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## Economic Commission for Asia and the Far East

CONTENTS

## WATER TARIFFS

It was suggested at the ninth session of the Economic Commission for Asia and the Far East held in Bandung early in 1953 that information on water tariffs be included in the programme of work of the Bureau of Flood Control, relating to dissemination of technical information on flood control and water resources development.

In compliance with the wishes of the Commission a circular letter was issued to the various governments of the region in April 1953 soliciting information in general on the subject, including departmental or other publications covering the ground and the following items in particular:

1. The basis on which water tariffs are calculated: whether water charges are based on the volume of water delivered or area irrigated irrespective of volume of water used, or according to the kind of crop. If based on the volume of water, the method of measurement employed. If not based on volume, the practical difficulties in the way of selling water by volume.

   If the water charge varies according to crops, the charges for different crops may be given, and whether charges are made for each watering or for the whole crop. Also whether water charge is based on area irrigated without consideration of the kind of crop.

2. Relation of charges for water to the value of crops and their water requirements.

3. When an irrigation project benefits proprietory lands and enhances their value, are any additional taxes imposed on the beneficiaries? If so, the amount and basis of calculation of such taxes may be given.

4. What, if any, penalties are imposed for wastage of irrigation water?

/5. Is there

5. Is there any difference in charges for water used for irrigation from different sources such as rivers, reservoirs or tubewells? What is the basis for such differences?

6. Are there any changes under consideration or proposed for charges for the supply of water for irrigation? If so, details may be supplied.

7. What is the average cost per acre of operation and maintenance expenses as compared with the charges for water?

8. Is the interest on capital investment and amortization taken into account when fixing charges for the water supplied for irrigation and other purposes.

The replies received from various countries of the region are given below:

A. BURMA

The water tariffs are based on area irrigated, irrespective of volume of water used or kind of crop grown, but depend on the soil classification as fixed by settlement operations. The soil classification is dependent on the money value of the produce of the land. Water rates are received as irrigation credit, as a share in the revenue assessed at consolidated rates on land irrigated from government works. This irrigation credit ranges from 69 per cent to 83.5 per cent of the revenue demand at consolidated assessment rates in certain areas, and from the whole consolidated rates less annas[1/] 2 to annas 12 per acre in other areas.

As irrigation water supply is made through pipe outlets, open masonry outlets etc., to water courses feeding many holdings through open channels, it is impracticable to measure the quantity of water supplied to each holding and thus the sale of water by volume is not possible.

/The consolidated

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1/ 16 annas = one rupee

The consolidated rate is fixed on soil classification taking into consideration extra revenue accruing from land which would not be assessed if irrigation works had not been constructed, and bears no relation to particular value of crops sown or its water requirements.

When an irrigation project benefits land and enhances its value, taxes are imposed as mentioned above, as irrigation credit is calculated at a certain percentage of the total demand assessed annually on the area benefited by government irrigation.

The penalty for wastage of canal water may be upto a fine not exceeding Rs.500/- or imprisonment for a term not exceeding 3 months or both.

At present all irrigation water supplied for cultivation is assessed on the same basis irrespective of the source of supply. No irrigation from tubewells has yet been provided. However, for supply of water for purposes other than for cultivation, the following charges are made irrespective of the source of supply of the water:

| | |
|---|---|
| For the supply of water in bulk | K[1/] 1.50 for 2,500 cu ft of water |
| For brickmaking, etc. | K 0.25 for 100 cu ft of water |
| For laying cement concrete and masonry | K 0.19 for 100 cu ft of water |
| For installing roads | K 15.00 per mile of road |
| For watering trees | K 0.05 per tree per annum |

No changes are under consideration or proposed for charges for the supply of water for irrigation. When lift irrigation is provided, perhaps, different charges will be introduced.

The average cost per acre of operation and maintenance expenses is K 1.69 as compared with K 3.6 for charges of water.[2/]

/B. CAMBODIA

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1/ K stands for Kyatt. 4.76 Kyatt = US$1.

2/ These figures have been taken from the irrigation works for the year 1933-34.

B. CAMBODIA

All irrigation works are undertaken by the State Government. Irrigation is done principally for the cultivation of rice. Water which is distributed for irrigation purposes in Cambodia is free of charge. As a result of this, the relation between the values of crops and the needs for watering the crops has never been studied. But when irrigation helps real estate properties, the land, thus made richer, is examined at the time of classification for an indication of real estate taxes.

The opening and closing of sluices for the distribution of water is the responsibility of special officials under the control of the agricultural hydraulic department in those works where irrigation is controlled. Therefore, there is no waste of water. In the networks where irrigation is carried out by the utilization of gravity flow, the water is abundant and waste is not to be feared.

In view of the fact that there are no water supply tariffs, on the one hand, and in view of private investments in the agricultural field, on the other, the question of fixing water rates in the light of interest on capital investment and amortization does not arise at all in Cambodia, which is a small country where each one is looking after the soil for himself, be he the big landlord or a small one. Reclassification of land for the establishment of taxes is the only form which could be applied in this matter.

C. CEYLON

The main crop irrigated in Ceylon is rice. No water charge is recovered but a maintenance rate is levied on irrigable area instead. There is a fixed charge and a variable charge. The fixed charge is usually one rupee per acre per annum. The variable charge is subject to the over-riding maximum of Rs.5/- per acre at present. The maintenance rate was waived during and after the second World War up to 1949, to encourage food production. The government is trying to colonize large tracts of jungle land. It is not usual in Ceylon to supply water by volume for irrigating rice fields.

/No reliable

No reliable figures are available regarding water requirements for crops. However, it may be stated that for rice the water required is 5 acre ft per acre during wet weather and 7.5 acre ft per acre during dry season.

As stated above the only tax levied is the maintenance rate. This rate, based on the estimated expenditure and the irrigable area, is approved at a meeting of the proprietors summoned for the purpose by the revenue officer. The basis of assessment depends upon the expenditure on maintaining the project. The rate is levied on the cost of maintenance only. The cost of construction of all major irrigation works is borne by Government. In the case of minor irrigation works, the proprietors maintain them and do not pay any maintenance rate.

The irrigation ordinance No.32 of 1946 deals with offences as follows:

Every person who

(a) wilfully and mischievously blocks up or obstructs, or causes to be in any way blocked up or obstructed, any channel or watercourse comprised in any irrigation work; or

(b) wilfully and mischievously cuts the bund, bank or side of any irrigation work; or

(c) wilfully and mischievously causes waste of water conserved by any irrigation work; or

(d) wilfully or wrongfully draws or converts to his own use any such water

shall be guilty of an offence, and shall, on conviction after summary trial before a magistrate, be liable to a fine not exceeding one hundred rupees, or to imprisonment of either description for a period not exceeding six months or to both such fine and imprisonment.

There is no difference in charges because of the source of irrigation.

The average cost per acre per annum for maintenance of major works is Rs.7.50 (1949-50 figures).

D. CHINA: Taiwan

In Taiwan water charges are not based on the volume of water supplied for irrigation but on the area irrigated. Collection of charges is done by hydraulic associations which are formed by farmers and land owners in irrigated areas. Standard of charges are fixed per chia (one chia = 0.9699 hectare = 2.3967 acre), according to the expenditure of the associations (including expenditure involved in operation and maintenance of works). Charges are also graded into various classes according to the quality of soil, and degree of convenience of irrigation. Standards and classes of charges are decided upon by general meetings of the associations and then approved by the government. In case the water is supplied by pumping, expenditure relating to operation, oil consumption and maintenance, depreciation of the pumps etc., is also taken into consideration when fixing charges. In case the supply of water is accompanied by drainage facilities, expenditure involved in maintenance of drainage lines etc. is also taken into consideration. In Taiwan water charges are collected as fees for memberships of the hydraulic association.

Since charges for water are fixed, as stated above, it can be said that there is no relationship between the value of crops and their water requirements. However some associations do accept produce in kind instead of money as membership fees. So that, at times, when the price of crops are rising, the fees will be correspondingly higher.

When an irrigation project benefits proprietory lands and enhances their value, the rate of land tax is correspondingly increased.

Hydraulic associations, generally, take care to save water. Usually, one inch of water is supplied to paddy fields. Ways of imposing penalties for wastage of irrigation water are being studied by various educational institutions and hydraulic associations. No rules imposing penalties for wastage of irrigation water have yet been laid down.

Charges are less in areas where irrigation water is supplied by artesian wells since fewer construction works are required. In areas where irrigation water is supplied by means of canals and dams, the charges are higher. Charges are

/still higher

still higher in areas where irrigation water is supplied by pumping. There are no set of standards for charges for the different means of irrigation.

In the event of fluctuation of prices and other contingencies, hydraulic associations may adjust membership fees. Such adjustment should be passed at a general meeting and approved by the government prior to its enforcement.

Regarding cost per acre of operation and maintenance expenses as compared with charges for water, on an average New Taiwan[1/] $3,500 per chia, (NT$1,460 or US$97.33 per acre) which includes seeds, fertilizers and labour plus NT$125 per chia (NT$52 or US$3.47 per acre) are levied by hydraulic associations as standard membership fees, excluding beneficiary charges which depend on new construction projects which are charged in addition.

Regarding the question of taking into account the interest on capital investment and amortization when fixing charges for the water supplied for irrigation and other purposes, the hydraulic associations are formed by farmers in irrigated areas and are non-profit enterprises. Benefits obtained by the associations, therefore, belong to the members themselves.

All the larger soil improvement works are financed from the State treasury and local sources. Such expenditure is generally provided for under the budgets of the state government and the hydraulic associations concerned without taking into account the interest on capital investment. The benefit that the government can derive as a result of the construction of such works is increase in land tax, and that on the side of the people it is the increase in yields.

## E. INDIA

Information from India has not so far been received and will be given in a subsequent issue of this journal.

/F. JAPAN

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1/ US$1 = NT$15.

F. JAPAN

Article 42 of the River Law, authorizes the administration to charge fees from the beneficiaries who make use of the installed facilities on rivers for irrigation "in common or exclusively". The income from the fees is attributed to the prefecture concerned.

Under the River Law, each prefecture is also authorized to collect fees for water use for power generation or industrial purposes according to the regulations made by each prefecture. In case of water used for power generation, however, permission has to be obtained from the Ministry of Construction for the levy of fees.

In spite of the provision of authority in the River Law charges for water have never been made so far even though irrigation has been practised in Japan since ancient times. The reasons are the inferior economic position of the Japanese farmer and the fact that the value of water is included in the price of paddy fields.

In Japan, in order to utilize water for irrigation or to drain it into rivers, the irrigation facilities are installed and irrigation and drainage canals constructed by several individual-farmers jointly. These farmers constitute a water utilization association; and they call it a land improvement district. Irrigation and drainage facilities are installed and maintained by these associations and the annual operating costs are allocated amongst the member farmers. Consequently no water tariffs are charged as the expenses are directly shared by the association members.

In case where water facilities are installed by a land improvement district, the required installation expenses and, if need be, the expenses for rehabilitation of damaged facilities are subsidized by the Government or public bodies within their budgetary limits. When the proposed projects are too large to be carried out by a land improvement district, the projects are sponsored by the central or local government. In such cases, the greater part of the required expenses is defrayed

/from the central

from the central or local governmen and the remaining portion is shared by the beneficiaries, but the maintenance expenses are as a rule, not defrayed from the central or local government.

As stated above, although the maintenance expenses are not regarded as water tariffs in the proper sense of the word, the computing basis of the maintenance expenses is given below:

Water charges vary with areas and associations, but they are mostly determined according to usage. The leading bases are:

(1) Acreage of paddy fields

(2) Land tax (land taxation standard prior to the revised Land Tax Law)

(3) Rental value of land (land taxation standard after the enforcement of the revised Land Tax Law

(4) Volume of water

(5) Grade of Soil productivity

(6) The above bases combined

Although water charges are in general imposed upon paddy fields with the recent increase in irrigated upland, water charges are being imposed upon upland farms also. In such cases, water charges for upland farms are generally imposed upon in proportion to the water charges for paddy fields. In fact the water charges do not vary with the crops planted.

Fixed asset tax is imposed on the agricultural land as a local tax. Imposition of this tax is made in proportion to the value of agricultural land determined on 1 January each year with due consideration given to soil fertility, advantage of location, land productivity of individual holding of agricultural land. Rate of tax is 1.6 per cent. Consequently, if there is an increase in the productivity, soil fertility etc. of the agricultural land as a result of land improvement and the value of the land is appraised higher, tax is also increased in accordance therewith. Above is the provision of Local Tax Law. However actually there is a gradual reduction in the tax made by and under the authority

/of a mayor

of a mayor of a city or town. Fifteen years is the period of redemption of a loan extended to the farmer or the association who carries out the land improvement project. It is the period in which the total amount of loan is to be redeemed. From the first year after the completion of a project the rate of tax is increased on the average each year and at the end of the 15th year the tax is imposed on the new value of the land at the rate of 1.6 per cent as provided for in the Law.

There is no specific penalty provision duly stipulated by laws or orders. But when water utilization association of land improvement district operates an irrigation water, the association establishes its own maintenance and operation plan or a mutual agreement and in case water has been wasted or illegally used penalties such as suspension or limitation of the water supply for certain period has been enforced.

If there is a difference in the expenses for drawing water from different water sources, naturally there is a difference in the operating and maintenance expenses of the water utilization associations of different water sources.

Investigations into data in the annual maintenance and operation expenses of 106 agricultural water utilization associations in 1950 gave the results given in Table 1.

Table 1

1 cho = 10 tan; 1 acre = approximately 4 tan

360 Yen = US$1

| Size in cho | No of Associations | Area in cho | Area in each district in cho | Total expenses of the association: Yen | Fee charged | |
|---|---|---|---|---|---|---|
| | | | | | in Yen per tan | US$ per acre |
| less than 500 | 34 | 9,579 | 280 | 21,065,911 | 220 | 2.44 |
| 500 - 1,000 | 31 | 22,583 | 728 | 41,760,467 | 185 | 2.11 |
| 1,000 - 3,000 | 29 | 48,448 | 1,670 | 70,780,788 | 146 | 1.62 |
| over 3,000 | 12 | 48,591 | 4,049 | 80,764,238 | 231 | 2.57 |
| Total | 106 | 129,201 | 6,727 | 214,371,404 | | |

The districts taken into account in Table 1 all get water from rivers.

/In case

In case where water utilization association irrigates or drains water by pumping electricity charge is added to the expenses. Expenditure on electricity of water utilization associations which use pumping systems during the year 1950 is given in Table 2.

That is, in the district where irrigation and drainage is carried out by pumping system additional cost of electricity is 45 yen per tan in 71 per cent of the total area, and 149 yen per tan in 15 per cent of the same. Due to the rise in the commodity price index, the cost in 1952 was 1.39 times that given in the table.

Because there is no direct water charge in the case of agriculture the question of interest on capital investment and amortization does not arise. However, when the water utilization association sums up a necessary operation and management expenses for water utilization facilities and installations and charges the same from member farmers, naturally the said charges include interest on the capital invested by the said association and amortization is also taken into account.

Table 2

| Rate per tan in yen | Benefited area in chos | percentage of area | Total expenses in yen | percentage of total expenses | Fee | |
|---|---|---|---|---|---|---|
| | | | | | yen per tan | US$ per acre |
| Less than 100 | 460,529 | 70.9 | 209,440,066 | 30.8 | 45 | 0.50 |
| 100 - 200 | 94,993.1 | 14.6 | 141,841,007 | 20.8 | 149 | 1.66 |
| 200 - 300 | 35,510 | 5.5 | 85,554,480 | 12.6 | 241 | 2.68 |
| 300 - 400 | 32,443 | 5.0 | 108,541,840 | 16 | 336 | 3.73 |
| 400 - 500 | 16,061 | 2.5 | 72,451,830 | 10.6 | 452 | 5.02 |
| 500 - 600 | 4,586 | 0.7 | 23,718,860 | 35 | 517 | 5.74 |
| 600 - 800 | 4,299.9 | 0.6 | 29,026,800 | 4.3 | 676 | 7.51 |
| 800 - 1,000 | 721.6 | 0.15 | 6,251,300 | 0.9 | 868 | 9.64 |
| Over 1,000 | 319 | 0.05 | 319,000 | 0.5 | 1,000 | 11.11 |
| Total | 649,464 | 100. | 680,016,183 | 100.0 | | |

/G. KOREA[1]/

G. KOREA[1/]

Water charges are based on the area irrigated irrespective of volume of water used. Charges are made for the whole crop after harvest.

Classification is made for water charges according to the quality of the land irrigated, water requirements, and previous conditions of the land as regards irrigation.

When an irrigation project benefits proprietory lands and enhances their value, additional taxes are imposed on the beneficiaries, which are based on the cost of the project and are in accordance with the classification of water charges.

No penalties are imposed for wastage of water but there are penalties for water robbery.

There are differences in charges and total expenses of the enterprise for irrigation from the reservoirs or pumping station. Total enterprising expenses are calculated according to the existing price index in the Republic of Korea which is from 8,160 Hwan to 10,200 Hwan per acre in case of reservoirs and from 6,120 Hwan to 8,160 Hwan per acre in case of pumping stations. The construction costs can be calculated from the existing price index which is 6,940 Hwan to 8,670 Hwan per acre in case of reservoirs and 5,200 Hwan to 6,940 Hwan per acre in case of pumping stations. The water charges can be computed according to the existing price index in the Republic of Korea which is 938 Hwan per acre on an average in case of reservoirs, and 1,020 Hwan per acre on an average in case of pumping stations. Among the construction costs, 50 per cent is subsidized by the government, and 50 per cent is met by the promoters of the enterprise. The debt is required to be paid in 15 to 20 annual installments.

In principle the water tariffs must be paid in cash, but payment in the form of crop yield is now under consideration for the convenience of the payers and as a contribution to national food policy.

Average cost per acre of operation and maintenance expenses is 204 Hwan in the case of reservoirs and 408 Hwan in the case of water pumps (river etc.).

The interest on capital investment is about 10 per cent per year, and this is taken into account when fixing water charges, which must be planned for amortization in a period ranging for 15 to 20 years.

/ H. LAOS

1/ Information contained in this section relates to the Republic of Korea.

H. LAOS

There is very little irrigation in Laos. Whatever water is available, is distributed free of charge.

I. MALAYA

The only crop in Malaya which is supplied with irrigation water is rice. Water tariffs are levied on the area irrigated and the basis for charging tariffs is potential productivity of the land. Water tariffs are imposed by the different state governments of the Federation of Malaya in accordance with the Irrigation Areas Ordinance. The rates are different in different states, but in general, the water rates recommended are as given in the table 3.

Table 3

| Classification of Land | Potential Production | | Water Tariff Recommended per acre per annum | |
|---|---|---|---|---|
| | Gantangs paddy per acre (635 gantangs of paddy equal to one ton of rice) | tons of rice per acre | in Malayan Dollars | in US$ |
| I | above 400 | above 0.63 | 6.00 | 1.95 |
| II | 250-400 | 0.40-0.63 | 4.00 | 1.31 |
| III | below 250 | below 0.40 | 2.00 | 0.65 |

There is no relation of charges for water to the value of crops and their water requirements. Where for unforeseen reasons the full supply of irrigation water has not been available during a season, government has powers to remit the water tariffs, in part or in whole.

No additional taxes are imposed on the beneficiaries, when an irrigation project benefits proprietory lands and enhances their value.

Any person who wilfully causes waste of water conserved by any irrigation works is liable on conviction to imprisonment for a period not exceeding six months, or to a fine not exceeding three hundred Malayan dollars, or to both such imprisonment and fine.

There is no difference in charges for water used for irrigation from different sources.

/There are

There are no changes under consideration or proposed for charges for the supply of water for irrigation except other than to increase the present tariffs.

Accurate information regarding the average cost per acre of operation and maintenance as compared with the charges per acre are not available as Maintenance Votes only include for labour and cost of materials and do not include salaries and allowances of overseers, inspectors, etc.

As rice is the staple food of the people, and as it is in short supply, government is prepared to contribute the capital cost of irrigation schemes, as a subsidy to stimulate rice cultivation, and so increase production. Hence interest on capital investment and amortization is not taken into account when fixing charges for the water supplied for irrigation and other purposes.

J. NEPAL

There is no basis for levying water cess in Nepal as yet. However the Government of Nepal have under consideration to levy proper and suitable water taxes, calculated on scientific basis to render the national irrigation schemes productive. Nevertheless, the Government is charging Rs½ [1/] per bigha or Rs 1-4-0 (US$0.26) per acre (Rs 3-0-0 per ha) for the paddy under the irrigation projects in operation.

The levied water-cess does not reveal any relation of charges for water to the value of crops, because Government is suffering a loss in running canals whereas the benefitted farmers at least produce 10 to 15 maunds (820 to 1,230 lbs) more per bigha besides ensuring the normal yield in droughty years, of the value of not less than Rs 100 or so. The nominal rate was fixed at the time when the cost of paddy was about Rs 1-8-0 per maund and the staff pay was comparatively much less.

The Government is considering to levy land betterment tax as well on the beneficiaries.

There has been no practice of imposing penalty for wastage of irrigation water.

/Changes to be

1/ Rs 4.76 = US$1.00

Changes to be made in water charges are under consideration of the Government. It is proposed that Rs 1-4-0 (US$0.26) per acre (Rs 3 per ha) being charged at present for paddy be enhanced to Rs 4-0-0 (US$0.84) per acre (Rs 10 per ha) and for rabi crops Rs 2-0-0 (US$0.27) per acre (Rs 5-0-0 per ha) may be charged.

Average cost per acre of operations and maintenance expenses is much more than the income from water-cess. It costs about Rs 4-0-0 (US$0.84) per acre (Rs 10-0-0 per ha).

The proposed water cess of Rs 4-0-0 (US$0.84) per acre (Rs 10-0-0 per ha) includes interest at the rate of 3 per cent per annum on the invested capital.

K. PAKISTAN

In all the provinces water tariffs vary according to the crop and are charged on the area actually irrigated irrespective of the quantity of water used by the cultivator for the maturity of the crop. The principal factors that generally guide the fixing of water tariffs are:

1. Quantity of water normally needed for the maturity of crop.
2. Quantity of water made available on the canal and the extent of its demand.
3. Availability of other means of irrigation in the tract such as wells, tubewells, river spills etc.
4. Nature of soil.
5. Value of crop.
6. Comparative cost of irrigation by other means such as open wells, tubewells, pumps, lifting of water through low heights etc.
7. Capacity of cultivator to pay water rate.

Water is not sold by volume. This system was tried two decades ago but it failed on account of the following reasons:

/1. The average

1. The average delta worked out higher by selling water by volume than by supplying water under existing system. The revenue realized was generally less.

2. Volumetric system of selling canal water was advantageous to big landlords only. Owners of small holdings did not like this system.

3. It involved an appreciable initial cost in the shape of metres, repairs and replacement of metres.

4. Recording and readings for the measurement of water was entrusted to unreliable officials which caused leakages of government revenue.

5. The volume of water sold varied considerably owing to climatic variation causing fluctuations.

Table 4, 5 and 6 show the water rates charged for some of the principal crops on certain canals in the Punjab, North Western Frontier Province and Bhawalpur. In the case of the Punjab the rates shown are meant for supplying canal water by flow from the water course to the field. When a land owner has to lift canal water to his comparatively high land, half rates are charged.

Charges are not levied for separate waterings but for the whole crop and strictly on the acreage on which any crop received maturity.

No distinct water rate is charged in Sind and Khairpur. There is consolidated land revenue assessment which includes water rates also. The rates of assessment are fixed periodically and nine-tenths of the assessment is credited towards water rate and the balance one-tenth towards land revenues.

/Table 4

Table 4

Statement showing water rates on principal crops in rupees per acre in the Punjab

(Rs 3.31 = US$1.00)

| Name of Crop | Lower Jhelum Canal (Perennial) | | | | | | Rangpur Canal (Non-perennial) | | | Indus Inundation Canals | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Schedule A | | | Schedule B a/ | | | | | | Khadar Canal | | | Other Canals | | |
| | Rs | As | P | Rs | As | P | Rs | As | P | Rs | As | P | Rs | As | P |
| 1. Wheat | 4 | 4 | 0 | 3 | 12 | 0 | 9 | 0 | 0 | 0 | 15 | 0 | 0 | 15 | 0 |
| 2. Rice | 6 | 8 | 0 | 4 | 4 | 0 | 5 | 4 | 0 | 2 | 10 | 0 | 2 | 4 | 0 |
| 3. Sugarcanes | 11 | 0 | 0 | 8 | 8 | 0 | 6 | 0 | 0 | 1 | 14 | 0 | 1 | 14 | 0 |
| 4. Oilseeds | 4 | 4 | 0 | 3 | 8 | 0 | 3 | 8 | 0 | 0 | 10 | 0 | 0 | 10 | 0 |
| 5. Cotton | 5 | 4 | 0 | 4 | 8 | 0 | 5 | 0 | 0 | 1 | 14 | 0 | 1 | 14 | 0 |
| 6. Folder | 2 | 8 | 0 | 2 | 8 | 0 | 2 | 0 | 0 | 1 | 9 | 0 | 1 | 9 | 0 |

a/ Schedule B is meant for tracts of inferior soil.

/Table 5

Table 5

Statement showing water rates on principal crops average water rates in rupees charged per acre in the North Western Frontier Province

(Rs 3.31 = US$1.00)

| No. | Class | Name of the Crop | Lower Swat Canal | | | Kabul River Canal | | | Phaspur Canal | | | Per |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Rs | As | P | Rs | As | P | Rs | As | P | |
| 1 | I | Sugarcanes | 8 | 13 | 0 | | - | | 5 | 8 | 0 | Annum |
| 2 | | Gardens, orchards, water nuts | 6 | 5 | 0 | 8 | 14 | 0 | | - | | " |
| 3 | II | Rice | 6 | 0 | 0 | 6 | 5 | 0 | 4 | 2 | 0 | Crop |
| 4 | III | Tobacco, spices, dyes, melon and vegetables | 4 | 12 | 0 | 6 | 6 | 0 | 4 | 2 | 0 | " |
| 5 | IV | Wheat, cotton, hemp & oil seeds | 4 | 6 | 0 | 4 | 12 | 0 | 3 | 8 | 0 | |
| 6 | | Oats | 3 | 13 | 0 | 4 | 1 | 0 | 3 | 8 | 0 | |
| 7 | V | Barley & Maize | 3 | 13 | 0 | 3 | 14 | 0 | 3 | 8 | 0 | |
| 8 | VI | Millet, pulses, shaftal, mania, lucerne gram and all rabi & kharif crops not otherwise specified | 3 | 4 | 0 | 4 | 1 | 0 | 2 | 14 | 0 | |
| 9 | VII | Grass | 0 | 13 | 0 | 2 | 4 | 0 | 2 | 5 | 0 | |

/Table 6

Table 6

Statement showing water rates on principal crops in Bhawalpur

(Rs 3.31 = US$1.00)

| S. No. | Crop | Watering required | Rate per acre per crop | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Perennial | | | Non-Perennial | | |
| | | | Rs | As | P | Rs | As | P |
| 1 | Sugarcane | 12 to 15 | 11 | 0 | 0 | 9 | 0 | 0 |
| 2 | Rice | 12 | 7 | 8 | - | 7 | 8 | - |
| 3 | Tobacco | 8 | 6 | 4 | - | 6 | 4 | - |
| 4 | Indigo & other dyes, species & drugs | 4 to 6 | 6 | 4 | - | 6 | 4 | - |
| 5 | Cotton | 10 | 5 | 4 | - | 5 | 4 | - |
| 6 | Fibres other than cotton, tarbuz and melons | 5 | 5 | - | - | 5 | - | - |
| 7 | Wheat & wheat gram mixed | 5 | 4 | 8 | - | 2 | - | - |
| 8 | Barley, oats maize, toria & other oil seeds | 4 | 4 | 4 | - | 2 | - | - |
| 9 | Bajra & pulses | 4 | 3 | 4 | - | 2 | 8 | - |
| 10 | Gram | 3 | 3 | 4 | | 2 | - | - |
| 11 | Fodder crops | 2 to 5 | 2 | 8 | - | 2 | - | - |

/The percentage

The percentage ratio of water rates to the value of crops on principal canals in the Punjab has been oscillating between 15.2 and 3.1 during the past half a century. The average of this ratio comes to 7.8 which means that water charges for the canal in the past have been on the average $\frac{1}{13}$ of the value of the crops. This is shown in table 7. Water requirements for the principal crops in the Punjab are shown in tables 8 and 9.

The relation of water charges to the value of the principal crops and their water requirements in Bhawalpur and North Western Frontier Province is shown in tables 5 and 6. From table 6 which contains the charges for water for different crops in Bhawalpur, it can be ascertained that the charges for water vary as the value of the crop.

In Sind, Khairpur and Baluchistan, water charges have no direct relation to the value of crops. As, however, the sliding scale of assessment applies to wheat, cotton and rice, the share representing water charges increases or decreases annually as the values of crop rise or fall. In respect of other crops which are assessed at flat rates, the increase or decrease takes place where the settlements are revised after a particular period fixed by the government.

/Table 7

Table 7

Statement showing percentage ratio of occupier's rate to value on the principal canals in the Punjab

(Rs 3.31 = US$1.00)

| Year | Area assessed during the year | Amount assessment in lakhs of Rupees | Rate per acre | Value of crops per acre | Percentage, ratio of occupier's rate to value of crops |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | Acres | Rs | Rs | Rs | |
| 1900-01 | 3,935,018 | 119.0 | 3.02 | 15,61,38,363 / 5,923,438 = 26.4 | 11.4 |
| 1901-02 | 3,883,994 | 127.7 | 3.29 | 14,71,54,510 / 5,413,709 = 27.2 | 12.1 |
| 1902-03 | 4,179,136 | 136.5 | 3.26 | 14,75,29,356 / 5,625,126 = 26.2 | 12.4 |
| 1903-04 | 4,538,775 | 148.7 | 3.28 | 16,36,54,462 / 6,331,367 = 25.8 | 12.7 |
| 1904-05 | 4,721,105 | 156.0 | 3.30 | 16,64,60,352 / 6,245,948 = 26.7 | 12.4 |
| 1905-06 | 4,936,156 | 156.0 | 3.17 | 16,74,70,902 / 6,836,704 = 24.5 | 12.9 |
| 1906-07 | 4,398,377 | 148.7 | 3.38 | 16,39,52,935 / 6,629,247 = 24.7 | 13.7 |
| 1907-08 | 4,437,592 | 156.8 | 3.63 | 15,28,27,415 / 5,960,509 = 26.5 | 13.3 |
| 1908-09 | 4,677,152 | 166.6 | 3.56 | 18,02,03,320 / 6,669,127 = 27.0 | 13.2 |
| 1909-10 | 4,578,522 | 165.6 | 3.61 | 20,67,99,371 / 6,387,887 = 32.4 | 11.1 |
| 1910-11 | 4,840,031 | 182.1 | 3.76 | 20,69,88,339 / 6,624,975 = 31.3 | 12.0 |
| 1911-12 | 5,722,078 | 210.6 | 3.68 | 25,83,37,457 / 7,648,914 = 33.8 | 10.9 |
| 1912-13 | 5,962,016 | 220.2 | 3.69 | 30,70,86,310 / 7,946,095 = 38.6 | 9.6 |
| 1913-14 | 5,881,204 | 220.8 | 3.75 | 26,45,31,725 / 7,962,276 = 33.2 | 11.3 |

Table 7 (cont'd)

| Year | Area assessed during the year | Amount assessment in lakhs of Rupees | Rate per acre | Value of crops per acre | Percentage, ratio of occupier's rate to value of crops |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | Acres | Rs | Rs | Rs | |
| 1914-15 | 6,220,502 | 230.0 | 3.70 | 27,76,29,480 / 8,521,874 = 32.6 | 11.3 |
| 1915-16 | 6,336,011 | 232.3 | 3.67 | 27,50,82,336 / 8,411,690 = 32.7 | 11.2 |
| 1916-17 | 6,617,225 | 252.4 | 3.81 | 32,09,18,736 / 8,890,364 = 36.1 | 10.6 |
| 1917-18 | 6,212,911 | 242.6 | 3.90 | 33,36,99,916 / 8,230,324 = 40.5 | 9.6 |
| 1918-19 | 6,858,406 | 267.9 | 3.91 | 55,09,39,000 / 8,430,020 = 65.4 | 6.3 |
| 1919-20 | 7,833,358 | 310.9 | 3.97 | 62,40,92,130 / 9,948,322 = 62.7 | 6.3 |
| 1920-21 | 7,587,962 | 300.9 | 3.97 | 51,68,23,676 / 9,343,400 = 55.3 | 7.2 |
| 1921-22 | 8,469,175 | 326.4 | 3.85 | 67,20,65,032 / 10,562,422 = 63.6 | 6.1 |
| 1922-23 | 8,371,542 | 332.7 | 3.97 | 49,42,66,385 / 10,695,639 = 46.2 | 8.6 |
| 1923-24 | 8,087,880 | 323.2 | 3.99 | 55,04,71,042 / 10,099,213 = 54.4 | 7.3 |
| 1924-25 | 7,935,743 | 378.4 | 4.77 | 57,71,10,100 / 10,143,078 = 56.9 | 8.4 |
| 1925-26 | 8,357,556 | 399.0 | 4.77 | 54,53,07,636 / 10,273,875 = 52.1 | 9.0 |
| 1926-27 | 8,208,563 | 372.8 | 4.54 | 45,77,53,509 / 9,972,061 = 45.9 | 9.9 |
| 1927-28 | 8,561,177 | 375.7 | 4.41 | 44,73,04,631 / 9,853,477 = 45.4 | 9.7 |
| 1928-29 | 9,733,026 | 435.9 | 4.48 | 55,06,38,537 / 11,868,759 = 46.4 | 9.7 |
| 1929-30 | 9,994,225 | 433.0 | 4.33 | 49,26,95,970 / 12,006,030 = 41.0 | 10.6 |

Table 7 (cont'd)

| Year | Area assessed during the year | Amount assessment in lakhs of Rupees | Rate per acre | Value of crops per acre | Percentages, ratio of occupier's rate to value of crops |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | Acres | Rs | Rs | Rs | |
| 1930-31 | 9,971,961 | 387.4 | 3.88 | 29,45,09,582 / 11,854,625 = 24.8 | 15.2 |
| 1931-32 | 9,301,881 | 359.3 | 3.86 | 32,73,76,373 / 11,244,684 = 29.1 | 13.3 |
| 1932-33 | 8,914,045 | 383 | 4.29 | 36,04,82,059 / 11,180,689 = 32.2 | 13.3 |
| 1933-34 | 9,490,442 | 395.3 | 4.05 | 32,26,81,407 / 1,09,82,668 = 29.4 | 13.7 |
| 1934-35 | 9,016,841 | 361.1 | 4.00 | 34,15,62,323 / 10,235,314 = 33.4 | 11.9 |
| 1935-36 | 9,539,946 | 388.7 | 4.05 | 38,99,74,152 / 10,981,116 = 35.5 | 11.1 |
| 1936-37 | 10,027,843 | 401.7 | 4.00 | 47,41,21,012 / 11,628,784 = 40.8 | 9.8 |
| 1937-38 | 10,540,068 | 422.3 | 4.00 | 40,31,68,364 / 12,220,704 = 33.0 | 12.1 |
| 1938-39 | 10,302,579 | 399.3 | 3.87 | 38,90,44,014 / 11,889,607 = 32.7 | 11.8 |
| 1939-40 | 10,729,761 | 417.6 | 3.88 | 50,74,57,696 / 12,660,131 = 40.1 | 9.6 |
| 1940-41 | 10,657,528 | 418.5 | 3.83 | 44,11,96,215 / 12,622,646 = 34.9 | 10.9 |
| 1941-42 | 12,168,618 | 419.6 | 3.44 | 64,80,89,637 / 12,757,064 = 50.8 | 6.7 |
| 1942-43 | 11,156,590 | 424.2 | 3.80 | 1,24,91,44,318 / 13,159,924 = 94.9 | 4.0 |
| 1943-44 | 11,425,697 | 465.2 | 4.07 | 1,16,63,69,431 / 13,699,803 = 85.1 | 4.7 |
| 1944-45 | 11,702,229 | 469.8 | 4.01 | 1,25,81,00,422 / 13,819,809 = 91.0 | 4.4 |

Table 7 (cont'd)

| Year | Area assessed during the year | Amount assessment in Lakhs of Rupees | Rate per acre | Value of crops per acre | Percentage, ratio of occupier's rate to value of crops |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| | Acres | Rs | Rs | Rs | |
| 1945-46 | 8,244,832 | 335.3 | 4.07 | $\frac{98,57,43,338}{9,577,132}$ = 102.9 | 4.0 |
| 1946-47 | 8,963,781 | 361.4 | 4.03 | $\frac{1,13,35,03,189}{8,963,781}$ = 126 | 3.2 |
| 1947-48 | 9,368,345 | 386.0 | 4.12 | $\frac{1,25,82,00,405}{9,368,345}$ = 134 | 3.1 |
| 1948-49 | 9,796,374 | 472.7 | 4.82 | $\frac{1,34,93,79,089}{9,976,374}$ = 138 | 3.5 |
| 1949-50 | 9,718,659 | 415.5 | 4.27 | $\frac{1,25,82,00,405}{9,718,659}$ = 129 | 3.3 |
| | | AVERAGE | 3.89 | 50.0 | 7.8 say $\frac{1}{13}$ |

/ Table 8

Table 8

Statement showing water requirements in inches of crops in the absence of rains

| S. No. | Crop | April | May | June | July | August | Sept. | Kharif total | Oct. | Nov. | Dec. | Jan. | Feb. | March | Total Rabi | Total of the year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Wheat | - | - | 4 | - | - | - | 4 | 4 | - | 3 | 3 | 3 | 3 | 16 | 20 |
| 2 | Gram | - | - | - | - | - | 4 | 4 | - | - | 3 | - | 3 | - | 6 | 10 |
| 3 | Toria | - | - | 4 | - | - | 4 | 8 | 3 | 3 | 3 | - | - | - | 9 | 17 |
| 4 | Barseem & Shaftal | 9 | 3 | 4 | - | - | 4 | 20 | 9 | 9 | 9 | 9 | 9 | 9 | 54 | 74 |
| 5 | Turnips | - | - | 4 | - | - | 4 | 8 | 3 | 3 | 3 | - | - | - | 9 | 17 |
| 6 | Other rabi crops | - | - | - | 4 | - | - | 4 | 4 | 3 | 3 | 3 | 3 | - | 16 | 20 |
| 7 | Rabi oil seeds | - | - | - | 4 | - | - | 4 | 4 | 3 | - | 3 | 3 | - | 13 | 17 |
| 8 | Sugarcanes | 6 | 12 | 12 | 12 | 9 | 9 | 60 | 6 | 6 | - | 4 | - | 4 | 20 | 80 |
| 9 | Cotton early | - | 4 | 3 | 6 | 6 | 6 | 25 | 6 | 3 | - | - | 4 | - | 13 | 38 |
| 10 | Cotton late | - | 4 | 4 | 6 | 6 | 6 | 26 | 6 | 3 | - | - | - | - | 9 | 35 |
| 11 | Zaid Rabi early 3% | 6 | 6 | - | - | - | - | 12 | - | - | - | - | 4 | 4 | 8 | 20 |
| 12 | Zaid rabi 7% | 4 | 6 | 6 | 3 | - | - | 19 | - | - | - | - | - | - | - | 19 |
| 13 | Rice June | - | 4-4 | 9-10 | 20 | 25 | 20 | 92 | - | - | - | - | - | - | - | 92 |
| 14 | Rice July | - | - | 4-4 | 20 | 25 | 20 | 73 | 12 | - | - | - | - | - | 12 | 85 |
| 15 | Other Kharif crops | - | - | 4 | 4 | 6 | 6 | 20 | - | - | - | - | - | - | - | 20 |

/Table 9

Table 9

(25 maunds = 1 ton)

| Principal Crop | Water Requirements for Maturity (Delta) | Yield/Acre |
|---|---|---|
| Sugar Cane | 3.5 ft | 300 mds |
| Rice | 2.5 " | 15 " |
| Cotton | 1.5 " | 6 " |
| Maize | 1.5 " | 18 " |
| Wheat | 1.25 " | 10 " |
| Barley | 1.25 " | 12 " |

A rate called "Owner's Rate" or "Water Advantage Rate" in addition to water rates is imposed, in the Punjab, on the owners of canal irrigated lands, for the benefits the proprietory owners derive, on account of the value of their lands being enhanced due to the supply of canal water. The "owner's rate" is usually limited to the sum which, under the rates for the time being in force for the assessment of land revenue, might be assessed on such lands on account of increase in the annual value and produce thereof caused by canal irrigation. This rate remains in force until the next settlement of the areas concerned and ultimately merges into the general rate bringing out higher rates of land revenue for the canal irrigated area at the next settlement. There is another tax known as "betterment tax". It is levied on the cultivation mainly to make up the loss incurred by the government in financing a project. On the Jhal project this rate has been fixed at Rs 60 (US$18.12) per acre.

In the North Western Frontier Province an additional tax called "Nahri Parta" is imposed on the beneficiaries, when an irrigation project benefits proprietory lands. The basis of calculation of this additional tax in this province has not yet been ascertained.

/In Bhawalpur,

In Bhawalpur, on the completion of the Sutlej Valley project an additional rate called "Water Advantage Rate" of Rs 2/8/- (US$0.76) per matured acre on perennial and Re -/8/- (US$0.15) per matured acre on non-perennial irrigation were imposed on proprietory lands. This has been incorporated in the revenue rates after the new settlement.

In Sind the government's share in the increased income of the land owner is secured by a revision of the settlements. The land revenue is calculated at one-third of the land-owners net assets, after deducting cost of cultivation etc.; when a new irrigation project results in an assured supply, it is assumed that the crop yield will be enhanced and the land owner's income will correspondingly increase. The revised assessment is therefore based on a higher estimated yield. Betterment levy is not imposed in this province. The question of imposition of "betterment tax" on the lands privately held has arisen in connection with the Lower Sind Barrage area and a scheme for such a tax which will be a portion of the difference between the present estimated value of the land and its value after it receives an assured water supply under Lower Sind Barrage is awaiting the final approval of the government.

No additional charges are imposed in Khairpur and Baluchistan.

In the Punjab and Bhawalpur, persons using canal water in an unauthorized manner or suffering it to run to waste are charged a special rate which is up to six times the normal charges. This special rate is in addition to such penalties as may be imposed by a court of law, under Section 70 of the Canal and Drainage Act VIII of 1873 and Section 430 of the Pakistan Penal Code.

In the North Western Frontier Province, the following penalties are imposed for wastage of irrigation water:

1. On cultivated lands the crop rates otherwise tenable on the flooded area, together with a positive rate equal to the ordinary charges for each distinct and separate occasion on which water is needed.

2. On uncultivated land the highest rate prescribed on the water tariffs provided that in every such case the Divisional Canal Officer may impose a lower charge, if he thinks fit, for each distinct and separate occasion on which water is wasted.

/3. If water

3. If water is standing in the form of a pond a price of Rs 20/- (US$6.04) per 2,500 cu ft of water is charged from the irrigators in whose turn such waste occurs.

In Sind, in the case of ordinary flooding of land the charges are calculated at such rate per acre as does not exceed treble the highest water rate tenable in respect of cultivated land in the same village as shall be fixed by the Executive Engineer. In any other case on all canals, treble the rate chargeable under Sind Canal Rule I calculated on volume of water estimated by the Executive Engineer to have been used in an unauthorized manner or wasted.

In Khairpur the charges for wastage of water are:

1. By area - Re -/8/- (US$0.15) per acre subject to the minimum of Re 1/- (US$0.30)

2. By measurement - Re -/2/- (US$0.04) per thousand cu ft

3. When wastage occurs on Public Works Department service road - Re 1/- (US$0.30) per acre subject to the minimum of Rs 2/- (US$0.60) per acre

4. When wastage occurs on provincial roads - Rs 2/- (US$0.60) per acre subject to the minimum of Rs 4/- (US$1.21).

In Baluchistan, persons found guilty of wasting water or using it in an unauthorized manner are liable to pay the charges which shall be made in respect of water so wasted. Persons who are responsible for the maintenance of water course, and who neglect to take proper precautions to prevent the wastage of water may be punished by an imposition of fine up to Rs 50/- (US$15.08) along with imprisonment for a time which may extend to one month.

There is a difference in the rates of water charges from sources other than rivers in the Punjab and North Western Frontier Province. The water rates for supply from wells have not yet been finally fixed but they are likely to be 3 to 4 times the rates for canal water from rivers. These charges will be based upon the consumption of electric power.

/In Sind

In Sind no separate charges exist for irrigation water which charges are merged in the assessment rates. Besides other factors the latter depend upon the mode of irrigation.

There is no difference in charges in Khairpur or Baluchistan.

Water charges were increased in the Punjab in 1949 but the increase was withdrawn due to undue hardship on the cultivators. Attempts have been made in the past to simplify the present assessment system by introducing a system involving a flat rate for all crops. The proposal is still under consideration. In Sind the assessment rates are shortly to be revised affecting the water rates as well. No change is contemplated in the North Western Frontier Province and Bhawalpur, Khairpur and Baluchistan.

The average cost of maintenance of irrigation works and channels in the Punjab for the years 1945-46 to 1950-51 comes to Rs 2/4/- (US$0.68) per acre while the average water charges for the same period work out to Rs 4/4/- (US$1.28) per acre.

In the North Western Frontier Province, for the year 1950-51 the average expense on maintenance work out to Rs 4.28 (US$1.30) per acre while the corresponding average water charges for the same period were Rs. 5.62 (US$1.70).

On Bhawalpur average working expenses in recent years are Rs 1/6/6 (US$0.42) per acre and average water rate for the same period equals Rs 3/8/- (US$1.06) per acre.

In Sind average maintenance and working expenses of Sukkur Barrage for the period 1942-47 work out to Rs 7/12/- (US$2.34) per acre and the average charges for water for the same period equal Rs 11/- (US$3.32) per acre.

In Khairpur the average cost per acre of operation and maintenance is Rs 1/4/- (US$0.38).

In the Punjab, North Western Frontier Province and Bhawalpur the interest charges on the capital cost of a project have only an indirect bearing on the water rate. As regards amortization, irrigation projects are considered

/on the

on the self supporting basis and not on the basis of self-liquidation; hence amortization is not considered.

K. THAILAND

No water tariffs exist in Thailand.

L. VIET-NAM

No taxes or charges are levied for water supplied for irrigation in Viet-Nam.

/PROGRESS ON

## PROGRESS ON RIVER VALLEY PROJECTS

### BURMA

#### Saingdin Hydro-Electric Scheme[1]

The Saingdin Hydro-Electric Plant, now under construction, is expected to finish within three years. Its capacity will be of 60,000 kW. Preparation have been made to carry out the work during rains as well. A transit camp has been constructed at Akyab for officers and labourers enroute to Saingdin.

Electricity will be supplied to three districts in Arakan Division and the Paper Factory at Ponnagyun, the Caustic Soda Factory at Akyab and the Salt Factory at Kyaukypu.

#### Hydro-electric power in Burma[2]

To meet the requirements of industrial development, it has been decided to set up a national power grid in Burma. To feed the power grid, steam, diesel and hydro plants drawing on the newly discovered rich Kalewa coalfield, the Yenangyaung-Chaulk oil wells, and the country's rainfed streams will be added to those plants already in existence.

Given top priority in the construction of power plants are the hydro plants on Pegu river, near Taikkyi, Saingdin Falls near Buthidaung in Akyab district and Balu Chaung near Loikaw in the Southern Shan State; and the steam plant at Myingyan.

### CEYLON

#### Development of the Mahaweli Ganga Basin[3]

The largest river which drains most of the Kandyan districts, the Mahaweli Ganga, in Ceylon, is to be developed for irrigation, flood protection and

/hydro-electric

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1/ Abstracted from New Times of Burma, Rangoon, 21 February 1954.
2/ Abstracted from New Times of Burma, Rangoon, 23 February 1954.
3/ Abstracted from Ceylon Daily News, Colombo, 14 January 1954.

hydro-electric power. The engineers of the Irrigation Department have been working on this river basin for some time and the investigation of the first reservoir site has been started by the Central Designs and Research Office of the department.

The site selected for the first reservoir is called Randenigala located about 10 miles below Kandy. A start has been made on the surveys and preliminary drillings to study the geology and the foundations. At the proposed site, the dam will intercept the drainage of 895 sq mi out of the 4,110 sq mi of the Mahaweli Ganga basin.

The reservoir will have a storage capacity of $2\frac{1}{2}$ million acre feet or about three times the storage capacity of Gal Oya Reservoir which is at present the largest in Ceylon. At the top, the dam will measure 2,500 ft with a spillway in this length to discharge 250,000 cfs. According to the present studies, the maximum height of the dam will rise 450 ft above the river bed. This will be about $3\frac{1}{2}$ times the height of Gal Oya dam. When the reservoir is full it will inundate 20 sq mi of Patna and undeveloped lands with the water rising 430 ft above the present river bed level.

In a normal year the water to be impounded at this site will be sufficient to irrigate 400,000 acres each year for one paddy crop and at the same time develop 65,000 kW of electric energy throughout the year. This is approximately 3.6 times the power output of Laxapana Hydro-Electric Scheme. When this volume of water is held back at Randenigala, it will help to reduce the floods in Manampitiya and Polonnaruwa areas during the worst times of the year.

Together with the investigation of the dam, a fast and short route to reach the dam is also being investigated. There are two routes possible - one is from Kandy through Teldeniya to Madugoda and then branching off at this point to reach the dam. The other is from Kandy, Hanguranketa to the dam site. Of the two, the former offers the least difficulties and is the least expensive to construct.

The proposed lower Badulla road which runs along the right bank of the Mahaweli Ganga will be completely submerged when the reservoir is constructed

/and a good

and a good amount of land served by the lower Badulla road along the banks of the Mahaweli Ganga would be reserved as forest sanctuaries to save the life of the reservoir. The new access road from Teldeniya to the dam will form an alternative route to Badulla crossing the Mahaweli Ganga at the dam and joining the present trace of lower Badulla road below the dam.

Present investigations of the department are directed mainly to the study of the dam foundations and the diversion tunnel to divert the river during construction. These investigations will be followed by an aerial survey of the land which will be inundated by the water spread. This particular site has been selected by the Irrigation Department engineers as the most convenient point to develop the water resources of this river because of the narrow gorge through which the river flows at this point and of the fact that the land that will be inundated by the river now is practically undeveloped patnas. Any site higher up in the river would involve the inundation of valuable agricultural land which engineers think should be safeguarded in the interest of the economy of the country.

As a point of power development it offers one of the best sites - being central and within reach of many of the important concentrations of population in the wet zone as well as in the dry zone.

According to the forecast made so far it is going to be the cheapest scheme undertaken with the maximum benefit to the country. The development of designs and estimates will take about six years to be finalized. This one scheme will bring under cultivation an area more than what is cultivated under irrigation now by all the major irrigation schemes in operation. It will also develop power to provide the power requirements of Ceylon for a number of years to come.

From the point of land development it will offer a large area of land to be brought under cultivation in the hinterland of the Kandyan districts which today suffer most from lack of development facilities. This scheme forms one of the many reservoirs proposed on the Mahaweli Ganga and its tributaries. There are nearly 18 other sites on the main river and its tributaries that are being studied by the engineers of the Irrigation Department to develop the water resources of Mahaweli Ganga to its utmost limit.

/More Rice

## More rice through artificial dew[1/]

One million acres of land which the Land Utilization Committee condemned as unirrigable and therefore not cultivable may be reclaimed for cultivation under a new scheme.

This scheme follows a discovery which may "revolutionzie agriculture". The discovery was made by S. Duvvedani, Director of the Dew Research Station in Israel. The finding of Duvvedani is that "artificial dew condition during periods of drought can save crops".

Attempts are being made in Ceylon to apply the above scheme to local conditions and cultivation. The million semi-arid acres of land, which could not be cultivated now, might be induced to grow crops with artificial dew.

## INDIA

### Progress of Indian River Valley Projects in 1953-1954

#### Bhakra-Nangal Project

The Bhakra-Nangal Project will release in July this year water for non-perennial irrigation of about 600,000 acres and power from the Nangal Hydel Channel Power House No. 1, according to a report of the Ministry of Irrigation and Power for 1953-54 submitted to the Indian Parliament.

The report adds that the Nangal dam is complete except for the installation of gates and gearings which is in progress. The Bhakra canals are scheduled to be completed by July. Work on the Bhakra dam, the second highest in the world, is expected to begin soon after the diversion of the Sutlej River through the tunnels next winter.

#### Kakrapar Weir

The Kakrapar Weir in Bombay State was opened by the Minister of Irrigation and Power on 29 June 1953. Irrigation facilities have been provided to 40,000 acres. The total expenditure up to the end of December 1953 amounted to Rs 33,400,000 (US$7,017,000).

/Tungabhadra Project

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1/ Abstracted from Ceylon Daily News, Colombo, 19 January 1954.

Tungabhadra Project

On the formation of Andhra State, the President of India issued a directive constituting the Tungabhadra Board for the execution of works of common interest to the states of Andhra and Mysore. The Board was later given overal control in respect of matters relating to works common to all the three participating states Andhra, Hyderabad and Mysore. The Hyderabad Government will, however, continue to construct, operate and maintain the project in so far as it falls within the State, subject to the overall control of the Board. The Board has constituted two sub-committees to look after the day-to-day administration. The project released the first irrigation waters last year.

Hirakud Dam

The Hirakud dam will be substantially completed and power and water for irrigation made available by July 1954. The revised estimates of State I, as recommended by the Control Board, have been approved by the Government of Orissa. The project will irrigate about 448,000 acres in Sambalpur and Bolangir and develop a power potential of 123,000 kW of installed capacity and 85,000 kW of firm capacity.

Damodar Valley Corporation Schemes

The projects under the Damodar Valley Corporation made substantial progress during the year under review. The Tilaya dam and the hydro-electric station were completed and the reservoirs filled to capacity during the last monsoon. At the Bokaro Thermal Power Station, with the exception of some minor works, all three units of 50,000 kW each have been put into commission. The Konar dam is expected to be finished before the monsoon sets in. It has already started storing water which will be used for cooling purposes at the Bokaro Termal Station. The diversion tunnel and the diversion channel at the Maithon project have been completed and work on the earth dam is likely to be over by the middle of this year. Work on the right abutment and part of the spillway is in progress. The dam is expected to be ready during 1954-55 and the hydro-electric station during 1955-56. At Panchet Hill the earth dam and excavation of the diversion channel are in progress. The Durgapur barrage and the canals project, which will divert the waters released from the dams upstream for purposes of irrigation, is making satisfactory progress and will be finished during 1956-57.

/Progress of

Progress of work on the transmission and distribution systems is according to schedule. About 268 route miles of 32 kV, 66 kV and 133 kV transmission lines have been laid. Thirteen grid sub-station and receiving stations have also been completed.

During 1953 the D.V.C. acquired 10,787 acres of land and gave compensation in cash totalling Rs 2,291,800 (US$481,470) and about 4,314 acres as "land for land" to persons displaced by various projects. So far, 3,695 families have been displaced by the various projects and all have been resettled. About 3,500 acres are to be reclaimed immediately for people to be displaced by the Maithon reservoir.

Controlling the Kosi

The scheme for controlling the Kosi river and providing irrigation was finalized during the year. It will involve the building of a barrage at Hanuman Nagar, flood banks and other protective measures. The estimated cost of the first stage is Rs 402,600,000. The work will be executed by the Bihar Government and the Central Government will render necessary technical assistance.

Other Projects

Investigations completed during the year related to the Narmada valley, Sabarmati and Madhya Pradesh (Mahanadi-Satara) projects and the reports are under examination. Data in regard to the Utlai dam in Bombay State, Tikarpara and Naraj dams in Orissa State and Assam projects are being collected.

Next year's programme

The next year's programme includes advisory and other assistance on the Kosi and the Trisuli projects in Nepal and on the Krishna and Godavari projects - two main river valley schemes of the south. Work on the proposals for a steam power station of 6,000 kW capacity at Kandla port, electrification of Satna, Rewa and Malhar and preparation of projects for Panna, Chatterpur, Tikangarh and Datia in Vindhya Pradesh will be finished. Load survey of areas in Rajasthan and Madhya Bharat to be served by the Chambal Hydro-Electric Scheme will also be undertaken. The Delhi State Electricity Board has taken in hand work on the electrification of Kalkaji, Malvianagar, Kilokri and Okhla.

/ The Mattupatti Dam

## The Mattupatti Dam [1/]

In the north Travancore hills at Mattupatti, 5,200 ft (1,560 m) above sea level, seven miles (11.2 km) from the planting township of Munnar and 75 mi (120 km) from Alwaye, the nearest railhead, in surroundings similar to the Nilgiri Glens is being constructed on the Palaar river, a tributary of Mudirapusha, an all-concrete dam, employing some novel methods of construction. It is also perhaps the first dam on which mechanization has been adopted on a larger scale than any other in South India. Mechanization has enabled work to be done throughout the year, in spite of the heavy monsoon experienced, in contrast to places like Pykara where the period of construction is restricted to fair weather. The storage created by this dam is for feeding the second and third machines of the second stage of the Pallivasal Hydro Electric Development scheme.

The height of the dam is 280 ft (84 m) above the deepest foundation on which 135 ft (40.5 m) is below the river bed because of faulty foundations. The dam which is a concrete gravity type structure, is 805 ft (241.5 m) long providing a storage of 1,900 million cu ft (538 million $m^3$) into a basin of 39 sq mi (101 $km^2$). The superficial water spread of the reservoir is 800 acres (324 ha). The maximum flood level is 150 ft (45 m) above river bed. The crest of the ogee type spillway is 134 ft (40.2 m) above river bed and three radial gates 22 ft (6.6 m) long and 17 ft 8 in (5.3 m) high, will dispose of a maximum flood of 16,000 cfs (395 $m^3$/sec). The volume of concrete involved in its construction is 5.7 million cu ft (161,407 $m^3$) costing Rs 5,700,000 (US$1,200,000). About 40,000 tons of cement is being used in its construction.

A power pipe with a diameter of 72.5 in (184.15 cm) and fitted with discharge regulators with its entrance protected by a trash rack 34 ft (10.2 m) above river bed with its exit on the downstream of the dam at river bed level

/ is built

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1/ Abstracted from an article by R. Dorai Rajan, Indian and Eastern Engineer, October 1953, p. 538.

is built into the dam. It will be utilized to feed a low head power station at a later stage when power demand requires it. Another discharge pipe of the same diameter is also provided 4 ft above bed level. Both these pipes are fitted with disperser valves.

A drainage gallery, 7 ft (2.1 m) by 4 ft (1.2 m) and about 18 ft from the water face of the dam and 15 ft (4.5 m) above the river bed level, is provided in the dam. In addition, a grouting gallery 10.5 ft (3.15 m) in front and 5 ft (1.5 m) below the drainage gallery is also constructed. Grouting work will be taken up later.

A very difficult piece of work was involved in dealing with the unsound foundations on the river bed. A faulty zone was discovered in the centre of the dam at river bed about 50 ft (15 m) wide at the heel of the dam and 30 ft (9 m) at the toe and was considered to be several miles long and of indefinite depth. The zone was divided into three sections and excavated up to a maximum of 130 ft (39 m) below river bed level and concreted. Special mat grouting was done wherever fractured rock was met with and this according to the advice of Dr. J.L. Savage of the United States of America was capable of withstanding the stresses induced by the dam structure. Percolation is prevented by a grout curtain of four lines of holes going down to 230 ft (69 m) below river bed level. Thirty thousand running feet (9,000 m) of holes were drilled and 1,000 tons of cement was injected into the faulty zone.

Due to the faulty zone and soft bed on the river bed, the spillway is shifted to the left bank taking advantage of the higher rock contours there as the conventional type of central spillway would involve construction of a costly reinforced concrete bucket and apron. Thus the flood waters could spill over the crest of the dam on to the rock at the toe of the dam which slopes down into the present diversion channel. The diversion channel has rock in its bed for a length of 150 ft (45 m) from the dam toe. To dissipate the energy of the sheet of water descending from the crest of the dam, the method of dispersion with "Splitters and Steps" is adopted, which is described below.

/ Above a step

Above a step formed high upon the face of the spillway numerous equally placed projections called splitters are formed, the tops of the splitters being bucket shaped. These projecting blocks serve two purposes. They divide the smooth sheet of water coming down the spillway into separate streams, thus opening up the sheet at many points for entrainment of air and they also convert into parabolic jets, those parts of the sheet that impinge on the bucket shaped tops of splitters. Water passing between the splitters, similarly is converted into projected jets where it strikes the steps a few feet further down the face. The net result is to project the whole stream into a foaming mass that falls clear of the dam with so much loss of energy as to produce no significant erosion.

To avoid all chances of breaking of the entrained air column under conditions of maximum discharge, a bus pipe will be chased in the spillway face and provided with holes connecting the bus pipe and the vertical face of the splitters. This bus pipe is extended into the training walls of the spillways and is connected to the atmosphere at both ends. The entrained air column created by the splitters and steps is connected to the atmosphere, thus avoiding all chances of negative pressures. After falling on the sloping rock, water descends into a stilling pool located at the present site of the diversion channel, from where it flows over a gear on to the natural bed of the stream with practically all the energy that the water acquired during its fall fully dispersed.

A saving of about Rs 600,000 (US$126,000) is expected by this novel design in preference to the central spillway and slotted buckets and stilling pools.

Another interesting innovation is the installation of a novel sand-washing plant as pure sand was not available in sufficient quantities. Originally fine aggregate was obtained by crushing stone. As this was found to be an expensive process, alternatives had to be found, to procure sand by cheaper methods. On investigation of the sites around the dam area extensive sand accretions were found within two or three miles in the valley above.

/ These pockets

These pockets of sand were believed to have been deposited by the abnormal floods of 1924. This pit sand was found, on analysis, to contain appreciably large percentage of loam and clay. Elimination of these impurities, to bring the quality of sand within accepted standards for fine aggregates in mass concrete, engaged the attention of the engineers, who evolved a method for sand washing. It is an adaptation of the Paterson Filter Plants.

Essentially, the principle in the process consisted in loosening the impurities adhering to the sand particles with compressed air and floating them to be drained off by means of an upward current of clear water. The plant in use consists of rectangular masonry tanks, each 12 ft x 8 ft x 4 ft (3.6 m x 2.4 m x 1.2 m) with over-flow and draining arrangements and with grid pipe systems for water and compressed air at the bottom. Holes 1/4 in (6.35 mm) diameter and staggered 6 in (15.24 cm) apart are provided on the lower side of the pipes for the water manifold, while holes $\frac{1}{16}$ in (1.6 mm) diameter, 4 in (10.16 cm) apart and similarly placed are provided for the air manifold. A layer of graded aggregate from 2 in (5.08 cm) to 0.5 in (1.27 cm) and 6 in (15.24 cm) thick is also provided at the bottom just covering the tops of the grids to prevent choking of the holes.

Raw pit sand quarried and sieved in the pits is brought in tipping wagons to the washing plant, being hauled by diesel locomotives. Normally 6 truck-loads of sand comprise one charge of a single unit in the plant. As soon as the unit is charged with sand, water is pumped in by centrifugal pumps, care being taken to see that the air valves and drain valves are properly closed. When a tank is nearly full, compressed air is let in for about 2 minutes, when water is about to overflow the shutters, air valves are partially closed and shutters lifted, thus flushing out the scum, floating matter and muddy turbidity in water containing suspended impurities. Water falls to the level of the sill of shutters and then the shutters are put back in position. The tank is again allowed to be filled with water. This process is repeated 6 to 8 times, depending upon the degree of impurities in the sand, until fairly clear water is observed at the top, when air is let in. Pumping of water and admission of compressed air are then stopped and water is allowed

/ to drain

to drain by opening of scour valve at the bed of the tank. A very thin layer of scum is observed at the top of the washed sand even after the most careful washing. This is removed with the help of a straight edged reeper. When water is completely drained, washed sand is loaded into wagons and trucked to the sand storage bins. The capacity of one unit in 8 hours, at Mattupatti, is approximately 1,100 cu ft (31.15 $m^3$). But of course, it will depend on the degree of impurity of raw pit sand.

In order to speed up construction a 10 ton cableway and a batching plant are installed for placing concrete.

The cableway with a span of 825 ft (247.5 m) has a fixed head tower 60 ft (18 m) high and a moving tower 40 ft (12 m) high on a radial track on the opposite bank to command the width of the dam. The load carriage travels along the ropeway at 1,000 ft (300 m) per minute and lowers and hoists the 10 ton skip at a speed of 250 ft (75 m) per minute. The skip is capable of carrying 4 cu yd (3.06 $m^3$) of concrete. The cableway has a capacity of laying 8,000 cu ft (226.5 $m^3$) of concrete in a shift of 8 hours. In actual practice it has been possible to do up to 14,000 cu ft (396.4 $m^3$) of concrete in two shifts of 8 hours each. A complete cycle of operation of the cableway takes about 6 minutes. The cost of the cableway is Rs 800,000 (US$168,000). The batching plant, costing Rs 100,000 (US$21,000) has an aggregate storage bin capacity of 60 - 70 tons with two 28 cu ft (0.79 $m^3$) non-tilting type electrically driven concrete mixters. The skip is hauled from the batching plant by a locomotive to the hooking point below the dam. The dam was expected to be completed before the end of 1953 or about a year in advance of the schedule. The adoption of the mechanized methods in construction is expected to result in a gain of Rs 2,000,000 (US$420,000) by way of revenue from electric power as the dam will be completed a year in advance of the schedule.

/ New Kosi

## New Kosi Projects Costs Rs 140 Crores Less

The Government of India has dropped the Rs 177 crore Kosi Dam project and taken up for execution a simpler project at a cost of Rs 37 crores.

As a result of further detailed examination, the Central Water and Power Commission has prepared an alternative scheme for irrigation and flood control of Kosi.

Three main features of the simplified project are: (1) Construction of a barrage at Hanuman Nagar, a short distance from the North Bihar-Nepal border for diverting supplies into the Eastern Kosi Canal for irrigational purposes and as a control point on the river; (2) Flood banks to be constructed on either side of the river; and (3) Diversion of flood waters into some of the old channels of the Kosi for flushing and thus reducing the intensity of floods. Work on the modified scheme will start early next year. The work is expected to be completed in three years. The original project would have taken at least 15 years for completion, it is stated. A team of Indian engineers have already left for China to study the method by which the Chinese Government has tamed the Huai river which had all the turbulent characteristics of the Kosi.

Both in the matter of finance and in the matter of technical assistance the Central Government would give Bihar every possible aid. Probably the entire amount would be given by the centre as a loan to the State Government. The Central Government would see that the project was executed in an efficient manner.

## Koyna Project Launched[1/]

The preliminary work on the Koyna Project was recently launched at the site of the proposed dam, two and a half miles from Helwak.

It is hoped that the power produced by this project would not only help the people of Bombay State but would enable the Bombay Government to undertake other projects as well.

/ For the development

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1/ Abstracted from "The Overseas Hindustan Times", New Delhi, 28 January 1954.

For the development of the country as a whole and the Bombay State in particular, expansion of industries was absolutely essential. Power from the Koyna Project would help the expansion of industry in the State and would provide employment to a large number of people.

The first stage of the project, which forms part of the Five-Year Plan, is estimated to cost Rs 330 million. The project, when completed, will give in the first stage of development about 230,000 kW of power to the Bombay-Poona area, and about 10,000 kW more will be distributed in the adjoining regions of Manarashtra. The Koyna, which is a tributary of the Krishna river and joins the main river near Karad in Satara district of Bombay State, has been known to engineers in India for its hydro-electric potentialities.

INDONESIA

Asahan Project [1]

The Asahan project which is to develop hydro-electric energy from the Asahan river waterfalls in North Sumatra, has been reported due for early realization by the Government of Indonesia and has featured in the talks with the Japanese Government on the reparation issue.

As early as before the last world war it was envisaged by the Dutch company, Billiton Maatschappy as part of the company's plan to set up factories for the processing of bauxite into aluminium.

The construction of the hydro-electric station was started in 1939. According to estimates, the Asahan waterfalls had a capacity of 800,000 hp which was considered enough to generate an electric power of 600,000 kW.

Factory-equipments had already been ordered from Europe, in fact part of it was only awaiting shipment to Indonesia, but due to the outbreak of the second world war all plans had to be annulled. In 1948 it was again planned to re-start the construction of the project, but it had to be postponed again as being still premature at that time.

/ MALAYA

1/ Abstracted from Times of Indonesia, Bandung, 3 February 1954.

MALAYA

## The Parit Hylam drainage scheme[1]

Under the $ 170,000 (Malayan)[2] drainage scheme at Parit Hylam, Senggarang in Johore, Malaya, started in July last year, which was expected to be completed in May 1954, a vast area of the coast, covering about 90,000 acres, planted chiefly with rubber and coconut, will become good yielding land which will benefit thousands of families. Since the scheme started, land values have increased several times.

The scheme will extend from Senggarang to Benit and early this year work was being carried out in the Senggarang extension and in the Parit Botak area. A large control gate, weighing about 500 tons, will be the main outlet for the scheme. It will discharge drainage water from approximately 16 sq mi of land into the sea. Nine excavators were employed in the scheme, which dig about 100,000 cu yd of earth each month.

PAKISTAN

## The two-year priority programme of Pakistan

In two previous issues of our Journal[3], we gave certain figures regarding the thermal power which was to be developed under the Two-Year Priority Programme in Pakistan. The position has since changed. The latest figures for the present planned capacity[4] are:

| | Steam (kW) | Diesel (kW) |
|---|---|---|
| 1. Karachi | 30,000 | - |
| 2. Lyallpur | 30,000 | 10.000 |
| 3. Hyderabad | 15,000 | - |
| 4. Sidhirganj | 20,000 | 9,000 |
| 5. Chittagong | - | 6,000 |
| 6. Khulna | - | 10,000 |
| Total | 95,000 | 35,000 |

/ Guddu

1/ Abstracted from The Malay Mail, 17 February 1954.
2/ M$3.06 = US$1.00.
3/ Flood Control Journal, (ST/ECAFE/SER.C/11), June 1952, pages 31-36 and (ST/ECAFE/SER.C/15), June 1953, p. 37.
4/ Government of Pakistan, Ministry of Economic Affairs. Letter No.XI. UN. 11/56, dated 23 January 1954.

## Guddu barrage [1]

The Guddu barrage scheme envisages the construction of a huge dam on the Indus river in Sind about 80 miles upstream of the Sukkur barrage. It is planned to irrigate over a million acres of land in the Upper Sind areas bordering Bahawalpur State. Preliminary survey work in connection with the construction of the barrage has already been undertaken.

## PHILIPPINES

### Progress in the development of water resources in the Philippines [2]

The Caliraya-Lumont plant valued at ₱ 13,582,392.19 [3] with a total capacity of 36,000 kW is now capable of generating a minimum energy of 160,000,000 kW annually. During the last fiscal year, however, the plant actually generated 224,725,000 kWh, of which 223,943,168 kWh were sold to the customers of the National Power Corporation.

The Corporation had in operation two units with a total capacity of 400 kW in the Talomo No.2 hydro-electric plant, whose value, less accrued depreciation, was ₱ 409,217.99. It had also in operation since 14 April 1953 a single unit of 400 kW in the Talomo 2A hydro-electric plant valued at ₱ 459,063.74. These two plants together produced 3,855,120 kWh of energy sold to Davao Light and Power Company.

The Corporation had under construction, during the year, the Ambuklao hydro-electric project with a total cost of ₱ 26,210,230.30. The important features of the project were: the construction of the road from the Pacdal circle to Ambuklao under contract with Marscon, Inc. which was completed at a cost of ₱ 2,741,920.36; diversion tunnel No.10, under contract with West Pacific Company, which cost ₱ 1,405,365.27; tailrace tunnel construction by Agvid Construction Co., with completed work valued at ₱ 1,512,335.97; construction of the dam, spillway and tunnels 11 and 12 undertaken partly

/ by administration

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1/ Abstracted from Dawn, Karachi, 3 January 1954.
2/ Abstracted from Manila Bulletin, Manila, 1 January 1954
3/ ₱ 2 = US$1.00.

by administration and now by Guy F. Atkinson Co. costing ₱ 15,892,620.41, including equipment; land and land-rights, ₱ 182,873.72; and construction personnel village, ₱ 271,137.81.

The construction of the 25,000 kW hydro-electric plant at Maria Cristina Falls was completed in May 1953 to deliver power for the requirements of the construction of the 50,000 ton fertilizer plant at Iligan, Lanao. The cost of this plant upto 30 June 1953 was ₱ 5,642,728.83 with the finishing touches only remaining to be done. The cost of the fertilizer plant upto 30 June 1953 was ₱ 12,972,128.86.

The construction of the Talomo No.2A hydro-electric plant was completed at a cost of ₱ 460,042.52 by the end of June 1952. This plant was placed in operation on 1 April 1953 and had already delivered 606,480 kWh of energy valued at ₱ 20,736.27.

The Corporation have under the Six-Year Programme projects including the development of the Marikine river with a capacity of 30,000 kW; Binga project with a capacity of 100,000 kW; Maria Cristina hydro-electric project unit No.2 with a capacity of 25,000 kW and unit No.3 with 50,000 kW; Maria Cristina fertilizer ammonium sulphate plant No.2 with a capacity of 50,000 t; and Maria Cristina ammonium nitrate plant No.3 with a capacity of 30,000 t.

/ NEWS OF

## NEWS OF INTEREST

### WATER RESOURCES DEVELOPMENT AND THE POLICY OF THE DEPARTMENT OF THE INTERIOR, UNITED STATES OF AMERICA[1]

The United States of America, Department of Interior has to deal with the functioning of the Department of Fish and Wildlife, Mines Geological Survey, National Parks, Bureau of Land Management, the Bureau of Reclamation, Bonneville Power Administration and several other bureaus. By their very nature these bureaus are frequently in conflict with one another and often with some other Department. They all come in close and day-to-day contact with the public. The net effect is that the Department of the Interior always seems to have one or more critical problems that require immediate attention.

Some of the problems are of greater significance to the United States than others but none required more urgent and thoughtful attention than that of establishing a sound policy concerning the generation, distribution and sale of Federal electric power. This is a problem which has national interest and concerning which there are deep and divergent convictions throughout the United States.

Since the Department of the Interior generates a fair share of the Federal power at its various Reclamation dams, and is the marketing agency for all the power generated by the Corps of Engineers at the flood control and navigation dams, it was logical that the Department of the Interior carry the burden in this matter. The Department does not have anything to do with the power generated and sold by the Tennessee Valley Authority, and the power marketting policy which was recently promulgated by the Department of the Interior does not apply to that organization.

/ In developing

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1/ Abstracted from Tudor, Ralph A.: "Interior Department Policy Reflects New Approach". Civil Engineering, December 1953. An address before the Membership Luncheon at American Society of Civil Engineers Annual Convention in New York.

In developing the policy, all the laws that have been passed and which are applicable to the particular question were first examined in the Department of the Interior. The reports and recommendations that have been made by congressional committees from time to time and the statements that have been made by the President of the United States were also examined. Based upon these documents and particularly the laws that have been passed, a proposed policy for the generation, transmission and sale of Federal power was prepared. It was discussed at length and in detail by the secretariat of the Department of the Interior. When it had taken preliminary form, conferences were held with the Chairman of the Federal Power Commission, the Chief of Army Engineers, the Deputy Director of the Bureau of the Budget and several congressional leaders so that their views might be had and incorporated where appropriate. Finally it was taken to the Cabinet and to the President before it was finally accepted.

This was released to the press on 18 August 1953 and the Department of the Interior was very much interested in the public reaction it received. It is a controversial question and it was featured and editorialized in the press in almost every state in the Union. The Department was criticized on the one hand for being too liberal and on the other hand for being too conservative. However the editorial comment was predominantly favourable.

The Administration's power policy is an honest statement of what the Department believe the law to be. Where the law was not entirely clear or where it did not cover the subject fully, the Department has tried to interpret it for the general good of the entire country and has endeavoured to avoid favour or penalty to any group or area.

The Department of the Interior was first concerned with the policy regarding generation of electricity. In so far as the Bureau of Reclamation is concerned, the primary responsibility of the Department is the reclamation of arid and semi-arid lands. The production of power is fundamentally a by-product of this reclamation. The Congress has never given the Department any responsibility for supplying the power needs of any area. That responsibility

/ truly rests

truly rests with the people locally. It is the responsibility of the Department of the Interior to give leadership and assistance in the conservation and wise utilization of the natural resources. The Department has no right to the exclusive responsibility for the contruction of dams or the generation, transmission and sale of electric energy.

Contrary to past practice, the Department will not oppose the construction of generating facilities by local interests either public or private when these local interests are willing and able to provide the facilities in accordance with licenses properly issued by the Federal Power Commission.

The controversy concerning the Hells Canyon development serves to illustrate the point just made. In this case the Bureau of Reclamation has a plan to build a single very large dam on the Snake river in a stretch where it serves as a border between the States of Oregon and Idaho. This project has never been authorized by Congress. In fact, it was considered by the Congress twice and on one occasion no action was taken while on the other it was specifically rejected.

A couple of years ago the Idaho Power Company initiated an application for a permit from the Federal Power Commission to build a single, smaller dam on this reach of the river. Later this application was amended to include three dams that would develop the same total head as the single large Federal project. The then Secretary of the Interior and the Secretary of Agriculture objected to the issuance of any such license and argued that the Federal Power Commission had no authority to issue one. The action was unusual for the Secretaries did not simply recommend rejection of the license application but became active protestants and litigants before the Federal Power Commission. This has only occurred twice before and all three exceptions have been since the beginning of 1950. Prior to that time the Department of the Interior had followed the customary procedure of advising the Federal Power Commission concerning licenses which were under consideration and abiding by the action of the Commission.

/ When the present

When the present government took over the responsibility of the Department of the Interior early in 1953, the government found themselves litigants in the case of Hells Canyon and arguing that the Federal Power Commission was without authority in the matter. The question was reviewed carefully in the Department and it was concluded that Congress had delegated to the Federal Power Commission the authority and the responsibility for considering license applications. The Congress had further charged the Federal Power Commission with rejecting application which did not reasonably develop the resources involved. In other words, the Federal Power Commission has all the authority and responsibility for safeguarding the interests of the Federal Government and of the people in these matters.

The Department of Interior, therefore, withdrew as litigant before the Federal Power Commission and thereby simply let the procedures that had been standard practice to all previous Administration until 1950 be followed. The Department has taken no position in support of or opposed to the proposal of the Idaho Power Company. The Department has advised the Federal Power Commission that certain minimum restriction and requirements should be written into the license if it is granted. The Department has also made available to the Federal Power Commission all reports and studies that have been made heretofore. Finally, all the personnel in the Department of the Interior that have had any part in the plans for the high Hells Canyon dam has been made available without any restraint on their testimony. Since the Department made the studies and reports on the Federal Hells Canyon project, all the testimony of the Department's witness will be in support of that development. All the facts at the disposal of the Department will be prescribed. The Department will not contest the right of the Federal Power Commission to make a decision in the matter and will abide by the decision when it is rendered.

/ The new policy

The new policy of the Department of the Interior, thus, is to let the ordinary processes of the administration of law be followed, and that the Department of the Interior will not oppose development by local interests.

In the Department of the Interior it is strongly believed that to adequately develop the resources of the country will require the partnership and participation of all of the interested parties. This includes the Federal Government, the states, local public utility districts and cooperatives, municipalities and free enterprise. This is not a new concept for it has been worked in many fields in the past. Congress has recognized it, for by law the Bureau of Reclamation and Army Engineers are required to submit all plans for Federal water development projects to the states for their review. There are also cases such as the Central Valley in California, the Bonneville Power Administration in the Pacific Northwest, the South-western Power Administration in Texas and Oklahoma, where Federal, local, public, and free-enterprise power are integrated together to the advantage of the community.

It is felt, however, that all too frequently in the past this partnership has not been as amicable as it should have been. The Federal Government has been too willing to use the threat of a "yardstick" or the construction of competing facilities to induce negotiations.

The Department of the Interior will continue to plan and to recommend construction of those projects which are economically sound, of advantage to the community, and where the local interests, either public or private, cannot for one reason or another perform the work themselves. Generally this will be the large multiple-purpose projects which because of their size, or non-reimburseable features, or in the state complications, are beyond the means of local effort.

There is strong belief in the principle that it is the role of the Department of the Interior to work with the local interests and to aid them in every proper way but to avoid taking over their responsibilities and authorities.

/ DAMMING A LARGE

## DAMMING A LARGE RIVER IN 52 DAYS[1/]

A break occurred in Dam No. 10 on the Muskingum river at Zanesville, Ohio, 22 April, 1952, destroying 70 ft (21 m) of the dam and creating a 45 ft (13.5 m) gap. The pool above the dam was lowered to such an extent that the navigation locks were in operative, and the water supply of the city of Zanesville and local industries was adversely affected. The required remedial work was unique in that it involved unprecedented time-saving action on the part of the Congress of the United States of America and the city of Zanesville, and the design and construction of a structure at minimum cost and in minimum time.

The dam was of the rock-and-earth filled timber crib type, 514 ft (154.2 m) long and 15 ft (4.5 m) high, constructed in 1841 by the State of Ohio as a part of the Muskingum river navigation system. Built on a rock foundation at the head of the rapids, it created a pool 9.3 mi (14.9 km) long. Navigation above and below the dam was facilitated by a canal extending downstream from the left abutment of the dam a distance of approximately 4,000 ft to a flight of two locks which provided a total lift of 15.4 ft (4.6 m).

Loss of the pool above the dam permitted a thorough inspection of the entire structure. It indicated that the reconstruction of the entire dam would cost but 40 per cent more than the repair of the break. From the point of view of navigation, the repair of the break or the reconstruction of the dam with Federal funds dit not appear to be warranted. Upon the petition of local interests, Congress authorized reconstruction of the dam, subject to certain provisions of local co-operation. This was approved by the city in a special election at which the issuance of necessary bonds for the city's contribution - between $250,000 and $500,000 - was voted by an overwhelming majority.

/ Design and

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1/ Abstracted from Pockras, Harry: "Damming a Large River in 52 Days". The Military Engineer, Washington, USA; January - February 1954, pages 48 and 49.

Design and specifications In the meantime, plans and specifications for the new dam were prepared by the Huntington, West Virginia, District of the Corps of Engineers. Limited time and funds precluded the construction of a conventional type dam that would necessitate the use of a cofferdam. The inability to use floating plant resulted in the specification of a dam of steel sheet pile cells. As designed, there were sixteen cells each 25 ft 5½ in (7.6 m) in diameter ranging from 12 to 17 ft (3.6 to 5.1 m) in height, spaced on 35 ft (10.5 m) 5½ in (14 cm) centers, with closure sections between the cells formed by upstream and downstream arcs of steel sheet piling and connections to the abutment formed by three oblong cells at the right bank and a short concrete plug between the last cell and the canal wall near the left bank. The new dam, 600 ft (180 m) long, would be constructed upstream of the old dam. By siting the cells riverward from each abutment and spanning the temporary opening between each cell with heavy timbers, it would be possible to place the next cell by a crane operating on tops of the previously placed cells. The temporary openings left between the cells would permit the passage of a considerable part of the flow in the river thus reducing the head during construction.

It was appreciated that, as the closures between the cells were effected, the velocity of flow through the remaining opening would render their closure extremely difficult. Therefore, drawings and specifications for the construction of the dam contained the following provisions:

(1) By removing alternate vertical timbers from the closed upper lock gate, it would be possible to divert 600 cfs (17 $m^3$/sec) of the river flow down the canal and through the openings in the gate and the lock filling valves. The average daily flow from the 6,059 sq mi (15,693 $km^2$) of drainage area above the dam for the months of August, September and October is 2,060 cfs (58.3 $m^3$/sec).

/ (2) By cutting

(2) By cutting off the flow of the swift water through the temporary openings between the cells by means of a bulkhead, a still-water condition would be created which would permit ready placing of the piles for the connecting arcs. This could be accomplished by initially wedling an angle to the pile in each cell forming the throat of the opening. These angles would then support a bulkhead frame, into which channel needles could be inserted to cut off all flow.

(3) The end cells could be constructed higher than the center cells, so that work could be continued even after the impounded water started to flow over the lower cells.

The cells and closures were originally designed to be filled with river-run sand and gravel, capped with 18 in of concrete. However, in case the bedrock might be shattered by the driving of the piling, thereby allowing the fill to be "sucked out", it was desirable to remove the overburden in each cell and place a 2-feet (0.6 m) layer of concrete in the bottom of each cell as a seal. Another possibility of failure was erosion of the bedrock at the toe of the dam, which might extend back under the piles and allow the fill to escape. To prevent this, an apron of derrick stone was believed to be necessary along the toe of the dam extending about 20 ft (6 m) downstream. A further precaution against failure was the provision of four blank-flanged pieces of 8 in (20 cm) diameter pipe in the concrete cap to permit periodic inspection of the fill within the cell.

The difficulty and cost of placing derrick stone made it necessary to reconsider the type of fill in the cells. Final plans provided for them to be filled with concrete. The tremied[1/] concrete in the bottom of the cells and the upper 18-in (47 cm) section of concrete were to contain 6.5 and 5 bags of cement per cubic yard, respectively. The concrete between was to consist of a lean mix, containing 3 bags of cement per cubic yard (0.76 $m^3$). Derrick-stone protection at the toe of the dam was eliminated.

Construction Work was begun during the week of 18 August, when the contractor simultaneously began the construction from each bank of access roadways on the river bed above the dam; excavation for the dam; construction of a timber template for setting the sheet piles; and unloading of the piles at the railhead

/ and trucking

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1/ Tremie = a large metal funnel used for the distribution of freshly mixed concrete over a site which is below water.

and trucking them to the site. Work on the upper gate of the locks and the canal was performed as described to permit the diversion of part of the flow of the river.

By September, work was well underway from both banks when a night shift was added. The first piles were set in cell No. 16 on 3 September; the first concrete placed was in that cell on 9 September. After that initial pour, there were only five working days during which no concrete was placed. Overburden within the cells was thoroughly cleaned out to bedrock to provide maximum bond between concrete and rock. When it was necessary to place concrete under water, a 1-yard tremie bucket was used. The top surface of the concrete was cured with wet sand for a period of fourteen days.

Before the closure arcs were set between the main cells, it was necessary to close off the opening between the cells by placing a bulkhead against the angles previously welded to the cells for that purpose. The abnormally low flow in the river (only 1,110 cfs of 31.3 $m^3$/sec) made it possible to operate the plant from dikes constructed above the dam. As the pool rose, new ramps were built to keep the equipment clear of water. Had the floor of the river been average or greater, the plant would have had to be operated from the tops of the cells.

Final concrete was placed the day after water topped the low part of the dam, just 52 days after the start. Good planning and execution, and low river flow, made possible the completion of the contract well ahead of the planned 100-day schedule.

The materials involved included approximately 22,000 linear feet (6,600 m) of steel piles, 6,000 cubic yards (170 $m^3$) of concrete, 2,200 cubic yards (62 $m^3$) of excavation, and 70 tons of derrick stone. The necessary access roads and dikes required an additional 8,000 cubic yards (226,4 $m^3$) of excavation. The major plant used consisted of three cranes, a bulldozer, two air compressors, three concrete buckets,and two pile driving hammers. The project was completed at a cost of $256,000, exclusive of the cost of the removal of the old dam.

## BURRINJUCK DAM ENLARGEMENT[1/]

Water conservation and Irrigation Commission, New South Wales, Australia has made good progress during the past twelve months with the strengthening and enlarging of Burrinjuck dam on the Murrumbidgee river. The greater proportion of the work has now been completed and within a few years the storage will be increased by 130,000 acre ft or 160,355 $m^3$ (one fifth of the present storage capacity).

Alteration to the dam include cement grouting of the main wall to eliminate leakage, construction of 24 huge concrete buttresses against the downstream face to strengthen the heightened wall, and enlargement of the spillway to incorporate three large steel gates. The buttresses, which contain some 55,000 cubic yards (42,075 $m^3$) of concrete weighing about 100,000 t are almost complete, and work is proceeding on the spillway. In the enlarged spillways and associated works there will be an additional 100,000 t of concrete.

## GEO-THERMAL STEAM INVESTIGATIONS IN NEW ZEALAND[1/]

New Zealand Government announces that following preliminary investigations into a proposal to manufacture heavy water in New Zealand, it has been decided to proceed no further with the project. The investigation were carried out in co-operation with the Harwell Atomic Energy Research Establishment in England and were based on the use of geo-thermal steam for the process. It is possible that the scheme may be revived later.

Investigation of geo-thermal stream resources in the North Island will continue with the object of applying them to the generation of electric power. A site for a geo-thermal steam station on the Waikato river near Wairakei has been selected, and the government's geo-thermal consultant Mr. Basil Wood, chief development engineer of Merz and McLellan, consulting engineer, has returned to London to proceed with plans for the plant.

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1/ Abstracted from Commonwealth Engineer, 1 February 1954, page 284.