the amount of unappropriated water it is necessary to ascertain first how much water has already been appropriated. Adequate provision for this purpose is gradually being made by the legislatures of some of the states. In Idaho, for example, the state engineer is authorized to ascertain the facts as to amount of water flowing in the streams, the acreage irrigated, and the size and capacity of the canals. Having brought together these and other essential facts, he becomes practically the expert witness of the court, thus doing away to a large extent with the disastrous effects resulting from the testimony of interested witnesses as to the amount of water which they have used.

The Idaho system is generally regarded as an advance upon that of Wyoming, where the state engineer not only ascertains the facts but is in effect a judicial officer rendering decisions as to the amount of water to which the various claimants are entitled. The prime requisite is to have the actual facts ascertained in a clear and impartial manner, so that decision when rendered either by the ordinary courts or by a special tribunal may be in accord with the facts, and the waters may be apportioned in accordance with actual conditions rather than the extravagant claims of interested parties. Until some such method is provided in all of the states it will be impossible for full development to take place, because of the uncertainties surrounding the matter.

CHAPTER XI.

STATES AND TERRITORIES OF THE ARID REGIONS.

EACH portion of the arid region possesses certain peculiarities of topography, climate, water supply, and cultural conditions. In discussing these it is convenient to consider them by political divisions, since the latter are easily recognized by name. Each state and territory is so large that it embraces usually a number of distinct climatic conditions, but in a brief review these may be classed together. For convenience the states and territories are here taken up in alphabetical order; they are: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

The following table gives the extent of irrigation at the beginning and end of the decade 1890–1900, and shows the gradual increase of this method of tilling the soil. The location of the irrigated areas is shown in Fig. 14, p. 54, together with the irrigable lands. The possible water supply is given in the last column of the table on p. 55 in millions of acres. There is water enough for over 60,000,000 acres if fully conserved by reser-

voirs or developed by wells, tunnels, and diversion canals.

AREA IRRIGATED.

State or Territory.	1890.	1900.	1905.
	Acres.	*Acres.*	*Acres.*
Arizona	70,000	190,000	200,000
California	1,200,000	1,500,000	1,800,000
Colorado	1,000,000	1,400,000	1,900,000
Idaho	230,000	600,000	800,000
Montana	380,000	1,000,000	1,300,000
Nevada	240,000	510,000	600,000
New Mexico	95,000	200,000	200,000
Oregon	180,000	400,000	400,000
Utah	300,000	650,000	700,000
Washington	100,000	150,000	200,000
Wyoming	250,000	600,000	700,000
Subhumid	70,000	100,000	300,000
Total	4,115,000	7,300,000	9,100,000

The total area of these states has been given on p. 6. A comparison of this with the acreage irrigated shows that the land cultivated in this manner forms less than 1 per cent of the total extent of most of these states. It is not to be supposed that the whole of the arid region is irrigable, but it is highly probable that the area can ultimately be increased until ten times as much land has been brought under cultivation. The size of these states is so great that it is impossible to form a clear conception of their extent without making comparisons with other political divisions

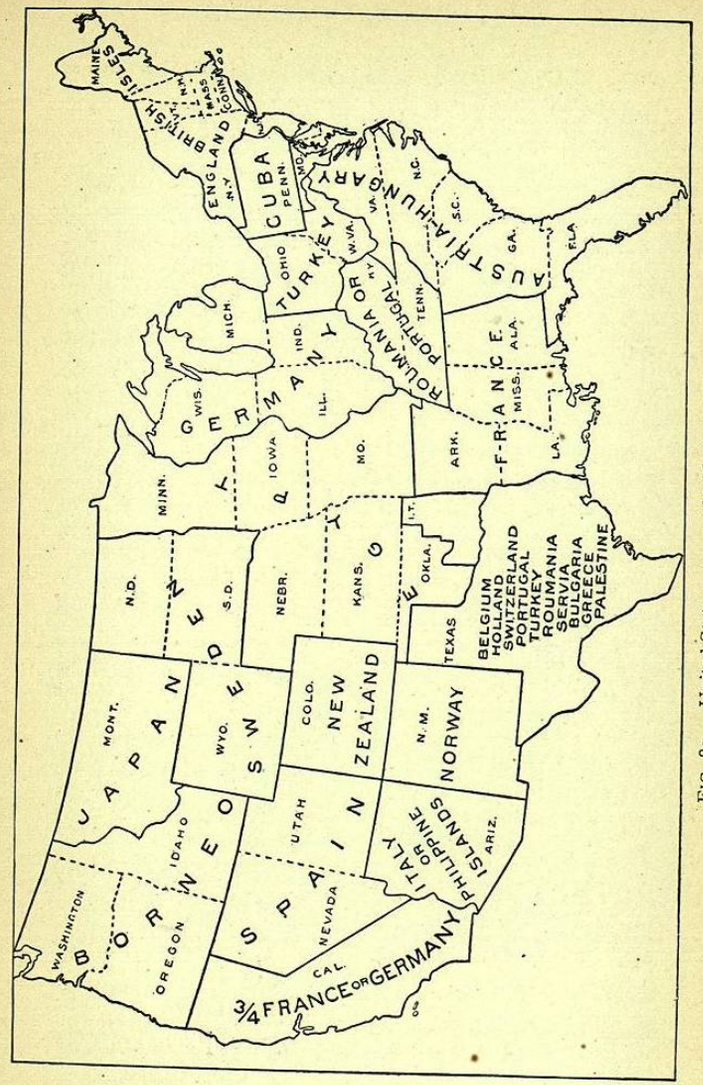


FIG. 89.— United States compared with foreign countries.

in the United States and with some of the countries of the Old World. A single county in one of these Western states or territories may be larger than one of the older states of the Atlantic seaboard. To bring out this comparison Fig. 89 has been prepared, showing the outlines of the states. Across these have been lettered the names of several foreign countries whose area is very nearly equal to that of one or more of the states. For example, Spain has about the same extent as Utah and Nevada. Italy is approximately equal in area to Arizona, or to the Philippine Islands. Various other interesting comparisons are afforded in the East as well as in the West.

Similar comparisons are made on Fig. 90, which shows only the western portion of the United States, and with a little different combination of foreign countries. In particular, the states Oregon and Washington are seen to be equivalent to Great Britain, Ireland, Denmark, and Switzerland. Having in mind the great difference in population, we cannot fail to be impressed with the opportunities for increase of population and industries, especially as the resources of these Western states are of great extent and have hardly yet been exploited. There is apparently no reason why our Western states should not, in the distant future, be capable of furnishing homes and profitable occupation for as large a population as some of the countries whose names are placed across

them. The ultimate realization of such conditions rests, however, largely upon the treatment which

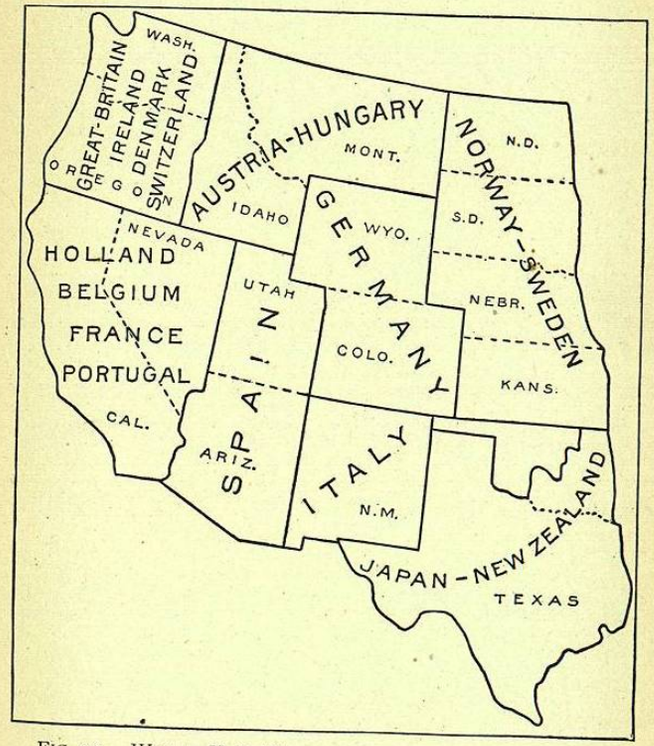


FIG. 90. — Western United States compared with foreign countries.

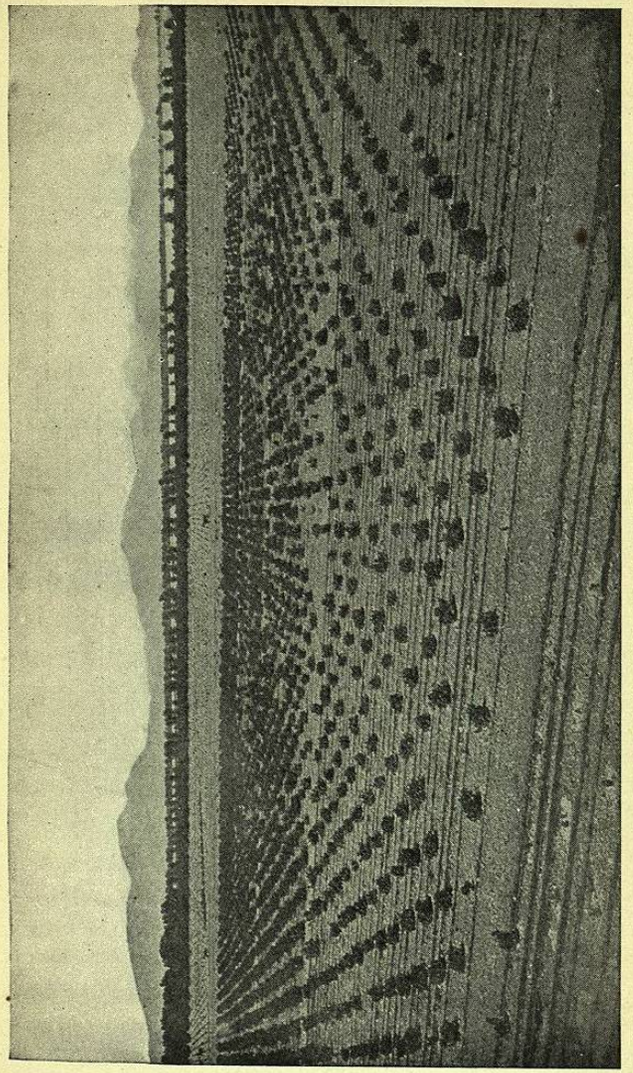
in the near future shall be accorded to the water resources, especially in the way of guarding these from speculative monopoly.

ARIZONA.

This territory, not yet admitted as a state, embraces 112,920 square miles, or 72,268,800 acres, in the driest and hottest part of the United States. Its population in 1900 was 122,931, nearly equal to that of the states of Nevada and Wyoming combined. The average for the whole territory is about one person to the square mile. In area the territory is a little larger than Italy, which has a population of 33,000,000, and a little smaller than the United Kingdom of Great Britain, with 41,000,000 people. The principal part of the population is in the Salt River Valley, in the vicinity of Phœnix, the capital city. The land here, as well as in many other parts of the territory, is extremely fertile, and lacks only an adequate water supply.

Increase of population and industry is limited directly by the possibilities of water storage. More land has already been brought under ditch and partly cultivated than can be supplied with water in ordinary years. Great tracts of country can, however, be utilized for home-making when the waters which now run to waste are carefully held for time of need.

Not only is the necessity for water storage greater in Arizona than in any other part of the United States, but the opportunities for constructing reservoirs on a large scale seem to be best there. There are in the territory a considerable



IRRIGATED VINEYARD NEAR PHŒNIX, ARIZONA.

number of valleys whose position and form offer unusual facilities for holding the occasional floods.

Considering the territory as a whole, there are two distinct provinces, separated by a line of cliffs or mesas extending diagonally from northwest to southeast. Above, or north of, this line the country may be pictured as a plateau having an elevation of approximately 6000 feet, much of it covered with pine forests. The surface is undulating, and mountain masses rise from it. The rivers have cut enormous canyons in this plateau, the Grand Canyon of the Colorado being one of the most stupendous gorges in the world.

The smaller tributaries of the Colorado flow in narrow gorges 1000 feet or more in depth, and the small streams which occupy the bottoms of these cannot be taken out to irrigate the upland. Agriculture without the artificial application of water is carried on to a small extent, especially on the higher plateaus, and some irrigation is practised wherever sufficient ground can be found along the mountain streams. The northern part of the territory cannot be considered as having large opportunities for the creation of homes when compared with the southern part.

From the south front of the great escarpment or mesa a number of streams flow southerly, joining to form Salt River and its large tributary, the Verde. These unite and flow westerly through a broad valley, entering Gila River, which con-

tinues southwesterly across the territory into Colorado River. The valley of Salt River on the south merges imperceptibly into the broad desert traversed by the Gila and reaching beyond the Mexican border. There are millions of acres of good land in this area, but only a small portion can ever be supplied with water, even after all the possible reservoirs have been built and artesian wells constructed. Since the maximum possible supply falls far short of the needs of all the land, the remainder must always be barren, unless some desert-loving plants valuable to man be discovered and introduced.

A short distance below the junction of the Salt and Verde a number of canals, heading on one side or the other of the stream, take out all of the ordinary flow and carry it to the lands in the vicinity of Phœnix. The altitude here is about 1000 feet, and the climatic conditions are such that oranges and other citrus fruits thrive, and in some localities dates have been successfully introduced. The principal forage crop is alfalfa, of which from five to seven cuttings a year are made if ample water is available. This enables the farmers to produce a large amount of hay from a relatively small acreage. With other products there are usually two crops each year, and sometimes more, the ground being immediately cultivated and planted after each harvest. Thus, with continuous warmth and sunshine and with the necessary water, intensive farming is practised, and it is estimated that a family of five persons can be well supported upon twenty acres, or even less, if covered with producing orchards.

Only a small portion of the good land is in actual use, the amount appearing almost insignificant on a map of the territory. This can be greatly increased by water storage, and in a less degree by deep or artesian wells. Around the Salt River Valley, on both the north and the east, among the mountains, are a number of storage sites, the most notable of these being at the junction of Tonto Creek and Salt River. Careful surveys of several of these localities have been made, plans prepared, and cost and benefits estimated. These investigations should be extended to include every possible locality.

South of the Salt River is the Upper Gila, a stream somewhat smaller, or furnishing a less amount of water. Along its course in the eastern part of the territory are several broad valleys, the most noteworthy being in the vicinity of Solomonville. Here, as in many other parts of the territory, Mormon pioneers have taken out ditches and brought large tracts of land under cultivation. Farther down, canals have been taken out to cover land southeasterly from Phœnix, in the vicinity of the town of Florence, and the supply here has been decidedly diminished by the diversions at points above.

Still farther west, and down-stream from Florence, near the junction of Salt River, is a large tract of desert land intersected by small, steep mountains which seem to rise out of the nearly level floor. This is the Gila River Indian Reservation, set aside for the Pima, Papago, and Maricopa Indians. These people have always been tillers of the soil, having practised irrigation long before the advent of the whites. Like most agricultural natives, they have been peaceable and friendly, and have even assisted immigrants in defending themselves from attack by the savage Apaches who dwell in the mountains near the head waters of the stream.

With the gradual diversion of the waters of Gila River in the vicinity of Florence, and particularly in the Solomonville Valley, the quantity in the river has been diminished, until for several years in succession there has not been a sufficient amount for the Indians. They have been forced to depend upon chance support, and, induced by hunger, to steal the cattle of their white neighbors. Their children have been sent to school and educated, but, on returning to their homes, find nothing to do, as farming cannot be practised without a water supply. To prevent actual starvation, the government has appropriated money for feeding these Indians, and while going to great expense in education, is at the same time pauperizing the people.

To enable these Indians to again become self-supporting, it is essential that they be provided with an ample water supply. Many investigations have been made, and it has been found that there are a number of places on the Gila River where reservoirs of large size can be built. It is not practicable, however, to construct small reservoirs, as these would be quickly filled with silt, and the expense of building dams for them would be nearly as great as that of structures for reservoirs of the largest possible capacity.

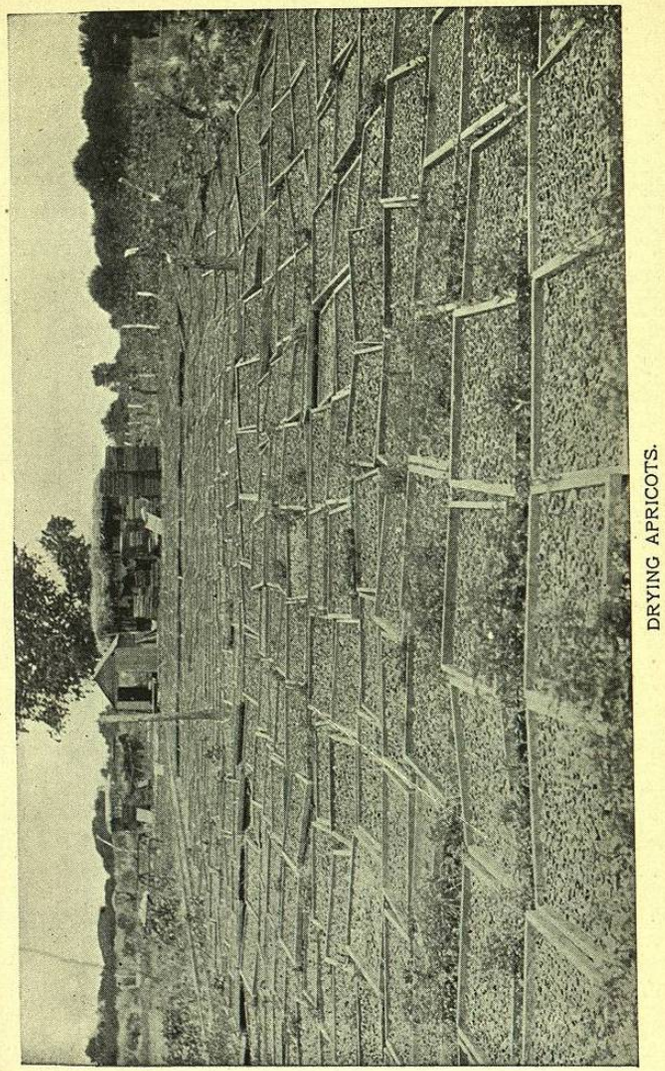
A considerable part of the Indian lands has been found to be saturated with water. Much of this is of good quality, and if pumped by using the power from mountain streams, it will be possible to restore the ancient agricultural practices. Believing this to be more economical than the construction of storage reservoirs, Congress in 1904 made an appropriation for sinking wells and beginning the installation of pumping plants.

There are a number of smaller streams in the southern part of the territory, each of which is now utilized to its full capacity when at ordinary stages. The floods of these streams could be stored and used upon tracts of government land, thus providing opportunities for many additional farms. The violence of some of these deluges is illustrated by Pl. VIII, giving a view of the bridge across Salt River, which was partly destroyed by a rush of water that carried out practically all of the dams

and head gates along its course. This is exceptional; but it is possible to provide storage to hold the ordinary floods on many of the streams and reduce the violence of the extraordinary ones.

There is probably no place in the United States, except possibly in Southern California, where the marvellous results accomplished by irrigation are more conspicuous than in Arizona, particularly in the Salt River Valley in the vicinity of Phœnix. Here, on the broad desert valley, bare of vegetation except for an occasional dry, dusty group of thorny plants, the venturesome pioneer took out small ditches, many of these following the ancient, almost obliterated, lines of the canals of the prehistoric agricultural Indians, the ruins of whose towns dot the plains. Under the brilliant and intense sunlight, the moistened soil yielded bountifully, and the small ditches were rapidly enlarged and canals built to cover more and more ground.

The dry climate, especially of the winter season, is found to be advantageous to human beings as well as to plants, and renewed vitality has been given to many an invalid from the cold and stormy North. The success attained with oranges and other citrus fruits, as well as with grapes, prunes, plums, and various fruits needing the warm climate, has led to a rapid widening of the area devoted to vineyards (Pl. XLVII) and orchards, these revenue-producing vines and trees being supplemented by luxuriant growth of palms, rose bushes, and innu-



DRYING APRICOTS.

merable varieties of ornamental and flowering shrubs. The delicate house plants, tenderly cared for in the North, here develop to wonderful size and variety, being hardly recognizable in the sturdy, treelike forms which threaten to bury the suburban houses in a perfect jungle of flowering branches and creepers, all the result of watering the dusty plains.

The fruits of the Salt River Valley are not brought into immediate competition with those of Southern California, as it is possible to put them upon the market at an earlier date, and a certain advantage is given in a shorter haul toward the Atlantic and Gulf states, this being an important item in the handling of the fresh fruits. Great quantities are thus shipped out; but the principal dependence is placed upon dried fruits (Pl. XLVIII) and upon alfalfa, which is used in fattening cattle that range throughout the year upon the mountains adjacent to the Salt River Valley and upon the plateaus of the northern part of the state.

The development of irrigation and the enlargement of the cultivated area is continuing up to the limit of the water supply, and many canals have been built or are projected to cover areas for which in ordinary seasons there is not sufficient water. In order to bring about economy, some of the ditches and canals have been consolidated, reducing the losses by seepage and evaporation. This is the first step in the evolution of a system of con-