

PERENNIAL IRRIGATION IN EGYPT.

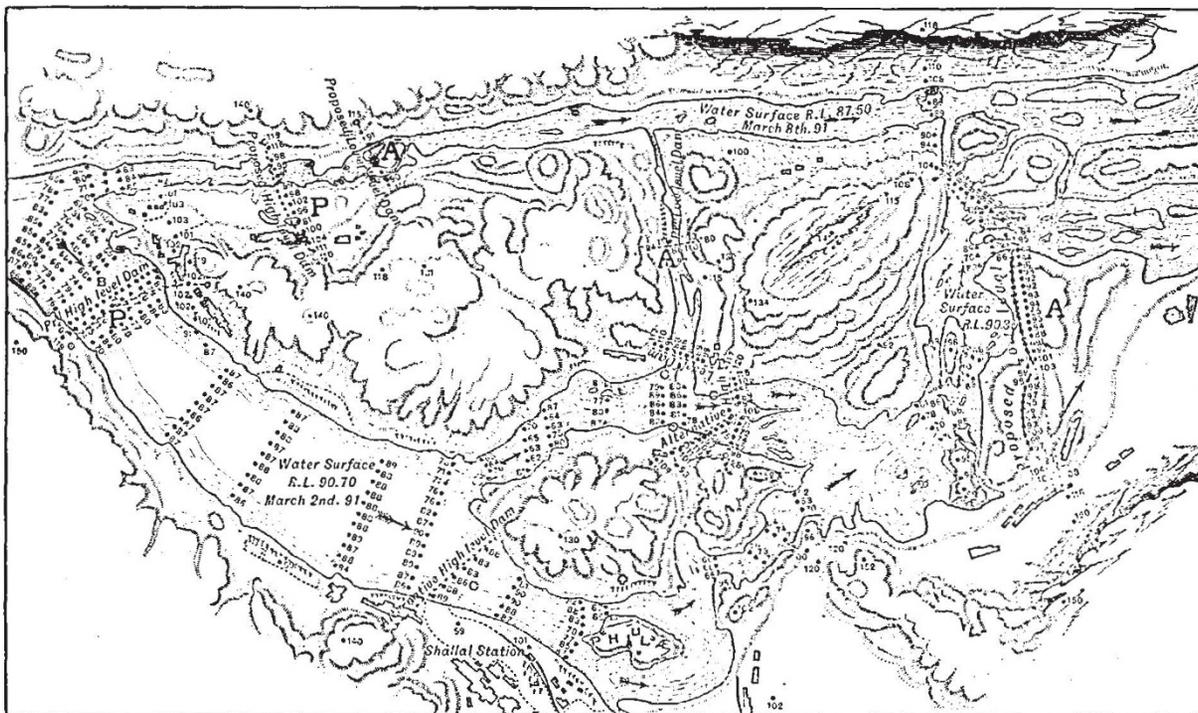
THE "Report on perennial irrigation and flood protection for Egypt," by Mr. Willcocks, brings us face to face with one of the most stupendous applications of science of modern times, and it is to be regretted that in consequence of the tardy arrival of the report and plans in this country, and of the general interest having been directed to a side issue, both the vastness of the scheme and the completeness and admirable method of the preliminary studies have received scant recognition.

Everybody is familiar with the saying of Herodotus that Egypt is the gift of the Nile, but only few are familiar with the conditions of the river, which are thus tersely stated in one of the appendices to the report. "The Nile drains nearly the whole of North-Eastern Africa, an area comprising 3,110,000 square kilometres. Its main tributary, the White Nile, has its sources to the south of Lake Victoria, and has traversed over 3500 kilometres before it is joined by the Blue Nile at Khartoum.

Taking the years since 1873 the mean of the minimums (which vary between May 14 and June 24) was -0.08 of the gauge; the mean of the maximums (which vary between August 20 and October 1) is 8.17. The Nile flood level at Assuân is then roughly 27 feet above average low water. The water therefore passing over the cataract varies enormously in quantity at low and high Nile; we have in an average of 20 years 440 cubic metres per second in May, 9170 in September.

Finally, of all this water which passes Assuân in such varying quantities at different times of the year, the total yearly average quantity being equal to 2990 cubic metres per second, 370 disappear before Cairo is reached, where the discharge is 2610 cubic metres per second; of this again 550 cubic metres are absorbed for the irrigation of Lower Egypt, so that 2060 cubic metres reach the sea each second, or 65,000,000,000 each year.

The rainfall as stated, treated as it is in Egypt at the present day, gives us the land area under cultivation, the number of crops per annum, and the quantity of produce



The Front Cataract at Assuân, showing the Dams proposed. P P, Philæ; A A A, Assuân.

From the junction onwards the river is known as the Nile, and after a further course of 3000 kilometres flows into the Mediterranean Sea by the Rosetta and Damietta mouths. The modulus of the Nile at Assuân is 2990 cubic metres per second, and at Cairo 2610 cubic metres per second.²⁹

The total mean annual rainfall in the Nile valley, including the desert north of Khartoum, amounts to 2,633,000,000,000 cubic metres. This water is brought to the main stream by the White Nile in a pretty constant quantity all the year round, but the river is liable to an annual flood which is due to the Saubat, the Blue Nile and the Atbara. Leaving out of consideration the accidents of the river above Assuân, we may state that at that place is the last of a series of cataracts, and also is a gauge by which the various heights of the river at different times of the year and in different years are recorded. The gauges are in metres, and are referred to mean low water level as zero. The zero at Assuân is 85 metres above the level of the Mediterranean.

on which the revenues of the country, and the food of the inhabitants, depend.

The question which has occupied the Egyptian engineers of late years has not been whether waste lands can be brought into cultivation and the agricultural yield increased if there were more water—that has long been obvious—but *how much* water was wanted in the worst years. Other questions were, whether the amount was available in the river, and at what period. First as to the amount wanted:—

		Area in feddans. ¹	Water wanted in cubic metres.
Upper Egypt	Assuân	1,200,000	1,160,000,000
	Assyût		
Middle Egypt	Assyût	1,200,000	950,000,000
	Cairo		
Lower Egypt	Cairo	2,810,000	1,551,500,000
	Sea		

¹ A feddan = $\frac{4200}{4047}$ of an acre.

The water requirement, then, is 3,661,000,000 cubic metres. We have already seen that 65,000,000,000 reach the sea each year. But it is not enough to know this yearly amount, we require to know the amount available after the flood each year. Taking the worst, Mr. Willcocks shows that the quantity available for storage in November, December, and January amounts to 6,100,000,000 cubic metres, practically twice the quantity wanted.

Next the water has to be stored above the place where it is wanted. Since the southern boundary of Egypt is below the second cataract that is out of the question; the only three possible sites for the dam are at Kalabshch, Assuân, and Silsila. And now a very important question comes in: the slope of the Nile, except at the cataracts, is so gradual that holding up water to any height by a dam will flood a long reach of the river valley up stream of the dam. The dam must be high to store a sufficient amount of water, and naturally the higher the dam the longer will be the flooded region. Thus a dam at Silsila submerges the whole valley to the first cataract including the town of Assuân. A dam at Assuân floods the valley up to Korosko (199 kilometres); a dam at Kalabshch floods the valley still further south.

It is to be gathered from Mr. Willcocks' report, and Mr. Garstin's (the Under-Secretary) note upon it, and the recommendation of the Technical Commission, the English and Italian members of which were Sir B. Baker and Signor Torricelli, that the Assuân site is the best. The foundations of the dam can be built in the dry and on hard igneous rock. The estimated cost of the dam is a little over £1,600,000.

The proposed dam is thus described by Mr. Willcocks: "The design for the work consists of a solid unsubmergible dam pierced with 100 undersluices 10 m. x 2 m., and constructed on solid rock. The piers between the undersluices are 3 metres wide, and every set of ten sluices is separated from the next by abutment piers 10 metres in width." The undersluices are regulated by Stoney's patent balanced roller gates.

The dam will be worked as follows: During the flood all the sluices will be open, and the flood waters, with all their contained fertilising mud, will be discharged through the undersluices. When the flood has passed, and the comparatively clear water supply has begun to flow, the lower undersluices will be gradually closed so that the water will begin to rise and flow through the higher sluices. When the water has risen to a height 3 or 4 metres above the floors of the higher sluices, or 10 or 11 above the floors of the lower ones, the latter will be entirely closed, and the river will discharge through the upper sluices, which will be gradually closed until the water gains its full level.

When the reservoir is emptied the reverse process will be followed, the higher sluices will be opened first, and then the lower ones, until the time is reached when the next annual flood is due.

It is next of importance to see how this stupendous scheme bears upon Egypt financially. It is pointed out that the value of the reclaimed lands may be estimated roughly at £46,000,000, the increase in the value of yearly rental at £3,700,000, and of the yearly produce £12,000,000.

It will be perfectly clear that if only half of these values are realised the scheme will work wonders for the prosperity of Egypt, and that it would be a crime not to go on with it.

Rests then the great drawback, that wherever the dam is erected a portion of the up-stream valley will be swamped. All the world has heard of the possible drowning of Philæ provided the dam be built at Assuân. But this cry could scarcely have been started by archaeologists, for as a matter of fact Philæ is only one temple site out of very many lying between Assuân and Korosko. Since

none of them have been completely explored, it is hazardous to state that it transcends the others in scientific importance, although certainly it is uneclipsed as a beautiful spot.

The ruins besides Philæ threatened with destruction have thus been stated by Mr. Somers Clarke in a letter to the Society of Antiquaries:—

"The dam will create a reservoir of enormous extent, not only drowning the island of Philæ, but extending southward into Nubia for nearly a hundred miles. When full the waters of the reservoir will rise several feet above the highest level of the pylon of the Temple of Isis at Philæ. The rocks surrounding the island are full of hieroglyphic inscription; these will spend many months under water, and there is yet much to be discovered in the immediate neighbourhood. At Debôt is a Ptolemaic temple, which retains its original girdle-wall, three great standing doorways, the first being the entrance through the girdle-wall, the second being the doorway in a ruined pylon, and the third standing more immediately before the temple. At Diinri are the remains of ancient structures still to be explored. At Kertassi there is, in fair preservation, a small hypæthral temple with Hathor-headed columns; a little south are extensive quarries, part of the surfaces covered with graffiti, chiefly Greek votive inscriptions. Surrounding the village of Kertassi is a great wall enclosure. At Tafch a small temple, very perfect, is still standing in the middle of the village, and near it are some remarkably interesting specimens of Roman masonry, but built in the Egyptian manner. They are the lower parts of houses, rectangular structures with their internal subdivisions still to be traced. At Kalabshch is the most magnificent structure in Lower Nubia. Overhanging the Nile are the remains of a grand quay pierced by two stairways leading on to a great platform. On this is a long terrace of approach from which we rise to another terrace, parallel with the course of the river and lying in front of the pylon. The walls of the temple are very perfect, the roofs only having fallen in. Surrounding the temple is a girdle-wall of masonry. The entrance court of the temple is full of graffiti of the greatest historic interest, and between the crannies of the fallen masonry can be seen many more now inaccessible. At Abu Hor are ancient remains and a quay standing by the river side; a place that needs careful exploration. At Dendûr are the remains of a temple dating from Roman times. The names of many native gods and princes are carved upon the walls. At Koshtemneh are the ruins of a great brick fort, and in one corner of it are the bases of the temple columns. At Dakkeh is a particularly interesting temple. Stones of an early building of Thothmes III. and Seti I. have been found, but the existing structure was begun under Egamenes, a native king, and completed under a Roman emperor, presumably Augustus. The pylon is absolutely perfect. This building would be engulfed. At Kobban, opposite Dakkeh, are the remains of a very large rectangular fortress of Egyptian crude brick, some 370 by 350 feet. The remains of a temple of the middle empire can be traced, and outside are the remains of temples of the XIXth dynasty. At Maharakah are the ruins of a very late temple. Its plan is unique. In addition to the places above mentioned there are traces of buried towns and of tombs in great abundance. The whole of these things will be submerged, and the inhabitants transported I know not where."

It has been stated by some that the destruction of these various memorials of antiquity has been regarded by the Egyptian engineers with absolute indifference. It is only just therefore to print the following extract from Mr. Garstin's note dated December 27, 1893, referring to the Assuân dam:—

"Unfortunately, with every advantage in its favour as to volume of water stored, soundness of foundation, and economy of construction, this site labours under the objection (which I fear may be found insuperable) of having Philæ temple on its up-stream side. No dam could be constructed on the cataract without inundating a great portion of this temple for several months every year. I agree with Colonel Ross that no project, which had this effect, should be admitted, unless it were impossible to find a reservoir site elsewhere. We cannot say that there are no other possible sites. There are Kalabshch, Philæ, and Gebel Silsila, which are all available, and we cannot therefore claim that if a dam has to be built, it must necessarily be

built at the head of the first cataract, and drown the temple of Philæ.

"Admitting this fact to the full, I still consider the Assuân site to be so superior to any other, that if any means could be found for obviating the difficulty which attaches to this temple, I think the subject well worth the consideration of the Egyptian Government, even although it involved additional cost to the project. On p. 36 of his report, Mr. Willcocks suggests the possibility of removing the temple of Philæ from its present site, taking it up stone by stone, and rebuilding it on the adjacent island of Bighè, where it would be well above the highest water level of the reservoir. I cannot say whether it would be possible to do this without injury to the temple. If so doing would cause any injury, or alteration of any kind to it, I should recommend the abandonment of the Assuân dam altogether. Any work which caused either partial damage to, or the flooding of this beautiful temple, would be rightly considered by the whole civilised world as an act of barbarism. Moreover, it would be an act not absolutely necessitated by the circumstances, for I repeat that we have other possible, though somewhat inferior, sites upon which to construct dams.

"If the removal of Philæ temple is, however, only a question of expenditure, the subject at once commands attention. In this matter I turn naturally to Mr. T. de Morgan, the able Director of the Department of Antiquities in Egypt. If it is possible to remove the temple, and rebuild it upon the adjacent island exactly as it stands at present, we may rely on his ability to do so; and I ask that his opinion as to the removal and reconstruction of Philæ temple be obtained before the project for the Assuân dam be altogether rejected.

"Were the removal of the temple to be successfully carried out, I cannot myself see that it would be an act of vandalism, which, as I read it, is a term meaning the wanton destruction of interesting relics. In this case there would be no question of wanton destruction. The Government of Egypt would duly weigh on one side, the advantages to the country of the safest and most economical dam which could be constructed north of Wady Halfa, and, on the other, the sentiment which clusters round the site of the present temple, and objects to its removal even if it could be done without injury. Finding the advantages to the country to outweigh the sentiment, it would proceed to carry out the work with a religious regard for every detail, and through the agency of the competent staff of the Department of Antiquities.

"Removals somewhat similar to that now proposed have been successfully carried out. Mr. Willcocks mentions in his report having himself, when at Rome, been a witness to the dismantling and rebuilding of the most ancient existing bridge over the Tiber by Italian engineers. Civilised nations in recent times have removed from their original sites, and set up in other countries, interesting and valuable monuments. The Elgin marbles taken from the Acropolis and deposited in the British Museum, afford an example, and so also do the Luxor obelisk in the Place de la Concorde, and Cleopatra's needle on the Thames Embankment. These records of the past have been removed from their historical surroundings, and set up amongst others with which they are not in keeping. We, on the contrary, prompted by a desire to benefit the country, suggest the removal of an ancient building from one site on the Nile to another which is but a few hundred yards distant. We propose re-erecting it exactly as it stands to-day, and on an island in the middle of the great lake which we hope to create, where it would form a beautiful and appropriate object in the landscape."

To us it seems clear that with such a case as the Egyptian engineers have made out for the increased water supply, it is certain that a dam will be built somewhere, and, to be more precise, unless the frontiers of Egypt are enlarged, between Wady Halfa and Assuân. Assuân, Philæ, and Kalabsheh have each been suggested, and in either case the memorials of antiquity along a long reach of the river will be necessarily destroyed. This being so, there is room for an attempt to carry to a completion the work begun by the French Expedition of 1798, and continued by Lepsius in 1844, by making an English survey of the Nile between Philæ and Wady Halfa. Archæologists associated with engineers in such a work as this would certainly be a more pleasant sight to gods and men than when indulging in charges of

"vandalism" and the like; and be it remembered no amount of money voted by Parliament, or by the Egyptian Government, no munificence of archæologists and others, with a view of dealing with the case of Philæ alone, will be of avail in final mitigation if a dam is to be built *anywhere*. To consider Philæ alone would convict us of a philistinism by the side of which the "vandalism" of the engineers were small indeed! On the other hand, when such a survey as that suggested has been completed; when what Maspero has called *l'histoire matérielle* of every temple has been investigated; every inscription copied, and every detail photographed, dam or no dam we shall be infinitely better off from the scientific point of view than we are now or should have been for the next century, if the question of the dam had not been raised.

J. NORMAN LOCKYER.

THE CENTENARY OF THE PARIS POLYTECHNIC SCHOOL.

THE hundredth anniversary of the foundation of the Polytechnic School of Paris was celebrated on the 17th, 18th, and 19th of May.

The 17th, consecrated to the memory of our comrades, comprised, in the morning at 10.30, a visit to the tomb of Monge M. Mercadier, Director of studies at the Polytechnic School, pronounced Monge's eulogy, and deputations from the Institute, &c., assisted him. At 2.30 the President of the Republic visited the school and examined the pupils. M. Faye made a speech recalling different events of the school. Then a tablet was put up to the memory of the comrades killed by the enemy a century ago. The 18th was the "cérémonie des ombres." Lastly the *fête*, which took place on the 19th at the Palais de Trocadéro, constituted, independently of its programme, a special attraction, as *fêtes* had never previously been given at night in the immense and magnificent hall. From 10 o'clock to midnight more than 5000 people took part in the gala entertainment, which was followed by a ball.

The palace and Trocadéro Park were brilliantly illuminated. The entertainment consisted almost entirely of compositions by old pupils of the school. It ended with an apotheosis by M. A. Silvestre, during which a remarkable picture, consecrated by M. Dupain to the glory of the school, was uncovered.

The eulogy on Monge, pronounced by M. Mercadier, was of great eloquence. Monge was, as a child, very remarkable. When sixteen he made a plan of his native town, having invented an instrument for determining angles. At the age of twenty-two he had already invented many things. With the aid of an engineering officer he got into the Engineering School at Mézières, where in 1768 he succeeded Bossut as professor of mathematics, and two years later, Nollet in a course of physics.

He published his great works on "Les Surfaces considérées d'après leur mode de génération" in the *Mémoires de l'Académie de Turin*. The illustrious Lagrange, after reading them, exclaimed "Avec son application de l'analyse à la représentation des surfaces, ce diable d'homme sera immortel!" "Ce diable d'homme" was but twenty-five, but—true to prophecy—made himself immortal.

In 1780 Monge was made professor of hydraulics; at the same time he entered the Academy of Sciences in the mechanical section. He lived six months in Paris, then six months at Mézières, but in 1783, on being made naval examiner, he returned to Paris for good.

He was an ardent revolutionist, and was made Minister of that department in 1793, during which time he unconsciously made a true friend of Buonaparte. In 1794 he helped to found the school in which he was a devoted professor.