CHAPTER 1

INTRODUCTION

1.1 GENERAL

Water is considered as the foundation of all civilizations in the world; all development activities are directly or indirectly dependant on water; and water plays a fundamental role in the ecosystem services. The scarcity of fresh water is increasingly felt for meeting the needs of human beings. Increasing demand and dwindling availability of fresh water are imposing stress on sharing and utilising this available water in an equitable manner. The frequent transboundary water conflicts and local level water conflicts are revealing this imbalance. It is always a formidable challenge to manage the available water resources by taking into account, its quantitative and qualitative aspects. This fact has been recognised by the policy-makers, scientists, technocrats and other stakeholders.

Today, sustainability is a well recognised and much discussed terminology and is often considered as a goal of many rural development policies. The purpose of sustainable water resources management is to sustain both the water supply capability and the environment, now and in the future. Because of the advancements and changes in technology, and amendments in the policy decisions over time, the water demand is continuously changing. Hence, the relationship between water use by farmers and the environmental needs is to be continually reviewed and adapted.

Optimum development and efficient utilization of the water resources assume great significance with growing population, urbanization and irrigation needs,
especially in the arid and semi-arid zones where water shortages are increasingly felt. Throughout the world, irrigation sector consumes considerable quantum of water; irrigation accounts for 90 percent of water withdrawn in some developing countries and significant proportions in more economically developed countries. Irrigation is inevitable for large scale farming to provide food for the ever increasing population. Although the ability of irrigation in ensuring food security and improving rural welfare is remarkable, there have been incidents of failures of irrigated agriculture. In river basins, where irrigation sector is the major water user, sustainable water management has to ensure a long-term, stable, and flexible water supply to meet the varying crop water demands, as well as other demands, at the same time preventing any negative environmental consequences from irrigation and excessive use of water. Sustainability in irrigation reflects a system concept for irrigation water management by applying a set of elements that interact in an interdependent fashion.

For the efficient planning and management of a complex water resources system, an optimal operating procedure is essential. Reservoirs form a major water resources system and their optimal operation is a very important area of water resource planning and management, as the interrelationship between some of the variables is nonlinear in nature. Conflicting and complementary uses of reservoir storage have to be scientifically addressed and managed for the efficient and effective water resources management. Due to the temporal variation of inflows and multipurpose demands, the task of allocation of available water becomes more complex. The application of system analysis to reservoir system design, operation and management is considered as one of the most important aspects of water resources engineering (Biswas, 1976).

The evaluation of current operating rules of existing reservoirs is very important to meet the changing demands according to the public needs and objectives. An operation or release plan is a set of rules for deciding how much quantity of water may be stored or released from a reservoir, or a group of reservoirs, under various conditions. Usually, an operation plan includes a set of quantitative criteria within
which some flexibility for operator judgement is allowed. The operating rules provide
guidance to the water managers for making the actual decision on water release from
time to time. System analysis models are developed to support reservoir planning
and operation during all phases of the project. These models help to:

- Decide the reservoir storage capacities and establish operating policies during
  the pre-construction planning;
- Evaluate the operating plans of existing reservoir systems;
- Govern the water allocation systems involving water rights and agreements be-
  tween water suppliers and users;
- Develop management strategies and operation plans for the next year or season;
  and
- Perform real-time operations.

1.2 INTER BASIN WATER TRANSFER

Inter Basin Water Transfer (IBWT) is a key strategy being used by water
managers to mitigate the flood and drought alike. Interlinking of rivers to facilitate
IBWT is debated as a prestigious project in India (Misra et al., 2007). In India,
during the past, a few long distance inter-basin water transfers have been carried
out. The Ministry of Water Resources established the National Water Development
Agency (NWDA) in 1982 to formulate proposals for interlinking of the Himalayan
and peninsular rivers for transfer of water from the surplus basins to the deficit ones,
for ensuring maximum utilization of water resources towards development purposes.
Fourteen interlinking of rivers in the Himalayan and sixteen in the peninsular regions
have been identified by the NWDA.

Interlinking of rivers in India is expected to greatly reduce the regional
imbalances in the availability of water in different river basins. It helps in utilising
the surplus water, for meeting the basic needs, which otherwise may flow to the sea. By constructing storage dams at appropriate locations as proposed by NWDA, the severity of floods and the resultant damages can be reduced to some extent. The flood peaks in the Ganga and Brahmaputra basins are estimated to reduce by about 20 to 30 per cent. Drought mitigation is another benefit to be achieved from inter-basin water transfers. Hydropower could be generated on a massive scale by the storage dams proposed under the interlinking of rivers. Most of the mega cities and urban centres in the country are already suffering from water shortages and many of the metropolitan cities depend upon long-distance inter-basin transfer of water for their domestic and industrial water supply. Most of the link canals are having a width varying from 50 to 100 m and a depth greater than 6 m. These interlinkings will greatly facilitate inland navigation from the north to down south. A boost to fresh water fisheries is also expected as a result of IBWT. Apart from these benefits, guaranteed minimum flows in the rivers are supposed to enhance ecosystem services and environmental wealth. However, the environmental impact of these projects, particularly in the context of climate change, has not been studied in detail.

The Periyar Project, Parambikulam-Aliyar Project, Kurnool-Cudappah Canal and the Telugu-Ganga Project are some of the examples of existing inter-basin water transfer schemes executed in south of India in the 19th and 20th centuries.

1.3 BACKGROUND OF THE STUDY

Parambikulam Aliyar Project (PAP) is a complex interstate multibasin multipurpose project commissioned in 1960s jointly by the Governments of Tamil Nadu and Kerala, facilitating inter-basin water transfer, with irrigation, power generation and drinking water supply as important components. It was conceived and executed for sharing the waters of three interstate rivers of the states of Kerala and Tamil Nadu, lying in the southern peninsular region of India. The historical documents on the PAP reveal that the original idea of this water sharing project dates back
to 1921. The PAP got materialised after prolonged discussions between the states of Kerala and Tamil Nadu. This project is recognised as the outcome of hard and sustained work done by a group of enthusiastic engineers who braved many natural disasters. The formal inauguration of the project was done by the first Prime Minister of independent India, Pandit Jawaharlal Nehru, on 7 October 1961. However, the construction of main network of the PAP was completed in 1970s only. During his inaugural speech, the then Prime Minister described the PAP project as the symbol of interstate cooperation in India (Padikkal and Rema, 2009). But recently, a few issues have cropped up mainly due to the water shortage for irrigation in the region.

The Aliyar reservoir constructed in the Aliyar river is a part of the Parambikulam group of reservoirs. Two irrigation canals, viz., Vettaikaranpudur and Pollachi canals take off from this reservoir and this reservoir is also meant to meet the requirements of the command area in Tamil Nadu and Kerala on the downstream side. The water released to the Aliyar river from the reservoir, after meeting the requirements of the command areas in Tamil Nadu, flows to the Chitturpuzha Project (CPP) to meet the irrigation requirements of the command area in Kerala as per the agreement.

The Chitturpuzha sub-basin of Bharathapuzha in Palakkad district is situated at the tail-end of the PAP system. The habitation of the area comprises mostly of farmers and agricultural labourers. The average annual rainfall in the area is only around 700 mm whereas the average annual rainfall of Kerala State is 3000 mm. During the past few years, frequent variation in the annual rainfall is observed in the area. This is the major reason for the people of the area to show concern for the water let into the Chitturpuzha from the Aliyar dam in Aliyar sub-basin of the PAP system. The present water allocation is based on the water supply pattern calculated in the 1970s. After 30 years, the earlier entitled quantum of 7.25 TMC is insufficient for irrigation and other purposes in the command area of the CPP due to several reasons like change in cropping pattern and variation in rainfall.
More recently, the sustainability of this water-sharing project has been questioned due to the changed social, economic and environmental conditions. Some disputes have risen between Kerala and Tamil Nadu on various aspects of the PAP, particularly with respect to water sharing. Tamil Nadu often restricts the release of water to Kerala side, which is leading to a situation of unrest in the region. Kerala State, which is the lower riparian, came up with the allegation that Tamil Nadu has violated the PAP agreement. In the recent decades, many questions have also been raised with regard to the limitations of the project (Padikkal and Rema, 2009).

There is an ongoing movement in Kerala to create awareness among the public about the impact of PAP on the river systems, supported by the media and Non Governmental Organisations (NGO) who work for the conservation of the river system and water distribution. The PAP agreement was open for review in 1988 as per the original agreement. Since then, Kerala and Tamil Nadu are holding a series of discussions at different levels. But a sustainable water sharing pattern acceptable to both the states has not been evolved from the discussions so far. The procedures for the revision of PAP agreement have not been completed. Discussions reveal that the project is not sustainable both from social and environmental angles. The sustainability and water sharing issues of the PAP have become a great concern for the people of the region and the Kerala Government has very recently referred the matter to the Supreme Court of India.

A planned operation of Aliyar reservoir is expected to help in efficient utilization of the available water, ensuring sustainable water sharing with regard to the PAP and removing the apprehensions of the people in the lower riparian state. From the available literature, it is revealed that there is scope for efficiently and effectively managing the system with the application of mathematical modelling techniques to reservoir operation problems. A comprehensive approach would be useful in developing real-time reservoir operation models.
The scope of the study is to understand the present water management scenario of the Aliyar sub-basin in the Bharathapuzha basin and to devise rules to optimally manage the inflow coming into the Aliyar dam lying within the PAP system so that the downstream command area of the CPP of Kerala State would be benefited to a greater degree. The present study is intended to provide a general guideline for the efficient operation of the Aliyar reservoir for better utilization of water resources in the Aliyar sub-basin.

1.4 OBJECTIVES

The present study aims at developing a decision support system for the Aliyar reservoir of the PAP through a detailed simulation study. An optimisation exercise also has been attempted. The objectives of the study are:

- To understand the present operational features and irrigation water demand of the Aliyar reservoir of the PAP
- To recognise the on-farm operational efficiency based on a socio-economic survey
- To come out with a simple decision support system for the Aliyar reservoir using simulation and optimisation techniques.

1.5 ORGANIZATION OF THESIS

The thesis comprises of seven chapters.

Chapter 1 brings out the scientific and practical importance of the study and justifies the need for a study on the present operational features of the Aliyar reservoir of the PAP and the irrigation water demand of the Aliyar sub-basin. Background of the study and objectives are detailed in this chapter.
Chapter 2 gives a brief review of the published literature with reference to the different analytical and modeling techniques applied in reservoir system management and brings out the relevance of the techniques made use of in this study.

Chapter 3 outlines the geographical characteristics of the basin system studied. The details of the Aliyar dam, and inter-basin regulations are also presented in this chapter. Hydrological aspects of the system along with the sub-systems are described and the basic irrigation demand is computed.

The sustainability analysis of the system and sub-systems carried out are presented in Chapter 4. A decade-wise analysis conducted to assess the trend in the performance of the systems over time is also presented in this chapter.

A stakeholder consultation process through semi-structured interviews and informal discussions was conducted to assess the performance of the system and to investigate the concerns of stakeholders in the command areas. The details of the survey are presented in Chapter 5.

Chapter 6 details the simulation analysis done using fuzzy logic and artificial neural network. The performance of the simulated models is evaluated using the standard statistical tools. The chapter also presents the results of a simple web-based optimisation for the Aliyar reservoir and also a comparison of findings obtained from the simulation and optimisation exercises.

A real-time modelling is presented in Chapter 7 by modifying the demand in the command area incorporating the feedback from the field survey.

Chapter 8 presents the summary and conclusions drawn from the study and also the scope for future investigations for efficient water management in the Aliyar command area of the PAP.