H2 Geography – Essay Model
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Topic: Hydrology
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Describe how water can be stored beneath the ground surface. Explain why the stores and flows of groundwater can vary in time and space within a drainage basin.

The ground is an important store for freshwater that is available for use and consumption to mankind. 30% of all freshwater on Earth is believed to be stored as groundwater and shallow groundwater remains a very important source of water for many settlements. As a result of both water usage by humans and the varying climatic or geology conditions, the stores and flows of groundwater would vary in time and space within a drainage basin.

Water is stored beneath the ground surface at different levels. Closest to the surface would be water that exists as soil moisture when water which hit the ground surface infiltrates into the ground and the regolith, which is a collection of loose particles that have been weathered from the bedrock. The water seeps into the wider pore spaces between these soil particles and thus this top layer holds most moisture per unit space. At the deeper level, water percolates into the join spaces that exists within the bed rocks and saturate any spaces available. The amount of water held in the deep ground is dependent on the permeability of the bedrock material.

Stores and flows of groundwater varies in time within the drainage basin as a result of storms (short moment) and seasonality (longer period). As climatic factors alter the input into the drainage basin via precipitation, the stores and flows of groundwater varies according to these inputs. A sudden storm would provide a huge supply of water to the ground, leading to a recharge of the stores of groundwater and filling it up. The rising water table as a result of this input would raise the local water pressure and increase the groundwater flow into channels or towards other areas of the ground with lower pressure (albeit rather slowly). On the other hand, a dry season, or prolonged deficient in precipitation would deplete the stores of groundwater and thus reduce the groundwater flow within the drainage basin. This depletion could be exacerbated by the presence of human settlements as the dry season meant that they would rely on groundwater stores more intensively (having dried up surface stores).

Spatial variation in stores and flows of groundwater is a natural outcome of the varying geology of the drainage basin in space. As the permeability of the bedrock material determines the capacity of the ground, the parts of the drainage basin dominated by rather impermeable bedrock like shale (an aquiclude) would have lower stores and less groundwater flows relative to the area of the drainage basin with a limestone bedrock (an aquifer). In an area with a mixture of aquifer and aquiclude, the positions of these rocks would impact on the flow of the groundwater. For example, an overlying aquiclude on an aquifer would apply pressure on the water in the aquifer, possibly leading to more rapid groundwater flows.

How may knowledge of the hydrological cycle and its components assist in devising flood prevention measures?

The hydrological cycle is responsible for the circulation of water around the Earth, between the different systems in the planet. The knowledge of the entire cycle and its components, including precipitation, the different flows and stores involved in the cycle, one is able to gain insights into the movement of water and thus devise means to prevent floods.

The key aspect of the hydrological cycle is that of the water input on land, which is precipitation. Understanding the seasonal variations in the inputs would allow us to gain insights into the seasonality of flooding and possibly even the frequency of flooding in a given area. As such, water at dams can be released at appropriate times so that the lakes can subsequently be used to hold back floodwaters when the high intense precipitation sets in. This way, flooding can be prevented.

Precipitation in the form of snow would spend longer time on the land as it flows into channels only when they melt. Knowledge of the volume of water contained in the snow and the time taken for the melting would

help assess if the area has the capacity to hold the water formed from snow melt. Flood can be prevented by attempting to melt some of the snow[1] during the winter time and allowing greater discharge during the season so that when summer comes, the discharge do not increase too much suddenly.

An understanding of the stores available to hold back water before they drain into a channel can be helpful as these components would eventually determine the lag time of the drainage basin. Deforestation removes interception storage and urbanization (which increases the area of concrete pavements, roads and walkways, would remove the soil moisture storage and the catchment area for groundwater store. Both of these activities would result in shortened lag time within the drainage basin. Thus, understanding these features in the hydrologic cycle would allow us to reverse these developments and take actions to prevent flooding that may result because of increased surface run-off due to lack of exposed land area to capture water in the groundwater stores.

Afforestation projects may be undertaken to raise interception storage in barren areas so that precipitation is intercepted and do not reach the channels that quickly. Large urban areas can be planned with more parkland so that there are spaces between covered ground that can accommodate the precipitation and would allow percolation so that groundwater stores are utilized efficiently. This would also provide the opportunities for groundwater recharge. Urban drainage systems can also be designed to allow water to seep into the ground rather than to deliver water efficiently to a central channel. All these measures that are derived from an understanding of the components of the hydrological cycle would help prevent flooding through the increase in lag time of the drainage systems on land.

The understanding of the flows within the hydrologic system would also help devise measures for flood prevention. By studying the discharge patterns of the river in concern, and the flood events, the capacity and pattern of flooding can be worked out. This way, developments of settlements can be guided in a way[2] that avoids the areas more prone to flooding. Assessing flood peaks can also help making decisions on how much flood space to allow when building artificial levees. Artificial flows can also be created through river engineering and knowledge of the flows and behavior of the river can also help determine the potential negative impacts of the river engineering or any chance that the engineering would backfire and worsen flooding downstream.

While this essay has broken down the hydrological cycle into parts where knowledge of certain components of the cycle can be used to devise flood prevention measures, in reality, the entire hydrological cycle must be taken into consideration as the relations between the precipitation, flows and stores are complex and these variables and interdependent. The precipitation would influence the flows and this in turn can change the natural capacity of the rivers. At the same time, the knowledge of infiltration capacity of the area inferred from local geology needs to be combined with knowledge of precipitation patterns to assess the flows in the area and thus work out the necessary measures to prevent flooding.

[1] Effect of this method unknown because I made it up

[2] Not directly addressing the question of flood prevention (this is a mitigation measure)