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Popular Article

Physical, Chemical and Microbial examination of water

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Introduction

The impact of seasonal change on water quality has been extensively documented and has attracted widespread attention in recent years. Seasonal changes like rising temperatures reduce dissolved oxygen levels in surface water. Scanty rainfall leads to less dilution of pollutants whereas frequent heavy spells of rainfall produce more pollution and sedimentation in river due to surface run off. Additionally, anthropogenic and animal activities affect water quality. Furthermore, the geology of the area, the soil condition, and contamination through seepage also contribute to alterations in the quality and availability of water.

The Indian climate is strongly influenced by the monsoon and is accordingly divided into four seasons, namely, summer or pre-monsoon (March to May), south west monsoon (June to September), post-monsoon (October and November), and winter (December to February). The rainfall over India has both large spatial and temporal variability. Rainfall during the south west monsoon ranges from 500 mm to 3200 mm. The temperature also varies significantly in different seasons ranging from a mean of 10 ºC to 32 ºC. India, in particular, is very vulnerable to extreme events, as is evident from recent occurrences of droughts and floods in the country, and its impact on water resources is likely to be more pronounced in the near future.

The Indian riverine system is strongly influenced by seasonal variations which directly affect its water quality due to fluctuations in its physicochemical properties like total dissolved solids, total suspended solids, salinity, and dissolved oxygen. A lean river flow especially during summer results in alterations in the ecological niche of aquatic organisms, flora and fauna, and

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self-purification capacity of the river.

In India, rivers are sources of raw water for industries and irrigation as well as drinking water for urban and rural areas. Ground water is another source of drinking water. However, many Indian states are water stressed regions. The major reasons for this are water pollution and over exploitation of ground water which ultimately affects water quality.

Anthropogenic activities, namely, discharges of domestic waste, untreated waste from sewage treatment plants, plastic materials, disposal of personal care products and household chemicals, improper disposal of car batteries, construction activities, mining activities, and pilgrim activities are deteriorating the water quality of rivers. Various agricultural, industrial, and mining activities contaminate ground water. These activities alter pH of water, increases turbidity of water, and raise the content of total dissolved solids and metals.

Maharashtra is one of the industrialized states of India which contributes towards social and economic growth of the country. Large parts of the state fall in the rain shadow and hence face water supply and quality challenges. Over 85% of drinking water supply in the state is dependent on ground water. Shallow ground water sources like open wells are prone to bacterial contamination. In order to reduce bacterial contamination of open wells, a well-established chlorination regime with availability of bleaching powder at Gram Panchayat (GP) level and regular treatment of water sources is essential. A local authority GP and Village Water Man are responsible for regular chlorination of open wells.

Pune, with a geographical area of 15,642 sq km, is the second largest district in the state and accounts for 5.08% of the total area. A large part of Pune district falls in the rain shadow zone and nearly 50% of the area is classified as drought areas. Like Pune district, drought prone areas are also present in many parts of Satara district.

The poor drinking water quality is a major cause of water borne diseases especially diarrhea which results in a large health burden for India. To address drinking water quality issues the National Water Policy (NWP) 1987 was updated in 2002 and later in 2012 by the Government of India. Adaptation to climate change has been considered in NWP 2012 through which planning and management of water resources and structures is being undertaken to cope with future climate change.

Water quality can be assessed by measuring different physical, chemical, and bacteriological parameters. To be able to compare multiple parameters between water samples/sources a mathematical model is used to express the water quality in a single value as

Water Quality Index (WQI). Seasonal analysis for water quality using different types of WQIs has been undertaken worldwide. However, selection of parameters for the WQIs varies in different studies. Thus, there is no single global standardized system for calculating and using WQIs.

WQI can be separated into Drinking Water Quality Index (DWQI), Health Water Quality Index (HWQI), and Acceptability Water Quality Index (AWQI). All parameters from the WHO guideline including microbiological parameters constitute DWQI. HWQI includes acceptability measurements related to health issues and microbial measurements, whereas AWQI incorporates acceptability measurements. To check the health status of Indian rivers, Salgaonkar and Deshpande (2003) proposed Overall Index Pollution (OIP). Yadav *et al*. (2014) compared 3 indices, namely, Ecological Quality Index (EQI), The River Pollution Index, and Overall Index Pollution (OIP) for water quality study of Chambal river.

Some WQIs include bacteriological parameters as they can influence quality. To assess the risk for water borne diseases, faecal coliforms and intestinal enterococci are traditionally used as indicators of faecal contamination and are used for monitoring drinking water quality.

This study was aimed at assessing the seasonal physical, chemical, and bacteriological water quality of natural water bodies and drinking water sources in twenty selected villages from Pune and Satara districts in different seasons. Physical and chemical quality of water was studied through Modified WQI. It was calculated for all water sources with exclusion of bacteriology and was estimated seasonally. Additionally, for rivers water quality was studied by inclusion of bacteriology in OIP.

Additionally, different water quality indices were compared. Faecal coliforms and intestinal enterococci were used for bacteriological assessment. Since FC have the capacity to survive in water for long periods of time without multiplication, they are the accepted indicator organisms for faecal contamination by WHO and BIS. The study focused on monitoring of seasonal water quality at village level since institutional and regulatory capacities to assess water bodies are limited in rural Maharashtra.

The seasonal water quality findings can be used to propose local water monitoring programs and water management strategies when resources are under pressure due to drought conditions. Additionally, the seasonal water quality findings can be used develop water quality models for climate change scenarios at the local scale.

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Testing Procedures

- Physical tests
- Chemical tests
- Bacteriological tests

Testing procedures and parameters may be grouped into physical, chemical, bacteriological and microscopic categories:

- Physical tests: - indicate properties detectable by the senses.
- Chemical tests: - determine the amounts of mineral and organic substances that affect water quality.
- Bacteriological tests: - show the presence of bacteria, characteristic of faecal pollution.

1. Physical tests

Colour, turbidity, total solids, dissolved solids, suspended solids, odour and taste are recorded.

Colour in water may be caused by the presence of minerals such as iron and manganese or by substances of vegetable origin such as algae and weeds. Colour tests indicate the efficacy of the water treatment system.

Turbidity in water is because of suspended solids and colloidal matter. It may be due to eroded soil caused by dredging or due to the growth of micro-organisms. High turbidity makes filtration expensive. If sewage solids are present, pathogens may be encased in the particles and escape the action of chlorine during disinfection.

Odour and taste are associated with the presence of living microscopic organisms; or decaying organic matter including weeds, algae; or industrial wastes containing ammonia, phenols, halogens, hydrocarbons. This taste is imparted to fish, rendering them unpalatable. While chlorination dilutes odour and taste caused by some contaminants, it generates a foul odour itself when added to waters polluted with detergents, algae and some other wastes.

2. Chemical tests

pH, hardness, presence of a selected group of chemical parameters, biocides, highly toxic chemicals, and B.O.D are estimated.

pH is a measure of hydrogen ion concentration. It is an indicator of relative acidity or alkalinity of water. Values of 9.5 and above indicate high alkalinity while values of 3 and below indicate acidity. Low pH values help in effective chlorination but cause problems with corrosion. Values below 4 generally do not support living organisms in the marine environment. Drinking water should have a pH between 6.5 and 8.5. Harbour basin water can vary between 6 and 9.

B.O.D. :- It denotes the amount of oxygen needed by micro-organisms for stabilization of decomposable organic matter under aerobic conditions. High B.O.D. means that there is less of oxygen to support life and indicates organic pollution.

3. Bacteriological tests

For technical and economic reasons, analytical procedures for the detection of harmful organisms are impractical for routine water quality surveillance. It must be appreciated that all that bacteriological analysis can prove is that, at the time of examination, contamination or bacteria indicative of faecal pollution, could or could not be demonstrated in a given sample of water using specified culture methods. In addition, the results of routine bacteriological examination must always be interpreted in the light of a thorough knowledge of the water supplies, including their source, treatment, and distribution.

Whenever changes in conditions lead to deterioration in the quality of the water supplied, or even if they should suggest an increased possibility of contamination, the frequency of bacteriological examination should be increased, so that a series of samples from well-chosen locations may identify the hazard and allow remedial action to be taken. Whenever a sanitary survey, including visual inspection, indicates that a water supply is obviously subject to pollution, remedial action must be taken, irrespective of the results of bacteriological examination. For unpiped rural supplies, sanitary surveys may often be the only form of examination that can be undertaken regularly.

The recognition that microbial infections can be waterborne has led to the development of methods for routine examination to ensure that water intended for human consumption is free from excremental pollution. Although it is now possible to detect the presence of many pathogens in water, the methods of isolation and enumeration are often complex and time-consuming. It is therefore impractical to monitor drinking water for every possible microbial pathogen that might occur with contamination. A more logical approach is the detection of organisms normally present in the faeces of man and other warm-blooded animals as indicators of excremental pollution, as well as of the efficacy of water treatment and disinfection. The presence of such organisms indicates the presence of faecal material and thus of intestinal pathogens. (*The intestinal tract of man contains countless rod-shaped bacteria known as coliform organisms and each person*

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discharges from 100 to 400 billion coliform organisms per day in addition to other kinds of bacteria). Conversely, the absence of faecal commensal organisms indicates that pathogens are probably also absent. Search for such indicators of faecal pollution thus provides a means of quality control. The use of normal intestinal organisms as indicators of faecal pollution rather than the pathogens themselves is a universally accepted principle for monitoring and assessing the microbial safety of water supplies. Ideally, the finding of such indicator bacteria should denote the possible presence of all relevant pathogens.

Indicator organisms should be abundant in excrement but absent, or present only in small numbers, in other sources; they should be easily isolated, identified and enumerated and should be unable to grow in water. They should also survive longer than pathogens in water and be more resistant to disinfectants, such as chlorine. In practice, these criteria cannot all be met by any one organism, although many of them are fulfilled by coliform organisms, especially *Escherichia coli* as the essential indicator of pollution by faecal material of human or animal origin.

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