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RESOURCES

Some findings and conjectures from recent research into resource development and use

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The first requirement for an understanding of contemporary economic and social life is a clear view of the relation between events and the ideas which interpret them.—JOHN KENNETH GALBRAITH

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Fresh Water From the Sea

THE PEOPLE OF COALINGA, California, used to have their fresh water shipped in at a cost of about \$7 a thousand gallons. Now the town's drinking water costs less than a fourth as much, thanks to a new 28,000-gallon-a-day desalinization plant that lowers the salt content of brackish wells from an undrinkable 2,000 parts per million to a quite tolerable 300. A much larger plant—275,000 gallons a day—now being built on arid St. Thomas in the Virgin Islands is expected to convert sea water for less than the \$5 a thousand gallons now paid for bringing fresh water in by barge. In Freeport, Texas, the new 1,000,000-gallon-a-day plant, built and operated by the Department of the Interior as part of a demonstration program, is reducing the salinity of Gulf of Mexico water from 35,000 to 50 or less parts per million within a cost range of \$1.00 to \$1.25 a thousand gallons.

A number of other such practical results are beginning to flow from recent research and development work in desalinization. Yet there is still a long way to go. Not many towns or cities in the United States pay as much as 30 cents a thousand gallons for municipal water supplies.

The big question mark is cost. Anyone with a teakettle, a flame, and something to trap and condense the steam can turn salt water into fresh. Men have been doing this for centuries. The hitch is that such primitive methods yield so little or, if tried on a larger scale, cost so much.

During the past decade, as more and more American cities began to worry about future supplies of fresh water and as scarcity of water was noted as one of the big problems in many of the countries to which we are giving economic aid, great advances



have been made toward better methods. Many of the new processes are simply large-scale and ingenious improvements in distillation—the old teakettle method—by use of unconventional fuels (including sun power, the oldest fuel of all), or by new adaptations of the principles of vacuum or compression. Another promising line of attack is ion exchange, by which mineral particles migrate through a membrane until the water on one side is nearly fresh, while on the other it becomes more salty. A third approach is through freezing; the ice that forms first is composed of nearly pure water. Still other methods are being tried. Progress is continuing, but as yet the cost barrier has not been broken, or even much more than chipped.

Irving Fox, vice president of Resources for the Future, sums up the situation in an article for *The Bulletin of the Atomic Scientists*. The gist of what he says is this:

Desalinization has been much discussed as the most promising way to increase fresh water supplies. Though not directly usable by men or crops, saline water is unlimited. Arid lands in many places are near the oceans. Prospects of low-cost fresh water from the sea recall the Biblical vision of making the desert bloom.

The trouble is that costs for the several processes that are being studied remain relatively high, the lowest yet attained being about \$1.00 a thousand gallons for freshening sea water. Current reports suggest that these costs may be lowered to 40 or 50 cents a thousand gallons. For brackish water containing about a tenth as much salt as sea water, current costs are about 30 cents a thousand gallons.

In contrast, the upper limit on the value of irrigation water in the United States is about five or six cents a thousand gallons. Few irrigation farmers can afford to pay much more than half that price. It is doubtful that farmers in low-income countries could afford to pay much more than one cent per thousand gallons for irrigation water. Municipalities in the United States could probably afford to pay 25 cents or 30 cents a thousand gallons, and a number actually do; but towns and cities in most areas can get their supplies for considerably less. Accordingly, the outlook now is that desalinization on a commercial basis will be limited to a relatively small number of locations where cities and industries can afford rather high-cost supplies. Only a first-class technological breakthrough can alter this outlook.



ONE ANSWER is continued research and development, not only in desalinization but also along other technological lines, both those that might actually increase supplies of fresh water—such as cloud seeding and other forms of weather modification, and those that might stretch supplies by reducing losses from evaporation—like replacing water-thirsty trees in dry areas with shallow-rooted grasses, or protecting reservoir supplies with a single-molecule plastic film. But none of these methods is as yet dependable.

Consequently the job of getting the most out of water resources still must be done largely by familiar methods: more dams to store water for use during periods of low stream flow, better means of reducing industrial and household pollution, and more attention to making sure that water supplies in each area are used for purposes that will bring the highest returns.



How Clean Is My Valley

EARLIER THIS YEAR Resources for the Future conducted a series of lectures dealing with ways in which other countries are meeting their natural resource problems and with lessons the United States might learn from them. (The collected papers will be published for RFF in December by The Johns Hopkins Press under the title of *Comparisons in Resource Management*.) "Pollution Abatement in the Ruhr" was one of the subjects. The remarks of Gordon M. Fair, Professor of Sanitary Engineering at Harvard, Abel Wolman, Professor of Sanitary Engineering at Johns Hopkins, and Edward J. Cleary, Executive Director and Chief Engineer of the Ohio Valley Water Sanitation Commission, are condensed here as they relate to an important aspect of water treatment—its financing.

"The visitor to the great industrial complex of the Ruhr, in West Germany," said Mr. Fair, "will be struck today by the absence of unsightly waste or neglected land and swamps, and the neatness of the contained water courses.

"This was not always so. . . ." As far back as the 1600's and until the turn of the present century, the condition of the Emscher River was the subject of complaints; also the river was feared for its floods. "Coal mines were sunk into the Emscher Valley in the 1860's. Here and there, the ground caved in above their workings. The resulting surface depressions had no outlets. . . Marshes formed. The flotsam and jetsam of household and industry rotted in the shallows. At the same time, the waste waters of the growing communities and industries polluted the river and its tributaries."

Around 1899 responsible citizens concluded that public authorities must proceed in common with mines and other industry to devise an effective master plan for the drainage basin as a whole. In 1904 the *Emscher-genossenschaft* or Em-

scher Association was created by legislation.

Between 1904 and 1930 five other similar river basin associations in the Ruhr District were legally constituted. Each Association was empowered to investigate, plan, design, construct, operate, maintain, repair, and replace all necessary installations or engineering works for the abatement of pollution in a given river basin and for the general management of its waters; furthermore, each Association was to accomplish its task in co-operation with all public and private corporations or persons that were themselves polluters or drew benefits from proposed improvements; and, last but not least, necessary financing was to take the form of (1) public loans for capital improvements and (2) internal allocation of running expenses to the members of each Association insofar as expenses were not covered by income.

Membership of each Association consists of industrial enterprises, whether mines, waterworks, hydroelectric plants, or other; and of the district's public administrative components. In some instances other public or private bodies also are members. "In financing the Associations' work the guiding principle is that both the cost of pollution abatement and the value of direct, as well as indirect, benefits derived by a member from the execution, maintenance, and operation of the different installations of the Association are assessable. In the *Emscher-genossenschaft*, enterprises other than mining are obligated only if their contributions equal or exceed 0.5 per cent of the annual budget. If they do not, the member district in which a given enterprise is situated is assessed. Association assessment then gives way to local taxation.

The expenditures of the river basin associations are sizable; the cumulated total capital improvements in 1954 have been placed at

\$125 million, and in 1955 at \$150 million. Apart from recent government payments for the repair of war-damaged structures and for the provision of flood storage space in impounding reservoirs, the funds are raised entirely by the Associations themselves. The total amount spent by the six river Associations during the year 1959 exceeded \$54 million, almost equally divided between running expenses and capital improvements.

Charges made upon an industry or municipality for industrial waste treatment are a substantial source of income. As an example of problems of equity that arise in determining such charges, Mr. Cleary took the hypothetical case of two phenol-producing plants, one of which produces 1,000 pounds of phenol, the other 100 pounds. The stream they both use can assimilate only 1,000 pounds of the 1,100-pound total. The Association decides which plant will have the treatment facilities; usually the reduction would take place at the larger one. But the plant that has the smaller phenol discharge and treats no waste would bear its proportional share of the cost.

The same situation holds for sewage treatment: No community wants to build a treatment plant if the benefits, but not the cost, are shared by others. The *Genossenschaft* therefore determines where treatment plants should be built, and then proceeds to build them, distributing the costs equitably among the beneficiaries.

IN THE UNITED STATES STREAM pollution is not yet at the critical stage that provoked action in the Ruhr District. But with growing urbanization and industrialization since the turn of the century, outlays for pollution abatement—primarily to protect people against disease—have been large.

"For 1954," Mr. Wolman said, "the Public Health Service estimated that residual sewage loads reaching streams from municipal and industrial sources had an oxygen requirement equivalent to 150 million people. The Service estimates the anticipated requirements for 1980 to be equivalent to 174 million people, dropping to 168 million in 2000 assuming increases in treatment facilities. To meet

these loads, some have estimated that \$1 billion annually will be required."

Water-borne enteric disease now is rare, he pointed out. "It is yet to be demonstrated whether the viruses offer a new but similar threat. The potential hazards of long-term repetitive ingestion of small amounts of exotic chemicals likewise are still to be evaluated.

"The main interest in our society today is with protection of the waters for recreation, wildlife, and aesthetic values. Here the man in the street, uncluttered by scientific doubts and delayed research, clamors for visible cleanliness rather than invisible risk. This shift in public perspective may provide the energetic drive to speed up correction. It remains to be seen how effective this enthusiasm is when dollar cost confronts the citizen."



Arboreal Enzymes

FOR A SIX-YEAR PERIOD that has just ended, Resources for the Future supported investigations by the U.S. Forest Service's Pacific Southwest Forest and Range Experiment Station into the physiology of flowering in pines. The research has been carried out by Dr. R. G. Stanley under the direction of Dr. N. T. Mirov. Concern over future supplies of timber was the underlying reason for the support; gaps in knowledge of the processes of reproduction have handicapped development of superior pine hybrids that could mean faster growth of good commercial trees. One of the gaps is how enzymes function in the reproductive process and affect the rate of plant growth.

In the course of the investigations Dr. Stanley learned that the terpene content of herbaceous plants varies at the time of flowering. He began to study the biological origin of terpenes in pines,

which involved a study of enzymes. Enzymes are substances formed in all living cells; they catalyze biological processes leading to the formation of chemical compounds and growth.

In basic research one never knows when some twisty bypath may unexpectedly straighten into a road that leads somewhere. This may be the case with Dr. Stanley's ideas for utilizing enzymes from forest trees, although it is still too early to say for certain.

THE STORY of Dr. Stanley's new concept is given in his own words:

"Cell enzymes synthesize and modify organic molecules essential to man's health and welfare. Papain is an enzyme from the latex of the papaya tree sold throughout the world as a meat tenderizer. Enzymes extracted from grain seeds are widely used in the manufacture of starch to prepare paper sizings and adhesives. The fermentative industry owes its origin and foundation to activities of enzymes. The chemical manufacturing industry recently started to employ enzymes to shorten the number of steps required to manufacture certain complex chemicals. In the meat packing industry the extraction and marketing of enzymes as byproducts from low grade animals and meat residues has been a commercial reality for five years.

"Enzymes are responsible for formation of the cellulose-lignin walls man uses as 'wood.' Many wood cells contain enzymes at harvest time. A direct solvent extraction can be made of the enzymes in wood. The extracted enzymes then could function in a test tube or a processing vat just as enzymes from animals and microorganisms are made to do. Under man's control these enzymes could produce outside the tree many valuable compounds they now synthesize only in the living tree. The wood or chips from which enzymes were taken would be structurally unharmed and could be used in normal commercial channels.

"Solvent extraction as a means of drying wood has recently advanced from laboratory bench to pilot plant. Many functioning enzymes have already been obtained outside the living plant. . . . The indication that functioning

enzymes present in pine or other trees may be extracted from the wood while the wood or pulp remains to be used in the usual manner is an example of the far-reaching potential for utilization of renewable resources. A new frontier for resource use, of potentially great benefit to future generations, awaits the marriage of enzyme chemistry to forestry."



National Parks In Britain

AS EARLY AS 1810 William Wordsworth said that visitors to the Lake District in northwest England thought of it as "a sort of national property, in which every man has a right and interest who has an eye to perceive and a heart to enjoy." Since then awareness of the need to protect unspoiled countryside has grown with the progress of industrialization and has become more and more vocal.

In 1949 the National Parks and Access to the Countryside Act was passed and the National Parks Commission inaugurated. Because of the small size of England and Wales, and the limited amount of unoccupied and relatively wild land, space for the recreation of some 46 million people has to compete with more strictly economic needs such as mineral-working, afforestation and the provision of water-gathering grounds, to say nothing of agriculture itself.

The result is that the British National Parks, as they were proposed and as they have come into being, include villages and even towns around the margins of up-

land areas and in their valleys. It follows that any national view of a Park system must come to terms with the local life of each Park. Not only farming but maybe even industry must flourish in a Park.—*H. C. Darby, at the 1961 RFF Forum.*

Passages

IF ALL FUTURE users of the wilderness areas could be brought into the market, they might well bid these areas away from other uses. In wilderness use they should last for centuries, they are not used up, exploited, destroyed in use, and should yield more total utility than in the commercial uses that would destroy them. It is somewhat like the market situation for such great works of art as, let us say, Schubert's songs. In the market of the time they sold for so little that they afforded Schubert only a miserable existence. If all the demanders of future generations could have been brought into the market, they would have made Schubert a millionaire.—*John Ise in Our National Park Policy.*

THERE IS NO SUCH THING as "requirements" or inflexible needs for particular materials, and this is true for every mineral, for water, and for any product or service that is consumed. We shall not suddenly find the economy collapsing simply because some material or other cannot any longer be found and produced at a price buyers are willing to pay. To say this another way, there is at the present time an enormous amount of substitutability present in our system, so much so that even if we "run out" of some materials (meaning by this that it is necessary to go to much more costly grades than those now

exploited), the current way of meeting life's needs could pretty much be continued by going to more plentiful materials—at a somewhat higher cost.—*Orris C. Herfindahl in Three Studies in Minerals Economics.*

THE GREATEST DRAIN on natural resources comes not so much from the increase in population as from the constantly rising standard of living. . . . No one regrets that what was a luxury for the father has become a necessity for the son; but does that necessity require a prodigality in use?—*Samuel T. Dana*

THE LUSH BENEFITS of technology have been limited to a very small proportion of the world's population. The 6 per cent who live in the United States have been blessed far beyond any other nation on earth. . . . Human fertility is outrunning human ingenuity.—*Robert C. Cook in Perspectives on Conservation.*



NEW RFF STUDIES

- Our National Park Policy: A Critical History*, by John Ise
720 pages 1961 Cloth, \$10.00
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