ASSIGNMENT

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SUBMITED TO:

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SUBJECT:

Water Demand Supply and Distribution

Answer of Question 1:

Hydrologic cycle:

Water cycle or hydrological cycle of the earth is the sum of all processes in which water moves from the land and ocean surface to the atmosphere and back in the form of precipitation.

Hydrological cycle includes the following processes:¬

1**. Evaporation** Evaporation occurs when water changes from liquid state to gaseous state. Evaporation occurs on water surfaces like lakes, seas etc. Evaporated moisture is lifted into atmosphere. Evaporation is the primary pathway in which water moves from the liquid state back into the water cycle as atmospheric water vapor.

2. Condensation Condensation is the process by which water vapor changes into water. Water vapor condenses to form dew, fog or clouds. Condensation takes place due to cooling of air.

3. Precipitation Precipitation is the process that occurs when water particles fall from the atmosphere and reach the ground. Precipitated water may fall into water bodies or on land. It then goes to streams or penetrates into the soil. There are different types of precipitation including rain, snow, hail, and sleet

4. Interception Interception is the process of interrupting the movement of water in the chain of transportation events leading to streams. When rain first begins some part of the rain does not reach the streams instead intercepted by the leaves, branches of plants and the forest floor.

5. Infiltration Infiltration is the physical process involving movement of water through the boundary area where atmosphere interfaces with the soil. Infiltrated water and water stored in the soil, can become subsurface runoff.

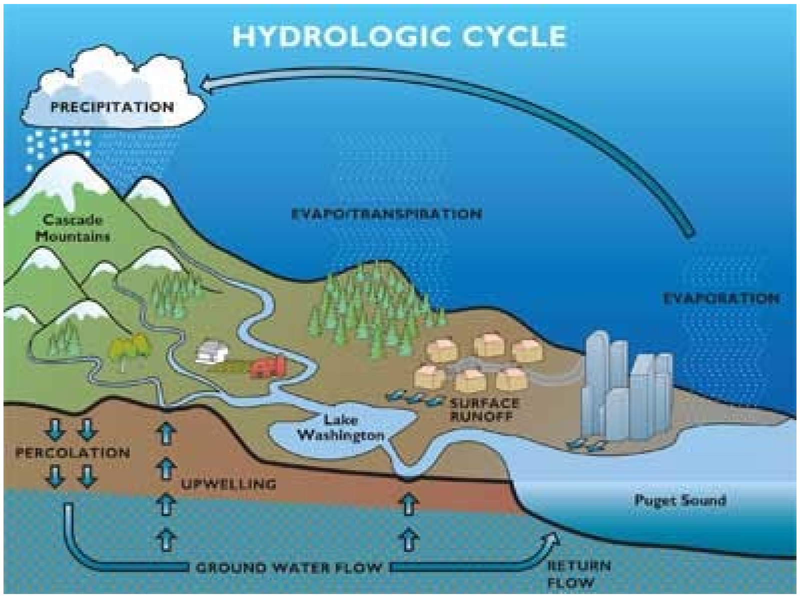
6. Percolation

7. Transpiration Transpiration is the process by which plants lose water out of their leaves. Transpiration gives evaporation a bit¬ of hand in getting the water vapor back up into the air

8 Runoff and storage. Runoff is a flow from a drainage¬ basin / catchment area in surface streams. It generally consists of the flow¬ that is unaffected by artificial diversions or storages.

Explanation;

The hydrologic or Water cycle is the continuous movement of water between the earth and the atmosphere. Water reaches land as precipitation such as rain and snow. Then the water evaporates, condenses in the atmosphere to form clouds, and falls to the earth again as precipitation, continuing the cycle.When water falls to the ground it can collect on the land becoming streams, rivers, lakes, or soaks in to the ground to become groundwater. Plants take up groundwater either using it or releasing it to the atmosphere.



Importance of hydrologic cycle:

The hydrologic cycle is important because it is how water reaches plants, animals and us! Besides providing people, animals and plants with water, it also moves things like nutrients, pathogens and sediment in and out of aquatic ecosystems.

Hydrological cycle is disturbed?

Science has shown that climate change touches every corner of our planet's ecosystem, and the water cycle is no exception. Because the processes involved are highly dependent on temperature, changes in one have consequences on the other. Specifically, as global temperatures have steadily increased at their fastest rates in millions of years, it's directly affected things like water vapor concentrations, clouds, precipitation patterns, and stream flow patterns, which are all related to the water cycle. Water evaporates from the land and sea, which eventually returns to Earth as rain and snow. Climate change intensifies this cycle because as air temperatures increase, more water evaporates into the air. Warmer air can hold more water vapor, which can lead to more intense rainstorms, causing major problems like extreme flooding in coastal communities around the world.

But it doesn't end there. At the same time that some areas are experiencing stronger storms, others are experiencing more dry air and even drought. As temperatures rises, evaporation increases and soils dry out. Then when rain does come, much of the water runs off the hard ground into rivers and streams, and the soil remains dry due to which more evaporation from the soil occurs and an increased risk of drought.

The removal of trees (deforestation) is having a major impact on the water cycle, as local and global climates change.

Normally, trees release water vapor when they transpire, producing a localized humidity. This water vapor then evaporates into the atmosphere where it accumulates before precipitating back to the Earth as rain, sleet or snow. Deforestation in one area can therefore affect the weather in another area because if trees are cut down, there is less water to be evaporated into the atmosphere and subsequently less rain.

At a local level, the land becomes drier and less stable. When it rains, instead of the water being soaked up, there is increased run-off and leaching. Areas can become more prone to both droughts and flooding, impacting on plants and animals, and also humans living near deforested areas.

The greenhouse effect is a natural phenomenon of Earth's atmosphere trapping a range of gases, which in turn capture infrared radiation to keep our Earth at a moderate temperature range compared to the other planets in our solar system

Human activity such as the burning of fossil fuels has an effect on the overall increase of the Earth's temperature. Raising the Earth's temperature may mean that there is an increase of evaporation, melting of ice or other processes of the water cycle that adversely affect the climate on Earth.

Answer Question 2:

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 Sustainable principles as those choices, decisions, actions and ethics that will best achieve ecological/biological integrity; protect qualities and functions of air, water, soil and other aspects of the natural environment; and preserve human cultures. Although many states have recognized the importance of sustainable water use, most states have not explicitly incorporated sustainability principles into the laws and policies that guide their allocation of groundwater.

Groundwater sustainability helps in some of the following ways

Groundwater as a source of water supply

Identify sources of potable water
• Determine consumptive use requirements
• Evaluate sustainability of groundwater withdrawals
• Compliance with state permitting and sustainability requirements

Protecting groundwater-dependent species and ecosystems

Identify ecosystems that depend on access to or discharge of groundwater
• Determine ecological water requirements
• Develop sustainability thresholds and triggers for management action
• Strategies for acquiring groundwater rights or other protective measures
• Delineate areas or activities that may affect groundwater discharge

Groundwater models to sustainably manage groundwater withdrawals

• Review, develop or run analytical and numerical models
• Estimate groundwater-level declines, stream flow depletions and the capture of aquifer discharge

Rainwater Harvesting

Rainwater harvesting is a technique of collection and storage of rainwater into natural reservoirs or tanks, or the infiltration of surface water into subsurface aquifers (before it is lost as surface runoff).

Method OF Rainwater Harvesting

Basically there are two methods of rainwater harvesting.

1) Rooftop rainwater harvesting:

2) Surface Runoff rainwater:

1) 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 diverted into an artificial recharge system.

2) **Surface Runoff rainwater**: In urban areas rainwater flows away as surface overflow. This runoff can be caught and be used for recharging aquifers by adopting appropriate methods

Rainwater Harvesting and Ground water Sustainability:

Groundwater constitutes about 89% of the total fresh water resources in the planet. But in recent years, due to over exploitation of ground water and erratic nature of monsoon, there has been depletion of ground water across the world. Depletion of ground water has reached to the extent that it is virtually impossible to get the water table back. Even though there is a possibility of recharge of water from the other areas, the process is very slow and may take one year to replenish one meter. In view of this management of ground water has become one of the most significant issues in recent times. Added to it, there are also environmental problems such as aqua for mining, salt water intrusion, stream base flow reduction etc. For several reasons the efficient management of ground water resources through market mechanism has become difficult.

Lack of rain water is serious problem throughout the world for both urban & rural community. The ancient water sources are as well, river and reservoirs, etc. are not effectively fulfilling water demand due to unbalanced rainfall. Therefore Rainwater harvesting system investigates as a new water source. The aim of the Rainwater harvesting system is to fulfill the water demand during the period of scarcity. The rain water harvesting (RWH) system is an alternative source of water.

Advantages:

1) Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply.

2) 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.

3) It also helps in the availability of potable water as rainwater is substantially free of salinity and other salts.

The reasons for using rain water harvesting system:

- Rain water harvesting increases the water supply, food production and maintain food security.
- Harvested rain water is generally gives the benefit to the households and individuals in the rural area.
- Since the rain water harvesting provide water supply which leads to the food security, this will contributes to the income from the crop yield.

Rainwater Harvesting is done for the purpose:

- To increase the ground water recharge.
- To reduce surface runoff from rainfall area.
- To reduce seawater ingress in coastal areas.
- To use the storage water for drinking and agricultural purpose during scarcity period.
- To avoid flood & water stagnation in urban areas
- To reduce water table depletion

Recharge of the ground water is a time consuming process, it take sufficient time to recharge ground water table. We cannot suddenly increase the ground water table after constructing any type of recharge structures. Rainwater harvesting is very beneficial concept in rural and urban areas, so we can prefer Rainwater harvesting system. This will help to recreate the source for depleting ground water resources. Also help to save the little amount of rain water which used to drain away from many years. Rain water harvesting is essential for humans and animals as well as for groundwater depletion.

Answer Question no 3:

DESIGN OF WATER SUPPLY SCHEME

Water Supply Systems to be designed requires two basic parameters:

QUALITY PARAMETER FOR DESIGN WATER SUPPLY SYSTEM;

A) Water consumption rate (Per Capita Demand in liters per day)

B) Population to be served

A) WATER CONSUMPTION;

It is the amount of water consumed by a community in one day. Water consumption is expressed as Liters/Capita/Day i.e lpcd

Water Demand = Per capita demand x Population

Water Demand is normally calculated for daily usage.

WATER DEMAND FOR DIFFERENT PURPOSES

Average Annual Daily Demand (AADD)

The total quantity of water supplied for a period of one year divided by the nos of days in year. If this demand is based on a single person then it is average per capita

q =Q/(365*P)

q= discharge rate (lpcd)

Q=Total quantity of water in liters

P= Population

Average Daily Demand (ADD) =Q/(365*P)

Max. Daily Demand (MDD)=ADD*1.80

Max. hourly Demand (MHD)=ADD*1.50

Max. weekly Demand (MWD)=ADD*1.48

Max. Monthly Demand (MMD)=ADD*1.28

Mini rate of Demand (MRD)=(0.25-0.50)*ADD

Peak Hourly Consumption; It is the peak consumption during any one hour of the years excluding the fire demand. The peak hourly consumption can be between 150 to 400 percent of the average hourly consumption during a peak day. It is around 150% of the maximum daily consumption. Water Supply Design

Peak Hourly demand = 1.5 x Max. Daily Demand = 2.25 x Avg. Daily Demand.

Average Daily Consumption ; ADD is based on location, time,season etc

The ADD is based on a number of factor like

Size of community, industries and commerce, characteristics of population, climate condition, distribution pressure, cost of water, system of supply, Quality of water, Air conditioning, Efficiency of the department, sewerage facility and conservation practices.

Types of Water Demands

1. **Domestic water demand**

2. **Institution and commercial demand**

3**. Demand for Public Use**

4. Losses and Wastes

5. Fire demand

Design period; Various components of the distribution system are designed for a certain period of time called the design period. During this period, the capacity of the component should be adequate unless the actual water demand differs from the forecast.

Population forecasting:

prior to design of a water supply scheme, it is necessary to forcast the future population. The future prediction of population on the basis of previous census record using mathematical, statistical or graphical method are know as population forecasting.

The knowledge of forecasting is important for design of any water supply scheme .It based on design period of population. The design period estimates will 1 to 50 years.

It is difficult to estimate the population growth due to economic and social factors involved . However, a few methods have been used for forecasting population.

Arithmetic Increase Method: Based of hypothesis that population rate of increase is constant.

This method is suitable for large and old city with considerable development. If it is used for small, average or comparatively new cities, it will give lower population estimate than actual value.

Mathematically The population after nth decade will be Pn : P(1+ n*r)

Where Pn is the projected population ,

n is the number of decades or years ,

P is the present population and r is the annual growth rate.

Geometric Growth method: According to this method it is assumed that the rate of increase of population growth in a community is proportional to the present population.

Mathematically dp/dt α P => dp/dt = K_g*P where K_g = Geometric growth constant. If P_o is the population at any time t_o and P_f is the population at time t_f then ∫dp/p = k_g ∫dt = Ln ($P_{f/}P_o$)

$P_o = K_g (L_f/L_o)$ => Ln ($P_{f/}P_o$ = $K_g \Delta t$ => Ln P_f = Ln P_o + $K_g \Delta t$ => $P_{f/}P_o$ =(c) $^{kg\Delta t}$

And $P_f = P_o$ (c) $^{kg\Delta t}$

This method gives somewhat larger value as compared to arithmetic method and be used for new cities with rapid growth. In normal practice arithmetic and geometric growth average is taken..

Logistic Method: when the growth rate of population due to birth , death and migration are under normal situation and not subjected to extraordinary changes due to unusual situation like war, epidemic, earth quake and refuges etc .then this method is used . According to this method

P= P_{sat} / **(1+$e^{a+b\Delta t}$)** where P_{sat} is the saturation population of the community and a,b are constants. P_{sat} , a and b can be determined from three successive census population and the equation are

P_{sat} =[2 $P_o P_1 P_2$ - P^2_1 ($P_o + P_2$)]/($P_o P_2$ - P^2_1)

A=ln [P_{sat} - P_2 / P_2]; and b=1/n [ln { P_o (P_{sat} - P_1 0)}/{ P_1 (P_{sat} - P_2 }]

Where n = time interval between succeeding censuses.

Curvilinear or comparative method: In this method it is assumed that the population of a city will grow in the same manner as in other cities in the past. This similarity between the cities includes geographical proximity, similarity of economic base, access to similar transportation system etc. In practice it is difficult to find similar cities.

Ratio method: Ration method of forecasting is based on the assumption that the population of a certain area or a city will increase in the same manner to a larger entity like a province, or a country. It requires calculation of ratio of local to required population in a sense of census years. Projection of the trend line using any of the technique and application of projected ratio to the estimated required population of projected ratio to the estimated required population in the year on interest . This method of forecasting does not take into account some special calculations in certain area bt have the following advantages.

Declining Growth method: this method like logistic assume that the city has some limiting saturation population and that its rate of growth is a function of population deficit.

Mathematically $dp/dt = (P_{sat} - P)$ where $\mathbf{P_{sat}}$ is the saturation population computed on some rational basis. Now $dp/dt = K_d(P_{sat} - P)$. Where K_d is the declining growth constant. The value of which will be $K_d = 1/nL\ n[(P_{sat} - P)/(P_{sat} - P_o)]$ where n = census interval between P_o and P

Future population can be estimated as $P_f = P_o + (P_{sat} - P)(1-e^{kdt})$

Example: Assuming a high –value residential area of 100 ha , has a housing density of 10 houses /ha with 4 persons per household. The average daily demand is 340 lpcd. Determine the water demand , including fire in this residential area.

Solution: Estimate population =(4 capita/house)* 10 houses/ha)(100ha)=4000 persons

Estimate Maximum daily flow =ADD*1.8=340 lpcd *1.8 * 4000persons=2448000 1/day $=2448\ m^3/day$

(Note: In case of Fire demand the flow must be at maximum demand and the duration of fire flow will be from 4 to 10 hours depending on fire nature)

Estimate fire demand $F=3.86(P)^{0.5}(1-0.01(P)^{0.5})=3.86(4)^{0.5}(1-0.01(4)^{0.5})= 7.57\ m^3/min.$

$=7.57\ m^3/min *60\ (minutes/hr) *10hr/24hr)=189.25\ m^3/day$

Total water demand = Maximum demand+Fire demand $=2448+189.25m^3/day$ **= 2627.25 m^3/day =0.0305 m^3/sec.**