Water Supply Engineering
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Lecture 22
Water Quality and Water Pollutants

Hello Friends, Welcome back! We are in the 5th week of course of Water Supply Engineering. From this week to next 2 to 3 weeks we will talk about water quality and its treatment. This particular week we will be focusing more about basics of water quality, and what is the philosophy of water treatment particularly for the urban water supply system and then subsequently in later couple of weeks later we will talk about more advanced treatment or procedures.

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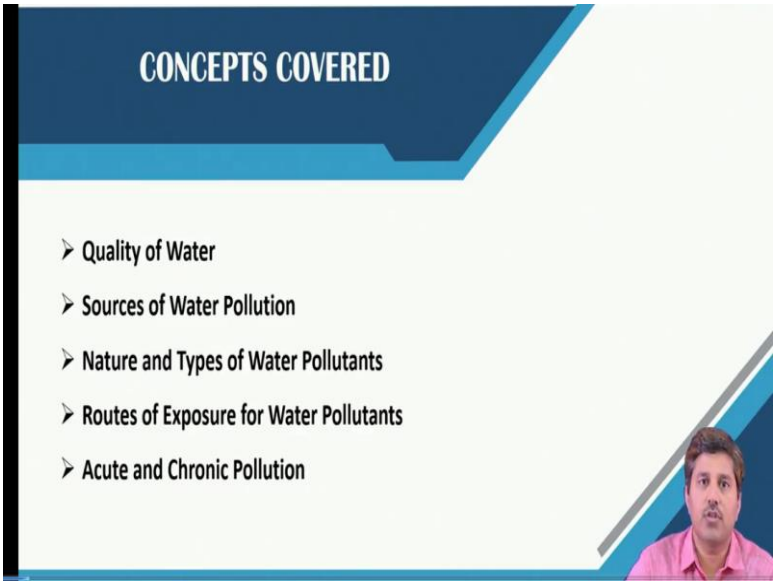

So, in this class we will be discussing on water quality and water pollutant and what we are going to cover is about the quality of water and then how water quality varies as per source, and what are the various sources of water pollution, then we will be talking about nature and types of water pollutants and what are the routes of exposure to water pollutants and acute and chronic pollution effects which we will cover in this particular lecture.

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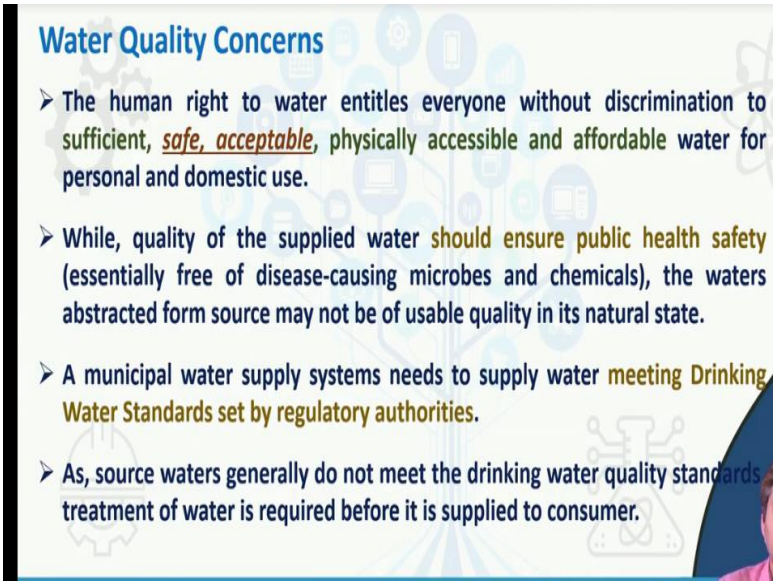

To begin with as discussed earlier also lets get back again to the basic right to water as been adopted by United Nations. So, this human right to water entities everyone without discrimination to sufficient, safe, acceptable, physically accessible and affordable water. So, there are 5 aspects which need to be satisfied. The water should be made available in sufficient quantity, in the safe condition, in the acceptable condition.

It should be physically accessible and it should be economically affordable. So,–we did discuss about quantity aspects of water availability how we estimate the demand which is more so about the adequate in terms of the quantity or the sufficientness of, water. Now, what we are going to discuss about the other two aspects which is safe and acceptable. Both of these are in some way or the other related to quality of water. Safe, essentially means safe, it should be safe to consume so it should not contain any such substance which can impart any harm or any toxicity to the consumer so that is the safe.

There should not be toxic chemicals, there should not be microbial which lead to some disease like water borne disease. Water should be safe from pollutants which can have adverse effects on the consumer, and it should be acceptable which the water is given to us, may be chemically or biologically safe but if it is a coloured water or apparently visible having turbidity or sediments are not considered and acceptable for drinking purpose. Some does not like to drink water which has certain colour.

The colour might be perfectly safe. We do use a lot of food colours which are safe for consumers but if somebody asked for a glass of water and it has certain colour, the person immediately takes care to drink it. You can drink coloured juice or soft drinks but when it comes to drink plain water, its natural condition is more or less colourless. Therefore, acceptability is safe and accept is more or less to the quality of water which will be discussing in this week.

While quantity of supplied water should ensure the quality of supplied water should ensure the public health safety means essentially disease causing from microbial and chemicals. The water accepted from the source may not be usable quality directly. Water which we have in a lakes, river, these days are not of that quality which can be drinked directly. In order to make this water suitable or good enough for the consumption.

We need to improvise its quality which is usually done by providing treatment. Further, the objective of municipal water supply system is typically to provide water which meets the drinking water standards which are set up by the different regulatory authorities. Like, in India we have BIS bureau of Indian Standards. Drinking water standards and water supplied should ideally meet those standards.

Similarly, there are different standards for different nations and international standards also which we will discuss later classes of this week. As source water generally does not meet the drinking water quality standards, we need treatment of water for making it good or improvising it to meet drinking water quality standards before it is supplied to the consumer.

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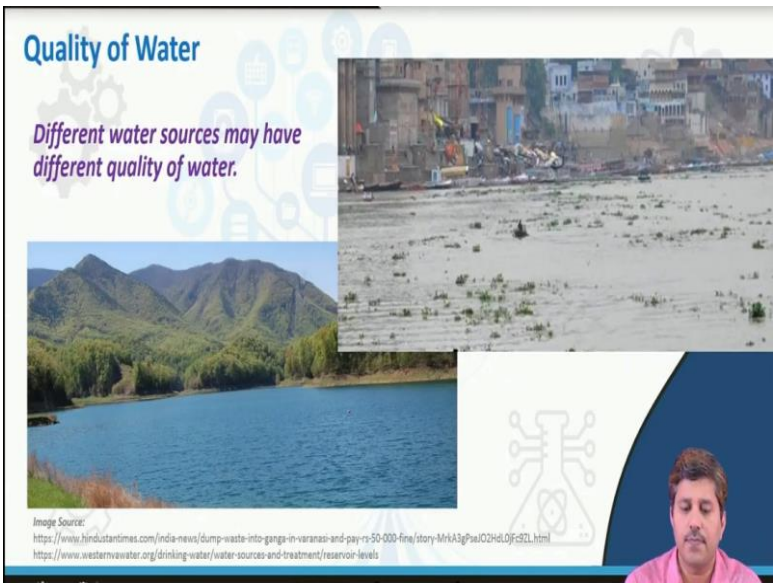

Now, when we talk about the quality of water, we see here a couple of water bodies. One looks pretty clean and the other looks pretty dirty. Apparently viewing these, one can say the dirty water body has some problem than the other which is clean. Ideally by viewing the images above, one can say that the qualities of water in these two sources are different.

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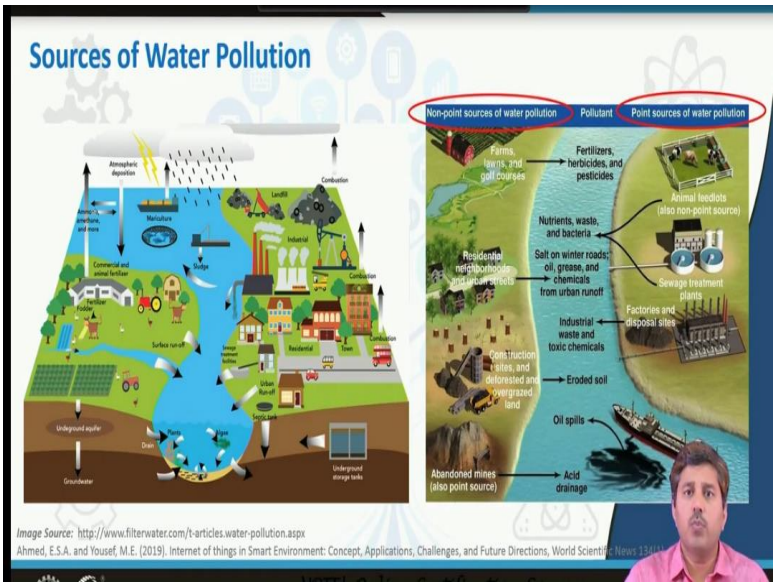

Similarly, different water sources may have different quality of water. It is just two surface sources but if you take two different groundwater sources, you do not expect the same quality of water lying in these sources. We actually may be dealing with different quality of water when we tap different sources. And many times the pollutants are strictly different when we tap different sources.

The pollutants available in ground water may totally be different to that available in the surface waters. Surface waters are more likely to have more sediments and ground water may have other types of chemicals like geogenic contaminants, various heavy metals like arsenic, fluoride etc. are more popular in ground water contaminants. Depending on the source of water may have a different characteristic of water.

Now, when we talk about the improvement of water quality we are essentially talking of removal of pollutants from water. Pollutants come in water through various sources of water. Pollution originally from water and these sources are broadly classified into the point sources and nonpoint sources. Nonpoint sources of pollution essentially mean the pollutant entering into the water is not the point at which pollutant enters is not fixed.

Basically, it is diffused or dispersed source like in Agriculture run off, when the field is irrigated we see several small grains or patches from where water leaks through and may go into the river or urban runoff, atmospheric deposition along with rain, the pollutants get deposited and they do not come at one specific point, Rather they are dispersed and distributed over areas. These types of sources are called nonpoint sources of pollution.

The point sources of pollution are the one which are more specific and are introduced at one particular point. Like in industries, water discharges from all the process and comes to a final point where industry releases its waste water or effluent. So the release point or effluent is faced which is called a point source. Similarly severe lines connect with the sewage of the entire city and bringing it to a treatment facility either fully or partially, treated sewage is again being released to a river or lake water bodies.

When it is released from sewage treatment facility or STP is released at one single point. The discharge of STP is a point source. If seen in above image the oil spill is coming from oil tanker is actually a point source specifically being released at one point. These are the some of the examples point sources and as discussed there are many point sources. There are in fact varieties of point sources as well as nonpoint sources which may contribute the various types of pollutants to the water.

We can get pollutants coming from agricultural, industrial, municipal, natural sources and nature and characteristic of pollutants also vary substantially.

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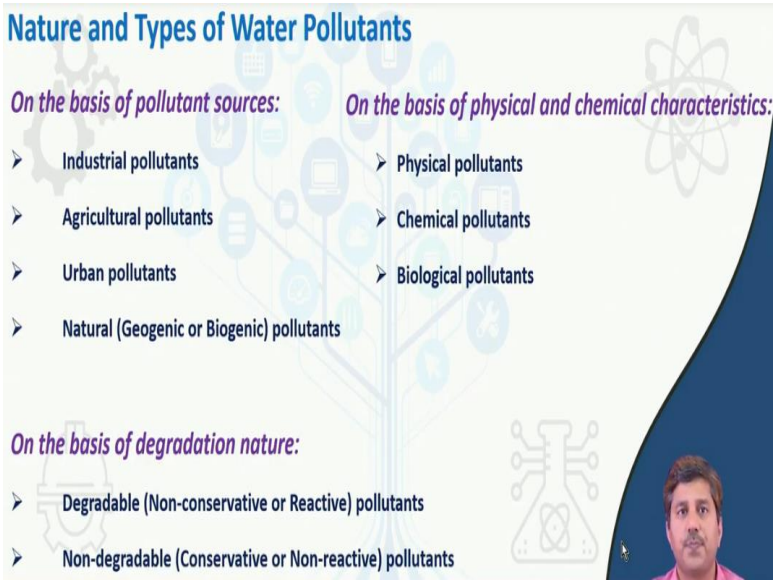

If we see the nature and types of pollutants, we can classify or categorize them on the basis of different aspects. If categorized on the basis of a source we can have industrial pollutants. Industrial pollutants are the one being released from industries mostly the chemicals. There are varieties of chemicals used in industry during their process and in manufacturing and these chemicals are released back into the environment and water bodies leading to a lot of industrial pollutants in water.

Our major rivers are all susceptible to these pollutants like, there are several places where the industrial effluent goes into the river Ganga. The tanneries or leather industries at downstream to Kanpur release its waste in the river Ganga but while the water reaches to Allahabad or Prayag, the water is obstructed at Prayag for domestic or municipal supply purpose.

The release of contaminants downstream to Kanpur may travel to the point of obstructed water of industrial contaminants present in water which is being obstructed to the municipal supply. This way the industrial pollutants may come into water which is treated and supplied and if the treatment is not adequate they may actually end up going to the consumer's tap and eventually entering into the food chain of the consumers.

The risk is always there; the industrial pollutants are mostly chemicals and could be actually variety of chemicals depending on the process of the industries. If talking about textiles, there are a lot of dye, phenols, etc. In distilleries there are sugar, fatty acids, tannin, etc. Leather industries release compounds like chromium based compounds may release very high COD; there are varieties of chemicals which come in the form of industrial pollutants.

Similarly, the agriculture pollutants, these are predominantly chemicals like fertilizer, pesticides when applied to agricultural field after event of rainfall or excessive irrigation these may find a way to the water bodies or may in fact reach the ground water like water pumps come into water. In this way agricultural pollutants are also toxic chemicals like pesticides or nutrient rich water like nitrogen and phosphorus compounds.

Agricultural pollutants also could be sand silts or sediments which wash out from sand which may add a lot of suspended silts as well. In Urban pollutants, the sewage that we release from our households so some of we release lot of pollutants, some are treated in STP and some are not and eventually finds their way.

There are natural pollutants which are very difficult to control like geogenic or biogenic pollutants and quite a few of ground water contaminants including various heavy metals like iron, arsenic, fluoride, nitrate, some radioactive compounds as well may come from the natural sources. These natural sources like biogenic and geogenic are introduced by natural processes.

Based on these sources we may have variety of pollutants, and it is not one pollutant will be exclusive in one category so in an example **(speech not clear 16:17)** which may be used in the agricultural field or household. These may come under agricultural pollutants with the same compound and composition of the chemical may also come in urban pollutants and also may come in industrial pollutants because it is being eventually produced in industries.

The waste released by the industries produce pesticides will have pesticides in industrial pollutants and when those pesticides applied on the agricultural field, agricultural runoff pesticides will have in agricultural pollutants and the same compound or some of its fraction

may be used in some urban set ups as well for gardening, for pest repellent in households then it comes in urban pollutant as well.

This way we can have different types of pollutants from where they come into water as the source in a pollutant. Similarly, we can have different class of pollutants in their physical and chemical properties. There may be physical properties generally which has the physical attribute like colour, sediments. These kinds of pollutants which have physical attributes are essentially physical attribute pollutants.

Chemical pollutants are the chemicals present in water and biological pollutants are the microbial pollutants present like virus, bacteria, fungi (**speech not clear 18:03**) come in the class of biological pollutants. Chemical pollutants are variety of organic and inorganic chemicals which may be present in water. As said there are also physical pollutants in the form of sediments, turbidity, etc. The pollutants may be classified based on their nature of degradation.

More so over, particularly the chemical pollutants may be degradable or non degradable in nature. The degradable natures of the pollutant are the one which gets decomposed in the natural systems by virtue of chemical or biochemical reaction. In organic matter like sugar, sucrose, glucose are present in water and if left for some period, the microbes present in water will decompose or degrade or such compounds may take part of chemical decomposition through hydrolysis or photo oxidation and gets degraded in water.

These compounds are called degradable pollutants because they get degraded or decomposed in the water. Majority of the organic matter are of this nature. These are also known as non conservative pollutant because they cannot conserve their mass so they get decomposed into smaller products. If a compound A gets converted to B or C or other smaller by products, the compound A will not remain as in water.

It is not able to conserve its mass. We may have a chain or pathway. When monitored on A, at anytime T = 0 monitored some concentration A0 but as the time progresses the concentration keeps on decreasing which means the compound A is not able to conserve its

mass so it is called non conservative pollutant or degradable pollutant because it gets degraded when composed in the medium.

These pollutants are also called reactive pollutants because they take part in the reaction and as a result it gets decomposed. Whereas opposite is the non degradable pollutants which are also known as conservative or non reactive pollutant. Non reactive will not take part in these chemical reactions. If A does not take any part then it remains as A, thus conserving its entire mass so they are called conservative pollutant or non degradable pollutant because they do not get degraded in the medium.

If pollutant which comes in water medium and gets decomposed and the decomposition could be to the complete scale of mineralization. Generally organic matters are made up of CHONP, but CHO are the main constituents. After complete mineralization they get into the products like CO_2, H_20 or N_2. Eventually, this is not contaminated and this escapes into atmosphere thereby not getting any toxic effect more or less out of the products except release of CO_2 which is a green house gas.

But water has become more or less free from CHONP compounds. This kind of compounds gets easily degraded in water are not a major threat as a water pollutant because they get decomposed or degraded in the system although the time may be high or low. This needs to explore in more detail on the time taken to degrade. While the conservative pollutants are of more threat because if there is arsenic, iron or certain pesticides present in water taking part in any reaction in water.

These remains in the water further may converting into forms of metals or elements but metals like arsenic, iron will remain in water until and unless it is removed by some other mechanism because natural decomposition reactions will not remove compounds. If there is antibiotic or pesticides which are not possible to get degraded by the microorganisms, it may remain in the system or much larger period.

Because it does not react with anything as it is a non reactive or non – degradable compound and conserves its mass causing major threat as it is difficult to remove these compounds in

water. And more so over natural products does not work on removal and need to be relied upon alternate systems. In this way pollutants can be classified into different aspects.

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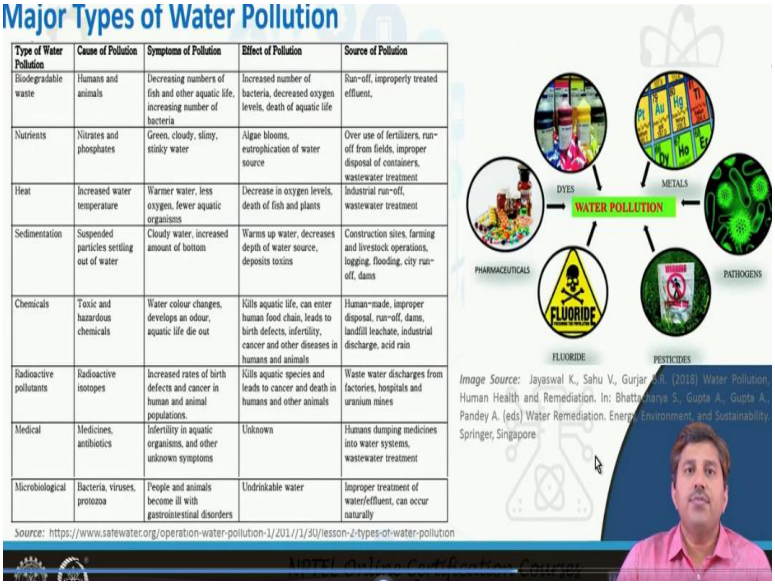

If you see the major types of water pollution, the most common water pollution is pharmaceuticals, fluoride, pesticides, pathogens, metals, dyes which may be present in water. If classified the pollutants list, we have biodegradable waste which sources will be run off, improperly treated effluent. And the symptoms would be of increase in bacteria and decrease in the growth of aquatic life.

There are nutrients which have nitrates and phosphates, heat which increase water temperature, sedimentation related to suspended particles, chemicals which are toxic and hazardous coming from sources of industries, radioactive pollutants coming from hospitals, industries, factories or geogenic sources adding radio isotopes to the system. From medical sources medicines, antibiotics and microbiologically are bacteria, virus, protozoa from different sources. In this way can have differentiated classes of water.

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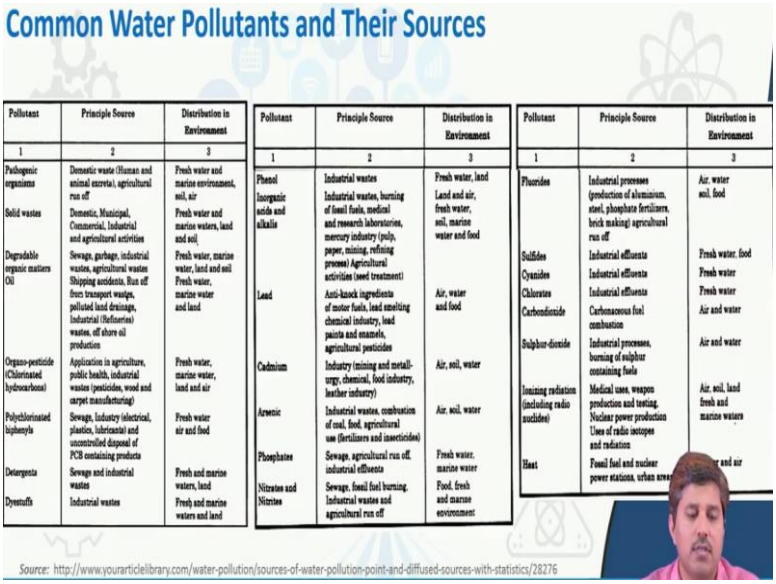

This is another list of common water pollutants and their sources. There are pathogenic organisms, solid waste, degradable organic matter Organ pesticides (chlorinated hydrocarbon), biphenyls, detergent, dyestuff, phenol, inorganic acid, lead, cadmium, phosphates, arsenic are the different kinds of waste coming into water from different kinds of source and distribution that come in the environment particularly water environment.

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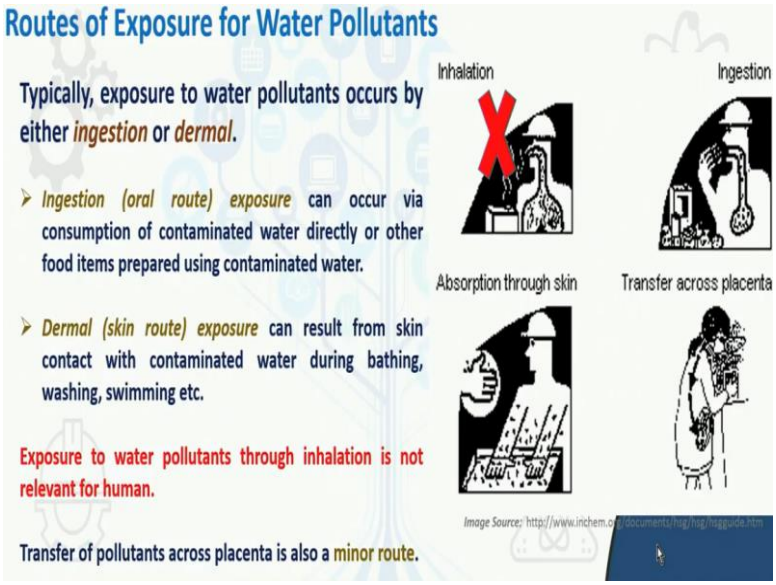

Once these pollutants are released in water they enter in our food chain affecting human by certain routes of exposure. The common routes of exposure to the environmental pollutants are inhalation, injection, dermal route. These are the 3 major routes basically from which we get exposed to the pollutants. There is another route of a pollutant which is transferred across the placenta where woman transfers these pollutants to babies while giving birth acquiring certain kind of pollutants but this is a minor route.

The major route through which one gets exposed is inhalation, injection and dermal. Now, inhalation is important for air pollutants because we do not inhale water. Inhalation is the important route for aquatic animals for water pollution because they inhale water. It has basically some value to them but for humans this route will not apply for water pollutants but prevalent for air pollutants.

The injection and dermal route are the major route which gets exposed to the pollutants. It is typically either injection or dermal. Injection or oral route is basically effective when it is consumed contaminated water directly or prepared through food items using contaminated water. The contaminants enter through our food chain while the dermal or skin route which result skin contact with contaminated water during bathing, washing or swimming

leads to the exposure of these contaminants. Whereas inhalation route is not relevant and transfer of the placenta are of a minor route.

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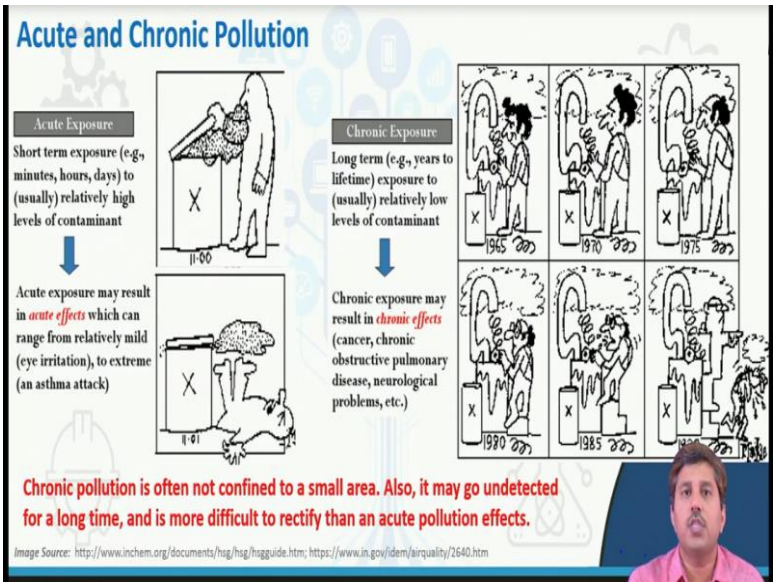

Once we get exposed to these pollutants, they may have different kinds of effect on us and two major classes of effects are based on two types of exposure which are acute and chronic. Acute exposure is of a short time relatively high level of a contaminant. When exposed to high level of a contaminant for a short period resulting into the symptoms arising in quick time happening in a few days are considered to be acute exposure or effect.

This can be exposed to any time of a contaminant in a much shorter period. For ex: drinking water of 3 to 4 days old or having some microbial growth contained with pathogens and if consumed will lead to fever, dysentery, etc. Majority, the epidemic or water borne diseases are the examples of acute effect as one gets exposed to contaminated water will effect severe in shorter span of time whereas chronic effects are generally the result of long term exposure of relatively low level of contaminants.

For ex: there are issues related to ground water like fluoride, arsenic, various antibiotics or pesticides present in water which are not treated properly and are consumed by humans. If there is a high content of fluoride of 2 to 3mg/L whereas the prescribed limit of fluoride is 1 to 1.5 mg/L. If consumed high fluoride or pesticides containing high ppm which is not permitted. And drinking immediately will not fall sick as people are been consuming from years together which is of kind smoking a cigarette.

As smoking is injurious to health but does not matter when consumed a single cigarette and will not fall sickly. It takes time for years might require 10 – 20 years apparently to show some effect. Same is with the water pollutants. Drinking fluoride, arsenic or pesticides contaminated water on regular basis for a period of 5 to 20 years, apparently it gets slowly accumulated in the body and reaches the level where it damages organs leading to cancerous effect.

So the chronic effects will not be noticed immediately, takes long time to detect these chronic effects because the nature of the effect could be cancer, obstructive pulmonary disease, neurological problems. Nature has serious effects. It is hard to rectify and difficult to treat and reverse those effects. As a result leads to more serious effects than the acute pollution effects generally and other features are not often confined to the small area

Because chronic pollutants are such that suppose pesticides or arsenic available in ground water and countries like Bangladesh are consumed and get effected in early stage about 5 to 10 years depending upon the susceptibility to affecting to human beings. Therefore, a large population is at risk with these pollutants because they are not often confined to the small area and may go undetected for a longer period.

People do not know that they do have certain effects to chronic exposure. For ex: if a person drinks contaminated water since 1965, in the year 1980 has started showing minor effects and when he reaches to 1990 he is on bed and is hard to reverse. In this way the chronic exposure is far more serious but very difficult to detect and control. Whereas acute exposures are easy to detect and treat as they occur for a short span of time.

If the dosage of acute exposure consumption is high, like of high level of pesticides becomes a poison which is hard to reverse. Otherwise, many of the acute exposures such as water borne diseases which are contaminated water like dysentery is cured. This can be detected and managed but chronic exposures are very difficult to detect and treat. These are some of the ways which we get exposed and kinds of effect that have on us.

That’s all for this class and for the next class we will discuss on assessment of water quality and its parameters and its significance in terms of contamination of water.

Thank You.