvested in the Konstanz district amounts to circa 15.5 GWh;
- By reactivating land no longer in use through the cultivation of energy-rich plants (poplars, willows, giant Chinese silver grass (*Miscanthus sinensis gigenteus*), etc.) 65 GWh could be generated yearly;
- Geothermal heat (heating buildings by means of geothermal probes) has a potential of approximately 30 GWh; and,
- Geothermal plants for energy from medium depth: ca. 200 GWh yearly; yearly generation of 200 GWh of electricity and yearly generation of 600 GWh heat from deep geothermal probes.

2. Threats and Responses

This section reviews contributions to unsustainable lake use and constraints to sustainable management of the lake.

2.1 Ecological Aspects

Even with the high proportion of organic farms and the conversion of many areas to integrated production methods, agriculture is still causing considerable environmental pollution and represents a potential for ecological problems for the natural area and the drinking water reservoir, Lake Constance. It has been proved that the use of chemicals and synthetic fertilizers and pesticides is causing dangerous nutrient loading in the lake and its tributaries.

There are no concepts for rural management. The sites of marginal returns which were cultivated up to now are being used less and less for agriculture. There is no integrative general management concept to secure the cultivation and to support the structural changes. There is a great danger of important and drastic loss of typical and valuable landscape structures and biodiversity.

In comparison to other destinations in Germany or Austria, Lake Constance does not have a profile towards ecologically-orientated tourism. A regional eco-label, legal requirements, subventions or special formation to distinguish and to promote sustainable tourism does not exist. Seasonal tourism (many day guests in July, August and September) causes high environmental pollution through traffic and other ways. Additionally, land consumption and urban sprawl are proceeding.

There is no cross-border protection concept for the whole lake shoreline and water body, no declaration of common protected areas, and no assimilation of already existing cross-border protected areas. In the Bodensee Agenda 21, the International Bodesee Conference (IBK; described below) took up a regional development project which was intended to contribute to the sustainable development of the environment, business and society. In the individual fields of activity designated in the model, appreciable contradictions and deficits are apparent. This is particularly the case in the areas of settlement development and transportation.

2.2 Social Aspects

The protection of environment and nature conservation is an issue in all political declarations and programs. Therefore, environmental problems (except for traffic-related ones) are only indirectly perceivable and are no longer as “obvious” as they once were. The inhabitants of the Lake Constance region get the false impression that nature conservation is in the control of competent authorities and that solutions will be sought.

The demand in environmentally-sound products in the fields of energy, food, transportation, leisure activities and tourism is still very feeble. Especially in economically difficult times, with a high rate of unemployment, consumers prefer buying cheap products thus accepting environmental stress.

Finally, it should be noted that there is no cross-border Lake Constance regional identity within the catchment area.

2.3 Economic Aspects

Economic and policy decision makers have not yet understood that the environmental orientation of the region is a chance to broaden the regional economic profile. For example, there are no special privileges (e.g., tax relief) for ecologically oriented enterprises. Also, high consumption of natural resources occurs through tourism and leisure infrastructure and lacks ecological orientation and environmental management. There is neither a frame of reference nor a marketing system for regional organic products. It was only possible to gain few food stores, restaurants, canteens and tourism agencies as customers. The share of regional organic products in the food

business is very small. Lake Constance is rarely used as a brand name.

2.4 Landscape and Waterscape

Settlement planning must be based to a greater extent than today on responsible land and soil usage. The shore regions are among the most densely settled areas in the basin with 500 inhabitants/km². The amount of settled and paved areas is more than twice as high in the shoreline communities as in those in the "second row." Despite the high costs of land zoned for construction, an increase in population of 4 to 12% by 2005 has been predicted for the lakeshore communities in the Lake Constance district (Bodenseekreis).

In response, in July 2001 the Lake Constance Foundation started the project "ECO-LUP: Environmental Management for Local Land Use Planning". The goal is to establish preparatory and legally binding sustainable land use planning through the development and introduction of an Environmental Management System (Eco-Audit) in urban land-use planning at the local level. The cities of Constance and Überlingen at the German border of the lake, the City of Dornbirn and the Municipality of Wolfurt in Austria are project partners.

In terms of transportation, the Lake Constance region has one of the highest concentrations of streets and traffic in rural Germany. For this reason, high priority must be given to the development of a regional transportation system by means of sensible international cooperation. Above all, the pleasing improvements in the public train, bus and ship systems should be continued in order to reduce the pollution caused by motorized forms of individual transport.

2.5 Tourism and Recreation

The lake and its neighboring regions are an important magnet for vacation guests and locals in their leisure time. Sixty percent of the annual visitors are concentrated on the ten most attractive places for outings. These visitors cause important environmental problems, especially traffic. Up to now, the measures to inform and sensitize these visitors have been inadequate.

In response, the introduction of the "Bodensee Erlebniskarte" as an all-inclusive-card by the "Internationale Bodensee-Tourismus GmbH" could have been a valid groundwork for touristic mobility which protects the environment, but up to now train and bus systems have not been properly added to the package. In 2001, the Lake Constance Foundation created "BodenseeClick", a web-based information system, which for the first time was able to combine public transportation schedules with destinations in the international region of interest for tourists. Unfortunately, the Lake Constance Tourism Association did not assume the management and continuation of BodenseeClick.

One of the few successful projects towards environmentally friendly tourism is the ECOCAMPING Project initiated by Lake Constance Foundation. Within ECOCAMPING, the Lake Constance Foundation developed an environmental management system for camping sites, oriented according to the EU-EMAS Eco-Audit Scheme. ECOCAMPING started in 1999 with 14 camping sites around Lake Constance. Now 49 camping sites in Baden-Württemberg and Bavaria are participating in this project and camping sites in other regions were scheduled to start in 2003/2004 to create ECOCAMPING working groups.

Recreational boating is also a threat to the lake. As a favorite venue for water recreation, Lake Constance has at present 55,000 officially registered watercraft, two-thirds of which have an engine. Recreational facilities such as buoy fields, harbors and jetties, and also buildings and parking lots take up about 45 km of the lakeshore in Baden-Württemberg alone. A further 30 km are used by beaches, camping grounds and lakeshore walkways. Along with the structural changes in and resulting damage to the shore zone and the shallows, the sport and recreational activities cause disturbances and damage to the sensitive animal and plant populations.

Particularly the lake's shallow bays are favorite places to anchor boats or for bathing, but these are preferred habitats of endangered plants and animals, as well. Today, the most valuable shore regions and shallows are closed to water sport or recreation either temporarily or throughout the year.

2.6 Fisheries

The threat to the fisheries of the lake is due to the fact that the lake has become oligotrophic again, and this has resulted in a decrease in the total catch, i.e. the natural catch limit has been reached. In 2000, there were approximately 140 professional fishermen in the Upper Lake region of Lake Constance, in the Lower Lake region there were 39. The decrease in the catch and in profits has forced many fishermen to work part-time or to try to improve their income by the direct sale of additionally bought goods. Most fishing businesses are family firms in which two generations work together. The fishery authorities expect the number of fishermen to continue to decrease.

Whitefish and perch are the main catches. The ten-year average for the fishermen on the Upper Lake is approximately 800 tons of whitefish and 270 tons of perch. The corresponding figures for the Lower Lake are 100 and 32 tons, respectively. Other species of fish include whitefish and, since the 1980s, the pope, a perch species.

The availability of fresh fish is dependent on the season. In general the catch in summer and autumn are higher than in spring or winter. Although the purchase of fish for the wholesaler is welcome regardless of the season, those working in the catering business are greatly dependent on tourism, especially on the German side of the lake. For this reason the German fishermen are involved to a greater extent in direct marketing.

As far as sustainability is concerned, fishing on Lake Constance is among the most progressive in Europe. It must be said, however, that even on Lake Constance there are questions and aspects that have not been sufficiently considered or investigated up to now. The lake was even stocked with some species from other lakes or distant regions of the world. For this reason, genetically deviant or non-native species can be found in the lake. The newcomers to the Lake Constance region include the zander and the rainbow trout.

The environment and wildlife protection agencies have up to now not taken sufficient notice of the consequences and the development of fishing. As a rule they only concerned themselves with fishing when direct conflicts arose, e.g. the shooting of cormorants. It was rare for them to look below the surface of the water.

In response, for the last three years the Lake Constance Council for the Environment has been more intensively occupied with the issue and has formulated a policy document with three main aims:

- to improve the expertise on fishing and fish biology in the wildlife protection organizations around Lake Constance;
- to provide validated specialist statements on issues of fish farming from the point of view of the protection of wildlife resources; and,
- to establish regular and constructive dialogue with the fishing industry, in order to find common positions and strategies.

2.7 Forestry

In the German area of Lake Constance basin, 35% percent of the land is forest. Broad-leaved trees are predominant in the western region of Lake Constance, whereas in the Upper Swabian hinterland pine trees make up 49% of the forest area. In both regions the potentially natural vegetation is broad-leaved trees rich in beeches. Wood-working and manufacturing firms are economically important. In the northern region of Lake Constance, for example, there are 35 sawmills, with an annual cut of 700,000 m^3, which is 20% of the total cut for the state of Baden-Württemberg. There are also approximately 150 carpentries and about 350 joineries. However, these medium-sized companies and the existence of numerous forest owners are being threatened by low prices and the pressure to import cheap timber.

Within the framework of the "Lake Constance: Ready for the Future" Project, specialist events on building with timber have been organized over a period of three years for local master-builders, mayors and town councilors. Moreover, the use of the red-hearted beech for the manufacture of furniture has been fostered along with improved marketing of regional firewood.

2.8 Water Management

The most important impulse for international cooperation was and is shared concern about drinking water. This German and Swiss common interest in its use will also continue to be of central significance for regional economic policy. In view of new stresses on the environment caused by increasing water usage, experts continue to strongly advocate wide-ranging protection measures in order to prevent a decrease in the quality of Lake Constance's water and to achieve the "lowest possible levels of fertilizer and pollutants in the lake".

2.9 Drinking Water Quality

Ensuring the quality of drinking water is the central challenge in the region. The total phosphorus content of the lake water rose from ‹10 mg/m^3 in the 1950s to 87 mg/m^3 in 1979. Thanks to international cooperation and investments totaling over six billion Swiss francs for construction and modernization of sewage canals and 220 water treatment plants, the phosphorus level was reduced to 12 mg/m^3 by 2001 (Figure 2).

According to a new model calculation by the Internationalen Gewässerschutzkommission für den Bodensee (IGKB, International Water Protection Commission for Lake Constance; described below), the oxygenation of the water nearest to the bottom of the lake can only be held at 4 mg/L (at least in the long term) if the concentration of phosphorus in the lake's open water can be lowered to approximately 10 mg/m^3. However, since that time it has been demonstrated that most of the lake trout spawn, which lies on the lake bottom, can no longer develop at an oxygen content of 4 mg/l (IGKB 2000).

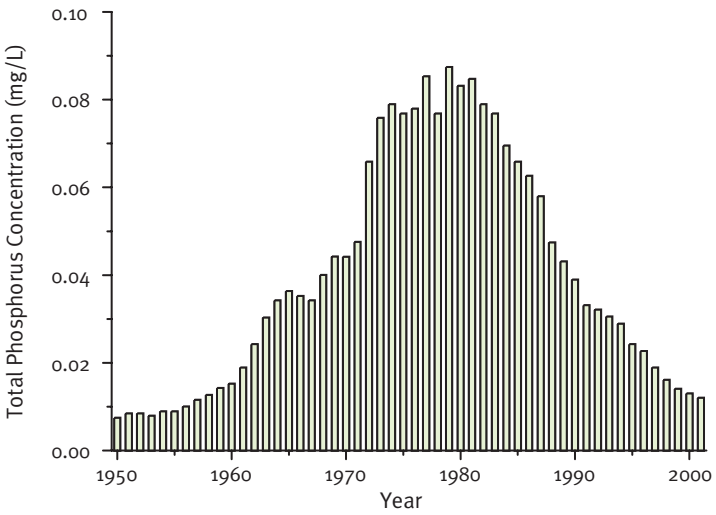

Figure 2. Total Phosphorus of Lake Constance (Upper Lake) during Mixing Period (February to April) (Source: International Commission for Water Conservancy for Lake Constance).

Rossknecht (1996) characterizes the pollution in Lake Constance as follows: "Numerous pollutants from domestic sewage, business, industry and agriculture are still flowing into the lake as before. Even in small amounts, they can have a negative influence on Lake Constance's spectrum of species, its ability to clean itself and thereby its entire ecosystem. For this reason, efforts to keep Lake Constance clean are to be continued with persistence." In particular, Rossknecht calls for a reduction in the levels of agricultural fertilizers being released into the lake, which are responsible for about 50% of the detectable phosphorus.

The successful reduction of the phosphorus reading does not diminish the fact that the concentrations currently being measured are still too high. In addition, countless other substances have been measured in Lake Constance's water such as nitrates and various plant-protective agents. The open water's nitrate content continues to show a slight increasing trend.

In the lake's tributaries, various plant-protection chemicals have been measured; first above all is Atrazin. After its usage was forbidden, the water's Diuron content rose noticeably. Since then, this global herbicide has been found regularly in all tributaries. In order to avoid the pollution of Lake Constance by plant-protection chemicals, a long-term, general reduction in the use of pesticides in the catchment area is required (Rossknecht 1996; Staatsanzeiger Baden-Württemberg Nr. 50/1996). In addition, the use of toxic and water-polluting anti-fouling paints for boats has yet to be fully enforced to this day.

2.10 Water Quantity

The draining of greater amounts of water from Lake Constance was regulated as early as 1967 by an international convention. The agreement ensures that before they are permitted to drain water, the lakeshore states are required to give each other adequate opportunity to take a stance: (a) in the case of planned usage outside of the region supplied by Lake Constance's hydraulic system, if the requested amount is above the level of 750 L/s in each case; or (b) in the case of planned usage inside of the region supplied by Lake Constance's hydraulic system, if the requested amount is above the level of 1,500 L/s in each case.

The administration union Lake Constance Water Supply (Bodenseewasserversorgung), which requires 130 million m^3 of water per year and supplies the state of Baden-Württemberg up to its northernmost parts, has permission from the state's authorities to drain 7,750 L/s on a daily average, including a nightly maximal usage of 10,500 L/s. It should be emphasized that in this case that average rate of evaporation is twice as high as the greatest amount permissible to drain from the lake.

2.11 Catchment Management

In order to ensure long-term protection of Lake Constance's drinking water reserves, the quality of the water in the tributaries is of decisive significance. For this reason, significant parts of the lake's catchment area (11,500 km^2) were included in the cleanup program. According to monitoring data, non-point sources of pollution, including fertilizers used in agriculture, present an acute problem, noting as above that 50% of the lake's detectable phosphorus comes from agriculture.

2.12 Chronology of Major Lake Management Issues and Activities

Fortunately, in the early 1960s, phosphorus was already recognized as the main factor responsible for eutrophication. Until the early 1970s, the major part of sewage entered the lake without any treatment. During the 1970s, an annual increase of 15% in phosphorus concentration was observed. As a result, algal growth increased greatly. In 1972, during a phase of unfavorable climatic conditions and extremely low water load, oxygen depletion beyond 2 mg/L occurred in the deepest part of the lake. In 1979, phosphorus reached its maximum value of 87 mg/m^3. During that time channel systems and efficient sewage plants with three purification stages (physical, biological and chemical) were built throughout the catchment area. More than €4 billion were invested to connect almost 92% of the inhabitants to these plants.

From 1980 onwards, the phosphorus increase was stopped and its concentration sunk from 87 mg/m^3 in 1979 to 12 mg/m^3 in 2001. Nevertheless the true scale to estimate the effect of restoration is not the reduction in phosphorus but the biological response of the lake, especially that of phytoplankton. For some years algal biomass has shown a decreasing trend. For example, in the shallow water zones and in the area of river mouths the success has been very convincing. The success can be considered a step in lake development towards a state typical of a lower nutrient level. The continuous data sets show that the phytoplankton composition and its seasonal distribution have changed to a situation known from the times when the lake was oligotrophic.

With increasing numbers of inhabitants, the problem of growth of the remaining phosphorus and other harmful substances becomes topical. Therefore the IGKB Guidelines from 1987 demand a holistic view to include the catchment area and all fields affecting the lake, especially in industry, agriculture, settlement and traffic. In addition to the stress caused by substantial loads, the stress by structural interferences is to be considered in the same way. Preventive measures should be realized before harmful effects occur.

All these efforts may serve to develop Lake Constance so that it is stable against anthropogenic stress coupled with unfavorable climatic conditions, which have increased during the last years. To obtain this state it is necessary to improve

the quality of the whole lake from its littoral to pelagic and profoundal zones. At the moment, Lake Constance can be looked at as an ecosystem in transition.

Table 2 provides a chronology of some of the major milestones in official environmental policies over the years at Lake Constance. Table 3 highlights some of the key contributions of NGOs over time.

2.13 Administrative and Political Framework

As a rule, the federal governments of the states bordering the lake hold responsibility for only the few areas covered in the international agreements that have been established. Important international bodies discussed below.

2.13.1 International Bodensee Conference (IBK)

The IBK is an inter-governmental organization of the lakeside federal states and cantons. It was founded in 1972. Today, the IBK has ten members: the Swiss Cantons of St.Gallen, Thurgau, Schaffhausen, Appenzell Innerrhoden, Appenzell Ausserrhoden and Zürich; the German States of Baden-Württemberg and Bayern: the Austrian State of Vorarlberg; and the Principality of Liechtenstein. The population and surface area of the above jurisdictions is given in Table 4.

All important IBK decisions are taken by consensus. The common activities are financed by the members. The percentage of financing of each member is fixed according to the extent of the territory. IBK is organized in a Permanent Committee and seven Commissions. Every year a conference with all prime ministers of the member states takes place in one of the member states. In 1999, the Environment Commission published a report entitled *Measures in the Fields of Agriculture and Water Protection in the Lake Constance Region* which summarized the problems, the legal and administrative framework, and necessary activities and measures to be taken, especially cross-border cooperation between the administrations.

Cooperation between IBK and other commissions and institutions is not regularly organized; however, one member of the IGKB is represented in the permanent committee of IBK. The publication "Bodensee-Informationsdienst" is distributed

Table 2. Milestones of Official Environmental Policy.

Year	Environmental Policy
1961	Agreement on the Protection of Lake Constance from Pollution
1971	Planning Guidelines for Construction Along the Shore of Lake Constance, Baden-Württemberg Ordinance
1976	Lake Constance Shipping Order
1977	International Guidelines for the Lake Constance Area, Zoning Commissions
1987	The Future of a Clean Lake Constance, Memorandum from the International Commission on Water Conservation for Lake Constance
1993	Introduction of stricter emission regulations for motor boats (Stage 1); (Stage 2 from 1996 onwards)
1994	Lake Constance Guidelines, International Lake Constance Conference
1994	Environmental Program for the Lake Constance Region of the Baden-Württemberg State Government
1997	Lake Constance Agenda, International Lake Constance Conference
2001	PLENUM for Western Lake Constance, the State of Baden-Württemberg's Program for the Preservation and Development of Nature and the Environment

Table 3. NGO Contributions to Internationalist and Integrationist Approaches.

Year	Contribution
1958	Founding of the Lake Constance Ornithological Working Group
1990	Project for Environmental Conservation on Lake Constance (German Environmental Protection Agency)
1991	Founding of the Lake Constance Ecological Council as an international association of nature and environmental conservationist organizations (actually 18 member associations)
1991	Model Project Constance "Linking of Biotopes and Extensification of Farmland in the District of Constance"
1994	Founding of the Lake Constance Foundation
1995	Position paper "Recreation and Tourism on Lake Constance" by Lake Constance Environmental Council
1997	Lake Constance Foundation confederation project "Sustainable Lake Constance" (Contributions to a lasting environmental safeguarding and development as a drinking water reservoir and international model region. The goal is to show by way of practical examples how environmental quality can be improved and natural resources used sustainably demonstrating that protecting nature and the environment is profitable for business.)
1998	Lake Constance Environmental Council Position paper "Environment and Transportation on the Bodensee"
2000	Position Paper "Fisheries" by the Lake Constance Environmental Council

every week via e-mail and is also available on the IBK's website. IBK has an office in Constance which handles public information and relations. In the case of specific aspects, the IBK´s experts can be involved.

The "Parlamentarier-Kommission" represents local people of the region. A regular exchange of information between IBK and this board is organized. Local people and stakeholders can present their questions and requests also in the IBK office in Constance.

The budget in 2002 for the IBK was €250,000, mainly used for personnel costs and communication and public relations. The IBK's work is funded by membership fees of the lakeside federal states and cantons. The basis for membership fees are population figures and share of lakeshore. Some projects are co-financed by the EU Interregional Program.

2.13.2 International Commission for Boating on Lake Constance (Internationale Schiffahrtskommission für den Bodensee, ISKB)

The ISKB was founded in 1973 as a state agreement among Austria, Germany and Switzerland. There are no fixed rules and system regarding communication and cooperation. If there are aspects related to the other commissions, the chairman of the other commission will receive a written advice.

There is no regular communication to the public. The Commission gives recommendations to the Federal States and Cantons only. The Commission informs via press releases, only if a decision of the Commission is of special relevance to the public.

There is no direct involvement of stakeholders in the Commission's work. In the case of the elaboration of new regulations, stakeholders can use the legal proceedings as a means of involvement in the member states. Results of these legal proceedings are included into the final recommendation of ISKB to the member states.

The ISKB has no budget of its own. All costs to organize a meeting, including follow-up, are covered by the member states by rotation system.

2.13.3 International Proxy Conference for the Lake Constance Fishery (Internationale Bevollmächtigt enkonferenz für die Bodenseefischerei, IBKF).

The IBKF was founded in 1893 and is responsible for the. "Agreement on the Use of Similar Regulations for the Fishing Industries on Lake Constance", which are the fishing regulations for Lake Constance, Upper Lake.

Minutes of all meetings are exchanged between the IBKF and IGKB, with request for comments on special problems to other commissions. Reports about annual activities are presented at annual meetings of other commissions. Members of different commissions work together in the EU working groups, such as the EU Water Framework Directive.

The IBKF's external communication is organized through yearly press-information about IBKF activities. Additional press information is provided about concrete items. Information about fishermen is the responsibility of the member states. Professional fishermen and line fishermen (anglers) are represented in the Lake Constance Fishery Federation (IBF). This federation can present requests to IBKF.

It was not possible to determine the 2002 budget. All general costs and studies of the IBFK are financed by lakeside federal states and cantons.

2.13.4 International Commission for the Protection of Lake Constance (Internationale Gewässerschutzkommission für den Bodensee, IGKB)

Lake Constance is a curiosity under international law. Clearly defined national frontiers between Switzerland and Germany exist in the Lower Lake. In the Upper Lake, only the shallow water area from the shoreline to 25 m water depth is national territory of the bordering countries. The major part of Upper Lake Constance is considered as common property, a so-called "condominium".

The IGKB was founded in 1959 by the three riparian countries (Austria, Germany, and Switzerland) in order to preserve the lake ecosystem from further degradation. In 1960 came an Agreement on the Protection of Lake Constance from Pollution (signed into law in November 1961). In 1987 the IGBK created

Table 4. Population and Surface Area of Jursiditions in the Lake Constance Basin.

Nation or Sub-national Entity	Inhabitants	Surface Area (km²)
Liechtenstein	32,015	160
Austria: State of Vorarlberg	363,971	2,601
Switzerland: Cantons of St. Gallen, Appenzell-Ausserrhoden, Appenzell-Innerrhoden, Thurgau, Schaffhausen, and Zürich	2,011,493	5,468.58
Germany: Sate of Baden-Württemberg's Federal State Districts of Konstanz, Bodenseekreis, Ravensburg, and Sigmaringen	862,610	4,318.71
Germany: State of Bayern's Federal State Districts of Lindau, Oberallgäu, and Stadt Kempten	284,882	1,913.35
Total	3,554,971	14,461.64

Source: Regio-Büro Bodensee.

a Memorandum called "The Future of a Clean Lake Constance: Long and Short Term Measures".

The main duties of the IGKB are the observation of the lake, confirmation of the causes of its pollution, recommendations for coordinated preventive measures, and discussion of the planned uses of the lake.

The commission meets at least once a year and is composed of delegates from member governments and a limited number of high officers of those governments. As an advisory agency, the commission cannot decide on rules and actions connected with environmental protection, but by agreement the regional governments are obliged to transform the recommendations of the IGKB into national law. A technical and scientific board of experts serves as official consultants to the commission. They elaborate the research program and prepare reports on the research sanctioned by the commission. The board of experts has three working groups for studying special problems concerning the topics "Lake", "Catchment Area" and "Accident Defense". The working results are summarized and published in so-called green reports (annual investigation data of the lake monitoring) and blue reports (case studies and special topics).

Communication and cooperation organized between the international Lake Constance commissions occurs through exchange of minutes between IGKB and other commissions. There are also common working groups, participation in the meetings of other commissions, and exchange of information (written, via phone or e-mail). The IGKB's external communication is organized through media information, a regular publication entitled Seespiegel, regular reports ("Green" and "Blue" Reihe) and special reports, working group public relations, and a website.

IGKB is not an executing agency and gives only recommendations to members. Stakeholders are involved according to the national legal possibilities.

The budget for 2002 could not be determined exactly. Approximately €232,000 was spent for common projects, reports and public relations. Not included are the consequential costs of recommendations by IGKB such as improvement of wastewater collection and wastewater treatment plants, which has represented an investment of more than €4 billion up to now.

Financing by the lakeside federal states and cantons according to their size, population and share of lake shore: Baden-Württemberg has the highest contribution with 57% of the total costs. European Union-Interregional Financing is used for special projects.

2.14 Nature Protection

The legal framework for nature preserves is different in each of the three states bordering Lake Constance. There are only a few existing extensive well-run preserves with effective regulations. These criteria for conservation and the areas themselves conform to international standards, in practice, show important deficiencies.

2.14.1 Ramsar Sites

Wollmatinger Ried-Giehrenmoos-Gnadensee and Mindelsee (Germany) and the Rhine delta (Austria) were nominated as Ramsar sites in 1976 and 1983, respectively. Ermatingen basin and Stein am Rhein in Switzerland are in the planning stage and a date of nomination has not yet been fixed.

2.14.2 NATURA 2000 Areas

Areas in Germany and Austria have been nominated for the NATURA 2000 network of nature preserves being planned by the European Union. The responsible administrative bodies have proceeded in quite different ways in terms of procedure and the extent of their plans.

Baden-Württemberg's official list (as of March 2001) designated a total of approximately 37,000 ha for the Lake Constance region. In contrast, the unofficial listing put together by NABU for the same region contains an area of a total of 91,383 ha which were determined in accordance with the criteria of the FFH guidelines, or those for the preservation of birds.

2.14.3 Regional Lake Shore Protection in Baden-Württemberg

In order to protect the valuable and sensitive shallows, which make up about 17% of the total lake surface, protected areas have been established in the Lake Constance shoreline plans set down by the Hochrhein-Bodensee and Bodensee-Oberschwaben (Upper Rhine-Lake Constance and Lake Constance-Upper Swabia) regional associations.

Protected Zone I is made up of shoreline close to its natural condition and transition zones with biotopes deserving protection or valuable fishing or spawning areas. In Baden-Württemberg 51% of the shoreline has been designated as belonging to this category. In such areas, embankments, harbor facilities, jetties, buoy fields and other constructions are not permitted. Public beaches may be renovated or expanded, mooring places for rescue crafts, lake access for windsurfers, drinking water pipes, telephone and electrical cables or pipes releasing water for treatment plants may be introduced.

Protected Zone II makes up 27% of the Lake Constance shoreline in Baden-Württemberg. Here, public and private structures may be expanded and other changes may be made if they can be reconciled to the need to protect the shallows, or if public interest is greater than protective policy.

The Lake Constance shoreline planning process has also designated areas for re-naturalization where the changes are intended to lead to an improvement in the condition of the current, the reintroduction of reed growth, the planting of trees and bushes along the shore or the removal of impediments to

fishing. Up to now, about 20 km of the shoreline have been re-naturalized.

Today, only 28% of the shoreline is ringed by reed growth. With very few exceptions, the reeds are found within nature and landscape conservation areas. Not only do fish, amphibians, and water birds depend on intact reed growth, but so do innumerable insects, spiders and snails. Exceptional events such as the "flood of the century" in 1999 demonstrate that the protected areas are much too small and do not create adequate space in which flora and fauna can find refuge. Injunctions concerning protected areas have created too many opportunities for additional construction.

3. Lessons Learned: Actions to be Taken on Lake Constance and Key Lessons Relevant to Other Lake Regions

3.1 Nature Conservation

For the protection of endangered natural habitats and species, international agreements must be followed, in particular on the basis of the EU guidelines for the protection of birds, the EU FFH guidelines and the creation of norms for Important Bird Areas. Of particular urgency is the recognition of Lake Constance as the most important migration rest and winter quarters for water birds in the Central European interior.

Due to the international situation, a concept for protected areas along the entire shore and lake area spanning all involved nations is necessary. The states bordering Lake Constance are urged to designate shared protected areas and to agree among themselves on the existing protected areas which span national borders, particularly in the Alter Rhein (Old Rhine), the Konstanzer Bucht (Constance Bay), the Ermatingen basin and at the Untersee-Ende (Lower Lake end) and the Hochrhein (Upper Rhine).

Regulations for water sport and hunting, as well as for other forms of interaction with the natural landscape must be internationally coordinated along a uniform basis for all comparable protected areas in the shore zones and shallows.

The key lesson for transboundary lake regions is that a legally binding concept including management plans and monitoring systems for all protected areas along the entire shore and lake area spanning all involved nations is necessary. This nature concept should follow international criteria (we recommend the criteria for EU Natura 2000 regions) and provide the necessary staff and financial resources. Perspectives for the development, extension and connection of protected areas must be pointed out and put into practice according to a binding time table.

For the implementation of the management plans and bio-monitoring in the most important protected areas there is a need for professional research and support stations which also deal with public relations and visitors interests. Regulations for water sports and hunting, as well as other forms of interaction with the natural landscape must be internationally/inter-regionally coordinated for protected and unprotected areas in the shore zones and shallows. In nature reserves adjacent to densely populated areas, sufficient buffer zones must be established. It is of special importance for the quality of the natural habitats to connect biotopes by green corridors—a main focus of ecological land use planning.

The European Union Water Framework Directive is a new innovative approach to protect all waters—rivers, lakes, coastal waters and ground waters. It sets up ambitious objectives to ensure that all waters meet "good status" by 2015. The directive sets up a system of management within river basins without stopping at the borders. It requires a cross-border co-operation between countries and all involved parties. Further information is given on the website, www.europa.eu.int/comm/environment/water/water-framework/overview.html

3.2 Agriculture

A clear public statement is needed from the states along Lake Constance that organic farming represents the method which most adequately preserves natural resources and therefore receives particular state support, through state-funded advertising and the use of regional organically-grown foods in the canteens of public institutions such as offices and universities.

When compensation payments are made to farmers, ecological minimal standards must be maintained such as a maximum occupation level of 1.5 large cattle unit per ha and a 10 percent level of compensatory organically maintained land from the total surface area in the form of hedges and natural borders. The introduction of internationally valid high ecological and social standards for the production and sale of agricultural products is necessary.

The marketing of regional organic food should be improved by the development of regional business structures and the creation of new outlets. For this purpose, new alliances and co-operations between agriculture, trade, distribution and commerce as well as tourism are necessary. Consumers (including holiday-makers) should be informed by information facilities and offers about the connection between environmentally sound agriculture, healthy food, and the preservation of cultural landscape and nature protection.

3.3 Honor Ecological Efforts in Agriculture

At Lake Constance, as in other areas, agricultural subsidies are socially accepted only when performance-related. A possibility to justify subsidies is to reward ecological achievements in agriculture. MEA, a Baden-Württemberg agro-environment program, is a good political example based on voluntary participation and providing economic incentives for good ecological achievements. In order to motivate as many farmers

as possible to participate in this program, it is important to honor simple measures which are easy to realize.

Pilot schemes are good, but broad effects are better. The realization of innovative pilot schemes is important to test new approaches and ideas and to further develop them. It is also important to draw attention to such projects during their implementation period since it is difficult to undertake effective public relations work and outreach to farmers if people cannot see the pilot activities when they are ongoing.

The European Union Agricultural Policy is in reformation. Healthy food supplies, quality, environmental conservation and regional development are finally included as objectives, but there is still no concrete process to guarantee that these objectives will be fulfilled. The use of the "Polluters Pays Principle" is not included. Farmers get subsidies, if they accept good agricultural practices, but no farmer needs to pay if he does not accept environmental friendly practices.

3.4 Women Create Acceptance

The integration of women into the development and decision-making process is of great importance. Particularly in rural areas, women's energy and competence are extremely well developed.

3.5 Fisheries

The loss of natural and nearly natural lakeshore areas needs to be stopped. Restoration measures must be planned and carried out taking into account the fish ecology as well. Although the lakeshore is under special legal protection in all three countries neighboring Lake Constance, the rate of embankment fortification is high and the settlement pressure is still increasing. Fish fauna benefit most from shallow waters and quiet shorelines. Restoration measures should not always take place lakeside but also should occur further inland in order not to fill up existing shallow zones.

At Lake Constance there are only fish sanctuaries where fishing is not completely forbidden. To promote certain fish species, appropriate protection zones should also be created. The already existing nature reserves should be integrated into this approach. Fishing in nature reserves should be reduced and, in the medium-term, be forbidden.

Fish stocking interferes with the complex interactions between the naturally occurring fish species and the rest of the fauna. Not only fish live in a lake, but there are also complex aquatic flora and fauna that have complex relations. It is useful for anglers and conservation organizations together to concentrate on the improvement of habitat and better water quality. Cormorant and goosander are protected species in the Lake Constance region and to frighten them away or to shoot them are not reasonable management measures.

3.6 Tourism

In order to support ecologically sound mobility in tourism, attractive fees are necessary. A first required step is the introduction of an international "Lake Constance Day Ticket" which would be valid within all public transportation systems in the Lake Constance area. In order to reduce the burden of mobile recreational traffic, the public routes leading from the area around the lake to the lakeside communities must be greatly improved. _It is recommended that no new tourism infrastructure be developed on the shore of Lake Constance. The environmental quality of accommodation and recreational facilities should be improved by the introduction of environmental management systems and incentives._ In addition, linking and the exchange of experiences among sustainably working tourism businesses should be promoted cross-border.

There are several key lessons about tourism that are relevant for other lake regions. Recently, tourism has been considered to be the best answer to all problems. It is, however, recommended not to overestimate the positive effects of tourism but to be aware of possible negative effects. International tourism is a short-lived, sensitive, and extremely competitive economic sector, susceptible to trends and all kinds of crises.

Currently environmentally sound tourism offers exceed the demand. A long-term tourism development planning with regular monitoring of the efficiency is necessary. This would include:

- Promotion of environmentally sound and socially acceptable tourism: recognized Ecolabel, i.e. European VISIT-Standard (www.yourvistit.info), environmental management systems (EMAS, ISO 14001), and Soft-Mobility-Concept (www.soft-mobility.com).

- Destination Monitoring: Within the LIFE-VISIT Project, ECOTRANS developed a set of indicators for tourism destinations including process indicators for sustainability policy, environmental performance indicators (transport, land use and biodiversity, energy, water, waste), social and cultural performance indicators and economic performance indicators. Further information is given at www.yourvisit.info.

- Information and sensitization of locals and guests by pointing out interactions (e.g. regional agricultural products and the preservation of the landscape), environmentally sound offers (your choice makes the difference), providing tips for environmentally friendly and socially acceptable behavior, etc.

- Entrepreneurs should get interested in sustainable tourism activities. A good example is ECOCAMPING, an environmental project for camping grounds. This project

has been running since four years very successfully and will be extended within the next years.

3.7 Boating and Water Sports

Recreational and professional boating must employ the highest standards of current environmental technology including biocide-free underwater coatings and emission-free or low-emission motors. Navigational infrastructure must be established in accordance with the needs of nature and the landscape, this should include no extension of the harbors along Lake Constance and the realization of the Lake Constance Guidelines (Bodensee-Leitbild). All these aspects of actions for Lake Constance are also relevant for other lakes.

3.8 Transportation

In the case of goods transport, the ecologically and socially responsible means of transportation has to be chosen. In general, the contribution of rail transport should be increased.

Pollution caused by private use of automobiles, travel by train, bus, ship should be recognized and use of bicycles and travel by foot must be given stronger support. In landscapes that are ecologically sensitive and in important recreational areas as well as within settled communities, limitations on motorized means of transport are necessary.

The saturation level and condition of the roadway network in the Lake Constance area are adequate, in some cases over-proportional. Lake Constance should not become a transit crossing-point for interregional highways. The further extension of interregional, regional and communal roadways is not necessary. In particular, the construction of S 18 through the valuable reed meadows of the Alpine Rhine valley has to be abandoned.

The railroad system is inadequate, especially on the German side of the lake. The improvements undertaken at some sites should be extended to the entire region. Concerning long-distance and regional transport, the Lake Constance region's connections to the major cities of Zurich, Munich and Stuttgart should be improved.

Key transportation lessons of relevance for other lake regions are:

- The importance of securing reliable, sufficient and high-quality public transport by extension of railway lines, bus connections and ship connections. Solar powered boats provide the optimum combination of public transport, use of renewable energies and sensitization of passengers for new environmental technologies.
- Attractive fares and comprehensible regional fare structure are the key to success. In the international Lake Constance area a Euregion day ticket valid for all means of transportation was introduced very successfully.
- Creation of information for locals and visitors on transportation facilities. In Constance, a mobility center was created. A good idea is also a ticket information service including trans-border information such as the one www.bodenseeclick.com has tried to establish.
- Promotion of cycling by improving the network of cycle tracks, clear signs, safe parking lots as well as support services (repair service, air supply, etc.).
- Use of car sharing instead of using privately owned cars.

3.9 Land Use Planning

Municipalities have a key role in spatial politics. Environmental management for Land Use Planning (ECOLUP) is a valid instrument to support sustainable land use planning, and especially to reduce land consumption. Within the implementation of the environmental management system (EMAS), the municipality together with relevant stakeholders, sets up environmental goals and concrete measures to reach these goals. The municipality uses few but relevant indicators to determine the status quo for each environmental aspect and to measure the results of the activities. This "environmental program" includes goals for land use planning, sealing/green belts, traffic/mobility, energy/climate, landscape, water and participation of citizens and is adopted by the municipal council. An environmental health manager is responsible for the well functioning of the system and for monitoring of the measures. More information is available at www.ecolup.info.

3.10 Financing and Networking

Networking, campaigning and public relations are very often independent of concrete projects and require additional personnel and financial resources. Programs to co-finance these important activities are necessary.

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