N° 2103.

GRANDE-BRETAGNE ET IRLANDE DU NORD ET EGYPTE

Echange de notes relatif à l'utilisation des eaux du Nil pour les besoins de l'irrigation. Le Caire, le 7 mai 1929.

GREAT BRITAIN AND NORTHERN IRELAND AND EGYPT

Exchange of Notes in regard to the Use of the Waters of the River Nile for Irrigation Purposes. Cairo, May 7, 1929.

No. 2103. — EXCHANGE OF NOTES BETWEEN HIS MAJESTY'S GOVERNMENT IN THE UNITED KINGDOM AND THE EGYPTIAN GOVERNMENT IN REGARD TO THE USE OF THE WATERS OF THE RIVER NILE FOR IRRIGATION PURPOSES. CAIRO, MAY 7, 1929.

Textes officiels anglais et français communiqués par le Secrétaire d'Etat aux Affaires étrangères de Sa Majesté en Grande Bretagne. L'enregistrement de cet échange de notes a eu lieu le 26 juillet 1929.

No. 1.

MOHAMED MAHMOUD PASHA TO LORD LLOYD.

PRÉSIDENCE
DU CONSEIL DES MINISTRES.

CAIRO, *May* 7, 1929.

EXCELLENCY,

In confirmation of our recent conversations, I have the honour to communicate to your Excellency the views of the Egyptian Government in regard to those irrigation questions which have been the subject of our discussions.

The Egyptian Government agree that a settlement of these questions cannot be deferred until such time as it may be possible for the two Governments to come to an agreement on the status of the Sudan, but, in concluding the present arrangements, expressly reserve their full liberty on the occasion of any negotiations which may precede such an agreement.

2. It is realised that the development of the Sudan requires a quantity of the Nile water greater than that which has been so far utilised by the Sudan. As your Excellency is aware, the Egyptian Government has always been anxious to encourage such development, and will therefore continue that policy, and be willing to agree with His Majesty's Government upon such an increase of this quantity as does not infringe Egypt's natural and historical rights in the waters of the Nile and its requirements of agricultural extension, subject to satisfactory assurances as to the safeguarding of Egyptian interests as detailed in later paragraphs of this note.

3. The Egyptian Government therefore accept the findings of the 1925 Nile Commission, whose report is annexed hereto, and is considered an integral part of the present agreement. They propose, however, that, in view of the delay in the construction of the Gebel Aulia Dam, which, under paragraph 40 of the Nile Commission's Report, is regarded as a counterpart of the Gezira scheme, the dates and quantities of gradual withdrawals of water from the Nile by the Sudan in

flood months as given in article 57 of the Commission's Report be modified in such a manner that the Sudan should not withdraw more than 126 cubic metres per second before 1936, it being understood that the schedule contained in the above-mentioned article will remain unaltered until the discharge of 126 cubic metres per second is reached. These quantities are based on the Nile Commission's Report, and are therefore subject to revision as foreseen therein.

4. It is further understood that the following arrangements will be observed in respect of irrigation works on the Nile :

(a) The Inspector-General of the Egyptian Irrigation Service in the Sudan, his staff, or any other officials whom the Minister of Public Works may nominate, shall have the full liberty to co-operate with the Resident Engineer of the Sennar Dam in the measurement of discharges and records to satisfy the Egyptian Government that the distribution of water and the regulation of the dam are carried out in accordance with the agreement reached. Detailed working arrangements agreed upon between the Minister of Public Works and the Irrigation Adviser to the Sudan Government will take effect as from the date of the confirmation of this note.

(b) Save with the previous agreement of the Egyptian Government, no irrigation or power works or measures are to be constructed or taken on the River Nile and its branches, or on the lakes from which it flows, so far as all these are in the Sudan or in countries under British administration, which would, in such a manner as to entail any prejudice to the interests of Egypt, either reduce the quantity of water arriving in Egypt, or modify the date of its arrival, or lower its level.

(c) The Egyptian Government, in carrying out all the necesary measures required for the complete study and record of the hydrology of the River Nile in the Sudan, will have all the necessary facilities for so doing.

(d) In case the Egyptian Government decide to construct in the Sudan any works on the river and its branches, or to take any measures with a view to increasing the water supply for the benefit of Egypt, they will agree beforehand with the local authorities on the measures to be taken for safeguarding local interests. The construction, maintenance and administration of the above-mentioned works shall be under the direct control of the Egyptian Government.

(e) His Britannic Majesty's Government in the United Kingdom of Great Britain and Northern Ireland shall use their good offices so that the carrying out of surveys, measurements, studies and works of the nature mentioned in the two preceding paragraphs is facilitated by the Governments of those regions under British influence.

(f) It is recognised that in the course of the operations here contemplated uncertainty may still arise from time to time either as to the correct interpretation of a question of principle or as to technical or administrative details. Every question of this kind will be approached in a spirit of mutual good faith.

In case of any difference of opinion arising as to the interpretation or execution of any of the preceding provisions, or as to any contravention thereof, which the two Governments find themselves unable to settle, the matter shall be referred to an independent body with a view to arbitration.

5. The present agreement can in no way be considered as affecting the control of the river, which is reserved for free discussion between the two Governments in the negotiations on the question of the Sudan.

I avail, etc.,

M. MAHMOUD,
President Council of Ministers.

ENCLOSURE IN N° 1.

Nile Commission, 1925.

REPORT.

CONTENTS.

[1] Not reproduced.

CHAPTER I.

INTRODUCTORY.

The appointment of the Commission arose from an exchange of notes dated the 26th January, 1925, between His Britannic Majesty's High Commissioner for Egypt and the President of the Egyptian Council of Ministers, in which it was agreed that a Commission should be appointed " for the purpose of examining and proposing the basis on which irrigation can be carried out with full consideration of the interests of Egypt and without detriment to her natural and historic rights. " [1]

2. The following were appointed members of the Commission :

Mr. J. J. Canter CREMERS, *Chairman.*
Mr. R. M. MACGREGOR, British Delegate.
Abdel Hamid SOLIMAN Pasha, Egyptian Delegate.

The Commission was called upon to report by the 30th June, 1925.

The Chairman arrived in Egypt on the 16th February, and the first meeting was held on the following day.

Mr. W. Allard, of the Egyptian Irrigation Department, was appointed Secretary.

3. After preliminary discussions and visits to the Delta Barrage and the offices of the Physical Department, the Commission was able to lay its plans and to define the general lines of statistical examination. It next visited the sadd near Edfina, which is made annually to close the mouth of the Rosetta branch of the Nile ; and then proceeed on a tour of inspection up the Nile, including the Sennar Dam and the canalisation works of the Sudan Gezira, the site of the proposed Gebel Aulia Dam, the Aswan Dam, the Isna Barrage, the site of the proposed Nag-Hamadi Barrage, and the basin systems in the vicinity of Sohag.

4. During the course of its sittings in Cairo and its tours of inspection, the Commission examined many of the records of the Physical and Irrigation Departments, and obtained by interviews the opinions of various officials, both in Egypt and the Sudan, on subjects connected with its task. On its return to Cairo at the end of March, the Commission applied itself to an examination of the statistics as they became available, calling from time to time for such further data as the progress of the enquiry rendered necessary.

[1] See Notes reproduced at Appendix A.

5. The Commission agreed at the outset of its deliberations that decisions arrived at during the examination of the problem, point by point, should in the first instance be provisional and subject to review at a later stage when it became possible to envisage the problem as a whole. By the early part of May most of the ground had been covered, and a large measure of agreement had been reached. On certain points further statistical information was still awaited. It was decided at this stage that further progress would be facilitated by the preparation of a draft report embodying the conclusions so far reached, and it was arranged that the two delegates should prepare separate drafts, from which, with the assistance of the Chairman, the final draft would be compiled.

6. At this juncture, the Chairman's health began to cause anxiety, and he found it increasingly difficult to take part in the work of the Commission. On the 21st May his indisposition took a graver turn, and it was realised that he was seriously ill. For some weeks there was every hope of his recovery, but most unhappily and to the great grief of his colleagues, he died on the 21st June. The British and Egyptian delegates take this opportunity of placing on record their appreciation of the high professional and personal gifts of their late colleague and their sense of the loss sustained by the Commission over which he had so ably presided, and by the engineering profession in general, through his untimely death.

7. The Chairman's illness necessitated the temporary adjounrment of the Commission at a time when its task was within measurable distance of completion, and his subsequent death obliged the two Governments to consider the most appropriate course to follow in these unforeseen circumstances. The delegates meanwhile had returned to their normal duties. In view of the progress that had already been made, and the desirability of completing the work, the two Governments eventually instructed their respective delegates to resume the studies, so unhappily interrupted, and to present their Report.

8. The remaining statistical information having been obtained, the two delegates reviewed the alternative drafts already prepared ; and finding no reason to depart substantially from any proposals common to both of them, they proceeded to compile this agreed Report, which they believe would have met with the approval of their late Chairman.

CHAPTER II.

Descriptive and General.

Previous History.

9. After the re-establishment of order in the Sudan, as a result of the campaign of 1896-98, a demand arose in the Sudan for the erection of pumps for irrigation on a small scale ; and, with the approval of the Egyptian Government, certain areas of land were given pumping rights. The area under permit was increased from time to time, as explained in detail in a later paragraph, some pumps being installed to test the possibilities of cotton growing, and others for the purpose of producing food grains at a time of scarcity during the war. The area now under irrigation in this way is inconsiderable, amounting to less than 40,000 feddans, of which rather more than half is licensed for perennial irrigation, the remainder being restricted to the flood season. An area of some 80,000 feddans in the Northern Sudan has been formed into basins, but, owing to the high levels of the land, they are only partly filled, even in years of high flood.

10. The greater part of the culturable land of the Sudan either possesses an adequate rainfall or is inaccessible by canals. The only considerable area suitable for canal irrigation is the triangular tract between the Blue and White Niles with its apex at Khartum and extending as far south as the Sennar-Kosti Railway. From 1905 onwards the possibility of irrigating some portion of this area had been under consideration ; and in 1913 a scheme was prepared for the irrigation of 100,000

feddans by means of a canal fed from the natural flow of the Blue Nile, the required levels being given by a barrage at Makwar. It was then believed that such a scheme would permit of the cotton crop being matured without detriment to Egyptian interests. Further experience of agricultural conditions, however, and the occurrence of the exceptionally low river of 1913-14, showed that this was impossible, and that the scheme should comprise a storage dam, and not merely a diversion barrage. With the addition of a reservoir for the storage of water abstracted from the natural flow during the flood season, it was calculated that the area could be increased to 300,000 feddans without the need for taking water from the river at low stage, and that such an increase of area was necessary to off-set the extra cost of the dam. The scheme was recast on these lines, but progress was interrupted by the war.

11. Simultaneously, the Egyptian Government had been considering the construction of a dam on the White Nile at Gebel Aulia, near Khartum, for the dual purpose of controlling high floods which threatened damage to Egypt, and of storing water for use during the summer season in Egypt. This scheme was also delayed by the war, though some work was actually executed during the years 1917-20.

12. The resumption of progress on both of these projects after the war was accompanied by vigorous public discussion and criticism in Egypt, directed chiefly against the accuracy of the data on which they were based. As a result of this the Egyptian Government in January 1920 appointed a Commission of Enquiry, known as the Nile Projects Commission, composed of three members, nominated by the Government of India, the University of Cambridge and the Government of the United States. The terms of reference to the Commission were as follows :

> The Commission is requested to give to the Egyptian Government its opinion of the projects prepared by the Ministry of Public Works with a view to the further regulation of the Nile supply for the benefit of Egypt and the Sudan. In particular, the Commission is requested :
>
> *(a)* To examine and report upon the physical data on which the projects are based.
>
> *(b)* To report upon the propriety of the manner in which, as a result of these projects, the increased supply of available water provided by them will be allocated at each stage of development between Egypt and the Sudan.
>
> *(c)* To advise as to the apportionment of the cost of the proposed works and of this enquiry as between Egypt and the Sudan.

The projects were those described in a publication of the Egyptian Government entitled " Nile Control ", and comprised the two dams already mentioned, a barrage in Upper Egypt, conservation works in the " Sadd " region and storage reservoirs in the Great Lakes.

13. The report of the Nile Projects Commission, which was published in 1921, found that the projects were based on reliable data, and advocated their execution. In view, however, of the estimated heavy cost of the Gebel Aulia Dam and its complementary works, the Egyptian Government decided in May 1921 to suspend all operations in connexion with this project. The Sudan Government, on the other hand, in view of the favourable report, decided to continue work on the Gezira Irrigation Scheme.

14. The majority of the Nile Projects Commission felt unable to advise on the problem of allocating those supplies of water which still remained unappropriated, and the only proposals made in this connexion, namely, those of Mr. Cory, the American member, were not adopted.

15. In view of the situation which had led to the appointment of the above-mentioned Commission, the British Government gave, in February 1920, an undertaking that the area of 300,000 feddans comprised in the Gezira Irrigation Scheme would not be exceeded without reference to the Egyptian Government ; and the work has been carried out within this limitation.

The Present Position.

16. The immediate programme of works outlined in " Nile Control " consisted of the following items :

(a) The Gebel Aulia Dam to provide additional water for Egypt.

(b) The Makwar Dam, or, as it is now called, the Sennar Dam, with a canal system to irrigate 600,000 feddans in the Sudan Gizira.

(c) A barrage at Nag-Hamadi in Upper Egypt.

For various reasons, first the war, and then financial and other difficulties, no progress has been made with items *(a)* and *(c)*. On the other hand, item *(b)* has been carried to completion, and came into operation in July 1925. The cost of this work has greatly exceeded the original estimates, and the Sudan Government, who are responsible for its financial results, desire to extend the area so as to reduce the risk of financial failure, and generally to develop still further the resources of the country.

17. It was an important feature of the programme that these three works should be carried out so as to come into operation simultaneously. The actual position, however, with which the Commission has to deal is that the Sudan has completed the canalisation of 300,000 feddans in the Gezira, and desires to advance a further stage, while Egypt has not yet been able to carry out her part of the original programme. During the time which has elapsed since the Commission was adjourned, the Egyptian Government have made considerable progress with their development programme, having now definitely sanctioned the construction of the Gebel Aulia Dam and the Nag-Hamadi Barrage, and the undertaking of an initial stage in the work of conserving the flow of the river in its course through the " Sadd " region.

18. The position as regards the limit of 300,000 feddans was modified by notes which passed between the British and Egyptian Governments in 1924 and 1925, of which the last two, giving rise to the appointment of this Commission, are contained in Appendix A. The effect of these was to terminate the 300,000 feddan limitation of 1920, and to call for some new arrangement to regulate expansion of irrigation in the Gezira.

Scope of the Present Proposals.

19. The Nile Projects Commission of 1920 had been requested to examine and to give its opinion on certain projects then under construction or under consideration by the Ministry of Public Works. A less specific charge has been laid upon the present Commission, which has been asked only to propose a basis for irrigation in which full consideration should be given to the rights and interests of Egypt. The Commission was thus let free to choose its own ground, to decide how far and in what direction its investigations should be carried, and the form which its proposals should take.

20. The information brought together and the programme of works outlined in the publication entitled " Nile Control ", the general conclusions of which were endorsed by the Nile Projects Commission, cover the very wide field of possible development of irrigation by works extending from the Great Lakes in Central Africa to the Mediterranean, and deal with possibilities belonging to the remote future as well as with works more immediately feasible. The present Commission has not attempted so wide a survey and, indeed, the time available precluded any such possibility. Nor has the Commission felt called upon to attempt a general analysis and definition of the principles underlying the allocation of water supplies between two communities. It is content to set out the considerations which have guided it towards its own conclusions.

21. Precedents in this matter of water allocation are rare and practice varied ; and the Commission is aware of no generally adopted code or standard practice upon which the settlement of a question of inter-communal water allocation might be based. Moreover, there are in the present case special factors, historical, political and technical, which might render inappropriate too strict an application of principles adopted elsewhere. The Commission, having regard to the previous history of the question, the present position as regards development, and the circumstances attending its own appointment, decided to approach its task with the object of devising a practical working arrangement which would respect the needs of established irrigation, while permitting such programme of extension as might be feasible under present conditions and those of the near future, without at the same time compromising in any way the possibilities of the more distant future.

22. The arrangement contemplated aims at interpreting in definite and technical terms the intentions of the note quoted in the opening paragraph of this Report, wherein it was explained that in authorising extensions of irrigation in the Sudan "the British Government, however solicitous for the prosperity of the Sudan, have no intention of trespassing upon the natural and historic rights of Egypt in the waters of the Nile, which they recognise to-day no less than in the past." The Commission has every hope that its proposals, framed in this spirit, and after full study of the technical aspects of the problem, may form an acceptable basis upon which, by harmonious and co-operative effort, the irrigation development of the future may be founded, and by which all existing rights may be perpetually safeguarded.

The Gezira Irrigation Scheme.

23. As already explained, the chief field for irrigation development in the Sudan is the Gezira, and therefore the conditions under which the irrigation of this tract is carried out must have an important bearing on the problem for which the Commission has been called upon to propose a solution. It will be convenient therefore, before proceeding further with the discussion, to give a more detailed account of this scheme.

24. The present scheme provides for the irrigation of an area of 300,000 feddans of cultivable land, of which one-third will be under cotton from July-August to not later than the 15th April, one-third under food crops from August-September to November in the case of durra and January in the case of lubia, and the remaining third fallow. From the 16th April to the 15th July there will be no crop on the ground, water being required for domestic purposes only. The really important crop is the cotton, both from the point of view of water consumption, and of the economic return from the undertaking.

25. From the 16th to the 31st July the canal will be gradually raised from domestic supply level to irrigation supply level, the reservoir level being of necessity raised at the same time. From the 31st July onwards the canal will be drawing its supply in accordance with the agricultural needs, with a maximum discharge of 84 cubic metres a second. During the month of November the reservoir will be raised to full storage level, the discharge taken from the river for this purpose being about 150 cubic metres a second for thirty days. During the first half of January the watering of lubia will cease, only the cotton remaining under irrigation. The calculations in " Nile Control ", upon which the scheme was based, indicated that the requirements of the cotton crop on the above area could be taken from the river without detriment to Egypt, even under the conditions of the abnormally low year 1913-14, up till 18th January, after which date the requirements will have to be met from the stored water in the reservoir. The scheme was accordingly so planned that the reservoir should contain the volume estimated to be necessary, with due allowance for losses, to meet the cotton requirements of the defined area from the 19th January to the 15th April, and domestic requirements from the latter date till the 15th July.

26. Besides the above restrictions as to the season during which the Gezira Scheme should draw upon the natural flow of the river, and the volume of water to be withdrawn during that season, there was the undertaking already mentioned in paragraph 15, limiting the area of cultivation in the Gezira to 300,000 feddans. Thus, even if it were found possible to use less water than the calculations provided for, the water so economised would not be considered as available for an additional area.

Present Commission. General Considerations.

27. From an irrigation point of view, the year in Egypt has always been treated as divisible into two seasons of about six months each. During one of these seasons the whole natural flow of the Nile, supplemented by the stored water of Aswan Reservoir, is used for irrigation, the mouths of the river being closed by earth banks as soon as conditions permit ; whilst during the other season water flows to the sea in volumes which for several months are very great.

28. The Sudan Gezira Scheme, which came into operation in July 1925, has been planned so as to draw water from the natural flow of the river only during the latter season, and to draw upon the water stored in the Sennar Reservoir during the low-river season. The Commission regards this as a sound principle ; and it is one which has always been accepted by the Sudan authorities, who only claim at this season of the year the volumes necessary for the small area of navigation supplied by pumps under a long-standing arrangement sanctioned by the Egyptian Government. The Commission accordingly determined that its first step should be the accurate division of the year into the two seasons by a detailed examination of the conditions at the two critical points at the beginning and the end of the season of surplus where the change of conditions occurs.

29. When this division of the year had been carried out it would be possible to reserve absolutely to Egypt the natural flow of the river during the low season, subject to the pumping rights already mentioned. The available supplies during the rest of the year would be examined with a view to seeing how much might reasonably be used in the Sudan, taking into account the requirements of corresponding development in Egypt. It would then remain to examine the minor questions of pump and basin irrigation in the Sudan, and to define the conditions on which these should be carried out.

30. The above are the general lines upon which the Commission decided to develop its proposals. It is now necessary to explain certain principles and methods followed in the actual examination of the problem. The fundamental operation is the division of the year, and in particular the determination of the date at which the Sudan should cease to draw on the natural river at Sennar. The method adopted in " Nile Control " was to make this date correspond with the first withdrawal of stored water at Aswan, and the Sennar Reservoir was designed to supply the requirements of the canal after the 18th January, this date corresponding to the first withdrawal at Aswan in 1913-14, an abnormally low year. The majority of the Nile Projects Commission had approved this method of determining the date, but had advocated that the date should be movable, and ordinarily later than the 18th January, in accordance with the condition of the river in each year, instead of being fixed absolutely with reference to the abnormal conditions of 1913-14.

31. The present Commission does not regard the time of first withdrawal of stored water at Aswan as a suitable criterion of the cessation of surplus flow in the river ; since it might well be that the stored water is reserved for some time after there ceases to be any surplus in the river, in anticipation of more acute needs in the later months. The Commission accordingly decided to discard this criterion, and to base its proposals on the actual cessation of surplus as indicated by

the working of the canals, the regulation at the Delta Barrage, and the closing of the sadds across the mouths of the river.

32. The Commission considered whether its proposals should be based on the abnormal conditions of 1913-14, or upon the mean of a series of years, or should provide something in the nature of a sliding-scale under which the date in question would be advanced or put back in accordance with the conditions obtaining in each year. The records of Nile floods cover a period of over 960 years, and years as low as 1913-14 have occurred only four times. The Commission felt that while the occasional occurrence of such years cannot be ignored, it should not be employed as a basis of any scheme. The sliding scale would present complications in working, and it was soon clear that the yearly fluctuations were not so important as to preclude the use of a mean date. It was accordingly decided to work on means, and to test the results so obtained by considering them with reference to specially low years. In particular, the Commission recognised that some special provision might be required to deal with a year like 1913-14.

33. The Commission also had to consider whether its proposals for regulating the expansion of irrigation in the Sudan should be expressed in terms of areas to be irrigated as well as of volumes to be utilised during certain specified seasons. In the past, as explained in paragraph 26, a definite area limitation of 300,000 feddans had been fixed for the Gezira Scheme, in addition to the restrictions imposed naturally by the storage capacity of the reservoir, and the precise definition of the season during which, and the extent to which, water may be abstracted from the natural flow of the river.

34. It is in terms of volumes and seasons that the actual statistical examinations of the whole problem must be conducted, and the record of the working of the reservoir, and of the volumes drawn off daily by the canal, must be maintained. And it is the volumes and seasons which best lend themselves to the imposition of checks necessary to ensure a proper control over the working of whatever arrangement may be arrived at as the result of the Commission's proposals.

35. An area limitation could not, in itself, constitute complete control over the volumes abstracted from the river, unless supplemented by a reservation as to the crops to be grown, and the system of crop rotation to be followed. It would involve also assumptions as to the volumes of water necessary for each different crop, and these assumptions would have to include a considerable margin to allow for error. Such a margin, comprising allowances for doubts as to reservoir capacity, losses, and water requirements of crops, would, by preventing full use being made of very valuable storage water, react unfavourably on the Sudan's interests, without corresponding advantage to Egypt. Consequently, an area limitation, unless pitched too high, would have the effect of removing the incentive to economy in the use of water, and it would clearly be to the advantage of neither party that water taken from the river should be used uneconomically.

36. In view of the above considerations, the Commission decided that its proposals should be stated in terms of volumes and seasons only. It was satisfied that the authorities concerned would have no difficulty in devising arrangements for ensuring complete control over the abstraction of water from the river and from the reservoir. Provided that such satisfactory arrangements are made, the Commission saw no necessity, from a technical point of view, of imposing an area limitation over and above the volumetric one. A definition of seasons and volumes to be extracted would, in accordance with irrigation practice, be satisfactory and adequate in itself ; and if it were held necessary, as formerly, to impose an area limitation as well, it would be for reasons outside the purview of a technical Commission.

37. There is another matter which the Commission had to consider in connexion with the method of handling the problem submitted to it. The greater part of Upper Egypt is under basin

irrigation, largely dependent on natural flood levels in the river, and only partially protected by barrages. Any abstraction of water in flood time in the Sudan must affect these levels to the detriment of the basin irrigation, and therefore to admit that the lands in question have an absolute right to undiminished natural levels must preclude any abstraction of water by the Sudan.

38. The Commission felt that in the circumstances it was impossible either, on the one hand, to postpone indefinitely all progress in the Sudan, or, on the other, to damage seriously, by precipitate action or by excessive abstraction, the basins of Upper Egypt. It was accordingly decided to take the line that consideration of levels could not be carried to the point of precluding development in the Sudan, but only to the point of setting a limit to the extent and rate of this development.

39. The Commission was assisted in coming to this conclusion by the decision of the Egyptian Government, soon after the appointment of the former, to undertake the construction of another barrage in Upper Egypt. It has also now been decided to construct, for the benefit of Egypt, the Gebel Aulia Dam in the Sudan. With the undertaking of these two works the question of levels in Upper Egypt loses much of the importance which might be attached to it if development by the Sudan only were in prospect.

40. A further question of a general nature, calling for decision as a preliminary to detailed examination of the problem, was whether the Gezira Canal and the Gebel Aulia Dam should be treated as being on the same footing, though the latter work had not yet made any effective progress. It was considered that, as both works had originally formed integral parts of the same programme, no special priority should be accorded to the completed Gezira Scheme in respect of the allocation of any further supplies found to be available, but that both should be treated as having equal priority to any extensions. As a corollary to this view, it follows, and it was so assumed by the Commission, that the Sudan should afford every facility for the construction of the Gebel Aulia Dam.

41. Finally, the Commission considered whether it must regard the completed Gezira Scheme as having an irrevocable right to take water to the extent and under the conditions provided for in " Nile Control ". There was the possibility that the Commission's examination of the statistics, including those of the years which had elapsed since the scheme was initiated, might lead to conclusions other than those of " Nile Control ". At the same time, the scheme had been undertaken and practically completed after full examination of the question, not only by the Egyptian authorities, but by the Nile Projects Commission ; and the Sudan Government had entered into certain commitments on the basis of the original water allotment. The Commission felt that in these circumstances any reduction in the volumes available for this scheme would raise issues with which, as a technical body, it would not be concerned. The detailed investigation of the basis of the original scheme by the methods adopted by the Commission has, however, shown, as will be seen later, that no serious divergence exists between the results of the present investigations and those previously arrived at.

CHAPTER III.

STATISTICAL.

42. As a preliminary to the detailed examination of the statistics, it will be convenient to describe briefly the nature of the records available, and to explain certain factors affecting the calculations.

Hydrological Records.

43. The annual maximum and minimum levels at Cairo are on record from 641 to 1451 A. D. and again from 1737, with one break, to the present day. These records cover a period exceeding

960 years, and are of value in determining the periodicity of abnormally low years. Daily gauge readings at Aswan and Cairo were begun in 1870, with occasional discharge observations. Since 1903 upstream and downstream levels and the position of the sluices at Aswan have been recorded daily, and by means of the calibration of these sluices, which has now been determined with a high degree of accuracy, the discharges in the earlier years have been calculated. Distribution at the Delta Barrage has been carried out since 1919 by the calibration method. In general the accuracy and system of record of the statistics are being continually improved, and they are now of a high order ; and great reliance can, in particular, be placed on those of the last seven years.

Time Lag.

44. The great distances and the small slope of the river make the time of travel an important factor in any calculations regarding the Nile. This time of travel has to be borne in mind continually, and where reference is made to the date of some event at Sennar, for example, it is necessary to reckon the corresponding date on which the effect will be felt at Aswan, or the Delta Barrage, before the significance of that effect can be properly appreciated. Reference, in short, must be both by time and place. The lag, moreover, is not constant, but varies with the river stage.

45. At the request of the Commission the time lag between one point and another has been calculated by the Physical Department. The calculations are contained in Appendix B, from which it will be seen that the total time of travel from Sennar to the Delta Barrage at the critical times is estimated to be :

In January-February = 34 days.
In July-August = 27 days.

Where necessary for the purpose of investigating special conditions, *i. e.*, low years, the lag taken into account has been specially calculated from the appropriate data.

Losses.

46. " Nile Control " (page 248) estimated that 124 volumes of water passing Khartum are reduced by losses to 100 at Aswan. In gauging the effect on the river conditions in Egypt of any abstraction at Sennar the Commission does not feel that it is necessary or even possible to take these losses into account for the purposes of the present proposals. It prefers to assume that the full effect of any abstraction at Sennar will be felt in Egypt without any reduction. At some future time this factor may become more precisely known, and also more important, and it can then be taken into account if necessary.

Division of the Year.

47. As already explained, the basic idea underlying the Commission's proposals is the division of the year into two seasons, during one of which the Gezira Canal would take water from the natural river, whilst during the other its supply would be drawn from storage, leaving the natural river reserved to Egypt. In this respect the Commission is merely following the principles of " Nile Control ", and of the Nile Projects Commission, but adopting other methods of studying the problem and of demonstrating the results. The examination of the conditions at the critical points where the supply of the rising river overtakes requirements and where, on the falling river, the reverse takes place, formed the most important part of the Commission's studies. The present Chapter is chiefly devoted to this examination, the presentation of its results, and the conclusions arrived at.

Rising River, July-August.

48. The conditions of the rising flood at the Delta Barrage are illustrated in Diagram No. 1 contained in Appendix C, which is based on the discharge passing down the river below the Delta Barrage. The river curves are those of the mean of 1912-25, the abnormally low year 1913, and of the year 1915, in which the conditions were, except for 1913, the worst of the series of fourteen years. The discharge used for irrigation below the barrage at this time of the year is taken into account ; and the effect of the Sennar Dam, operated as provided in the table [1] on page 87 of " Nile Control ", is shown with due allowance for the time lag, which, as already explained, varies with the stage of the flood.

49. It is seen from the diagram that in average years by the time the effect of withdrawals of water at the Sennar Dam is felt at the Delta Barrage the supply passing down the river branches amounts to nearly 150 million cubic metres daily, and that the effect is negligible under these conditions. In 1915 the effect would have been appreciable but not injurious. Under 1913 conditions the effect would have been to take water from the river about ten days in advance of the establishment of the real rise of the flood. The conclusion to be drawn from this diagram is that, provided the rise of the river is not later than in 1915, the arrangement in " Nile Control " is quite suitable, whereby the Gezira Canal would begin on the 16th July to draw on the river at Sennar to the extent of the prescribed volumes. In years worse than 1915 some postponement of this date would be needed to avoid taking water actually required for irrigation in Egypt.

50. It was explained in paragraph 41 that the Commission would feel that, on general grounds, any proposal for reducing volumes already allotted to this scheme, and in respect of which commitments had already been entered into, would be outside its province. The question of postponing the opening of the canal for a few days in occasional years of a late rise of the river appears, however, to the Commission in a somewhat different light. At this time of the year the water is chiefly required in Egypt for the durra crop, which should be sown as early as possible if the best results are to be obtained. Similarly, in the Sudan Gezira, early sowing of the cotton is desired. It seems reasonable that in a year when the rise of the river is delayed, the Sudan should share with Egypt whatever disadvantages may attach to the late sowing of the crops.

51. The conditions of 1915 may be regarded as the worst conditions under which the " Nile Control" arrangement would be suitable; and those of 1913 as the worst likely to occur. A sliding-scale whereby the opening date would be postponed in proportion as the conditions fell short of those of 1915 would meet the reqiurements which the Commission has in view. Such a sliding-scale might be derived from the figures contained in Appendix E. It is seen that both in 1915 and in 1913, on the date when the Sudan could have begun to draw on the river, the combined discharge of the Blue and White Niles amounted to 142 million cubic metres a day ; and that the mean discharge for the preceding five days was 135 millions a day. Adopting a figure of 160 millions to allow a margin, it could be arranged that the Gezira Canal should not draw on the natural river until a mean total discharge of 160 millions a day for five days is reached at Sennar and Malakal, allowing for ten day's' lag in the case of the latter.

52. The Commission, whilst putting forward this proposal from considerations of equity, does not believe that in fact any appreciable harm would be done to Egyptian interests if the Sennar works were operated according to the "Nile Control" scheme, regardless of the character of the season. Moreover, as stated in an earlier paragraph, it is not in favour of introducing complications such as might be involved in the use of a sliding-scale. But in this case the criterion as to the

[1] Reproduced as Appendix D.

character of the season is so direct, and the procedure so simple, that no difficulties should arise on the rare occasions when the sliding-scale would be called into play. The Commission accordingly recommends the adoption of this arrangement if the authorities concerned think it worth while to depart from the simplicity of a fixed date.

Flood Season.

53. The rise of the river having, as already seen, become well established in the latter half of July, it has now to be seen what volumes, if any, could, consistently with the interests of Egypt, and the principles followed by the Commission, be taken in the Sudan, in addition to the volumes allowed for the present Gezira Scheme, as detailed in " Nile Control ". Diagrams Nos. 2 to 4 show the volumes escaped into the sea under average conditions and in the two lowest years, 1915 and 1913, and the effect which will be produced by the Gezira Canal and the filling of the Sennar and Gebel Aulia Reservoirs. With regard to the latter reservoir, the Commission understands that the final details of a revised scheme have now been approved by the Ministry of Public Works, but the Commission is not aware of the exact particulars. The filling as shown on the diagram is an assumption made by the Commission with the object, chiefly, of showing the proportion which the capacity of this reservoir bears to the volumes available at this season. The water of the White Nile being free of silt, the filling of this reservoir, unlike that of Aswan or Sennar, can be carried out at any time.

54. Although there is seen to be a large volume of unused water at this season, the Commission felt that any additional water allotted to the Sudan should, for two reasons, be on a moderate scale. In the first place, the losses in the new reservoirs at Sennar and Gebel Aulia are at present a doubtful factor, and will only become known accurately when the works have been in operation for a year of two. In the second place, there is the question of levels as affecting the basins in Upper Egypt, to which the Commission has given careful consideration. Appendix F has been prepared to show the effect at Aswan of the withdrawal of volumes of 100, 150 and 200 cubic metres a second during the low floods of 1911, 1913, 1915 and 1918. No calculations have been made as to the effect of the filling of the Gebel Aulia Reservoir in its revised form, but it is clear that this reservoir must have a much greater influence on the levels in Egypt than the abstractions at Sennar now contemplated.

55. An important consideration bearing on this question is that, judging by the results of the pumping schemes, the irrigation requirements of the Gezira Canal will not be at their maximum in August and September, the season when the flood is at its maximum. The cotton crop is sown in the Sudan in the latter part of July and the early part of August, and, owing to rainfall at this season, the second watering is not required till the latter part of September, the food crop meanwhile being sown after the cotton. Consequently, whatever maximum discharge may be fixed for the Gezira Canal in flood time, it will, in fact, be taking a reduced discharge at the time of the basin filling in Egypt.

56. It has always been recognised that a lowering of levels in Upper Egypt, with consequent increased difficulty of filling the basins, must result from the working of the Gebel Aulia and Gezira schemes. The basins in the Sudan will be similarly affected. The present Commission is not disposed to enter into an argument on general principles as to how far the maintenance of levels can be regarded as an established right.

Approaching the matter as a body of engineers invited to advise on a practical question, the Commission considers that development or conservation works in the upper part of the river should not be indefinitely restricted by considerations of the natural levels lower down, but that the Sudan should accept a limited rate of progress, so as to afford Egypt the opportunity to overtake the

effect of development in the Sudan by construction of the works which formed her part of the original programme.

57. Subject to the above proviso, the Commission finds that from the 1st August the additional volumes shown in the following table could be taken at Sennar in flood time. The 1st August at Sennar corresponds to about the 25th August at the Delta Barrage, a date by which the flood is well established in its rise, and the Delta Canals have attained their full supply levels. It further recommends that the additional volume should be taken progressively on a scale not exceeding that in the following table :

Year	Maximum Discharges in Cubic Metres per second		
	Already sanctioned for initial Scheme	Proposed Addition	Total
1925–26	84	—	84
1926–27	84	—	84
1927–28	84	—	84
1928–29	84	—	84
1929–30	84	12	96
1930–31	84	24	108
1931–32	84	36	120
1932–33	84	48	132
1933–34	84	60	144
1934–35	84	72	156
1935–36	84	84	168

NOTE. — The maximum discharge is 84 cubic metres a second in August, September, October and November; and 80 cubic metres a second in December.

58. The Commission finds that in a year like 1913 the final filling of the Sennar Reservoir might have to be modified from the " Nile Control " programme if the additional discharge now proposed is taken by the canal. In all such years the programme of filling Aswan is carefully considered and adapted to the conditions prevailing. The Commission foresees no difficulty in the application of the same methods to the relatively small volume required for the Sennar Reservoir, and does not think it necessary to make any specific proposals in a matter which is best left for the authorities concerned to deal with if and when the need arises.

Falling River. January–February.

59. The Commission devoted much time to considering whether the 18th January could be taken as correctly marking the cessation of surplus in the river. Appendix G, with its accompanying statement of dates, gives an attempt to arrive at the correct date, employing as criteria the demands of the canals, the gradual shrinkage of the volumes passing the Delta Barrage and the closing of the sadds, or earth banks, at the river mouths.

60. The earlier years may be discarded as unreliable or inapplicable to present conditions. The year 1917-18 was entirely abnormal, as the river remained in flood all through the summer. Taking the remaining years in two groups, there ceased to be any excess water on the following mean dates :

	Delta Barrage	Corresponding Date at Sennar
1910–17	February 21	January 18
1919–25	February 11	January 8

Thus the earlier group of years representing the conditions obtaining when the Gezira Scheme was being planned gives, by the method now employed, the same date at Sennar as was actually

adopted by the framers of the scheme, namely, the 18th January. On the other hand, according to the data of the more recent years, the date would be the 8th January.

61. By way of further study of this question, the Commission invited Dr. Hurst, Director-General of the Physical Department, and Mr. Butcher, Director of the Delta Barrage, to investigate separately, and by whatever method seemed to them most appropriate, the conditions at this season of the year. They were asked firstly to test the correctness of the " Nile Control " date of the 18th January, and, secondly, assuming that the Gebel Aulia Dam had come into operation, to ascertain up to what date the surplus still remaining would permit of the Gezira Scheme being allowed the additional volume found by the Commission to be available during the flood season. The object in making the assumption that the Gebel Aulia Dam was actually in operation was to give effect to the view expressed in paragraph 40, *i. e.*, to ensure that there should be sufficient water for the Gebel Aulia Dam and the resulting development of irrigation in Egypt before any further allotment of water were made for the Gezira.

62. Dr. Hurst based his study on the figures of 1920, which, for the month of February, was the lowest of the six years 1919-20 to 1924-25. The method adopted and the results arrived at are set out in Appendix H and its accompanying Diagram No. 5. The conclusion arrived at is that under existing conditions, *i. e.*, ignoring the Gebel Aulia Reservoir, the Gezira Canal could be given the " Nile Control " volumes up to the 23rd February, Delta Barrage date, corresponding to the 20th January at Sennar. Taking Gebel Aulia into account without the losses in the reservoir, the date would be the 12th January at Sennar, while, allowing for these losses, the date would be the 8th January. As regards the additional water for the Gezira, it was found that, ignoring the losses, the proposed additional supply could be taken up to the 1st January at Sennar, and, with losses taken into account, up to the 28th December.

63. Mr. Butcher employed a different method, explained in the note in Appendix J, based on the average of the six years 1918-19 to 1923-24, for which period the records, as already mentioned, are exceptionally detailed and reliable. It is important to know how these six years compare with the mean of a longer cycle ; and Appendix J shows that the mean supply in December and January of these years represents 91 per cent. of the corresponding mean of the last twenty years, and that all six years are below the average of the twenty years. The Commission regards these years as affording a suitable basis of calculation.

64. Nothing was known to the Commission of the manner in which the additional storage water of the Gebel Aulia Reservoir would eventually be employed. Mr. Butcher, finding that the storage amounted to an addition of about 22 per cent. to Egypt's supplies during the summer season, assumed that a corresponding expansion would take place in the demands for water at other seasons of the year. It is doubtful if such a result would actually occur, but the effect of this assumption on the calculations is certainly favourable to Egypt. Assuming the Sennar and Gebel Aulia Reservoirs to be both in operation, there would, according to the Diagram No. 6 employed in this calculation, be sufficient water to meet all requirements in full up to the 10th February corresponding to the 7th January at Sennar, after which there would still remain available a volume of 140 millions now running into the sea.

65. The diagram shows the effect of the further abstraction of 80 cubic metres a second after providing for the Gezira Canal on the " Nile Control " basis, and the expansion of cultivation in Egypt following the construction of the Gebel Aulia Reservoir. It will be seen that the additional volume can be abstracted up to the 5th February at the Delta Barrage, corresponding to the 2nd January at Sennar, without taking water now in use for existing cultivation, and leaving a discharge

of 75 million cubic metres a day for navigation requirements during the annual closure of the canals in Egypt.

66. As another means of exhibiting graphically the conditions at this season of the year, and their relation in time to conditions at Sennar, Diagram No. 7 was prepared. This shows the daily discharges of the two branches in January and February in the four lowest years, 1913, 1916, 1920 and 1922. The volumes being stored at Aswan at the same time are also plotted on the diagram, which therefore gives a fairly complete representation of conditions at this season. The Sennar dates, the 31st December and the 18th January, are also shown on the diagram, the appropriate lag being employed.

67. It will be seen that the calculations referred to in paragraph 60, so far as the earlier years are concerned, and Dr. Hurst's first calculation, both tend to confirm the arrangement by which the Gezira Canal was planned to draw on the river up till the 8th January. These calculations ignore the effect of the Gebel Aulia Reservoir, whilst the view expressed in paragraph 40, that no special priority should be given to the Gezira Scheme, would require that account be taken of both schemes. Taking both into account, the date given by Dr. Hurst's calculations is the 8th January. Although the Commission takes the view stated as to priority, it is not prepared to argue that such a view should be applied retrospectively, and that the basis of a completed scheme should necessarily be changed as the result of the adoption of a new principle, new data and new methods of calculation.

68. Turning now to Mr. Butcher's calculations, attention must be drawn to the importance of the factor introduced by the closing of the sadds on the river branches at this time of the year. This operation requires the use of considerable volumes of water in order to maintain a sufficient flow through the gap in the uncompleted sadd to prevent the entry of sea water into the river. The closing is carried out under present conditions in February in most years, but, with the coming into operation of the Gezira Scheme and the Gebel Aulia Reservoir, the resulting increased draw on the river will be such that, unless the sadds are closed earlier than at present, the water necessary to exclude the salt must be taken from storage.

69. With an earlier closing of the mouths of the river the water used under present conditions for excluding sea water will become part of the irrigation supply at this season. It is, in fact, included in the volume of 140 millions referred to in paragraph 64 as available after the date when a shortage would first be felt, namely, the 7th January, at Sennar. Now, according to the scale provided in " Nile Control " the Gezira Scheme would draw from the river a volume of 69 millions, or almost exactly one-half of the available 140 millions. Thus, with the change in the time of closing the sadds, which, according to Mr. Butcher's forecast, must take place with expansion of irrigation, the first instalment of the Gezira Scheme, though drawing its supply from the river till the 18th January would not be taking water at present used for irrigation in Egypt. In this calculation the Commission sees confirmation for the view that, as far as the present Gezira Scheme is concerned, no change need be proposed in the original date the 18th January.

70. As regards the date up to which the additional supply could be taken, the results of the two investigations agree fairly well, being in the one case the 28th December and in the other the 2nd January (Sennar dates). The Commission recommends that the additional water be taken till the 31st December. It is important to explain at this point that for purposes of silt clearance and other works, the canals in Egypt are closed every year towards the end of December and reopened in the early part of February, the actual dates of reopening of the different canal systems depending on the completion of the closure works. This closure is an annual necessity and it must always take place at this season, as climatic conditions render it impossible at any other. It therefore forms an important feature of the irrigation year in Egypt. It is the reopening of the canals after this closure which accounts for the rapid disappearance of surplus water in Egypt in February and the fact the

shortage occurs at a fairly constant date every year. The effect of the Commission's recommendation in this paragraph is therefore that the Gezira Canal should not take any additional water from the river after the time corresponding to the reopening of the canals in Egypt.

71. The arrangement by which the Gezira Canal would draw the volumes provided in " Nile Control " from the natural river to the 18th January, but would take no extra water after the 31st December, may perhaps be made clearer if the extent to which the Sudan may draw upon the river in January is expressed in terms of total volumes without the use of the date the 18th January. The volume provided in " Nile Control " is 117 million cubic metres up to the 18th January, and the Commission's proposal is that no more than this should be taken in January. As explained in paragraph 49, the Sudan will not again draw on the natural river till the 16th July. Thus from the 1st January to the 15th July the Sudan will only take from the natural river, exclusive of the comparatively small volumes for pumps, a volume of 117 million cubic metres. At this period of the year Egypt will have practically all the remainder of the natural flow amounting, from the figures in Appendix K, to about 13,000 million cubic metres, as well as the volumes stored at Aswan and Gebel Aulia. Viewed in this light, the question of the precise date in January up to which the Sudan should draw the " Nile Control " volumes of 4.5 million cubic metres a day from the river is seen to be a matter of relatively minor importance from the point of view of the water supply of Egypt. On the other hand, it would be of real importance to the Sudan, whose resources during the low-river season would amount to no more than the contents of the Sennar Reservoir, *i. e.*, something of the order of 500 million cubic metres, with rights in the natural river limited to the above volume of 117 millions and the small volume for the pumps.

72. The Commission carefully considered whether it should propose any special provisions for dealing with abnormally low years, such as 1913-14. It was aware that in such a year, with the Gezira Scheme drawing on the natural river up to the 18th January, the Sudan would, on the method of calculation employed in this Report, be drawing to some extent on water not actually surplus to Egyptian requirements. In order to deal specially with such years it would be necessary to adopt some criterion or index by which abnormal conditions would be defined, a sliding-scale to regulate the amount of water to be taken by the Sudan in these years, and a method of forecasting these conditions some time in advance of their actual occurrence.

73. Various arrangements were thought of and discussed with the Physical Department. Finally, the Commission decided that, in view of the relative insignificance of the volumes involved, the rarity of abnormally low years, and the fact that the Egyptian Government has now definitely embarked on a policy of developing the latent resources of the river, it would be of doubtful utility to propose special arrangements which would involve elaborate forecasting, would open the door to misunderstanding and friction, and which might never be needed. On the facts themselves and on the general grounds set out in paragraph 41, the Commission would not propose any change in the original plan by which the volumes originally provided for the Gezira Canal in " Nile Control " may be taken from the natural river up to the 18th January.

74. As regards the additional water, however, the considerations in paragraph 41 do not apply and the Commission felt that its proposals must take into account the occurrence of low years, even if this involved the inconvenience of a sliding-scale. Owing to the winter closure of canals in Egypt, there is an important difference between the use of water at Sennar in the first eighteen days of January and its use in December. For whereas water taken in January might affect irrigation supply in Egypt, that taken in December would only be felt in Egypt during the time of closure of the canals, during which period the river is in flow to the sea, and navigation is the only

interest involved. Thus, in considering a sliding-scale for regulating the date at which the additional water should cease to be drawn from the river, the test to be applied is the effect of the proposed abstraction of water upon navigation facilities in Egypt.

75. There is no absolute figure of discharge which can be adopted as the minimum required for navigation at any time. In " Nile Control " a figure of 1,500 to 2,000 millions downstream Aswan is mentioned as being required in January for navigation ; and, in the minority recommendation of the Nile Projects Commission, the figure of 1,500 millions was proposed. As mentioned in paragraph 65, the arrangement proposed in this Report would provide a discharge of 75 millions a day, or 2,300 during the month, under conditions somewhat below average. It would not be possible to fix such a discharge as an absolute minimum even for the worst years, since in January 1914 the discharge is seen (Diagram No. 7) to have fallen to 40 millions a day, and even less, at the Delta Barrage.

76. An arrangement arrived at by another line of argument was considered by the Commission. The natural river is seen from Diagram No. 6 to be falling at a mean daily rate of about 1 million cubic metres a day at the end of January at the Barrage, corresponding to the end of December at Sennar. The total volume now proposed to be abstracted at Sennar in December is approximately 14 millions a day. Thus, whatever conditions would have occurred in Egypt in previous years would, under the new conditions, occur about fourteen days earlier. A possible arrangement would be to have a sliding-scale by which, according to the character of the season, the date for ceasing to take the extra water would be advanced until, under 1913-14 conditions, it would be the 18th December instead of the 31st December as in ordinary years.

77. As an index of the character of the year, the total natural river as at Aswan in the month of December may be employed. To determine the conditions to which the 31st December would be applicable, there is the calculation referred to in paragraph 62, indicating that in 1919-20 the date should have been the 28th December, and the calculation referred to in paragraph 65, indicating the 2nd January. Now, in 1919-20, the total December flow is seen (Appendix J) to have amounted to 4,410 millions, whilst in the six years employed for the second calculation it averaged 4,860 millions. From this it appears that a total of about 4,700 millions would be a suitable zero for the sliding-scale. At the other end of the scale is the 1913-14 figure of 2,800 millions. On this basis the sliding-scale would take the following simple form : The date up to which the Sudan will take the additional volume of 80 cubic metres a second will be the 31st December in all years in which the total natural river at Aswan in December is not less than 4,700 million cubic metres ; and it will be earlier in low years at the rate of three days for every 400 millions by which the actual total December natural river in any year falls short of 4,700 millions.

78. This scale may have the appearance of being somewhat of an approximation, but it is devised from the data available upon the only basis which is applicable at this season of the year, namely, navigation needs, which do not lend themselves to accurate definition. It is in accordance with recorded facts, and it serves the purpose which the Commission has in mind, adjusting the Sudan's supply in accordance with the vicissitudes of the season, from which neither party can reasonably enjoy immunity. In practice the Sudan would be obliged to go on drawing from the river until the end of December, and to make good the overdraft later on when the criterion of the year had been determined.

79. There are two outstanding objections to a sliding-scale on the lines proposed. In the first place, any such arrangement opens the door to possible differences of opinion as to the figures

upon which it depends ; and it may well be that a fixed date, with its immunity from the possibility of dispute, is preferable to an arrangement theoretically desirable, but liable in practice to lead to friction between the authorities who will have to work it. In the second place, and accentuating the above objection, the suggested scale depends upon the natural river at Aswan, and, with two more reservoirs in operation above this point, the computation of the natural river at Aswan must become a difficult matter, involving a number of doubtful factors. It is, however, the best that the Commission can devise which will serve the purpose in view, namely, to ensure that the working of the Gezira Canal is, so far as extensions are concerned, adjusted to suit the conditions of low years.

CHAPTER IV.

Pump and Basin Irrigation in the Sudan.

80. As pointed out in an earlier paragraph, the areas in the Sudan under pump and basin irrigation are on a small scale, and therefore relatively unimportant as factors in the situation. Nevertheless, important considerations are involved, and the Commission has devoted considerable thought in particular to the question of pump irrigation.

Pump Irrigation.

81. Prior to 1904 pumps had been licensed in the Sudan, with the approval of the Egyptian authorities, to the extent of about 2,000 feddans of perennial irrigation. On the completion of the Aswan dam in that year an increase of 10,000 feddans was approved, to which was added, on the raising of the dam in 1912, a further 10,000 feddans. The approved area of perennial pump irrigation is therefore about 22,000 feddans. There is some doubt as to the total area authorised to receive perennial pumping, some of the records tending to show that the 10,000 feddans approved on the completion of the Aswan Dam included the area previously licensed, whilst others tend to show that the 10,000 feddans was for new licences. The difference is not of great importance, but the Commission is of opinion that the matter should be cleared up by the authorities concerned so as to avoid future misunderstanding.

82. The British delegate suggested that the two Governments concerned might be prepared to agree that, following the above analogy, the area of perennial pumping in the Sudan should be increased by 20,000 feddans on the completion of the Gebel Aulia Dam. This is not, however, a technical point, and it goes somewhat beyond the scope of this Report, as defined in earlier paragraphs ; for it raises the question whether the Sudan should be held entitled, by virtue merely of its geographical position, to draw on the river at a time when there is no surplus.

83. It should be noted that perennial pumping must involve taking water during the low stage of the river, and although in practice the actual area under irrigation in the summer has so far always been much less than the sanctioned area, the above suggestion would permit the Sudan to draw on water which is at present beneficially used by Egypt. However, in view of the relative unimportance of the volumes that would actually be drawn from the river during its low stage by a limited expansion of perennial pumping, the Commission feels that the Governments should have no difficulty in settling this question without the intervention of a technical body, and it accordingly refrains from making a definite recommendation.

84. In addition to the above perennial irrigation, the Sudan was authorised in 1905, under an order of the Egyptian Ministry of Public Works, to pump without restriction of area from the 15th July to the end of February (Sudan dates). This authority has, so far, been utilised to the extent of about 16,000 feddans. The investigations of present conditions, as set out in this Report, indicate that the flood season, to which this permit was intended to apply, cannot be said to extend beyond the end of December (Sennar) ; and, therefore, in accordance with the principles adopted by the Commission, flood pumping, should, in the case of any new areas, cease at this date. Agricultural conditions, however, are such that pumping under these conditions would have little value. Consequently, it becomes necessary to consider how non-perennial pumping in the Sudan can be regulated in the future consistently with the principles of this Report, and under present conditions of supply in the river.

85. A solution which suggests itself is that the water consumed after the end of December on any new areas of non-perennial pumping should be compensated for by the release of storage water from the Sennar Reservoir. A change in the method of working the reservoir would make available an additional volume, not taken into account in the calculations for the Gezira Irrigation Scheme, which could be utilised for this purpose. The original plan for working the Gezira Canal, as explained in an earlier part of this report, was that from the 15th April till the 15th July the canal should remain in flow with a discharge drawn from the reservoir estimated as being necessary for domestic purposes throughout the irrigated tract. Under this arrangement the reservoir would naturally have to be kept up to the level required to give this supply. Owing to the relative levels of the canal and the natural river, a volume estimated at about 150 million cubic metres would, under these conditions, remain permanently impounded in the reservoir. If the domestic water supply were raised by pumps, it would be possible to release this volume, and thus return to the river any volumes required to compensate for the water abstracted by pumps after the close of the flood season, *i. e.*, end of December (Sennar).

86. This volume must be again taken from the river in July before the canal can be brought into operation for the following season ; and Diagram No. 1 shows that, in a year of average or high flood, no serious effect would be produced on conditions in Egypt at the corresponding dates. In a year of very late flood the programme of filling of Sennar Dam can be retarded, in accordance with the arrangement proposed in paragraph 51, so as to reduce to a negligible quantity the effect of the above extraction. This should not present any difficulty to the authorities concerned, and the Commission feels that the occasional occurrence of very exceptional conditions should not be regarded as precluding the adoption of measures suitable under ordinary conditions, and not impracticable even under bad conditions. The Commission is of opinion therefore that permits for flood pumps working to the end of February can therefore continue to expand gradually as in the past, so long as any water pumped after the end of December can be compensated for in the manner explained above.

Basin Irrigation in the Sudan.

87. There are areas of basin land in the Sudan totalling about 80,000 feddans, of which, however, only a small part is annually flooded. These basins are, it is understood, not capable of much improvement, and are of no great agricultural value. The land is high and the conditions seem to be such that they cannot be filled from canals taking off at a distance upstream, as is the case in Egypt. They will suffer to some extent from the abstraction of water at Sennar and Gebel Aulia, but the arguments employed in connexion with the basins of Upper Egypt apply here also.

The Commission does not regard this question of basin irrigation in the Sudan as an important factor in the problem before it, and sees no need to make any special recommendations in this connexion.

CHAPTER V.

SUMMARY AND CONCLUSION.

Summary.

88. The Commission's main findings may be summarised as follows :

(a) The natural flow of the river should be reserved for the benefit of Egypt from the 19th January to the 15th July (at Sennar), subject to the pumping in the Sudan as defined below.

(b) The Gezira Canal may begin to draw on the natural flow of the river on the 16th July, the canal being gradually raised to full supply level by the 31st July, according to the scale fixed in " Nile Control ", contained in Appendix D, provided that a mean total discharge of 160 million cubic metres a day must have been reached at Sennar and Malakal during the preceding five days, allowing for ten days lag in the case of the latter.

(c) From the 1st August to the 31st December the Gezira Canal may, subject to the progressive scale laid down in paragraph 57 of this Report, draw the following volumes from the river :

The 1st August to 30th November, 168 cubic metres a second ;

The 1st to 31st December, 160 cubic metres a second, provided that, in any year in which the total flow of the natural river in December as at Aswan is less than 4,700 million cubic metres, 80 cubic metres a second shall be taken from the natural river during the whole of December, and the balance shall be taken from the natural river up to a date preceding the end of the month by three days for every 400 million cubic metres by which the actual total December natural river in that year falls short of 4,700 million cubic metres.

(d) The Gezira Canal may not draw during the month of January more than the volumes provided in " Nile Control ", *i. e.*, 80 cubic metres a second from the 1st to 15th, and 52 cubic metres a second from the 16th to 18th, a total of 117 million cubic metres.

(e) The final filling of the Sennar Reservoir from the level required to give full supply in the canal to the full storage level of the reservoir should be carried out in November, as provided in " Nile Control ".

(f) Any further flood pumping carried out in the Sudan up to the end of February should be considered as drawing its supply from the Sennar Reservoir after the 31st December. In other words, a volume equal to that consumed on these areas after the 31st December, according to ascertained data, should be discharged from the reservoir as compensation to Egypt, and the Sennar Reservoir should be worked so as to provide the additional storage required to cover the compensation volumes as above.

(g) After the end of February only perennial pumping, as referred to in paragraph 81, should be carried out in the Sudan.

Conclusion.

89. The Commission foresees that it will be necessary from time to time to review the questions discussed in this Report. It regards it as essential that all established irrigation should be respected in any future review of the question. In particular, the Sudan should only take from the natural river in January, exclusive of pumping rights as now existing, the " Nile Control " volume of 117 million cubic metres. All other requirements till July should be provided by the Sudan from storage or other conservation works.

90. The Commission has been impressed by the fact that future development in Egypt may require the construction of works in the Sudan and neighbouring territories, such as Uganda, Kenya and Tanganyika, and it feels that Egypt should be able to count on receiving all assistance from the administrative authorities in the Sudan in respect of schemes undertaken in the Sudan, as well as from the British Government in any questions concerning the neighbouring territories.

91. The Commission has endeavoured to find a practical and workable basis for irrigation, and to foresee, and, as far as possible, to provide for, any difficulties that may arise in the future. But it is aware that doubtful points may well arise in the interpretation of any document, and that differences of opinion as to fact cannot fail to occur from time to time in such matters as the volumes of water flowing in a river or canal, discharged through sluices, or lost by evaporation or seepage. It does not feel called upon to make proposals with regard to special arrangements for dealing with such doubts and differences, which seem to be outside the sphere of a technical commission. It does, however, desire to record emphatically the view that neither the elaborate drafting of an agreement nor the provision of special machinery for adjudication should be allowed to obscure the importance of mutual confidence and co-operation in all matters concerning the river and its waters.

92. Finally, the Commission desires to draw attention to the very great importance of continued study of the river and systematic record of the statistics. A very good hydrological organisation has been built up, and its continued efficiency is absolutely essential, not only to fresh development work, but also to the correct working of the arrangements proposed in this Report, or, indeed, of any other arrangements that could be devised.

Abdul Hamid SOLIMAN,
Egyptian Delegate.

R. M. MACGREGOR,
British Delegate.

CAIRO, *March* 21, 1926.

APPENDIX A.

NOTES EXCHANGED.

[1] TRADUCTION. — TRANSLATION.

ZIWER PASHA TO LORD ALLENBY.

CAIRO, *January* 26, 1925.

YOUR EXCELLENCY,

In the note which your Excellency, on behalf of His Britannic Majesty's Government, addressed to my predecessor on the 22nd November, 1924, you asked that the area of land to be irrigated in the Sudan Gezira should be increased from 300,000 feddans to an unlimited extent.

To this note my predecessor replied in a note of the 23rd November, in which he declared that the question of immediately modifying the limit fixed for the area to be irrigated in the Gezira was, to say the least, premature and should, in accordance with the repeated declarations of His Britannic Majesty's Government, be settled by mutual agreement, taking into consideration the vital interests of Egyptian agriculture.

In view of this reply your Excellency then informed the Egyptian Government, in a note of the same date, that instructions had been given to the Sudan Government to the effect that it was free in future to irrigate an unlimited extent of land in the Gezira.

Now that friendly relations have happily been re-established between our two countries, it is my duty to draw your Excellency's attention to the fact that the measure announced in your note of the 23rd November has raised the most serious apprehensions in this country. Further, your Excellency is aware that in all the discussions which have taken place in the past between the two Governments with a view to reaching an agreement as to the control of the waters of the Nile, and in particular on the subject of the development of irrigation in the Sudan, the Egyptian Government has always firmly asserted its rights in the waters of the Nile.

The Egyptian Government has always maintained that this development should in no case be of such a nature as to be harmful to the irrigation of Egypt or to prejudice future projects, so necessary to meet the needs of the rapidly increasing agricultural population of this country. I do not think I am wrong in asserting that this principle, vital to Egypt, has been fully admitted by His Britannic Majesty's Government.

I have, therefore, to request your Excellency to be so good as to reconsider the question of the irrigation of the Gezira and to withdraw the instructions referred to in the above-mentioned note of the 23rd November, 1924, since such a measure could only serve to strengthen the good relations between our two countries.

I avail, etc....

A. ZIWER,
President of the Council of Ministers,
Minister for Foreign Affairs.

[1] Communiqué par le Foreing Office de Sa Majesté britannique.

[1] Communicated by His Britannic Majesty's Foreign Office.

LORD ALLENBY TO ZIWER PASHA.

CAIRO, *January* 26, 1925.

SIR,

I have the honour to acknowledge the receipt of the note which your Excellency was good enough to address to me to-day asking me to reconsider the question of the irrigation of the Gezira and to revoke the instructions mentioned in the note which I addressed to your Excellency's predecessor on the 23rd November, 1924.

2. His Majesty's Government appreciate the sincerity of the friendly feelings expressed by your Excellency and fully share your desire to restore and strengthen the good relations between our two countries which have been so unhappily disturbed.

3. I am therefore glad to be able to inform your Excellency that I am now in a position to impart to you the views of my Government on this subject.

4. I need not remind your Excellency that for forty years the British Government watched over the development of the agricultural well-being of Egypt, and I would assure your Excellency at once that the British Government, however solicitous for the prosperity of the Sudan, have no intention of trespassing upon the natural and historic rights of Egypt in the waters of the Nile, which they recognise to-day no less than in the past, and in giving the instructions in question to the Sudan Government His Majesty's Government intended that they should be interpreted in this sense.

5. Moved by these considerations and in proof of their intentions, His Majesty's Government are disposed to direct the Government of the Sudan not to give effect to the previous instructions in regard to the unlimited development of the Sudan Gezira mentioned in the note of the 23rd November, on the understanding that an expert committee composed of Mr. J. J. Canter Cremers, Chairman, who has been chosen by agreement between the two Governments, Mr. R. M. MacGregor, British Delegate, and Abdul Hamid Soliman Pasha, Egyptian Delegate, who has been selected by the Egyptian Government, shall meet not later than the 15th February, 1925, for the purpose of examining and proposing the basis on which irrigation can be carried out with full consideration of the interests of Egypt and without detriment to her natural and historic rights.

6. It is understood that the Committee will present its report by the 30th June, 1925.

I avail, etc.

ALLENBY, F. M.,
High Commissioner.

APPENDIX B.

TIME TAKEN FOR CHANGES OF RIVER LEVEL AT SENNAR TO REACH DELTA BARRAGE.

Method of Determination.

Characteristic points on the gauge diagram at Makwar were traced to the gauge diagram of Khartum gauge. The number of days for the points to reach Khartum depends upon the level of the river. The number of days was therefore plotted against the gauge reading at Makwar and a mean curve drawn through the points.

The lag for a given date is obtained by reading from this curve the lag corresponding to the gauge on that date. This is the only practicable method which can be employed.

The same method has been adopted for the reaches Tamaniat to Wadi Halfa, Wadi Halfa to Aswan and Aswan to El-Leisi, and the lag in the different reaches added together to make the total lag.

One day was added for the lag from El-Leisi to Delta Barrage and 0.7 day for the lag from Khartum to Tamaniat.

This method, using the curves obtained by Dr. Phillips, was checked by Dr. Hurst for the early part of January at Makwar. Dr. Hurst used similar methods, but traced the characteristic points over different stretches of the river.

The following are the results obtained :

	Days.
Dr. Hurst, First Method.	
Makwar, date (approximate) January 6-15, mean gauge (1919-24) 6.00, lag to Soba. . . .	4.9
Soba, date (approximate) January 11-20, mean gauge Khartum 10.94, lag to Tamaniat. .	.8
Tamaniat, date January 12-21, mean gauge 10.64, lag to Atbara.	3.1
Atbara, date January 16-25, mean gauge 10.47, lag to Halfa.	10.6
	19.4
Dr. Hurst, Second Method.	
Makwar, date January 6-15, mean gauge 6.00, lag to Khartum.	5.3
Khartum, date January 11-20, mean gauge 10.94, lag to Halfa.	14.9
	20.2
Dr. Phillips.	
Makwar, date January 6-15, mean gauge 6.00, lag to Khartum.	5.7
Assumed, Soba to Tamaniat	1.0
Tamaniat, date January 13-22, gauge 10.61, lag to Halfa	14.7
	21.4
Halfa, date January 28-February 6, gauge 2.12, lag to Aswan.	3.5
Collecting Results.	
Makwar to Khartum.	
Dr. Hurst (1)	5.3
Dr. Hurst (2)	5.3
Dr. Phillips	5.7
Mean	5.4
Khartum to Halfa.	
Dr. Hurst (1)	14.1
Dr. Hurst (2)	14.9
Dr. Phillips	15.7
Mr. Watt	15.5
Mean	15.0
Halfa to Aswan.	
Dr. Phillips	3.5
Mr. Watt	3.5
Mean	3.5

Mean Makwar to Aswan is therefore 23.9, say 24 days.

Using the ordinary curves obtained by the Hydrological Service of the Physical Department, the lag from Aswan to Delta Barrage corresponding to the mean gauge (1919-24) at Aswan for February 1-10 is 10 days.

Mean lag from Makwar to Delta Barrage is therefore 34 days.

In the same way the mean lag from Makwar to Delta Barrage for the years 1912-25 was determined for the 15th July at Makwar and was found to be 27 days.

For specially low years the lag was worked out for each individual case.

(Signed) H. E. HURST,
Director-General, Physical Service.

N° 2103

APPENDIX C.

TOTAL DISCHARGE ROSETTA AND DAMIETTA BRANCHES, JULY-AUGUST.

(Millions of cubic metres per day.)

Date at Barrage	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	Mean
July 20	10	0	0	1	0	20	62	2	23	1	0	23	24	16	13
25	12	0	0	6	0	50	57	9	35	1	1	24	40	24	18
August 1	21	0	0	9	92	93	75	34	125	13	30	44	93	28	47
5	23	0	0	12	265	110	125	87	140	16	47	74	120	43	76
10	125	0	38	27	410	170	150	190	220	40	135	250	200	84	146
15	330	17	270	61	490	370	195	340	340	190	280	350	340	149	266
20	390	22	460	165	550	460	240	390	360	360	450	440	370	284	346
25	450	40	480	195	550	400	300	365	500	375	440	525	420	335	384
31	430	115	515	200	595	395	345	355	510	385	435	515	530	327	404

TIME LAGS EMPLOYED IN DIAGRAM NO. 1.

Year	Makwar Date	Lag in Days to Delta Barrage	Corresponding Delta Barrage Date
1913	July 15	33 days	August 17
	,, 31	28 ,,	,, 28
	August 31	22 ,,	September 22
1915	July 15	30 days	August 14
	,, 31	22 ,,	,, 22
	August 31	22 ,,	September 22
Mean year, 1912 to 1925	July 15	27 days	August 11
	,, 31	21 ,,	,, 21
	August 31	19 ,,	September 19

(Signed) H. E. HURST,
Director-General, Physical Service.

APPENDIX D.

TABLE SHOWING APPROXIMATE VOLUME EXTRACTED FROM THE RIVER TO RAISE THE LEVEL TO FULL CANAL SUPPLY LEVEL ON JULY 31, THE LEVEL IN THE CANAL BEING RAISED FROM SUMMER LEVEL TO FULL SUPPLY LEVEL IN THE SAME PERIOD.

(Figures reproduced from " Nile Control ", p. 87.)

Day of July	Reservoir Level	Corresponding Contents of Reservoir	Volumes taken from River to raise U. S. Level		Level in Canal	Volume taken by Canal	Total Volume taken from River
	R. L.	Millions of Cubic Metres	Millions of Cubic Metres	Cubic Metres per Sec.	R. L.	Cubic Metres per Sec.	Cubic Metres per Sec.
15	414.50	68.5	—	—	414.50	10	10.0
16	414.60	73.8	5.3	61.4	414.60	11	72.0
17	414.70	79.1	5.3	61.4	414.70	14	75.0
18	414.80	84.4	5.3	61.4	414.79	16	77.0
19	414.90	89.7	5.3	61.4	414.89	18	79.0
20	415.00	95.0	5.3	61.4	414.99	20	81.0
21	415.20	107.0	12.0	139.0	415.18	25	164.0
22	415.40	119.0	12.0	139.0	415.38	31	170.0
23	415.60	131.4	12.4	144.0	415.58	37	181.0
24	415.80	144.2	12.8	148.0	415.77	43	191.0
25	416.00	157.0	12.8	148.0	415.97	49	197.0
26	416.20	172.0	15.0	174.0	416.17	55	229.0
27	416.40	187.0	15.0	174.0	416.36	62	236.0
28	416.60	202.0	15.0	174.0	416.55	69	243.0
29	416.80	217.0	15.0	174.0	416.74	75	249.0
30	417.00	232.0	15.0	174.0	416.94	84	258.0
31	417.20	250.0	18.0	208.0	416.94	84	292.0

Canal Head Discharge, from table on p. 108.

August 1st to November 30th . . . . . 84 cubic metres per second.
December 1st to January 15th . . . . . 80 ,, ,,
January 15th to 18th . . . . . 52 ,, ,,

APPENDIX E.

CRITERION FOR DETERMINING THE DATE AT WHICH WATER MAY FIRST BE ABSTRACTED FROM THE RIVER AT MAKWAR AT THE BEGINNING OF THE FLOOD.

Makwar Date	Makwar Discharge Mills./Day	Malakal Date	Malakal Discharge Mills./Day	Sum of Makwar and Malakal Discharges
1913				
June 21–30	5.9	June 11–20	57.0	62.9
July 1–10	32.1	21–30	56.5	88.6
11–20	60.9	July 1–10	67.6	128.5
21–31	92.1	11–20	72.7	164.8
Aug. 1–10	153.0	21–31	77.1	230.1
1915				
June 21–30	64.4	June 11–20	61.3	125.7
July 1–10	56.0	21–30	69.6	125.6
11–20	101.0	July 1–10	74.2	175.2
21–31	179.0	11–20	78.5	257.5
Aug. 1–10	325.0	21–31	83.3	408.3

Diagram No. 1 shows that in 1915 there was just sufficient water for Sudan to begin taking water at Makwar on the 11th July. Sum of Makwar and Malakal at this date equals 142 mills/day.

Same diagram shows that in 1913 sufficient supply for Sudan to begin to take water was not reached until the 20th July. Sum of Makwar and Malakal reached 142 mills/day on the 21st July as at Makwar.

In each case the discharge in the previous five days was approximately 135 mills/day.

(Signed) H. E. HURST.
Director-General, Physical Service.

APPENDIX F.

APPROXIMATE REDUCTION IN ASWAN GAUGE DUE TO ABSTRACTION OF 100, 150 AND 200 CUBIC METRES PER SECOND AT ASWAN DURING LOW FLOODS OF 1911, 1913, 1915 AND 1918.

(Aswan Discharges to nearest 100 cubic metres per second. Reductions to nearest centimetre.)

	1911				1913				1915				1918			
	Mean Discharge Cu. m.sec.	Reduction in Centimetres			Mean Discharge Cu. m. /sec.	Reduction in Centimetres			Mean Discharge Cu. m. /sec.	Reduction in Centimetres			Mean Discharge Cu. m. /sec.	Reduction in Centimetres		
		100	150	200		100	150	200		100	150	200		100	150	200
August 1–10	3,100	9	13	18	1,500	13	19	26	2,200	11	16	21	3,600	8	13	17
11–20	4,800	7	10	14	2,000	11	16	22	4,500	7	11	15	5,000	7	11	14
21–31	8,200	5	8	10	3,500	8	13	17	5,000	7	10	14	6,400	6	9	12
September 1–10	8,800	5	7	9	4,600	7	11	15	5,200	7	10	14	7,800	5	8	10
11–20	9,600	4	6	8	4,700	7	10	14	5,600	6	10	13	7,000	5	8	11
21–30	8,700	5	7	9	4,500	7	11	15	6,500	6	8	11	6,000	6	9	12
October 1–10	6,900	5	8	11	3,700	8	12	16	6,300	6	9	12	5,200	7	10	14
11–20	5,500	7	10	13	2,800	10	14	19	5,600	6	10	13	4,300	8	11	15
21–31	4,700	7	10	14	2,200	11	16	21	4,700	7	11	14	3,500	8	13	17

(Signed) H. E. HURST.
Director-General, Physical Service.

APPENDIX G.

EXPLANATORY NOTE.

Date on which Shortage Occurred in Lower Egypt.

The dates on which the Rosetta and Damietta Branches were closed established a definite limit to the period of excess supply.

The dates are, however, not sufficient in themselves to fix the actual date on which shortage of supply was first felt, as water may be passing down the Nile branches for utility purposes and the canal discharges definitely limited to supply the Nile branches.

Damietta Branch. — Water in this branch is required for irrigation purposes through the Zifta main canals. A further supply is required during the construction of the Faraskour sadd in order to keep back the salt water.

Shortage is therefore considered to have been established if the discharge over Zifta Weir is less than 5 millions and no other water is available to increase this discharge.

Rosetta Branch. — Little or no water is required for irrigation, but a certain minimum discharge must be maintained during the last weeks of the construction of the Mehallet-el-Amir sadd to keep back the salt water.

This minimum discharge is considered to be :

5 millions for one week before the ideal date for closing the sadd.

10 millions for last week but one before the ideal date for closing the sadd.
15 millions for last week but two before the ideal date for closing the sadd.

Shortage is therefore considered to have been established if and when the available excess discharge falls below these figures.

The ideal date for closing the sadd is considered to be the date on which the total supply is equal to the total demand for irrigation purposes only, plus 5 millions over Zifta Weir. This date corresponds with the date of closure of the Rosetta Branch unless excess water is still available in the Damietta Branch.

The accompanying table shows the date necessary to establish the actual date of shortage on the above assumptions.

The records from 1919 onwards are complete and the date arrived at may be taken as correct.

The records before 1919 are less complete and the dates arrived at are therefore less reliable.

Furthermore, the system of feeding Zifta Circle down the Damietta Branch was not a routine procedure before 1919, and it is therefore less easy to determine whether water supplied to the Damietta Branch was for irrigation purposes or was actually in excess of the demand.

The question as to when shortage occurred has been considered for the years before 1919, in exactly the same way as for the period after 1919, that is to say, as if the present system of feeding Zifta down the Damietta Branch had been established.

Except in certain individual years the dates finally arrived at are fairly definite and may be accepted as such.

In any year such as 1923 there is a comparatively long period throughout which the excess, if any, was very small, and the exact date of shortage is difficult to establish.

(Signed) A. D. BUTCHER,
Director Delta Barrage.

DATE AT DELTA BARRAGE ON WHICH ALL WATER WAS REQUIRED FOR IRRIGATION OR CONSTRUCTION OF SADDS.

Year		Rosetta Branch				Damietta Branch				Zifta Weir	A	Remarks
		Closed	Last Day of Discharge			Closed	Last Day of Discharge					
			5 Mil.	10 Mil.	15 Mil.		5 Mil.	10 Mil.	15 Mil.	5 Mil.		
Records good	1925...	F. 23	F. 21	F. 15	F. 11	M. 17	M. 5	F. 20	F. 14	F. 15	F. 11[1]	[1] There was a flush on the Damietta Branch, February 25 to March 2.
	1924...	F. 23	F. 18	F. 12	F. 9	M. 19	M. 9	M. 3	F. 29	M. 4	Feb. 9	[2] The date is rather indefinite, but between February 6 and February 13.
	1923...	M. 4	F. 27	F. 23	F. 20	M. 23	M. 17	F. 6	J. 31	F. 7	» 13[7]	[3] Subsequently reopened for flush and finally closed March 6, about.
	1922...	F. 25	F. 10	F. 8	F. 6	M. 23	M. 16	F. 18	F. 11	F. 15	» 11[2]	[4] Shortage occurred February 7 to 20, but final shortage not until March 9.
	1921...	F. 23	F. 13	F. 13	F. 13	F. 22	F. 22	F. 15	F. 15	F. 9	» 13	[5] Flush to Faraskour Pool to clear out salt.
	1920...	F. 24	F. 19	F. 9	F. 8	F. 14	F. 12	F. 4	J. 28	F. 2	» 8	[6] Damietta Branch was opened and closed again several times.
	1919...	F. 15	F. 15	F. 11	F. 11	J. 16[3]	M. 5[8]	J. 8	D. 28	J. 15	» 12	[7] There was no excess from February 4 to February 22, and a mean date has been taken as February 13.
										Mean	Feb. 11	[8] Also on January 13.
Records less Reliable	1918...	Not closed		...	...	A. 4	...	...	...	...	...	
	1917...	A. 5	A. 4	M. 29	M. 26	A. 27[6]	A. 23	A. 19	A. 18[5]	...	M. 30	
	1916...	F. 15	F. 14	F. 14	F. 9	F. 11	F. 11	J. 11	J. 11	J. 12	Feb. 10	
	1915...	M. 10	M. 9	M. 8	M. 6	F. 14[1]	F. 11	J. 13	J. 13	...	» 7[4]	
	1914...	F. 12	F. 10	F. 7	F. 3	November 29, 1913				...	» 3	
	1913...	M. 3	M. 1	F. 16	F. 11	M. 10	M. 8	J. 30	J. 21	...	» 11	
	1912...	F. 16	F. 15	F. 13	F. 12	F. 27	F. 25	F. 25	F. 22	...	» 12	
	1911...	M. 30	M. 28	M. 18	F. 22	M. 25	M. 14	M. 13	F. 23	...	» 22	
	1910...	Ap. 7	A. 5	A. 5	M. 31	Not closed	M. 1	...	...	...	Mar. 22	
										Mean	Feb. 21	
Records become Unreliable	1909...	M. 19	M. 25	M. 25	M. 21	M. 6	M. 5	M. 5	M. 5	No Records	Mar. 16	
	1908...	M. 16	M. 12	M. 4	M. 2	F. 10	F. 9	F. 6	F. 4		Feb. 25	
	1907...	M. 27	F. 9	F. 9	F. 9	M. 16	M. 14	M. 5	M. 1	...	M. 3	
	1906...	M. 25	M. 25	M. 22	M. 13	F. 28	F. 27	F. 20	F. 20	...	» 20	
	1905...	M. 23	M. 19	M. 16	M. 9	M. 12	M. 11	F. 21	F. 20	...	» 20	
	1904...	M. 5	M. 5	M. 5	M. 5	A. 12	A. 11	A. 6	M. 28	...	Mar. 18	
	1903...	M. 22	M. 16	M. 10	M. 5	December 17, 1902				...	Feb. 27	
	1902...	M. 23	M. 21	M. 5	F. 26	December 13, 1901				...	» 13	

Note A. — The dates shown in the last column are the first dates on which there was no water in the Rosetta and Damietta Branches in excess of that required for irrigation and for the construction of the Nile Sadds.

(Signed) A. D. BUTCHER,
Director, Delta Barrage.

(Signed) H. E. HURST,
Director-General, Physical Service.

APPENDIX H.

Explanatory Note on Diagram No. 5.

The year 1919-20 has been chosen as a means of determining the critical date for various stages of expansion. All these dates fall in the first part of February (Barrage). The following list shows that from the point of view of the critical date 1919-20 was probably the lowest of recent times [1], excepting 1913-14. Hence the dates will fall earlier in this year than in most others.

Monthly Totals—February.

Million Cubic Metres.

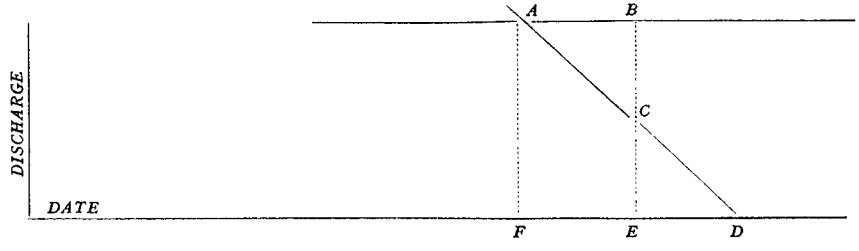
Year	Aswan Natural River	Delta Barrage Branches
1913	2,020	1,000
1914	1,150	200
1915	3,060	700
1916	2,400	600
1917	3,920	1,300
1918	3,990	1,300
1919	2,180	936
1920	2,110	438
1921	2,340	999
1922	2,090	726
1923	2,350	728
1924	2,650	902

It has been assumed that all the discharge of December, January and February down the Damietta Branch was required, as it was plainly being regulated. The Rosetta discharge therefore has been taken as representing surplus. In the diagram a smoothed curve has been drawn for this.

The discharge required for extra cultivation developable from the Gebel Aulia Dam has been taken as 12 millions per day, except in January, when it would be practically zero. This has been obtained by supposing the storage of the Gebel Aulia reservoir to be the equivalent of 2 milliards at Aswan, and this will be required to give water for 170 days to summer cultivation, or at the rate of 12 millions per day. Failing information as to how this water will be used, it is not worth while making more elaborate assumptions.

The losses in Gebel Aulia have been taken as 11 millions per day while it is standing full, on information obtained from Mr. Tabor.

The date has been determined as follows :



A D is available discharge. *B E* required discharge.
A B C = *C D E* and *E* is the critical date.

[1] The surplus at the Delta Barrage in February was less in 1920 than in any other year excepting 1914.

The closing of the sadds has not been considered, as when once extra water is available in Egypt the present arrangements for closing will need reconsideration, and the sadds will probably be closed earlier.

(Signed) H. E. HURST,
Director-General, PhysicalService.

APPENDIX I.

EXPLANATORY NOTE ON DIAGRAM No. 6.

All discharges shown in the diagram are referred to dates at the Delta Barrage by introducing the appropriate lag, but without transmission losses.

Discharges are the actual means of the six years from November 1918 to February 1924, the period during which the records are most reliable and complete.

Delta Canals + Ibrahimia. — The discharges shown include the Damietta branch of the Nile which, at this season of the year, may be considered as a channel serving the canals at Zifta Barrage and riverain cultivation.

Addition for Land Developed by Gebel Aulia.

In default of a complete programme for the utilisation of the Gebel Aulia water, it has been assumed that the whole of the storage there available will be used during the period of shortage and for the development of new areas, so that a corresponding increase of water for irrigation during the period of excess will also be required.

No substantial error is made by considering that this increase will be necessary at the Delta Barrage, or to make good a deficit at the Barrage caused by the development of areas further south.

It is further assumed that the increase of water required from December to February will be proportional to the increase in the total summer supply available.

This is arrived at as follows :

Average date on which Aswan Reservoir is empty, 1919-24, 20th July.
Beginning of summer conditions assumed 1st February.
Mean total discharge passing Aswan, February 1st-July 20th, 1919-24, 12,340 mills.
Mean total losses for same period, February 1st-July 20th, 1919-24, 340 mills.
Mean total discharge available for Delta Canals and Ibrahimia, 12,000 mills.
Estimated total increase due to Gebel Aulia, 2,700 mills.

Hence estimated increase in water requirements during December, January and February, 22 per cent.

Twenty-two per cent has therefore been added to the curve for Delta Canals + Ibrahimia to represent water requirements after the completion of Gebel Aulia.

Gezira Canal and Sennar Reservoir. — The water requirements for the Gezira Canal and Reservoir have been taken direct from " Nile Control ", and have been deducted from the discharge available at Cairo without any adjustments for losses. The effect of allocating a discharge of 7 millions to the Sudan in December in addition to the " Nile Control " figures is also shown.

Aswan Reservoir. — The area between the Aswan natural river and the Cairo discharge curve represents the water taken to fill the Aswan Reservoir, but to the quantity shown (namely, 2,042 millions) the gains which occur between Aswan and Cairo must be added in order to arrive at the full contents of the reservoir.

Water for Closing Sadds. — A considerable quantity of water is required, under existing circumstances, in order to maintain a flow through the Nile Sadds at Faraskour and Mehallet-el-Amir during their construction in February, when surplus water has usually been available in the past.

The completion and full exploitation of the Gebel Aulia Reservoir will, however, put back the date when shortage begins and necessitate earlier closure of the sadds in the future, and the water necessary is therefore shown at a correspondingly earlier date.

From the diagram it is clear that, on the mean of the years 1918-24, all demands can be satisfied in full up to the 10th February. From the 10th to the 22nd February (the date corresponding to " Nile Control's " 18th January at Sennar), future demands cannot be satisfied in full, but a total cube of 140 millions will still be available above present requirements.

(Signed) A. D. BUTCHER,
Director, Delta Barrage.

APPENDIX J.

ASWAN NATURAL RIVER.

Total Discharge in Millions of Cubic Metres.

	December	January	Total
1905–06	5,100	4,060	9,160
1906–07	5,590	4,320	9,910
1907–08	4,480	3,550	8,030
1908–09	5,750	4,250	10,000
1909–10	6,420	5,030	11,450
1910–11	6,020	4,500	10,520
1911–12	5,370	3,800	9,170
1912–13	4,220	3,240	7,460
1913–14	2,810	1,720	4,530
1914–15	6,700	4,500	11,200
1915–16	5,260	3,840	9,100
1916–17	7,510	5,270	12,780
1917–18	7,250	5,270	12,520
1918–19	4,620	3,440	8,060
1919–20	4,410	3,340	7,750
1920–21	5,310	3,790	9,100
1921–22	4,690	3,540	8,230
1922–23	4,950	3,630	8,580
1923–24	5,200	3,990	9,190
1924–25	5,500	3,840	9,340
Mean, 1905–06 to 1924–25	5,358	3,946	9,304
" 1918–19 to 1923–24	4,863	3,621	8,485

(Signed) H. E. HURST,
Director-General, Physical Service.

APPENDIX K.

ASWAN NATURAL RIVER DISCHARGES.
10-Day Totals in Millions of Cubic Metres.

Date	1919	1920	1921	1922	1923	1924	Mean mills day
Jan. 1–10.	1,207	1,216	1,361	1,255	1,267	1,400	128.4
11–20.	1,144	1,093	1,205	1,135	1,160	1,300	117.3
21–31.	1,087	1,033	1,227	1,149	1,206	1,292	106.0
Feb. 1–10.	858	822	933	889	990	1,021	91.9
11–20.	768	721	846	718	812	933	80.0
21–28. . . . . }	556	570	559	480	547	693	68.1
29. . . . . }							
Mar. 1–10.	669	582	636	538	568	648	60.7
11–20.	607	523	549	477	489	609	54.2
21–31.	633	561	554	446	488	592	49.6
Apr. 1–10.	521	466	458	371	417	455	44.8
11–20.	503	466	433	333	383	434	42.5
21–30.	483	436	417	302	397	430	41.1
May 1–10.	457	411	399	284	407	480	40.6
11–20.	446	395	369	243	456	459	39.5
21–31.	443	416	402	282	516	534	39.3
June 11–10	423	375	343	271	405	511	38.8
11–20.	483	406	451	269	596	546	45.8
21–30.	625	925	514	365	1,045	574	67.5
July 1–10.	673	1,009	639	556	1,127	699	78.4
11–20.	1,125	1,420	894	727	1,145	1,476	113.1
21–31.	2,117	2,690	1,401	1,877	2,027	2,708	194.2
Aug. 1–10.	3,966	4,089	2,723	3,417	4,480	4,076	379.2
11–20.	6,060	6,007	5,379	6,830	7,211	6,024	625.2
21–31.	6,986	8,382	7,275	8,156	9,437	8,962	745.4
Sept. 1–10.	6,921	6,721	6,967	8,856	8,078	7,722	754.4
11–20.	7,398	5,673	6,096	9,798	7,169	8,553	744.8
21–30.	7,190	5,089	6,414	7,659	7,167	7,224	679.0
Oct. 1–10.	5,789	5,220	6,076	5,806	6,902	5,854	594.1
11–20.	3,970	4,918	4,861	5,543	5,837	4,958	501.4
21–31.	3,282	4,520	4,034	4,966	4,445	4,053	383.3
Nov. 1–10.	2,420	3,558	2,964	3,418	2,808	2,827	299.9
11–20.	1,989	2,770	2,321	2,686	2,264	2,522	242.5
21–30.	1,728	2,170	1,949	2,201	2,009	2,516	209.6
Dec. 1–10.	1,569	1,937	1,677	1,821	1,828	2,059	181.5
11–20.	1,419	1,715	1,524	1,571	1,668	1,750	160.8
21–31.	1,426	1,662	1,491	1,557	1,708	1,695	144.5

Total of mean natural river 21st January to 31st July corresponding approximately to 1st January to 15th July at Sennar = 13,214 million cubic metres.

(Signed) H. E. HURST,
Director-General, Physical Service.

No. 2.

LORD LLOYD TO MOHAMED MAHMOUD PASHA[1].

THE RESIDENCY, CAIRO, *May* 7, 1929.

SIR,

I have the honour to acknowledge receipt of the note which your Excellency has been good enough to address to me to-day.

2. In confirming the arrangements mutually agreed upon as recited in your Excellency's note, I am to express the gratification of His Britannic Majesty's Government in the United Kingdom of Great Britain and Northern Ireland that these discussions have led to a settlement which cannot fail to facilitate development and to promote prosperity in Egypt and the Sudan.

3. His Majesty's Government in the United Kingdom concur in your Excellency's view that this agreement is, and should be, essentially directed towards the regulation of irrigation arrangements on the basis of the Nile Commission Report, and has no bearing on the *status quo* in the Sudan.

4. In conclusion, I would remind your Excellency that His Majesty's Government in the United Kingdom have already acknowledged the natural and historical rights of Egypt in the waters of the Nile. I am to state that His Majesty's Government in the United Kingdom regard the safeguarding of those rights as a fundamental principle of British policy, and to convey to your Excellency the most positive assurances that this principle and the detailed provisions of this agreement will be observed at all times and under any conditions that may arise.

I avail, etc.

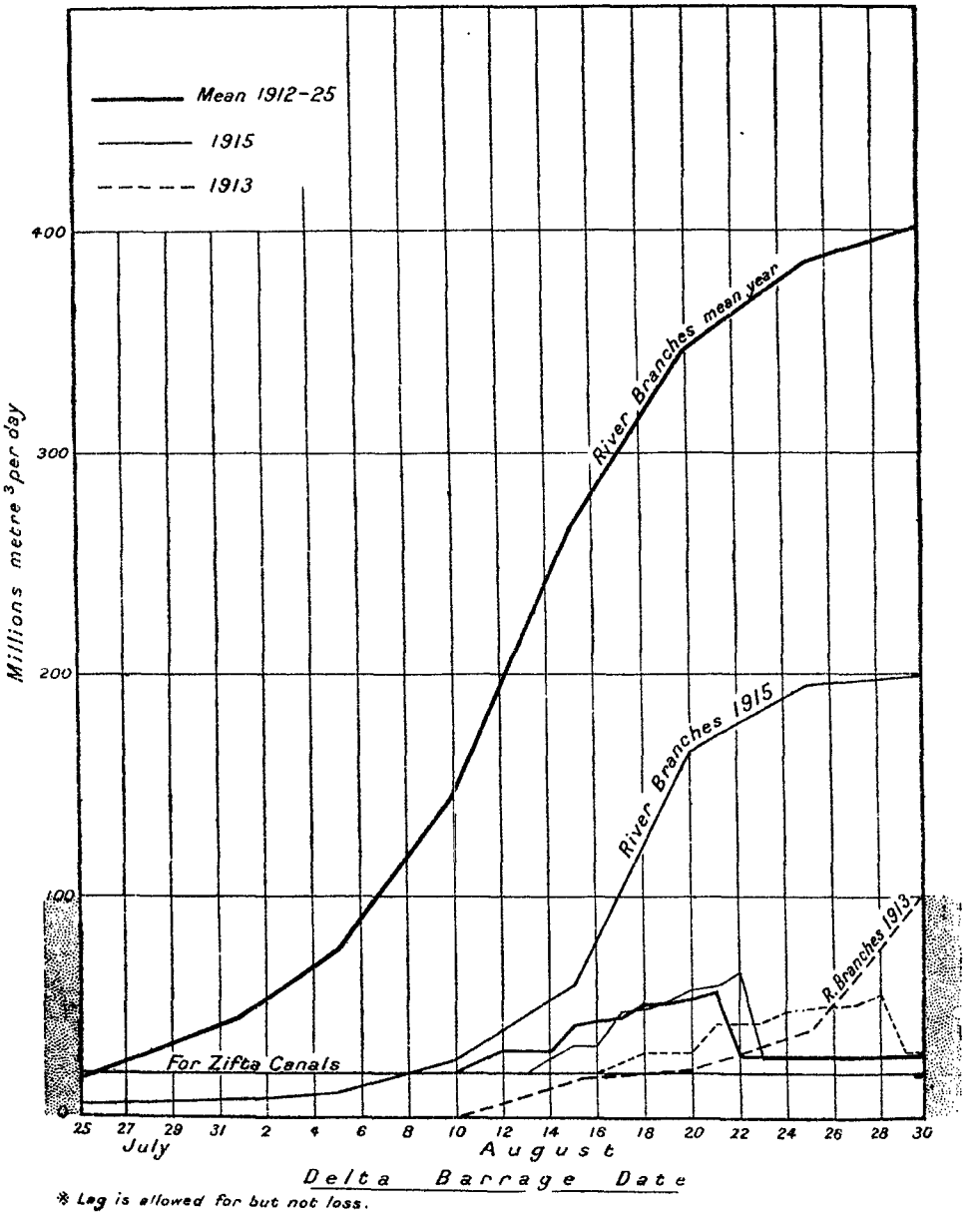
LLOYD,
High Commissioner.

---

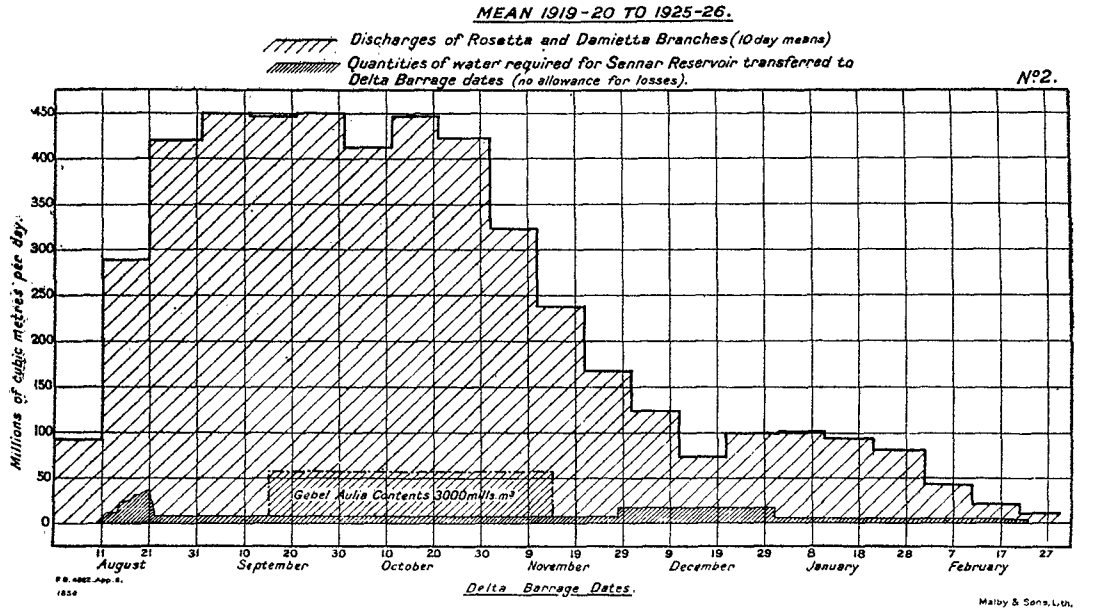
[1] Pour la note N° 1, voir page 44, de ce volume.

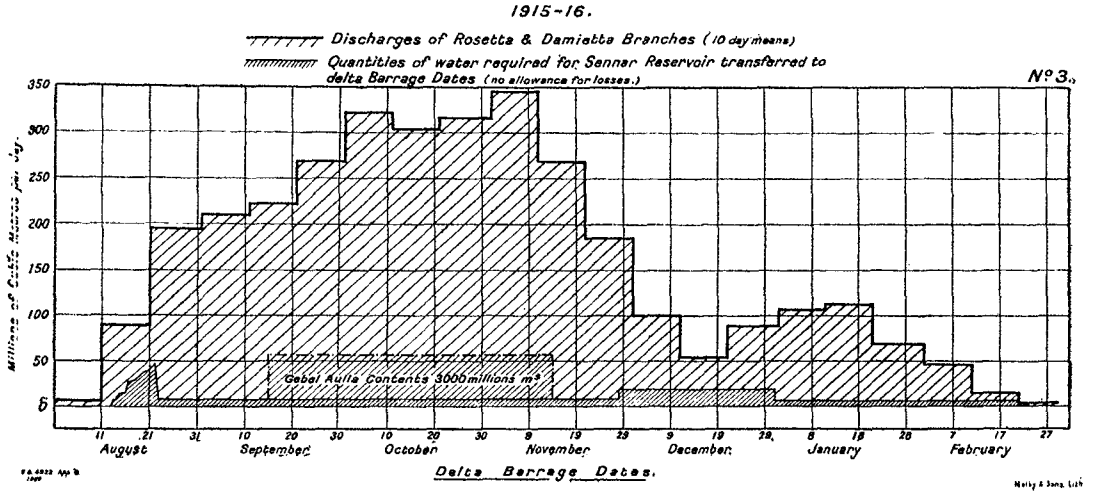
※ *Water taken for Sennar Reservoir & Gezira Canal transferred to Delta Barrage and sum of Discharges of Rosetta and Damietta Branches.*

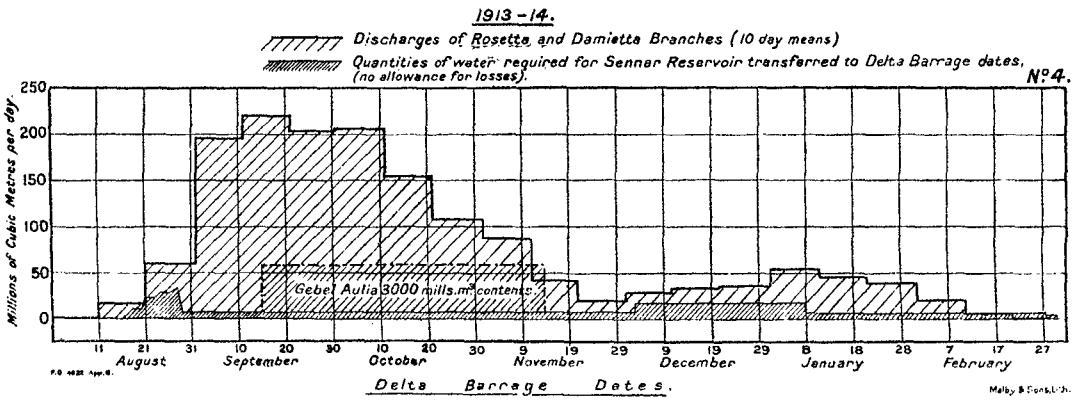
N° 1.

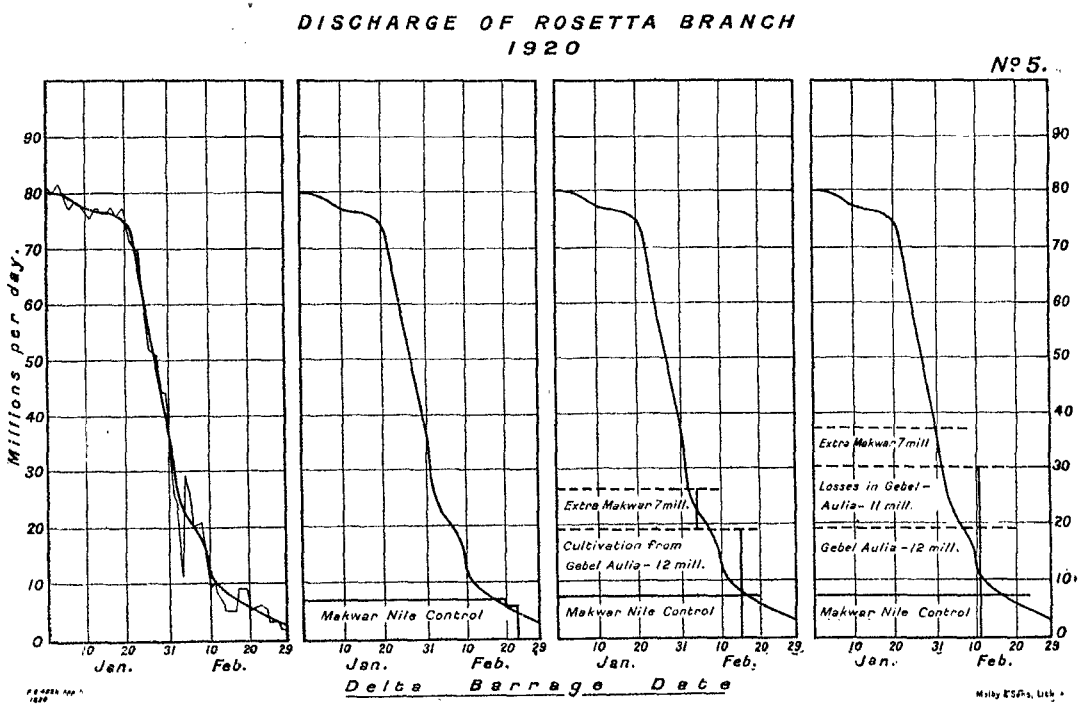


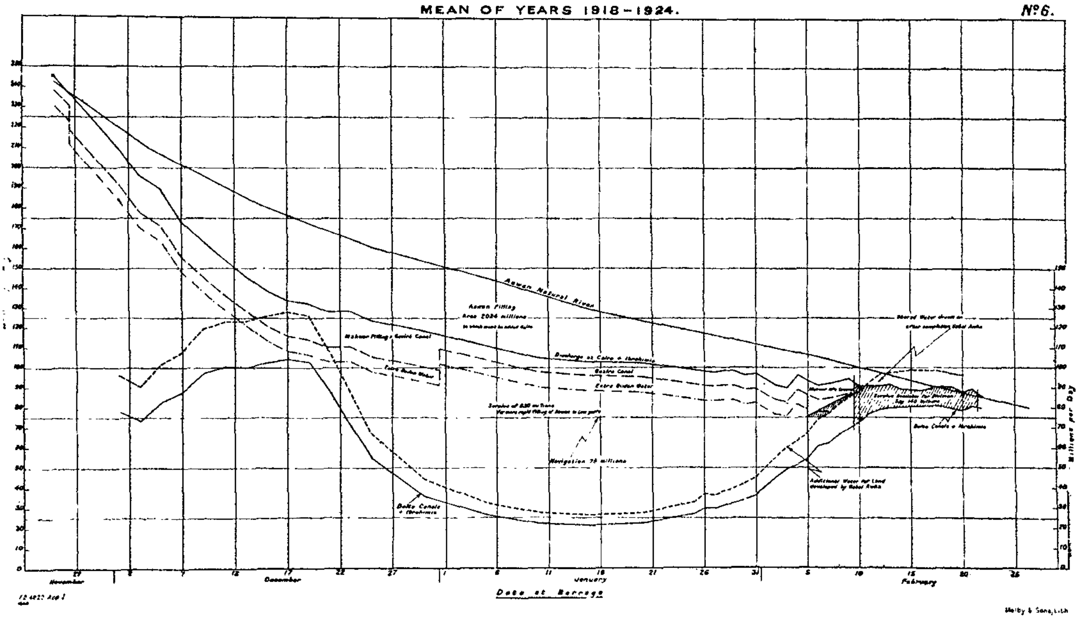
※ *Leg is allowed for but not loss.*

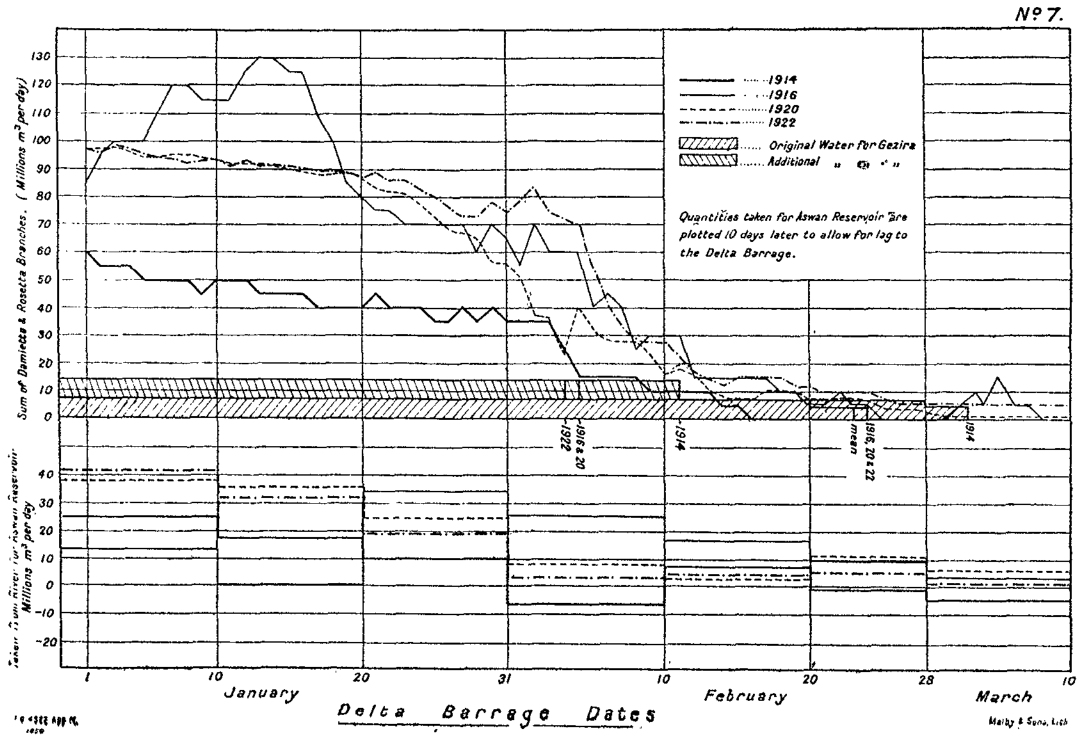

MEAN 1919-20 TO 1925-26.
Discharges of Rosetta and Damietta Branches (10 day means)
Quantities of water required for Sennar Reservoir transferred to Delta Barrage dates (no allowance for losses).
No. 2.
Millions of cubic metres per day.
Gebel Aulia Contents 3000 millions m³
August
September
October
November
December
January
February
Delta Barrage Dates.
Malby & Sons, Lith.


1915-16.
Discharges of Rosetta & Damietta Branches (10 day means)
Quantities of water required for Sennar Reservoir transferred to delta Barrage Dates (no allowance for losses.)
No. 3.
Gebel Aulia Contents 3000 millions m³
August
September
October
November
December
January
February
Delta Barrage Dates.


1913-14.
Discharges of Rosetta and Damietta Branches (10 day means)
Quantities of water required for Sennar Reservoir transferred to Delta Barrage dates, (no allowance for losses).
No 4.
Millions of Cubic Metres per day.
250
200
150
100
50
0
Gebel Aulia 3000 mills. m³ contents.
11 21 31 10 20 30 10 20 30 9 19 29 9 19 29 8 18 28 7 17 27
August
September
October
November
December
January
February
Delta Barrage Dates.


DISCHARGE OF ROSETTA BRANCH
1920
No 5.
Millions per day.
90
80
70
60
50
40
30
20
10
0
Jan.
Feb.
Makwar Nile Control
Extra Makwar 7 mill.
Cultivation from Gebel Aulia - 12 mill.
Losses in Gebel-Aulia - 11 mill.
Gebel Aulia - 12 mill.
Delta Barrage Date


MEAN OF YEARS 1918-1924.
Nº6.
Aswan Natural River
Navigation 75 millions
Delta Canals
Date at Barrage
Melby & Sons, Lith.


Nº 7.
1914
1916
1920
1922
Original Water for Gezira
Additional " " "
Quantities taken for Aswan Reservoir are plotted 10 days later to allow for lag to the Delta Barrage.
Sum of Damietta & Rosetta Branches. (Millions m³ per day)
Millions m³ per day
1922
1916 & 20
1914
mean
1916, 20 & 22
1914
1
10
20
31
10
20
28
10
January
February
March
Delta Barrage Dates
Malby & Sons, Lith.