Chapter 5
From Hydrological Models to Policy-Relevant Decision Support Systems (DSSs): A Historical Perspective

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ABSTRACT

Since the advent of modern computing platforms in the 1960s and despite scepticisms and uncertainties, modelling systems have become indispensable tools in water resources management. They have been postulated to support the decision-making process and hence the term decision support systems (DSSs) emerged. Hydroinformatics is a recent term compared to computational hydraulics and hydrological watershed modelling but it is an encompassing cross disciplinary concept covering hydraulics, hydrology, environmental engineering, socioeconomic and political (institutional) disciplines and it uses information and communication technologies to provide evidences for decision-makers. The aims of this chapter are two fold: (a) to review the current trends in modelling activities based on historical precedence; and (b) to present a conceptual framework for development of a comprehensive DSS using a case study approach. Hence, this chapter consists of three main parts: (1) a historical account of the DSSs, starting from early single process models to current integrated comprehensive basin-wide DSSs; (2) having established a historical perspective, case studies from Iranian experience are presented to outline a methodological (conceptual) framework for developing a comprehensive DSS. Examples of policy-relevant DSSs from the latest research are also presented. It is concluded that there would be a greater demand in the future to develop integrated policy-relevant DSSs comprising not only the technical and engineering aspects but to include the socioeconomic and political sciences as well. The new DSSs should be able to deal with uncertainties such as climate change (i.e. to have scenario analysis capabilities), be able to compare different management strategies using multi-criteria analysis tools and to include socio-economic, institutional and environmental sustainability criteria.

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INTRODUCTION

Hydroinformatics is a relatively recent field compared to the well-established fields of computational hydraulics and hydrological watershed modelling. Hydroinformatics draws its origin from hydrology, computational hydraulics, environmental engineering, information and communication technologies and the social sciences. This European concept was conceived for the first time by Professor Mike Abbott in 1991 in a book called ‘Hydroinformatics’ (Abbott, 1991). However, hydraulic/hydrologic modelling dates back to the late 1950s starting with single process models. A turning point came in the 1960s when digital computers became widely available and since then there has been a tremendous increase in modelling activities throughout the world. Models were conceived and developed to solve complex and pressing water resources problems and have been used in the design of hydraulic structures; today, they offer huge potential in the planning and management of aquatic environments.

A survey of the literature review shows an array of terms used to describe the modelling systems (a combination of computer based, simulation, optimization, information and database management tools or systems) which in principle have the same applied meanings; e.g. integrated models, decision support systems (DSSs), knowledge based ‘expert’ systems; large catchment/ watershed modelling systems, river basin management systems; hydroinformatics modelling systems or scenario simulations and modelling systems, integrated modelling systems and so forth (e.g. Loucks, 1995; Welp, 2001; Sharifi, 2003). A comprehensive DSS can have four components (e.g. Jarre et al., 2008; Sharifi, 2003):

a. a structured knowledge base storing underlying information (inputs or databases and outputs)
b. an information system for accessing and retrieving the information
c. a modelling component predicting the outcome of a problem posed (‘inference engine’)d. a framework that facilitates communication between the user, the knowledge base and the inference engine

With increasing pressure on limited water resources due to population growth and greater demand, there is a need for an integrated modelling (DSS) approach to simulate future demand and assess the impact of water resources development plans on the available resource in terms of quantity and quality. To deal with inadequate management practices, concepts such as Integrated Water Resources Management (IWRM: GWP, 2000), sustainable development and ecosystem approach were developed and adopted by many countries around the globe. IWRM uses a systems analysis approach to management i.e. policies, scenarios, management options (measures) and strategies to evaluate and assess different management plans. DSSs have been recognised to help with the decision-making process and their use is now an integral part of planning and management of water resources. There is no doubt that DSSs have contributed greatly to the advancement of the planning and management of water resources. Therefore, the main aim of DSSs is to provide information or ‘evidence’ for a sound decision using the available data and technologies.

The goal of the chapter is to postulate on the future trend of DSS development and application. So the main question is how an integrated or ‘comprehensive’ basin wide DSS can be developed which satisfies end-user needs? To answer this question, a historical analysis is made of DSS development. Then based on experience from developing DSSs for Iranian river basins, a methodological (conceptual) framework for an ideal comprehensive DSS is envisaged; followed by a survey of policy-relevant DSSs from the latest research.

This chapter consists of two main parts: (1) a historical overview of DSS development which
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