Circular No. 32 1950

STATE OF ILLINOIS

Water Resources Conservation in Illinois

Issued by

Department of Registration and Education
NOBLE J. PUFFER, *Director*

State Water Survey Division
A. M. BUSWELL, *Chief*
Urbana, Illinois

WATER RESOURCE CONSERVATION IN ILLINOIS

H. E. HUDSON, JR.
State Water Survey, Vrbana

In common with the rest of the United States, Illinois has been experiencing growth in population, with resulting greater density of population, larger communities, and increasing opportunities for the affairs of men to infringe on the affairs of other men. Thus the way we treat our resources comes to have an increasingly important effect on men, far greater than was the case a few decades ago.

With this increasing saturation of population has come development of a form of inertia, caused by the increasing growth of investment in business of every kind. A man now has a greater stake in his farm, in his factory, or in whatever enterprise he is engaged in. It takes more capital to start an enterprise, and this leads to higher overhead costs, so that men are much less amenable to changes in their way of doing things. This of course has led to regulation. Inevitably it will lead to increasing regulation in the field of resource development. If history repeats itself, we may expect the increasing regulation to come at times of stress such as periods of war or periods of depression. Thus we must give thought to the needs of the future at times when conditions are "normal."

GENERAL SITUATION

Figure 1 shows the principal sources of water supplies in Illinois. It will be noted that in a large part of southern Illinois, municipal water supplies are secured almost entirety from surface water sources, principally impounding reservoirs. Through the marginal drift area and through the minor rock well area, difficulty is noted in securing sufficient groundwater for municipal or industrial use.

There are exceptions to the above generalizations, where porous gravel deposits occur along streams or in buried bedrock valleys in these areas.

In general, groundwater levels throughout Illinois have not been seriously affected by works of man. In certain locations, there have been minor effects caused by drainage activities, by dredging channels, and to some extent by the increased cultivation of the land. A century ago, when little of Illinois was under cultivation and most of the soil was in prairie grasses, infiltration rates were high, and rates of penetration of rainfall into the earth were rapid. . With the changing trend of use of land to cultivated crops such as corn and soybeans, infiltration rates have been reduced. There has probably been some lowering of water tables owing to this change in land use, but no data are now available to measure the amount of the effect. The influence is probably relatively minor compared to the effects that are occurring in areas of large population, where heavy groundwater developments have taken place.

GROUNDWATER

The occurrence of groundwater is determined by measuringwater levels

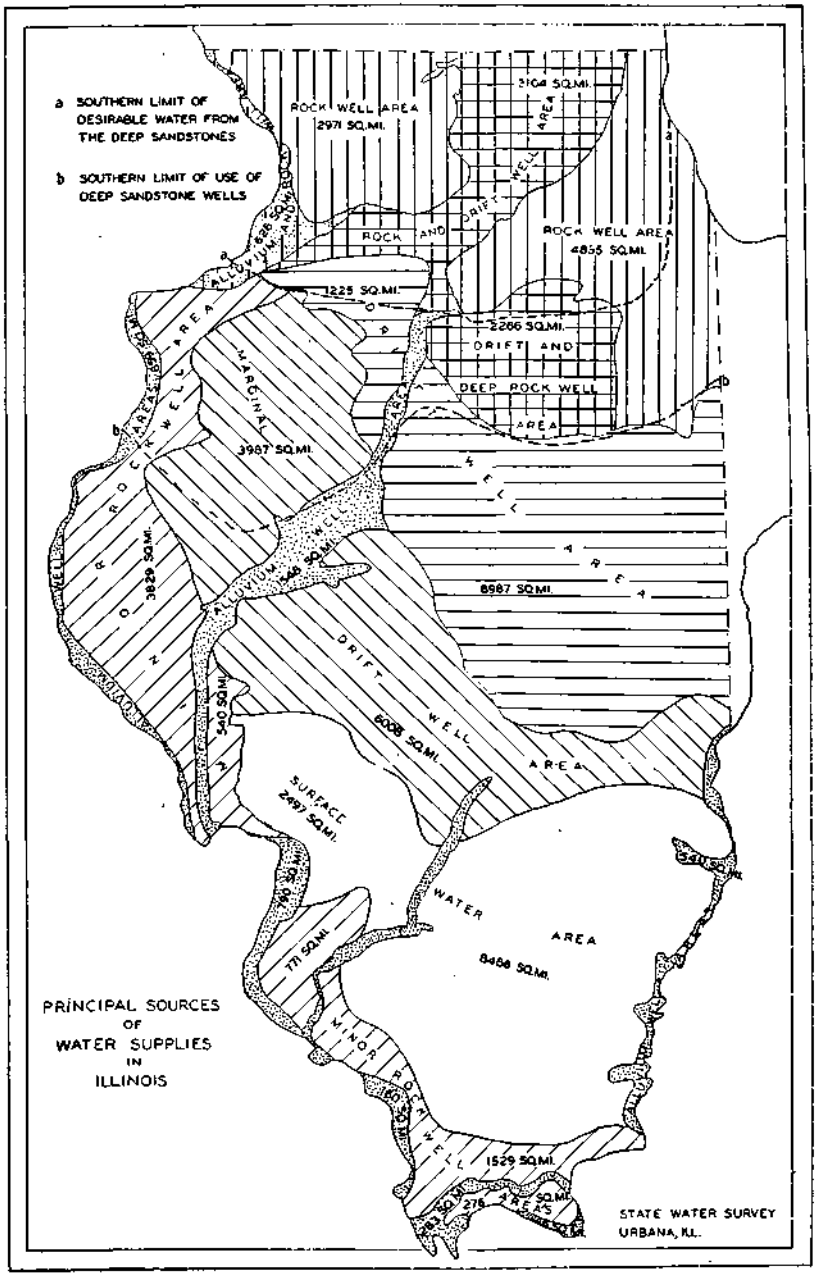

FIG. 1.—Principal sources of water supplies in Illinois.

in wells, by making pumping tests to observe the movement of those water levels, and by special chemical techniques to measure the movement of the waters and to identify their sources.

Recharge of groundwater from precipitation is a very slow business. With a comparatively few exceptions, it takes at best many months, and sometimes requires centuries. As Dr. Buswell, Chief of the Water Survey, has remarked, in some locations our best solution is to have prayed for rain 5,000 years ago. Groundwater data indicate that, over about four-fifths of the state, water can be secured in some quantity, but there are limits to the amounts that can be obtained at any given location..

Throughout northern Illinois it is possible to secure water in large quantities from wells drilled deep into the bedrock. In the east central part of Illinois, comparatively large volumes can be secured from wells drilled in the glacial drift. At many locations in the state there are limited deposits of sand and gravel that can yield sizable quantities of water, but these are difficult to locate and evaluate, requiring careful engineering study in each separate case.

For the most part our groundwater resources are healthy, unaffected by human activity. But at places where large concentrations of population have relied on groundwater, symptoms of trouble are appearing. These local problems have led many to suspect that groundwater resources over the whole state were failing. It is true that there have been difficulties at Chicago, Joliet, Rock Island, Peoria, East St. Louis, and Champaign-Urbana. Some of these local situations have become quite acute, most noticeable being that at Chicago, where water levels in deep wells are now as much as 500 feet lower than they once were. The lowering of water levels in heavily pumped areas affects less than five percent of the area of Illinois and, from the point of view of depletion of total water resources available in the state, it is not of great importance. Outside these areas of receding water levels there are large quantities of groundwater available which can be developed, although the costs of these new sources will be greater than the cost of the present groundwater development.

More than half the total population of Illinois is-housed in the small portion of the state in which groundwater levels have been lowered by heavy extraction. These groundwater recessions therefore are of major importance to a large and vital section of Illinois' economy. The fact that the groundwater difficulties are limited in areal extent must not be allowed to obscure the influence of these effects on a major portion of the state's population.

TABLE 1.—INDUSTRIAL USE OF GROUNDWATER

Metropolitan area	Total use Mil. Gal./Day	Per capita use Gal./Day
Los Angeles, Calif..	360	124
Long Island, N. Y..	280	61
Houston, Texas. . .	170	333
Memphis, Tenn....	105	316
San Antonio, Texas	100	313
E. St. Louis, Ill... .	89	736
Peoria, Ill.	85	680
Philadelphia, Pa.- Camden, N. J.	85	29
Dayton, Ohio.	85	313
Chicago, Ill.	84	21

Table 1 shows a summary of groundwater use in the 10 largest areas of industrial groundwater de-

velopment in the United States. It is interesting. to note that three of these areas are located in Illinois: Chicago, Peoria, and East St. Louis. It is even more interesting to note that, of the 10 largest industrial groundwater developments (probably the largest 10 in the world), the two most intensive developments, when considered on a basis of the amount of water taken per person per day are East St. Louis and Peoria. Water is a major factor in industrial development, and it has been an extremely important factor in the growth of the state.

SURFACE -WATER

The rain that falls in the state and some that falls in our neighbor states, Indiana and Wisconsin, can travel three paths. It can evaporate ; about two-thirds of it does. It can run off into streams; about one-third of it does. It could soak down into the earth to become part of our groundwater supply. Our best arithmetic indicates that only a very tiny fraction gets into the groundwater supply.

We measure the amount of surface water that occurs in Illinois through stream gaging installations operated by the U. S. Geological Survey office in Champaign. Another important part of the surface water study is the measuring of water quality, done by chemical analyses carried on in our laboratories.

Streams dry up at times and cannot be relied on to produce a dependable constant yield. Man therefore resorts to construction of impounding reservoirs to store water for the dry periods. Illinois has available approximately 600 useful reservoir sites. We have about 500 lakes and reservoirs. You can see that we have used a substantial proportion of the sites available; it is therefore of great importance that we use wisely those that remain. In the past, reservoirs have been constructed without full regard to soil and water relationships. Recent surveys indicate disturbing silting rates. We have come to realize that the conservation of soil is an essential to preservation of surface water resources. Unless we can succeed in keeping the topsoil on our farms, our society will come to an abrupt realization that the farms are no longer valuable, and the reservoir sites are full of sediment. Present data indicate that this may become a real problem during our children's lifetime.

If we are thrifty with our surface water resources, safeguarding them against silting and polluting, Illinois will have enough supply to support a population 10 times as great as it now has without re-use of water. Re-use techniques, using the water after self-purification in streams or after special chemical purification, would let Illinois support a population many times greater yet.

Our surface water resources are adequate for any foreseeable needs of the state, but they can seriously deteriorate if we fail to husband them.

SOIL-WATER RELATIONSHIPS

The principal source of turbidity in most rivers is the erosion of soil from the land. This is clearly illustrated by considering the Illinois River Valley. It is calculated that the total amount of suspended material which would be discharged into Illinois River by populations which use it as a place of waste disposal would amount to approximately 75,000 tons per year if sewage were untreated. This would average about

FIG. 2.—Soil particles leaving the cultivated field.

FIG. 3.—Sediment deposit along a small stream in Illinois.

8 to 10 parts per million. Modern sewage treatment methods could reduce this by about 90 percent: the total suspended solids discharged into the river from treatment plants thus averages about one part per million.

In comparison, the amount of silt which reaches the river from eroding agricultural land is estimated at 6 million tons annually or 418 parts per million. The problem of clarifying the Illinois River is therefore to a large extent an agricultural problem, although it is also a pollutional problem. The soil particles which discolor the Illinois River originate on the cultivated farmland of the drainage basin, as illustrated in figure 2. The answer to the problem lies in the establishment of practices and farming methods that will reduce the loss of soil from farms. Establishing these practices is a slow job, but the County Soil Conservation Districts are at work on it.

SOURCE OF SOIL POLLUTION IN ILLINOIS

Most people think of erosion as a phenomenon that occurs primarily on steep lands, frequently taking the form of gully erosion. State Water Survey studies indicate that the bulk of the sediment does not come from steep land. Most of the sediment reaching Illinois streams comes from sheet erosion of comparatively level or gently sloping lands, lands which are being used for production of intertilled crops (corn and soybeans). Difficulty arises due to the fact that the land is kept bare by continual tillage so that it is more readily erodible. The absence of a protective cover of vegetation intensifies the action of splash-erosion by raindrops. From the farms the silt finds its way through drainage ditches and small streams into the major tributaries and thence into the main river. Along each of the small streams and major tributaries, some of the sediment is deposited. Figure 3 shows a sediment deposit along the course of a small intermittent stream. A substantial proportion of the silt, however, still reaches the main river.

A century ago the Illinois River valley was an area largely devoted to prairie and timber. An analysis of the soil survey maps indicates

that of the total area of the Illinois valley in Illinois, 21 percent was originally timberland, 61 percent was prairie, and 18 percent was terrace and bottomland soils.

The Illinois program of sedimentation study is built around work by the State Water Survey in measuring the actual amount of sediment accumulated in reservoirs, and in compiling the hydrologic and engineering facts relative to each of the reservoirs. The lake owners provide records of construction, modifications and use, and labor to aid in the actual surveys. The Office of Research, Soil Conservation Service, contributes technical advice and guidance and furnishes some of the equipment for the work.

Cooperating in the studies, the Soil Conservation Districts within the counties, which are operated by local farmers, collect data on the erosion on the land. The data include complete or sample surveys of conditions on the watershed for each reservoir surveyed, such as location of eroding areas, extent and degree of erosion, slopes of land, and soil groups involved in the erosion process. The Agricultural Experiment Station of the University of Illinois analyzes samples of sediment taken during the engineering survey of the lake to determine the source of the sediment. The Experiment Station also summarizes the conservation survey data furnished by the local districts and directs the analysis of the survey so that the points of most serious erosion may be determined.

Figure 4 shows a sediment deposit in a public water supply reservoir on the Illinois River basin.

Under this cooperative program, the Water Survey has been involved

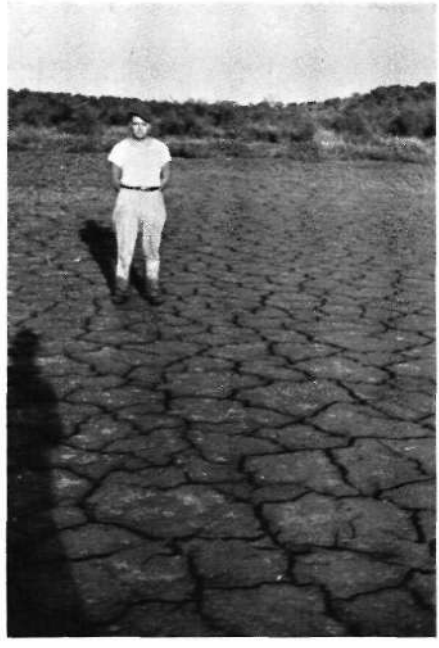

FIG. 4.—Deposit of silt in an Illinois reservoir.

in the surveying of 14 reservoirs, eight of which are located in the Illinois valley. (See fig. 5.) In choosing a site for survey work it is necessary to give consideration to kinds of soils involved in the watershed, as determined from basic data furnished by the State Soil Survey, and on many other factors, such as the rainfall, the topography of the land, and the farming practices in the area of study.

The results of the Illinois surveys are summarized in figure 6. The amount of silt that arrives in reservoirs is shown as the vertical axis, and the size of the contributing watershed is shown as the horizontal axis. From this graph it is seen that the contribution of silt into reservoirs from small watersheds is greater per square mile than the amount of silt that arrives in reservoirs which receive the flow from large

watersheds. This occurs because a portion of the sediment drops out of the flow of water enroute from the point of erosion to the reservoir. There is a substantial loss of sediment on small watercourses along the way (fig. 3).

Figure 6 does not indicate that erosion is worse in small watersheds than in large ones, but rather that less sediment per square mile arrives in the large reservoirs than in the small ones. The average annual rate of sediment production on the smallest watershed studies is in the neighborhood of 3 acre feet per square mile, which checks reasonably well with a mean figure of 7 tons of sediment per acre, estimated by studies on the land.

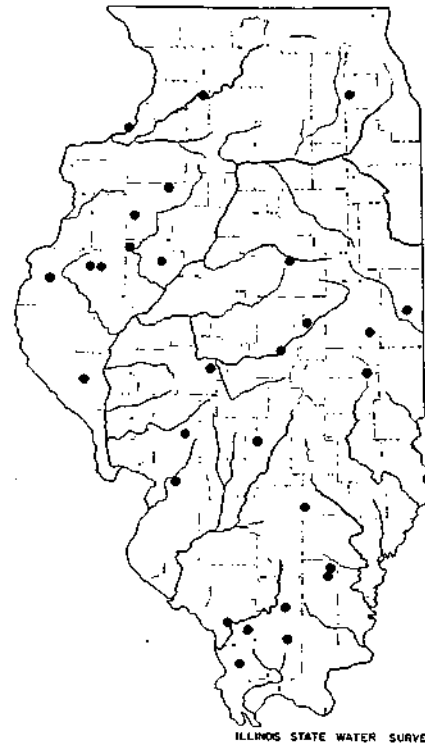

FIG. 5.—Reservoir sedimentation surveys in Illinois, April 1, 1950.

SILTING RATE OF ILLINOIS RIVER

An analysis of the data shown in figure 5 makes it possible to estimate what is happening in the Illinois Valley. Using existing reservoir survey data, the amount of sediment

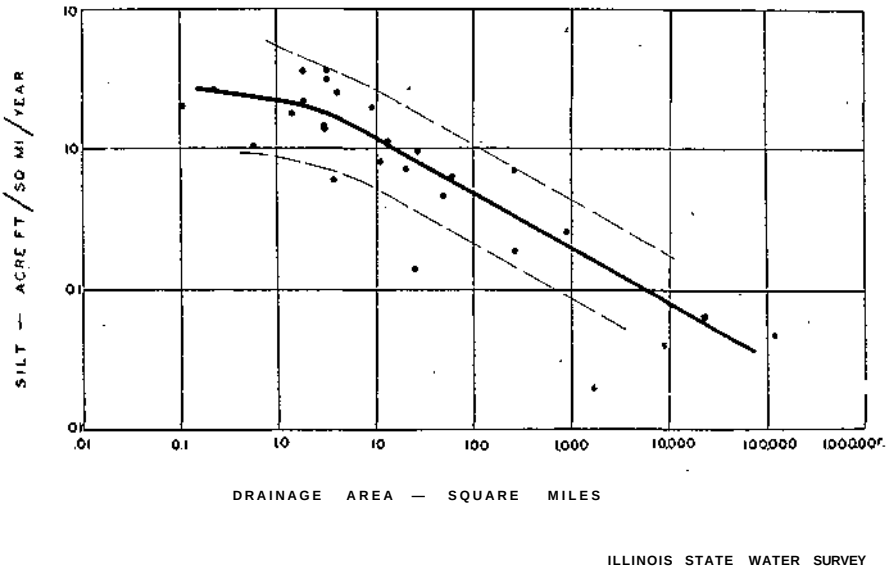

FIG. 6.—Sediment production rates in Illinois.

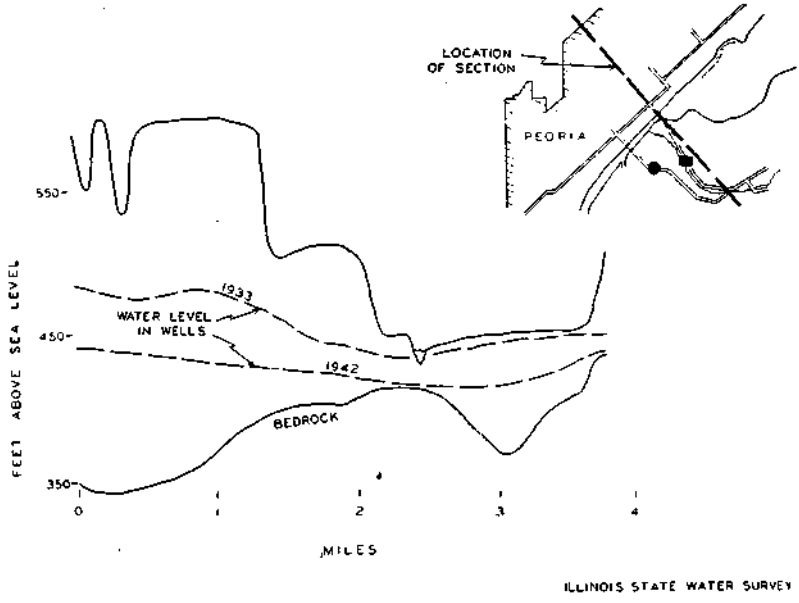

FIG. 7.—Groundwater cross-section at Peoria.

reaching the Illinois has been estimated, together with the amount of sediment that passes on out of the Illinois. We find that the total erosion in the Illinois valley is probably in the neighborhood of 68 thousand acre feet per year. The amount of this sediment which reaches the Illinois River is of the order of 4,000 acre feet per year. The amount which is discharged at the mouth of the Illinois is approximately 1,500 acre feet of sediment per year, leaving about 2,400 acre feet of sediment deposited along the Illinois valley. If we estimate the length of the Illinois as 295 miles, and the mean available flood plain of the valley as 4,640 feet wide, we find that enough sediment deposits to cause the valley floor to rise at the rate of about one foot in 70 years. The rate of sedimentation in the channel proper is probably considerably higher.

Figure 7 shows the situation which has developed at Peoria. The figure depicts a cross-section through the city of Peoria taken as shown in the heavy dashed line in the upper righthand portion. It is a cross-section at right angles to the river at. the bottom of the Peoria lake, at the beginning of Peoria Narrows. In this cross-section it may be seen that groundwater levels in 1933 were generally higher than those in the river. The heavy industrial use which has grown in the last few decades at Peoria has resulted in a lowering of groundwater levels to the point where, in much of the Peoria region, groundwater levels are now far below the level of the water in the river. In most situations it is expected that the creation of such a situation will lead to discharge of water from the river into the ground. Water Survey studies indicate that this happens to a very

small extent at the locations shown, so that the groundwater deposits in the Peoria region must depend primarily on water entering them from other sources than the Illinois River (1). Thus the presence of sediments in the river exert a marked adverse effect on the availability of groundwater for industrial use.

SUMMARY

There is an extraordinary relationship between soil and water resources which is not given adequate consideration. It is a complex relationship, but the basic facts are known and can be applied in the interest of conservation of surface water.

Over-development of groundwater resources is taking place at a few areas in Illinois. Eventually the cost of pumping the water from progressively greater depths may be a stronger controlling factor than any legal conservation measures. In the Chicago area this may mean a greater demand on Lake Michigan, where from the engineering point of view a considerably larger withdrawal could be made.

There are solutions for every water shortage occurring in Illinois. It is our responsibility to spotlight the facts on water resource availability and use. As the activities of men cause increasing interferences in the use of water resources, and regulation comes to be advocated, these facts will become the basis for deciding what is to be done.

REFERENCE

(1) "Groundwater in the Peoria Region," Illinois State Water Survey Division Bulletin 39, 1950.