A Water Problem That Continues to Be Rediscovered: Nonpoint Source Pollution

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Nonpoint source problems began when wandering groups of humans, accompanied by their animals, decided to change their lifestyles by establishing semi-permanent or permanent settlements. This shift from hunter-gatherers to nomadic groups, then to partial settlements and finally to more permanent residences and villages placed an ever-increasing burden upon the local natural resources.

When one reviews the history of Europe, the Far East, the Middle East, or South America, increasing evidence suggests that major shifts and declines in the population of these regions were instigated by depletion of their soils through excessive tilling and grazing. In addition, essential soil nutrients and trace metals were lost by the disruption of the stabilizing vegetation and the ensuing high runoff. In China and other Far East countries where burgeoning populations left little room for population movement, eroded soils sometimes often had to be laboriously packed by basket back to denuded terraces.

The soil's ability to regenerate itself also was damaged through compaction by human and animal traffic. In some instances, the loss of soils and consequent drops in productivity led to jungle growths reclaiming cities and states. Internal and external conflicts also played a role.

Examination of sediment cores taken from lakes existing since glacial times (10,000 to 20,000 years) can provide a profound regional history of such soil losses and subsequent water quality changes. Hutchinson (1970) provided an interesting insight into nonpoint source enrichment when he described the history of an Italian crater lake, known as Lago di Monteros. The productivity of this waterbody varied greatly over 22,000 years or so. The first changes came as a result of natural runoff. But then a spate of increased productivity in Lago di Monteros occurred after initial road building by Romans -- about 171 B.C. The lake then stabilized and its productivity decreased until medieval times. Cultivation and pig farming in that period further enriched its waters. In recent times, contemporary road building seems to have again altered its nutrient level.

Franco and Wetzel (1983) consider contaminated water supplies to be a major cause of the great plague that afflicted Europe in the 1300's. This chain of events began with land deforestation. More land devoted to agriculture was needed to feed the increasing number of people. Poor land-use practices led to erosion, flooding, and a drop in productivity. A chronically undernourished, disease-susceptible population was the result. The degraded water supplies most likely triggered and sustained the plague which killed one of every four Europeans within a three-year period.

However, for centuries, in most world areas, villagers with such problems as overpopulation, crop failures, and conflicts could move to a new site, a new region, or perhaps even a new continent. The latter is what happened on the North American continent. There, for the first 100 years or so, affairs went fairly well, at least as far as water supplies were concerned. Each household could be self-sufficient. But by the early 1700's, it was necessary to provide water control structures to supply water to the fledgling cities and early industries. Eventually, the urge and need to move to the undeveloped West came to the new nation. This western movement accentuated this "cut and burn, plow, cultivate for a few years, and then move on" mentality that had been growing since early times.

Looking at the situation today, nearly all resources in the United States have been treated in a similar manner -- the buffalo, anadromous fish, mineral-rich areas, and the great western forests. Exacerbating the situation, when the continent was largely settled and secondary water-related problems arose, only structural and engineering solutions were sought. Reservoirs were built in the mid- and late-1800's to supply water for growing populations in eastern cities and their industries. Similar waterworks were constructed for western irrigation and hydraulic mining purposes. In the same time period, the Congress began appropriating money to the U.S. Army Corps of Engineers to clear debris and sand bars from major river systems. This need was apparent, but the underlying cause was not recognized.

By the turn of the century, the U.S. Bureau of Reclamation had been founded to further the cause of western irrigation. However, by then some insight developed in regard to deforestation and overgrazing. Along the Wasatch Front in Utah, deforestation and overgrazing on mountain slopes had resulted in massive amounts of sediment and boulders being deposited in city and town streets. Drinking water supplies had been fouled with silt and animal wastes. The formation of the U.S. Forest Service, establishment of grazing permits, and restriction of access to forest watersheds slowed and sometimes reduced these hazards by the late-1930's.

The legislation of the 1930's remained mostly

developmental in nature, with large appropriations being made for the Army Corps of Engineers and Bureau of Reclamation. However, the Soil Conservation Service was established during this time period to help conserve the nation's water and soil. The New Deal Recovery Acts of the late 1930's provided funds for the Works Progress Administration and the Civilian Conservation Corps to terrace damaged forest slopes, replant trees, and build sediment traps on streams. These activities assisted in alleviating some problems.

But with the entry of the United States into World War II, water conservation and pollution control efforts essentially were put on hold. Under the war effort, large military and industrial complexes with the necessary adjacent cities were established with little regard for hazardous waste disposal, runoff, or waste treatment. The construction of huge hydropower dams was accelerated and all other resources exploited to aid the war effort. Accelerated nonpoint source pollution problems were effectively masked by industrial and municipal discharges to streams.

After the cessation of hostilities, the pollution picture remained about the same. When flammable effluents in streams and rivers caught on fire in the 1950's, who noticed urban runoff, sediment, agriculture, and pesticide contamination? The Clean Water Act of 1948 (PL 80-845) had been passed but provided relatively little assistance to individual states as it dealt mostly with interstate waters. A series of corrective statues followed: the Federal Water Pollution Control Act of 1956 and the 1965 Water Quality Act that set water quality standards and established the Federal Water Pollution Control Administration. However, little enforcement could occur. This situation and the lack of uniform standards led to the 1972 Water Pollution Control Act (PL 92-500) which set forth new provisions with the objective to "restore and maintain the chemical, physical, and biological integrity of the nation's water." The Federal Water Pollution Control Administration became the U.S. Environmental Protection Agency (EPA).

Many Americans had realized that their natural resources, including water, were exhaustible. On the other hand, their expectations for zero discharges of contaminants was beyond the nation's technical abilities. Protection and restoration thus became key elements in the country's cleanup efforts. Through much national debate and discussion by Congress, with input from state agencies, the EPA, and industry, the National Commission on Water Quality endorsed the policies established by Public Law 92-500, but put more responsibility on the individual states and eased some of the requirements. These changes are reflected in the Clean Water Act of 1977 (PL 95-217).

However, the American people began to wonder why a large number of their streams and rivers still appeared degraded even after the passage of all this legislation. The Government Accounting Office subsequently made inquires in areas where large grants had been made for waste collection and treatment facilities. Professional organizations and a number of state agencies also surveyed their constituents to assess their water quality problems. It was determined that the treatment of effluents from municipalities and industries had significantly improved, but the population growth and accelerated inflation had reduced the effects of the grants' program and growing state and federal financing problems had slowed progress.

At the same time, the nation had experienced a long period of prosperity from the 1960's through the mid-1970's. This triggered an exodus of more affluent families from the larger cities to suburban and rural living environments where they expected to experience clean streams, lakes, and rivers. However, uncontrolled runoff from disturbed surface areas, such as new construction and roads required for the urban expansion as well as increased farmland cultivation, enlarged animal holding areas, hobby farms, and other sources resulted in a less desirable environment than the new residents expected. This degraded urban and semi-rural environment became a new source of contention and citizen concern.

Parallel events earlier had stirred additional environmental concerns in the United States. The first Comprehensive Water Pollution Control Act (PL 80-845) had also spawned the National Water Pollution Control Research Laboratory at Cincinnati (later to become known as the R.A. Taft Engineering Center). Scientists and engineers at this center and those centers to follow such as the Pacific Northwest Laboratory at Corvallis began technical investigations, publishing their findings in small manuals and professional journals. Some writers just after the turn of the century had included watershed descriptions in their publications, such as H.S. Davis' *Instructions for Conducting Stream and Lake Surveys* (1938). By the late 1940's, many university faculties began to understand the need for an advantage of interdisciplinary as well as applied research. The Public Health Service training grants that followed in the late 1950's and early 1960's paved the way for emergence of a cadre of scientists and engineers in the mid- and late-1960's to look more in depth at all aspects of water quality. These events culminated in a call by the National Academy of Sciences (NAS) for an international symposium on eutrophication. This event was held at the University of Wisconsin at Madison in June 1967, with sponsorship by the NAS, the National Science Foundation (NSF), and other water-interested agencies. Nearly 600 individuals attended from the U.S. and 11 foreign countries. All aspects of eutrophication were discussed and the implications of urban drainage, agricultural practices, and nutrient output from managed forests were thoroughly and candidly reviewed.

Three years later the American Society of Limnology and Oceanography convened an invited conference on nutrients and eutrophication: the *Limiting Nutrient Controversy*. This conference was also co-sponsored by the EPA, the Michigan Institute of Water Research, and the U.S. Office of Water Resources Research (OWRR). The importance of phosphorus, its sources and interaction in the aquatic environment was emphasized along with the overenrichment of large estuarine areas by nonpoint sources.

By this time, it had become apparent that contaminants other than those discharged by municipal or industrial sewage works were a major cause of stream, lake, and estuarine problems. Anyone who traveled by air over major river courses could note that the effluent from treatment plants appeared a great deal more clear than the receiving bodies of water. Lakes other than the major bodies of water (e.g. the Great Lakes, Lake Washington, Lake Tahoe and Crater Lake) had been long neglected. Public Law 92-500 Section 314 had provided for water quality classification of public lakes as well as diagnostic, restoration, reusability, and protection features but little money had been appropriated.

When PL 95-217 was enacted in 1977, some funds were appropriated to begin a lakes' program. Another large step was taken earlier to integrate and better understand the connection between watersheds, lakes, and rivers. At a national meeting entitled *Lake Protection and Management*, held at the university of Wisconsin in October 1974, considerable discussion had revolved around the need for lake restoration research and the education and involvement of the public. Many representatives of professional water organizations were present but no single group felt this could be done within their particular organization. As a result of the deliberations, plans for organizing the North American Lakes Management Society (NALMS) were drawn up. NALMS was formalized in Portland, Maine in September 1980 at the *International Conference on Lake Protection and Restoration.*

NALMS organizers had recognized the prime need for watershed protection in order to restore and rehabilitate lakes. This group also became an active voice in public affairs. Largely through the efforts of NALMS members, the first national symposium on non-source pollution was held in Kansas City in May, 1985. Six other sponsors and 39 co-sponsors made up of water agencies and water quality professional associations assisted. Several members of Congress and staff attended and the impetus was given for providing funding for Section 319 of the Clean Water Act.

Almost simultaneously in 1985, another group -- mostly with Great Lakes interests -- sponsored a regional conference on nonpoint source pollution at Milwaukee, Wisconsin. The Universities Council on Water Resources (UCOWR), with assistance from NSF, also sponsored a conference on national water resources research needs in Maryland the same year. Prevailing throughout this meeting was a call to better understand the "connectedness" of water issues -- i.e. watersheds, surface waters, groundwater, estuarine, and wetlands systems. Conferences sponsored primarily by the water research institutes and centers of the Pacific Northwest/Oceania Region of the National Institutes for Water Resources took place as well in Seattle and Spokane, Washington in 1988 - 1992.

The University of Washington and Washington State University, with input from Oregon State University, presented a 1988 regional conference sponsored by EPA Region X on nonpoint source pollution problems. This region encompasses areas of high, moderate and low rainfall areas. Presentations were made in Seattle and Spokane.

The Pacific Rim centers and institutes from Washington, Idaho, Alaska, Oregon, Guam, and Hawaii also presented a conference in Tacoma, Washington in 1991 that covered the high to low runoff problems of the contiguous western states. The special concerns of island environments also were examined. These conferences were supported by EPA, state agencies, soil conservation districts, and the U.S. Geological Survey. These same centers recently have been active participants in programs such as Adopt-a-Stream, Stream Walk, and Water Education for Teachers (WET) in an effort to educate students and the public about stream quality and sources of pollution. In these programs, citizens can actively become involved in protecting and improving watersheds, stream courses, wetlands, and lakes.

Watershed '93, a national conference held in Alexandria, Virginia in March 1993, was a natural outcome of the activities previously described in this paper as well as many others currently taking place across the nation. Today's citizens are a great deal better informed than their predecessors about water, especially those in an urban environment with surface bodies of water. At *Watershed '93*, we had expected an attendance of about 500. We had 1,100 attendees from 42 states, several territories as well as South Africa, Canada, and the United Kingdom.

High interest levels in state agency activities are the result of grassroot concern about water quality and multiple use of streams and rivers. Many communities now derive a good portion of their income from tourist activities with both the hosts and the visitors being very interested in restoring and maintaining both water quality and aesthetic conditions.

Native American participation in water decisions also has increased dramatically in the past 20 years. Court recognition of the sovereign rights of the tribes has resulted in their taking an even stronger hand in water management on their reservations. Restoration and protection of reserva-

tion streams and lakes through watershed protection is a high priority from both a practical and a heritage point of view. Good fisheries and waterfowl production are both a food supply and a source of tourist income for the tribes.

At this time, there seems to be a major impetus to push ahead and mitigate and/or solve some major nonpoint source problems. However, because of the diversity and lack of concern of commitment in the past by many state agencies, a large question remains about how much effort will be made. In some states, relatively few individuals are assigned to this area. In fact, in one state, there is only one individual. In many instances, data are not being collected uniformly nor shared. Method of analyses and reporting also are not uniform. However, nonpoint source pollution control will require cooperative efforts between individual state agencies as well as federal agencies. Watersheds overlap state lines and in many instances national boundaries.

Many engineers and scientists are graduating in water resources and environmental engineering with little exposure to nonpoint source problems or solutions. As budgets are crunched and reduced, there has been a retreat toward more traditional lines of training. Interdisciplinary programs have suffered. Universities give lip service to interdisciplinary research and teaching but find them difficult to recognize because of traditional departmental structures -- similar to their nebulous rewards for public service activities on the part of the faculties.

Much of the progress made to date on nonpoint source cleanup has been by individual initiatives, efforts, and "on-the-job training." The Soil Conservation Service, and especially soil conservation districts, have immeasurably helped reduce nonpoint source pollution through their grassroot efforts. Additionally, technology transfer has occurred through conferences such as those ones described earlier. The EPA is now assisting with information transfer by supporting *Nonpoint Source News Notes*, a newsletter published by Terrene, a nonprofit educational organization. NALMS also consistently includes nonpoint source as a major agenda item in its regional and international meetings. The Soil Conservation Service and the EPA have developed a directory of nonpoint source water quality contacts and a video, "Clear Water, Clear Choices." The latter are recent examples of information transfer.

A considerable number of individuals prior to the *Watershed '93* Conference expressed their concern over lack of coordinated regional and national efforts. These persons took direct action by forming the National Nonpoint Source Federation (NNSF). Mr. James Fraser of Dynamac Corporation was elected president of the NNSF. The group draws its membership from agriculture, industry, academia, agencies, and citizens.

In summary, it is apparent that watershed and nonpoint source problems have been with us from the time mankind first established semi-permanent residences and began tilling the soil. For several thousands of years, we could leave our problems behind and including some not so habitable. We have ignored downstream results to date and now we have to address them. To sustain reasonable living standards and promote global health and viable economics, nonpoint and other pollution problems must be understood and sharply reduced.

References

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