Chapter 1

Introduction

Agriculture is the backbone of the Indian economy. More than 55-60% of the country's working population is engaged in agriculture. Agricultural growth and sustainability largely depends on water, which is the prime input. The Indian monsoon is known for its vagaries. Almost 85 percent of the rainfall is provided by the Southwest monsoon (June to September) and some parts of Southern India receive rain from the Northeast monsoon (November to December) as well. Rainfall distribution is uneven with respect to time and space, which is frequently erratic. The mismatching of rainfall and crop-water requirements is quite common. A large part of the country is arid and semiarid as rainfall is not sufficient to ensure even a single crop. Furthermore, the low-rainfall areas of the country have a fairly high coefficient of variation. Droughts are experienced quite often in one part of the country or another. Irrigation is, therefore, an inseparable part of the welfare of Indian agriculture.

The management of irrigation in India differs conceptually from that practiced in those developed countries where limited water is not a constraint. Good management, efficient operation and well-executed maintenance of irrigation systems are essential to the success and sustainability of irrigated agriculture. They result in better performance, better crop yields and sustained production. One of the key objectives in the management of an irrigation system is to provide levels of service as agreed with the relevant government authorities and the consumers at the minimum achievable cost.

In many parts of the world, irrigation systems are performing well below their potential. The problem of poor irrigation performance has stimulated the interest of a whole range of development professionals. There is unanimous agreement among them for the need to improve the operation of irrigation systems in order to increase productivity. In most countries great importance is now placed on programs for rehabilitation, operation and maintenance of existing projects. However, works included in these programs are often limited to canal lining, land leveling,

construction of additional control structures, rehabilitation of existing control structures, improvement of access roads and to non-physical components such as staff training, improvement of cost recovery systems and so on. Too often, not enough attention is paid to alternative approaches to irrigation management, system operation and design.

Generally canals are used for water distribution to remote areas. Large canal network is developed in last few years all over India, one of the major developing countries in the world. Canal network includes main, branch, distributaries, sub-distributaries, and minors. Measurement of Discharge and level in open canal is quite difficult, and appropriate method should be implemented at specific site. It is learnt that, unless canal efficiency is improved, it is difficult to mitigate the water problem in future. The wastage of water must be controlled to achieve the goal.

The first step towards the improvement in the canal efficiency is to make discharge measurements at all the inlets / outlets of the canal, make water audit, analyze the same and take corrective action. Water being very sensitive issue, with the social aspect, any change has to be done very carefully.

Monitoring and Automation of Canal Network is quite a recent concept. Initial work started in 1975, and picked up since 1985 in developed countries. Implementation of similar pilot schemes started in India during the year 1995. These schemes were implemented mostly by SCADA personnel. The working of SCADA in industrial environment is quite different than Water Sector applications for Dams, Canals and Water Treatment Plants (WTP) etc. SCADA requirements for water sector applications are fairly different, as they have to cater to completely different requirements and environmental conditions. The system has to work without any holidays, thus we cannot have any preventive maintenance concept, in this system.

All the above facts kindled the path of research work to design the most useful, cost effective and easily implementable system, suitable for Water Resource and Water Distribution authorities, throughout the country; improving Agriculture yield, by delivering water exactly at right time in right quantities, avoiding wastage, thus improving the operational efficiency of the canal.

The flexible, high-quality operation of a canal system will yield many benefits, some of which are:

- Increased crop production.
- Reduced effects of climate change
- Accurate and equitable distribution of water.
- Reduced Water wastage.
- Reduced water use.
- Improved response to emergencies.
- Better service to the Water User Associations.
- Social benefits (user's satisfaction, less conflict).
- Increased power generation.
- Improved Standard of Living of Labor.
- Convenient water management.
- Decreased flood damage.
- Environmental protection.
- Fish and wildlife enhancement.

The management of irrigation systems has gained importance over the last five decades due to tremendous increase in irrigated area in most of the developing countries in general and India, in particular, primarily as a result of massive investments and improvements in new and existing surface irrigation projects. There has been a growing realization of possible improvement in water management for a more efficient use of the available water resources, as the cost new projects is prohibitive. The potential of improved Instrumentation, Communication, Computer Science and Information technology applications for improved irrigation system management was realized long ago, but concentrated efforts on this front have only been made in the last ten to fifteen years. The use of computers, communication and information to control irrigation systems will yield many benefits, resulting in obvious economic savings and in intangible benefits whose value cannot be measured in monetary terms.

The engineering side includes modernization and rehabilitation of all headwork and their replacement where they have outlived their usefulness, and modernization of

canals, canal structures, in particular the regulating devices, provision of additional cross regulators, permanent outlets.

The administrative side includes the consolidation of land, volumetric supply of irrigation water, changes in water rate policy, reduction in interstate water disputes, educating farmers and the like.

All of this can be achieved by improved water management at farm level, keeping in mind the existing constraints of the physical system and its operational constraints.

It is easier to plan and design a new project to be operated on the canal automation concept than to implement that concept in existing water resource projects. Physical and operational constraints must be evaluated and based on the impact of each constraint; the dynamic system design approach will have to be formulated to produce an economical technical solution.

It is essential to consider the root cause of the failures of the systems implemented in developing countries in general and India in particular, and design and implement the most applicable one. It seems quite easy on paper, but it is really tough task to Design, Implement & Run such a Canal Automation system in India. The regional problems also must be addressed in a different fashion.

Inadequate or excess water in quantity, time and space are the primary constraints on agricultural production. Normally, tail-end users are those who do not get their legitimate share of water. Due unreliable availability of water through canals, farmers generally irrigate their farms with as much water as possible and as frequently as possible whenever water is available. This practice not only reduces the farm yield but cannot be continued when water for irrigation is insufficient. Application of more water to crops does not necessarily mean better yields; on the contrary, it may lead to problems of water logging and thereby adversely affect crop yields, including increased salinity in the soil, degrading it still further.

The first step towards the monitoring of canal network is implementation of Supervisory Control and Data Acquisition (SCADA) system helping in delivering required quantum of water on-time, as per the pre-defined schedule by analyzing the

complete network, for all scheduled / unscheduled requirements. It also generates various reports; trends, graphs etc. Statistics generated can be utilized for improving the water utility and in turn the canal efficiency.

Implementing SCADA also helps in resolving rural Drinking and Agriculture water problems improving the standard of living in rural areas, reducing the gap between Rural and Urban societies, bringing about the social balance. Improved Industrial output is also achieved by implementing SCADA.

Implementation of SCADA in Developing countries is a challenge due to various reasons. Once successful, at one place, it can be adopted at other places with minor changes suitable for local conditions and to other Developing Countries.

Since most of the research is made at various sites in India, during the professional assignments by the researcher, resolving site problems, in general, make it operative and then converting the solutions useful globally (specific to developing countries). The results thus obtained are implemented on specific sites and does not carry any inference with respect to references mentioned. Most of the references relates to either developed countries or of theoretical in nature, as regards to developing countries like in India, since no similar work is carried out and in operation so far. The references as mentioned are for study purposes only so there is no citation of the same in the normal thesis.

The basic objective of the research is to Define and design a most suitable, implementable, easily operable, convenient and cost effective system to improve canal- efficiency to make the water available, "At right place, In right quantity, At right time, for Agriculture, Drinking, and Industry", help improving the overall standard of living of a common man, more on the rural sector in developing countries in general and India in particular, thus improving the utility of this natural resource - THE BLUE GOLD

This task is sub divided in to

- Reliable (Tamper proof) and Accurate Discharge and Level measurement system
- Selection of Proper Power Supply Source.
- Control Algorithm for particular application.

- Selection of Proper discharge scheme.
- Adaption of most suitable Communication method
- Most effective GUI and SCADA system at Master, SCADA Stations.
- Implementation of concepts at field.

Most of the work is carried out at the field, during professional commitments.

The thesis is organized in six chapters as:

Chapter I – Introduction discusses the basics of the growing concerns about water. Water is getting scarcer and scarcer, due to a many reasons, like increasing Population, Industrialization and increased Agriculture. Conservation of Water is the only solution to mitigate this ever growing problem. Open canals is one of the major means of carrying water for Drinking, Irrigation and Industrial use at distance. This chapter describes the typical canal control system. The effectiveness of availability of water for use, at any particular part of the canal, at particular time, depends upon canal network efficiency along with control system. Measurements of parameters like discharge, level, gate openings, temperature etc at Head and Cross Regulators and sector (or reach of the canal) are key factors in confirming the canal efficiency. Generally, Head Regulators and Cross Regulators are used to control the water through the main canals, their distributaries and sub- distributaries.

Chapter II – Present Scenario covers the details of the researcher's visits, observations and analysis of the results, of similar schemes executed in India, and during professional career, while installation of similar systems, during the period of this study.

Chapter III – Measurements of Canal flow parameters with communication system: Measurement of flow in open canal is very tricky. Many methods and equipment are available, though all the old methods are still in use, and followed. Various improved open channel flow measurement equipment are available due to Advancements in Electronics, Instrumentation, Sensor technology and Software with detailed study of Hydrology. This chapter also deals with various Sensors used for water level and discharge measurements in the canal with basic capabilities and limitations. Communication is a mission critical parameter for proper operation of the

system. Various methods of communication systems are considered in this Chapter with advantages and limitations of each method.

Chapter IV – Control Philosophy: This chapter deals with the following canal control philosophies.

- Upstream Control.
- Downstream control.
- Constant Volume Control
- Controlled Volume Control (Dynamic Regulation).

All of these control systems are explained explicitly, with its advantages and disadvantages.

Chapter V – SCADA System and Power Supply This chapter relates with control philosophy algorithm and typical software for data collection, validation, computation, and display with proper GUI, with appropriate data storage schemes for such huge data. The software also generates alarms, and intimates the same to proper authorities via GSM. Proper selection of both the computer Hardware and Software is of primary importance, as the system has to work round the clock. Other software additions, like event logging, event printing, generating and printing proper reports, trend curves, water auditing etc. should be a part of the SCADA. Controlling the Communication is also a part of this SCADA. **Power supply** deals with the use of power supplies for the total scheme, more related to measuring stations. Though variety of power supplies are available, one must be very critical in implementing a proper solution. It also refers to some typical design calculations for Solar Power at Measuring Centers. This investigation also suggested another unconventional source of energy for this particular application, though some trials must be taken.

Chapter VI– Conclusions & Future Scope: This chapter gives a review of a new scheme, from concept to inception, with maintenance of the same, including defining most suitable scheme considering the site conditions typically applicable for developing countries, along with the financial implications. It indicates the analysis of probable mixed control method to be adopted for new scheme, with appropriate methodology, consultant, and implementation. This chapter also includes topics like

documentation and training to office and field staff, an essential part for proper running of the scheme.

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