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EFFECTS OF UPSTREAM STORAGES ON THE PRESENT ECO SYSTEMS IN AREAS DOWNSTREAM OF KOTRI BARRAGE

BY
Barkat Ali Luna
Muhammad Jabbar

EFFECTS OF UPSTREAM STORAGES ON THE PRESENT ECO-SYSTEM IN AREAS DOWNSTREAM OF KOTRI BARRAGE

Engr. Barkat Ali Luna[1], Engr. Muhammad Jabar [2]

SUMMARY

The National dialogue on the proposed Kalabagh Dam raised the issue of possible effects of new upstream storages on the present ECO-System downstream of Kotri Barrage. This has been the subject of heated discussions for quite some time in the past. Different views have been presented by different people and the issue has been politicized quite unnecessarily. The authors believe that it is imperative to place the facts and non-facts about the issue before the profession and the public. Through this paper, the authors have attempted to distinguish facts from non-facts about the issue. Relevant conclusions from this paper are abstracted below in the following summary :-

SEA WATER INTRUSION

There will be no adverse effect due to Sea water intrusion because the groundwater in the entire reach from Kotri to Sea (174 miles) is already saline and hazardous for irrigation and drinking purposes. There is no possibility of its improvement in future even if the river flows downstream of Kotri Barrage are increased.

MANGROVE FORESTS

The Indus Active Delta area is already (almost)devoid of mangrove forests. Only 2.3% of the mangroves exist in this area. The remaining 97.7% exist on the west and east of the Delta area where the mangroves are thriving. They consist of the high salt tolerant species "Avicennia Marina" which can also be grown in the Delta area. As such the construction of any dam of the Upper Indus will not produce any adverse effect on mangroves in the Indus Delta area.

FISHERIES

Fish movement in the Indus River is presently suffering due to the defective design of fish ladders at Kotri and Sukkur Barrages. A small reduction in the downstream Kotri releases during summer as a result of construction of any dam on the upper Indus will have no effect on fisheries in the Delta area.

RIVERINE FORESTS

The productivity of the riverine forests is already on the decline because of the reduced extent and duration of annual flooding. Irrigated forestry is essential for the maintenance

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[1] Ex-Director Irrigation Research Institute Punjab
[2] Ex-General Manager, (WAPDA)

of forest ecosystem which is possible from the canals running outside the flood embankments.

RIVERINE IRRGATION

Reverine irrigation is already in poor shape with low and erratic yields. Pumped irrigation is already being practiced in some areas which can be extended to the rest by installing pumps on the existing canals outside the flood embankments.

DOMESTIC WATER SUPPLY

There are about 200 villages in the riverine area out of which about 135 villages get their domestic water supply directly from the canals of the Kotri Barrage running parallel to the bunds. The remaining villages can be served from the canals proposed for irrigation. This arrangement will improve the present situation.

MAXIMUM BENEFIT TO SINDH

Under the provisions of the Water Apportionment Accord, Sindh will be the maximum gainer from the stored supplies if a dam is built on the Upper Indus and Sindh will be worst hit, in case no dam is built.

INTRODUCTION

The ecological disciplines which can possibly be affected in Sindh area downstream of Kotri Barrage by construction of upstream storages on the Indus River are the following :

- Sea Water Intrusion
- Mangrove Forests
- Fisheries
- Riverine Forests
- Riverine Irrigation
- Domestic Water Supply
- Irrigation Supplies to the Sindh Area.

A detailed study has recently been carried out to evaluate possible impact on the above disciplines. This study has revealed that the apprehensions expressed by a section of the people in Sindh who oppose the construction of Kalabagh Dam on the Indus River are the result of lack of knowledge and unrealistic assumptions. It has highlighted the urgent need for informing the people-at-large about the facts and non-facts as well as real issues and non issues about Kalabagh Dam or any other dam on the Upper Indus River.

There is a saying in Arabic language.

الناس عداء ما جهلوا

(People oppose those things about which they are ignorant). Such people develop "conditioned thinking " as a result of continued reading of and listening to cooked stories that have no logical background. This study was meant to differentiate facts from non-facts and issues from non-issues. This is extremely essential for advancing development of water and power sector in Pakistan which cannot be achieved without the construction of Kalabagh Dam and other proposed storage sites on the Indus River.

STUDY AREA

The study area comprises mainly the Riverine area below Kotri and the Indus Active Delta which is an integral part of the Indus Tidal Delta. Location map of the area is shown on Fig-1.

INDUS TIDAL DELTA

The southern region of Sindh that forms the Tidal Delta comprises all the lands that are inundated by high tides in the Arabian Sea and are exposed at low tides. This area, of

about 1,525,930[1] acres, stretches from Karachi in the west to the Rann of kutch along the Indian Border. Its width varies between five and twenty-five miles. It contains mangroves swamps and thickets of tamarisk ,which lie along the coast and tidal estuaries.

This part of the delta is mainly influenced by the tides of the Arabian Sea and not by the waters of the Indus, except a small frontage on the Sea, described below as "Indus active Delta". At present mangrove forests cover an area of about 321,510[1] acres of the Indus Tidal Delta.

INDUS ACTIVE DELTA

From the point where Indus bifurcates to the point where it joins the Sea the area is known as Indus Active Delta. It is a part of Indus Riverine area, and covers about 294,244[1] acres. This Active Delta is now the only part of the Tidal Delta that is still receiving regular supplies of fresh water and silt from the Indus through Kotri Barrage. The Active Delta has the soil of almost recent formation due to accretion in the river bed. The area is low lying and well drained and is of better composition. All these factors are conducive to the flourishing of mangroves but in the Active Delta the mangroves cover a small area of about 7,400[1] acres only.

INDUS RIVERINE4 AREA (ACTIVE FLOOD PLAIN)

An Active Flood Plain is found on both sides of the Indus River from Kotri up to the Active Delta. Bunds have been constructed to confine flood flows within the active Flood Plain. It covers about 336,540 acres and may be described as the summer bed of the Indus River . The river keeps on changing its course within this landform. Erosion and deposition take place over vast areas and the surface becomes stable only after the flood water has receded.

. SEA WATER INTRUSION

POSSIBLE EFFECT ON GROUNDWATER

The Sea tides rise and fall into the Indus estuary twice daily. This phenomenon can possibly affect the Tidal Delta Area in two ways.(1) the Sea water seeping from the estuary may render the ground water saline and make it unfit for irrigation and drinking purposes and (2) it may cause salinity in the soil above the ground water and render it unfit for growing any crops. As far as no (1) is concerned, the ground water in the entire reach from Kotri to Sea (174 miles) is already saline and hazardous for irrigation and drinking purposes. Proof of this fact is available on record in the PC-1 Performa of Kotri Barrage project and Field Investigations Report prepared by Master Planning Division of

WAPDA (1979) in the command area of Kotri Barrage. This ground water was saline when in the pre-canal era, the entire flow of the Indus River and its five tributaries (182

[1] International Union for Conservation of National (1992)

MAF per annum) flowed through this reach for centuries. It remained saline after the flow of three eastern rivers (33 MAF) was taken away by India and also after the Indus Basin canal system withdrew 105 MAF of water from the rivers. Certainly it will not be affected if another 6.1 MAF is stored by the Kalabagh Dam Project. A saline groundwater which could not improve with the flow of 182 MAF continued over centuries, will not change if 6.1 MAF of Kalabagh Dam are allowed to flow in the river channel in future.

POSSIBLE EFFECT ON SOIL ABOVE THE GROUNDWATER

Regarding no.(2) i.e. soil above the groundwater there is no flow down stream Kotri during the winter season. Table-1 shows the no. of days in a year with no flow downstream Kotri. It would be seen that the river channel remains dry for about 3 to 8 months every year. During this period the tidal waves rise and fall unchecked in the Indus Tidal Delta and the soil above the ground water attains maximum possible salinity and is therefore unfit for sowing any Rabi crop. During the summer no crops are grown in the riverine area due to the possibility of flood inundation at any time. It is, in fact, due to this reason that at present no irrigation is practiced in the Indus Active Delta. It would be realized that under such circumstances Sea water intrusion as a result of the construction of Kalabagh Dam does not carry any meaning. Therefore, any amount of water released downstream of Kotri during the flood months to check Sea water intrusion will be a sheer waste. Wisdom demands that surplus water should be gainfully utilized for growing food and fibre for the human population instead of wasting it into the Sea.

It may also be mentioned that apart from the Indus Active Delta there are numerous creeks/estuaries along the shore line from Karachi to the Indian Border. Sea tides also rise and fall twice daily in these estuaries, but no problem due to Sea water intrusion ever existed in these area.

The study concludes that Sea water intrusion cannot cause any harm to the underground aquifer which is already highly saline from the prehistoric days and is unfit for irrigation and drinking purposes. Similarly the soil above the groundwater in the Indus Active Delta attains maximum salinity during the winter season when there is no flow downstream Kotri. As such no Rabi crop can be grown in the Active Delta Area. During summer no Kharif crop can be grown due to the possibility of flood inundation. Therefore Sea water intrusion in the Indus Active Delta does not carry any meaningful effect.

MANGROVE FORESTS

Mangroves are trees which grow along tidal estuaries in salt marshes and on muddy coasts and characteristically have exposed supporting roots in large numbers. Due to their thick root system at the bottom they dampen the velocity of tides and thus provide a spawning ground for the fish. Although they can survive long periods in high salinity, occasional dilution of sea water with fresh water is needed for them to flourish. The shape of young mangrove plants and thick forests can be seen in Figures 2 and 3.

The total area under mangrove forests is about 321,510 acres which is spread over the shore line from Karachi to the Indian Border. The photograph in Fig-4 taken from the satellite imageries shows (in pink colour) the distribution of mangrove forests as well as the Indus Active Delta in the center. It would be noticed that there are thick mangrove forests from Karachi to the Active Delta and from Active Delta to the Indian Border. In the Active Delta area there are only 7,400 acres which constitute just 2.3% of the whole mangrove forest area.

DEVELOPMENT OF HIGH SALT TOLERANT SPECIES OF MANGROVES

During the 19th Century, Indus River had more than 12 branches in its delta area covering the shore line from Karachi to the Indian Border, as shown in Fig-5. As a result, flood discharge used to spread over the whole area from Karachi to the India Border. With development of human settlements, the Government of Sindh (GOS) constructed bunds along both sides of the Indus River which stopped inundation on both sides and thus supply of fresh water was cut-off on both sides of Indus Delta towards Karachi and the India Border.

In the Indus delta, 8 species of mangroves have been recorded in the past. Of these, only 2 or 3 are flourishing now, of which one (Avicennia marina,(local name timer) now comprises more than 95% of surviving trees. Reduction in or stoppage of river flow, and consequent increase in salinity, is the principal cause of extinction of other mangrove species from the Indus Delta, as were least able to tolerate high salt concentrations. The currently most abundant species, Avicennia marina, is the most salt-tolerant. It can tolerate salinity upto 85000 ppm while the Sea water Salinity is upto 35,000 ppm.

EFFECT OF FOREST MANAGEMENT MEASURES

The largest blocks of mangroves located towards the Karachi side and on the Indian Border side are under the control of the Sindh Forest Department which exercises management control over growth and exploitation of the mangroves. These large areas are considered as protected forests where the Sindh Forest Department grows young plants, takes their care and protects them from cutting and grazing with the result, that the mangroves are thriving in these areas.

However, the area surrounding the mouth of the Indus(Active Delta) has the lowest density of mangroves (7400 acres only). This area is in theory controlled by the Central Board of Revenue because it used to be cultivated with red rice, when the Indus flowed more strongly. It is obvious that a combination of no control and land clearance for red rice cultivation have contributed to decimation of the mangrove stands in this area. This situation has resulted in no forest control management, no planting of new trees, no look after and increased cutting and grazing in the area. If the high salt tolerant variety Avicennia marina is grown in this area and forest management measures are adopted, mangroves in the Active Delta area can thrive the same way as they do on the Karachi side and on the side of the Indian Border.

OCCASIONAL DILUTION OF SEA WATER WITH FRESH WATER

It can be argued that on the Karachi side and on the Indian Border side, some fresh water(or less saline water) is brought to the shore line by lower Indus drains. Yes, these drains do bring less saline water (than the Sea water), because the underground water is saline; but the Indus River, its two main branches, the Mutni and the Ochito rivers and their creeks also bring seepage water to the Indus Delta area during the winter and large supplies of flood water during the summer. The obvious reason for extinction of mangrove forests in the delta area is lack of forest management. This area should be placed under the control of the Sindh Forest Department and treated as a protected forest area. If these measures are adopted and the high salt tolerant variety(Avivennia Marina) is planted thick mangrove forests can also grow in the Active Delta area.

It is apparent that the assumption of adverse affect on mangrove forests as a result of the construction of Kalabagh Dam is a non-fact. It is non-issue and can not be made a basis to stop the construction of Kalabagh Dam Project.

FISHERIRES

PALLA FISH

The "Palla" which is one of choicest table fish in the area, is a migratory sea-water fish which spawns only in the sweet waters of the Indus and later drops back to the sea. At the time of fresh water flows to sea during June, it migrates as adults upstream into the river to spawn .The trigger for the migration is believed to be the increase in fresh water flow during this month., which the fish may detect with the smell of lower salinity water. This quest leads them to their spawning areas.

It produces enormous number of tiny free-floating eggs, which drift back downstream, hatching and developing into larvae. Three days after they hatch, the young larvae leave for the estuary where the survivors develop into small fish, then move out to sea to grow to adult size and come back again later (unless they are caught) to recommence the spawning cycle.

Near the mouth of the river the fishing begins as early as February and as the floods increase, fishing activities more upstream. From April to August most of the fishing is done between Kar Shah and Kotri Barrage if the River is in high flood, but if floods are medium or low, fishing continues throughout the river length from the mouth of Indus Kotri Barrage. Peak catches of Palla are during June and July which are the hottest months, least suited for fish marketing.

Before the barrage was built at Sukkur in 1935, Palla fish were reported to migrate as far north as Multan, but after its construction, the run of fish beyond Sukkur stopped. Later on 1955 the Kotri Barrage constructed near Hyderabad resulted in further reduction in the Palla run. The fish ladders provided at this barrage proved a failure. The fish cannot climb the fish ladder due to its faulty design. The fish now migrate only upto Kotri barrage where they congregate and are consequently caught in large numbers.

For up-stream migration Palla needs a channel depth of about five feet which occurs at a flow of about 30,000 cusec. This depth of flown is generally available through out the flood season (Construction of Kalabagh Dam will not change this situation). This discharge flowing continuously throughout the month of June (the period of Palla migration) would require a total flow volume of 1.789 MAF.

SHRIMP FISHERIES

The present day tidal deltaic plain is characterized by numerous crisscrossing creeks/channels and swampy mudflats. This area of about 1.526 million acres, stretches from Karachi in the west to the Rann of Katch along the Indian border. It is the most important area for the fishing industry and is closely linked with the coastal mangroves. The Indus delta mangroves are important as nursery ground for fish especially for the commercial and artisanal Shrimp fishery. Mangroves provide shelter and protection to many fish species during their early stages of life. The juveniles of shrimp grow in estuaries of Indus delta and migrate to the sea after achieving a certain size, where these attain sexual maturity. Maximum migration takes place during recruitment. At this time of massive migration, the fleet of trawlers line up in front of the mouth of the deltaic creaks and catch as many shrimps as possible without any consideration of the stage of development in which these shrimps are.

The shrimp fishery in Sindh forms the most important sector in fisheries because of its foreign exchange earning potential and the creation of jobs in the industry. During the past decade the production of shrimp fish in Sindh has shown a mixed trend. There was an overall increase from 26,460 metric tons in 1983 to 33,900 metric tons in 1993 with a Decline in the production in 1989 to 22,955 metric tons. The year 1993 shows a production of 33,900 metric tons and a sharp increase over the preceding years. (Source:- Agriculture Statistic of Pakistan, Ministry of F&A,G.O.P., Islamabad).

CONCLUSIONS

- There Is no evidence available to establish that due to any reduction in the flows d/s Kotri fish population in Sindh has declined. Statistics confirm that there has been a gradual increase in the inland fish production since 1947. Table – 2 shows an increase of 178% in fish production from 1981 to 1997.

- The greatest damage to migratory fish (Palla) population is being caused by the construction of Kotri barrage and its defective fish ladders which do not allow the Palla fish to ascend beyond Kotri.. As a result of this unsurpassable barrier the Palla fish species have lost 2/3 of their breeding ground. The breeding is now restricted only to 50 – 147 mile reach from the sea shore.

- Indiscriminate fishing of young Palla fish from deltaic region and offshore areas is adversely affecting the stock situation. If not checked it will cause an ecological imbalance in the marine eco-system.

- There has been a gradual increase in the overall catch of Shrimp in Pakistan. However, because of high profitability, increase in the number of trawlers has taken place. Their number now exceeds highest sustainable yield levels. Hence the catch per effort has decreased..

RECOMMENDATIONS

Following steps are recommended to promote fisheries in Sindh :

1. For increasing the production of Palla fish in the Indus River it is recommended that :

    - Palla fish shall not be stopped from their migration by barriers which may either prevent them from getting up-stream or undoubtedly delay them in reaching the spawning grounds. Scientifically designed facilities at Kotri, Sukkur & Guddu Barrages for passing Palla fish across these barrages may be provided.

    - There is need for greater restriction in over-fishing in the deltaic areas and to establish hatcheries in the public sector in lower Sindh where Palla should be bred and grown to a certain size and then released into the river system. Artificial breeding has been successfully carried out elsewhere in Indo-Pakistan sub-continent.

    - A channel of five feet depth shall be maintained during the migratory period (June) of Palla fish.

- The major damage to fishery in Sindh is being done by uncontrolled increase in the fleet size . Such a situation leads to a fall in the per-effort catch and if the trend continues it will result in serious and in some cases irreparable damage to the stock position. The capacity of the fleet over and above the optimum required should be eliminated.

- Shrimp fishing should be completely stopped during the period of the year when massive migration of juvenile shrimp takes place, from breeding and rearing grounds in the Indus delta, into the sea.

- There is also need to promote shrimp farming at appropriate locations. Hatcheries for Shrimp breeding as well as training institutions for shrimp culture should be established,.

RIVERINE FORESTS

According to the Sindh Forest Department record, the riverine forests below Kotri cover an area of 104,4305 acres. They are made up of an assortment of tree species. The most important of these species is Acacia Nilotica. Riverine forests at present rely on annual flooding by Indus for their survival. The Indus below Kotri starts rising in June and continues until it reaches its annual peak in July or August. During the flood season, the river discharges its overflowing waters into the surrounding forests and depending on the peak discharge, thoroughly irrigates some or all of them.

FLOOD IRRIGATION IS ERRATIC

Due to difference in topography, not all areas under forests get flooded equally. The area between the bunds can be divided into I) high level area which are seldom flooded, ii) intermediate areas which are seldom flooded, ii) intermediate areas which are subject to flooding every five or six years, and iii) low-lying areas subject to annual flooding or almost once in two years. The land in each of these categories must be managed differently. Obviously, there are random gradations in elevation and not all land fits conveniently into one class or another.

River flows vary from 200,000 cusecs to 1,000,000 cusecs from year to year, but only at peak flows do the highest lands receive water. Riverine forest do not benefit much from the normal 200,000 cusecs flowing constantly over months.

FOREST ECO-SYSTEM ALREADY UNDER STRESS

The study has recalled that with discharge of 500,000 cusecs only 45.7% of the forest area receives water in 5 out of 11 years. Almost 16% of the high level forests receive flood water once in 12 years when the peak discharge is over 675,000 cusecs. It is clear that the flood events that are occurring at present are insufficient to maintain the forests.

The productivity of the reverine forests is already on the decline because of the reduced extent and duration of annual flooding. Acacia Nilotica , an important source of timber, is said to require 20 to 25 days of flooding each year for optimal growth. The required duration of flooding is not available even at present and the eco-system of forests is already under stress.

NEED FOR PUMPED IRRIGATION

There is urgent need that some alternative measures are adopted to sustain the riverine forests. Fortunately a possibility exists to irrigate these forest by pumping supplies from the canals running parallel to both the embankments along left and right banks of the Indus River.

Under the above situation, it is untrue to say that the eco-system of forests will be adversely affected by the construction of Kalabagh or any other dam on the Indus River. These forests need pumped irrigation supplies even at present which can be supplied from the existing canals running along the left and right banks of the Indus River. The annual water supply requirement of the present forested area has been estimated to be 0.643 MAF.

RECOMMENDATIONS

As riverine forests meet the important social & ecological needs of lower Sindh area, these forests can not be allowed to degenerate. Irrigated forestry is therefore essential for the maintenance of the forest ecosystem. For this purpose a scheme should be prepared for pumping supplies to the tune of 0.64 MAF from the existing irrigation canals running parallel to both the embankments along left and right banks of the Indus River.

RIVERINE IRRIGATION

LOW YIELDS OF CROPS

Agriculture is the main stay of the riverine inhabitants' earnings. This agriculture depends primarily on residual soil moisture. Soil moisture stress, before the time of maturing, results in low yields. The various major crops being grown in the riverine area are Fruits (14%),Rice (12%), Sugar Cane (7%); Wheat (12%); Pulses (7%) and Fodder (8%). Flood irrigation carries a high element of risk. Crops are grown on a single irrigation and therefore their yields are erratic and lower than their potential.

At present in the riverine area from Kotri to delta, land cultivation mainly depends upon flood characteristics, i.e. magnitude, level, duration and timing during the year. High lands situated far from the river channel near the embankments have less frequent flooding and as such these areas are being provided supplementary irrigation through lift pumps installed on the canals running out side the bunds.

Out of the total gross area of 336.542[1] acres nearly 95,038[1] acres is under-cultivation. The present cropped area in the reach below Kotri is about 107,168[1] acres out of this, 48,632[1] acres are cultivated in Kharif and 58,536[1] acres in Rabi. Annual cropping intensity is about 112 percent with 51 percent in Kharif and 61 percent in Rabi.

Irrigation is not practiced in the Active Delta. This is partly because of the high salinity of the soil which has been reclaimed from the sea , and partly due to the frequent inundation of this low lying land by the sea water.

LIFT IRRGATION

At present 31,479[1] acres out of the total area of 95,038[1] acres are under lift pump irrigation. About 250 pumps provide irrigation to 24,951[1] acres using water from canals outside the riverine area. About 6,528 acres get water from Indus through 83 pumps. The irrigation during Rabi relies on leakage through the gates at Kotri, escapes of canal water, or seepage of groundwater into the river downstream of the barrage. Any reduction in flows downstream of Kotri in the Rabi season could reduce the acreage of crops that can be irrigated in this area.

The spills of river Indus during summer provide irrigation to an area of 63,559[1] acres. A reduction in flood flow during the Kharif season will reduce the average area inundated each year, which will reduce the average area inundated each year, which will reduce the acreage of crops that may be grown in this area on the flood recession. With varying levels and discharges in the Indus, the only way to attain an assured water supply for crops is to install more lift pumps on the existing canals running outside, along then two bunds. Water requirements for the present C.C.A have been estimated to be 1,67,344[1] A.F in Kharif and 1,41,950[1] A.F in Rabi (total = 0.31 MAF).

RECOMMENDATIONS

Provision for 0.31 MAF of additional water for irrigation in the riverine area should be incorporated in the upstream future reservoirs such as Manchar-Sehwan Complex, Kalabagh Dam, Basha Dam etc. The existing canals running parallel to the two embankments can be remodeled to carry the additional discharge for riverine irrigation (including the forests).

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[1] Report; Riverine Development in Sindh:WAPDA 7 LUNDP (1994)

DOMESTIC WATER SUPPLY

POPULATION OF THE RIVERINE AREA

The population of the riverine area below Kotri is estimated to be about 120,000 out of which that of the active delta area is over 10,000. Water for drinking purposes including live stock is obtained mainly from surface supplies. Hand pumps and open wells are not very common as a source of drinking water. The main constraint to ground water development is the deteriorated ground water quality with brackish or saline water occurring at very shallow depth.

There are about 200 villages in the riverine area, out of which about 135 villages get their water directly from the canals of Kotri Barrage running parallel to the bunds. Thirty four (34) villages collect water from the Indus.

QUALITY OF DOMESTIC WATER SUPPLY

Surface water of the Indus river downstream of Kotri barrage becomes saline after one month with no release from Kotri barrage. This increased salinity is caused by the seepage of saline ground water into the river bed. A small release from Kotri will provide sufficient dilution to control the salinity of the river water to acceptable level upto Aghimani. The INDUSALT computer model based on the conditions surveyed in March 1997, suggests that a freshwater flow of 175 cfs would be sufficient for the purpose. A maximum resource of about 0.08 MAF would be required to maintain this residual flow for 240 days when there is no flow downstream of Kotri Barrage.

RECOMMENDATIONS

In future the canals as proposed for irrigation of riverine forests and riverine irrigation shall meet all the domestic water requirements of the villages located in the riverine area. This arrangement is needed even at present and shall also meet the requirements for the future.

REQUIREMENTS FOR THE ACTIVE DELTA AREA

The only source of drinking water for about 67 villages, in the Active Delta, located from Karo Chan to Sea, is the creek channels. When during floods the water level rises in the creeks, they store water in ponds for drinking purposes. The population of the Active Delta (about 10,000 fishermen) rely on this stored fresh water as their source of drinking water during the Rabi season. If water stored proves insufficient, they are forced to bring it by boats from other places or to buy it from water sellers.

RECOMMENDATIONS FOR MINIMUM FLOWS DOWNSTREAM KOTRI

The study recommended minimum flows downstream Kotri, on 10-days period basis, to meet all requirements discussed above. These minimum are given in Table-3 and same are summarized in the Box below.

BOX
RECOMMENDED MINIMUM FLOWS DOWNSTREAM KOTRI

Sr. No	Item	Recommended Flows (MAF)	Remarks
1.	To check sea water intrusion	Nil	-
2.	To maintain mangrove forests	Nil	-
3.	To maintain riverine forests	0.64	-As per recommendations in sub-para 6.4
4.	To dilute saline ground water seepage entering into Indus	0.08	To met the present need as Explained under sub-para 8.2
5.	To maintain riverine irrigation	0.31	As per recommendations in sub-para 7.4
6.	To maintain Palla fish migration	1.79	-As per recommendations in sub-para 5.4
7.	Domestic water supply	Nil	
	TOTAL	2.82	

ADDITIONAL IRRIGATION SUPPLIES SINDH

ADDITIONAL SUPPLIES AFTER THE CONSTRUCTION OF MANGLA & TARBELA DAMS

There are three barrages on the Indus River in Sindh:

- Sukkur Barrage where seven canals take off with a designed discharge of 48,000 cusecs.
- Guddu Barrage which has three off-taking canals with a designed discharge of 36,500 cusecs.
- Kotri Barrage having three off-taking canals with a designed discharge of 40,500 cusecs.

Total designed discharge of all the canals equals 125,000 cusecs. During the summer season, these canals run to their full capacity due to the abundance of flows in the River Indus, However, during the winter spare capacity is available in the canals due to the limited river flows and the crop remain stressed due to inadequate supplies during late Rabi, early Kharif and late Kharif periods. With the construction of Mangla and Tarbela Dams the position of supplies to the Sindh area improved considerably both during

Kharif and Rabi seasons. Kharif supplies increased from 24.91 MAF to 28.34 MAF after Mangla and further to 29.14 MAF after Tarbela. Similarly the Rabi supplies increased from 10.65 MAF to 12.34 MAF in post Mangla and post Tarbela periods respectively. The Rabi supplies which are more valuable registered an increase of 16% in post Mangla period and 42% in post Tarbela period. Details are shown in Table-4.

ADDITIONAL SUPPLIES TO SINDH FROM KALABAGH DAM

Like Mangla and Tarbela Dams the proposed Kalabagh Dam would also provide additional supplies to the Sindh area. The Water Apportionment Accord (WAA) (1991) specified a total volume of 117.35 MAF for distribution among the four provinces. Against this figure, present actual canal withdrawals are only 105.35 MAF. There is a shortfall of 12.00 MAF which is not being utilized by the provinces. This shortfall consists of 8.4 MAF available during the summer and 3.6 MAF which is not available during the winter season. The available discharge of 8.4 MAF during summer is not being utilized because there is no water available during early Kharif and late Kharif periods for sowing and maturing of the kharif crop. With the construction of an upper Indus dam/Kalabagh dam the short fall of 12.00 MAF will become utilizable and Sindh will be able to utilize an additional discharge of 5.18 MAF over and above its present level of canal withdrawals. Out of this 5.18 MAF, 1.55 MAF will be provided from the stored supplies while the remaining 3.63 MAF will be utilized from the available summer discharge. A detailed picture of the present and future distribution of supplies under WAA among the four provinces is given in Table-5.

MAXIMUM GAIN TO SINDH AREA

It would be seen from Table-5 that with the construction of upper Indus dam / Kalabagh dam Sindh will derive the maximum benefit as compared to other provinces. With the availability of 12.00 MFA (additional) WAA supplies) the shares of various provinces will be as below:-

PROVINCES	ADDITIONAL SUPPLIES ALLOCATED UNDER WAA (MAF)
2. Punjab	1.58
3. Sindh	5.18
4. NWFP	3.35
5. Balochistan	1.89
Total:-	12.00

Utilization of 5.18 MAF in Sindh during the various Kharif periods will be as below;

CROP PERIOD	ADDITIONAL SUPPLIES FOR SINDH (MAF)
1. Early Kharif	0.98
2. Main Kharif period	3.46
3. Late Kharif	0.74
TOTAL:	5.18

Details of the above mentioned additional supplies to Sindh can be seen in Part-A and Part-B of Table – 5. With the additional supply of 5.18 MAF, an area of 4.8 million acres can be cultivated in Kharif at a water allowance of 3 cusecs per 1,000 acres.

It may be mentioned that in the absence of these additional supplies Sindh would be the worst sufferer because Punjab and NWFP have more rains and more fresh groundwater that can provide some relief during the emergencies. Sindh is not that fortunate in these two natural aspects. By 2010 siltation in Mangla, Tarbela and Chashma reservoirs will reach 5.3 MAF. This would further worsen the situation. It may be emphasized that due notice should be taken of these hard facts (1) that with the construction of an upper Indus Dam Sindh will be the maximum gainer and (2) that in the absence of a storage dam Sindh would be worst hit. There is an urgent need that the affected people should be informed about this situation without further loss of time.

CONCLUSION

We started with an Arabic proverb that said "people oppose those things which they are ignorant about " and we conclude with the Quranic verse.

وَلَا تَكُونُوا كَالَّذِينَ نَسُوا اللَّهَ فَأَنسَاهُمْ أَنفُسَهُمْ (سورہ حشر)

(Don't become such people who forget the God Almighty ,because God then makes them forget their ownselves). Who are the people who forget their ownselves- those who do not understand their own benefits, their own interests, their own welfare and the needs of their kith and kin. Certainly we will destroy our own interest, and our own generations if we do not build the upper Indus dam and Kalabagh is the only option that we have at the present moment.

It may be noted that Kalabagh Dam has already proved its worth. It was scheduled to be completed in 1993. We failed to complete it by this date and are now facing a very serious power crisis through the Independent Power Producer (IPPs). Had we completed it in time, there would have been no power crisis. If we do not complete it in the next 10 years there will be a food crisis which we can ill afford.

We humbly pray to the Almighty; "God give us the wisdom to understand our national interests and the courage to fulfil our responsibilities towards our future generations".

TABLE-1

YEARLY NO FLOW CONDITION DOWNSTREAM KOTRI

Year	Total Days in a Year with No Flow Downstream Kotri	Continuous No Flow Periods (Number of Days)		
		I	II	III
1977	101	25	29	44
1978	125	78	18	29
1979	137	44	67	-
1980	202	135	62	-
1981	140	56	67	-
1982	156	60	44	-
1983	126	93	27	-
1984	180	71	53	43
1985	251	155	86	-
1986	217	135	71	-
1987	133	80	45	-
1988	100	53	37	-
1989	158	70	30	39
1990	69	59	-	-
1991	34	27	-	-
1992	44	34	-	-
1993	77	77	-	-
1994	100	54	46	-
1995	101	50	51	-
1996	181	84	30	39
1997	58	31	-	-

Source: Data from SWHP, WAPDA

TABLE-2

FISHING CRAFTS AND FISH PRODUCTION
INLAND FISHERIES

Year	Inland Fishing Crafts (Nos.)			Production (1000 Tons)
	Sail Boats	Row Boats	Total	
1981	2,120	2,065	4,185	36.8
1982	2,120	2,065	4,185	37.3
1983	2,302	2,397	4,699	37.4
1984	2,489	2,729	5,218	44.6
1985	2,710	3,100	5,810	46.6
1986	2,950	3,520	6,470	50.8
1987	3,183	3,738	6,921	53.6
1988	3,200	3,800	7,000	54.0
1989	3,215	3,860	7,075	57.5
1990	3,280	3,900	7,180	60.3
1991	6,941	3,144	10,085	58.0
1992	3,484	2,731	6,215	60.0
1993	3,457	2,777	6,234	60.3
1994	4,278	6,208	10,486	71.8
1995	3,138	2,355	5,493	75.4
1996	3,165	2,348	5,513	91.4
1997	3,195	2,407	5,602	102.5

Source: Agriculture Statistics of Pakistan, Ministry of Food and Agriculture, G.O. P. Islamabad/Marine Fisheries, Karachi.

TABLE - 3
RECOMMENDED MINIMUM FLOWS DOWNSTREAM OF KOTRI

Months		EXISTING FLOWS DS KOTRI (MAF)			RECOMMENDED MINIMUM FLOWS DOWNSTREAM KOTRI									
		AVERAGE	MINIMUM	MAXIMUM	Immediate Requirements	To be provided to Sindh under para 7 of WAA	To be managed by Sindh from its own share under para 4 of WAA					Recommended Minimum Flows Below Kotri on full implementation of WAA		
		1974-94	1991-92	1993-94	To check Saline Ground Water[1] Seepage entered into India (A.F)	To check Sea Water Intrusion (A.F)	Water Requirements							
							To maintain Mangroves Forests[2] (7,000 acres) (A.F)	Delta Fish Migration (A.F)	Domestic Water Supply (A.F)	Forest Needs[3] (A.F)	Irrigation Needs[4] (A.F)	Releases to Canals (MAF)	Releases to River Indus (MAF)	Total Releases (MAF)
RABI														
OCT	1	0.700	0.073	0.095	3,475	Nil	Nil	Nil	Nil	17,600	9,345	0.027	0.003	0.030
	2	0.459	0.053	0.081	3,475	Nil	Nil	Nil	Nil	17,600	9,345	0.027	0.003	0.030
	3	0.179	Nil	0.065	3,820	Nil	Nil	Nil	Nil	19,370	10,280	0.030	0.004	0.033
NOV	1	0.118	Nil	0.032	3,475	Nil	Nil	Nil	Nil	17,600	10,225	0.028	0.003	0.031
	2	0.075	Nil	0.006	3,475	Nil	Nil	Nil	Nil	17,600	10,225	0.028	0.003	0.031
	3	0.056	Nil	0.002	3,475	Nil	Nil	Nil	Nil	17,600	10,229	0.028	0.003	0.031
DEC	1	0.045	Nil	Nil	3,475	Nil	Nil	Nil	Nil	17,600	7,295	0.025	0.003	0.028
	2	0.031	Nil	Nil	3,475	Nil	Nil	Nil	Nil	17,600	7,295	0.025	0.003	0.028
	3	0.101	0.052	0.125	3,820	Nil	Nil	Nil	Nil	19,370	8,036	0.027	0.004	0.031
JAN	1	0.115	0.058	0.133	3,475	Nil	Nil	Nil	Nil	17,600	7,715	0.025	0.003	0.029
	2	0.142	0.082	0.020	3,475	Nil	Nil	Nil	Nil	17,600	7,715	0.025	0.003	0.029
	3	0.131	0.002	0.013	3,820	Nil	Nil	Nil	Nil	19,370	8,497	0.028	0.004	0.032
FEB	1	0.125	0.006	0.042	3,475	Nil	Nil	Nil	Nil	17,600	7,735	0.025	0.003	0.029
	2	0.074	Nil	0.004	3,475	Nil	Nil	Nil	Nil	17,600	7,735	0.025	0.003	0.029
	3	0.028	Nil	0.002	2,800	Nil	Nil	Nil	Nil	14,089	6,235	0.020	0.003	0.023
MAR	1	0.055	Nil	0.002	3,475	Nil	Nil	Nil	Nil	17,600	4,490	0.022	0.003	0.026
	2	0.039	Nil	0.002	3,475	Nil	Nil	Nil	Nil	17,600	4,490	0.022	0.003	0.026
	3	0.074	Nil	Nil	3,820	Nil	Nil	Nil	Nil	19,364	4,943	0.024	0.004	0.028
TOTAL (R)		2.611	0.261	0.646	63,056	Nil	Nil	Nil	Nil	329,193	141,560	0.462	0.063	0.525
KHARIF														
APR	1	0.272	0.018	Nil	3,475	Nil	Nil	Nil	Nil	17,600	5,476	0.023	0.003	0.026
	2	0.357	0.131	Nil	3,475	Nil	Nil	Nil	Nil	17,600	5,476	0.023	0.003	0.026
	3	0.492	0.254	Nil	3,475	Nil	Nil	Nil	Nil	17,600	5,476	0.023	0.003	0.026
MAY	1	0.491	0.158	Nil	3,475	Nil	Nil	Nil	Nil	17,600	6,600	0.024	0.003	0.026
	2	0.564	0.568	Nil	3,475	Nil	Nil	Nil	Nil	17,600	6,600	0.024	0.003	0.026
	3	0.628	0.498	Nil	3,820	Nil	Nil	Nil	Nil	19,365	7,260	0.027	0.004	0.030
JUN	1	0.561	0.040	0.028	Nil	Nil	Nil	Nil	Nil	17,620	7,510	0.025	0.000	0.025
	2	0.588	0.012	0.187	Nil	Nil	Nil	Nil	Nil	17,600	7,510	0.025	0.000	0.025
	3	0.514	0.064	0.491	Nil	Nil	Nil	595,000	Nil	17,633	7,507	0.025	0.595	0.620
JUL	1	1.331	0.079	0.109	Nil	Nil	Nil	595,000	Nil	17,630	12,370	0.030	0.595	0.625
	2	2.206	0.195	4.202	Nil	Nil	Nil	595,000	Nil	17,600	12,370	0.030	0.595	0.625
	3	1.804	0.138	2.917	Nil	Nil	Nil	Nil	Nil	19,365	13,606	0.033	0.000	0.033
AUG	1	4.631	0.085	12,051	Nil	Nil	Nil	Nil	Nil	17,600	12,070	0.030	0.000	0.030
	2	6.125	1.311	15.243	Nil	Nil	Nil	Nil	Nil	17,600	12,070	0.030	0.000	0.030
	3	6.292	4.135	17.361	Nil	Nil	Nil	Nil	Nil	19,365	13,296	0.033	0.000	0.033
SEP	1	4.229	1.692	13.439	Nil	Nil	Nil	Nil	Nil	17,600	10,775	0.028	0.000	0.028
	2	3.139	0.046	12.999	Nil	Nil	Nil	Nil	Nil	17,600	10,775	0.028	0.000	0.028
	3	1.739	Nil	3.362	Nil	Nil	Nil	Nil	Nil	17,600	10,775	0.028	0.000	0.028
TOTAL (K)		38.610	9.442	97.307	25,156	Nil	Nil	1,786,000	Nil	322,161	167,342	0.489	1.806	2.294
TOTAL (R+K)		41.221	9.703	97.952	84,260	Nil	Nil	1,786,000	Nil	647,464	325,292	0.951	1.869	2.819

[1] Minimum flow required to dilute saline ground water seepage between Kotri and Agriman to keep fresh water environment. (Needed immediately)

[2] To be supplied to Sindh under para 7 of the WAA (1991)

[3] To maintain mangroves of rest of Active Delta

[4] To irrigate Riverine Forests

[5] To irrigate riverine lands

[6] Remaining surplus below Kotri after excluding Eastern rivers (1.7 MAF), Inflows in Western rivers (2 MAF) and additional Water Allocation(11.8 MAF) from flow.

TABLE-4

1.0 SEASONAL CANAL WITHDRAWALS IN SINDH AFTER THE CONSTRUCTION OF MANGLA AND TARBELA DAMS

Years	Stage	Average Annual Withdrawals (MAF)			Increase in Rabi Season
		Kharif	Rabi	Total	
1960-67	Pre-Mangla	24.91	10.65	35.56	-
1967-77	Pre-Tarbela	28.34	12.34	40.68	16%
1977-96	Post Tarbela	29.14	15.11	44.25	42%

Source: I&P Department, Govt of Sindh

2.0 DISTRIBUTION OF STORED SUPPLIES FROM THE KALABAGH DAM

Province	Percentage	Supply (MAF)
Punjab	37	2.257
Sindh	37	2.257
NWFP	14	0.854
Balochistan	12	0.732
Total:-	**100**	**6.100**

Source: WAA (1991)

TABLE-5

WATER APPORTIONMENT ACCORD (1991)

PRESENT AND FUTURE DISTRIBUTION OF SUPPLIES AMONG THE FOUR PROVINCES

PART-A *

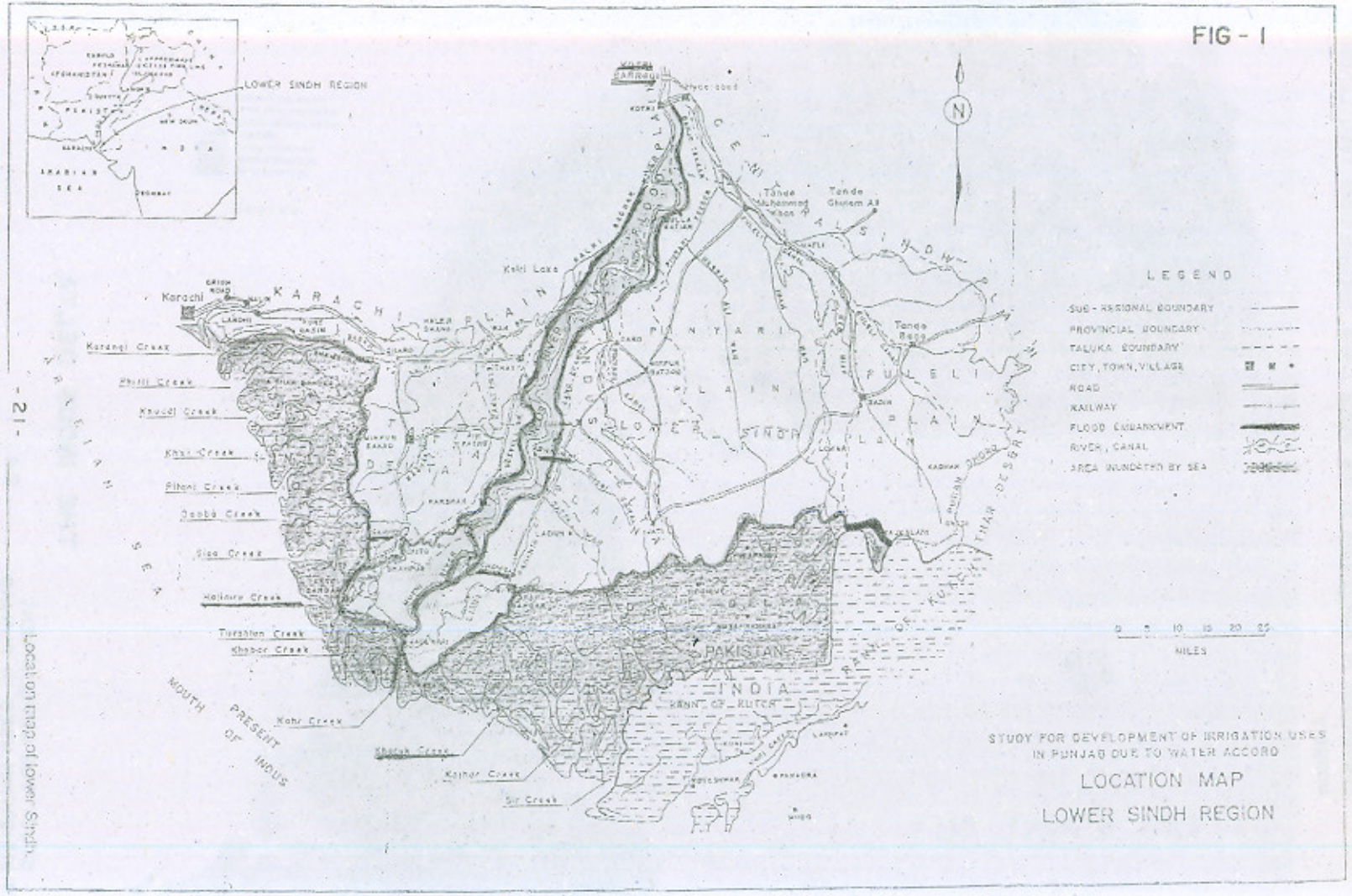
WATER APPROPRIATION SPECIFIED IN INDUS WATER ACCORD (1991)				Present Canal Withdrawals (Actual) (MAF)	Additional Supplies Allocated Under WAA (MAF)
Province	Kharif (MAF)	Rabi (MAF)	Total (MAF)		
Punjab	37.07	18.87	55.94	54.36	1.58
Sindh	33.94	14.82	48.76	43.58	5.18
NWFP (a) Irrigation Canals	3.48	2.30	5.78	5.43	3.35
(b) Civil Canals	1.80	1.20	3.00		
Balochistan	2.85	1.02	3.87	1.98	1.89
Total:-	**79.14**	**38.21**	**117.35**	**105.35**	**12.00**

PART-B *

Seasonal Distribution of Additional Supplies Available for Sindh with the New Storage.

	Crop Period	Additional Supplies for 4 Provinces (MAF)	Additional Supply for Sindh (MAF)	Remarks
i)	Early Kharif (April 1 - May 3)	2.20	0.98	To be made available from the new storage
ii)	Main Kharif Period (June 1 - July 3)	8.40	3.46	Already available during the summer
iii)	Late Kharif (Sep. 1 - Sep. 3)	1.40.	0.74	To be made available from the new storage
	Total:-	**12.00**	**5.18**	

* Source: - Water Apportionment Accord 1999.



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Location map of lower Sindh

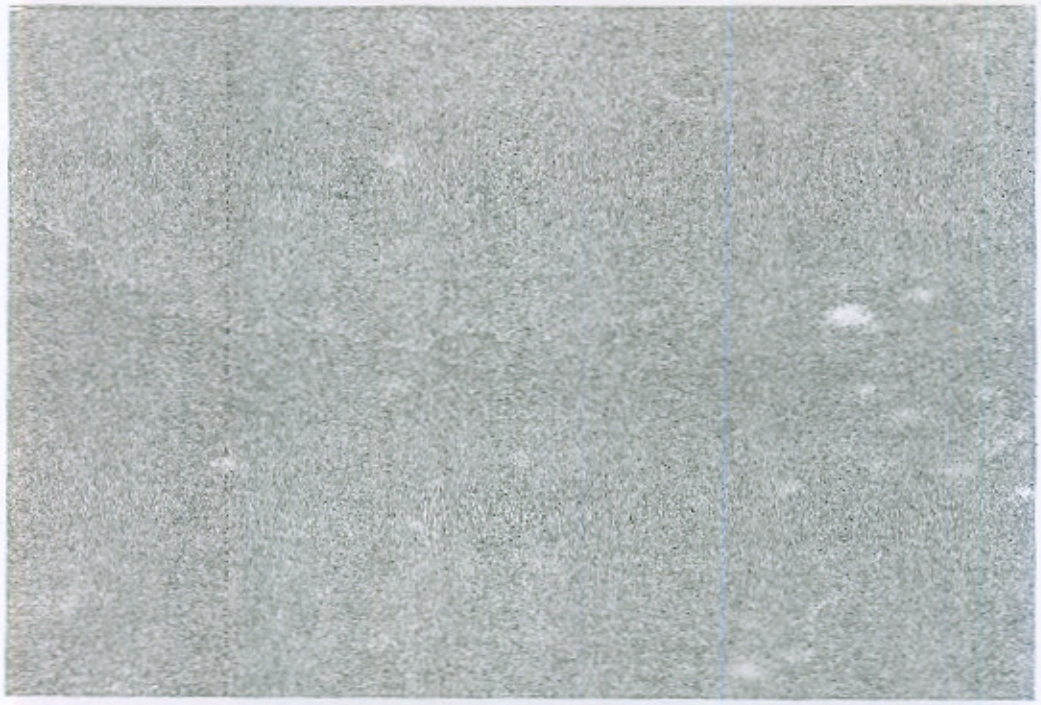
Figure 4

Distribution of mangroves in the Indus Delta, derived from 1990 Landsat imagery.

THE INDUS DELTA

STUDY FOR DEVELOPMENT
OF IRRIGATION USES IN PUNJAB

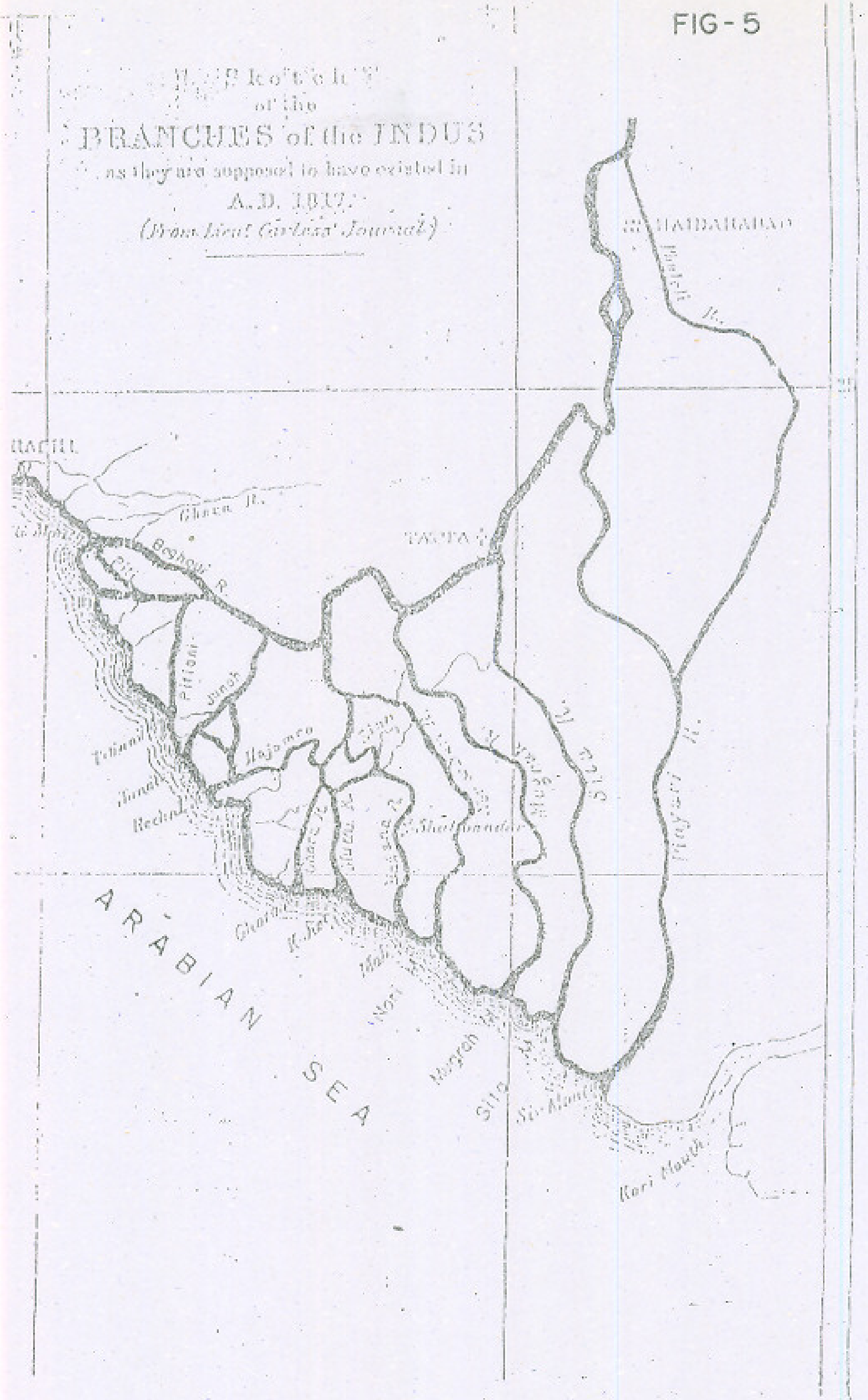
- 24 -



Avicennia marina near Korangi Creek,to show pneumatophores growing vertically from the underground roots of the trees in the background.

Rhizophora seedlings in a replanted area near Korangi Creek, around 4 years old.

FIG - 5



of the
BRANCHES of the INDUS
as they are supposed to have existed in
A.D. 1817.
HAIDARABAD
TATTA
ARABIAN SEA
Ghara R.
Beghou R.
Pittiani
Hajamro
Shahbandar
Sir-Mouth
Kori Mouth