

WATER QUALITY MONITORING AND ASSESSMENT: NEED AND ISSUES

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Abstract- Water is the most basic natural resources. Water is used for multiple purposes in a technological society. Water is not only one of the most essential commodities of our day-to-day life, but the development of this natural resource also plays a crucial role in economic and social development processes. While the total amount of water available in the world is constant, it causes problems of scarcity and suitability. The challenge, therefore, is to obtain water suitable for various uses. Water quality is important because it directly affects the health of the people, animals and plants that drink or otherwise utilize the water. When water quality is compromised, its usage puts users at risk of developing health complications. It is therefore imperative that man develops, uses and manages this scarce commodity as rationally and efficiently as possible. In order to execute this task, accurate and adequate information must be available about the quality of the water under constantly changing human pressures and natural forces. Hence, Water quality monitoring and assessment programs are vital for all nations. Objective of such programs is to monitor and assess the fresh available water quality sources.

Key words: water quality, water quality monitoring, water quality assessment

INTRODUCTION

Water Quality

Water quality is commonly defined by its physical, chemical, biological and aesthetic (appearance and smell) characteristics. Water may be used for drinking, irrigating crops and watering stock, industrial processes, production of fish, shellfish and crustaceans, wildlife habitats, protection of aquatic ecosystems, navigation and shipping, recreation (swimming, boating), and scientific study and education. (Postolache et al, 2012).

Factors affecting water quality

The water quality of rivers and lakes changes with the seasons and geographic areas, even when there is no pollution present. Absolutely pure water is not found in nature. When the rain falls, dust, volcanic gases, and natural gases in the air, such as carbon dioxide, oxygen, and nitrogen, are all dissolved or entrapped in rain. Other gases such as sulfur dioxide, nitrogen oxide as well as toxic chemicals, or lead are in the air, are also collected in the rain as it falls to the ground. When the water flows as runoff, through the soil and rocks, it dissolves and picks up other substances. For instance, if the soils contain high amounts of soluble substances, such as limestone, the runoff will have high concentrations of calcium carbonate. Where the water flows over rocks high in metals, such as ore bodies, it will dissolve those metals.

Water quality is affected largely by uncontrolled land use for urbanisation or deforestation, accidental (or unauthorised) release of chemical substances, discharge of untreated wastes or leaching of noxious liquids from solid waste deposits. Similarly, the uncontrolled and excessive use of fertilisers and pesticides has long-term effects on ground and surface water resources (Chapman, 1996).

Pollution and water quality degradation interfere with vital and legitimate water uses at any scale, i.e. local, regional or international (Meybeck *et al.*, 1989). As shown in Table 1, some types of uses are more prone to be affected than others.

Table 1 Limits of water uses due to water quality degradation (Chapman,1996)

Pollutant	Use						
	Drinking water	Aquatic wildlife, fisheries	Recreation	Irrigation	Industrial uses	Power and cooling	Transport
Pathogens	1	0	1	2	1	NA	NA
Suspended Solids	1	1	1	2	2	2	1
Organic matter	1	2	1	+	1	2	NA
Algae	2	2	1	+	1	2	2
Nitrate	1	2	NA	+	1	NA	NA
Salts	1	1	NA	1	1	NA	NA
Trace elements	1	1	2	2	2	NA	NA
Organic Micro pollutants	1	1	2	2	?	NA	NA
Acidification	2	1	2	?	2	2	NA

1 Marked impairment causing major treatment or excluding the desired use
2 Minor impairment
0 No impairment
NA Not applicable
+ Degraded water quality may be beneficial for this specific use
? Effects not yet fully realised

WATER QUALITY MONITORING AND ASSESSMENT

Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The ‘monitoring’ comprise all activities to obtain ‘information’ with respect to the water system. Water quality monitoring has a direct relation with chemistry, biology, statistics and also economics. Its scope is also related to the types of water uses and functions which are manifold and the nature of the sources of water such as surface water (rivers and lakes), sea water groundwater.

Need of Water Quality Monitoring

Demand for the world’s increasingly scarce water supply is rising rapidly, challenging its availability for food production and putting global food security at risk. Agriculture, upon which a burgeoning population depends for food, is competing with industrial, household, and environmental uses for this scarce water supply. Even as demand for water by all users grows, groundwater is being depleted, other water ecosystems are becoming polluted and degraded, and developing new sources of water is getting more costly.(Rosegrant,2002)

Almost all users will place heavy demands on the world’s water supply under the business as usual scenario. Total global water withdrawals in 2025 are projected to increase by 22 percent above 1995 withdrawals Projected withdrawals in developing countries will increase 27 percent over the 30-year period, while developed-country withdrawals will increase by 11 percent. Together, consumption of water for domestic, industrial, and livestock uses—that is, all non-irrigation uses will increase dramatically, rising by 62 percent from 1995 to 2025 . Because of rapid population growth and rising per capita water use, total domestic consumption will increase by 71 percent, of which more than 90 percent will be in developing countries.(Rosegrant, 2002). These projections show the

challenges for meeting all the demands of society. Hence Water quality management is essential for ensuring the most rational and efficient use of water. Water quality management is for a great deal controlled by authorization of discharges of dangerous substances for which monitoring of discharges, effluents and influenced surface water is essential (CPCB,2008).

Objectives of water quality assessment

Since water resources are usually put to several competing beneficial uses, monitoring which is used to acquire necessary information should reflect the data needs of the various users involved (Helmer, 1994). Consequently, there are two different types of monitoring programmes, depending on how many assessment objectives have to be met:

- *Single-objective monitoring* which may be set up to address one problem area only. This involves a simple set of variables, such as: pH, alkalinity and some cations for acid rain; nutrients and chlorophyll pigments for eutrophication; various nitrogenous compounds for nitrate pollution; or sodium, calcium, chloride and a few other elements for irrigation.
- *Multi-objective monitoring* which may cover various water uses and provide data for more than one assessment programme, such as drinking water supply, industrial manufacturing, fisheries or aquatic life, thereby involving a large set of variables. The Commission of the European Communities has a list in excess of 100 micropollutants to be considered in drinking water alone.

The implementation of the assessment programme objectives may focus on the spatial distribution of quality (high station number), on trends (high sampling frequency), or on pollutants (in-depth inventories). Full coverage of all three requirements is virtually impossible, or very costly. Consequently preliminary surveys are necessary in order to determine the necessary focus of an operational programme. Table 2 summarises the existing types of water quality operations in relation to their main objectives. The process of determining objectives should start with an in-depth investigation of all factors and activities which exert an influence, directly or indirectly, on water quality. Inventories have to be prepared on:

- the geographical features of the area, including: topography, relief, lithology, pedology, climate, land-use, hydrogeology, hydrology etc.,
- water uses, including: dams, canals, water withdrawal for cities and industries, agricultural activities, navigation, recreation, fisheries, etc., and
- pollution sources (present and expected), including: domestic, industrial and agricultural, as well as their stage of pollution control and waste treatment facilities. (Chapman,1996).

Table 2 Typical objectives of water quality assessment operations

	Type of operation	Major focus of water quality assessment
<i>Common operations</i>		
1.	Multipurpose monitoring	Space and time distribution of water quality in general
2.	Trend monitoring	Long-term evolution of pollution (concentrations and loads)

3.	Basic survey	Identification and location of major survey problems and their spatial distribution
4.	Operational surveillance	Water quality for specific uses and related water quality descriptors (variables)
<i>Specific operations</i>		
1.	Background Monitoring	Background levels for studying natural processes; used as reference point for pollution and impact assessments
2.	Preliminary Surveys	Inventory of pollutants and their space and time variability prior to monitoring programme design
3.	Emergency surveys	Rapid inventory and analysis of pollutants, rapid situation assessment following a catastrophic event
4.	Impact surveys	Sampling limited in time and space, generally focusing on few variables, near pollution sources
5.	Modelling surveys	Intensive water quality assessment limited in time and space and choice of variables, for example, eutrophication models or oxygen balance models
6.	Early warning surveillance	At critical water use locations such as major drinking water intakes or fisheries; continuous and sensitive measurements

STEPS FOR WATER QUALITY MONITORING

Water quality monitoring involves 8 steps as explained below (CPCB,2008)

Step-1 Setting Water Quality Monitoring Objectives

Before formulation of any water quality monitoring programme it is very important to have clear understanding on the monitoring objectives. Everybody of the programme team should be fully aware of the objectives, methodology, quality assurance, data validation and other aspects. Clearly environmental monitoring must have a purpose and a function in the process of risk assessment and pollution control. In risk management, monitoring is essential in the stage of problem recognition (indication of water quality deviations), the stage of analysis (with respect to the expected changes) and the stage of management (verification or control of strategy results).

Step 2: Assessment resources availability

Once the monitoring objectives are known, it is important to look into the availability of resources for monitoring. Generally a compromise is made between quality and quantity of data required to fulfil certain objective(s) and resources available. Before planning water quality monitoring programme it is important to ensure that following resources are available:

- a. Sampling equipment (as per checklist)
- b. Transport for sampling
- c. Laboratory facilities
- d. Trained Manpower adequate number and competence
- e. Equipment/instruments for desired parameters analysis
- f. Chemicals/glasswares and other gadgets for analysis of desired parameters
- g. Funds for operation and maintenance of laboratory

Step 3: Reconnaissance survey

It is important to make a reconnaissance survey of the river during the planning stage, noting all sources of wastes, all entering tributaries that might contribute a potential pollutant, and all uses and abstractions of the water. This action will also include a survey of background information such as geography, topography, climate and weather, hydrology, hydrogeology, land use, urbanization, industrialization and agriculture, including farming in the riverbed. This information will help in an appropriate siting of sampling locations.

Step 4: Network design

In designing the sampling network, it is important to consider optimum number of sampling location, sampling frequency and parameters required to fulfil the desired objectives.

Step 5: Sampling

Planning for sampling

When planning a sampling programme the number of sampling stations or wells that can be sampled in one day is required. For this is necessary to know the required time needed for sampling, and other actions required, at the site. Since purging is a time consuming activity an estimate of the required purging time is a must to arrive at a fair estimate of the sampling time.

Surface water sampling

- Samples will be collected from well-mixed section of the river (main stream) 30 cm below the water surface using a weighted bottle or DO sampler.
- Samples from reservoir sites will be collected from the outgoing canal, power channel or water intake structure, in case water is pumped.

Different types of samples can be collected:

1) Grab sample (also called spot - or catch samples)

One sample is taken at a given location and time. In case of a flowing river, they are usually taken from the middle of the flowing water (main) stream and in the middle of the water column. When a source is known to vary with time, spot samples collected at suitable time intervals and analyzed separately, can document the extent, frequency and duration of these variations. Sampling intervals are to be chosen on the basis of the expected frequency with which changes occur. This may vary from continuous recording, or sampling every 5 minutes, to several hours or more.

2) Composite samples

In most cases, these samples refer to a mixture of spot samples collected at the same sampling site at different times.

Step 6: Laboratory work

Laboratory work consists of using different analytical techniques for different parameters to be assessed.

Step 7: Data management

This includes data storage and data validation. Data analysis could be used to summarise the data; to transform them to aid understanding or to compare them with a water quality standard that is couched in statistical terms (annual mean, standard deviation, trend, seasonal changes or a percentile for certain parameters). The data can also be summarized in form of index. Graphical presentation of data includes time series graphs, histograms, pie charts, profile plots (river profiles), geographical plots (contours).

Step 8: Quality Assurance

The QA programme for a laboratory or a group of laboratories should contain a set of operating principles, written down and agreed upon by the organisation, delineating specific functions and responsibilities of each person involved and the chain of command.

CONCLUSIONS

Water Monitoring programmes are useful to scarce to protect our waterways from pollution. Farmers can use the information to help better manage their land and crops. The local, state and national governments use monitoring information to help control pollution levels. Water quality assessment programmes are used to understand exactly how we impact our water supply. Such programmes are helpful for developing framework by policy makers and government regulatory authorities for maintaining the quality of the already scarce fresh water sources.

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