Similarly, Clifford K. Beck, deputy director of regulation for the AEC, says that virtually all nuclear reactors actually discharge only about 1 percent of the AEC's radioactivity limits for liquid wastes, so reducing those limits to one-third of their former value might have no practical effect on the radioactivity actually discharged.

So why has the power company called Tsivoglou's recommendations "unnecessarily strict?" Because, says A. V. Dienhart, NSP's manager of engineering, the company wants a margin of error so that it is not subject to legal action if the plant fails to perform as expected, or if an operating emergency causes radioactive discharges to increase above the expected level. Dienhart told *Science* that while the plant will probably discharge only about 1 percent of the AEC's radiation limits during normal cooling operations, these percentages may rise by a factor of 10 during periods of low river flow. At such periods the discharges would thus be of the same order of magnitude as Tsivoglou's recommended standards. Dienhart is also concerned that the company may have to analyze precisely what isotopes are released, instead of treating the effluent as a gross mixture, as AEC allows.

Legal questions have been raised as to whether the MPCA has the authority to put Tsivoglou's recommendations into effect. Both Howard K. Shapar, the AEC's assistant general counsel for licensing and regulation, and Richard A. Emerick, special assistant attorney general for Minnesota, have expressed opinions that the states do not have jurisdiction to regulate radioactive effluent from nuclear reactors. But Harold P. Green, professor of law at George Washington University and a leading authority on nuclear matters, has suggested that, while the Atomic Energy Act clearly prohibits state standards that are less stringent than the AEC's, it is less clear that the act prohibits state regulations that are more stringent. Green suggests that the question should be litigated.

Meanwhile, according to Robert Tuveson, MPCA chairman, Minnesota is "going to rely on Tsivoglou's recommendations and try to implement them," let the legal chips fall where they may. Neither the power company nor the AEC has yet threatened to go to court, so the regulations might well go unchallenged. If so, Minnesota will apparently have the stiffest radioactivity safeguards in the nation.

This prospect pleases some of the original critics of the Monticello plant, but others feel the regulations will still be too lax. They seek a complete ban on radioactive discharges, a concept Tsivoglou rejects as unnecessary and unrealistically expensive. But even if the critics don't get everything they want, there is no question that the Minnesota protest movement—in which local scientists took the lead and challenged the expertise of distant authorities—has had a significant impact on the MPCA and on public opinion.

—PHILIP M. BOFFEY

Development in the Poor Nations: How To Avoid Fouling the Nest

For the poor nations the word *development* has carried the connotation of something necessarily good—of "progress," of a break with traditional, "backward" ways and adoption of the ways of the technologically advanced countries. A political leader who, with the help of a modern donor nation and the international agencies, can have his country build an Aswan Dam and a "Lake Nasser" clothes himself and his regime with conspicuous symbols of progress and modernity. Although some scientists and conservationists are now worried, it seems that, in the past, little thought has been given to the environmental problems that headlong development may bring.

The price of development has included pollution problems, loss of farmlands and habitat (for people as well as wildlife), and even the spread of disease. Some environmental disruption is an unavoidable concomitant of development, but, as ecologists and other environmental scientists insist, harmful effects can often be anticipated and minimized if development is preceded by ecological studies and careful planning.

Though the poorer nations remain intent on development goals, and though the industrialized countries continue to encourage them in this, signs are appearing that the commitment to change may come to be tempered with caution. For example, last September, in Paris, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) held a conference on rational use and conservation of the biosphere, and among delegates of the 63 participating nations there clearly was awareness that development often has led to environmental problems.

In December the U.N. General Assembly decided to convene, in 1972, a conference on the human environment, and this meeting, too, will be concerned partly with ecological problems arising from economic development. It may soon be the vogue to view environmental problems in a world perspective. A recent Sierra Club advertisement in the New York *Times* bore the heading "Earth National Park" and warned that unless his global habitat is better protected, man himself will become an endangered species.

Late last year the Conservation Foundation (a Washington-based organization serving as a "bridge between ideas and action" in the field of conservation) and the Center for the Biology of Natural Systems, of Washington University in St. Louis, sponsored a 3-day conference on the "ecological aspects of international development." This meeting, held at a conference center near Washington, is believed to represent the first ecological "post audit" of international development ever conducted.

The conference participants, numbering almost 70, were mainly scientists (mostly biologists) and social scientists from the United States and abroad. They included such people as S. Dillon Ripley, secretary of the Smithsonian Institution; E. B. Worthington, scientific director of the International Biological Program (IBP), London; Gunnar Myrdal, internationally known Swedish economist; and Barry Commoner, director of the Center for the Biology of Natural Systems.

Russell Train, conference chairman and then president of the Conservation Foundation (but now Under Secretary of the Interior), told the conferees that the purpose of the meeting was to build a clear case for making ecological considerations central to development planning and decision making. To do this, the conferees presented and discussed numerous case histories of development activities which have either been destructive in themselves or have produced detrimental side effects, some of which environmental scientists could have predicted.

"Horror Stories"

These "horror stories," as they were called, involved a variety of activities, such as colonization of new lands, dam building and irrigation, pest control, and extraction of minerals and timber from oceanic islands. A sampling of these case histories follows.

● *Colonization of new lands.* In Brazil's Amazon basin an agricultural colony was established in the late 1940's at the confluence of the Madeira and Madrede Dios rivers. Rain forests were cut away and the land was tilled, with disastrous consequences. For the soils of the region, rich in iron oxide and alumina, are highly subject to a process called laterization, which can quickly turn cleared lands into rocky, brushy barrens. Reporting on the colony's fate, Mary McNeil, development geologist of Lockheed Aircraft International, said the colonists' toil to survive was unbelievable. They cultivated their fields among blocks of laterite and found the soils they were working compacting to rock in 5 years' time. This colonization scheme, Miss McNeil noted, repeated the errors of earlier attempts in Brazil to colonize regions where the soil was lateritic.

● *Dams, reservoirs, and irrigation.* Kariba Dam, constructed in the 1950's on the Zambezi River between Zambia and Rhodesia, has formed a huge, 1700-square-mile reservoir rivaled in size only by the reservoirs created by the Volta Dam in Ghana and the Aswan Dam in the United Arab Republic. Planned largely for generating hydroelectric power, the Kariba project is said to have led to a variety of unanticipated problems. According to a conference paper by Theodore Scudder, professor of anthropology at California Institute of Technology, serious soil erosion is occurring because farmers who were flooded off their former lands have refused to change their traditional farming methods to suit conditions in relocation areas.

Also, vegetation along the shores of Kariba Lake has created habitat attractive to the tsetse fly, aggravating the pest control problem in this Central African region, where the population is heavily dependent on animal protein.

Other problems beset the project. For example, aquatic plants invaded Kariba Lake, and, within 4 years of the dam's completion, covered more than one-tenth of the lake's surface, interfering with commercial fishing and creating other difficulties.

Egypt's Aswan High Dam, with its hydropower, irrigation, navigation, and flood-control potential, has been considered one of the most promising of the great postwar developments. Yet, in a conference paper, Henry van der Schalie, of the University of Michigan's Museum of Zoology, viewed this project (completed only last year) pessimistically. He said that it is virtually certain to lead to a disastrous spread of schistosomiasis along the upper Nile, a region where heretofore the incidence of this debilitating, often fatal parasitic disease has been comparatively low. This is predictable, van der Schalie explained, because the project to bring year-round irrigation to the upper Nile provides the canals and ditches preferred by the schistosome's snail host. In the Nile delta, where year-round irrigation has long been practiced, the incidence of schistosomiasis is high, nearly all the inhabitants of some villages being infected. Moreover, attempts to combat schistosomiasis by snail eradication and sanitation measures, or by the treatment of infected persons, are said to have had only limited success.

● *Pest control.* Heavy use of synthetic organic pesticides for the control of cotton pests in Peru's Cañete Valley during an 8-year period that ended in 1956 had nearly ruinous results. A former director of the Cañete farmers' agricultural experiment station, Theodore B. Barducci, author of a conference paper, said he had recommended against reliance on these pesticides but found farmers of the valley seduced by the promotional claims of the pesticide manufacturers.

Target insects gradually developed immunity to the insecticides, while useful insects that had helped to keep the pests in check were destroyed, Barducci said. In 1957, however, use of the synthetic pesticides was generally prohibited in the valley, and a pest-control program that relied partly on biological methods was established. For example, useful insects were reintroduced and farmers were told to prepare their soils dry—a condition unfavorable to the propagation of the cotton pests. The new program, Barducci said, has been successful; the pest populations have declined and cotton yields have returned to satisfactory levels.

● *Oceanic islands.* F. Raymond Fosberg, of the Smithsonian's Museum of Natural History, described oceanic islands as being especially vulnerable to mismanagement. This is so, he said, because such islands are small and are often characterized by unique, irreplaceable biotas having a history of more or less local evolution. The island of Banaba in the central Pacific, he reported, was recently abandoned by its inhabitants following phosphate mining operations. Most of the vegetation had been eliminated and most of the soil removed. Supplies of fresh water, always marginal, had become undependable. Phosphate islands of the eastern Indian Ocean also have been mined, Fosberg said, and, except for their marine resources, are now scarcely capable of supporting human life.

Carl A. Carlozzi, professor of resource planning at the University of Massachusetts, told of threats to the Caribbean's Lesser Antilles—for example, from the building of huge resort hotels which overtax local waste disposal systems. According to Carlozzi, the government of Dominica, in the British West Indies, last year entered a contract with a Canadian lumber company, allowing this firm to begin cutting Crown Land forests for export. Adequate provisions for conservation and forest regeneration are, he feels, plainly lacking.

Islands such as Dominica (and perhaps most underdeveloped countries) have neither the capital nor the markets for developing their resources on their own, Carlozzi pointed out. Therefore, development is frequently left to foreign investors who, in using the local resources, are guided less by conservation principles than by considerations of profit.

Divergent Views

Although one of the conference's underlying assumptions was that development will continue throughout the world, it was evident that many of those who participated held highly conservative views about altering the natural scene. Yet others took the po-

sition that, even if a project can be expected to create serious new problems, this is not necessarily reason to give it up.

This divergence of views was evident in the discussion of the Aswan Dam project. "This dam is not an asset," said van der Schalie, who in the past has done field work on Egypt's schistosomiasis problem as a leader of a World Health Organization team. "It is bound to be a liability until such time as we know how to control the intermediate [snail] host." However, John F. V. Phillips, an agricultural scientist from the University of Natal in South Africa, said that, despite the schistosomiasis threat, irrigation should be extended, for progress in controlling the disease must eventually come.

In another context, Kenneth E. Boulding, a University of Colorado economist, also expressed the view that it is altogether plausible and defensible to attack one problem even though you are thereby creating new problems for others to solve. "There is a whole school of economics which argues that the way you get growth is to upset things," he said. Though ecologists tend to be too "equilibrium-minded," their approach to development problems may have the virtue of helping the world avoid irremediable disasters, Boulding suggested.

As others observed, the ecological approach generally is not followed, for a variety of reasons. One reason cited is that ecologists often cannot predict with certainty the consequences of following various schemes of development. Conjecture that harmful side effects may result from a proposed development seldom prevails over claims that the project will produce tangible benefits.

And, according to Barry Commoner, a "reductionist" attitude prevails among scientists, hampering the development of ecological understanding. "The assumption is too often made that [a complex system] can be understood simply by looking at the properties of its isolated parts," he said. "This is what leads to the substitution of molecular biology for the biology of natural systems. This is what leads sociologists to become psychologists, what leads psychologists to become physiologists, what makes physiologists cellular biologists, and turns cellular biologists into chemists, and chemists into physicists, and physicists into mathematicians. Everybody is looking for the higher science."

A reductionist bias is apparent in technology, too, Commoner said, suggesting that technology poses a special danger in that its success in accomplishing discrete tasks (for example, building hydropower plants or better automobiles) leads to the illusory idea that, for any problem which arises, a technological solution will be found.

Also, as Lynton K. Caldwell, a political scientist from Indiana University, observed, unwise development plans are often an aspect of political opportunism. To have sound planning, he said, ways must be found to make decision makers apply ecologically relevant criteria and to protect these officials from the temptations and political stresses of their situation.

Such a prescription would be regarded by many as naively idealistic if considered an antidote to pork-barrel politics in the United States, but in the case of the developing nations there may be at least a chance that it will work. The reason is that, for many of their more ambitious public projects, these nations depend on assistance from the industrialized nations and from international institutions such as the World Bank. These donor nations and institutions would seem, therefore, to be in a strong position to insist, as a condition for grants or loans, that ecological factors be considered in all project-selection and preinvestment surveys and in the carrying out of the project itself. Just such use of financial leverage by the assistance-granting nations and agencies was recommended by Kirk P. Rodgers, a natural resources specialist of the Pan American Union.

While the aid-granting agencies and nations have not been indifferent to the environmental effects of projects which they sponsor, it seems clear that they have not exercised their potential influence to anything like the extent Rodgers had in mind.

It might prove easier to persuade the international aid-granting institutions to adopt a tough policy of this kind than to persuade government agencies such as the U.S. Agency for International Development (AID) to do so. From the record it is evident that government aid programs are run at least in part with an eye on political considerations.

In any case, AID apparently seldom puts much pressure on assisted countries to focus their attention on environmental effects of development. John Rothberg, AID's science liaison officer, stressed the point that, while his agency can withhold assistance from an unsound project, nevertheless the assisted nations for the most part make their own development plans, for better or for worse.

The long-term solution to the problem of reconciling development planning with ecological factors was seen to lie in research and education, a conviction which would seem to find support in the increasing interest in, and influence of, ecology in the United States. The International Biological Program represents a significant research effort to gain further understanding of natural ecosystems, but the IBP has been weakly financed and may not produce all the results originally expected of it. (Meanwhile, at the request of the conferees, the Conservation Foundation and the Center for the Biology of Natural Systems will continue to collect ecological "horror stories.")

In his paper, Caldwell raised the question whether it might be possible to infuse public opinion throughout the world with a simple, valid concept such as "spaceship earth." Later, from the floor of the conference, he observed that, ultimately, science—meaning verifiable knowledge of ecological processes—should prove decisive. "In the long run," he said, "science is a very powerful influence. We don't burn witches any longer. We don't treat the insane as though they were invaded by devils. Science does change human behavior, but to change it massively takes time, and time is rapidly running out."—LUTHER J. CARTER

RECENT DEATHS

Leonard S. Fosdick, 65; professor of biochemistry at Northwestern University Dental School; 31 January.

George Glockler, 78; former chief scientist of the Army Research Office and chairman of the department of physical chemistry at the University of Iowa; 14 January.

Egon A. Hiedemann, 69; research professor emeritus in physics at Michigan State University; 8 February.

James S. Pickering, 71; astronomer emeritus of the Hayden Planetarium; 14 February.

Arthur D. Whedon, 88; former chairman of the department of zoology and physiology at North Dakota State University; 9 January.