Wat. Sci. Tech. Vol.16, York, pp.435-441. 0273-1223/84 $0.00 + .50
Printed in Great Britain.

WATER QUALITY MANAGEMENT IN SAKARYA RIVER BASIN: I. PLANNING PHASE

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ABSTRACT

This article deals with the planning of water quality management studies of the "Sakarya River Basin Management Project" which was submitted to NATO Science Committee for support through the Science for Stability Program. The background and justification of the project are described and then the objectives are presented by phases. The activities that have already been carried out in the planning and the feasibility phases are discussed. A detailed account is given of the procedure for mathematical model development and application, and the methodology for monitoring system design.

KEYWORDS

Water quality management, river pollution, mathematical models,monitoring .

INTRODUCTION

Turkey is a country with considerable water potential. Although a fairly large amount of work has been carried out in Turkey in last decades to develop the nation's water resources, only a minor part of the potential is being utilized. In the "Fourth Five-Year-Development-Plan" for the period of 1979-1983, it has been emphasized that the water resources of the country should be used more rationally considering the rapid increase of water demand on various sectors, and the limited availability of these resources in certain regions. It was pointed out that the demand for water in the national scale can be satisfied by the existing water potential into a considerably distant future, the problem being to provide water of an adequate quality and quantity at the times and places it is needed.

In order to develop "a better understanding of water resources management" and to explore "the possibilities of integrated river basin management as the foundation of comprehensive management of the na-

tional water resources for all purposes" , it was decided to undertake a pilot-project in a river basin, the Sakarya River Basin, with assistance from the NATO Science Committee, within the "Science for Stability" program. The basic objective of the project whether national or regional should be to ensure that water is not a limiting factor in the growth of the economy (ITU, 1982). In fact, not only water quantity but also water quality aspects must be taken into consideration in preparing plans for water resources management. These objectives could best be achieved by an inter disciplinary team that would develop possible water resource system designs and management plans, and evaluate their economic, ecological, environmental and social impacts in a system analysis framework. In this context, Environmental Engineering Department of ITU participated in the project to organize, coordinate, undertake, pursue and evaluate the pertinent studies in the field of water quality management. This paper intends to describe the proposed activities of the water quality management project in a procedural approach within the planning phase of the study.

SAKARYA RIVER BASIN

The Sakarya is one of the largest rivers in Turkey and certainly one of the most interesting. Its catchment area is 58000 km^2, approximately 7 % of Turkey's surface area (Fig. 1). The catchment area of

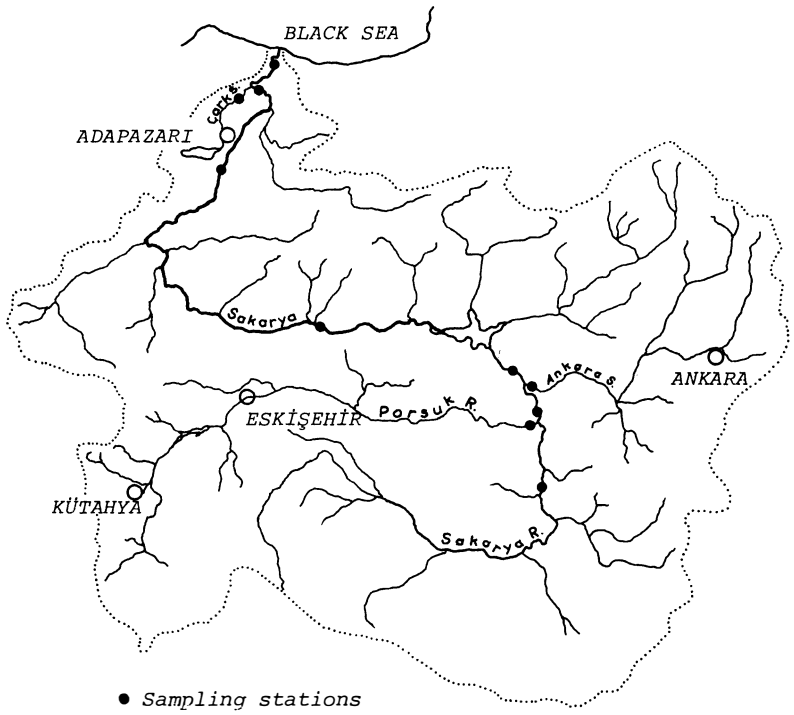

Fig. 1. The Sakarya River Basin.

Sakarya extends through several cities of Turkey, Ankara, Kütahya, Eskişehir and Adapazarı being the major ones. The number of inhabitants in the basin is approximately 4 million, nearly 10% of Turkey's population.

The river's average annual discharge is 190 m^3/s. The Sakarya has a discharge which virtually never drops below 20 m^3/s and seldom exceeds 1000 m^3/s. This means that the river is not suited as a commercial waterway, but it may be suitable as a reliable source of drinking, industrial and irrigation water. The basin includes three hydroelectrical dams, namely Sarıyar, Gökçekaya and Porsuk. At the present time , Gökçekaya Dam is the second largest hydroplant in Turkey. The basin is quite rich in its power potential, with an estimated capacity of 1300 MW.

Agricultural activities in the basin are rather extensive, and consequently the major part of population is engaged in farming. For this reason, several irrigation systems have been designed and put into operation by governmental agencies.

Water for the capital city Ankara is being provided by Ankara Stream which is one of the major tributaries of the Sakarya River.Another important tributary, the Porsuk Stream has been considered as a major source of water supply for the city of Eskişehir. It was reported that a total of $70x10^6$ m^3/year of water could be provided from the Porsuk Dam Reservoir for the city (ITU, 1982).

It is known that pollution problems in the basin are increasing rapidly due to the growth of population and industry. Some tributaries, namely Porsuk, Ankara and Çark Stream are already heavily polluted. (Gönenç, 1979; DSI, 1980). The state of pollution of these tributaries can be described by gross and chemical pollution which are characterised by high level biochemical oxygen demand (BOD) and suspended solids (SS) concentrations. However, the most characteristic observation about Sakarya River Basin is that only pathogenic pollution is present in the main stream, arising from the untreated discharge of sewage, agricultural and animal wastes, and domestic refuse.

Although pollution problems in the basin are increasing rapidly, the basin has a water potential not only to satisfy the future intended uses in the region, but also to provide transfer of water to neighbouring basins (ITU, 1982). Therefore, the need for long-term water quality control and management, as well as the short term water quality control , is obvious.

OBJECTIVES OF THE PROJECT

The main purposes of the water quality management project are to deliver information to water resources management, to assess the effects of water resources management on water quality , and to ascertain the effect of alterations on pollution control works. These main purposes could only be satisfied when proper evaluation is carried out within the framework of the following specific objectives :

1. Providing information on current water quality and quantity (water quality data collection).

2. Assessment of the detrimental effects of present and possible future effluent discharges on water quality in the river basin.

3. Estimation of the impact on quality of large scale river regulation, and of increasing withdrawals from and returns to the river.

4. Determination of consent conditions based upon the river-quality objectives.

5. Evaluation and formulation of the prevention strategy.

6. Estimation of a methodology for water quality monitoring.

7. Recommendation of an authority for comprehensive management of water quality in the basin.

PLANNING PROCEDURE AND RESULTS

It has been proposed that the stated objectives of the study mentioned above can be attained in two major stages :

1. First and second objectives constitute "the short term objective".

2. All other objectives are parts of "the long term objectives".

Flow diagrams of the adopted stepwise procedural approach for these two stages are schematized in Fig. 2 and Fig. 3, respectively.

As illustrated in Fig. 2, all activities have been planned for development of a water quality model, by which assessment of detrimental effects of present and possible future effluent discharges on water quality may be possible.

It has been considered that the natural division of the modelling procedure into two steps, the first related to the use of a priori theoretical knowledge, and the second related to a posteriori measurement knowledge, would be very useful as indicated by Beck (1982). There is insufficient information regarding the water body under investigation to justify favoring one of the numerous mathematical models over another. Thus, a preliminary experimental program has been considered necessary for the selection of main processes affecting the state variables. The state variables may be dissolved oxygen concentration, BOD_5 and concentrations of different species of nitrogen. The state variables are to be considered as the parts of processes, e.g. photosynthesis, respiration, reaeration, degradation, and nitrification. This preliminary survey program has been suggested as a method for estimating the means and variances of the state variables at some point in time or over some relatively short interval of time, during which variations can be assumed to arise from stationary random processes. The locations of the sampling stations are shown in Fig. 1 . The river is rather polluted at these locations which are critical for the development of subbasins. The diurnal variations of the state variables in the critical period which may be during the warmest period of the year and/or the period in which the natural water flow is at a minimum, are proposed to be investigated. Analysis of the data from this preliminary survey will make it possible to select the main processes affecting state variables in the river.

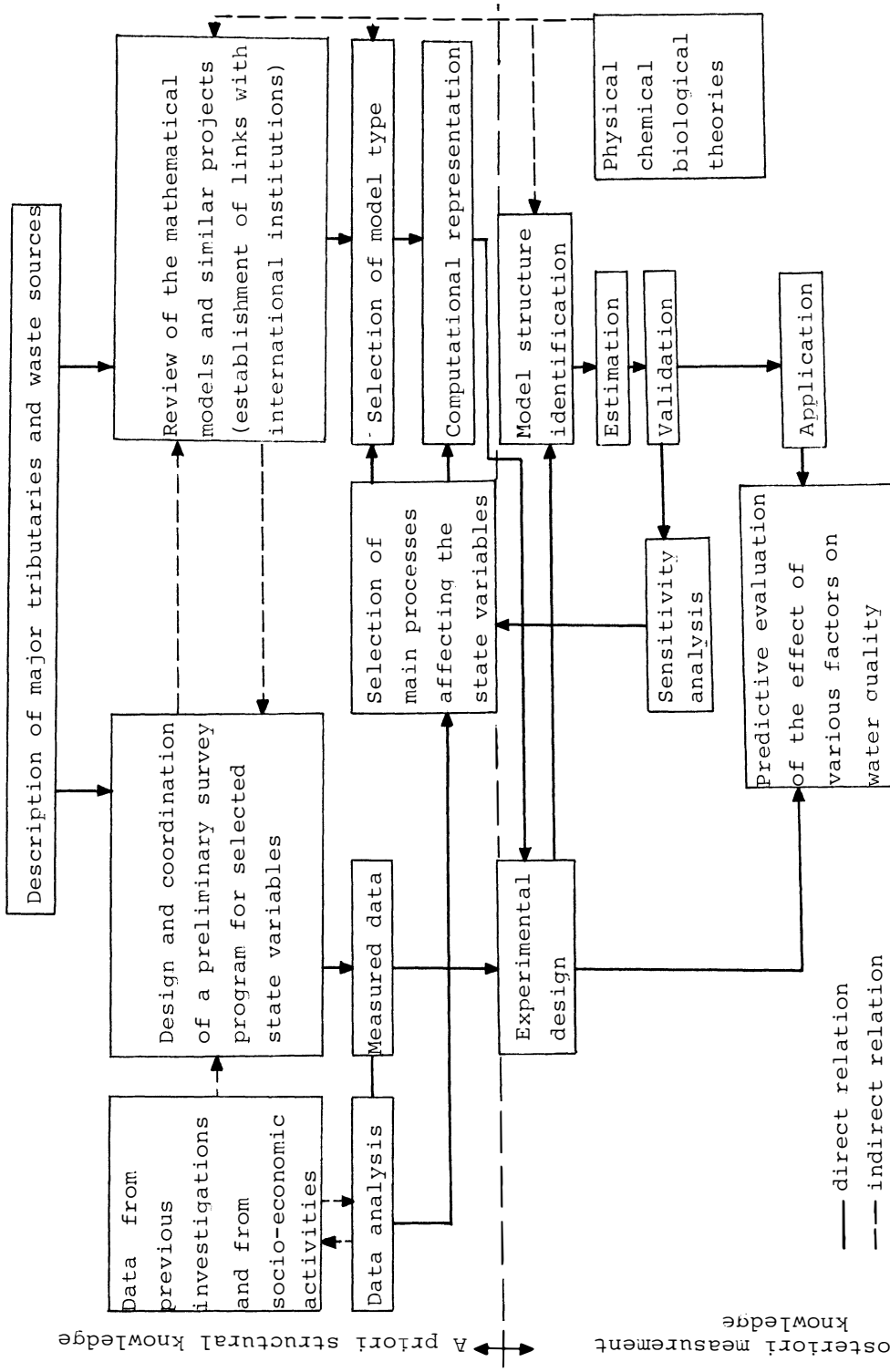

Fig. 2. Schematic outline of the short-term study program, adopted from Beck, 1982

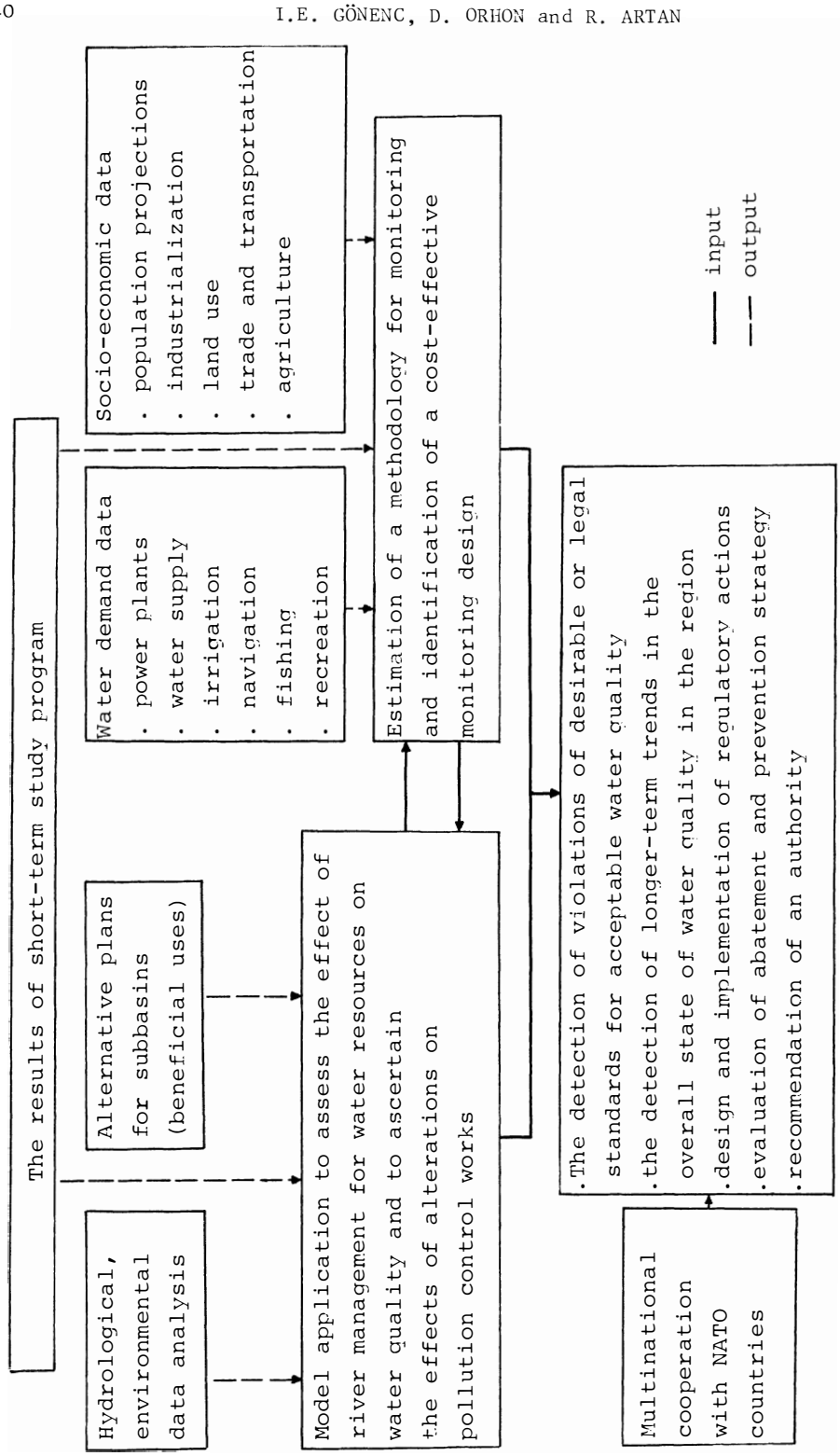

Fig. 3. Schematic outline of the long-term study program

Based upon the collected preliminary data, several alternative models suggested for similar studies elsewhere will be reviewed, and one of them will be adopted according to the procedure given in Fig. 2. The set of continuing case studies may also provide useful information upon which experimental design for model structure identification and model validation can be planned.

The modelling will also be a first approximation for the design of a further extensive monitoring program including all pertinent parameters for all intended beneficial uses in the river basin. The long-term study program, as outlined in Fig. 3, is supposed to be based mainly on the outputs of the short-term study evaluation, along with all supporting data and investigations. The basic part of the long-term study can be summarized as the "estimation of a methodology for water quality monitoring". The multiple purpose monitoring program, required for the study, should be designed to include and to provide for the evaluation of the following elements:

- water quality information for policy purposes,
- design and evaluation of control systems,
- information for enforcement,
- opportunities for efficiency.

The iterative cycle of the system may be outlined as: perception ⟶ monitoring ⟶ data interpretation and design of regulatory action ⟶ implementation of regulatory actions (Beck, 1982).

Another equally important aspect of water quality management, especially significant for Turkey in general, and for the basin considered, is the legal status for the implementation of the forthcoming proposals. As it stands today, the legal situation is such that responsibilities related to water quality control and management are shared between government agencies that act in a way completely independent of each other. But, it is generally accepted that water quality control and management programs should be directed by an authority based on river basin boundaries, and the regional basin authorities themselves be coordinated by an overall central or national authority. Thus, another important objective of the project would be to provide a set of alternatives to encourage the organization of an authority/authorities for comprehensive water quality management in the basin.

REFERENCES

Beck, M. B. (1982). *The Development and Application of Models for Water Quality Management - A Review*. Paper to UNESCO International Workshop, La Coruna, Spain.

DSI (State Hydraulic Works, Turkey). (1980). *Protection of Inland Water Quality, Porsuk River Pilot Project*. UNDP/WHO Project, TUR/77/019, DSI, Ankara.

Gönenç, I. E. (1979). *The Effect of Longitudinal Dispersion on the Inorganic Nitrogen Profile in Streams*. Ph. D. thesis, Technical University of Istanbul, Istanbul (in Turkish).

ITU (Technical University of Istanbul). (1982). *Revised Project Plan on River Basin Management for the Sakarya River Basin*. Technical University of Istanbul, Istanbul.