Reconnaissance Survey and Network Design

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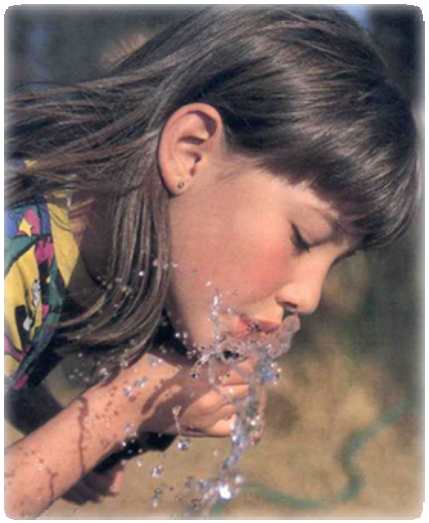
Introduction

- Water is most essential but scarce resource in our country.
- Presently the quality & the availability of the fresh water resources is the most pressing of the many environmental challenges on the national horizon.
- The stress on water resources is from multiple sources and the impacts can take diverse forms.



- Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality & quantity of water in our country.
- <u>The situation warrants :</u>

✓ improved water resource, and

✓ water quality management strategies.

Water Quality

Water quality is a complex subject, which involves physical, chemical, hydrological and biological characteristics of water and their complex and delicate relations.

From the user's point of view, the term "water quality" is defined as "those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water".

Examples

- For drinking : water should be pure, wholesome, & potable.
- For irrigation : dissolved solids and toxicants are important,
- For outdoor bathing : pathogens are important
- Textiles, paper, brewing, and dozens of other industries using water, have their specific water quality needs.

Water Quality Monitoring (WQM)

WQM is one of the first steps required in the rational development and management of water resources.

The ‘monitoring’ comprise all activities to obtain ‘information’ with respect to the water system.

WQM 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 and groundwater.

What is Monitoring ?

Webster's dictionary defines monitoring as:

(1) to check and sometimes to adjust for quality or fidelity,

(2) to watch, observe or check, especially for a special purpose, (3) to keep track of

A distinction can be made between different monitoring activities:

Survey: short term observation(s) on water quality (in present context) to fulfil definite objective(s);

Surveillance: a continued programme of surveys systematically undertaken to provide a series of observations in definite time period;

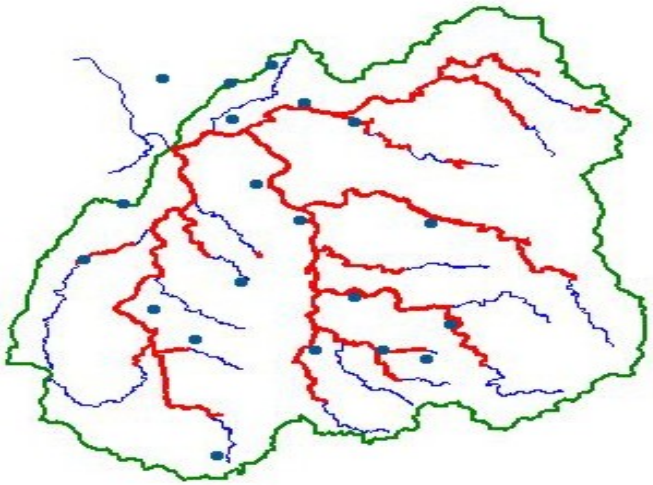
Monitoring: continuous surveillance undertaken to fulfil set of objectives.

WQM involves 8 steps as explained below:

Step-1 Setting WQM Objectives

Step-2 Assessment of Resources Availability

- Laboratory facilities and competence
- Transport
- Manpower: adequate number and competence



Step-3 Reconnaissance Survey

- Map of the area
- Background information
- Human activities
- Potential polluting sources
- Water abstractions and uses
- Hydrological information
- Water regulation

Step-4 Network Design

- Selection of sampling locations
- Optimum number of locations
- Parameters to be measured
- Frequency of sampling
- Component to be samples - water, sediment or biota

Step-5 Sampling
- Representative sampling
- Field testing
- Sample preservation and transport

Step-6 Laboratory Work
- Laboratory procedures
- Physical, chemical analysis
- Microbiological and biological analysis

Step-7 Data Management
- Storage
- Statistical analysis
- Presentation
- Interpretation
- Reporting

Step-8 Quality Assurance
- Production of reliable data
- Quality control
- Internal AQC
- External AQC

Step-3: Reconnaissance Survey

- ✓Most WQM programs have the objective of defining pollution, and relating it to its sources.
- ✓After this the reductions in discharges, which are necessary to remedy the problem, can be determined.
- ✓Reviewing all available reports and records concerning the water quality of all waste discharges and of the receiving water body may save several days of field work and may prevent the collection of useless data.

It is important to make a reconnaissance survey of the river during the planning stage, noting all sources of wastes, all tributaries that might contribute a potential pollutant, and all uses & abstractions of the water.

This action 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.

Reconnaissance Survey....contd

For groundwater quality monitoring network, it is important to conduct survey to identify potential sources of pollution.

For groundwater pollution monitoring generally existing structures in the potentially polluted sites are selected.

Since variation in groundwater quality is very high and unpredictable, it is practically not possible to cover assessment of groundwater quality of a particular area fully.

Thus, a compromise has to be made between resources available and criticality of information required. It commonly agreed that groundwater quality is generally degraded in the urban, industrial, solid wastes dumpsites and agricultural areas. In such areas a reasonable network is adopted for groundwater quality monitoring depending on resources available.

Sometimes groundwater structures need to be created in view of the criticality of the information needed for a particular area. Because of the heavy cost involved in sampling and analysis, it is well worth devoting time and effort to careful planning of a monitoring system.

Reconnaissance Survey...contd

This survey will give an overview of the:

•Geographical location of the water body to be monitored,

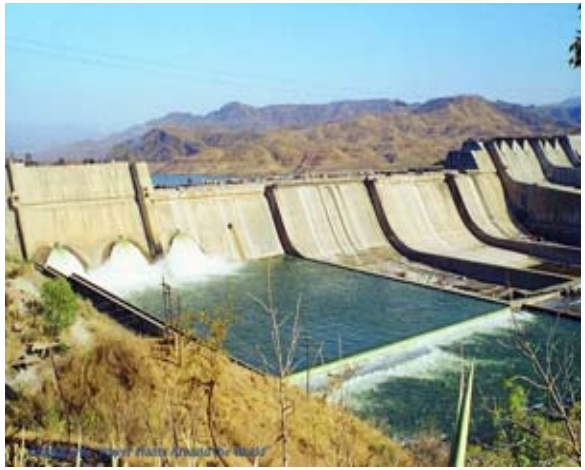
•Its accessibility,

•All kind of human influences to decide appropriate sampling location, and also

•Appropriate no. of sampling locations.

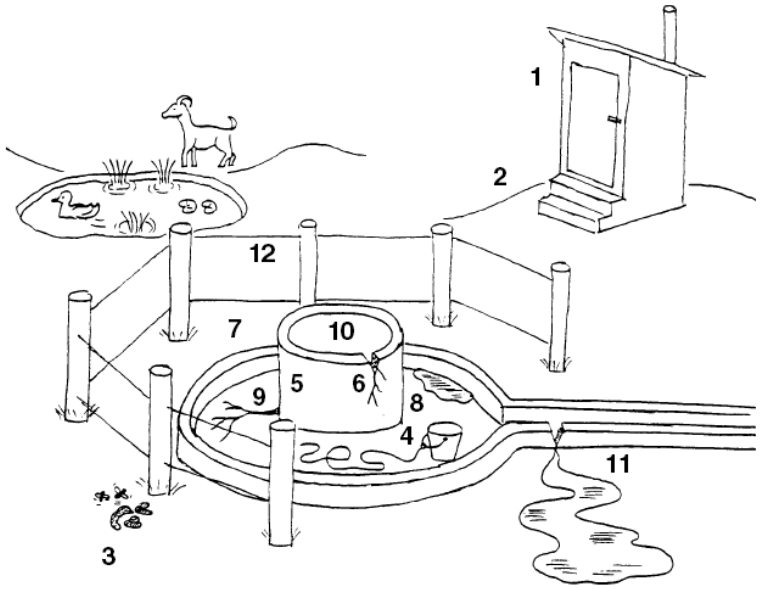
The survey may include acquisition of following information:

a. Location map
b. Background information on water body
c. Human activities around the water body like mass bathing, melon farming, cattle wading etc
d. Identification of potential polluting sources
e. Water abstraction – quantity and uses
f. Water flow regulation - schedule, quantity etc



The above information will help in proper designing the network and also planning the schedule for sampling.

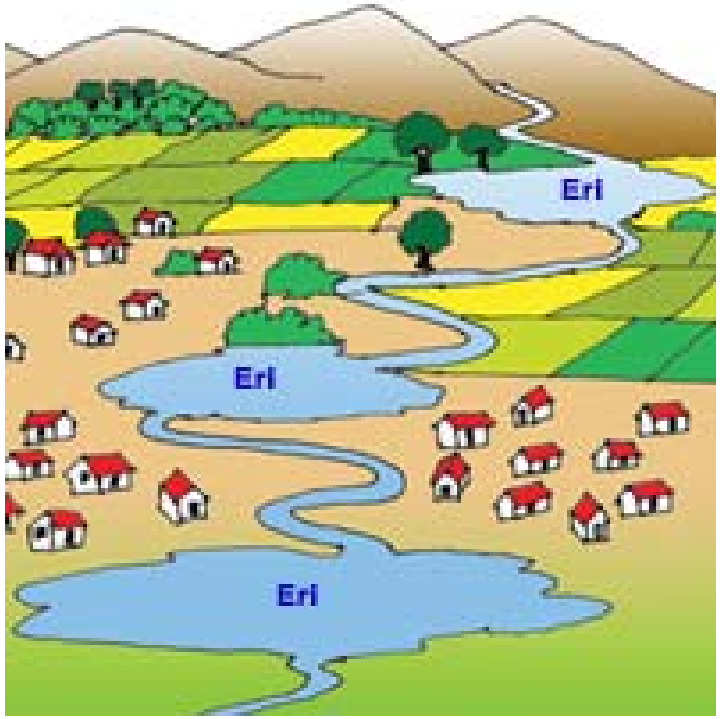
Step-4: Network Design



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.

Under NWMP, CPCB has set certain important criteria for selection of sampling location.

Criteria for Site Selection



The sampling site selection is generally linked with WQM objectives.

Ex. if the monitoring is carried out for judging suitability of water for drinking water source then the monitoring site should be closer to the intake point whereas for outdoor bathing it should be near bathing ghats.

After understanding the factors affecting water quality, it is necessary to select specific reaches or areas of the stream or river to sample.

There is no set number of sampling stations that will be sufficient to monitor all the possible types of waste discharges.

There is no routine methodology for site selection on a cook book basis. However, there are some basic rules. If these rules are carefully followed, a basically sound sampling design will be the result.

Some general criteria for selecting appropriate sampling sites

1)Always have a reference station up-stream of all possible discharge points. The usual purpose of a monitoring exercise is to determine the degree of anthropogenic pollution, and the damage that is caused to aquatic life. The reference station serves to assess the situation w.r.t. background water quality and biological aspects, which may vary locally and regionally.

2)Drinking water intake points, bathing ghats, irrigation canal off-take points should be considered for monitoring.

3) Sampling stations should be located upstream & downstream of pollution outfalls like city sewage drains and industrial effluent outfalls.

4) All samples must be representative., which means that the determinants in the sample must have the same value as the water body at the place and time of sampling. In order to achieve this it is important that the sample is collected from well-mixed zone.

5) Additional downstream stations are necessary to assess the extent of the influence of an outfall, and locate the point of recovery.

General criteria for selecting appropriate sampling sites....contd

6) In large rivers like Ganga, Yamuna, Godavari etc. where mixing is poor & incomplete, the effluent may tend to follow one bank. Stations on both sides downstream are useful to make an estimate of the extent of the mixing zone.

7) In large rivers a balance has to be found between the selection of a few stations giving poor coverage, and the selection of more stations having different substrates and dissimilar fauna, which can not be compared spatially.

8) In order to enable comparisons among sampling stations, it is essential that all stations be sampled approximately at the same time. Not more than two weeks should elapse between the sampling of the first and last station in a river.

9) Sites for biological sampling should match with sites for chemical sampling.

10) Biological sampling stations need to be selected with proper attention to representative habitats (kind of substrate, depth & flow). All sampling stations in a certain river should preferably be ecologically similar. To increase biological and chemical comparability, they should have similar substrate (sand, gravel, rock, or mud), depth, presence of rifles and pools, stream width, flow velocity, bank cover, human disturbances, etc.

General criteria for selecting appropriate sampling sites....contd

11) The conventional location of macro-invertebrate sampling stations in rivers arises not only from an assumed uniformity of substrate and fauna, but also from the ease with which it may be sampled by means of handnets and stonelifting or kicking, and from the ease of access.

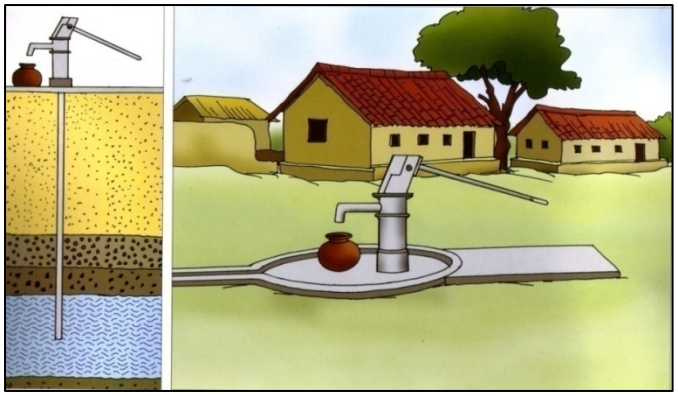
12) For estimation of the oxygen exchange rate of the river, a measurement of cross section is required. Any station should be typical w.r.t. the cross section of the river.

13) The sampling team normally has to carry an appreciable burden of sampling gear and water samples, and the distance they can walk is limited. Easily accessible sites should be selected. The site should also be accessible under all conditions of weather and riverflow.

14) Sample preservation:
Heavy metals: The samples need not be preserved (or with conc. $HNO_{3)}$.
Other parameters: Cold storage or addition of certain preservatives.
BOD and bacterial counts: Samples cannot be preserved and need to reach the laboratory shortly after taking the sample (i.e. Within 24 hours)

15) The collection of samples can be hazardous at some locations in bad weather (such as high flow). Such sampling sites can better be avoided.

General criteria for selecting appropriate sampling sites....contd



16) There are many disturbing influences in the rivers, especially cattle wading, melon farming, fishing, sand recovery, etc.. These disturbances can drastically influence chemical processes and the nature of the biological community. Dams and barrages provide a different kind of habitat. Such sampling sites should be avoided.

17) Availability of sampling facilities such as bridges, boats, & possibilities for wading are important criteria in the selection of sampling sites.

18) In case of groundwater sampling select only wells (TW, DW, HP) which are in use.

19) For groundwater pollution monitoring generally existing structures in the potentially polluted sites is selected.

20) Since variation in groundwater quality is very high & unpredictable, it is practically not possible to cover assessment of groundwater quality of a particular area fully.

21) Groundwater quality is generally degraded in the urban, industrial, solid wastes dumpsites and agricultural areas. In such areas a reasonable network is adopted for groundwater quality monitoring depending on resources available. Sometimes groundwater structures need to be created in view of the criticality of the information needed for a particular area.

Zonation

The occurrence of two general types of zonation in water bodies should be mentioned here because of their significance for the planning and execution of large scale sampling programs.

Cross-sectional zonation. A cross-section of the river and lakes will usually reveal gradients in depth, current velocities and sediment and water characteristics.

Longitudinal zonation. On a large geographical scale rivers may be classified in a number of zones: highland brooks and lowland courses both subdivided in upper and lower reaches.

Sampling frequency

✓The sampling frequency is governed by the level of variation in water quality of a water body.

✓If variations are large in a short duration of time, a larger frequency is required to cover such variations.

✓On the other hand, if there is no significant variation in water quality, frequent collection of sample is not required.

The water quality variations could be of 2 types i.e. random and cyclic or seasonal.

• In case of random variations e.g. Due to sudden rainfall in the catchment or sudden release of water from the dam etc., increased frequency may not help much as such variations are highly unpredictable. Thus, within the available resources it is not cost effective to cover such variations.

•In case of the water bodies having cyclic variations more frequently, sampling on monthly basis is justified. But for all those water bodies having stable water quality round the year, monthly sampling is not justified.

Frequency and Parameters

• On routine basis, a combination of general parameters, nutrients, oxygen consuming substances and major ions should be analyzed at all stations.

• Depending upon the industrial activities anticipated at the upstream of the sampling station other parameters like micro-pollutants, pesticides or other site specific variables may be included at lower frequency. Such stations need to be identified.

• A list of parameters to be considered for analysis and frequency of sampling is provided in the “Protocol for Water Quality Monitoring” notified by Govt of India.

• It was also emphasized that biological monitoring should form an important part of our WQM programme due to its inherent advantages.

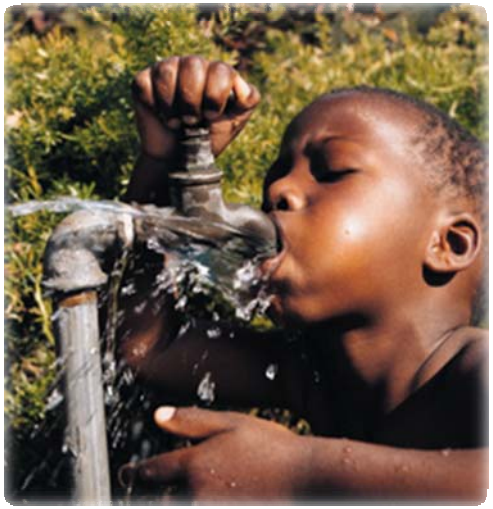
• Sediment needs to be analyzed for micro pollutant in some stretches as most of micro pollutants are associated with sediment. This should form part of monitoring programme.

Parameters & frequency of monitoring in surface waters

Type of Station	Frequency	Parameter
Baseline:	**Perennial rivers and Lakes :** 4 times a year **Seasonal rivers :** 3-4 times (at equal spacing) during flow period.	**(A) <u>Pre-monsoon:</u>** Once a year Analyse 25 parameters as listed below : **(a)General :** Colour, odour, temp, pH, EC, DO, turbidity, TDS **(b) Nutrients :** NH_3-N, NO_2 + NO_3, Total P **(c)Organic Matter :** BOD, COD **(d)Major ions :** K, Na, Ca, Mg, CO_3, HCO_3, Cl, SO_4, **(e)Other inorganics :** F, B and other location-specific parameter, if any **(f)Microbiological :** Total and Faecal Coliforms **(B)Rest of the year (after the pre-monsoon sampling) at every three months' interval:** Analyse 10 parameters: Colour, Odour, Temp., pH, EC,DO, NO_2 + NO_3, BOD, Total & Faecal Coliforms.

Parameters & frequency of monitoring in surface waters

Type of Station	Frequency	Parameter
Trend:	Once every month starting April-May (pre-monsoon), i.e. 12 times a year	baseline monitoring **(B)Other months :** Analyse 15 parameters as listed below **(a)General:** Colour, Odour, Temp, pH, EC, DO & Turbidity **(b)Nutrients :** NH_3-N, NO_2 + NO_3, Total P **(c)Organic Matter :** BOD, COD **(d)Major ions : Cl** **(e)Microbiological :** Total and Faecal coliforms **(C)Micropollutant :**Once in a year in monsoon season **(i)Pesticides-Alpha BHC, Beta BHC, Gama BHC** (Lindane), OP-DDT, PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldrin, 2,4-D, Carboryl (Carbamate), Malathian, Methyl Parathian, Anilophos, Chloropyriphos **(ii)Toxic Metals-** As,Cd,Hg,Zn,Cr,Pb,Ni,Fe (Pesticides & Toxic metals may be analysed once a year)



- This does not, however, restrict analysis of more parameters depending upon specific requirements of the analysing agency and its manpower availability.

- For lakes/reservoirs, monitoring of additional parameters, like Total Kjeldhal Nitrogen, Chlorophyll, total plankton count and productivity, are to be included in the list of parameters.

- If bio-monitoring is done in rivers/lakes/reservoirs, additional parameters, like Photosynthesis - Respiration (P/R) ratio, saprobity index and diversity index are to be included.

- The list of pesticides & toxic metals is flexible and should be decided on need basis.

Parameters & frequency of monitoring in Groundwaters

Type of Station	Frequency	Parameter
Baseline:	Twice a year in Pre & Post Monsoon season. The frequency may be reviewed after 3 years of monitoring	**(A)Pre & Post Monsoon season:** Analyse 20 parameters as listed below : **(a)General :** Colour, odour, temp, pH, EC, TDS **(b)Nutrients :** NO_2 + NO_3, orthophosphate **(c) Organic Matter :** COD **(d)Major ions:** K^+, Na^+, Ca^{++}, Mg^{++}, CO_3, HCO_3, Cl, SO_4 **(e)Other inorganics :** F, B and other location-specific parameter, if any

Parameters & frequency of monitoring in Groundwaters

Type of Station	Frequency	Parameter
Trend:	4 times every year (once in pre-monsoon, April-May, and thereafter at intervals of 3 months)	<u>Baseline monitoring.</u> **(B)Other times:** Analyse 14 parameters as listed below **(a)General :** Colour, odour, temp, EC, pH, TDS **(b)Nutrients :** NO_2 + NO_3, orthophosphate **(c)Organic Matter :** COD **(d)Major ions :** Cl **(e)Other organics :** F, B **(f)Microbiological :** Total and faecal coliforms **(C) Micropollutant :** **(i)Pesticides-** Alpha BHC, Beta BHC, Gama BHC (Lindane),OP-DDT, PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldrin, 2,4-D, Carboryl (Carbamate), Malathian, Methyl Parathian, Anilophos, Chloropyriphos **(ii) Toxic metals-** Fe, Cu, Cr, Ni, Pb, Cd, Zn, Hg, As

- The parameters to be analysed as mentioned above are the minimal requirement.

- This does not, however, restrict analysis of more parameters depending upon specific requirements of the analysing agency and its man power availability.

- If COD value exceeds 20 mg/l , the sample is to be analysed for BOD also.

- The list of pesticides & toxic metals is flexible and should be decided on need basis

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