

CHAPTER 119

LAND USE AS A FACTOR IN COASTAL WATER QUALITY

by

P. H. McGahey
Professor Emeritus
University of California
Berkeley

Public Concern for the Coastal Zone

Recognition of coastal and estuarine waters as a part of the overall water resources of a nation is a development that became evident only in quite recent years in the United States. To a significant degree it is associated with an aroused public concern for the quality of something currently described loosely as "the environment" -- a concern which initially reached a critical mass in about the year 1969. To be sure, the oceans have always fascinated men of all sorts from adventurers to scientists, but the emergence of a broad public interest in the quality of ocean water, particularly in the coastal zone, is the result of several factors, not all of which are scientifically defensible. One such factor is the notion that the oceans are teeming with life which may well become man's final source of food when he has overwhelmed by sheer numbers the physical and biological carrying capacity of the land. Such an estimate of the potential of the sea seems to have been obtained by multiplying the volume of the oceans by the biomass concentration typical of the continental shelves. That it is a vast exaggeration in no way detracts from its potential to energize public reaction. However, the truth that aquatic life is most abundant in the coastal zones, and the prospect that man must manage this zone in a better manner if that life is to continue to contribute to his well being, only makes it the more important that the quality of coastal waters be a matter of concern and of purposeful management. To this end a considerable degree of public overestimation of the role of the sea in sustaining human life is a force that can be harnessed to productive programs of intelligent action. In fact, an appreciable amount of purely emotional concern for such catchwords as "ecosystems," "endangered species," "habitat," etc. can be tolerated and often used productively without any debating of its validity as long as it does not impose a serious constraint upon society without generating any corresponding benefit to either man or his fellow creatures.

But concern for coastal waters and the problems of their quality cannot be confined to food for man nor to habitat for marine biota. It is an inescapable spinoff of urbanization and an aspect of the need of urban man for recreational facilities. Nor is this situation likely to get any better, because the tendency for human beings to become urban dwellers is a worldwide phenomenon. In the U.S.A. the 1970 census revealed that 75 to 80 percent of its citizens were living on less than 10 percent of the land. Various estimates anticipate that by the year 2000, 90 percent of some 300 million people in the United States will live on 3 to 5 percent of the land. More significant, however, is the census finding that 73 percent of the U.S. population live within 50 miles of the sea coast or the Great Lakes. Thus it must be presumed that the coast is a factor in the life of more than

three-quarters of our people at some time during each year. Similar statistics for other nations are not at hand at this writing but one may readily presume that the percentage of Canadians, for instance, who are similarly influenced by the ocean is no less than that of the United States.

What does urban man demand of coastal waters? First he wants access to them, generally to a degree far in excess of that readily available in the vicinity of any large concentration of population. He wants beaches for his bathing and basking. He wants marinas for his boat; open water for water skiing; room to sail or to speed under power. He wants an aesthetically pleasing water. He wants fish and wildfowl; and he wants clean water free from health hazards, nuisance conditions, and whatever other aspects he may associate with another of his catchwords — "pollution."

The Coastal Zone as a Factor in Water Quality

The quality of coastal waters is inescapably a function of what happens on the land, especially within the coastal zone. Man not only wants the physical and psychological benefits of an unpolluted nearshore water, but also he wants to occupy on a continuous and permanent basis both the shoreline and the landward coastal zone; and he prefers for this purpose the estuaries and embayments that mark the terminus of coastal and inland valleys. Here he seeks both economic gain and the accommodation of large numbers of people, on which such gain depends, by erecting high-rise waterfront apartments with a superior, and often a preemptive, view of the water. He wants to, and does, reserve to individuals the beach and marina areas, thus limiting public access to the shoreline or concentrating recreationists in a few inadequate beach parks. He wants and needs harbor facilities for commercial shipping. In fact, urban settlements to a large degree began along the seacoasts and other major waterways where transportation by boat and barge might serve the human needs and the search for wealth that goes with commerce. In terms of coastal water quality this phenomenon had several major effects.

One such effect is the result of the natural untidiness of man. It involves the desire of people to be rid of unwanted wastes in the least expensive and troublesome manner. Because essentially all coastal cities have been long in their development, waste discharge practices began when man's tolerance level for the unaesthetic was somewhat higher than it is today. Consequently, the method of dealing with domestic and industrial wastewaters was to pipe them in a raw state directly to an estuary or embayment by the shortest route from the area of origin. This compounded the number of points of discharge of sewage as the city grew. In many cities, both storm water and sewage flowed through the same conduit. Initially such a waste disposal practice may have had little effect on the life of coastal waters. Later, as the extent of the population concentration increased, the oxygen demanding potential of decomposing organic matter came to endanger the oxygen resources required by aquatic organisms. Moreover, the presence of bacteria of intestinal origin became a hazard to the health of people using beaches and coastal waters, or eating shellfish taken from them.

The development of industry, which made large cities possible, increased the range of "pollutants" in sewage to include toxic metals and exotic chemicals, leading to a new spectrum of dangers to the users of coastal waters — be they men or creatures less able to control their own destiny.

Concerning domestic and industrial sewage discharges it may be said that both man's aesthetic sense and his ability to increase the volume and variety of waterborne wastes have grown faster than his willingness to depart from ancient practices, faster than his knowledge of the effects of wastes on marine life, and faster than his economic and technological progress in collecting together the discharges from dozens of outfalls and upgrading them to levels which he is still trying to establish as appropriate. Therefore it may be said that sewerage of man's homes and factories in the coastal zone can contribute to coastal waters such things as unsightly floating debris and grease, toxic ions and chemicals, oxygen consuming organic matter, nutrients, and bacteria and viruses. The effects of these may include loss of clarity of water, aesthetic nuisance, health hazards to man, and observable direct, or little understood indirect, effects on aquatic biota. Not all effects of waste discharges, however, are necessarily detrimental. The amount and the state of nutrients in human wastes may be suited to the support of a thriving marine community. The point, in the context of the present discussion, is that wastewater discharge from urbanized land is a major factor in the quality of coastal waters bordering such land.

A second factor in land-water quality relationships in urban development derives from the physical use of the land itself. Coastal valleys in nature intercept some of the sediment brought down by natural floods. Typically such valleys also contain low lying marshy land which intercepts surface runoff and serves as habitat for plants and wildfowl, as well as for mosquitoes and other insects which man in his own interest dare not tolerate. As the city grows, these valley and marsh lands come under development. Swamps are drained of water and of stored organic nutrients. Natural stream beds are straightened and lined with concrete or replaced with conduits. These measures hasten both flood and less severe surface runoff to the sea. Roofs, streets, and paved parking lots, which characterize urban development, likewise hasten rain water to the sea. One effect on coastal water quality is to increase the drop in salinity resulting from fresh water inputs, and to discharge to the coastal water a variety of debris generated by men living in large concentrations, carrying on his industry, and wearing down countless automobile tires in the streets.

There are also other aspects of urbanization that affect the quality of waters moving from the land to the sea. Both the search for a view and the limited availability of valley land encourages urban development of hills and mountain sides. On steep land, as on flat land, the most economic use of costly equipment during land development is to prepare the entire site quickly. Thus, stripping of vegetation and reshaping of land surface generates a source of sediments which may in time of heavy rainfall be disastrous to aquatic biota or habitat. Conversely, protecting a city from floods by control reservoirs may so reduce the sediment budget of a coastal area that long existing beaches disappear.

Associated with the drainage of urbanized land may be water quality factors resulting from the commercial and household use of pesticides; and from fertilizing of gardens, lawns, and parks. Although the alarmist may fear that toxic materials from such sources may harm marine life, or that nutrients may stimulate excessive growth of aquatic plants, little is known of the effects in either a general or a specific case of human occupancy of land. The same holds true for surface runoff from agriculturally or industrially developed land. What is known then is the kind of water quality factors that urban land development generates and, more important, that if one does not like the presence of such factors in coastal waters he shall have to look to land use management practices to determine what he can do about it.

Controlling the Quality of Coastal Waters

The foregoing conclusion is deliberately drawn before it is thoroughly documented in order to facilitate an examination of our traditional control measures and an evaluation of our areas of ignorance of appropriate objectives for coastal water quality control.

Most anyone familiar with North America will agree that the freedom to own and to use and abuse land is a heritage of Americans much harder to invade than that of their freedom similarly to abuse water. Moreover, what is today considered an improper use of a land resource may at some earlier date have been its highest beneficial use. Specifically, in pioneer times when agriculture was the strongest base of local economy and land ownership the symbol of affluence, a man's livelihood depended upon subduing wilderness, not upon creating one by legislation. Furthermore, society is yet far from ready to consider its vast system of scientific agriculture as a pollution of the land which must summarily be ended. In fact, the continuance and the success of agriculture is perhaps the most institutionalized aspect of our civilization.

With water the story is different. Concern for the quality of water developed slowly. Knowledge of the role of water quality in health is scarcely a century old. Nevertheless in the case of drinking water it is a comparatively well resolved problem. The concept of other beneficial uses for which quality should be considered, however, has been institutionalized less than 25 years. To control water quality the abuser of water becomes known as a "polluter," the abuse itself as "pollution," and "pollution control" as the appropriate regulatory response. But most of this charade began with fresh water and with flowing water, which differs from land in a special way — it is a transport system rather than a sink; and its capacity to suffer pollution is one of concentration or degree. This led men naturally in the direction of "pollution control" aimed at the local discharge and at the control of its concentration at the source. Once such a concept was institutionalized it took a considerable period of years to come around to the viewpoint that water is a resource like air and land and so should be protected as a resource. The extension of this concept to that of protecting water quality for environmental reasons is little more than three years old.

Consequently, slowly developing water quality standards and objectives have been concerned with water per se and have had but limited secondary effects on restraining the use of land.

Coastal waters, with the exception of health and nuisance oriented factors, were not given particularly wide attention from a quality of resource viewpoint until "environmental quality" became a catchword. Prior to that time the ocean was considered as the earth's ultimate sink and all but hopeless in quality; quality, of course, being measured in terms of physical condition and chemical and microbiological constituents rather than in terms of its suitability for marine ecosystems.

Popular concern for "environment" and "ecology" aroused interest in protecting the quality of coastal waters for environmental objectives. Understandably, the effort is taking the "pollution control" route long applied to fresh waters. Thus, unwittingly the initial attempt is to overcome the results of poor or nonexistent land use planning and management by imposing increasingly severe restrictions on the quality of water discharged by land-based industries, cities, and agriculture. That this will have any important feedback effect in controlling land use in such a manner as to attain coastal water quality must be considered a forlorn hope.

Consideration is, of course, being given at many governmental levels of how land use management for protecting the air, water, and land environments as a single unit might be initiated. Generally proposals in this context take the form of greater governmental control by new agencies so broad in concept that simply organizing the agency and institutionalizing its power should allow the ocean to get a great deal saltier before its quality is related to the land in any specific way. Nevertheless, efforts to protect the quality of coastal waters are in evidence. In 1971 federal and state regulatory agencies began demanding that storm water runoff from coastal cities be collected and treated to some degree before permitting it to enter coastal waters. Just how this is to be accomplished in a city such as San Francisco with hills draining in three directions into the ocean and the Bay is less clear than is the evidence that authority will demand it. However, in evaluating such factors as those herein presented one thing does become quite clear. That is, that land as well as water will have to be managed simultaneously if national objectives related to coastal waters are to be realized.

The Search for Criteria

It is, of course, one thing to demonstrate rationally that the quality of coastal waters can be managed only by controlling how man husband the land, but quite another to identify the appropriate land-water relationship, and to establish criteria suited to protecting both the quality of coastal waters and the quality of life within such water. It is at this point that we must recognize that our environmental goals are in danger of outrunning the limits of either understanding or good sense. Two boundary conditions can be set, neither of which makes sense of any kind. One is to do nothing to protect the quality of coastal waters; the other is to do nothing that

could conceivably pollute them. Few men can be found to advocate the first, whereas a loud and organized group of "true believers" have persuaded themselves that the latter must prevail — presumably without terminating mankind. Unfortunately, man simply does not have the knowledge necessary to establish realistic objectives, to evaluate the tradeoffs necessary to achieve such objectives, nor even to judge how much of the violence done an ecosystem in a given coastal area is attributable to nature and how much to man — or by what chain of circumstances it occurred. We may as well confess that despite our current zeal to save the oceans we really do not know what to save them from nor precisely for what purpose they are to be saved. But that does not mean that we should not try to find out.

Numerous studies to shed light upon the darkness I have indicated are in progress. To undertake a catalog of all ongoing work having land-water-ecosystems relationships in coastal zones is beyond the scope of this paper. Right here in Vancouver studies are aimed at evaluating the land-water relationships east of Vancouver Island and in the Frazier River. All I know of the early results of this study is that the chap who built Vancouver Island is going to have a hard time justifying it to the Sierra Club.

Work with which I am personally familiar is in progress in Hawaii under a Sea Grant to the University of Hawaii for studies which include the quality of coastal waters. There are several reasons why this particular study has a unique potential for developing criteria to relate coastal water quality to land management practices and for evaluating the resources of the coastal zone both landward and seaward of the shoreline.

To begin with, essentially all of inhabited Hawaii is shoreline or coastal zone, thus coastal waters are little influenced by what man does on inland rivers. Moreover, there are still situations in which the discharge from land to water, and consequently the coastal water environment is little affected by the presence of humans. This affords an opportunity to establish some baseline against which to evaluate human activity on land — a need which cannot be overemphasized. Next there are situations as at Kaneohe Bay where intense urbanization of a coastal valley has occurred and changes in water quality and biota have been observed in the presence of treated sewage. Moreover, plans to discharge sewage elsewhere are in progress and the opportunity is developing to observe changes in the environment and in the biota of Kaneohe Bay when only urban runoff afflicts its waters.

"Before" and "after" studies with raw sewage are in prospect and in progress in relation to Honolulu's sewage discharge at Sand Island. The sugar cane industry has likewise been isolated for evaluation of "before" and "after" effects of sugarcane culture and milling operations. Thus, Hawaii, by reason of its coastal zone and shoreline development and the relative ease of segregating the effects on water quality and biota of urban, agricultural, and industrial development of land, affords a particularly good place for land use versus coastal water quality evaluations which lead on to needed criteria. The state has certain other characteristics of significance. Water temperatures and weather permit almost uninterrupted year round work in the ocean. Having no continental shelf, deep water exploration and resource studies are especially convenient. This same

phenomenon, however, accentuates Hawaii's need for information on dozens of the subjects which appear on the program of this Conference.

Of course a very great percentage of the coastline of the North American continent is influenced by what man does on inland rivers and tributary land. Here again we need some baseline data to differentiate between what man and what nature does to coastal water quality. Perhaps here in western Canada, where great upriver cities have not yet overwhelmed nature is the best place to seek such baseline criteria.

Conclusion

Nature has long used the ocean as a sink. If the quality of coastal waters which, as I noted earlier is the critical zone, is to be maintained as near as possible in some optimum condition, then it will never be enough merely to take up a sample of the water, frown over it in the laboratory, and lower the values in an increasing spectrum of "standards." We shall have to know more of how land use, land development, and land management practices, especially in the coastal zone, affects the quality of coastal waters, and what that quality means to life in that water. Then we shall have to know enough about natural shifts in ecosystems and what kind of ecosystems we want to maintain, or can possibly maintain, to make intelligent tradeoffs between land and water quality decisions. Finally, we shall have to reexamine the degree of freedom that goes with our land in order to adapt it to a population load which now brings these waters to a condition with which man must become concerned.

ABSTRACT

Coastal and estuarine waters are only now being fully recognized as a major sector of America's overall water resource. Protection of the quality of such waters for environmental objectives has understandably followed the same "pollution control" route long applied to fresh waters. This leads to attempts to overcome the results of poor or nonexistent land management regulations by imposing increasingly severe restrictions on the quality of water discharged by land-based cities and industries. Human occupancy of the coastal zone leads inevitably to the straightening and lining of drainage channels, the paving of streets and parking lots, the stripping of vegetation from land during subdividing, the overloading of land area with housing, the commercial and industrial use of pesticides and fertilizers, and various other phenomena which contribute to the degradation of the quality of coastal waters and water environments. Although freedom to own and abuse land is a heritage of Americans somewhat more difficult to invade than is their freedom similarly to abuse water, it is becoming clear that land as well as water will have to be managed if national objectives related to coastal waters are to be realized. Upriver activities lead to degradation of coastal waters in some situations. In others occupancy of the coastal zone is the major factor.