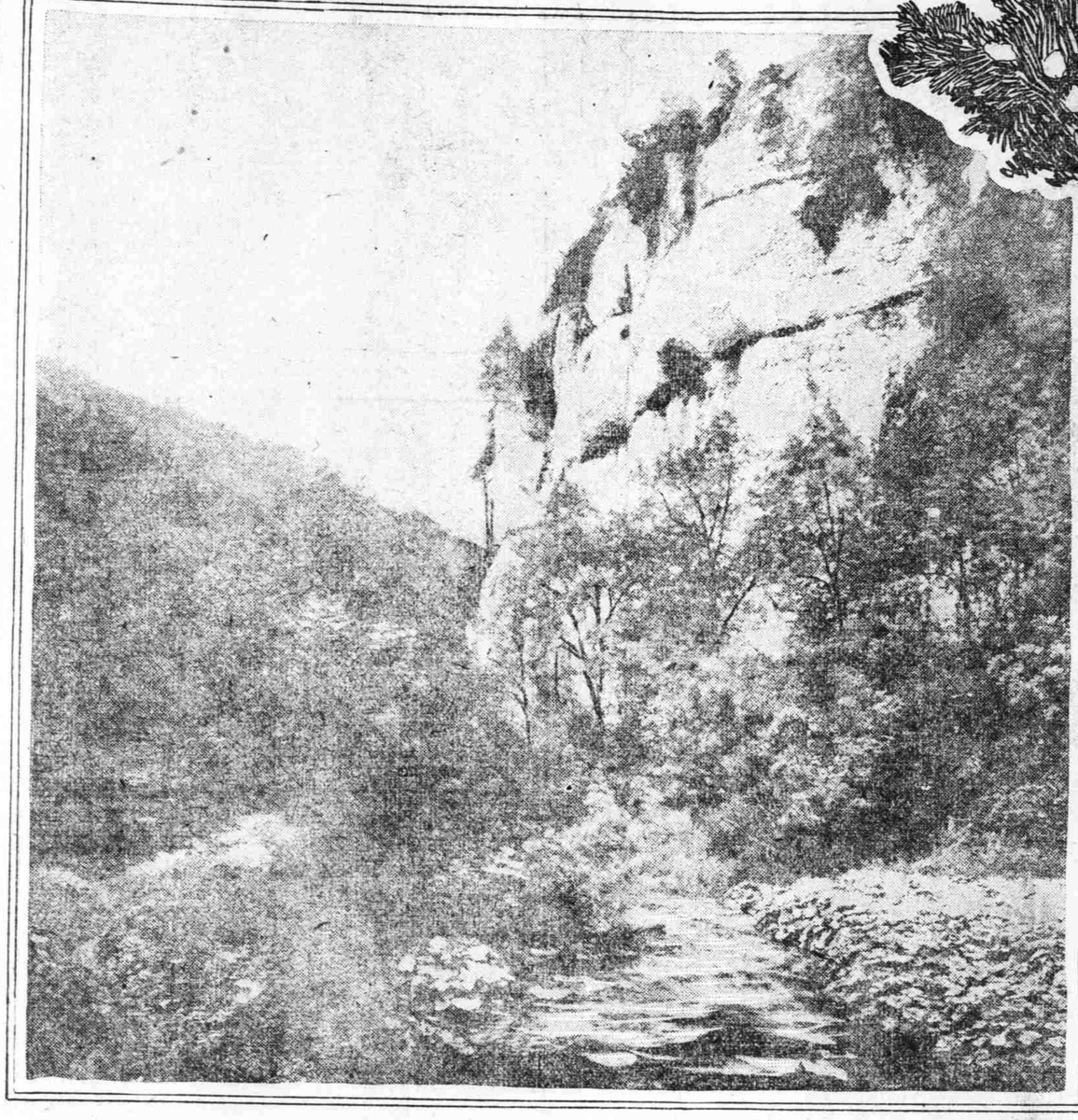
Irrigating THE SOUDAN

Making the Desert Bloom like a Rose



NATURAL RESERVOIR ON BLUE NILE FIFTEEN MILES OUT FROM LAKE TSANA

RUNNING AN ENGINEERING LINE ON NATURAL DAM WELL NEAR LAKE TSANA

EMPEROR MENELIK, WHO OWNS LAKE TSANA.

BERBER AFRICA JUNCTION OF BLUE AND WHITE NILES

LORD CROMER BRITISH PREMIER IN EGYPT.

The Soudan, where the English hero Gordon waited in vain the relief that Mr. Gladstone never sent—an error, by the way, that caused Mr. Gladstone to change from prime minister of the British Empire to a retired country gentleman in the neighborhood of Folkestone, Suffolk—is about to undergo a transformation from barren, shifting sands, more treacherous and less hospitable than the waves of the North Sea, to a veritable garden. A succession of harvests and pleasant reaches of cultivated fields will greet the traveler along that railway which Kitchener pushed from the junction of the Blue and the White Niles, straight across the sands to Khartoum, and there avenged the death of Gordon. In the Soudan, when it rains, the stolid Mohammedans fall on their knees and pray. Such events are told and retold from one generation to another. In other words, scientists calculate that it rains in the Soudan proper about once in every 100 years.

The transformation of the Soudan from an arid, sand-blasted desert to one of the most fertile countries of the world, it is expected, will require five years of hard labor, about $50,000,000, and a force of some 300 European engineers and overseers, and probably from 20,000 to 40,000 fellaheen. The tremendous change in the prosperity of Egypt is owing to the marvelous engineering which has enabled the British to dam the Nile in several places and by the construction of regulators to make it possible for the Valley of the Nile to secure a regular and certain irrigation. This means that the famines which enabled Joseph to gain the favor of the Pharaoh by his true Jewish forethought and commercial ability are now a thing of the past in Egypt. The lean and fat kine have been replaced in modern Egypt, under the sagacious ruling of Lord Cromer, who, in the name of the Khedive, rules Egypt and keeps in his embroidered pocket the great key to the Suez approach to India by a constant succession of well-fattened beeves. More than that, without vexatious taxation, the Egyptian fellah has been able to pay more than the interest of the bonds and stocks issued to secure the funds of the irrigation in Egypt proper.

But the Soudan, which is separated from Egypt by the lofty cliffs of the Nile Mountains, and which is really a strong depression which leads up to the slightly higher desert of the Sahara, presents a problem in irrigation far more difficult. Nevertheless, the engineers, who for years have been studying the possibilities of the Blue Nile in connection with irrigating the Soudan, have solved the question. Sir William Garstin, who is at the head of the department of irrigation in Egypt under Lord Cromer, after studying the reports made to him by Engineers C. E. Dupuis and P. M. Tottenham, has grouped the various engineering and scientific problems in connection with irrigating the Soudan under the following heads:

Open dam near Wad Medani, on the Blue Nile.

Dam and storage reservoir near Rosaires, on the Blue Nile.

River Gash irrigation.

Dam and storage reservoir near Khasm-el-Girba, on theAtbara River.

Storage reservoirs on the Dinder and Rahad Rivers.

Storage reservoirs on the Upper Atbara.

WHERE THE WATER COMES FROM.

The water, which it is proposed to store and gradually let drivel down during the dry season in the bed of the Blue Nile, actually descends from the heavens over a large section of Abyssinia. As a result the British fertilization of the Soudan practically and politically depends upon the consent of Emperor Menelik, the most potent barbaric and altogether crafty ruler of Abyssinia. Menelik withheld his consent for sometime. In the first place, the Soudan was the natural and providential guarantee against his future absorption into the maw of the British lion. With a cultivated and consequently populous and more or less civilized Soudan, Abyssinia would occupy the now historical and traditional post in British diplomacy of being the next natural and inevitable addition to the British Empire. However, Menelik has been worked on and bribed and lied to so thoroughly and so skilfully that his consent has been given, despite the counter-intriguing of the French Foreign Office. The key to the whole situation is Lake Tsana.

Lake Tsana is about the size of Lake Ontario and is the largest body of fresh water in North Africa. While not the chief source of the Blue Nile, which gushes through the Soudan five months in the year, and is merely a succession of shallow puddles the remaining time, it is the only possible hope of Soudan irrigation. And yet, now that it has been arranged with Abyssinia, the problem of irrigating the Soudan is in many ways an easy one. The Blue Nile has none of the terrific falls which plagued the engineers who arranged for the control of the real Nile.

Vast Quantities of Water Available

When calculating what the possibilities of Lake Tsana as a storage reservoir may be, it will be as well to note that the natural discharges of the Blue Nile are and what supplementing they will require at certain seasons. The flood discharge varies from 70,000 to 120,000 gallons a second, sufficient for all land within reach. If the Soudan abstracts so considerable a quantity of the flood as to affect the levels of the Nile in Egypt materially, this will be a matter of no consequence when all Egypt is converted to perennial irrigation. If it is not so converted, then Egypt must meet the situation by making dams to produce artificially the levels required, as the volume of the flood will be always more than sufficient. In high floods the retention of the flood levels will be a relief to Egypt. It is, therefore, evident that the flood supply is equal to all requirements, since a discharge of 20,000 gallons a second would fill 1,800,000 acres of basin in 30 days; though what the possible basin may become is one of those tilings which is not yet determined.

In winter the Blue Nile discharge shrinks from 4,000 to 2,000 gallons a second, or, in other words, from 350,000,000 to 270,000,000 gallons a day, sufficient for a million acres if the minimum discharge is used as determining the area, or for 1,500,000 acres if the average discharge is taken.

In summer the Blue Nile discharge at Khartoum may be anything between 2,000 gallons a second and nothing. In 1903 it fell to nothing. So that, without storage of water, summer crops cannot be grown by irrigation from the Blue Nile. And so comes the question of water storage and the consideration of the advantages offered by Lake Tsana as a reservoir.

The area of Lake Tsana itself is 3,000 square miles, and its catchment, exclusive of the lake area, is 14,000 square miles. The rainfall is three feet each year, falling almost wholly in the four months of June, July, August and September. The proportion of the rainfall that reaches the lake is 25 per cent. The outflow from the lake is calculated to be 80,000,000 gallons a day as an average for the year.

Calculating in the same way in the case of the White Nile lakes, we have the following:

	Gallons Each Year.
Quantity entering the lake..	65,720,000,000
Quantity discharged.....	29,240,000,000
Quantity evaporated.....	36,480,000,000

From the foregoing calculations it is evident that the effective reservoir capacity of the lake is 30,000,000,000 gallons, and it may fall to 20,000,000,000 in a year of scanty rainfall and rise to 50,000,000,000 in a year of abundant rain. Sir W. Garstin accepts the figures of 30,000,000,000 as probably obtainable. If, now, this total available volume is concentrated in the outflow of 100 days—a regulator, to be built at the outfall, being kept closed for the remainder of the year—the discharge obtainable would be 300,000,000 gallons a day, sufficient—allowing for loss on the way—for about 2,000,000 acres of land under perennial irrigation. But perennially irrigated lands should, for the sake of rotation of crops, have a supply of water available at all seasons. Now the natural winter discharge of the Blue Nile is, at its lowest, sufficient for 1,000,000 acres only. If then we make allowance for keeping up the Blue Nile discharge in winter to 3,000 gallons a second, so as to provide sufficient for a gross area of 1,500,000 acres, the quantity available for storage to use during the 100 days of summer will be reduced to 20,000 gallons and the gross area of land under perennial irrigation to about 1,500,000 acres, and this is, apparently, the maximum that the Soudan can expect from the Blue Nile and Lake Tsana. There may be other reservoir sites besides Lake Tsana still to be discovered on the Blue Nile itself or on its tributaries, but if favorable sites are found there is still to be solved the problem of filling them and at the same time of avoiding mud deposit in the reservoir.

WORK ON LAKE TSANA.

As regards the work necessary to convert Lake Tsana into a reservoir to store 30,000,000,000 gallons a regulator should be built on the outflow channel about 15 miles distant from the lake. The regulator would have 40 openings of nine feet each, with its floor sunk 12 feet below the high-water level in the lake; it would be capable of passing 200,000,000 gallons a day and would have to hold up six feet head of water. The rock bed above and below the regulator would have to be cut down for some distance to form the channels of approach and discharge. Were such a reservoir made, a dam near Wad Medani would also be necessary to provide for the distribution of the summer water to the lands lying in the Ghezireh, south of Khartoum, between the White and Blue Niles, and the lands on the right of the Blue Nile.

One of the great advantages of the system of basin irrigation, which is being built now in the Soudan, is that large areas can be cultivated with a very few laborers, and as the Soudan is one of the most sparsely populated portions of the earth, that will be a big point gained. The two great systems of irrigation are known as basin and channel irrigation. Basin irrigation is where the water is run off into basins some seven or eight miles apart, and from each basin some 40 or 50 square miles of territory are supplied with water, while in the channel irrigation the water simply runs down into little ducts or channels at the will of the farmers. The basin irrigation is more easily controlled and is under more even distribution, owing to its centralized method of handling the water, and in a decidedly lawless territory, such as the Soudon, the basin irrigation is far more practicable. At the same time both these systems can be carried on in the same territory. The basin system is more expensive, but the British engineers consider it the best for the Soudan for at least a century to come.

Immediately to the south of Khartoum a large number of basins are now being erected, which should irrigate about 1,000,000 acres on that side of the river, and also feed the flood channels of 1,000,000 acres which will be embanked and inundated every year in the upper Egypt basin system. These basin lands lie between Wad Medani, Shendy and Berber. The Blue Nile will be relieved of a portion of its labor after it reaches the Maroe Islands, where the Atbara River joins the Blue Nile and relieves somewhat the demand on the main stream of the Soudan.

The true agricultural future of the tracts adjoining the Blue Nile does not, however, lie in the direction of summer irrigation, but rather in the development of those crops which can be ripened during the summer months. The soil of the Gherizeh and of a large portion of the lands lying to the east of the river much resembles that of parts of Dakota, which produce the finest wheat. The soil of the two countries is very similar, but in the Soudan one important agent is wanting, viz.: a winter rainfall. Without this, winter crops cannot be raised, except in comparatively small areas adjacent to the river. Canal or basin irrigation must then be supplied as a substitute for the absence of rain in winter. Were this provided the Province of Sennaar and the southern portion of the Province of Khartoum might become one of the finest wheat-producing areas in the world.

Water in Winter Needed.

The winter discharge of the Blue Nile falls by the end of January or February amounts to 2,000 gallons a second, or about 170,000,000 gallons a day. Sir W. Garstin reckons that "such a discharge would be sufficient for the irrigation of 800,000 acres of winter crop at the least." Considering that 170,000,000 gallons a day is the discharge at the end of winter waterings in February, and that the discharge is some 40,000,000 a day in December, and some 30,000,000 a day in January, it would be safe to reckon the winter discharge of the Blue Nile sufficient for 1,000,000 acres. No attempt has been made by Sir W. Garstin to calculate what use could be made of the flood in filling basins and raising crops by inundation of the land during flood, as is done in Upper Egypt without any winter waterings.

To distribute the winter water, dams are being built similar to the great delta dam, with the usual distributing canals and works on both sides of the river. The work will begin with the irrigation of the northern portion of the Ghezireh and of those tracts on the eastern bank lying to the north of Wad Medani. Here the country is open and comparatively free from bush and forest. Moreover, from its vicinity to Khartoum and the railway, it would appear to lend itself to improvement more than do the remoter areas to the south. This dam is being constructed at the point where the Rahad River joins the Blue Nile, so that the east bank canal will be carried down to the north, without having to cross any stream of importance. In fact, the engineers are solving the identical problem which faced Ismail Pasha's engineers, who were called upon to provide for the irrigation of the Khedive's sugar-cane estates in Middle Egypt, alongside a chain of basins; a problem they solved without the help of a dam on the river, as the existence of the corvee or unpaid labor system overcame the difficulty of want of ready money to pay for the large amount of earthwork excavated. They dug the Ibrahimia Canal, with a head open to the river, and at Derut, 40 miles from Assiout, they constructed regulators to distribute the water between the basin feeders and the perennially flowing canals. The dam and Ibrahimia Canal head at Assiout, lately constructed, completed the scheme which is now serving as a model for the Blue Nile project.

Lord Cromer, in a recent interview with the writer, figures out that the dams and locks of the entire Soudan system will cost $7,000,000, while the canals and basins will cost $30,000,000. The necessary bond issues for commencement of the work, amounting to $10,000,000, were all absorbed in London and New York about 18 months ago at a very fair figure. The interest is at a little over 4 per cent., while Lord Cromer declares that, managed in the same fashion as the irrigation of Egypt proper, at the end of 10 years the revenues derived from the Soudan irrigation should pay a little over 10½ per cent. on the investment, thus leaving a clear 6 per cent. to be poured into the sinking funds under Lord Cromer's control. The working out of these irrigation problems in Egypt have been the financial and human salvation of the country. Under Ismail Pasha the financial condition of Egypt could not have been worse.

What We Will Do in the West.

The American people have a somewhat similar problem for them in the great West, which has already assumed the attitude of a national question, both the recent political platforms having declared in favor of prompt aid for the arid lands in the West. Humanity in general has become so accustomed to considering that what nature does is best that it is difficult to convince the average American that farming where irrigation is intelligently applied is far more profitable and less laborious. The arid lands of the West when properly irrigated will undoubtedly form the garden spot of the continent. The taxes for the water can be absolutely relied on to be less than the losses from drouth or too heavy rainfall or from frost and hail in territories which depend on a natural water supply.

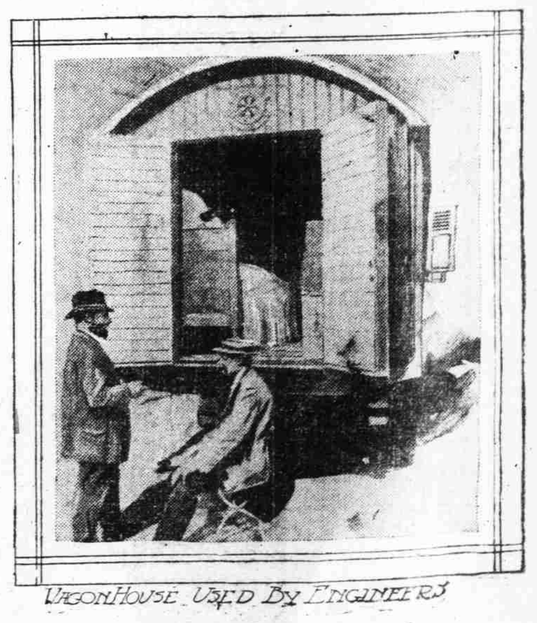
The first great undertaking in the irrigation line in the Soudan problem was, of course, the construction of the first dam, 16 miles south of where the Blue Nile flows out of Lake Tsana. At this point the Blue Nile is slightly over a mile and a half in width, and just after it leaves the body of the lake it has a very heavy fall and for a greater portion of its course a rocky bed. This means that the engineering difficulty should not be as severe as in the main Nile, where the great dam had to be constructed on a softer bottom, entailing deep excavations for a proper bed. Moreover, the sides of the dam near Lake Tsana are formed of strong rock-ribbed strata, which saves an immense amount of concrete and granite construction. The loss of water, therefore, will be comparatively small, leakage being almost out of the question, and when the system of locks is finally constructed in the river bed between Rosaries and Khartoum the canals will carry off the water on either side. Thus a summer irrigation of Ghezireh and of the eastern provinces will be easily and simply effected. Supplementary storage reservoirs will be built wherever the small rivers of the Soudan flow into the Blue Nile. The Atbara situation has already been explained, and similar reservoirs are being built for the Dinder and Rahad Rivers.

TO BE COMPLETE BY 1910.

By 1910, then, at the latest, the fields of the Soudan should be green with millet and corn, while the most important crop is expected to prove the fine Egyptian cotton, which excels the American product, and may yet make Egypt one of the wealthiest countries in the world. France now realizes more bitterly than ever the importance of the Fashoda incident. Driven back from the upper end of the Soudan, too wise to attempt to coerce Abyssinia where Menelik dashed the hopes and slaughtered the soldiers of Italy, France may now definitely see the restriction of her African influence to that almost worthless strip of land edging the Southern Mediterranean coast. With an irrigated Soudan one finds inevitably an irritated France, but while France may prove irritable, she will hardly prove intractable.

The spending of what will total $50,000,000 in forcing the waters of Lake Tsana to hold their dashing forces and to gently ripple as the need arises over the sands of the Soudan is undoubtedly a political triumph for Great Britain, yet to the world at large and the Soudanese in particular the constant encroachment of Great Britain, however prompted by a selfish absorption of territory, can only prove an unalloyed blessing. The triumph of the Briton in Africa is merely a case of the survival of the fittest. A study of British methods in Egypt is now already being made by several of our finest engineers, under the direction of the State Department at Washington.

In British hands the spade and ploughshare inevitably succeed the sabre and the rifle. The picture of the undaunted and abandoned Gordon holding his mud-walled citadel in Khartoum in 1880, dying finally upon the savage spears of the Mullah's Arab horsemen, is slowly but surely fading to give place to a Soudanese landscape of rose gardens and fields ripe for the harvest. Certainly the fairy tales of the future will be those created by that modern magician—the engineer; those engineers who now boldly attack a continent and change the face of nature as moulded thousands of years ago.



WAGON HOUSE USED BY ENGINEERS