<u>IQRA NATIONAL UNIVERSITY PESHAWAR</u>

<u>DEPARTMENT OF CIVIL ENGINEERING</u>

<u>M.S TRANSPORTATION</u>

<u>Submitted To:</u>

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Q1. What is "Hydrological Cycle"? Now-a-days there is general discussion that Hydrological Cycle has been disturbed. Is this myth or reality? Briefly explain.

Answer:

HYDROLOGICAL CYCLE:

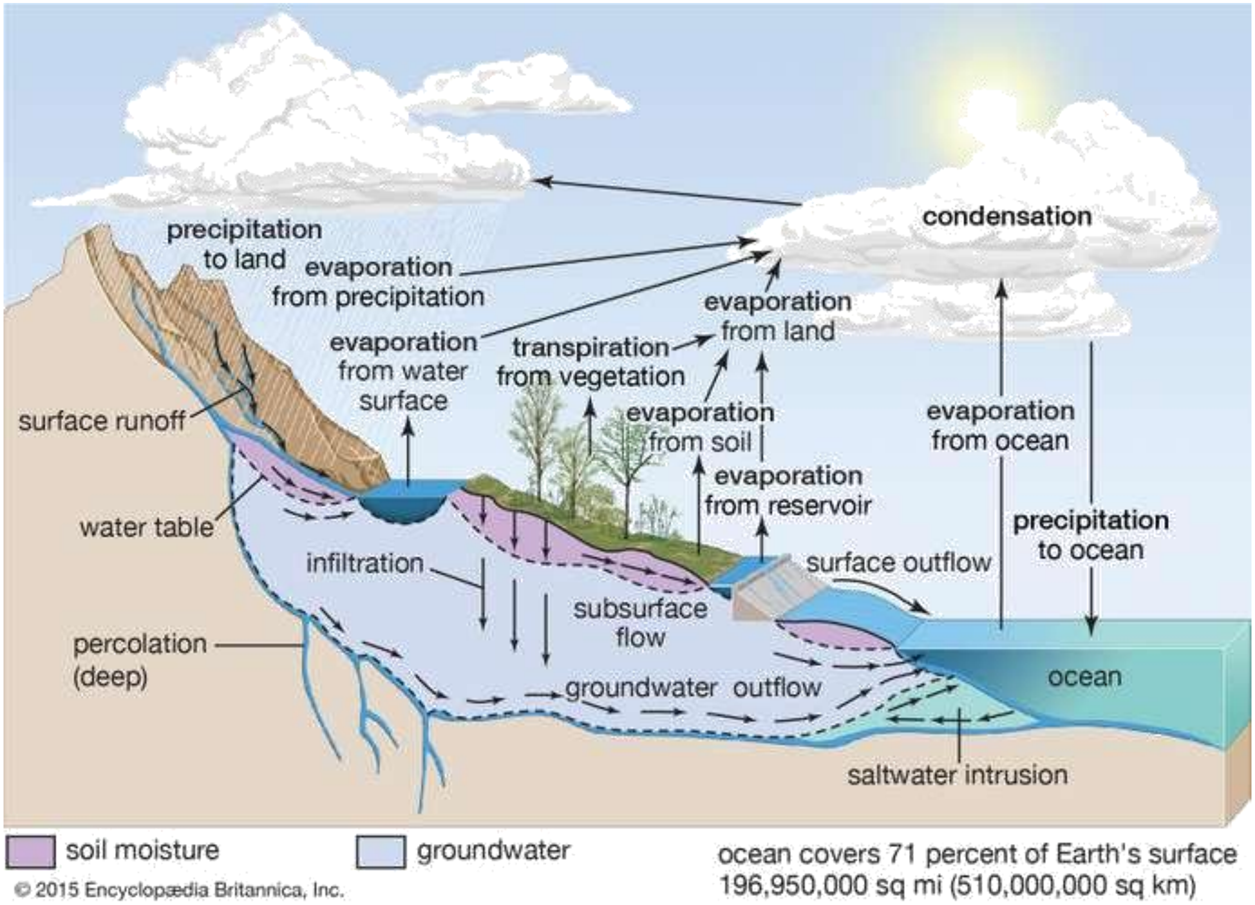
Water cycle, also called **hydrologic cycle**, cycle that involves the continuous circulation of water in the Earth-atmosphere system. Water Cycle deals with the origin and distribution of water on the globe. Complex pathways include passage of water from gaseous stage in the atmosphere to ocean, lakes, rivers etc.

The following most important process involved in Water Cycle.

1. Evaporation
2. Condensation
3. Precipitation
4. Interception
5. Infiltration
6. Percolation
7. Transpiration
8. Runoff & Storage

Although the total amount of water within the cycle remains essentially constant, its distribution among the various processes is continually changing.

The following diagram shows various steps/cycle of "Hydrological Cycle".



Effects/ Disturbance on "Hydrological Cycle"

Although an exact inventory of global water withdrawal has been difficult to assemble, the general features of anthropogenic water use are more or less known. Reviews of the recent literature (Shiklomanov 1996, Gleick 2000) show a range in estimated global water withdrawals for the year 2000 between approximately 4000 and 5000 km$_3$/yr. Despite reductions in the annual rate of increase in withdrawals from 1970 (Shiklomanov 1996, 2000, Gleick 1998a), global water use has grown more or less exponentially with human population and economic development over the industrial era. By one account (L'vovich and White 1990), there was a 15-fold increase in aggregate water use between 1800 and 1980, when the global population increased by a factor of four (Haub 1994). Aggregate irretrievable water losses (consumption), driven mainly by evaporation from irrigated land, increased 13-fold during this period.

Global consumption for 1995 has been estimated at approximately 2300 km^3/yr, or 60% of total water withdrawal (Shiklomanov 1996).

To place such water use into perspective, it is necessary to consider the global supply of renewable water. Using recent estimates of long-term average runoff from the continents totaling approximately 40,000 km^3/yr (Fekete et al. 1999, Shiklomanov 2000) and an estimated withdrawal of 4000–5000 km^3/yr, humans exploit from 10% to 15% of current water supply. It therefore might appear that water withdrawal over the entire globe is but a small fraction of continental runoff and that water poses no major limitation to human development. However, of the 31% of global runoff that is spatially and temporally accessible to society, more than half is withdrawn (35%) or maintained for instream uses (19%; Postel et al. 1996). And, by the early 1990s, several arid zone countries showed relative use rates much larger than the global average (e.g., Azerbaijan, Egypt, and Libya, which were already using 55%, 110%, and 770% of their respective sustainable water supplies; WRI 1998). Contemporary society is thus highly dependent on, and in many places limited by, the terrestrial water cycle defined by contemporary climate.

This dependency is likely to intensify as a consequence of population growth and economic development. From 1950 to 1998, water availability had already decreased from 16,000 to 6700 m^3/yr per capita (WRI 1998, Fekete et al. 1999). If we assume no appreciable change in global runoff over the next several decades, a projected increase in global population by 2025 to approximately 8 billion people (WRI 1998) means that per capita supplies will continue to decline to approximately 5000 m^3/yr (WRI 1998). Tabulating these statistics from the standpoint of accessible water, per capita availability would be reduced to approximately 1500 m^3/yr. Given an estimate of mean global water use of 625 m^3/yr per capita for 2025 (Shiklomanov 1996, 1997), withdrawals could therefore exceed 40% of the accessible global water resource even with presumed increases in use efficiency. This has obvious implications for human society and natural ecosystems, both of which are highly dependent on renewable supplies of water.

The primary application of water is to irrigate cropland in the many regions of the world where rain-fed agriculture is limited or where specific crops such as paddy rice typically are inundated during growth. Irrigation produces more than 40% of global food and agricultural commodity output (Shiklomanov 1996, 1997, UN 1997) on but 15–20% of all agricultural land worldwide. Recently, the extent of irrigated land is placed at approximately 2.5 million km_2, with a more than 50% rise between 1970 and 1995 (Gleick 1998a). For 1990, estimates of global irrigation withdrawals range from approximately 2300 to 2700 km_3/yr or approximately 60–75% of all water withdrawals (Shiklomanov 1996, 1997). By some accounts (L'vovich and White 1990, Shiklomanov 1996, 1997), irretrievable losses of water total 60–70% of all water withdrawn for all purposes, and irrigation alone accounts for 85–90% of this consumption. Providing adequate irrigation water to a growing population constitutes a major international security concern well into the future (UN 1997).

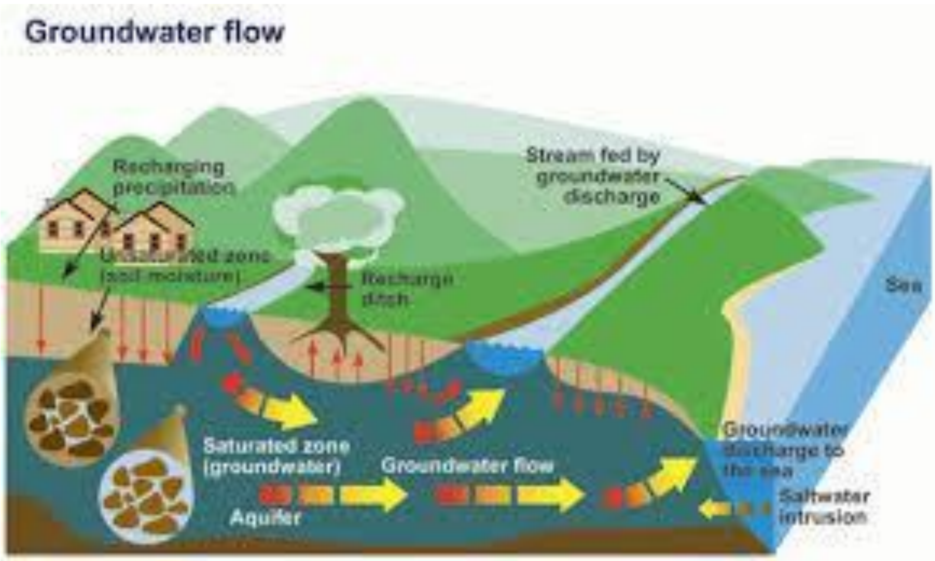
In view of the above explanation it is cleared that “Hydrological Cycle” is disturbed by one way or other way by Human usage/interference.
For safe and regular “Hydrological Cycle” we will educate peoples Nationally & Internationally by growing more plants, built of safe reservoirs and reduction of mountainous/Rock cutting.

Q2: Briefly describe "Ground water Sustainability"? How can "Rainwater Harvesting" be linked to ground water sustainability?

Answer:

Ground water Sustainability:

Groundwater sustainability is the development and use of **groundwater** resources to meet current and future beneficial uses without causing unacceptable environmental or socioeconomic consequences.



Groundwater is the water found under ground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soils, sand and rocks called aquifers. It is one of the Nation's most important natural resources. It plays a major role in ensuring livelihood security across the world, especially in economies that depend on agriculture. Ground water contains mineral ions which slowly dissolve from soil particles, sediments, and rocks named as dissolved solids. Continuous discharge of industrial effluents, domestic sewage use of fertilizers and pesticides, waste dump and over exploitation of the resource have badly impact on ground water sustainability. Though over utilization of ground water is the key factor for ground water depletion but there are other factors which have negative impact on ground water sustainability.

The most important impact of groundwater depletion is loss of base flow; other impacts being severe crisis of safe drinking water and irrigated water. Lastly it is to be mentioned that protection of the water resource from depletion is not possible unless the users agree to cooperate and manage the resource themselves in a sustainable manner.

Moreover the state also needs to play a key role of facilitating and fostering community action for sustainable management.

Rainwater Harvesting linked to Ground Water:

Rainwater harvesting is a multipurpose way of supplying usable **water** to consumers during a crisis period, recharging the **groundwater** and finally reducing the runoff and **water** logging during the season of heavy **rainfall**. Traditional knowledge, skills, and materials can be used for this system.

Basically there are two methods of rainwater harvesting.

1. Rooftop rainwater harvesting
2. Surface Runoff rainwater

Rooftop rainwater harvesting:

It is the system in which rainwater is collected from the roofs of the houses/buildings. It can either be stored in a tank or divered into an atrtificail recharge system.

Surface Runoff rainwater:

In urban areas rainwater flows away as surface overflow. This runoff can be caught and be used for recharging aquifers bt adopting appropriate methods.

Reasons for shortage of water:

1. Population increase
2. Industrialization
3. Urbanization
4. Increase in per capita utilization
5. Less peculation area due to increase in paved surface

Advantages:

- Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply.
- It provides water when there is a drought, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable ground water levels to be sustained.
- It also help in the availability of potable water as rain water is substantially free of salinity and other salts.

Reasons for rainwater harvesting:

- To conserve & augment the storage of ground water
- To reduce water table deletion
- To improve the quality of ground water
- To reduce sea water intrusion in coastal areas
- To avoid flood & water stagnation in Urban areas

Rainwater harvesting is the accumulating and storing of rainwater for reuse, in natural or manmade catchment areas.

Rainwater harvesting is a process of direct collection of precipitation falling on the roof or on the ground for productive purposes (like agricultural and human use related to water). Because the runoff water causes erosion so it is harvested and utilized and considered as a rudimentary form of irrigation. Rainwater is a purest form of water though to harvest water is a simple and inexpensive technique. In recent years, it has become compulsory for the new home construction to build proper roofs for rainwater drainage. If an efficient rainwater harvesting system is adopted then it is assured that there would be a water reserve in case of water shortage. Henceforth, investing in a great rainwater harvesting system is well worth for future use.

RWH is usually treated as an umbrella which describes the whole methods of collection and runoff forms such as rooftop runoff, overland flow, stream flow, etc. from rainfall. From the past few years, water harvesting (WH) has become essential because the surface water is inadequate to meet the growing demand of human beings (Khan, 2014).

The amount of water harvested depends on the frequency and intensity of rainfall, catchment characteristics, water demands and how much run off occurs and how quickly. Moreover, in urban areas adequate space for surface storage is not available, rooftop and runoff rainwater harvesting is ideal solution to solve the water storage problem.

Q3: What ‘Quality Parameters” should be considered in designing water supply system for community?

Answer:

Typical Village/town water supply system constitutes of a gravity/pumping based transmission and distribution system from local/distant water source with needed water treatment system.

Standard Water supply System in village/town

Sources	Open Well, Tube Well, Hand pump, Pond, Dam Site, External Pipe Supply, Rain Water Harvesting System/Tank
Village/town level Treatment	Reverse Osmosis System (RO), Chlorination, Sedimentation, Sand Filter, etc.
Storage	Elevated Surface Reservoirs (ESR), Ground Service Reservoirs (GSR), Sump
Distribution	Main Line, Sub-Main Line, Branch Pipe Line, Household Level Tape, Stand Post, Washing Unit.

Water Treatment:

Water from source is treated at village level and even at household level, if needed. If bulk water available from the distant source is treated and potable, then further treatment may not be required at village level. There are various processes of treatment based on the source and quality of water in specific region.

- Village/town level water treatment systems are located mainly near head works. The treatment units are located in such a manner, where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required. Sufficient area should be reserved near the treatment units for further expansion in future. Basic treatment system at village/town level involves removal of suspended solids through sedimentation, removal of micro-organisms and colloidal matter through sand/gravel filters, water softening through reverse osmosis (RO) system, disinfection through chlorination and any other chemical/specialized treatment for removal of fluoride, salinity etc.
- Treatment at household level is needed as there may be chances of water contamination while transmission of water. This mainly includes basic filtration for removal of any silt, etc.; boiling for removal of microorganisms or chlorination for

disinfection. It is very important to carry out water test in order to decide upon the type of treatment. It is also essential to carry regular water testing from various points starting from source to distribution points to maintain potable water quality.

Water Quality and Testing:

Water from ground or surface sources are not always potable for drinking and need some level of water treatment prior to supply for water supply system. Following are some of the quality issues that are normally seen in various types of water sources:

Water Source	Type of Quality issue
Surface water	
Lakes and ponds	Development of algae on top, development of Microorganisms, high turbidity in bottom layers. May be affected by organic and chemical pollutants by disposal of wastewater.
River, irrigation canals	Organic debris, mineral salts May be affected by organic and chemical pollutants by disposal of wastewater.
Ground Water	
Well, tube wells, hand pump etc	Salinity, fluoride, alkalinity, hardness Chemical contaminations due to disposal of domestic waste/industrial chemical near by

Types of tests to be conducted:

a. Physical test including temperature, turbidity, colour, taste, and odour.

b. Chemical tests including pH, alkalinity, acidity, hardness, calcium, magnesium, iron, manganese, copper, zinc, aluminum, sulphates, fluorides, chlorides, nitrates, total dissolved and suspended solids, tests for toxic chemicals (lead, mercury etc.), test for radio-activity.

c. Bacteriological examination for presence of bacteria like coliform, E-col

Water Treatment Systems:

Normally, water supplied for drinking is treated at head works under the water supply system. However, water needs treatment even at household level as there may me chances of water contamination while transmission of water. Type of treatment depends on quality of raw water and source. Chart below enlists some of the common methods of water treatment used in water supply system:

Type of Filtration	Purpose	Type of Unit
Sedimentation	Removal of suspended solids like sand, clay, silt etc.	Sedimentation tanks
Sedimentation with coagulation	Removal of suspended solids, color, odour, taste, turbidity etc.	Sedimentation with chemical input
Filtration	Removal of microorganism and colloidal matter	Slow/rapid sand filter
Water softening plant	Removal of water hardness/salts	RO (reverse osmosis plant)
Disinfection	Removal of pathogenic bacteria	Chlorination
specialized water treatment plants	Removal of fluoride	De-fluoridation units, Nalgonda System
–	Excessive salinity	De-salination plants

Village/Town Level Water Treatment Systems:

- Village/town level water treatment systems are located mainly near head works, and should be located near to village/town if possible so as to avoid contamination in further water conveyance.
- The treatment units should be located in such a manner where possible that flow of water from one unit to other can be done by gravity, so that additional pumping of water is not required.
- Sufficient area should be reserved near the treatment units for further expansion in future.

Types of Water Treatment System at Village/Town Level:

1. **Primary Screening:**

- Screens are fixed in the intake works or at the entrance of treatment plant so as to remove the floating matters as leaves, dead animals etc.

2. **Sedimentation:**

- In this process, suspended solids are made to settle by gravity under still water conditions. The sedimentation tanks may be rectangular or circular in shape.

Advantages:

- Plain sedimentation lightens the load on the subsequent process.
- The operation of subsequent purification process can be controlled in better way.
- Less quantity of chemicals is required in the subsequent treatment processes.

3. **Sedimentation with coagulation:**

- This process is used when raw water contains fine clay and colloidal impurities and needs extra chemical treatment for them to settle unlike plain sedimentation. In this process certain chemical/coagulant are added in the process along with sedimentation for impurities to settle down. This process is useful in removal of colour, odour and taste from water. Turbidity and bacteria can also be removed to certain extent.
- Coagulants are added based on pH of water. Alum or aluminium sulphate is common and cheaper coagulants added in the process. They are added in powder
or solution form to raw water through some mechanical means.

4. **Filtration:**

    - This involves treatment of water by passing it through bed of sand, gravel and other granular materials. This system is useful in removal of bacteria, colour, odour, taste. • This system is highly useful in removal of suspended impurities.