Chapter 6.7

Wastewater Systems Management at the Regional Level

Maria da Conceição Cunha
University of Coimbra, Portugal

ABSTRACT

Wastewater systems are very important environmental systems. They should be carefully planned and managed to contribute to a more sustainable development. Decision models are very useful tools that can contribute to defining the best solutions for these purposes. In this chapter an overview about the planning and management of wastewater systems and presentation of different decision models is given. Solutions methods are discussed and the results that can be obtained with such models are commented on. The vulnerability of such systems is reflected and new approaches are proposed to tackle them.

INTRODUCTION

Wastewater Problems in the Context of an Integrated Water Resources Management

There is a world-wide concern about 'good water status', a concept that should be analyzed within the framework of an Integrated Water Resources Management (IWRM). A systemic view should be considered in order to develop methodological tools capable of handling simultaneously all the facets (environmental, economical, social and technological) involved in the IWRM approach. Wastewater systems are very sensitive water systems that should be properly planned and managed so that they can contribute to a better environment. These issues have to be tackled at regional level, because past experience suggests that in many cases it is impossible to find efficient planning and management solutions to wastewater problems unless these solutions are sought for relatively large geographical areas. Local solutions often lead to the misspending of

Figure 1. Extreme solutions for wastewater problems at regional level
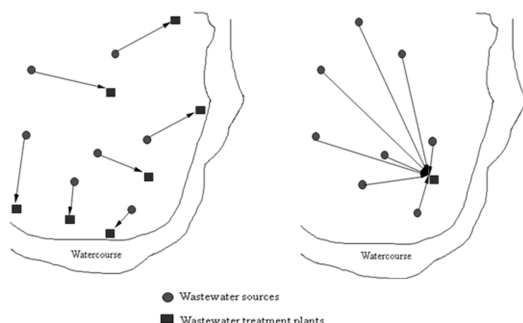
natural and capital resources and to the generation of pollution foci. The solutions that can be envisaged lie between two extremes: one where each community deals with its own wastewater and the other where wastewater from all communities is treated in a single plant (Figure 1).

The Role of the Decision Models

Decision models are crucial to obtaining good solutions that will enhance IWRM. They can be tailored to incorporate the various interdependencies and interactions between the technical, economic, environmental and social aspects appropriate to achieving consistent and harmonious solutions. Decision models for wastewater systems involve a component for wastewater collection and another for wastewater treatment plants. How to design the sewer network to convey wastewater to the treatment plants? What location and size should be defined? These issues have to be considered simultaneously. The decision models should represent real world systems realistically and should include appropriate simulation models to carefully assess the effects of the decisions to be taken. The search for the optimum solution somewhere between the two extremes mentioned above is a very complex task, given the extraordinarily high number of possible combinations for collecting wastewater and transporting it to the various

available locations of wastewater treatment plants (examples in Figure 2).

An important criterion for defining the solution is cost, with all the other issues involved in such problems it is usually represented as a constraint. We should keep in mind that decision models have to be considered within a wider decision process. Various solutions close to the optimum solution should be provided to decision makers, solutions that take into account specific economic and physical characteristics of real world problems. The decision procedure should be interactive, where decision makers can ask engineers at any time for a sensitivity analysis to assess the consequences of including new aspects or slightly changing some parameters.

Economies of Scale in Regional Wastewater Systems

The cost functions for wastewater systems, including capital, maintenance and replacement costs, are usually strictly concave, thus representing economies of scale. This indicates that solutions would tend to concentrate treatment in to one or very few plants rather than in a larger number of plants. The influence of the degree of economies of scale can be seen in the results in Table 1. The results concern a case study where all data is maintained except the cost function ($C=aQ^b$), so only if the level of the economy of scale is changed will the solutions differ. As this level increases (lower value of b) the solution is obtained for a

Figure 2. Different solutions for wastewater problems at regional level
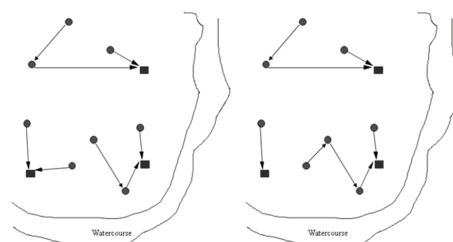
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