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

Ans: Hydrological cycle refers to the movement of water of oceans, atmosphere and lands in a series of continuous interchanges of both geographic position and physical state. 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. It deals with the origin and distribution of water on the globe.

Of the many processes involved in the water cycle, the most important are evaporation, transpiration, condensation, precipitation, and surface runoff. Water is lost to the atmosphere from the earth out of rivers, lakes, oceans, underground sources, plants and animals. This moisture gets condensed at higher levels and falls to the earth as precipitation in the form of rain, snow, hail, dew, sleet, frost etc. Since the total amount of moisture in this entire system remains constant, a balance is required between evapotranspiration and precipitation. The hydrological cycle maintains this balance.

Many factors have an impact on the normal workings of the water cycle. Some of these may be natural but others are man–made.

Natural changes over time affecting hydrological cycle:

The following are the some of the factors:

- **Storm events:**

Storm events lead to an increase in both channel flow and surface runoff. Flood events can occur depending upon the drainage basin.

- **Seasonal changes:**

Seasons with high levels of precipitation lead to increased surface runoff and channel flow. In contrast, drier seasons will lead to reduced river discharge and no runoff. In mountainous regions, increased channel flow and runoff can occur due to ice melt.

- **Ecosystem changes:**

Plant successions may change the dominant type of vegetation in an area. If vegetation dies off due to natural events there will be less absorption of water by plant roots, and less transpiration – which may reduce precipitation.

Human changes over time affecting hydrological cycle: The factors are listed as below:

- **Climate change:**

Increasing global temperature is leading to a reduction in size of mountain glaciers and therefore future dependency on this water will become more of an issue as this input declines after a period of increased discharge. Potential drought conditions and associated economic and social impacts will be likely consequences.

- **Farming practices:**

Particularly in hotter climates, farming can have a significant effect on the water cycle. Irrigation for plants can lower channel levels in rivers together with groundwater levels if wells are the source for the irrigation.

- **Deforestation:**

Removing vegetation for agriculture, urbanization or for fuel supply, an important water store and water-transfer capacity is lost.

- **Land use change:**

Change from natural landscape to urbanized landscape increases impermeable surfaces. This leads to an increase in runoff and a reduction in infiltration.

Human activities are the major cause of climate change. The foremost cause is global warming. Burning fossil fuels, such as coal and oil, has increased the concentration of carbon dioxide. Due to expansion of the greenhouse effect, global warming has risen. As per this phenomenon, gases such as water vapors, carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons in the our atmosphere prevents the heat to leave the earth's atmosphere; resultantly, the ozone layer depletes and the temperature rises. Global warming is the main cause for climate change which may profoundly affect atmospheric water vapor concentrations, clouds, precipitation patterns, and runoff and stream flow patterns.
Based on the above, it is not a myth but a reality that Hydrological Cycle has been disturbed due to climate change.

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

Ans: Ground water Sustainability
Ground water is the availability of underground water 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. 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 (RWH) is the capturing of rain from rooftops, catchments, local streams, seasonal floodwaters, and watershed management to conserve water; to provide drinking water, irrigation water, and groundwater recharge; and to reduce storm water discharges, urban flood, water overloading in sewage treatment plants, and sea water ingress in coastal areas.

The rainwater harvesting is a promising alternative infrastructure in the imminence of increasing water scarcity and escalating demand for water supply. It maximizes water efficiency by capturing it rather than letting it run off. Therefore, rainwater harvesting augments availability of water, self-reliance, and sustainability. It acts as an environmental measure to mitigate floods by reducing urban flood and reduce seawater ingress, sediment transport, or soil erosions to coastal areas.

Water is considered an everlasting free source that can be acquired naturally. Demand for processed supply water is growing higher due to an increasing population. Sustainable use of water could maintain a balance between its demand and supply.

Rainwater harvesting (RWH) is the most traditional and sustainable method, which could be easily used for potable and non-potable purposes both in residential and commercial buildings. This could reduce the pressure on processed supply water which enhances the green living. RWH system offers sufficient amount of water and energy savings through lower consumption.

Q3. What **"Quality Parameters"** should be considered in designing water supply system for a community?

Ans: Safe quality of water supplied to communities is an important consideration in the protection of human health and well-being, it is not the only factor that affects consumers. Access to water is of paramount concern and other factors, such as the population served, the reliability of the supply and the cost to the consumer, must therefore be taken into account.

The provision of an adequate supply of safe water was one of the prime concern of primary health care. The principal risks to human health associated with the consumption of polluted water are microbiological in nature, although the importance of chemical contamination should not be underestimated. Drinking-water should be suitable for human consumption and for all usual domestic purposes.

World Health organization has issued guidelines for drinking-water quality. Subsequently every country has established National Environmental Quality Standards. According to Pakistan NEQS following water quality parameters are taken into consideration for designing water supply system for community:
1- Physical 2- Chemical 3- Biological 4- Radiological.

Microbiological aspects:

Ideally, drinking-water should not contain any microorganisms known to be pathogenic-capable of causing disease-or any bacteria indicative of faecal pollution. To ensure that a drinking-water supply satisfies these guidelines, samples should be examined regularly.

A complementary strategy for securing the microbiological safety of drinking-water supplies has also been advocated by WHO and a number of other agencies, based on the minimum treatment for certain types of water. This helps to ensure the elimination of faecal pathogens by specifying the conditions to be observed and treatments to be applied at the water-treatment plant.
Guideline values for bacteriological quality is given below:

Organisms	Guideline value
All water intended for drinking	
E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Treated water entering the distribution system	
E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system	
E. coli or thermotolerant coliform bacteria	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period.

Disinfection:

Terminal disinfection is essential for surface waters after treatment and for protected groundwater sources when E. coli or thermotolerant (faecal) coliforms are detected. Chlorine in one form or another is the most commonly used disinfectant worldwide. For terminal chlorination, there should be a free chlorine residual of at least 0.5mg/litre after a minimum contact time of 30 minutes at a pH of less than 8.0, as for inactivation of enteric viruses. When chlorine is used as a disinfectant in a piped distribution system, it is desirable to maintain a free chlorine residual of 0.2–0.5mg/litre throughout, to reduce the risk of microbial regrowth and the health risk of recontamination.

High levels of turbidity can protect microorganisms from the effects of disinfection, stimulate the growth of bacteria, and give rise to a significant chlorine demand. Effective disinfection requires that turbidity is less than 5 NTU; ideally, median turbidity should be below 1 NTU.

Chemical aspects:

The great majority of health-related water quality problems are the result of bacteriological or other biological contamination. Nevertheless, a significant number of very serious problems may occur as a result of the chemical contamination of water resources.

Physical and aesthetic aspects:

The chemical and physical quality of water may affect its acceptability to consumers. Turbidity, colour, taste, and odour, whether of natural or other origin, affect consumer perceptions and behaviour. It is therefore wise to be aware of consumer perceptions and to take into account both health-related guidelines and aesthetic criteria when assessing drinking-water supplies.

- Turbidity in excess of 5 NTU (5 JTU) may be noticeable and consequently objectionable to consumers.
- Colour in drinking-water may be due to the presence of organic matter such as humic substances, metals such as iron and manganese, or highly coloured industrial wastes. Drinking-water should ideally be colourless.
- Odour in water is due mainly to the presence of organic substances. Some odours are indicative of increased biological activity, while others may originate from industrial pollution.

The combined perception of substances detected by the senses of taste and smell is often called “taste”. “Taste” problems in drinking-water supplies are often the largest single cause of consumer complaints. Changes in the normal taste of a public water supply may signal changes in the quality of the raw water source or deficiencies in the treatment process.

Water should be free of tastes and odours that would be objectionable to the majority of consumers.