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INTEGRATED APPROACH FOR WATER AND WATER MANAGEMENT

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SUMMARY - The main purpose of water resources development is to put the water in sufficient quantity and at desired quality under guarantee at the desired time and location, and prevent human life against the detrimental effects of these resources. It is obvious that water resources development projects for irrigation purposes have significant economical and social functions such as increasing productivity in agricultural sector, accelerated economical development, decrease in migration from rural areas to towns and cities, contribution toward the solution of unemployment problems. The basic objective of irrigation projects is to raise the economical and social welfare of farmers to the possible highest level. To meet this objective, it is necessary to establish a proper operation-maintenance and management organization and also to establish an effective input supply and marketing system along with an effective training and broadcasting. Environmental factors were stressed out in Turkey especially after 1980s. Water quality spoiled out due to fast urbanization and industrialization and available water resources decreased. Water quality spoils along the river basin are principally based on the factors such as industrial and domestic waste water utilization in agriculture, types of land utilization, soil properties, sediment transport and erosion. All these factors brought into the agenda the new approaches in water resources development and management. Development of economical potential of above and under ground water resources with a sustainable approach along with the consideration of environmental effects has a significant importance to maintain sustainability in socio-economical development. A sustainable water resource development will only be possible by a proper institutional mechanism, participated management, and full payment of the cost of all the water related services by the beneficiaries, sustainability of research and development activities and selection of proper technology.

Key words: agricultural water management, participatory irrigation management, Turkey.

INTRODUCTION

Turkey has important soil and water resources. However, proper utilization and development of these resources require large investment and labor. Industrial and domestic water demands are increasing day by day due to intensive irrigated agriculture to meet the food demand of increasing population and due to fast industrialization and urbanization along with socio-economic development. Meeting these increasing sectorial demands makes the management of this limited resource a complex issue. Maintenance and operation of irrigation facilities constructed by DSI initially were carried out by DSI. However, along with the changing and developing conditions and due to irrational operation of these facilities by the state, non-performing the maintenance and repair services fully, and due to the cost of these facilities to the state, a participatory irrigation management approach was brought into agenda and adopted too. In this way, active participation of the users into facility operation, maintenance, repair and water management were aimed to be provided.

Privatization in agricultural sector is carried out by farmer participation in projects. Farmer participation in irrigation projects is provided in various ways. In Turkey, following the construction, facilities are transferred to farmers provided that ownership belongs to the state. The main objective for the transfer of irrigation facilities to the operating organization is to provide the adaptation of the users to the water management services and to provide active participation of the users into operation, maintenance, repair and water management services. Developed countries have already left the field based evaluation of the problems, they prefer to solve the problems at watershed level. Natural resource preservation in some watersheds is assigned to the watershed management established by the people living on these watersheds. Watershed is defined as a basic unit providing environmental and socio-economic benefits enhanced with a proper management. Preservation of soil and water resources at watershed level is seen as the best alternative toward the water quality

preservation and development. Natural resource preservation has become an important issue in Turkey and works have already been started toward the sustainability of these resources.

WATER MANAGEMENT PROBLEMS IN TURKEY

As it was in most of the developing countries, in Turkey, objectives haven't met in irrigation projects to which large amounts of budgets were allocated even after several years from the system construction and these systems were operated highly below their potentials. That is why, there is a need for a monitoring and evaluation system, which is able to decide and warn irrigation management about whether the desired benefits were obtained or not by using the performance indicators. Then, a strategic management unit, which is able to evaluate the system with a proper performance indicator, set applicable in country conditions has to be formed within the association.

Improper irrigation applications and management and deficiencies in operation-maintenance and management organization and training system caused the problems such as of excessive water use, erosion, rise in water table, desertification in soils and irrigation rates and efficiencies remained at low levels (64% and 44%, respectively) and an effective water use couldn't be provided. Irrigation water cost return rates at highly low levels, 17% and increase in land area opened for irrigation year by year caused an excessive load on the budget allocated to maintenance –repair and management of state operated irrigation schemes. That is why, maintenance and repair couldn't be carried out for much irrigation and significant amounts of renewal need were arisen. In addition to this, service providence by the state to increasing irrigated lands was become a difficult issue.

Due to the lack of an efficient and sufficient farmer training service, soil-plant-water relations in irrigated agriculture and effect of them on human and environment are less stressed out. Then, the producer can no be sufficiently trained and, as a result of this, problems such as excessive water use, improper land preparation for irrigation, drainage, high water table, and salinity are arisen. State invest approximately 4,600 dollars/ha as irrigation infrastructure to irrigate the land. Considering this big investment on irrigation, state does not spend even 1% of this amount for the training of farmers.

Success of an irrigation association depends on preparation of a proper irrigation programming and water delivery programming based on current conditions. This issue is especially important in regions with limited water resources and it provides a significant increase in yield and water use efficiency. In this works, climate, soil and water resources of the region, properties of plants grown, irrigation system and irrigation method used, and farmer demands and decisions of association management are all taken into account. The biggest problem in irrigation is not to provide the right amount of water to the plant at the right time.

Water pricing in Turkey is carried out on the basis of irrigated land and the type of plant grown since the infrastructure to measure the amount of water used by the enterprises is not sufficient and a few association are using pricing based on 'irrigation duration' (TL/hour). A pricing method based on volumetric basis will encourage the water saving methods and technologies. The infrastructure for volumetric basis (m^3 or hour) has to be established and the transition has to be speeded up.

The researches have shown that control on irrigating farmers was insufficient and farmers were using couple time higher amounts of water than they need to use. This is mostly due to lack of farmer training and lack of water management practices in associations. Planned water delivery works based on farmer demand has to be changed in to a state preventing the farmer excessive water use. As a result of this, farmers earn less due to yield loses and wash out of plant nutrients on one hand, sustainability of natural resources are endangered on the other hand due to the environmental reasons such as soil erosion, rise in water table and desertification.

Pricing of water fees are determined on water prices lists prepared by association technical personnel and approved by Association Council and collected as whole in advance or in installments. The collected money is used for operational costs of the association and for repair and maintenance. The assistance is requested for costly repair and maintenances from DSI.

Since the most of association operated irrigations schemes are old facilities, they have high annual repair and maintenance costs. Especially renewals of the earthen channels with the concrete paved

channels, outlet and measurement structures on channels, prevention of high water tables are all costly issues. The irrigation fees cannot meet the repair and maintenance cost of these old facilities. On the other hand, associations allocate a small amount of their annual budget (0.5-1.5) for repair and maintenance. With these little funds, productive operation and development of transferred schemes will not be possible. Programs toward the modernization and rehabilitation of irrigation facilities have to be developed.

The training activities for irrigation engineers and water delivery technicians before or after the association establishment are not sufficient. Irrigation association administrators and personnel employed in associations are not trained enough about operation and maintenance of irrigation schemes, water management issues, especially plant water consumption, irrigation water demands, irrigation time scheduling, preparation of water delivery plans.

Sufficient equipment and machinery are needed in irrigation associations to perform the repair and maintenance needs on time. A machinery park has to be established for this purpose. Assistance should be provided to the associations in this issue, a shared machinery park could be established on a basin or region scale.

AGRICULTURAL WATER MANAGEMENT RESEARCH AND APPLICATION PROJECTS

"Management Operation and Maintenance of GAP Irrigation Systems Project", coordinated by GAP Regional Development Administration, has significant contributions toward the formation of the basis for planning of "Agricultural Water Management Research and Application Projects". The main purpose of the agricultural water management research and application project is characterized as follows:

- To protect natural resources at the basin level;
- To make some studies about water management on the basis of the irrigation association;
- To make some basic and applying researches on the hydrology, water resources, erosion, sedimentation, water quality, water management and land use;
- To make alternative solutions about basin management by forming database for a sample plot area;
- To educate both farmers and technicians working for the irrigation association or governmental offices;
- To make cooperation with the universities, research institutes, and irrigation associations in both, inside and outside of Turkey;
- To make evaluation of the irrigation management with two years field studies, and to put some alternative solution on the plot area (Salihli Right Side Irrigation District);
- Making an evaluation on natural resources protection, testing with models and setting a database for watershed management in a plot watershed to be selected;
- To make appropriate water distribution in current conditions by using irrigation based on management information system.

The studies to realize these aims were given in Table 1. Project steps are given in table below.

Table 1. Irrigation District and Watershed Related Studies

Studies Related to Irrigation District	Studies Related to Watershed
❑ Current data ❑ Properties of the soil and water resources ❑ Physical efficiency ❑ Management efficiency ❑ Capabilities of the farmers to determine when to irrigate ❑ Maintenance, operation, planned water distribution ❑ Education for both farmers and technicians	❑ Watershed boundaries ❑ Hydrologic events and water quality ❑ Watershed database model ❑ Appropriate hydrological models ❑ Some alternative solutions to protect natural resources

Salihli Right Bank Irrigation Association

Water resource of the irrigation association established in 19.12.1994 in Salihli Town of Manisa is Demirköprü dam on Gediz River. Construction of most of the irrigation facilities, Adala regulator and irrigation channels were started in 1933 and first phase was put into operation in 1942. Construction of secondary and discharge channels were completed between the years 1959-1963. Concrete pavement of the tertiary channels was carried out between the years 1966-1968. Deepening of discharge channels were taken under the scope of Lower Gediz project, works were started in 1982 and completed in 1984. Gross irrigation land area of the association is 9101 ha. Net irrigated land area between the years 1995-1999 was about 6000 ha. In addition to this, about 2500 ha area, mostly owned by big enterprises, is irrigated by underground water. Within the irrigation area, there are 2 counties, 11 villages. Association serves for 1462 taxpayers and there are 4246 plots located in irrigation area. Average plot size is 2.14 ha. There is a total of 294 km long irrigation channel as of 20 km long earthen main channel, 69 km long secondary channel and 205 km long tertiary channel, 277 km long drainage channel and 110 km long service road available in irrigation area. Irrigation channel length for unit area is 32.3 m/ha and length of drainage channel is 12 m/ha. A serious repair-maintenance and cleaning work were not carried out in channels since 1980. Checks and outlets panels on secondary and tertiary channels are repaired by the association when necessitates. An excessive destruction was arisen on concrete paved tertiary channels. It is necessary to replace these 40-60 years old concrete paved channels with closed pressurized pipe lines.

Weed development in irrigation channels is at its highest level. Reeds, canes and deposited sediment have to be cleaned our regularly. Rise in water table occurs since the drainage channels are not cleared and this affects the yield negatively. Generally, furrow irrigation method is applied in irrigation area and border irrigation is also applied in limited manner. Currently, the other methods are not available. Since water delivery based on irrigation scheduling was not carried out, excessive water use negatively affects the soil quality.

Training about irrigation was significantly insufficient or almost not available. There is not an institution or agency making an effort toward detailed irrigation scheduling based on daily meteorological data and application of this plan and toward the irrigation training. That is why the benefits expected from irrigation investments can not be provided.

Farmers were actively participated in establishment of the association and association elections. There are 42 council members in association management. A general secretary, an accountant, 7 water delivery technicians, a machinery operator, a guard, an office man are permanently employed in irrigation association and when needed temporary personnel are employed. 27 hand radio communicator, a computer, 2 trucks, a tractor and trailer, a grader and a rubber wheeled loader are available in the irrigation association.

When the irrigation demands are above the channel capacity, water demands of farmers are met with 1-2 day delay. The farmer receiving water carries out his irrigation in the same day as long as he needed. However, determination of irrigation duration based on soil, climate and plant conditions of the region will definitely prevent the excessive water use.

Demand based water delivery is applied in the association. However, apart from the other associations, besides the land area, number irrigation is also used for water pricing. Irrigation requests are collected a day ahead of the irrigations. During the irrigation season, for the first irrigation request, the water price is collected in advance. Water prices for the other irrigations are collected in November. For the farmers who have irrigated his filed 5 times or more, water prices for the irrigations starting from the fifth one is reduced by 50%. A considerable problem is arisen in water fee collection and farmer abeyance to irrigation order.

Revenues of the association consist of water fees, late payment fines, interest revenues and the other revenues. Total cost for the year 2002 is 387 billion TL (Turkish Lira). 105 billion was used for personnel, 30 billion for running and 252 billion for repair and maintenance. All these costs were covered by association revenues.

Project Activities

i) Monitoring of meteorological parameters and their application into irrigation planning are extensively seen in developed countries. An automatic meteorological station, able to gather climate data at 12 minutes intervals, was bought and placed at a location representing the Salihli Right Bank Irrigation Association area and precipitation, temperature, relative humidity, solar radiation, wind speed and direction values were gathered. Together with the station, plant water consumption and vineyard disease modules were also bought and put in to use of Local Directorate of Agriculture and irrigation association. Vineyard disease module has provided opportunities for directorate of town agriculture to warn farmers against diseases.

ii) Before the irrigation season, a questionnaire study was carried out in 13 villages covering about 550 farmers to determine the farmers' thoughts about the irrigation association to evaluate their irrigation practices. The questionnaire has clearly shown how well the activities of the association were adopted by the farmers and how big the social problems in irrigation operation.

iii) The 24 soil profile pits were opened to update the information about different soil series in study area and 18 of them were defined. Soil samples from each profile were taken in horizon base, and the samples pre-processed and were made ready for laboratory analysis. Structure, field capacity, permanent wilting point, pH, electrical conductivity, lime content, organic matter, exchangeable cation capacity analysis along with physical and chemical analysis such as unit weight, hydraulic conductivity were carried out on these samples. The resulted data were evaluated. In field, 157 boring were made to determine the boundaries of each series, then detailed soil map was completed and "Basic Soil Map" with a scale of 1/25000 was created. In detailed soil investigation and mapping studies, soil series and their phases were used as mapping units.

iv) Salihli Right Bank Irrigation area has 8 secondary and 113 tertiary channel. Water is taken to earthen main channel from Adala regulator. Water level in main channel is measured by DSI with 7 electronically limnigraph (Fig. 1). 6 of these electronic limnigraph Y1, Y2, Y3, and Y4 are placed in secondary channels, Y2-T37 are placed at tertiary channel entrances and Y2 is placed in the middle of the channel and one electronic limnigraph is placed in main discharge channel to determine the amount of drainage water.

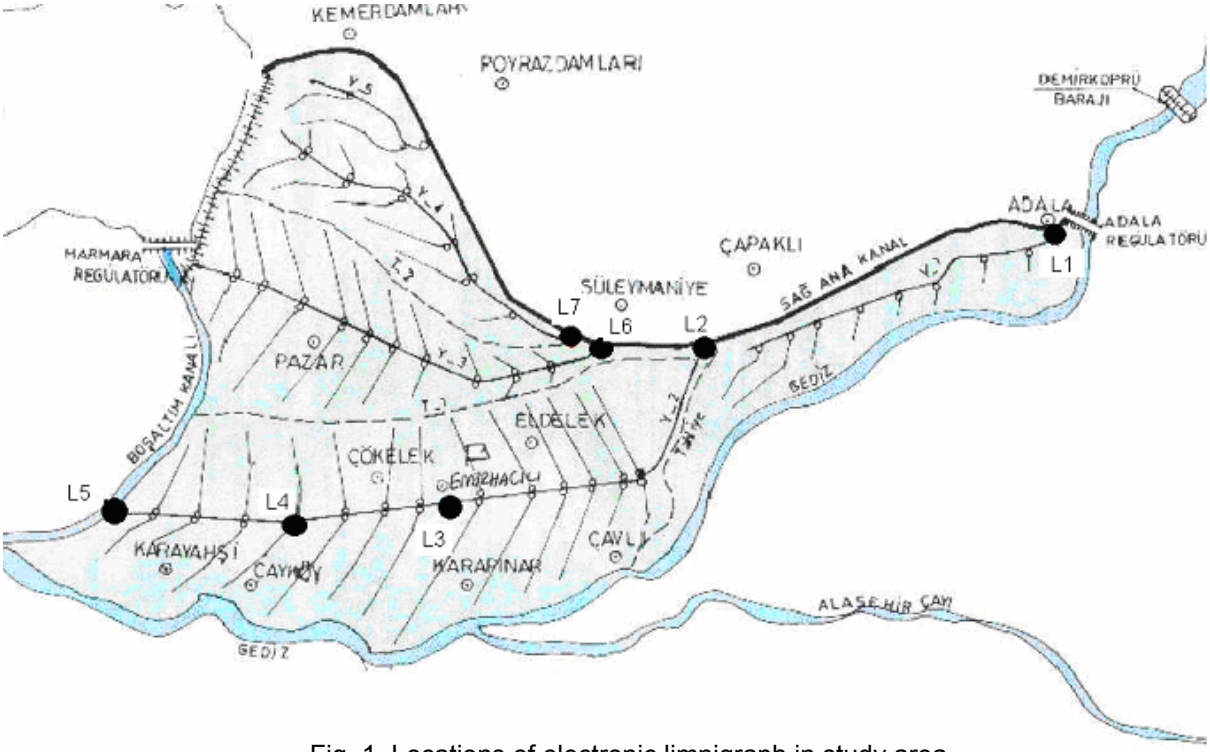

Fig. 1. Locations of electronic limnigraph in study area

v) During the irrigation season between the dates of June 15 – September10, water conveyance efficiencies for secondary and tertiary channels were determined. It was determined that some tertiary irrigation channels have significantly low water conveyance efficiencies.

vi) 25 plots were selected based on soil investigation results, plant types, and villages. 3 access tubes were placed in each plot. Soil humidity measurements were taken before and 24 hours after each irrigation at selected plots with Aquapro Soil Moisture Sensors which uses the electrical conductivity method for humidity determination. The resulted values were used to determine the water application efficiencies.

vii) Since one of the most important problems is the rise in water table in study area, 83 observation wells were opened and periodically water table elevations were measured at 61 of them. Beside the water elevations, electrical conductivities of well waters were also measured.

viii) To evaluate the environmental effects of irrigation, water samples were taken each from irrigation and drainage waters in each month and electrical conductivity, biological oxygen demand (BOD) and chemical oxygen demand (COD) values were determined for these samples. For this purpose, water samples were taken from irrigation and drainage waters before the irrigation season, between the irrigations and at the end of irrigation season and the above mentioned analysis were carried out on them. The results have shown evidences about possible use of drainage water.

CONCLUSIONS

To provide the desired benefits from the irrigation projects which were constructed by allocating big budgetary amounts, the following issues have to be considered:

- Provide an organization and farmer participation in an approach from bottom to top;
- Transition to closed pipe pressurized irrigation systems;
- Encourage the application of modern irrigation and agricultural techniques;
- Prevent the excessive water and fertilizer use;
- Water delivery planning based on irrigation time scheduling and current soil-crop-climate conditions;
- Employment of irrigation expert group in water user organizations;
- Dividing the water user organizations into water user groups;
- Provide participation of water users into all irrigation related costs;
- Encourage contracted farming;
- Provide a inter-institutional coordination;
- Prevent off-purpose use of agricultural lands;
- Always take the environmental protection and sustainability into consideration in all these activities.

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