

## **Water Quality Management**

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This lecture provides a background to support the necessity for water quality management in the sustainable use of water resources. It also identifies what is water quality management, what comprises assessment for water quality, problems, standards and key actions required for effective water quality management.

### **Introduction**

Water is essential for all life therefore water resources management must be for sustainable use. The movement of freshwater is characterized by the hydrological cycle (including floods and droughts) which demonstrates that water is inextricably linked with the environment. This implies that actions in the environment and more specifically the catchment/watershed impact on the water resources. Similarly water impacts on the environment. However the very nature of water is such that its characteristics vary in both quantity and quality in time and space.

The quality of water itself is a significant factor to the limits on the amount of available water that may be used for various purposes. What nature provides as available quantities may be reduced if the quality of water does not permit its use for a specific purpose. This leads to additional costs in the development of the water resource to meet both quantity and quality requirements needed for the particular use. Thus water quality directly affects the quantity of water that can be employed for various purposes.

The rapid growth of population and urban communities and industrial and agricultural activities has significantly contributed to the deterioration of water quality of lakes, rivers, groundwater and coastal waters worldwide.

Pollution of the environment including its freshwater resources is the result of human society's activities. Also the use of water results in its degradation. Often this is incremental and contamination results through repeated use.

It is expected that with economic development in the coming years, there will be a substantial increase of water demand and therefore an increase of pollution discharge, if no measures are taken. Already as populations and economic activities grow many countries are rapidly reaching conditions of water scarcity or facing limits to economic development. The widespread scarcity, gradual degradation and pollution of freshwater resources in many regions of the world, along with the encroachment of incompatible activities, demand integrated water resources planning and management. It is therefore of paramount importance that freshwater as a finite and vulnerable resource be managed holistically taking into consideration the integration of sectoral water plans and programmes within the framework of national economic and social policy. Management must also recognize the interconnectedness of the elements related to freshwater and freshwater quality.

### **What is Water Quality Management?**

Water quality management deals with all aspects of water quality problems relating to the many beneficial uses of water. Water quality is a reflection or response of water composition to all inputs and processes, whether natural or cultural.

Water quality management should not be equated to water pollution control which generally is the adequate treatment and disposal of wastewater.

In the definition of water quality management above, water uses consist of intake; on site, and instream flow uses. Intake uses include water for domestic, agricultural and industrial purposes, or uses that remove water from the source.

On site uses primarily refer to water consumed by swamps, wetlands, evaporation from water bodies, natural vegetation, and unirrigated crops and wildlife. Flow uses include water for estuaries, wastewater dilution, navigation, hydroelectric power production, and fish, wildlife and recreation purposes.

Water quality management serves to optimize water quality for all beneficial uses. Implied in this, is that water should be managed so that no use at any one location will be

detrimental to its use at another location. In managing water quality, the factors and inputs that must be considered, include both man-made sources and natural causes. With respect to water quality changes, natural causes include geologic formations, vegetation, geographic factors and natural eutrophication.

### **Assessment for Water Quality**

Water quality is assessed by its physical, biological and chemical characteristics. Contamination can alter one or all of these characteristics and may originate from point or from ambient sources.

The investigation and management of water resources systems for water quality must include consideration and evaluation of

- (a) the physical, chemical and biological composition of headwaters and significant groundwater discharges.
- (b) water quantity and quality requirements for all existing and potential water uses
- (c) the means of water withdrawal and their effect on water quality and quantity
- (d) the existing and future water and wastewater treatment technology used to alter water quality
- (e) the wastewater outfall configuration and effluent mixing
- (f) the eutrophication status of the receiving waters
- (g) the waste assimilative capacity of the receiving waters.
- (h) the ecological changes that might be caused by wastewater discharges
- (i) the potential effects of discharged waters.

## **Water Quality Problems**

The World Health Organisation (WHO) considers waters to be polluted when they are altered in composition or condition, directly or indirectly, as a result of man's activities so that they become unsuitable, or less suitable, for any or all of the functions or purposes for which they would be suitable in their natural state.

Major problems affecting the water quality of rivers and lakes vary according to the specific situations. Problems may arise from inadequately treated sewage, poor landuse practices, loss and destruction of catchment areas, inadequate controls on the discharges of industrial waste waters, poor siting of industrial plants, deforestation, uncontrolled poor agricultural practices and a lack of integrated watershed management.

Some of the effects of the above are leaching of nutrients and pesticides, threatened ecosystems, public health risks, erosion, sedimentation and deforestation leading to land degradation.

Many of these negative effects may have arisen from environmentally destructive development and a lack of public awareness and education on the protection of surface and groundwater resources.

## **Stream and Effluent Water Quality Standards.**

To effectively control water quality, it must be described in precise technical quantitative terms to allow the decision for effluent discharge limitations or a beneficial use of the water to be formulated.

In addition any requirements for water quality must be imposed with consideration of the concomitant level of treatment requirements of wastewater effluents or water supply intakes upstream and downstream from the point of interest.

For the purpose of quantifying the water quality, numerical values of the concentration of various substances present in the water samples are determined through physical,

chemical and biological techniques of analysis. Quantification of the water quality, however, should be the result of a statistical evaluation of a number of samples taken at various locations, flows and times.

Accuracy of the water quality quantification is related to the frequency of the data acquisition and its statistical reliability. The process of quantifying water then involves a comparison of the statistical water quality characteristics with water quality criteria or standards.

Water quality standards used throughout the world are generally either in the category of stream standards or effluent standards or a combination. In the United States although primary emphasis is on effluent standards, stream standards are enforced where the effluent loadings exceed the waste assimilative capacity, as determined by stream standards (water quality limiting cases).

In water pollution control practice, the waste assimilative capacity connotes the capability of a receiving water to assimilate a certain quantity of waste material, under the worst possible conditions, without causing deleterious effects.

### **Beneficial Uses of Water**

Since the intended use of a water dictates the water quality requirements, delineation of water allocated for specific uses is mandatory.

The traditionally accepted beneficial uses of water reflect the multi-interest utilization of water resources. These uses include domestic water supply, industrial, water supply, agricultural water supply, fisheries, urban development, hydropower generation, transportation (navigation), recreational waters, sanitation, assimilation of wastes and other activities. Clearly these uses span a wide spectrum of water quality requirements.

## **Key Actions To Address Water Quality Management**

Key actions to address water quality management include

1. development of appropriate, cost effective and reliable data programmes that can inform sound judgments on environmental policy, management and regulatory needs. This is most important when we realize that developing countries are extremely data poor – both in amount and reliability and that part of the current water crisis, is the failure of national data programmes to produce information that can be used to estimate the contributions and impacts of different categories of pollution sources.
2. water resources protection and conservation. One focus of this must be rehabilitation or remediation of important but degraded catchment areas as a means of increasing the quantity of useable water both for human and ecosystem needs. This is particularly critical on small islands.
3. water pollution prevention and control. In this there is the application of the ‘polluter pays’ principle to the sources where appropriate; establishment of standards for the discharge of effluents and for the receiving waters; use of new technologies, product and process change, pollution reduction at source and effluent reuse, recycling and recovery, treatment and environmentally safe disposal for pollution minimization. In addition, there is the mandatory environmental impact assessment of major water resource development projects with the potential to impair water quality and ecosystems. Also, the identification and application of best environmental practices at reasonable cost.
4. development and application of clean technology. This focuses on the control of industrial waste discharges in an integrated manner and through the application of measures derived from a broad based life cycle analysis. Also included are the

- treatment of municipal wastewater for safe reuse in agriculture and aquaculture; development of biotechnology for waste treatment and development of appropriate methods for water pollution control considering traditional and indigenous practices.
5. groundwater protection. This comprises prevention of aquifer pollution through the regulation of toxic substances and the establishment of protection zones, water quality monitoring measures to mitigate saline intrusion and measures to improve safety and integrity of wells.
  6. protection of aquatic ecosystems. This focuses on rehabilitation of polluted and degraded waters to restore aquatic habitats and ecosystems and conservation and protection of wetlands.
  7. protection of freshwater living resources. This focuses on the control and monitoring of water quality to allow for sustainable development of inland fisheries and the protection of ecosystems from pollution and degradation.
  8. monitoring and surveillance of water resources and waters receiving wastes. This focuses on the establishment of networks for monitoring of waters receiving wastes and pollution; surveillance of pollution sources to improve compliance, application of environmental impact assessment and geographic information systems; monitoring of chemical utilization and national land use to prevent degradation.
  9. development of legal instruments to protect the quality of water resources. This focuses on the monitoring and control of pollution and the application of environmental impact assessment.

## **Implementation**

Effective implementation of water demand management, water quality management and overall integrated water management will only take place when we understand what it is to holistically manage water for sustainability and every individual understands his/her responsibility as stewards of the environment. Inherent in this, is the fact that water is everybody's business, water is inextricably linked to the environment, water is essential for all life and water supports socio-economic development. It is therefore imperative that water managers understand their responsibility to educate the public and themselves, involve stakeholders in planning and decision-making, facilitate an effective multidisciplinary approach and utilize appropriate technology.

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