TOPIC: WATER REMEDIATION APPROACHES FOR DRINKING WATER SUPPLIES

SUB-TOPIC:
PART A: SOURCES OF DRINKING WATER AND THE APPROACHES USED TO REMEDIATE DRINKING WATER SUPPLIES

Supporting Transcript

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SLIDE 1

In this lesson we will cover a mini-series on water remediation approaches for drinking water supplies. In this lecture we'll be thinking about different sources of drinking water supplies and some of the approaches that can be used to remediate drinking water supplies

SLIDE 2

Firstly we'll be talking about the different sources and types of drinking water, before going over the different approaches we can use for drinking water supplies.

SLIDE 3

As I'm sure you are all aware, the world has an increasing population, and these extra people drive demand for resources, which this includes drinking water. Global warming has a profound effect on drinking water availability and can lead to extra stresses, for example through melting of glaciers which would otherwise provide seasonal meltwater to rivers like the Ganges. And the WHO estimates that around 30% of the world's population do not have access to a safely-managed drinking water service, which is defined as one which is accessible in the premises and free from contamination. And so following analysis of drinking water to find out if and what contamination it contains, drinking water remediation provides a way of increasing clean drinking water supply.

SLIDE 4

By the end of this lecture you should be able to explain the different main types and sources of drinking water, and be familiar with some of the different approaches to water remediation.

SLIDE 6

There are three main sources of drinking water. Perhaps the most accessible of the three is surface water, as we can tap this from lakes, rivers and streams. Since surface water is prone to evaporation, its availability can vary depending on the time of year and can be severely reduced in the hotter months of a year. We can also generally get a higher microbial contamination of surface water as compared to groundwater or rainwater, which can necessitate some form of treatment in order for it to become potable.

When safe or reliable surface water supplies aren't available, groundwater can provide many with drinking water and in fact 71% of Myanmar's population use groundwater for drinking. Using groundwater requires pumping, which often can become contaminated with natural or anthropogenic contaminants.

Rainwater is perhaps the least likely to suffer contamination, although this can still occur when rain reacts with particles in the atmosphere and can also become contaminated when it is stored. It is very dependent on the location and the season, and storage conditions are very important for water safety.

SLIDE 7

These show some of the ways in which rainwater can be collected in Myanmar – they can be a vital source of water for households and small communities. Here we have two types of common rainwater harvesting tanks, the one on the left is a community system supported by aid organizations; the tank on the right is a typical household systems that might be encountered in Myanmar. It must be stressed that the proper rainwater storage is very important to avoid contamination.

SLIDE 8

Here we have an example of a shallow dug well in Myanmar, and on the right we also have a tube well, which typically reach to deeper depths than dug wells. Tube wells commonly consist of PVC plastic tubing with screening at the bottom which strain out water from sand. Water is then pumped to the surface using a hand pump or motorized pump. It's important to consider that although groundwater is typically low in microbes, groundwater chemical contaminants can be present in dug wells or tube wells and can be very dangerous even though they cannot be seen, tasted or smelled.

SLIDE 9

And now that we've looked at the types of drinking water available, let's look at how the quality of this can be improved.

SLIDE 10

Drinking water remediation may include a number of processes which can be used to improve the quality of the water. These will either aim to either improve the chemical quality, which can be contaminants like heavy metals, salts or pesticides, improving the microbial quality, by removing bacteria and viruses or by improving the taste, smell or colour to make it more aesthetically appealing.

SLIDE 11
Let's talk about some types of processes that are involved when we treat the drinking water. I'll just briefly cover each before discussing some of them in more detail Each approach may be most suitable to a purpose or different type of geochemical setting. Generally, a relatively simple solution, is to switch the source of the drinking water to something less contaminated than the one before, such as lower arsenic groundwater. Although not a chemical process, we can still class this as a form of remediation.

Precipitation is used to drive a chemical towards an insoluble form and settle out of the solution. This is especially used for solutes like iron and manganese, which become insoluble in certain forms at certain conditions, but also can be used for arsenic reduction by co-precipitation.

We can use adsorbents including activated alumina to remove some contaminants from the water. These may bind chemically in different ways and this could be something like ionic bonding or chelation, where the adsorbent immobilises the contaminant onto its surface. Either way, the ongoing monitoring and evaluation of the adsorbent is very important as the binding sites can become full or so the adsorbent may need to be replaced periodically.

There's membrane filtration, where the solution is passed through some sort of filter, separating the contaminants from the water by differences in size or charge mechanisms as they pass through some sort of membrane filter.

Oxidation can be used to chemically oxidise the contamination so that it is no longer harmful or becomes less mobile. This can, in some cases, be performed in situ.

And the last one listed is bioremediation, which can take similar form to adsorption or oxidation, with the difference here that a biological substance is being used, such as a biosorbents used to sorb heavy metals.

SLIDE 12

Let's talk more about some of these individually. So as we said, it's often very easy to just find another source of drinking water, for example some studies on arsenic in groundwater have painted wells red to indicate that they are unsafe, and green for safe, which means people can choose their water source accordingly. But by switching water source, sometimes there are trade-offs in quality, reliability or costs between different types of water. And it's sometimes claimed that the deeper you extract your water from, the safer it becomes. In fact, this isn't always the case and sometimes chemicals or surface derived contaminants can transport to deeper groundwater supplies. Testing water quality is the best way to know if a particular source is safe.

SLIDE 13

Without going too much into the selection of the remediation strategies, which we'll do next time, it's important to consider the scale of the remediation that we are talking about, at this point. And we can divide these into three groups, household or small community supply, which may be appropriate to treat water for only a few households, then for larger communities and for municipal supplies, where municipal means the water becomes part of the public supply system in areas where centralized systems exist. But although the scales of remediation are completely different, the underlying processes are often the same, and broadly fit into the categories that we have discussed.

SLIDE 14

So let's talk about some advantages of using precipitation and adsorption as forms of remediation. Precipitation involves a process by which dissolved species change into insoluble solid phase particulates through either coagulation, aeration-filtration and lime softening and often relies on co-precipitation of metal hydroxides. The advantages of using precipitation as a form of remediation are that it is a relatively low cost and simple method, where the chemicals used are widely available. It is generally effective across a range of raw water quality and the designs of such systems are well established. There are many disadvantages also. Since precipitation relies on creating conditions to take things out of solution, a sludge is inevitably produced, which needs to be managed, treated or disposed of carefully. The process may also be difficult to optimize and there may be poor removal of some contaminants.

SLIDE 15

Now adsorption is commonly used for the removal of heavy metals from a solution. It's a relatively simple process and the adsorbent can be produced relatively easily, the top right image shows some alginate beads being made, and which are being used to adsorb heavy metals found in mine drainage. There are lots of different forms of adsorbents available and a lot of these are natural and low cost. This is perhaps the most commonly used remediation strategy as a result. The disadvantages are that this can vary in effectiveness, especially across different target contaminants. The process can require frequent maintenance and also requires that the adsorbent is either replaced periodically, or that some form of desorption occurs so that the adsorbent is replenished. The results of such methods can often be very unpredictable as well, particularly as there can be lots of different chemicals and reaction pathways going on.

SLIDE 17

In summary, whether rainwater, surface water and groundwater is used as drinking water much depends on the context and what is available to a community. In general, the aims of drinking water remediation are to improve the chemical or microbial quality, in addition to the smell, taste colour of the water. And finally, there are many forms of water quality remediation and these take different scales, each with advantages and disadvantages.

SLIDE 19

For the learning exercise, number one, I'd like you to explain why one community may use primarily rainwater as their drinking water supply, whilst another may use mainly tube wells to source theirs
Secondly, I'd like you to think how the remediation systems designed for different scales may be different? Think about how scaling up a process from domestic use to a system designed for a large community will change the process, not just in terms of the size.

SLIDE 21

Here is a list of the references used for the slides.

SLIDE 22

And an open access paper on in-situ biological water treatment remediation options, if you are interested

SLIDE 23

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