DEVELOPMENT OF WATER RESOURCES

Irrigation

It is the artificial supply of water to land in order to encourage the plant growth. It is very important in Arid, Semi Arid and Humid areas just to improve yield. In our country 75% of cultivated area is under irrigation. This system has developed from traditional lift irrigation to complex canal system. But in our country agriculture totally depends on irrigation.

Why We Need Irrigation

1. Most of the areas in our country experience aridity or semi-aridity which increases from north to south.
2. High variability in the distribution of rainfall. This variability ranges from 30 to 70 % in humid areas, 30 to 40 % in arid areas and 40 to 70 % in semi arid areas.
3. Long dry spell (April to June and October to November) in Pakistan.
4. High variability in the timings of rainfall.
5. Small no. of rainy days which are 20 in south, 20 to 50 days in northern areas and 93 at Murree per annum.
6. High rate of evapo-transpiration especially in arid and semi arid areas.
7. In 1948 India has stopped the water of canals, irrigated the areas of newly founded Pakistan.
8. Recently India has constructed the dams on River Indus and River Chenab.

Methods of Irrigation

There are **two** methods of irrigation.

1. Traditional / Conventional Methods of irrigation.

i. **Lift Irrigation**
ii. **Shaduf**
iii. **Charsa**
iv. **Persian Wheel**
v. **Karez**

2. Modern Methods of irrigation

i. **Tubewell**
ii. **Canals.**

Traditional Methods of Irrigation

Lift Irrigation

One of the oldest methods of irrigation in Pakistan is lift irrigation. In early times, water was lifted by hand in a bucket attached to a rope from shallow wells and ditches. Because it involved a considerable amount of labor, only a small area of land could be irrigated.

Shaduf

The shaduf consists of a bucket suspended by a rope from one end of the pole. A weight (like a rock) is placed at the other end of the pole. The pole is suspended on a **Y** shaped post at a well or a river bank. The bucket is dipped into the water by hand and the weight at the other end of the pole helps to lift it up. With a lot of efforts, only one-tenth of a hectare can be irrigated and this method is now outdated.

Photograph of Lift Irrigation.

Photograph of Lift Irrigation

Photograph of Shaduf.

Photograph of Shaduf

Charsa

In this method the use of animal power to pull the bucket, which was suspended by a rope on a pully erected near a well. It then became possible to draw water from wells up to a depth of 5 to 7 metres, meaning that a larger area could be irrigated.

Photograph of Charsa.

Photograph of Charsa

Persian Wheel

In the Persian wheel, a number of buckets are lowered into a well on a chain. As a result, there is a continuous supply of water as the empty buckets descend into the well and come out full of water. With this method, water up to a depth of 23 to 26 metres can be accessed and powered by a pair of Bullocks or Camel. The Persian wheel, along with the charsa, are the most common methods of lift irrigation in Pakistan and have used for several centuries.

Study **Fig.1**, Photograph **A** of **Persian Wheel**.

Photograph of Persian Wheel

Photograph of Persian Wheel.

Photograph of Persian wheel

Photograph of Persian wheel

Photograph of Persian wheel

Q.1. With reference to the photograph A, explain how this machine is used for water supply.

Ans. Worked by animal (bullock or camel) or man power.
Using wooden shaft / pole.
Turns horizental wheel / a wheel rotated.
Which is attached to vertical wheel.
With buckets / cups to raise water.
Water goes into trough / pipe / channel.

Modern Methods of Irrigation

Tubewell

The tubewell is a fairly new addition to Pakistan's irrigation system. It can tap water up to depths of several hundred metres and is operated by diesel or electric motors. Tubewell also help to lower the water-table thereby protecting the land from water logging and salinity.

Photograph of Tubewell

Photograph of Tubewell

Advantages of Tubewell

1. More efficient / faster / does not need to rest.
2. Larger area can be irrigated.
3. Regular supply / can be used at any time of year / continuous.
4. Cleaner water.
5. Reduces waterlogging and salinity.
6. Less labor required.

Disadvantages of Tubewell

1. Expensive / cannot be used by poor farmers.
2. Maintenance is difficult / expensive.
3. Diesel is expensive.
4. Spare parts are expensive.
5. Reduces groundwater / lower water table.

Photograph of Tubewell

Photograph of Tubewell

Fig.1, map shows the **irrigated** areas.

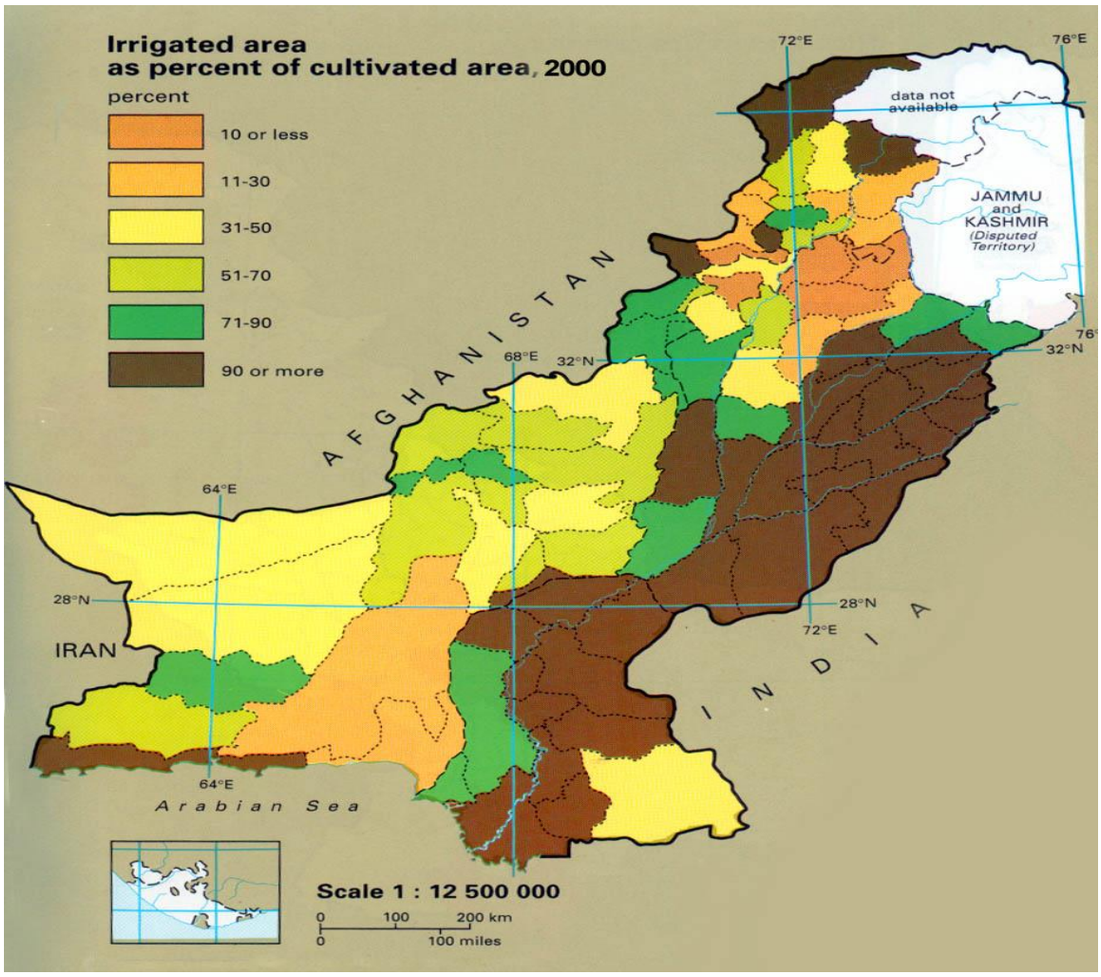


Fig.1

Pakistan is water-deficit country. The rainfall is neither sufficient nor regular and does not meet the growing needs of water. Agriculture is a major user and good yields depend on the adequate availability of water at the right time. The increasing pressures of population and industrialisation have already placed great demands on water supplies and there are an ever increasing number of local and regional conflicts over water availability and use.

Q.1. Why do the writers refer to Pakistan as a 'water-deficit country'?

Ans. Insufficient rainfall.
Growing needs.

Q.2. Using examples, explain why there ae conflicts over water availability and use.

Ans. **Examples**.

Farming vs Industry. Domestic vs food processing vs HEP vs others.
India vs Pakistan 1947 – 1960.
NWFP and Punjab vs Sindh.

Explanation.

Irrigation for more agriculture.
Industrialisation – water for washing, cooling, processing.
Population growth – need for more.
Electricity for modern technology.

Most farmers in Balochistan do not have access to water from the River Indus. There are many small rivers that flow into shallow lakes but they are dry for most of the year. These small rivers can provide some water for irrigation. Other sources of water are underground and some water flows in tunnels form the mountains.

Q.3. Describe the irrigation methods that can be used by farmers in Balochistan and comment on the success of such schemes for increasing farming output.

Ans. Karez.
Canals from rivers.
Wells.
Shaduf to lift water.
Charsa to lift water.
Persian wheel to lift water.
Tanks for storage. Dams (small).

Success:- less important now, neglected – bad.
Sources drying up.
Lack of government investment.
Continuous supply – good.
Only water in the desert (oasis) good.
Water from mountains put to good use – good.
Does not evaporate – good.

Canal

A man made water way used to transport goods or irrigation water.
Canal has **two** types.

i. **Inundation Canals / Seasonal Canals**
ii. **Perennial Canals**.

Inundation / Seasonal Canals

These are seasonal canals and provide water to the fields in summer when the donner rivers are in flood. These canals open in rainy season and closed in winters. These canals are beneficial for kharif crops. Rabi crops took advantage of the moisture left in the land from summer flooding.

These canals irrigate the active flood plains where the land is sufficiently leveled and down ward slopes from the river banks. The main net work of these canals in sindh and southern Punjab. The bar upland areas were not served by these canals as they could not rise up 5 to 7 metres high bluff separating the flood plains and the bar upland.

Advantages

1. To reduce the flood pressure.
2. Useful for lower areas like Sindh and southern Punjab.

Disadvantages

1. Do not supply water through out the year.
2. Single crop is cultivated.
3. Do not supply water to upland areas.

Perennial Canals

These canal bring water to the fields through out the year and are useful for both crops. These canals have been taken out in bar upland areas from the dams and barrages.

Q.1. What are perennial canals and how may they lead to problem of waterlogging and salinity in area S, photograph B.

Ans. Canals that can supply water al year round from reservoirs / barrages, via link canals.

Problems

Too much irrigation water leading to evaporation in hot, dry climate.
Rise of water table.
Rise of salts to surface.

Advantages

1. Supply of water round the year.
2. Both crops are benefited.
3. Provide water to the higher areas.

A. Lined Canals

Lined canals are paved with cement and brickwork on the bed and sides.

Photograph of Lined Canal

B. Unlined Canals

Unlined canals are without any brick work. Their bottom and sides are of earth and soil.

Photograph of Unlined Canal

Disadvantages of Unlined Canals

1. Rise water table to the surface level.
2. Cause waterlogging and salinity.

Factors leading to the development of the canal irrigation system in Pakistan.

1. Cheap labor and availability of cement reduces the cost of canal construction.
2. Southward slope of the rivers makes construction of canals easier because water flows southwards naturally.
3. Huge quantities of water from monsoon rainfall and melting of snow can be stored in in reservoirs during summer season.
4. Irregular supply of water in the rivers is then regulated by construction of dams and barrages.
5. Soft soil and level land of the Indus plain makes digging of canal easier than in the rugged lands of Baluchistan.

Why do we construct the canals / Purpose?

1. To reduce pressure of floods.
2. To avoid wastage of water.
3. To provide water for irrigation.

Effectiveness of conventional methods of irrigation

1. Limited areas are irrigated due to less amount of water.
2. Require manual labour or animal power.
3. More time consuming.
4. Difficult to maintain, built and use.(karez)

Study **Fig.2**, which shows canal water supply in Pakistan.

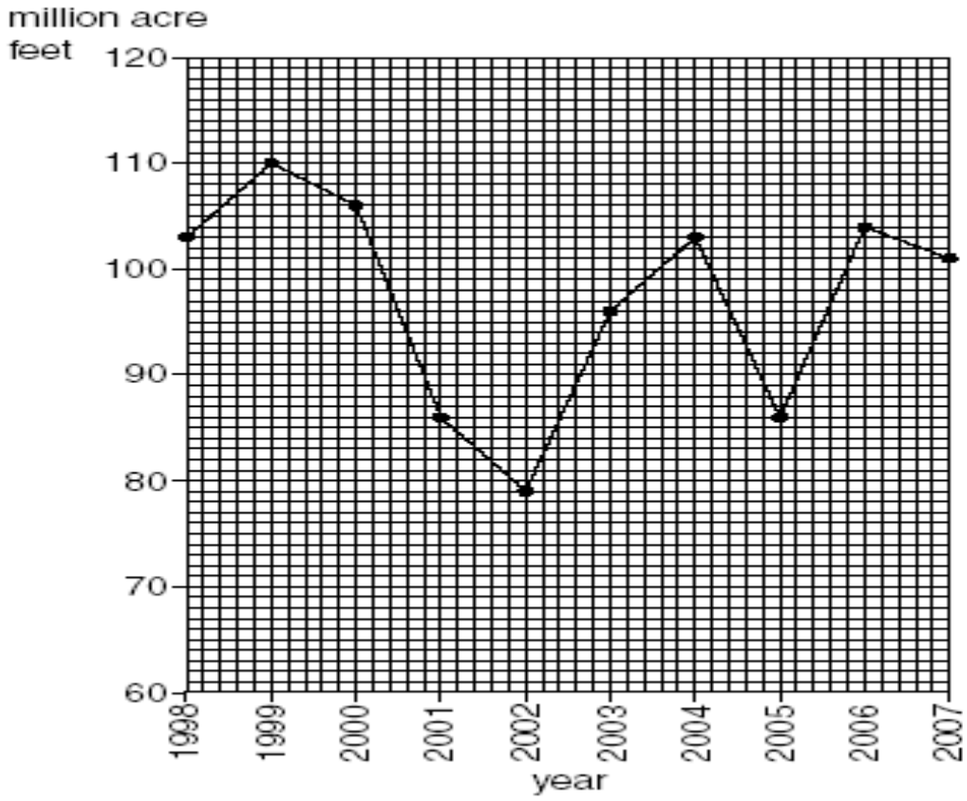


Fig.2

Q.1. Study Fig.3. In which year was the water supply highest?
Ans. 1999

Q.2. How much higher was this than the supply in 2002?
Ans. 31 (million acre feet).

Q.3. Why is there not enough water supply from canals to meet the needs of all users?

Ans. Shortage of rainfall.
Evaporation.
Less river water / restrictions by India / more dams on rivers.
Siltation in reservoirs / canals.
Seepage / leakage from canals.
Wastage by users.
Water pollution.
High demand / variety of uses.
Theft of water.
Population increase.
Lack of investment.

Water Table

Level of ground water is called water table. It is very easy to obtain ground water in foothills of mountains and difficult in desert areas.

Water logging

The rise of the water table to the surface level is called water logging and the appearance of salty patches is called salinity.
Water available all year.
Crops given more water than they use.
Water table rises to surface level.
Fertilizers add to salts in water.
Salts left behind / form a hard crust on surface.
Soil becomes infertile / toxic.

Salinity

Evaporation of water.
Salt in irrigation water.
Salts brought to surface.
Unlined canals leak.

Measures (to overcome the problem of waterlogging and salinity)

1. Lining the canals.
2. Planting the trees in affected areas.
3. Installing the tubewells.
4. Education to improve farming methods.
5. Flushing out of salts by water from tubewells surface drains.

The tubewells pump out water at high speed and keep the water level down. If the pumped water is fresh, it could be used for irrigation, e.g. in Punjab province. If pumped water is saline it would be drained into river or lake, e.g. in sindh which is drained into Manchar Lake.

6. Government Schemes

Government of Pakistan have chalked out a reclamation project to solve the problem in 1959. Name of the project was **SCARP** (Salinity control and Reclamation project). According to it Indus Basin divided into different projects and tubewells were installed.

SCARP I.

It covers the areas of Rechna Doab including Faisalabad and Sheikhupura and Reclaimed 1.9 million acres.

SCARP II.

It includes the areas of Chaj Doab and reclaimed 2.27 million acres. 3311tubewells were installed, 450 miles long lined canals and channels were built.

SCARP III.

It includes the areas of Jhang, Muzaffargarh and covers 1.28 million acres.1550 tubewells were installed, 150 miles long lined canals and channels were built.

SCARP IV and V.

It includes the areas from Khairpur to Ran Kutch in Sindh and 257 miles long lined canals built to carry extra water to Manchar Lake.

Q.1. Explain why waterlogging and salinity of soils causes problems to farmers.
Ans. Reduces cultivable area / makes land un-usable.
Reduces yield / damage crops.
Reduces income / profit.
Expensive to reclaim land.

Study **Photograph B**, showing an area in Hyderabad District damaged by waterlogging and salinity.

Photograph B

Q.2. Describe the appearance of the area S in photograph B

Ans. Bare / no vegetation.
Cracks / cracked mud.
Pools of water.
Saline water.
White / mustard color.
Edged with black / grey.

Q.3 Name the project set up to control salinity.

Ans Salinity Control and Reclamation Project **(SCARP).**

The Indus Water Treaty (1960)

In 1947, when Pakistan was created, the province of Punjab was divided. Part of it was given to India and part to Pakistan. The head works at Madhupur on the river Ravi and at Firozpur on the Sutlej were in India, but many of the canals that branched off from them were irrigating agriculture lands of the newly founded Pakistan.

In March 1948, India stopped the flow of water into Pakistani canals. This was a serious matter. Pakistan took the issue up with India and an interim agreement was arrived at on 4 May 1948. For a permanent solution to the problem, negotiations started in 1952 under the auspices of the World Bank. In September 1960, an agreement was signed which came to be known as the Indus Water Treaty, Pakistan received exclusive rights over the three western Rivers, the Indus, Jhelum and Chenab and India those of the three eastern rivers,

The Ravi, Beas and Sutlej. There was to be a transitional period ending on 31 March 1970, which was extendable by three more years. During this transitional period, India agreed to continue supplying water to Pakistan. During the same period, it was expected that Pakistan would construct two storage dams, five Barrages, one Gated Siphon and eight link canals to divert some of the water of the western rivers into the interfluves of the eastern rivers. The construction cost was to be met with the help of aid from the United States, The United Kingdom, West Germany, Canada, Australia and New Zealand. A part of the cost was also to be paid by India. The remaining expenditure was to be met by Pakistan. The replacement works were entrusted to **WAPDA.**

Q.1 In which year was the Indus Water Treaty signed?

Ans. **1960.**

Q.2 Why was the Indus Water Treaty necessary for Pakistan?

Ans.
1. Most of Pakistan suffers from low rainfall.
2. Most of Pakistan suffers from unreliable rainfall.
3. Increasing population means more food is needed.
4. Punjab divided between India and Pakistan in 1947 / at partition.
5. Head waters of Pakistan's main rivers / eastern rivers, Ravi, Beas, Sutlej are in India. Head works in India at Madhupur on Ravi and at Firozpur on Sutlej. Canals from them provided water for irrigated land in Pakistan.
6. India cut off water supplies to Pakistan in 1948 and the land became arid.
7. Pakistan made to buy water from India.
8. Construction of dams on western rivers by India.

Dam

A man made structure built across a river in order to control the flow of water / use Water for irrigation. Following are the types of dam.

Tarbela Dam **(IWT)**

The two storages dams which were to be built as part of the Indus Water Treaty were at Tarbela and Mangla. The Tarbela Dam is located on the River Indus near Tarbela about 47 kilometres upstream from Atock. It is a multipurpose project designed to store 11.0 million acre-feet of water and to generate 2.1 million kilowatts of electricity. It irrigates part of the Potwar Plateau, but its main function is to supply water to the Chashma-Jhelum Link Canal through which the Trimmu-Sidhnai-Mailsi-Bahawal Link Canal system is also fed.The Tarbela Dam also feeds the Taunsa-Panjnad Link Canal. The Jinnah, Chashma, Taunsa, Gudu, Sukkur and Kotri Barrages built on the River Indus are supplied with water from the Tarbela Dam in winter when the flow is low. It is 143 metres high and has a reservoir area of 243 square km. It has nine huge gates to control the outflow of water. It is the world's largest earth filled dam and has two big spillways from the reservoir which was impressive feature.

Photograph of Tarbela Dam.

Photograph of Tarbela Dam

Mangla Dam (IWT)

The Mangla Dam which was completed in 1969, is located on the River Jhelum and has a storage capacity of 5.5 million acre-feet. In future, it will be possible to raise its storage capacity to 9.6 million acre-feet. It supplies water to canals irrigating the chaj and bari doabs. The water is also used to generate electricity. Ultimately, three million kilowatts of electricity will be generated from this dam. The Mangla lake, besides serving as the reservoir of the dam, has also been developed as a fishing center and a tourist resort.

Photograph of Mangla Dam.

Photograph of Mangla Dam

Warsak Dam

Warsak a multipurpose project, designed to provide water for irrigation and for the generation of electricity. It is located on the river Kabul about 32 kms. from Peshawar. Its installed capacity is 240MW.

Kurramgarhi Dam

It is located on the river Kurram at Kurramgarhi. The dam provides water to the Bannu civil canals and has improved the irrigation of 530 square kms. of land.

Ghazi Barotha Project

A new hydel project which is located on the river Indus near Ghazi town. It is a large project with a capacity of 1450 MW. It is expected to be completed soon.

Purpose of the Reservoirs / Dams

1. The dam and reservoir is used for flood control, irrigation and generation of HEP.
2. The reservoir is an artificial lake which can be used for fishing, boating and recreation.
3. Water can be supplied to nearby towns for domestic purposes.
4. The dam also provides a road across the river.

Small Hydel Plants

There are a number of small hydel plants in Pakistan. Their installed capacity is 107 MW. One of them is Renala, located in the Upper Bari Doab Canal and commissioned in1925, it is the oldest hydel plant in Pakistan. Another is in Rasul, located between the Upper and Lower Jhelum Canals. It was commissioned in 1952, after which import of electricity from India was stopped.

Small Dams

Besides large irrigation projects, a number of small dams have also been built in the Western Highlands. They irrigate relatively smaller areas and are located on narrow streams commanding small alluvial areas in hilly regions. Some of these dams have been built by the **WAPDA** and others by the Small Dams Organisation set up by the Agricultural Development Corporation. An example of a smaller dam is **Rawal** dam on the river Kurang. Besides supplying water to Islamabad, it irrigates about 50 square kms. of land. The **Khanpur** dam on the river Haro, which will irrigate 148 square kms. in the Abbotabad, Attock and Rawalpindi districts, has been recently commissioned. Balochistan has a number of small dams. The **Nari-Bolan** Project uses the monsoon flow of the Bolan River to irrigates 97 square kms. of the Sibi plains. The **Narachip** Project irrigates 13 square kms. of the Loralai District. The Hab Dam in the Lasbela District, which was commissioned in 1982, is designed to irrigate 340 square kms. of land in and around Lasbela and Karachi.

Q.1 What are the natural factors that have favored the construction of dams and reservoirs.

Ans. Deep valleys increases storage capacity / provides high head of water for hydel.
Narrow valleys for dams reduces amount of materials required for dam.
Solid rock for dams to support weight of dam.
Large basins For water storage.
Impervious rocks for reservoir to seepage of water.
Low evaporation rates.
Forested valley sides hold soil / slow rate of siltation.
High precipitation/ rainfall / snowfall.

Study **Fig.3**, shows a diagram of a **hydel plant**

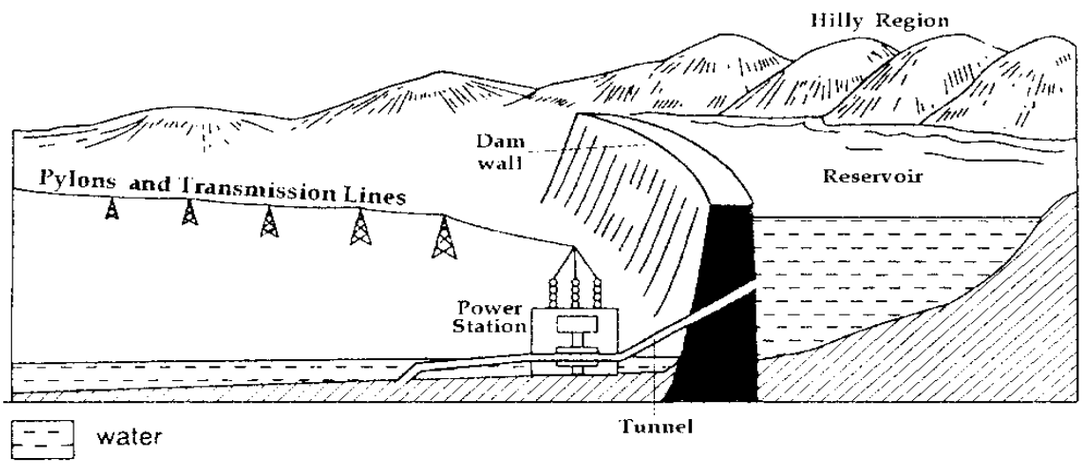


Fig.3

Main Features of a Hydel Plant are:

1. The dam wall is constructed to create a water reservoir.

2. Tunnel leads the water from the reservoir to the turbine.

3. The power station is located at the base of the dam. The force of water from the tunnel runs the turbine which moves the generator. The generator generates the electric current.

4. The reservoir is the storage of water which is necessary to run the turbine continuously.

5. A natural feature is the hilly region where the dam site is located. Hills are seen in the back ground.

6. Pylons and transmission lines to supply electric current to nearby large towns.

Study **Fig.4**, which shows the distribution of large and small dams.

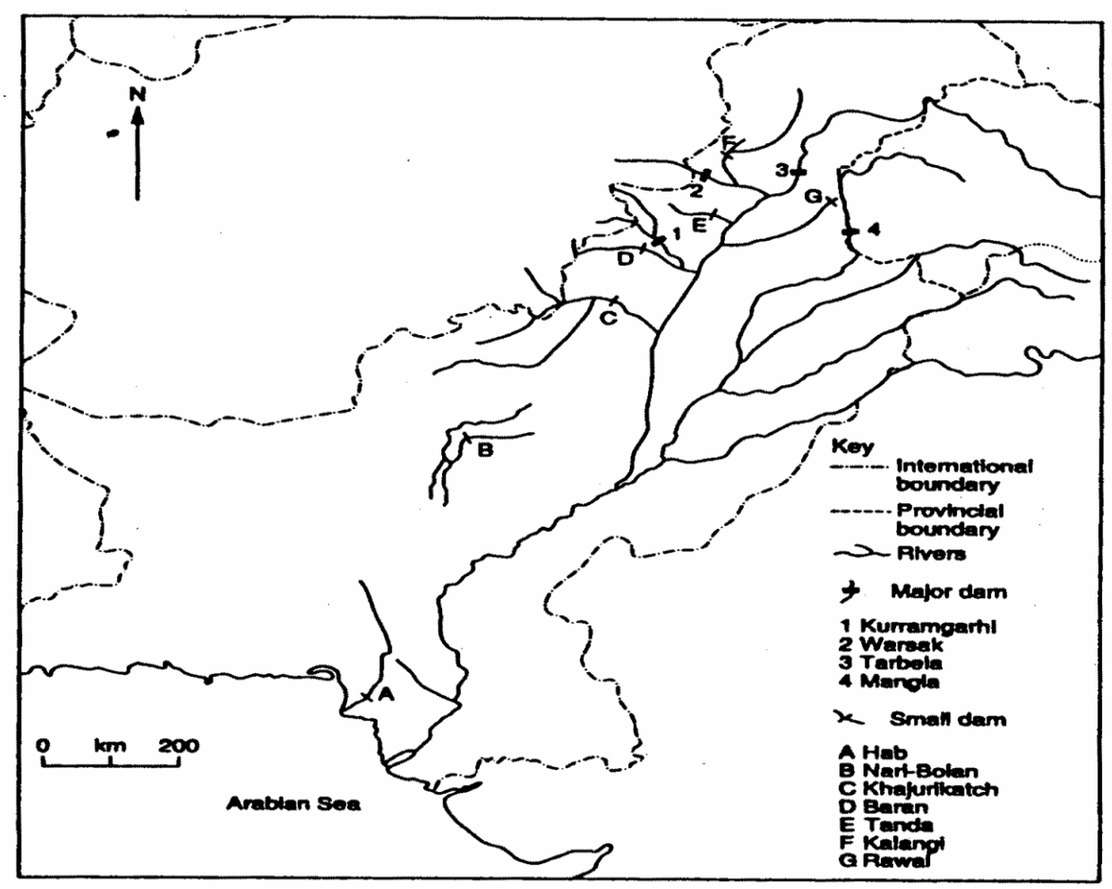


Fig.4

Q.2 Study the map, Fig.4, describe the distribution of the dams.

Ans. **1**. In mountains.
2. Major dams all in **N** / and **NW** Pakistan / Upper Punjab and NWFP.
3. Major dams all on river Indus and its tributaries.
4. Most of small dams are in **N** and **NW**.
5. Most of small dams are on tributaries of the river Indus.
6. One small dam on river **Hab** in south (Baluchistan).
7. One small dam near Sibi.

Q.3 Naming an industry in each case, describe three different purposes for which manufacturing and processing industries use water.

Ans. **1**. Cooling water for iron and steel industry.
2. Washing / cleaning in textile industry.
3. For boiling in food processing.
4. As ice to preserve frozen food.
5. To provide humidity in textile mills.

Q.4 Compare the purposes for which the water is stored by the two types of dam.

Ans. **1**. Small dams and large dams store water mainly for irrigation.
2. Major dams serve near and far areas but small dams only serve local areas.
3. Small and major dams provide water for the use of domestic and industry.
4. Major dams are more multi-purpose than small dams.
5. Two major dams have purpose of providing water to link canals……
…..Tarbela and Mangla dams
…..water from Indus and Jhelum rivers
…..transferred to eastern rivers.
6. All major dams are major suppliers of HEP but small dams supply little / no HEP.
7. The reservoirs behind both large and small dams are used for fishing / recreation e.g. Mangla reservoir produces 2 % of inland fish catch.
8. Large dams more important for flood control than small dams.

Q.5 State three problems caused by the storage of water in reservoirs and its use for agriculture.

Ans. By storage of water.
1. People have to be moved from the area to be flooded for storage.
2. Silting of reservoirs.
3. Loss of silt downstream for agriculture.
4. Loss of water downstream for irrigation by inundation canals.

By use for agriculture.
1. Water logging in irrigated areas.
2. Salinity in irrigated areas.
3. So much used in Punjab that parts of Sindh are suffering from a shortage of water.

Q.6 What is silting and how is it caused.

Ans. Silting means the deposition of silt, mud and sand on the bed of the reservoirs.

Causes of siltation.

1. Rivers erode the material from bed / sides.
2. Large load carried by the river.
3. Deforestation.

Q.7 Why is silting a problem / effects.

Ans. **1**. May damage the machinery.
2. May block the pipes.
3. Increases the risk of flooding.
4. May shorten the life of reservoir.
5. Decreases water holding capacity of the reservoir / canals which limits the HEP production / water for irrigation.
6. Has to be removed for drinking water.
7. Expensive / difficult to remove.

Methods to control the silt

1. Planting trees along the hill slopes surrounding the river valley.
2. To build small dams in the river up streams from the dam.
3. To build small dams in the tributary streams joining the main river.

Q.8 Other than supplying water to industry, for what purposes may reservoirs and dams be used?

Ans. Storage of water. Hydro electric power. Domestic water. Irrigation. Fishing. Recreation of reservoir. Flood control, Road on dam.

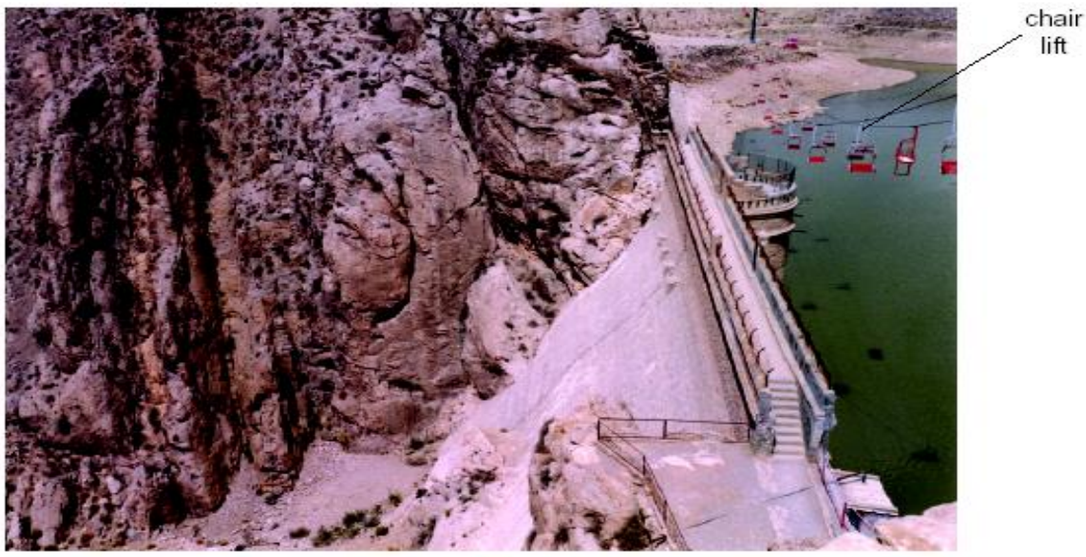
Q.9 Name in full the two institutions set up by the government to build the dams.

Ans. **1**. Water and Power Development Authority.**(WAPDA)**
2. Small Dams Organization.**(SDO)**

Q.10 Why do the reservoirs of these dams hold large quantities of water?

Ans. Deep valley / large valley.
Steep sites.
Large river / permanent flow / water from snowfields / glaciers.
Low evaporation / cool climate.
High rainfall.

Study **photograph C** showing the **Hanna Dam**.



Photograph C

Q.11. Describe the site of the dam.

Ans. Steep rock.
Bare rock / rocky / barren.
Deep and narrow valleys.
Gravel / sand.

Q.12. What evidence shows that the water level in the reservoirs is low?

Ans. Dry ground / Silt / flat land at edge.

Q.13. Compare the barrage shown in Photograph D with the dam in Photograph C.

Ans. **Barrage is**:- Longer / wider / less high.
Water on both sides.
Low / flatter land.

Dam is:- Steep rock.
Bare rock / rocky / barren.
Deep and narrow valleys.
Gravel / sand.

Study **Photograph D** showing the **Balloki Barrage.**

Photograph D

Q.14. Suggest why the amount of water stored in the reservoir is decreasing.

Ans. Siltation / silting deposited due to soil erosion / deforestation.
Less water supply due to climatic change / lower rainfall.
Increased usage.

Q.15. What can be done to stop the amount of water in the reservoir from reducing further?

Ans. Silt traps.
Afforestation.
Removal of silt.
Reducing wastage / pollution.

Barrage

A structure built across a river in order to store water / to use water for irrigation.

Photograph of Trimmu Barrage

Details of the five barrages and the gated siphon constructed under the Indus water Treaty are given below:

Chashma Barrage (IWT)

Located on the River Indus and completed in 1970. Designed to divert one million cusecs into the Chashma-Jhelum Link, thereby irrigating areas served by the Sidhnai-Mailsi-Bahawal Link system and the Haveli and Rangpur canals.

Rasul Barrage (IWT)

Located on the River Jhelum and completed in 1968. Its flood discharge capacity is 850,000 cusecs. Supplies water to the Rasul Qadirabad Link canal and eventually to the Sulaimanki Barrage on the Sutlej.

Marala Barrage (IWT)

Located on the River Chenab and completed in 1969. Its flood discharge capacity is 1.1 million cusecs. Supplies water to the Ravi Link canal and the Upper Chenab Canal.

Qadirabad Barrage (IWT)

Located on the River Chenab and completed in 1970. Its discharge capacity is 0.9million cusecs. Supplies water to the Qadirabad Balloki Link through the Rasul Qadirabad Link.

Mailsi Siphon (IWT)

A gated siphon located on the River Sutlej near Mailsi. Its purpose is to carry water on the Sidhnai-Mailsi Link across the Sutlej into the Bahawal canal. The Sidhnai Barrage supplies water to the Sidhnai-Mailsi Link canal.

Uses / Purpose of Barrages

1. Provide water for irrigation.
2. Reduce flood pressure.
3. Source of inland fishing.
4. Act as a bridge across the river with a road connecting both river banks.

Difference between Barrage and Dam

1. No generation of HEP on Barrages, Dams generate the HEP.
2. Barrages can be constructed in flat areas, Dams are constructed in mountainous areas.
3. Less construction cost on barrages and High construction cost on Dams.
4. Barrages are constructed in 1-2 years and dams are constructed 10-15 years.

Other Barrages

Jinnah Barrage

It is located on the river Indus. Two canals have been taken out from this barrage. Namely Upper Thal Canal, South Thal Canal. It irrigates the areas of Mianwali Muzaffargarh, Khushab, Bhakkar, Lieh and irrigates the 2200000 acres.

Taunsa Barrage

It is located on the river Indus. Two canals have been taken out from this barrage. Namely Right and Left Bank canal and Taunsa Panjnad Link canal. These canals irrigates the areas of Muzaffargarh, D.G.Khan, Rajanpur and drained 1900000 acres.

Guddu Barrage

It is located on the river Indus. Three canals have been taken out from this barrage.
Namely Ghotki, Begari and Desert Pat Feeder canals. These canals irrigates the areas of Sukkur, Mirpur, Rohri, Jacobabad and commanded area is 11600 square kilometers.

Kotri / Ghulam Muhammad Barrage

It is located on the river Indus. Four canals have been taken out from this barrage. Namely Kotri, Kalri, Penyari and Phuleli. These canals irrigates the areas of Badin, Sanghar, Hyderabad, Mirpur, Nawabshah and irrigates11100 square kms. of land.

Sukkur Barrage

It is located on the river Indus. Seven canals have been taken out from this Barrage, namely NW canal, Rohri canal, Nara, East Khairpur, West Khairpur, Rice, Dadu and irrigates 22000 square kms. These canals irrigates the areas of Hyderabad, Sanghar, Larkana, Dadu, Nawabshah and Khairpur.

Q.1 Name an example of a barrage.

Ans

Balloki	Kotri	Sidhnai	Chashma	Marala
Sukkur	Guddu	Sulaimanke	Islam	Khanki
Qadirabad	Taunsa	Rasul	Trimmu.	Jinnah
Panjnad				

Q.2 What is the main purpose of a barrage and how is this purpose achieved?

Ans. Main Purpose:

To provide water for irrigation.

How purpose is achieved:

1. Gates closed.
2. Barrages store water behind it.
3. Canals / Link canals take water and distribute it into a network of smaller canals.
4. Link canals take water from western rivers to eastern rivers.

Q.3 Briefly describe the changes that have taken place in the land use of the lower Indus plain as a result of building barrages.

Ans.
1. Large areas (previously desert)are cultivated.
2. Different crops are cultivated e.g. rice / sugarcane / wheat / bananas.
3. Led to an increase in land used for settlement.
4. Water logging and salinity (areas) due to poor management of irrigation.

Cusec

Cubic unit of water passing per second through a river or canal.

Discharge

The quantity of water passing through a river.

Span

Door of a Barrage.

Gated Siphon

Inverted U-shaped pipe which carries water over a barrier to the other side. The flow of water is controlled by the gate.

Link Canal

Canal which carries water from one canal to another.

Link canals **(under the Indus Water Treaty)**

1. **Rasul Qadirabad**

Carries water from the Rasul Barrage on the River Jhelum to the River Chenab.

2. **Qadirabad-Balloki**

An extension of the Rasul-Qadirabad Link by which water is transferred to Ravi.

3. **Balloki-Sulaimanke**

Connects the Ravi and Sutlej.

4. **Trimmu-Sidhnai**

Transfers water from the Trimmu Barrage to the Ravi.

5. **Sidhnai-Mailsi**

Takes the water transferred from the Trimmu Barrage to the Ravi into the Sutlej.

6. **Mailsi-Bahawal**

Supplies water to the Bahawal canal.

7. **Chashma-Jhelum**

Transfers water from the Chashma Barrage on the Indus to the Jhelum.

8. **Taunsa-Panjnad**

Transfers water from the Taunsa Barrage on the Indus to the Chenab to feed the canals in Punjab

Fig.5, shows the irrigation system of Pakistan.

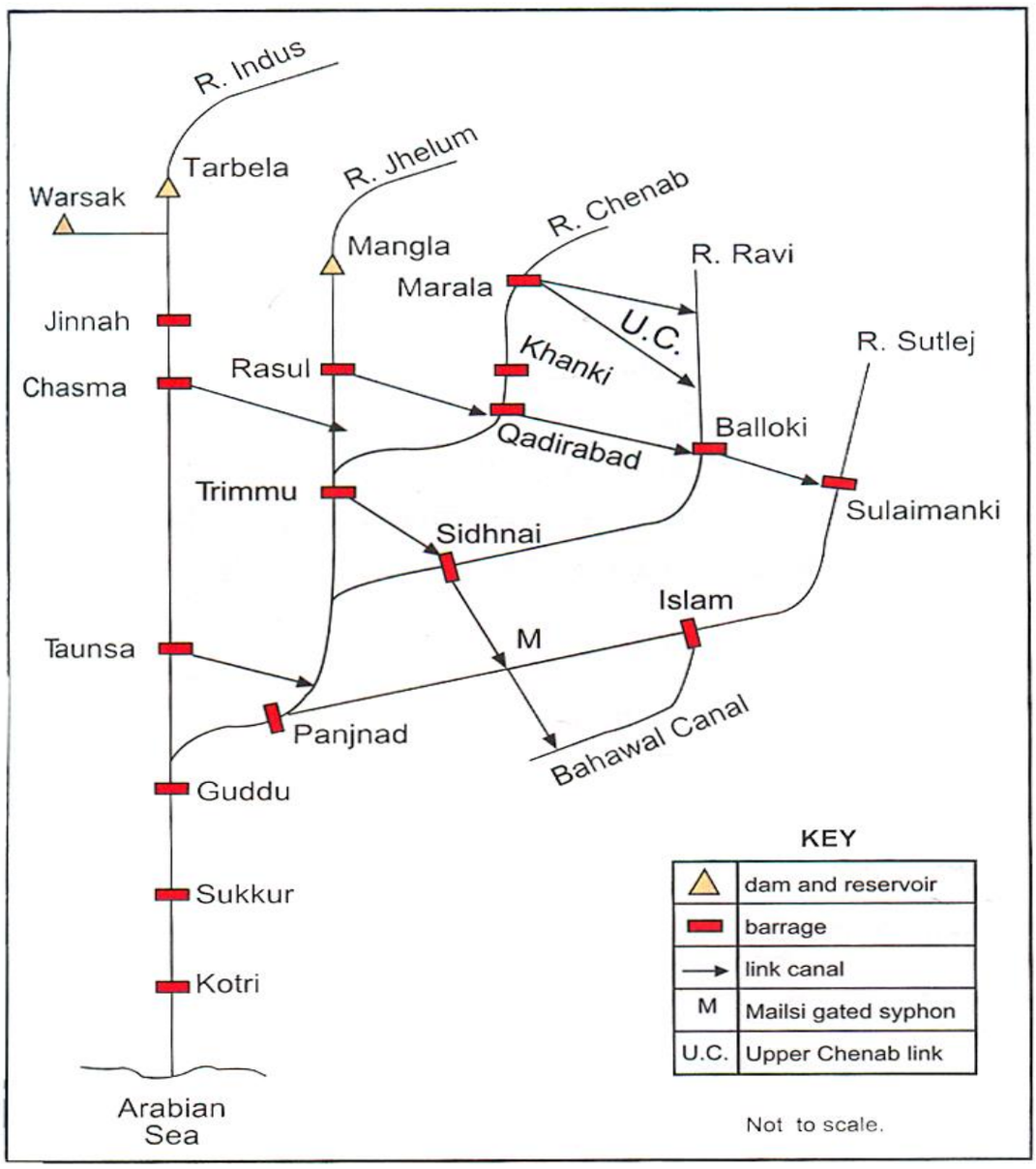


Fig.5

Purpose of the Link Canals

1. In general the purpose of the link canals is to transfer water from the three western rivers (Indus. Jhelum. Chenab) to two eastern rivers (Ravi and Sutlej).
2. To provide water for irrigation canal / perennials canals.
3. To compensate for water lost (to India) from eastern rivers.

Remodel the Existing Canals

In addition to the construction of new links, existing link canals, like the **Marala-Ravi**, **Balloki - Sulaimanke** and **Bambanwala-Ravi-Bedian-Dipalpur (BRB)**, have been remodeled. Thus, Punjab is interlaced with a network of canals to compensate the loss of three eastern rivers to India.

Prupose of Remodel the Existing Canals

1. Assurance of continuous supply of water for irrigation.
2. To avoid siltation.
3. To avoid soil erosion.

Minor Irrigation System

1 .Karez

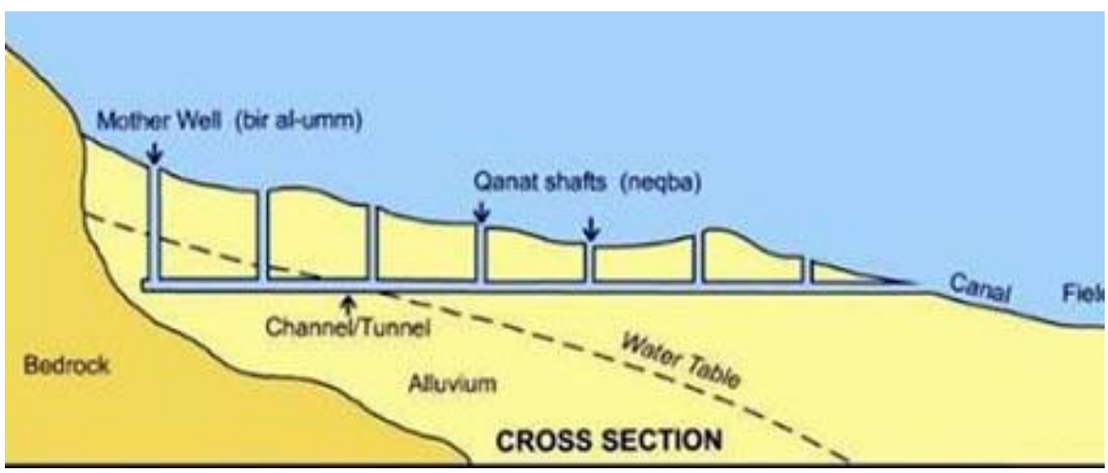
The karez is a water-tunnel or a narrow underground canal. It starts from the base of a hill or mountain where ground water is present. It runs for 1 or 2 kms under ground (or sometimes up to 10 kms). The karez irrigates orchards and agricultural fields. Throughout its length, the karez is dotted with vertical shafts which are used to clean and repair it and in certain areas they are used to extract water for domestic purposes. If the karez is cleaned and repaired regularly, it can remain productive for a century or more. The selection of a site for digging the karez is done by experienced village elders, while the digging and repair is done by a group of laborers trained in this tradition.

The karez is usually privately owned by a group of people rather than a single person. The owners share the water according to their percentage share in the karez. The main problem of karez is that its water cannot be stopped from flowing. Further more their maintenance is difficult and expensive. Karez irrigation is practiced only in Baluchistan. Within this broad region, most of the karez are located in Zhob, Loralai, the Quetta-Pishin and Mastung valleys and in favorable areas in Makran. However, karez irrigation is gradually losing its importance.

Main Points (Karez)

Underground canals / tunnel
Uses ground water
Vertical shafts for cleaning
Irrigates oases
Example – Quetta – Pishun valley, Mastung valley.

Photograph of Karez



Photograph of Karez

Advantages

Continuous supply
Water from mountains put to good use
Does not evaporate
Only water in the desert.

Disadvantages

Less important
Lack of government investment
Less rain in Baluchistan.

Q.1. Explain how karez irrigation helps date palms to grow in the oases.
Ans. Provides water for irrigation
Underground canals
Reduces evaporation
More rain on mountains / higher slopes

2. The Diversion Canal

The Diversion canal and Sailaba are minor irrigation systems which are practiced in the western highlands. In the diversion canal, water is taken off from narrow streams through small man-made channel to irrigate small areas. This can only be done when the river is full. Diversion canals are called kaurjo in Makran. This form of irrigation is practiced over a large area, from Chitral to Makran.

3. Sailaba

Sailaba irrigation uses the surface run-off of hill slopes. Whenever a sufficient quantity of rainfall takes place, water flows down hill slopes and reaches the plains, where the agricultural fields are located. This water is diverted into the fields and nourishes the crops. Of course, a sufficient quantity of rainfall does not take place every year, so this method of irrigation has limited utility. The available water is never enough to irrigate a large area of land.

Ground Water

Water beneath the surface of the ground called ground water.

There is a scarcity of water in Pakistan and so there is a big need of irrigation for the cultivation of crops. Both ground water and surface water are used for irrigation. Ground water is tapped by tubewells, karez, and wells. Surface water is tapped by canals, diversion and sailaba. They are used to re-channel the surface water flowing into the streams and rivers. Ground water is extremely useful in the areas like Baluchistan Plateau and desert areas because in these areas irrigation is impossible due to less rainfall and unsuited land. In big cities like Karachi, there is a shortage of water due to growing population. People use water for domestic purposes so they pump out the water through pipes drilled into the ground.

Ground water can be saline or sweet. It is non-saline near the source of re-charge i.e rivers and major canals. It gradually becomes more saline as the distance from re-charge sources increases.

In big industrial cities like Karachi, ground water may not be fit for human consumption due to seepage of toxic chemicals, sewage or sea-water into the ground. Therefore ground water should be tested in a laboratory before it is used.