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The Address of the President: Water Problems

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THE ADDRESS OF THE PRESIDENT

WATER PROBLEMS

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Few truisms have wider application than "familiarity breeds contempt." Man takes for granted common and therefore important things such as sunshine, clouds, rain, summer heat and winter cold, the normal winds and calms, the air we breathe, soil, ordinary hills and valleys. They do not attract the attention of the general population. It is true that every twenty-four hours more than a million tons of sand, silt, mud and dissolved salts are carried in Mississippi River past the Carrollton gage at New Orleans and dumped into the Gulf of Mexico. This is too common and familiar — and important — a fact to make the front page. The man has not bitten the dog.

We drive across the valleys and divides of Iowa that are really important to us, but with which we are familiar, without seeing them, but will travel fifteen hundred miles to see the Grand Canyon of the Colorado of which there is but one on earth. We turn faucets and drink water from Iowa wells or streams without thinking about it, but rave over the geysers and hot springs of Yellowstone Park. Please do not misunderstand me. I do not wish to encourage travel and seeing the sights less but to plead for an understanding of the common things around us more.

Water is one of these common substances. We think we are familiar with it. We pay little or no real attention to it until there comes a drouth or a flood, or a subsiding ground water table causes the well to go dry, or soil erosion becomes distressingly evident. And then, not having previously given water the attention it deserves, we do not know what to do about it.

Familiar as it is and contemptuous of it as people in general are, I wish today to speak particularly of water and its problems. After all we could not live and the earth would not be as it is and habitable without water. To a considerable degree the welfare of the state we represent depends on the solution of its water problems.

It is my purpose today to state some of the problems pertaining to water, with especial reference to Iowa, but I am not in position to solve them at this time. Problems are seldom solved before they are stated. I feel that if these water problems are brought out into the open now, they are more likely to be solved in time for the solutions to be of use than if the questions are not presented until the answers are known.

The study of geology, which as the name indicates, is nothing more or less than earthology, recognizes four grand divisions of the earth: lithosphere, atmosphere, hydrosphere, and biosphere. Of course, hydrosphere is just a long name for water. Although in general the water of the earth occupies a position just outside the lithosphere and just inside the atmosphere, it penetrates at least some distance into the lithosphere, for there are soil moisture and water in wells, caves, fissures and pores, and there is water in the air in the form of clouds, fog, dew, etc. Also a large part of the organisms of the biosphere is water.

For present purposes earth water can be classified as atmospheric water (clouds, etc.), surface water (oceans, lakes, swamps, streams), and lithospheric water known as ground or underground water. The water in solid form locked up in the hydrous minerals of the lithosphere is merely mentioned in passing.

Although there may be such a thing as "juvenile" water which was included within the lithosphere from its very beginnings and there is certainly a considerable amount of "connate" water trapped in sediments of all ages as the sediments were deposited, the surface and subsurface waters with which we are dealing today come almost entirely from the atmosphere either directly or indirectly. Even connate ground water was at the surface before being included within the sediments.

By using energy received from the sun in the form of heat, evaporation takes place on the surfaces of oceans, lakes, swamps, and streams, on the leaves of growing plants, and from the liquid water in porous soil, subsoil, and bed-rock where the voids are also occupied by and open to the air. Water is thus changed from the liquid to the gaseous phase. Evaporation is most rapid when and where the relative humidity is low, the temperature is high, and the water is agitated or "atomized" as in spray over surf or at rapids and falls. Hot, dry winds suck up much moisture from leaves. Condensation, which is the exact reverse of evaporation, takes place when and where moist air is cooled, as where air rises on the windward sides of mountains or in ascending calms in low pressure areas, as air in wind moves poleward, or if warm air areas are invaded by and give up heat to colder air masses. These principles are so well known that I should probably apologize for reviewing them here.

But precipitation, which is of even greater importance directly, is not so well understood and constitutes a water problem. After all a rainless cloud is not of great value. And rainless clouds are the rule, rain clouds the exception.

Why do so few clouds give up their water by precipitating? This is certainly one of the questions that cannot be answered today. Some study of the subject has been made, however. Perhaps precipitation is more likely if water condenses on the surfaces of dust particles in the air. Clouds that form by rapid and great condensation may be more likely to give rain or snow than those that form more slowly. Contrary to popular belief, liquid or solid water particles in clouds are probably not shaken together by thunder or artificial explosions to form rain drops or snow flakes that fall from cloud to ground. Statistics do not show that it rains more often in the United States than in England on the afternoon or evening of the Fourth of July. Neither was there an appreciable average increase in the rainfall in Europe between August, 1914, and November, 1918.

The most promising answer lies in the fact that the water or ice particles of which clouds are made are so small as to be controlled more largely by their electrical charges than by gravity. If all the particles of a given cloud or of two adjacent clouds are positively or negatively charged, the particles repel one another and there is no aggregation. If on the other hand, some are positively and some negatively charged, there is mutual attraction, the charges are neutralized and gravity has its way with the resulting drops or flakes. Thus precipitation may be caused by flocculation.

Whatever the cause of precipitation, it appears that, for the present at least, we will have to take it as it comes. So far artificial rain making, though easy in controlled conditions under a bell-jar, is not an accomplished fact in the open air.

It is often said that there is more or less precipitation now than formerly in given areas. The land of Canaan is described in the Old Testament as a "land flowing with milk and honey," but it is certainly not like that today. However, Abraham and Moses were familiar with even drier regions to the east and south and by comparison, or rather contrast, Canaan was truly the promised land.

In the drouth years of 1934 and 1936, there was a good deal of fear that Iowa was on its way to become a desert. There was considerable deficiency in rainfall, but Charles D. Reed of the U. S.

Weather Bureau has explained that damage to crops was due more to hot dry winds than to actual drouth. Statistics show that precipitation and temperature vary in irregular and so far unpredictable cycles rather than continuously and progressively in any given direction.

So, unless I am mistaken, the total annual supply of water and its distribution throughout the year is neither controllable nor predictable. The major problem is to find out how best to use what we have and how to conserve it for future generations.

Of the water which falls on the surface, some is re-evaporated, some flows off in streams to the sea or to lakes, and some seeps into the ground to become ground water. Over long periods of years about as much water must seep out as seeps in. If more water entered the lithosphere year after year than was lost, the water table would rise so that there would be more and more discharge through springs and by seepage into the beds of rivers. Hence a smaller proportion of the water precipitated would seep in and more water would seep out until a balance was reached. Similarly, if the annual loss exceeded the annual contribution, the water table would fall, springs would dry up, permanent streams would become intermittent, the porous sponge of unfilled pores at and near the surface would be increased in volume and thus losses would decrease and gains increase to balance the books. The amount of precipitation and its distribution, the topography of the land surface, the porosity of the soil, the amount and type of vegetal cover, and other conditions determine whether the balance is reached with a high or a low water table and with an abundance or a deficiency of surface and subsurface water.

Suppose we now be a bit more concrete and practical. In other words, let me point out very briefly some specific problems.

There is the problem of our Iowa lakes. Our friend J. N. Darling calls them sick lakes, and I heard him say that one of them is "as dead as a dodo." How can they be desilted and further silting be prevented or reduced? How can pollution be avoided, so that the water will support abundant fish life as of old and be suitable for bathing and boating? How eliminate or reduce the growth of harmful algae which have appeared even in those lakes which now receive no raw sewage from towns on or near their shores? The lake survey made recently by the State Conservation Commission and the State Planning Board in coöperation, the work in progress at Macbride Lakeside Laboratory now owned by the state, and the project now under construction to divert treated sewage from Spirit and Okoboji Lakes and bypass it to the Little Sioux River should go far toward answering these questions.

Only a few years ago engineers were draining lakes and swamps in northern Iowa and straightening streams, so that more land could be put under cultivation. The land so drained did not prove to be of great value and water that would otherwise have been stored in the basins or in voids beneath the surface escaped down the streams carrying heavy loads of good soil, creating new flood hazards, etc. Much of this drainage appears to have been a mistake. Perhaps these drainage ditches should now be filled up or dammed, but who knows?

There has been and is a great deal of difference of opinion regarding improving the streams for purposes of navigation. Both before and since the advent of the New Deal large sums of federal money have been spent in building twenty-four new dams and locks across the Mississippi River in the 635 mile stretch between St. Paul and the mouth of Illinois River, so as to create a nine-foot channel connecting with the Illinois and Lower Mississippi waterways. Whether freight traffic on the river and reduced freight rates on competing railways will be sufficient to warrant the outlay remains to be seen. The railroads are already in bad financial condition; can they stand such tariff reductions? Will the slack water pools silt badly in spite of the new-type of low head movable dams being constructed? What will be the effect on wild life and recreation? These questions are beyond the specialist in any one field. The hydraulic and constructional engineer, the economist, and to some extent the geologist are all involved. Also, it is political and the Interstate Commerce Commission will have its say. In any case, the project is almost completed and it will not be long before it will be known whether we have bought a white elephant or some useful public works.

Will the completion of the Fort Peck dam and the improvement of Missouri River result in brisk river traffic, so that steamboats and barges will be a common sight here in Sioux City?

Can electric power be produced more cheaply in Iowa by burning Iowa coal or by building new dams and hydro-electric plants on the Des Moines, the Iowa, the Cedar, etc.? If the answer when found should favor water power, should there be numerous small plants, each developing a small amount of prime power, or only a few high dams and larger plants? Will the pools upstream from such dams be useful for recreation, flood control and water conservation at the same time they are used to develop power, or to use Mr. Darling's term again, will they be aquatic deserts?

The problem of stream pollution appears to be nearing solution by the building of sewage disposal plants at all but one or two of our river cities. The State Department of Health and the municipalities concerned should be thanked for their services and sacrifices along this line. And the work has been accomplished, so far at least, without a single court action.

The State Conservation Commission has recently completed several dams and pools for recreation purposes on smaller streams in state parks and others are under construction or contemplated. These are splendid projects and will serve the state well in future.

Problems of flood control, though not as important in Iowa as in some other states, are difficult enough. But flood control and soil erosion control are closely related, and it would be difficult to exaggerate the importance of the latter problem in Iowa. Neither large storage reservoirs on major streams, nor numerous headwater reservoirs, nor reforestation, nor terracing, nor strip farming, nor contour plowing, nor liming is the answer by itself.

One of the first steps to be taken in an intelligent study of such problems is to determine how much running water there is and how it is distributed between low-flow and flood stages in the streams. Until recently there has been no comprehensive and permanent program of stream and lake gaging in Iowa. In 1935 the Water Resources Division of the State Planning Board published a 567 page bulletin entitled *Stream Flow Records of Iowa, 1873-1932*. The title describes the book. You will be glad to know that there are now forty-six gaging stations in operation in Iowa, and one more is under construction. This important program is participated in financially for the state by the Legislature through the Committee on Retrenchment and Reform, the Conservation Commission, the Department of Health, the Highway Commission, the Institute of Hydraulic Research, and the State Geological Survey. The state funds are matched by the Surface Water Division of the U. S. Geological Survey. Many of the gages are equipped with continuous automatic recorders and all are read once a day and more frequently during flood stages. Actual discharge measurements are made at each station about once a month.

In 1936 the Planning Board in coöperation with the National Resources Committee prepared reports on all the drainage basins in the state. The basins were divided into six groups. A volume has already been published on each of four of the groups and the other two reports are nearing completion. In these reports most of the water problems of Iowa are discussed and numerous recommendations are made.

The Agricultural and engineering experiment stations of the Iowa State College, the State Forestry Department, the Federal Soil Conservation Service, the U. S. Army Engineers, and other agencies are also coöperating in attempting to solve Iowa's stream problems.

Ground water and its problems are even more important than surface water in this state. About 90% of our people use ground water for drinking purposes. Our great livestock and poultry industry depends almost entirely on wells for a dependable water supply. Nearly all of our industrial plants, large and small, have wells. As a whole, Iowa has an investment in wells amounting to something like 150 million dollars. In spite of careful work by the State Department of Health and the Iowa Geological Survey over many years, not all of this can be considered as a good investment. Some of the wells are polluted and unfit for drinking purposes for either man or beast. Some of them go dry in the dry season just when they are most needed. In some parts of the state well water is either insufficient in quantity or so highly mineralized as to be scarcely usable or entirely unfit for anything but fire protection. Some wells are deeper than they need to be, and others are not deep enough. In many wells water satisfactory in both quantity and quality is produced from some deep geological aquifer, but the water from this source is contaminated by bacteriologically polluted or too highly mineralized water from horizons closer to the surface, because the well is not cased or the casing leaks. In other cases satisfactory water at shallow depths has been cased out and less suitable water at greater depths is being produced.

Within the limits of their budgets and staffs the Department of Health and the Geological Survey are doing their best to study such problems as these and to give owners and drillers of wells information and advice. Drillers' logs and drill cuttings are studied in the laboratories of the Geological Survey. Possible sources of pollution and the best means of casing out polluted water are investigated by the Department of Health. These two state departments coöperate in an effective manner. Many times their respective experts travel together, making well locations, giving advice concerning probable depths and expectable quantities and qualities of water, being present during the sealing and cementing of casing and pumping tests, sampling the water for bacterial and mineral analysis, etc.

During the past three years almost 1,500 water samples collected by employees of the Department of Health, the Geological Survey, and the Planning Board, from city, town, industrial and farm water supplies, have been analyzed chemically at the expense of the Planning Board in the State Hygienic Laboratory. Complete information concerning all these wells and the quality of their waters will be published within the next few months. A complete set of structure contour and isopach (equal thickness) maps showing the position beneath the surface and the thickness of each of the main water producing horizons throughout the state are now being prepared by the Iowa Geological Survey for publication by the Planning Board.

Should well drillers be licensed to fulfill minimum requirements listed by the Department of Health and to furnish samples of drill cuttings for study by the Geological Survey? Should well owners be permitted to let contracts for drilling except by permit after inspection and approval of the site by the two state departments concerned? Should towns and industrial groups be required to employ competent engineers to draw up specifications and to make inspections during the drilling and after completion of the wells?

It is possible that a bill will be drawn up covering these and other points for presentation to the Legislature. If so, it should have the approval of the State Drillers' Association, the State Engineering Society, the Department of Health, and the Geological Survey.

Numerous wells are being drilled in our larger towns to be used for air conditioning theatres, stores, hotels, restaurants, etc. This practice brings up some new problems. Since 1933 such installations have increased 1,400%. During the operation of the plants a large quantity of water per minute is needed. After being used once the water goes off through the sewer. At times the capacity of the city sewage disposal plant is exceeded and the sewage being treated is too much diluted to be handled in the regular way. If diverted to storm sewers, these also may be filled nearly or quite to capacity just when needed to carry off rain water after quick storms. The temperature of water so used needs to be as low as possible, which means that it must come from shallow wells. The temperature of the lithosphere increases downward at a rate of 1° F. per 80-100 feet of depth. The removal of so much water from shallow wells may lower the water table and so exhaust ground water supplies that there is not enough for other purposes.

One suggested solution to this problem is to return the water to the aquifer from which it came through disposal wells. A questionnaire was sent recently to American state geologists inquiring if there exists in the states legislation restricting or controlling the production of water for air conditioning purposes or requiring or prohibiting the use of disposal wells. The results were published in the April number of *The Driller*. The inquiry was answered for Iowa by Dr. A. C. Tester, who was until recently Assistant State Geologist and director of the ground water division of the Iowa Geological Survey. Three states, Minnesota, Wisconsin and Iowa, reported unfavorably on disposal wells, chiefly on the ground that there would be danger of pollution of the whole aquifer from which the water was taken and to which it was returned. Eighteen of the replies were more or less favorable to disposal wells and the rest were non-committal. So here is still another unsolved problem.

It is often stated that the water table has been lowered to a dangerous extent by deforestation, over-grazing, over-cultivation, artificial drainage of surface basins, and drouth. As a matter of fact, there are few, if any, authentic data by which the truth or the falsity of this statement can be determined. Truly some old wells have gone dry. But in some other wells the water stands higher than it used to, at least at some times. There is a real need for a considerable number of observation wells in Iowa. Nebraska has almost 500 of them, but they have been in use for too short a time to warrant generalization. I am glad to announce that by matching funds now allocated to the ground water division of the Iowa Geological Survey with the corresponding division of the U. S. Geological Survey, Mr. T. W. Robinson, ground water engineer of the federal survey, will report at Iowa City on July 1, 1938. It is hoped and believed that his services or those of some other federal engineer or engineers will thus be continued in Iowa indefinitely. Some of Mr. Robinson's first duties will be to put the first observation wells into service and to study the possibility and advisability of recharging natural underground water reservoirs.

The solution of these and other water problems too numerous to mention will depend upon the vision, industry and persistence of the several state and federal departments most interested and especially on their willingness and ability to coöperate. I wish that the Iowa Academy of Science, as a semi-official department of the state, could take a larger part of the responsibility.

State University of Iowa,
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