Natural Resources

What are natural resources and it's two types?

Natural resources are materials or substances that occur in nature and can be used for economic gain or to fulfill human needs. These resources are typically classified into two main types:

1. **Renewable resources:** These are resources that can be naturally replenished or replaced relatively quickly within the human timescale. Examples include sunlight, wind, water, timber, and certain types of crops. Renewable resources are generally sustainable if managed properly because they have the ability to regenerate or renew themselves.

2. **Non-renewable resources:** These are finite resources that exist in limited quantities and cannot be easily replaced within a short period. Non-renewable resources include fossil fuels (coal, oil, natural gas), minerals (such as copper, gold, iron ore), and other elements found in the Earth's crust. Once these resources are depleted, they cannot be readily replenished in human timescales.

Both types of resources are vital for human activities and industries, but non-renewable resources pose challenges due to their limited availability and potential environmental impacts during extraction and use. Sustainable management and conservation of both renewable and non-renewable resources are essential for the well-being of current and future generations

What's Hydrological Cycle.?

The hydrological cycle, also known as the water cycle, is a continuous process that describes the movement of water on, above, and below the surface of the Earth. It involves the circulation and transformation of water between different states—solid, liquid, and gas—within the atmosphere, the Earth's surface, and underground. The cycle consists of several key processes:

1. **Evaporation:** The cycle begins as heat from the sun causes water from oceans, rivers, lakes, and other water bodies to evaporate, turning liquid water into water vapor.

2. **Condensation:** Water vapor rises into the atmosphere, where it cools and condenses to form clouds. This process occurs as water vapor molecules come together and form tiny water droplets around particles in the air.

3. **Precipitation:** When the condensed water droplets in clouds become too heavy, they fall to the Earth's surface as precipitation. This can take the form of rain, snow, sleet, or hail.

4. **Runoff:** Precipitation that falls on land can flow over the surface as runoff, making its way into rivers, lakes, and oceans. Some of it seeps into the ground, becoming groundwater.

5. **Transpiration:** Plants release water vapor through small openings in their leaves in a process called transpiration. This water vapor also contributes to the moisture in the atmosphere.

These processes continuously interact and redistribute water throughout the planet, ensuring a continuous supply of freshwater for various ecosystems, human consumption, agriculture, and otheruses. The hydrological cycle is vital for maintaining the Earth's water balance and sustaining life on the planet.

Importance of Rivers to Pakistan

Rivers hold immense significance for Pakistan due to their crucial role in the country's agriculture, economy, and overall livelihood. The two main rivers of Pakistan are:

The Importance of Rivers to Pakistan:

1. ****Agriculture**:** Rivers like the Indus and Jhelum provide water for irrigation, supporting a vast agricultural sector. The water from these rivers sustains crops and livelihoods for millions of people in Pakistan.

2. ****Hydropower**:** Pakistan utilizes the rivers to generate hydroelectric power. Dams and hydroelectric projects along these rivers contribute significantly to the country's energy production.

3. ****Transportation**:** Historically, rivers served as crucial transportation routes for trade and commerce. While their role in transportation has diminished with the advent of modern infrastructure, they still serve as transportation corridors in some regions.

4. ****Ecosystem Support**:** River ecosystems support diverse flora and fauna, contributing to biodiversity and providing habitats for various species. They also play a role in maintaining ecological balance and supporting the environment.

These rivers' significance underscores their impact on Pakistan's economy, agriculture, and overall well-being, highlighting the vital role that water resources play in the country's development and sustenance.

The two main Rivers are

1. Indus River
2. Rivers of Balochistan

The Indus River

The Indus River is one of the longest rivers in Asia and holds immense importance for Pakistan's agriculture and economy. Here are some key points about the Indus River:

1. **Length:** The total length of the Indus River is approximately 3,180 kilometers (1,980 miles). It originates in the Tibetan Plateau in the vicinity of Lake Mansarovar in Tibet. The river begins its journey from a glacier near the Kailash Mountain range in the southwestern part of Tibet.

2. **Course:** From its origin in Tibet, the Indus River flows through Tibet, India (Jammu and Kashmir), and Pakistan. In India, it runs through the region of Ladakh before entering Pakistan. The river then flows through Pakistan in a southwesterly direction.

3. **Tributaries:** The Indus River is fed by various tributaries along its course. Some of the major tributaries include the Jhelum, Chenab, Ravi, and Sutlej rivers. These tributaries significantly contribute to the water flow and irrigation systems in both India and Pakistan.

4. **Importance:** The Indus River is of paramount importance to Pakistan's agriculture and economy. Its water supports the extensive irrigation system known as the Indus Basin Irrigation System, which sustains agriculture in the Indus Valley. This irrigation system facilitates the cultivation of crops like wheat, cotton, rice, and sugarcane, among others, contributing significantly to Pakistan's agricultural output.

Overall, the Indus River plays a crucial role in the livelihoods, agriculture, and energy generation of both Pakistan and the regions it traverses before reaching the Arabian Sea.

Rivers to the West of River Indus

To the west of the River Indus, several rivers contribute to the water network of the region, primarily in the neighboring countries of Pakistan. Some significant rivers situated to the west of the Indus River include:

1. **Kabul River:** The Kabul River is a major river in Afghanistan and flows into Pakistan. It joins the Indus River near the city of Attock in Pakistan. The Kabul River is an important tributary of the Indus and contributes to the water resources in the region.

2. **Kurram River:** The Kurram River is another important river in Afghanistan that flows into Pakistan. It joins the Indus River near the town of Isa Khel in Pakistan's Khyber Pakhtunkhwa province. The Kurram River serves as a tributary of the Indus, adding to the water flow of the region.

3. **Gomal River:** The Gomal River originates in Afghanistan and flows into Pakistan's Khyber Pakhtunkhwa province. It eventually merges with the Indus River near the town of Kulachi. The Gomal River is important for irrigation and contributes to the overall water resources of the region.

These rivers, originating in the mountainous regions of Afghanistan and merging with the Indus River in Pakistan, form an essential part of the water network in the western regions of Pakistan. They contribute to irrigation, agriculture, and the overall hydrology of the area, supporting livelihoods and ecosystems along their courses.

Rivers of Balochistan

The drainage pattern of the rivers of Balochistan is as follows:

Quetta, being a high-altitude region, has the central position in the drainage pattern of Balochistan.

The rivers Zhob, Khandar and Kalachi drain into the Indus because they flow eastwards.

The rivers Loralai, Chakar, Bolan and Mula are absorbed into the Kachhi Sibi Plain.

The rivers Hab, Porali, Hingol and Mashkel drain into the Arabian Sea.

Many small rivers flow westwards and drain into shallow depressions called hamuns.

What is Ground Water

Sure, groundwater is water that's stored beneath the Earth's surface in spaces between rocks and soil. It's accessed through wells and is a crucial source of freshwater for various needs like drinking, agriculture, and industry.

Water Table

The water table is the level below the Earth's surface at which the soil and rock are saturated with water. It's the upper boundary of the zone of saturation, where all the spaces between particles are filled with water. The depth of the water table can vary due to factors like rainfall, geology, and human activities, and it's important as it determines the availability of groundwater for wells and other uses.

Industrial and Agricultural Uses of Water

Water serves vital roles in both industrial and agricultural sectors:

Industrial Uses of Water:

1. **Manufacturing Processes:** Water is a key component in various manufacturing processes across industries like textiles, chemicals, electronics, and food and beverage production. It's used for cooling, cleaning, dilution, and as a solvent in many manufacturing steps.

2. **Cooling and Heating:** Industries use water for cooling machinery and equipment, as well as for heating purposes in boilers and other industrial processes.

3. **Power Generation:** Water is essential in power generation, particularly in hydroelectric power plants where the force of flowing water generates electricity. It's also used in thermal power plants for cooling purposes.

4. **Cleaning and Sanitation:** Water plays a crucial role in sanitation and cleaning within industries. It's used for washing equipment, maintaining cleanliness in facilities, and in wastewater treatment processes.

Agricultural Uses of Water:

1. **Irrigation:** Agriculture is the largest consumer of water globally, primarily for irrigation. Water is used to irrigate crops, ensuring their growth and productivity.

2. **Livestock and Animal Husbandry:** Water is necessary for livestock to drink and for various husbandry practices, such as cleaning and maintaining hygiene in animal shelters.

3. **Processing and Cultivation:** Water is used in food processing, cleaning produce, and in some cases, in cultivating aquaculture (fish farming).

4. **Soil Conservation:** Controlled use of water in agricultural practices, such as drip irrigation or conservation methods, helps in soil conservation and reduces water wastage.

Both sectors heavily rely on water for their operations and outputs. Balancing water usage in these sectors is crucial for sustainability, especially considering the increasing demands on water resources and the need for efficient and responsible water management practices.

Development of the Irrigation System in Pakistan

Pakistan's irrigation system, tracing back to ancient times, features canals, British-era structures, and major dams like Mangla and Tarbela. The Indus Waters Treaty in 1960 regulated shared river resources. Canals, mainly in Punjab and Sindh, support agriculture. Innovations address water scarcity, focusing on efficiency. Ongoing modernization aims for better water management and sustained farming.

Conventional Systems

1. **Shaduf:** An ancient irrigation tool, the shaduf is a manual device consisting of a long pole with a bucket at one end and a counterweight at the other. It's used to lift water from a lower source (like a river or well) to a higher level for irrigation purposes.

2. **Charsa:** It's a traditional irrigation system found in parts of Pakistan and Afghanistan. It involves diverting water from rivers or streams into a network of earthen channels to distribute water to agricultural fields.

3. **Persian Wheel:** Also known as the Rahat in some regions, it's a mechanical water-lifting device consisting of a series of buckets attached to a wheel. Animals or workers provide the energy to rotate the wheel, lifting water from a well or source for irrigation.

4. **Karez:** A subterranean irrigation system found in arid regions, particularly in parts of the Middle East and Central Asia. It consists of a series of tunnels that tap into groundwater sources, providing a reliable water supply for irrigation and domestic use.

5. **Inundation Canals:** These canals are designed to carry excess water from rivers during periods of high flow or floods to adjacent lands for irrigation. They help in controlled flooding to nourish agricultural fields.

6. **Diversion Channel:** A channel constructed to divert water from a river or stream to supply it to specific areas for irrigation or other purposes. It helps control the flow of water to desired locations.

7. **Tank Irrigation:** This method involves capturing and storing rainwater in tanks or reservoirs, usually in rural areas, for later use in irrigation. It's a form of rainwater harvesting to support agricultural needs during dry seasons.

Each of these irrigation systems represents traditional or historical methods employed in different regions to efficiently utilize water for agriculture and other purposes, showcasing diverse techniques adapted to specific geographic and cultural contexts.

Use and Effectiveness of Conventional Methods of Irrigation

Modren Systems

Perennial canals are linked to dams and barrages to provide water throughout year; they can irrigate a vast area

Tubewells: Tubewells are vertical wells equipped with pipes and a pump system used to extract groundwater for irrigation. They're prevalent in areas with access to groundwater reservoirs. Tubewells are efficient in providing a reliable water supply, especially during dry seasons, but excessive use can deplete groundwater resources and lead to issues like declining water tables and potential saltwater intrusion in coastal areas.

Sprinklers and Sprays: Sprinkler irrigation involves distributing water through a system of pipes and sprinkler heads that spray water over the crops. It mimics rainfall and allows for even water distribution. Sprinklers are suitable for various crops and terrains, reducing water wastage due to evaporation. However, they can be costly to install and maintain.

Tankers: Tanker irrigation involves transporting water to fields using tankers, especially in areas with limited access to water sources or unreliable water infrastructure. Tankers carry water to remote or drought-affected areas, providing short-term relief during water scarcity. However, it's an expensive and temporary solution that may not be sustainable in the long run.

Each of these irrigation methods offers specific advantages and challenges. They contribute to ensuring water availability for agricultural purposes, but their effectiveness and sustainability depend on factors like local water availability, infrastructure, cost, and environmental impact. Efforts are ongoing to combine these methods with modern technologies to improve water efficiency and sustainable agricultural practices.

Indus Water Treaty

The Indus Waters Treaty is an agreement between India and Pakistan that was brokered by the World Bank and signed in 1960. This treaty pertains to the sharing of the waters of the Indus River and its tributaries, which flow through both countries.

The treaty allocates the waters of the six major rivers of the Indus basin: the Indus, Jhelum, and Chenab, which flow through India before reaching Pakistan; and the Sutlej, Beas, and Ravi, which flow through India before entering Pakistan. The treaty divides the rivers into eastern and western rivers, with India having control over the eastern rivers and Pakistan having control over the western rivers.

Under the treaty, India can use a portion of the waters of the eastern rivers for non-consumptive uses such as irrigation, power generation, and other purposes but with specific restrictions on storage capacity. India is also obligated to let a certain amount of water flow uninterruptedly to Pakistan.

The treaty established a Permanent Indus Commission to resolve disputes and address concerns related to the treaty's implementation. Despite several conflicts between India and Pakistan, the treaty has largely endured and has been considered one of the most successful water-sharing agreements globally, although disputes and issues have arisen periodically over its implementation and interpretations.

What are Dams and Barrages?

Dams and barrages are both structures built across rivers or water bodies to manage and control water flow for various purposes, but they serve different functions.

1. **Dams:**

- Dams are large structures built across rivers or streams, usually in narrow valleys, to impound water and create reservoirs.

- They are designed to control the flow of water, store it in the reservoir, and release it as needed.

- Dams serve multiple purposes, including providing water for irrigation, generating hydroelectric power, controlling floods, and supplying water for domestic, industrial, and agricultural use.

- There are different types of dams, such as arch dams, gravity dams, embankment dams, and more, each suited for different geographical and hydrological conditions.

2. **Barrages:**

- Barrages are structures built across rivers or estuaries to control water flow and create a pool or lake on the upstream side.

- Unlike dams, barrages usually don't create large reservoirs; instead, they are often used to divert water into canals for irrigation or to regulate water flow for navigation purposes.

- Barrages are commonly used in areas where there is a need to manage water levels, divert water for irrigation, or control salinity in estuaries.

Both dams and barrages play essential roles in managing water resources, but their designs, purposes, and functions differ based on the specific requirements of the area they serve.

Dams

1. Magla Dam
2. Tarbela Dam

Barrages

1. Chashma
2. Rasul Barrage
3. Maraia Barrage
4. Qadirabad Barrage

Small Dams and Large Dams

Small Dams	Large Dams
Store water for irrigation	Store water for irrigation
Irrigate local areas only	Irrigate a vast area
Supply water for industrial and domestic use	Supply water for industrial and domestic use
Supply little or no electricity	Major suppliers of HEP
Silting problem is easier to solve	Silting problem is difficult to solve
Require comparatively low initial investment, so better suited to Pakistan's economy	Initial investment cost is very high
Maintenance cost is low	Maintenance cost is high
Construction time is less and yields quick results	Construction time is more and does not yield quick results
Less important for flood control	More important for flood control
Very few people are evacuated in order to construct the dam	Large-scale evacuation is required. 40,000 people were evacuated for raising of the Mangla Project
Small dams have little impact on rivers, watersheds and aquatic ecosystems	Large dams generally have a range of extensive impacts on rivers, watersheds and aquatic ecosystems that are more negative and have led to irreversible loss of species and ecosystems

Siltation in Resovoirs

Siltation in reservoirs refers to the gradual accumulation of silt, sediment, and other debris carried by flowing water, which settles at the bottom of the reservoir. This process occurs over time as water flowing into the reservoir slows down, leading to the deposition of particles carried by the incoming water.

Several factors contribute to siltation in reservoirs:

1. **Erosion:** Natural erosion processes from surrounding land areas, rivers, and streams cause soil and sediment to be carried by water and deposited in the reservoir.

2. **Deforestation and Land Use Changes:** Removal of vegetation and changes in land use practices, such as farming, mining, or construction, can accelerate erosion, increasing the amount of sediment carried into the reservoir.

3. **Construction Activities:** During the construction of dams or other infrastructure, disturbance of the land can release sediment into the water, contributing to siltation.

Siltation in reservoirs can have various consequences:

- **Reduction in Storage Capacity:** As sediment accumulates at the bottom of the reservoir, it reduces the volume of water that the reservoir can hold, affecting its storage capacity for water supply, irrigation, and power generation.

- **Impact on Water Quality:** Sediment accumulation can impact water quality, affecting the chemistry and clarity of the water. It can also carry nutrients and pollutants, potentially affecting aquatic ecosystems and human water usage.

- **Maintenance Costs:** Siltation requires regular dredging or desilting operations to remove the accumulated sediment, which can be costly and logistically challenging.

Efforts to mitigate siltation in reservoirs include:

- Implementing soil conservation measures in upstream areas to reduce soil erosion.

- Afforestation and reforestation to stabilize soil and prevent erosion.

- Sediment trapping structures or check dams upstream to reduce the amount of sediment entering the reservoir.

- Regular maintenance and desilting operations to remove accumulated sediment and maintain the reservoir's capacity.

Managing siltation is crucial to maintaining the effectiveness and functionality of reservoirs for their intended purposes and ensuring sustained water availability and quality.

Causes

- Abundance of silt eroded from Karakoram, Hindu Kush and Himalayan mountains.
- Deforestation - ruthless cutting of trees for fuel and timber.
- Rivers form deep, narrow valleys in mountainous areas. Most eroded material is washed down to plains and piles up in reservoirs of dams.

Effects

- Silt accumulates and blocks canals.
- Weakens the foundation of dams.
- Reservoir capacity is reduced; lower flow of water affects generation of hydroelectric power. It also reduces the amount of water available for irrigation.
- Flow of floodwater is hampered, which may cause heavy damage to the dam because of mounds of silt which block the flow of water.

Control

- Large-scale afforestation, especially on foothills of Himalayas.
- Cement canal embankments to make cleaning easier.
- Install silt trap before water flows to dams.
- Regulate water flow e.g. by operating reservoir at lower level during flood and allowing free flow during low flow season to wash out sediment.
- Raise dam height to increase reservoir capacity.

Water Logging and Salinity

Waterlogging and salinity are interconnected issues that often occur in irrigated areas, particularly in agricultural regions where there's intensive use of irrigation.

1. **Waterlogging:**

- Waterlogging happens when the water table rises to the extent that it saturates the soil, preventing proper drainage and causing the soil to become excessively wet.

- It occurs when there's an excess of irrigation water or poor drainage, leading to the accumulation of water in the root zone of plants.

- Prolonged waterlogging can deprive plant roots of oxygen, leading to reduced crop yields, root damage, and ultimately plant death.

- Causes of waterlogging include inadequate drainage systems, high water tables, over-irrigation, or inappropriate land grading.

2. **Salinity:**

- Salinity refers to the accumulation of salts in the soil, typically in arid or semi-arid regions where evaporation rates exceed precipitation.

- Salts naturally present in the soil dissolve in irrigation water and, when the water evaporates, leave the salts behind. Over time, these salts accumulate in the soil.

- High salinity levels can hinder plant growth and decrease agricultural productivity.

- Salinity issues often occur alongside waterlogging because the excess water brings salts closer to the soil surface as it evaporates, exacerbating the salinity problem.

How to solve the problems of Water logging and Salinity

Solving waterlogging and salinity issues requires a combination of preventive measures and management strategies. Here are some effective approaches to address these problems:

Waterlogging:

1. **Improved Drainage Systems:**

   - Install subsurface drains, surface ditches, or other drainage systems to efficiently remove excess water from the soil.

   - Ensure these drainage systems are properly maintained and functioning to prevent waterlogging.

2. **Land Grading and Slope Management:**

   - Properly grade the land to facilitate water runoff and prevent water accumulation in low-lying areas.

   - Use contour farming or terracing to control water flow and prevent waterlogging.

3. **Use of Suitable Irrigation Practices:**

   - Employ more efficient irrigation methods like drip irrigation or sprinkler systems to apply water directly to the root zone, reducing excess water in the soil.

   - Implement scheduling techniques to match irrigation with crop water requirements, avoiding over-irrigation.

4. **Crop Selection:**

   - Choose crops that are better suited to the local soil and water conditions, particularly those that are more tolerant to waterlogging.

Salinity:

1. **Improved Water Management:**

   - Opt for practices like controlled flooding, where irrigation water is managed to minimize water table rise and salt accumulation.

   - Implement proper water usage practices to prevent excessive evaporation and reduce the concentration of salts in the soil.

2. **Leaching:**

   - Use controlled leaching with freshwater to flush out accumulated salts from the soil profile.

   - Ensure proper drainage during leaching to avoid further waterlogging issues.

3. **Soil Amendments and Reclamation:**

   - Apply gypsum or other soil amendments that can displace harmful salts, improving soil structure and reducing salinity.

- Incorporate organic matter into the soil to enhance its ability to retain moisture and nutrients, while also aiding in salt displacement.

4. **Crop Rotation and Salt-Tolerant Plants:**

   - Practice crop rotation with salt-tolerant plants to help manage salinity levels in the soil.

   - Utilize plants that can absorb excess salts, such as halophytes, to mitigate soil salinity.

5. **Monitoring and Testing:**

   - Regularly monitor soil salinity levels to track changes and adjust management practices accordingly.

   - Conduct soil tests to determine the specific types and amounts of salts present, aiding in the selection of appropriate remedial measures.

By integrating these approaches and employing a combination of preventive measures and management strategies, it's possible to effectively mitigate waterlogging and salinity issues, ensuring sustainable land use and maintaining soil productivity.

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