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Gholamreza Asadollahfardi

Water Quality Management

Assessment and Interpretation

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Chapter 1
Introduction

Abstract The abatement of fresh water and groundwater resources, increasing population as well as industrial demands render the protection and preservation of these resources all the more important. Water quality is a term applied to indicate the suitability or unsuitability of water for various uses. Each type of water uses needs certain physical, chemical and biological characteristic while various uses have some common characteristic. Water quality management is the management of water quality of the physical, chemical and biological characteristic of water; therefore, management and regulatory agencies can use to evaluate alternatives and make necessary decisions. In this chapter, after defining a few water quality terms and a brief review of the significance of water quality management, the framework of the book was described.

1.1 Introduction

Life on this planet is positively linked to water. The dwindling fresh water resources, increasing population as well as industrial demands render the protection and preservation of these resources all the more important. The situation is particularly of concern in semiarid and arid countries with growing population and industry. Groundwater resources are scanty and the rainfall, though meager, is not uniform. One such country is Iran, located in the Middle East, to receive merely enough rainfall in its Northern and Western parts to sustain those regions themselves, while the rest of the land mass is either semi arid or arid. Hence, healthy sized budgets and time need to be devoted to constructing infrastructure for the transportation of drinking water from the more endowed parts of drier ones. Needless to say, protection and maintenance of water quality over the long haul is very important.

It is necessary to establish the current quality of surface and ground water resources before measures can be taken to control water pollution. Briefly, the process involves establishing water quality monitoring stations along the waterway to collect samples for the analysis of the characteristic of water followed by rigorous interpretation of the collected data since the colossal amount of data without

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proper interpretation can, in no way, lend any effective aid to water quality management. Many methods have been developed to interpret the data. Deterministic and statistical methods are examples. However, among all the methods available today, water quality indices are perhaps among the simplest and yet extremely useful methods. The results of interpretations derived from this method are understandable for both water quality managers and the general public.

Water quality is a term applied to indicate the suitability of water for various uses. Each type of water uses needs certain physical, chemical and biological characteristic while various uses have some common characteristic. The composition of surface and ground water depends on the characteristic of the catchment area such as geological, topographical, meteorological and biological of the area. Water quality in various areas is hardly ever constant, and the variations are caused by changes in concentration of any inputs to water body. Such variations may be natural or man—made and either cyclic or random. Random variation of water owing to unpredictable events. As an example, storm can increase flow and increasing pollution due to the wash of its catchment area. Therefore, the nature of water quality is stochastic and deterministic. Consequently, for proper interpretation of the data understating both of the characteristic is vital.

Water quality monitoring is the effort to find quantitative information on the physical. Chemical and biological characteristics of water using statistical sample (Sander 1983). Monitoring means watching the ongoing flow of water to make sure no law and regulation are broken. However, the word has a different meaning when utilized to refer to water quality measurements, as a result has the term network taken on a meaning beyond the strict definition of the word when referring to water quality monitoring. Network design means to determine the location of sampling stations (Sander 1983). The location of sampling stations and type of water quality parameters depends on the objective of water usage. The water quality situation is a function of complex natural and man-made causes and of the resulting integration in both space and time. Therefore, abstracting the core of the water quality conditions at a reasonable cost is very difficult.

For water pollution control, it is necessary to figure out surface and ground water quality. The first stage in this process is to establish water quality monitoring stations to collect samples to analyze the characteristic of water. The second stage is type of sample collection which is very important because collected samples should be representative of the water body. The third stage involves interpreting the collected data since huge amounts of data without proper interpretation cannot help water quality management effectively (Asadollahfardi 2000).

The first stage in water quality management is establishing enough and suitable selected monitoring stations considering the objective of water uses. The Second stage is the availability of enough data with proper precision regarding the aim of water use. The third stage is an interpretation of the data which the outcome of this step can help water quality management for water quality planning to control water quality.

The principal aim of the global freshwater quality monitoring project, Global Environment Monitoring System (GEMS)/WATER presents a descriptive example

of the intricacy of the assessment task and its relation to management (WHO 1987), to offer water quality assessments to governments, the scientific society and the public, on the quality of the world's fresh water in relation to human and aquatic ecosystem health, and global environmental concerns, specifically:

- To describe the rank of water quality;
- To spot and quantify trends in water quality;
- To define the cause of observed conditions and trends
- To identify the types of water quality difficulty that happen in specific geographical areas; and
- To provide the accumulated information and assessments in a form that is for resource

In other words, water quality management is the management of water quality of the physical, chemical and biological characteristic of water (Sanders 1983); therefore, management and regulatory agencies can use to evaluate alternatives and make necessary decisions.

This book consists of six chapters. This chapter includes significance and definition a few terms of water, and necessary steps for water quality planning; in Chap. 2, in the first step the significance of appropriate water quality site selection is defined and then a summary of Sanders method, Multiple-Criteria Decision Making (MCDM) and Dynamic Programming Approach (DPA) is described and finally, an application of the Sanders method for existing water quality monitoring stations in the Kārūn River is assessed. Chapter 3 encompasses the previous researchers' work, detailed information of National Sanitation Foundation Water Quality Index (NSFWQI) and British Columbia WQI and two case studies using NSFWQI and British Columbia WQI. In Chap. 4, the historical background of using time series, a summary of Box-Jenkins time series and method of building, diagnostic and predicting the future of the time series model, as well as a brief explanation of exponential smoothing and the Winter's method is described. Finally, as a practical exercise, an application of time series model as a case study is depicted. Eventually in Chap. 5 a summary of artificial neural network and as a case study is discussed. In Chap. 6 introduces the deterministic model Ce-Qual-W2 and then two applications of the model are described. The first application is to study changing of total dissolved solids in Karkheh Dam in southwest of Iran and the second study is about Kārūn River in Khouzestan province, Iran.

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Chapter 2
Selection of Water Quality Monitoring Stations

Abstract Due to financial constraints and improper selection of water quality stations considering the objective of water uses, water quality monitoring network design is an efficient method to manage water quality. The most crucial part is to find appropriate locations for monitoring stations. In the past, most of water quality selection stations were subjective and the designs on the network had some human error. However, now there are several mathematical methods using experimental data for assessment of existing monitoring stations or designing new network such as Sanders method, multiple criteria decision making (MCDM) and dynamic programming approach (DPA) that developed by researchers. In the following chapter, after reviewing the historical background of developing and application of the methods, the theory of these methods was described in details. Finally, the application of the Sanders Method to design number of water quality monitoring stations in the Kārūn River which located in the south west of Iran was studied.

2.1 Historical Background

Allocation of the water quality monitoring site is the first and the significant step in the design of the water quality network. The importance of water quality network control concerning pollution causes creation of water quality stations in the network. However, finical constraints causes to decrease the number of water quality station in the network. Regarding optimizations of a number of monitoring stations some techniques were developed such as Sanders method, artificial neural network, Multi-Criteria Decision Method (MCDM) and Dynamic Program Approach (DPA). Some researches were carried out by Sharp (1970, 1971); Dandy (1976); Sanders (1983); Schilperoort and Groot (1983); Ward and Loftis (1986); MacKenzie et al. (1987); Woldt and Bogardi (1992); Harmancioglu and Alpaslan (1992); Hudak and Loaiciga (1993); Karemi (2002); Ozkul et al. (2003); Khalil and Quarda (2009); Noori et al. (2007); Karamouz et al. (2009); Khalil et al. (2011); Asadollahfardi et al. (2011). The DPA technique, which is a general method for maximizing and minimizing mathematical functions for solving a problem together with Multi-Criteria Decision,

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