TOPIC: WATER QUALITY – IMPORTANCE AND REGULATORY SETTINGS

SUB-TOPIC: PART B: WATER TYPES

Supporting Transcript

PRESENTED BY: Sam Addison, The University of Manchester

CONTENT COORDINATOR: Dr. Laura Richards, The University of Manchester (Department of Earth and Environmental Sciences)

This transcript accompanies associated presentation slides and video content developed for the TIDE project in 2021, with acknowledgements and disclaimer as noted in associated files.

Slide 1

Hello, I am Sam Addison and welcome to this lesson on water quality with a specific focus on water types.

Slide 2

In this lesson we will begin with an introduction and talk about the objectives of the lesson. The lesson will have three key sections, these are on the distribution of water, surface and groundwater and finally water type and composition. At the end of the lesson there will be a learning exercise and information for further learning.

Slide 3

This lesson will investigate the distribution of water on Earth, and describe the various types of water. This lesson will build on knowledge learnt in "Water Quality - Importance and Regulatory Settings - Part A: Water quality - definitions and importance".

Slide 4

The objectives of this lesson are to be able to discuss how water is distributed across Earth, to be able to classify different water types and finally, to be able to compare the different types of water.

Slide 5 – Section Break

Slide 6 – water cycle

In Part A of this lesson we discussed what the water cycle is and what it does. A key element of the water cycle is that water is continuously moving through the water cycle and changing form. Therefore, depending on where we find water within the cycle this can have impacts on the properties of the water. Because of this we need to be able to understand the different types of water and what challenges and priorities they bring.

Slide 7

As we have just mentioned that the type of water varies in form across the water cycle. As the water cycle is global it means that the distribution of the Earth's water varies in type.

As can be seen in the figure only 2.5% of the worlds water is freshwater whilst the rest is saline. Of the freshwater 30% is groundwater and 1.2% is surface water. Groundwater and surface water is how humans access drinking water and this will be the focus of the lesson.

Slide 8

Equally whilst the type of water varies across Earth the distribution of the freshwater also is unevenly distributed. This is because variations around the globe such as the geography and geology controls how the water cycle functions over regions and countries around the world and so changes the distribution of the freshwater within the water cycle.

Because of this, it means that the distribution of fresh water is not distributed across the planet evenly and instead different countries possess more freshwater than other. This is exemplified by the fact that fewer than 10 countries possess 60 % of the worlds available freshwater supply.

The freshwater that these countries have is because they have large supplies of either groundwater or surface water. However, importantly even these sources vary significantly over entire countries. India and USA for example whilst being part of the 9 countries with 60% of global fresh water, actually have many areas within their countries with water scarcity issues, whilst other areas have water surplus.

Slide 9 – Section break

Slide 10 – Surface water

So what do we mean by surface water? Well, surface water is any water that collects on ground level and is produced from precipitation. The collection of water leads to surface water bodies such as lakes, river, streams, oceans and wet lands. These bodies of water are created and supplied by water from precipitation directly into the body of water itself, or from water run off into the body of water.

Slide 11

Groundwater on the other hand is water beneath the surface of the ground. The bodies of water are called aquifers, where the rock is saturated with water. This water underground may occur close to the land surface, as in a marsh, or it may lie many hundreds of feet below the surface. Water at very shallow depths might be just a few hours old; at moderate depth, it may be 100 years old; and at great depth or after having flowed long distances from places of entry, the water may have been in the ground for several thousand years. Groundwater supplies are replenished, or recharged, by rain and snow melt that seeps down into the cracks and crevices beneath the land's surface.

Slide 12

Although ground water and surface water are usually evaluated as separate water masses, they are connected by the ground-water/surface-water transition zone and are not discrete entities. These interactions are difficult to observe and measure and so groundwater and surface water can be difficult to differentiate. There are many ways in which surface water and ground water interact and this is often controlled by the environment in which the transition zone is within. If in a mountainous region then groundwater and surface water would interact in the valleys as seen in the image, where as the function of their interaction would change if the environment was on the coast, in glacial terrains or in river settings.

This interaction is caused as water goes underground from when it rains water runs over the surface into rivers and lakes and eventually back to the ocean, or it can travel through the soil to the groundwater and flows underground. The water travels downward because of gravity. It will move down through the spaces between soil or sand grains in the surface soil and keep going through the unsaturated zone until it reaches the water table. The water table is the top of the “saturated zone”: the saturated zone being the place where all of the spaces between the sand grains are filled with

water. The water is stopped from continuing down to the centre of the earth by a layer of rock or clay that it can't travel through. The column of water on top of the impermeable layer travels slowly downhill toward a low point. It may be released as a spring, seep into a lake or river, travel to the ocean underground.

Slide 13 – Section break

Slide 14

The different water types can have very different general properties such as chemical composition. An example of this is the difference in rainwater, seawater, river water and groundwaters, in respect to their concentrations of total dissolved solids. Looking at total dissolved solids, the average values for rainwater are : 7mg l^{-1}, whilst it is much higher for river at with an average of 118mg l^{-1} and even higher in seawater with 34 400 mg l^{-1}, whilst total dissolved solids values for groundwater vary too much for an average to be meaningful. TDS highlights how significantly these different water types can be from each other, and can be a good indicator of water quality.

River water and groundwater differ from rainwater in that both have greater TDS values and different relative proportions of dissolved substances. Rivers may also contain solid particles in suspension, in addition to dissolved substances. Groundwater usually has a low content of suspended solids because these are filtered out as the water passes through the ground. Organic processes in soils, the solution of soluble minerals in rocks, interaction with clays and other minerals, and the chemical weathering of rocks are responsible for the changes in composition as rainwater becomes surface water or groundwater.

Slide 15

As generally surface water and groundwater have a key difference in that one is above ground whilst the other is underground it means that they differ in some key processes and this leads to differences in their composition as mentioned with differences in total dissolved solids.

This difference also means that typically groundwater usually has a low content of suspended solids because these are filtered out as the water passes through the ground, whilst for surface waters they do not have the filter that groundwater has.

Slide 16

But, whilst the different water types can have very different compositions, the clear distinction between water types is not realistic. In nature often groundwaters and surface waters can be very similar and where they interact as alluded to earlier it can be difficult to distinguish between them. As highlighted when discussing the total dissolved solids, whilst averages for sea water and rainwater can be discussed, because groundwater TDS can vary so significantly an average is not meaningful. This highlights how difficult it is to clearly define and distinguish surface and groundwaters.

The reason as to why the composition of groundwater can vary so much is dependant on the aquifer storing the groundwater. Aquifers can be unconfined or confined, where confined aquifers are those capped by impermeable rock whilst unconfined will be capped by permeable rock. This distinction changes the accessibility of contaminants getting into the aquifer. A confined aquifer often have an unconfined part where the major part of natural recharge takes place. Alternatively, the recharge takes place by leakage from adjacent aquifers through a confining or semi confining layer. The changes in aquifers means that groundwater can vary significantly in how connected it is to surface water and therefore how similar it is to surface water. And because of the interchange of water between these

two components of the hydrologic system, development or contamination of one commonly affects the other.

The changing nature of groundwater in similarity to surface water can be highlighted by TDS. Generally, near the recharge area, groundwater has low TDS values, but as the water flows through the aquifer it gains more dissolved substances, so the TDS values are usually higher at discharge points.

Slide 17

Contamination is the topic of an entire lesson series within this course, however, we will briefly just think about contamination in the context of what has been discussed in this lesson.

It is important to think about how the processes that control the composition of water in different water types as discussed in this lesson, will ultimately also lead to similar impacts on the contamination of the different water types.

Slide 18 – Section Break

Slide 19

The key points to take from this lesson are that firstly distribution of water on Earth is not even. Secondly, ground water and surface water have different key properties, which will impact their composition differently. And lastly, groundwater and surface water can often interact however, which adds to the difficulty of understanding their properties.

Slide 20 – Section Break

Slide 21

For the learning exercise for this lesson, it is to think about the water that you may use for example for drinking or cooking with. Where does the water come from? Is it from a groundwater source or surface water? Think about how your water source may link to the water cycle and other processes talked about in this lesson.

Slide 22 – Section Break

Slide 23

The slide shows where the information talked about in this lesson is sourced.

Slide 24

Thank you for taking part in this lesson and hope you enjoyed learning about water quality and different water types.