8.

Use and Control of Water Resources

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LAND AND WATER ARE INSEPARABLE IN THEIR USE. This is true from the driest desert areas to the wettest humid areas. This inseparability is true both with respect to water which falls on land in the form of precipitation and with respect to water which flows over, through or under the area. However, the interrelationships between land and water vary greatly in different parts of the United States and even more in different parts of the world. Both land and water are related closely to climate. It is customary to characterize climate in relation to both land and water in broad zones as arid, semiarid, subhumid, humid, and the like.

Water may be diffused on the surface of the land, or it may be in rather definte stream channels on top of the ground, or it may be found in surface lakes, or in underground channels and reservoirs. It may be found in a liquid, gaseous, or solid state in various areas and periods of time.

USE OF WATER

Uses of water are many and varied. Water uses may be characterized as positive in the sense that they are helpful and valuable to human beings, or as negative in the sense that they are harmful and destructive. Uses of water are also characterized as consumptive and nonconsumptive, depending upon whether the amount of the water is diminished by this particular use so that it is not available in equal quantity for some other use. In the final analysis, no use of water is consumptive since all water returns ultimately to the hydrologic cycle and is used over and over again. However, at a particular time and place water may be and frequently is consumed or used up for a particular purpose thus rendering its use for this particular purpose and area as competitive with other alternative uses.

A complete enumeration of all the uses of water in a complex economy such as ours is too much for any one person to compile. It is impossible to measure all uses of water in the United States and impossible to put the various uses on a common basis of measurement. Following are some of the major uses of water, beginning with the more basic ones, and such statistics as are available.

MAINTENANCE OF LIFE PROCESSES. Water is essential to the maintenance of all forms of life, both beneficial and malign. The primary use of water then can be considered as the maintenance of the life cycle—human, animal, and vegetable. In the more arid areas, restrictions are placed on the use of water to meet essential needs. These needs are defined as the continuance of human life and sufficient animal and plant life to sustain human existence. High priorities in the use of water are granted in all climates to consumption by livestock, for the purpose of increasing both the human food supply and the supply of animal labor. Water which falls in the form of precipitation, of course, supports all types of plant life. One of the main reasons for man's management of water is to encourage some form of plant growth, either by increasing the supply of water at critical periods or by removing excess amounts of it. In arid and semiarid regions, water is used for irrigation of commercial crops and for flushing harmful salts out of the soil as a preliminary to such production. In some cities, a large part of the municipal water supply is used for lawns, trees, and other decorative plant growth, but the use of water for these purposes is first and frequently curtailed when the supply is in danger.

Irrigation is undertaken primarily to maintain life processes in farm crops. It is not the only use of water which falls in this category, but it is one for which statistics are most readily available. There are in the United States today approximately 300 thousand farms on which irrigation is practiced (Fig. 8.1). This is 5 per cent of the total number of farms in the United States. The acreage of the irrigated land is 21 million, although the total area within irrigated farms is more than 100 million acres. For these 21 million acres of irrigated land an estimated total water supply of 62 million acre feet is supplied. It has been estimated that the present irrigated area is roughly half of the potential irrigable area within the United States.

FOR SANITATION AND TO CARRY OFF WASTES OF VARIOUS KINDS. Our modern industrial civilization is based upon the disposal of direct human wastes and those wastes which grow out of our industrial life. The more common way of disposing of such wastes is to carry them off in solution or in suspension and to discharge them in some body of water, either a river, lake, or ocean. Such wastes then become oxidized or diluted so as to no longer be harmful or obnoxious. However, there is frequently an interim time period and an interim area in which such wastes are harmful to aquatic life and prevent or obstruct many other uses of the water. A major part of the water supply in urban areas is used to carry off wastes. Next to human consumption the use of water for this purpose is most important. Water is also essential to personal hygiene and has many other domestic uses.

Practically all municipalities of any size in the United States have a water system which may or which may not be supplemented by individual sources of water, particularly wells and cisterns. In a large proportion of the cases this central water supply is provided by the municipality itself. Of the total population of the United States, 56.5 per cent live in cities, towns, and villages of 2,500 persons or more. With respect to cities having a population of 25 thousand persons or more, their gross debt on account of municipal water supply enterprises exceeds one billion dollars. According to the United States Geological Survey, the total quantity used for municipal water purposes is about 12 billion gallons daily. These municipal purposes include not only direct human consumption but also the disposal of wastes, industrial use, consumption by animals and consumption by plants.

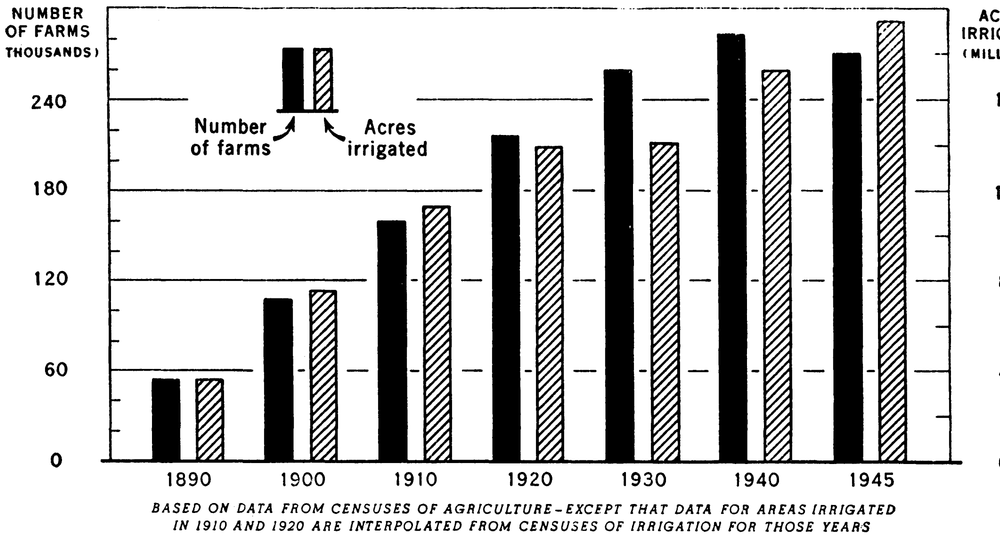


FIG. 8.1.—Irrigated farms and acreage, 17 western states, 1890–1945. The acreage of irrigated land has increased rather steadily from one census period to another, and the number of irrigated farms likewise, at least up until 1940. Roughly 5 per cent of the farms in the United States are irrigated, and the area of irrigated land is roughly 5 per cent of the total crop land area of the United States. (BAE, USDA.)

FOR INDUSTRIAL CONSUMPTION. Many modern industrial processes use large quantities of water either directly or as a means of carrying out certain processes or for a wash, for heat transference, or air conditioning or for other purposes. Water may also be a source of certain raw materials, such as salts and various chemicals. Some of the water so used is consumed, subject to the reservations expressed earlier, and some of it is returned to the stream or other area from which it was originally taken.

Most of the foregoing uses are consumptive in character in the sense that they prevent the immediate re-use of the same water.

FOR GENERATION OF ENERGY—EITHER HYDRO-ELECTRIC OR DIRECT MECHANICAL POWER. One of the earliest forms of energy, other than human or livestock energy, was water power. The early industrial development of New England, for instance, was based largely upon the readily available water power. In more recent decades hydro-electric power has become increasingly important at least in total quantity. Hydro-electric energy is still only a small proportion of total energy and its proportion has not increased in recent years. The great expansion in hydro-electric facilities has been matched by an equally large expansion of energy output of other sources, particularly in the use of petroleum. Generation of hydro-electric energy requires a gradient or fall in a stream, or the harnessing of the ocean tides. In any event the potential energy is dissipated or wasted if unused and the development of a hydro-electric plant merely harnesses for human use energy that is otherwise wasted. Generation of hydro-electric energy is in one sense a consumptive use of water since it does prevent the immediate re-use of this water for the same purpose. However, it generally does not prevent the use of this water for other purposes and often does not interfere with the use of water which would have occurred in the absence of hydro-electric developments. In connection with other sources of energy, water is used in the production of energy in the form of steam.

The use of water for the generation of hydro-electric power has increased greatly in the United States in the past twenty years. There is today a capacity of 16 million kilowatts for the generation of hydro-electric energy and these produce over 83 billion kilowatt hours of electricity annually. The present development of hydro-electric power in the United States probably does not exceed 20 per cent of the total potenial.

FOR NAVIGATION. Oceans, lakes, and streams were once the major, indeed almost sole, channels of large scale commercial transportation in the world and in this country in our earlier period. While they have lost in relative importance due to the great increase in railroad, highway, and air transportation, water transportation is still extremely important in many parts of the world. It is less important within the United States than in perhaps any other major country because we have developed other means of transportation to such a great extent. However, even within the United States there is considerable water transportation and in recent years we have discovered that it has possibilities previously overlooked. The movement of freight from this country to most of the other countries is still predominately by water transportation. However, water often has a negative value for transportation, since it is often a barrier to other forms of transportation.

Although inland and coastal water transportation in the United States are not so important relative to total intercity transportation, there is still an appreciable quantity of freight that uses these means. In 1947, approximately 150 billion ton miles of freight moved over inland and coastal waters. This is about 20 per cent of the total ton miles provided by the railroads of the United States, and about twice the total ton miles provided by the highways. Inland and coastal waters are less important for the transportation of persons than they are for transportation of freight.

AS A HOME FOR FISH AND WILDLIFE. Water whether fresh or salt is the habitat for fish and provides the major constituent of the habitat of many forms of wildlife. In addition to the commercial value of fish, both fish and wildlife are valuable for recreational and similar purposes.

FOR RECREATION. Lakes and streams are valuable for direct recreational purposes such as swimming, boating, and the like. Snow and ice also offer many opportunities for recreation.

TO PREVENT THE INTRUSION OF SEA WATER. One of the interesting but less important uses of fresh water is to prevent the intrusion of salt water into the delta of the streams entering into the ocean. Unless an adequate flow of fresh water is available, salt water enters channels and often does serious damage to the plant and animal life in delta areas.

MAJOR NEGATIVE USES OF WATER—PREVENTION OF FLOODS. A flood has frequently been defined as the overtopping of the normal banks of the stream including the erosion of the stream banks themselves. This definition assumes that normal amounts of water can be confined to the stream channel and that only abnormal amounts overtop the banks. When such overtopping occurs, damage follows.

It is very difficult to secure a reasonably reliable estimate of the damages resulting from floods in the United States. This is partly because the occurrence of floods is not regular and uniform but is highly variable from year to year. An estimate for the years 1924–1937 placed the average annual loss of property from floods at 102 million dollars. An average of 90 persons lost their lives annually because of floods during that period. For the fiscal year 1949, Congress appropriated more than 400 million dollars for flood control work by the Corps of Engineers. Expenditures for flood control are more likely to rise than to decline in the future. Even if dams and other structures reduce the flood hazard the fact that industry and urban development is occurring in areas subject to flood hazards is likely to increase the demand for additional flood protection.

MAJOR NEGATIVE USES OF WATER—PREVENTION OR MINIMIZATION OF SOIL EROSION BY MOVING WATER. Whenever water moves, in any volume and at any speed, it tends to move soil particles with it. Its power to move soil particles increases geometrically as the volume and speed of the water increases. One of the major water problems of the world is to get excess water off or into the land safely. Since conservation of farm lands is discussed in another chapter, this aspect of water use and management will not be considered further here.

MAJOR NEGATIVE USE OF WATER—DRAINAGE OF AREAS WHICH NATURALLY HAVE EXCESSIVE WATER. In many areas water stands on the surface of the land or the soil is saturated with water at or near the surface. Such a water-land relationship greatly limits plant growth, and precludes commercial crop production. Many such areas have been drained and converted successfully to farming. In other instances, drainage is less successful or is a failure. Drainage of a swampy area may completely change the land-water relationship sometimes with wholly unexpected results. For instance, the land may subside or sink when the water is drawn off, or, if the soil has peat in it, fires may break out. Large areas of the United States are in need of drainage and some of them could probably be drained successfully.

Drainage outlets have been provided and improved for more than 100 million acres, although not all of this can be considered as adequately drained. About 30 million acres of partly improved lands can be improved for crop use with proper drainage. About 20 million acres or more of unimproved lands can be drained at a reasonable cost and made suitable for farming.

ADVERSE WEATHER, IN THE FORM OF SNOW, ICE, HAIL, AND RAIN, ALSO A NEGATIVE USE OF WATER. The chief source of water is from storms of various kinds, and to that extent they are helpful. However, many types of storms bring some ill effects, and severe storms may bring serious damage in various ways. A consideration of all aspects of this relationship would get rather afield from a study of water.

MULTIPLE USES OF WATER

The foregoing discussion has been in terms of single uses of water, with here and there a suggestion that much water can be and is used for two or more purposes, either simultaneously or in sequence. For instance, as a stream comes from a mountain range it may be used for generation of hydro-electric power and later diverted for

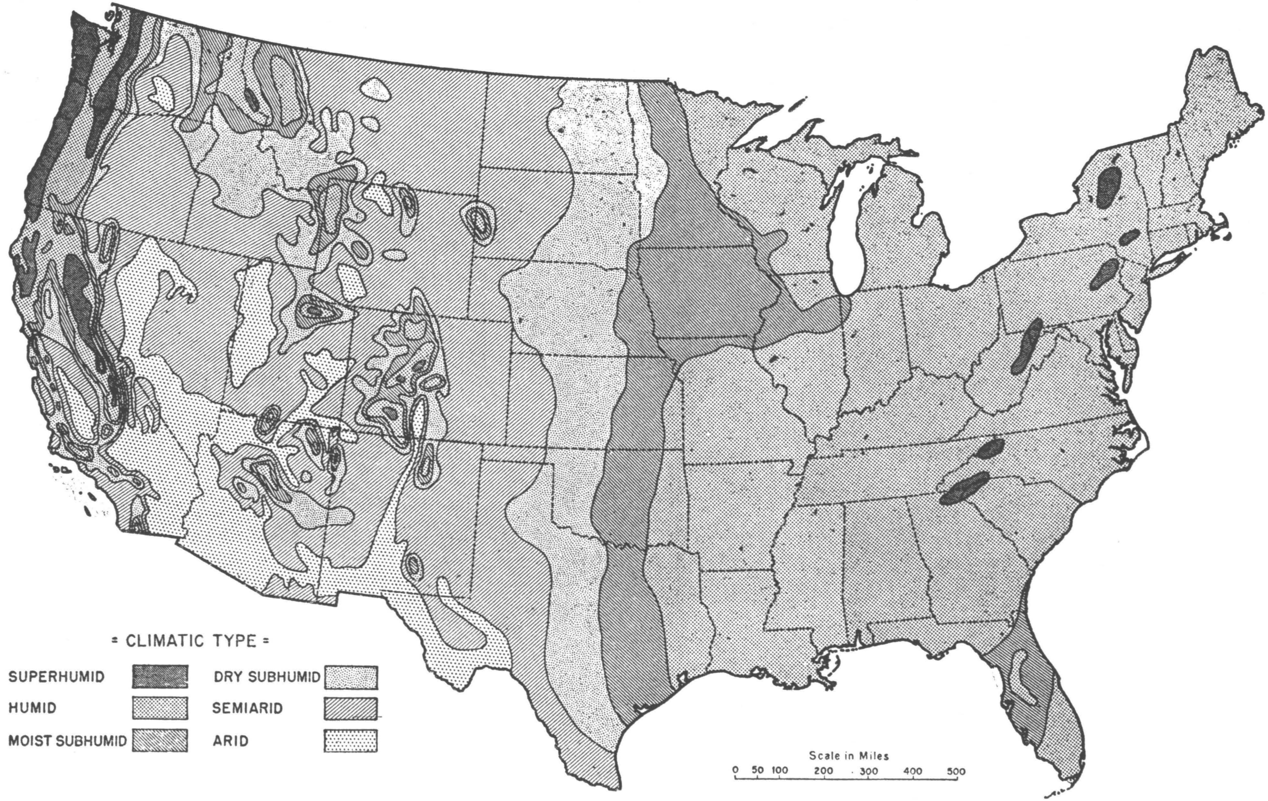


FIG. 8.2.—Distribution of rainfall. A classification of the United States into arid and semiarid, subhumid, and humid regions conceals many important but lesser differences in amount of precipitation. The nature of water use and of water problems varies considerably between such broad zones, however.

irrigation. This is an illustration of uses in sequence. On the other hand, a single dam may be the means of producing hydro-electric power and of diverting water for irrigation. This is a multiple purpose structure, although the uses of the water are actually in sequence. In other instances the same water may be used for recreational and power purposes at the same time or at least in the same place. Other examples of multiple use of water could be cited.

As the water supplies of the nation become more fully used the need for multiple uses becomes apparent. Oftentimes, a single purpose use of water needs only slight modification in order to produce substantial additional values. This is both good economics and good engineering. It also calls for the necessary institutional arrangements so that the full values from each use can be fully developed.

CHARACTERISTICS OF WATER THAT GIVE IT VALUE

Several factors influence the economic value or usefulness of water to humans. First, of course, is the amount of water. Up to a certain point additional quantities of water add value. The amount of the water can be measured either in terms of acre feet (the amount of water required to cover an acre of land to a depth of one foot), or the flow of water can be measured in terms of second feet (the number of cubic feet flowing past a given point in a second). A stream of water containing one cubic foot per second produces an acre foot of water in approximately 12 hours. In the drier parts of the United States more water is ordinarily more valuable than less water. To a considerable extent the same thing is true even in the humid areas, assuming that the supply is not increased too rapidly by sudden storms. However, there frequently comes a point in many climatic regions when additional quantities of water due to unusually heavy precipitation are less valuable than smaller amounts would be. Since the total amount of water is determined by annual precipitation in the area or in its watershed, very little can now be done to influence total supply (Fig. 8.2).

Experiments with artificial rainmaking in recent years open literally unforeseeable potentialities for modifying total water supply of an area. Perhaps in 100 years we can have exactly the amount of precipitation we want everywhere in the world. Water may sometimes be imported from other areas by means of extensive engineering works. Total stream runoff is subject to more influence by man, through watershed management. But even here, practical possibilities are often not large.

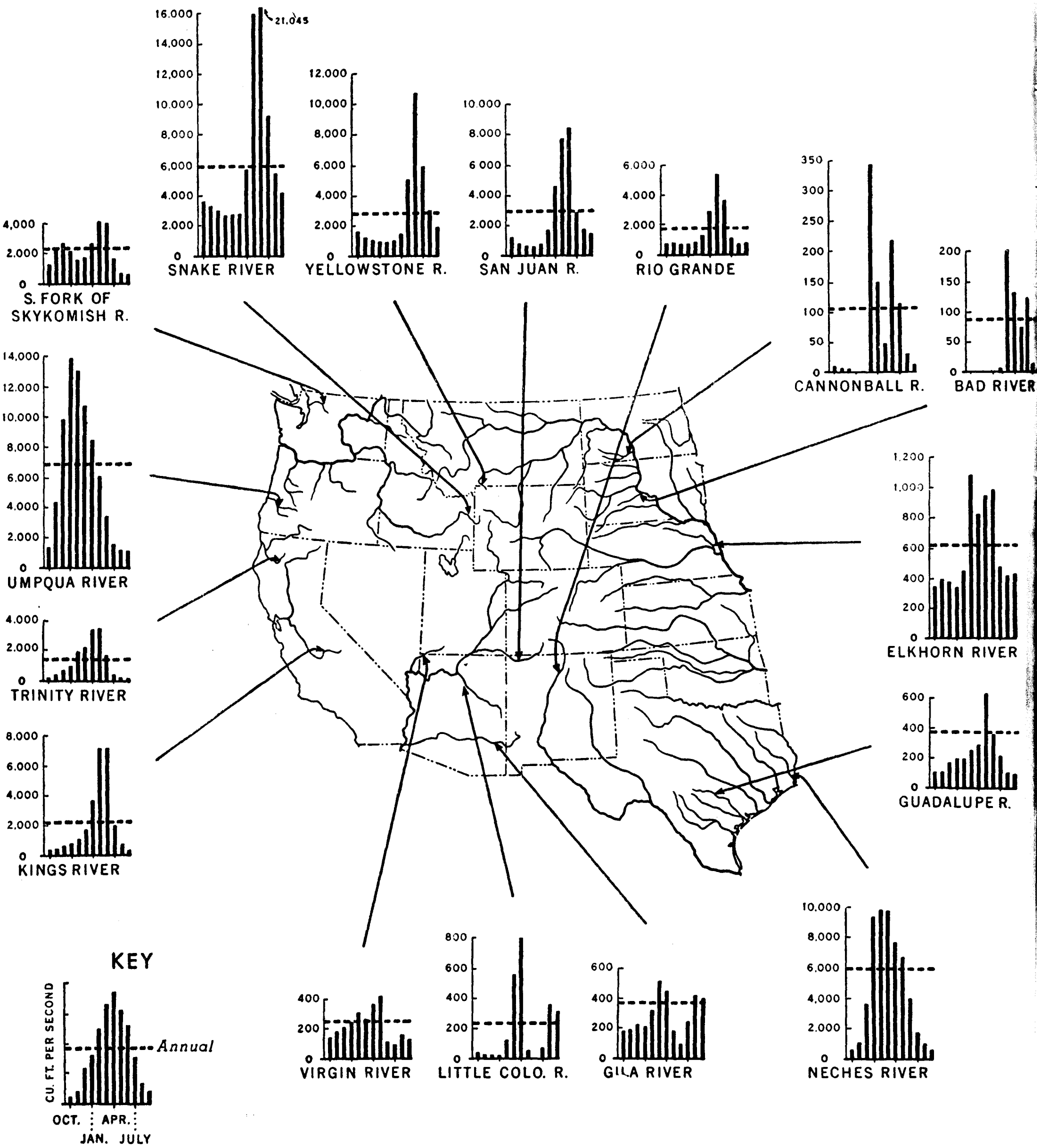


FIG. 8.3.—Normal seasonal flow of western streams. The season of maximum and minimum stream flow, and the difference between the maximum and minimum amounts differs considerably among western streams. In relatively few instances is the unregulated flow ideal for man's use.

Another factor which adds value to water is a gradient or a fall in the stream or movement of water. A gradient is necessary for the production of hydro-electric power and thus is valuable. On the other hand, a gradient in a stream or on the surface of the land is likely to lead to erosion and hence causes damage. The production of electricity is partly the result of the quantity or amount of water available and partly the result of the gradient of the stream. There is nothing that can be done practically to change the gradient of a stream for power production. Through terraces and otherwise, the gradient by which water leaves fields and other areas can be modified and thus erosion lessened.

The seasonality with which precipitation occurs or the seasonal changes in the flow of the stream also affect the value of water. For some purposes an even flow throughout the year is most valuable. This is true for navigation, for instance. The demand for electricity is not entirely constant throughout the year, but reasonably so, and thus a regular flow of water is most valuable for the generation of electrical energy. The need for water for irrigation or for urban use increases during the summer and hence a somewhat uneven distribution of water throughout the year, the greatest supply in the months of greatest need, would be more valuable than a more regular flow. Many streams have their season of peak flow of water at a time when such water is least valuable (Fig. 8.3). At the extreme, peak flow may produce a flood and cause damage rather than create value. Changes in seasonality of precipitation come in the same category as changes in total precipitation—a future possibility of enormous potentiality, but not practical now. Seasonality of stream flow can be modified within rather narrow limits by watershed management. Storage and regulating dams can alter stream flow below them, often by almost any degree to which it would be economic to construct the necessary dams.

Closely related to the matter of seasonality of water supply or water flow is the variability in supply. The total quantity of water available may vary greatly from one year to another (Fig. 8.4). Likewise, the flow or supply at one season such as summer may vary greatly from the available supply or flow at the same season in other years. Variability may even exist from day to day, particularly in some climatic and watershed conditions. Ordinarily, variability in supply or flow diminishes the value of a given quantity of water. Thus far, it has proven impossible materially to reduce variability in total water supply. The supply for certain uses or the flow at certain

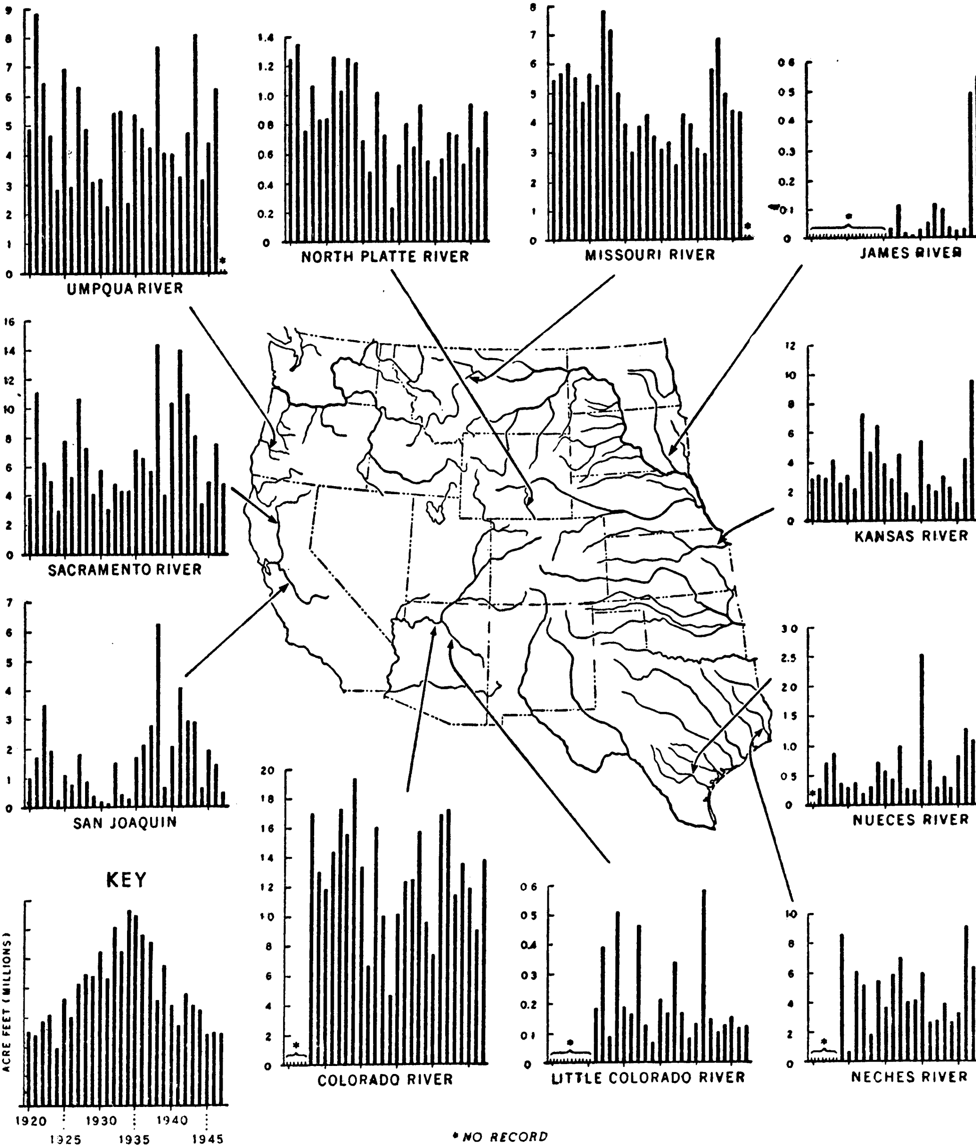


FIG. 8.4.—Annual variation in stream flow. Western streams differ greatly in the extent of their year to year variations in total stream flow. Generally, the more variable is stream flow from year to year, the less valuable it is. (BAE, USDA.)

points can be regularized by use of large storage dams, capable of holding water over from year to year, if adequate storage sites exist and if it is economic to do so. Thus, Hoover Dam can store more than 2 years normal runoff of the Colorado River at that point. By releasing this stored water as needed, the flow below the dam can be regularized under almost any climatic conditions.

Also, closely related to these two matters is the predictability of the supply or flow. A variable supply may be predictable at least under some conditions. For instance, a flood flow on the upper part of a stream will produce a large flow, possibly flood flow, at a lower point on the same stream at some later time. Both the amount and the time of this later peak may be predictable with very high accuracy. In areas where a large part of the stream flow comes from melting snows, snow surveys provide considerable information as to the probable future variation in total water supply and some information as to the timing of such future runoff. The supply of ground water can also be predicted with fair accuracy following a drought or a wet year. To the extent variability in stream flow or water supply can be predicted, the disadvantages of such variability in supply are less. It is then possible to make some provisions against either shortages or excessive supplies.

The purity of water also greatly influences its value. Practically no water in nature is completely pure, but instead it contains varying amounts of materials in solution or in suspension. By far the greatest part of the water in the world is in the oceans where it contains appreciable quantities of various salts. Thus far it has not been feasible to use sea water for many uses except navigation, fishing and recreation. However, serious attention is now being given to the possibility of purifying sea water for urban and agricultural use. Experiments of this nature thus far appear encouraging. Even so-called fresh water differs greatly in the amount of salts contained naturally in it. This in turn greatly influences their usability for some purposes, particularly for many industrial purposes. An unfortunately high percentage of the fresh water of this and other countries contains large amounts of impurities because of man's activities. Agricultural and other land uses may lead to erosion and to the presence of silt in streams. Industrial processes and the disposal of urban wastes have increased the impurities in streams of this country enormously. Man can purify water when it is to his interest to do so, but in practice he has been far more active in polluting than in purifying water.

RIGHTS TO USE WATER IN THE UNITED STATES

There are two broad doctrines under which rights are acquired to the use of water in the United States. These are the Riparian Doctrine which applies generally in the humid areas, and the Appropriation Doctrine which applies generally to the arid areas.

THE RIPARIAN DOCTRINE. The Riparian Doctrine was imported from England, where it was part of the common law. Under it any land owner is entitled to use water flowing through or alongside of his land, or water bordering on his land, as long as his use does not diminish either the quantity or the quality of the water. Under this doctrine streams in England were used to produce water power, as well as for other purposes. This doctrine fitted the original colonies in the United States quite well, and the use of streams for water power took place under it. As strictly interpreted, this doctrine would prevent pollution of streams by the dumping of industrial or urban wastes. However, enforcement of this doctrine generally lay with the injured land owner whose riparian rights were destroyed or lessened by such dumping. Since so many cities have so generally dumped wastes into streams, by common consent the Riparian Doctrine is frequently tacitly modified as far as the preservation of the quality of the water is concerned.

THE APPROPRIATION DOCTRINE. The Appropriation Doctrine with regard to water was brought from Spain by way of Mexico. It originated in an arid area and permitted the actual appropriation of limited water supplies in order to permit their consumptive use. It has been applied rather generally in the arid western states where irrigation and other consumptive uses of water are larger. Under it a right to the use of water is obtained by application to the appropriate state official. "First in time, is first in right," is a common saying in the West to indicate that a priority of right is obtained by the date of the filing. "Beneficial use is the measure and basis of right," is another expression common in the West and indicates that rights cannot be obtained for more water than can be beneficially used.

Both the Riparian and Appropriation Doctrines can be applied not only to surface water supplies but to ground water supplies also. However, no doctrine has been applied consistently and beneficially to the use of a great deal of ground water resources of the United States. In most parts of the United States where ground water supplies are used to a substantial degree, these supplies have been overutilized with a consequent decline in the ground water level. In some Western States provision has been made in fairly recent years for the appropriation of ground water so as to limit its use to the average annual supply.

STREAM BASIN COORDINATION

Closely related to the matter of multiple use of the water is the necessity for coordination of water uses within a single stream basin Much of the early development of water was for single purposes and often entirely uncoordinated with other uses of water within the same basin. For instance, one municipality might take water from the stream for municipal purposes while another dumped its wastes into the same stream. Or, a hydro-electric power plant might be erected upon a stream without regard for the needs of irrigation from the same stream. Many other instances of single-purpose uncoordinated development could be cited. Such developments are bad enough as long as water resources are only partially utilized. However, as water resources come to be more and more fully utilized, it becomes increasingly necessary to take account of other uses of the same stream. Unless this is done conflicts and lawsuits are almost sure to arise. Less obvious but perhaps more important, the full values of the stream will not be realized.

There are many problems encountered in the coordination of water developments within a single stream basin. In the first place, there are the technical aspects of coordinating one use with another. Some reference has previously been made to these. The dams or other structures needed for one purpose may not be fully usable for other purposes, or the plan of operation of a structure may depend upon its use. Water used for one purpose may thereby be unavailable for other uses or may be less valuable for such other uses. The water needs of one area may conflict with those of another area either for the same or for different purposes. These and many other technical problems arise.

Such problems immediately lead into a consideration of the economic problems involved. Is it better to forego 10 per cent of the potential power production in order to obtain 25 per cent more irrigation water, for instance? Is it worthwhile to construct larger reservoirs in order to hold back more of the flood waters for productive use, or is it more profitable to allow more of the water to run to waste and to protect the area from flood by levees or dikes?

These are but a few of the many questions that may arise. Each of the technical questions of water use has an equally difficult economic problem. These problems are frequently further complicated by the fact that the costs and benefits from the different types of developments are forthcoming at different dates in the future and, hence, are not always directly comparable.

Estimation of costs and benefits have preceded private water developments, although the actual results have often fallen far short of the calculations or hopes. Calculations of cost benefit ratios, and restriction of development to those projects showing favorable ratios, have been required of federal agencies. This requirement has been ineffective in operation because costs are generally underestimated and benefits often grossly overestimated. Estimation of economic benefits from water developments is difficult enough at best, even when the estimator is not under pressure to come up with the answer the construction engineer wants. There has been a tendency on the part of economists to underestimate indirect benefits and to underestimate the rate of economic growth and its effect on value of water developments. On the other hand, engineers and promoters have overestimated these same items even more grossly.

Perhaps even more difficult than either the technical or economic problems are the political problems involved in the stream basin problems. If the stream basin is relatively small and lies entirely within the same political unit and within an area of generally similar interests and standards of value, then the problem may not be too difficult. However, most of our larger streams lie in two or more states and many more include areas with widely varied interests and viewpoints.

These political problems of coordinated river developments are well illustrated on the Missouri River. There is a basic conflict of interests between the upper watershed areas where the greatest interest is in irrigation and hydro-electric power, and the lower basin areas where there is great concern over navigation and flood control. In addition to this specific and perhaps extreme illustration there are a great many cases in which varied uses of water are attempted on a stream which flows in two or more states, and which soon come in conflict. There is a widespread tendency to regard the water which rises in a state as somehow the exclusive property of that state even though it may be physically impossible to hold it within the state and to use it there. Political problems are particularly acute when there is insufficient water available to serve all potential demands.

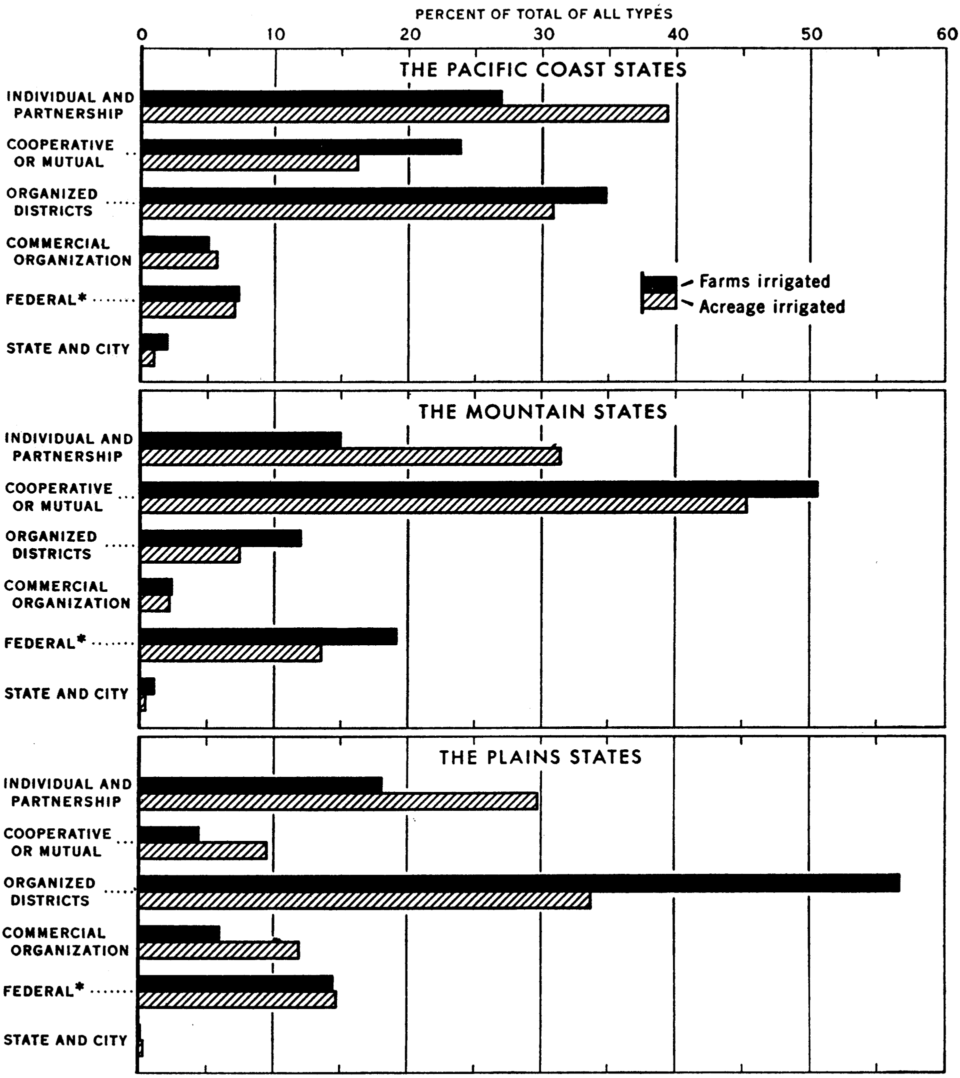
FEDERAL WATER PROGRAMS

Although much of the use of water which has occurred in the United States to date has been made by individuals or corporations, or at the most by municipalities and states, there is reason to believe that most of the large scale water programs of the future will be federal in character. The federal government has already carried on extensive programs in irrigation, hydro-electric power, navigation, and flood control. The magnitude of these programs has increased greatly in the past 20 years. There is reason to believe that such federal programs will increase in relative importance in the future.

It is easier to consider federal water programs in terms of agencies rather than in terms of the specific kinds of programs since most federal water programs are mutiple purpose in character.

The Bureau of Reclamation has provided a full project water supply for 2.5 million acres, and a full or supplemental water supply under special water service contracts for 2.7 million additional acres (Fig. 8.5). Most of the future irrigation of the West will be with water provided by federal reclamation projects. Large scale reclamation water developments are under way on the Columbia, Colorado, Rio Grande, and Missouri Rivers and their tributaries, and in the Central Valley of California. The Bureau of Reclamation has invested 1½ billion dollars in construction to date and has under way, or authority for, projects whose ultimate costs will exceed 3 billion dollars. It has been developing long range programs for the ultimate irrigation of something between 10 and 20 million acres of land. Until 1928 the Bureau of Reclamation was almost entirely concerned with irrigation. The approval of the Boulder Dam Project on the Colorado in that year brought a greatly increased emphasis to the production of electricity and this has become increasingly important on later projects (Fig. 8.6). With the passage of years emphasis has shifted from single to multiple purpose projects with increased attention to flood control, navigation, recreation, wildlife, and such other uses in addition to the primary ones of irrigation and hydro-electric power. An important phase of the federal program is its watershed investigations and soil and moisture operations (Fig. 8.7).

The Bureau of Reclamation has been permanently identified with two major policy uses. Under its basic law the acreage of land for which one person can get water on federal reclamation projects is limited to 160 acres. This acreage limitation is designed to promote family size farms, to spread widely the benefits of irrigation, and to



DATA FROM CENSUS OF IRRIGATION, 1940. **BUREAU OF RECLAMATION AND INDIAN SERVICE.*

PACIFIC STATES INCLUDE WASHINGTON, OREGON, AND CALIFORNIA; MOUNTAIN STATES INCLUDE MONTANA, IDAHO, WYOMING, COLORADO, NEW MEXICO, ARIZONA, UTAH, AND NEVADA; PLAINS STATES INCLUDE NORTH DAKOTA, SOUTH DAKOTA, NEBRASKA, KANSAS, OKLAHOMA, AND TEXAS.

FIG. 8.5.—Irrigation by types of enterprises. Most irrigation development in the past has been by private capital, much of it in rather small enterprises. In the future, most irrigation development will be by federal agencies, largely because the remaining possibilties consist of large projects requiring large investment of capital. (BAE, USDA.)

prevent speculative gains on federal reclamation projects. This policy continues the homestead principle for public lands. Although it has been attacked several times since its adoption in 1902, it has been defended successfully every time so far. Under its legislation the Bureau of Reclamation is required to give preference in the sale of electrical power to public distribution agencies. Such a preference is not in terms of price at which electricity is sold, but rather is a preference for the available supply of electricity. Most of the benefits to the consumer from the public generation of electricity are lost unless the transmission lines and distribution facilities are also publicly owned, and unless the price policy passes on to the consumer the advantages of such public ownership. Accordingly, the Bureau of Reclamation has sought to encourage public distribution of electricity and a power price policy which will pass on to the consumer the benefits of such a policy. This policy has also been under heavy attack at times. The chief line of attack against this policy has been against appropriations for the necessary transmission lines. In some areas, privately owned companies have worked out cooperative arrangements with the Bureau of Reclamation and the public distributing agencies whereby federally generated electric energy is carried over privately owned power lines by payment of reasonable charges.

The Corps of Engineers, Department of the Army, has historically been concerned first with navigation and secondly with flood control. Up until the middle 30's, virtually the only devices used for flood control were levees and dikes. However, the disastrous floods of the Mississippi River in 1927 had demonstrated the limited usefulness of levees not supplemented by storage reservoirs. Under the Flood Control Act of 1936, and more recent acts, the Corps of Engineers has built a number of large dams which are capable of multiple purpose use and have been so used. These dams restrain flood waters which can be used at other seasons to improve navigation, to generate power, or for irrigation. Thus, beginning at the lower parts of major streams the Corps of Engineers has gradually worked upstream until it is now engaged in very similar activities to those of the Bureau of Reclamation which began at a different point on the streams.

The Corps of Engineers has not been engaged in controversies over policies similar to those of the Bureau of Reclamation. Theoretically, it does not provide irrigation water. Wherever it does improve the water supply, advantage is taken of this by private

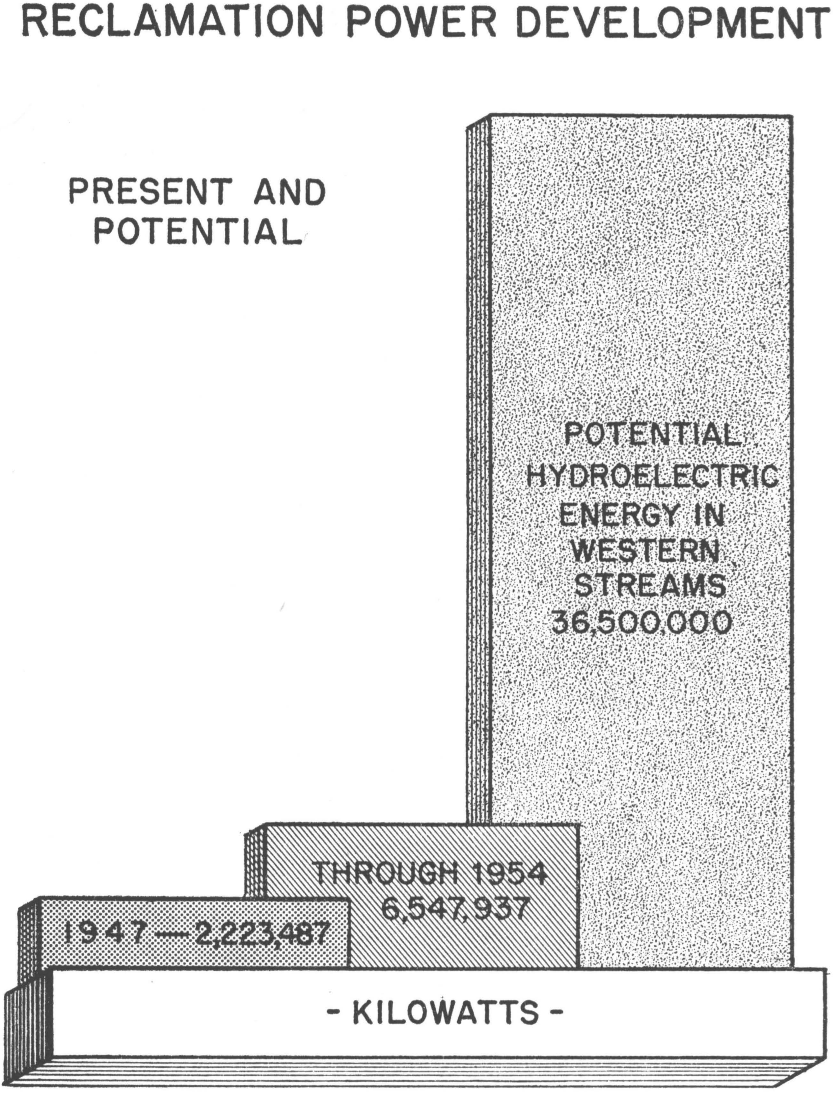


FIG. 8.6.—Reclamation power development. Development of hydroelectric energy by the Bureau of Reclamation is comparatively recent, having begun on a major scale since Hoover Dam was started in 1928. Construction under way and planned will nearly treble the amounts now produced, but even then will far from have exhausted the potentialities of western streams. (BAE, USDA.)

interests which construct necessary irrigation works. There is no acreage limitation provision in its legislation. The electricity generated at dams constructed by the Corps of Engineers is turned over to the Secretary of the Interior for his sale and disposal. The Corps has thus avoided controversy over public distribution of power generated at dams built by it. The private power companies have generally supported the Corps in its program.

The Bureau of Reclamation and the Corps of Engineers are each working in the same general field of water development. There has been widespread and bitter criticism of their rivalry in this field. The Hoover Commission gave particular attention to this problem. The report of the Task Force on Natural Resources, particularly pages 16–39 and 65–182, deals with this subject. The Task Force says, "The difficulty is that under existing policies and organization there is wholly inadequate assurance that projects undertaken are feasible, and that the objective of maximum benefits at the lowest cost is being attained." Former Governor Leslie A. Miller of Wyoming, chairman of the Task Force, has popularized his views, and presumably those of a majority of the Task Force, in an article in the *Saturday Evening Post* for May 14, 1949. His views are summarized in these brief quotations about the Army Engineers and the Bureau of Reclamation.

> "The two agencies are so violently jealous of each other that an extravagant and wholly senseless competition has sprung up . . .
>
> "In their indecent zeal to extend their empires, both agencies are guilty of underestimating—apparently deliberately—the cost of the projects they propose to build . . .
>
> "Both agencies stoop to deception in furtherance of their efforts to stake out claims on projects . . .
>
> "Both agencies are guilty of brazen and pernicious lobbying to achieve their ends."

It is inevitable that such rivalry should exist as long as there are two agencies both working in the same general field. To the extent that independent engineering studies are made on the same problems, there may be something gained by having two agencies working in this field. With this exception, there is certainly much lost by having two agencies. The difficulty comes in evolving and carrying out a coordinated program when two agencies are each working on a major scale on the same stream. Many water development projects have been criticized as being of the "pork barrel" type, that is, the cost to the federal government is greater than the cost to the local

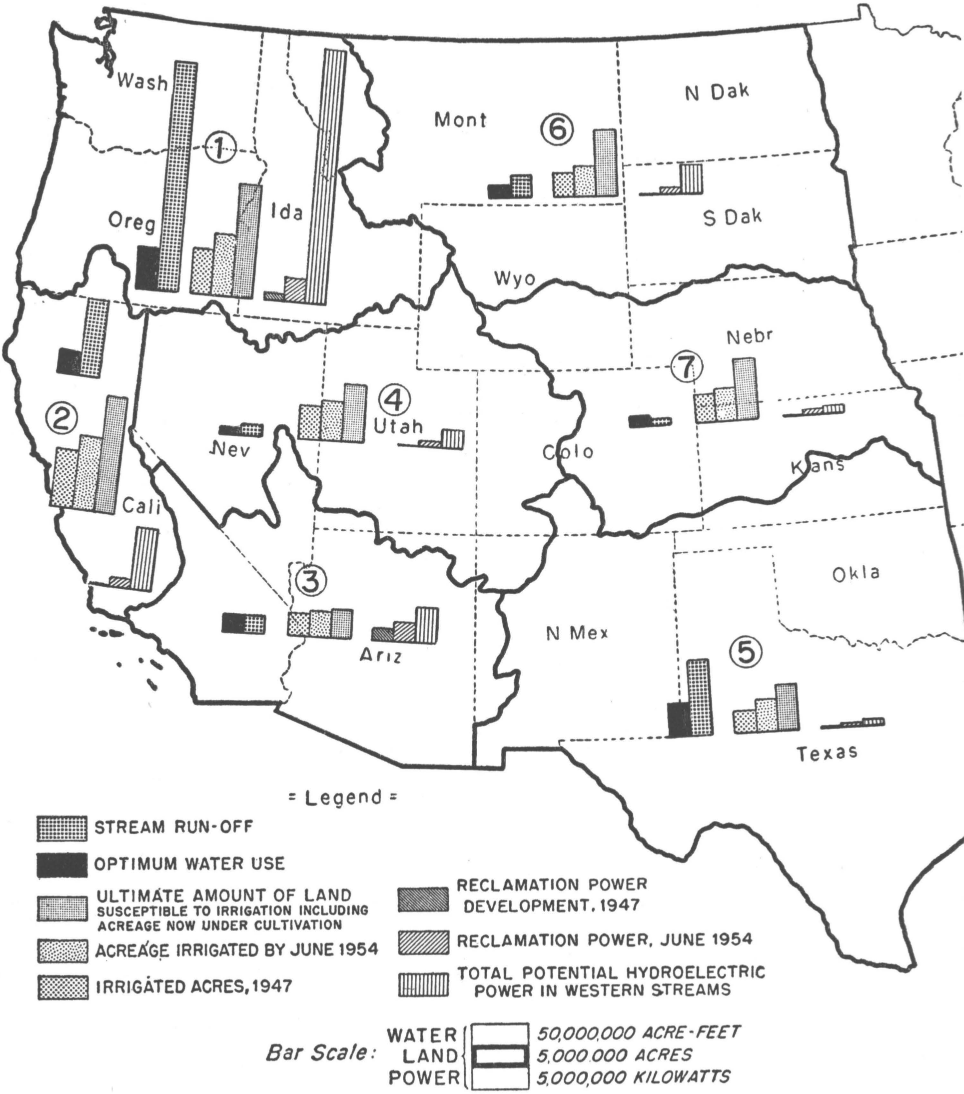


FIG. 8.7.—Western water resources and use. The various western river basins differ considerably in their potential water resources and in the degree to which these potentials have been realized. In most stream basins there is greater opportunity for expansion of hydro-electric power production than in expansion of irrigation.

community but the benefits are greater than the costs to the local community. Thus a local area benefits from the expenditure of federal funds for a water development project even though the nation as a whole does not. It is extremely difficult for any Congressman to vote against water developments in his district. It is almost axiomatic that a large flood control or navigation improvement program never fails of passage through Congress.

It is a mistake to assume this struggle is a purely bureaucratic one, although there is plenty of that in it too. Each program and agency has strong political support from groups which believe in its program or which benefit directly from its activities. Moreover, each agency continues to exist and to receive appropriations from a Congress that could bring order out of this rivalry if it chose.

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