TRAVEL NOTES: VISIT TO THE UNITED STATES

15 March - 4 April 1974

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MEMORANDUM

To: Prof. H. Raiffa
Prof. Y. Rozanov

Date: 6 June 1974

From: Dr. I. Belyaev
Dr. P. Koryavov

Subject: Visit to the United States 15 March - 4 April 1974

The purpose of our trip to the United States was to visit United States' Universities for discussions of the different aspects of complex use of water resources and to participate in the International Symposium on Use of Computer and Automation for Water Resource Systems, Washington, D.C. 26 March - 4 April 1974. Our itinerary is attached as Appendix I to this report.

The main goals of our visit were to study the latest achievements of theoretical and applied investigation of water resources problems, to have scientific contacts and discussions with research specialist, to survey the current situation, ascertaining the main direction of research and to realize the possibility of obtaining new publications, reports and technical materials which could be used at IIASA and the National Member's Organization's research centers.

The full list of references is attached to this report and our comments about them are in the text. These materials are available at the IIASA Library and at the Water Resources Group and we hope that they will be useful in research done by the IIASA scholars and other projects.

ENGINEERING SYSTEMS DEPARTMENT UNIVERSITY OF CALIFORNIA (LOS ANGELES)

At the Engineering Systems Department of the University of California, we met Prof. William Yeh, Dr. Leonard Becker and their colleagues. This group has developed methodology and applied it toward solving the concrete problems of water resources in California, but their methods could be used for solutions to similar problems elsewhere. The main direction of their research is as follows:

1. The mathematical modelling of non-stationary flow in open channels. (See [1]). They have had valuable experience in dealing with numerical solution of partical differential equations and describing the flow properties along the river.

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2. Optimal timing, sequencing and sizing of multiple reservior surface water supply facilities (See [2] and [3]). The methodology development of the group was applied to the design of a system of six reserviors on the Eel River in North California.

3. Optimization of real-time operation on a multiple reservior system (See [4] and [5]). The developed methodology was applied to the Water Resources Systems in Sacramento and the Trinity River in California. The Computer Standard Program in reference [4] could be adapted for any number of reserviors in system with different physical constraints.

This group also did research in some aspects of applied mathematics concerned with the problem of water resources (See [6] - [8]).

It seems reasonable to have contacts and collaboration with this group and use their mathematical models, when they are suitable, in complex models of river basins developed at IIASA.

CALIFORNIA INSTITUTE OF TECHNOLOGY
(PASADENA)

At the California Institute of Technology, we met Dr. John List and Prof. Lester Lees.

Dr. List is working out a model for the Colorado River. The model is in a stage of preparation and will be finished approximately at the end of this year. Dr. List hopes that his model will serve as the basis for analysis of the different alternatives of development for the Colorado River Basin, and that it may be used for the principle recommendation. That model includes a description of the salinity of the water. He believes the model will give an estimation of the development of the Colorado River Basin for the next 25 years. The previous results of Dr. List are connected with air pollution and heat pollution in the Los Angeles area of Southern California (See [9]).

Prof. Lester Lees is the Director of the Environmental Quality Laboratory. This laboratory studies many different problems concerning the environment, and one of the main studies is that of the future situation in California where very intensive industrial development and use of new atomic power stations are forecasted. The main results of their study are given in references [10] - [14].

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We also planned to meet Prof. Norman Brooks and Prof. Jack MacKee at the California Institute of Technology. Unfortunately, they were not in Pasedena at the time and a meeting was not possible.

UNIVERSITY OF SOUTHERN CALIFORNIA

(LOS ANGELES)

We planned to spend one day with Prof. Lindsdert from the RAND Corp., Santa Monica during our stay in Los Angeles. But due to his unexpected illness, we had the opportunity to except Prof. Chang's invitation to visit the University of Southern California. There is no special group at the University of Southern California that studies mathematical modelling of river basins and other water resources systems, but they have a very good experimental laboratory and study the motion of stratified flows, the problem of stability of the boundary between the fluids with different densities and do some physical modelling of wave motion in the bank water constructions.

SYSTEMS AND INDUSTRIAL ENGINEERING DEPARTMENT AND

WATER RESOURCES RESEARCH CENTER

UNIVERSITY OF ARIZONA (TUCSON)

At the Systems and Industrial Engineering Department, we met Dr. Lucien Duckstein and his colleagues. We understand that this group in collaboration with other departments of the University, make a lot of concrete models for different water resources systems aspects. For example, they worked out a stochastic model for runoff produced by a short time rainfall (See [15]), a stochastic model for daily change of river flow in arid zones (See [16]) and stochastic model for elevation effect on rainfall (See [17]). They also analysized hydrologic models for changing watersheds (See [18] and [19]) and have suggested some new approaches for estimation of alternatives of water resources systems development on the base of the lower part of the Mekong river (See [20]). Furthermore, they have considered application of Bayesian Decision theory to the problem of hydrologic designing. (See [21]). Duckstein's group has good scientific relations with different water resources organizations. They have taken part in the working out of different methodological problems for solution of concrete problems. For example, they have collaborated with Hungarian specialist, particularly in the study of reliability of a levee reach (See [22]) and the effect of wind and tides on optimum control of large lakes (See [23]). In the first case, they applied research to Sebes-Közös River and in the second to Lake Balaton in Hungary.

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If IIASA plans to have contacts with the Hungarian specialists and to use the Tisza River to apply some of the developed methodology, then it seems reasonable to have the group from the University of Arizona as a partner in this business.

Some other problems, such as cost-effectiveness analysis of waste-water reuses and space-time sampling of ecological systems, are touched in articles [24] - [26]. The total list of publications is given in reference [27].

At the Water Resources Center, we met Dr. S.D. Resnick, who briefly reviewed their recent research. This Center examines problems principly concerned with engineering water resources with direct application to practical purposes (See [28] - [41]). Some of them are connected with artificial reduction of evaporation, determination of infiltration rates, ground water recharge, precipitation harvesting and seepage control, sediment removal, etc..

GEOLOGICAL SURVEY, US DEPARTMENT OF THE INTERIOR (RESTON)

We met Dr. N.C. Matalas at the US National Academy of Sciences in Washington, D.C. the day before the Symposium and had a long conversation with him. His group of eight to nine scientists has the main methodological direction of obtaining optimal experimental data - finding an optimal number of observation points and the frequency of observation for the solution of the quantity problem of water resources.

However, they have a few additional applied projects. One is the ground water estimation project for Israel and another involves the mathematical modelling for Puerto Rican water resources. This Puerto Rican screening model of alternative water resources projects will be finished in June 1974. It consists of two sub-models for supply and demand. Mix integer programming was used for the computerized realization of this model.

Dr. Matalas has plans to begin the study of some ecology and thermal pollution problems and chemical and biological treatment, then on the basis of this research, intends to suggest some standards for water quality.

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OFFICE OF WATER RESOURCES RESEARCH,
US DEPARTMENT OF THE INTERIOR
(WASHINGTON)

During the Symposium we met Dr. W.A. Hall who is now the director of the Office of Water Resources Research. This Office is collecting information about all the research on water resources in the USA and has a bank of data concerning that research. Their computer, when required, will automatically prepare an abstract on any given project.

Dr. Hall has extensive experience in river basin modelling and we consider scientific contacts with him and his office advantageous to the IIASA water project.

RESOURCES FOR THE FUTURE, INC.
(WASHINGTON)

At RFF we met Dr. Allen V. Kneese, Director of the Quality of the Environment Program and Dr. Walter Spofford, Jr.. Dr. Kneese is the Chairman of the Subcommittee on Water Resources of the Advisory Committee on the IIASA of the US National Academy of Sciences. Dr. Spofford is a member of this Subcommittee.

Some recent results of research by Dr. Kneese, Dr. Spofford and their colleagues are known very will at IIASA (See [12] - [17]). A review of this research was given at the Water Resources Seminar in February of this year by Dr. P. Koryavov. It seems important that their mathematical model of environmental quality management is complex one. The results include a description of the industry, the environment, and the damage made by residuals to different receptors. It is also significant that as a result of their research, a software for computers has been developed. This software is very useful and could be utilized in solving analogue problems everywhere. We are quite pleased that Dr. Spofford will spend two or three months at IIASA and hope that there will be fruitful collaboration between the IIASA Water Resources Group and Resources for the Future.

OFFICE OF HYDROLOGY, NATIONAL WEATHER SERVICE
(SILVER SPRINGS)

During the Symposium, we met Dr. Robert A. Clark, who is the leading specialist of the Office of Hydrology of the National Weather Service. We discussed with him various aspects of complex mathematical modelling of water resources

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systems. Some of these points were connected with the forecast of runoff and the mathematical modelling of melting snow. Dr. Clark welcomed the opportunity to collaborate with IIASA scientists and sent us a few reports concerning the questions we discussed (See [48], [49] and [50]). The results of the investigation in this report give, at first glance, the impression that they could be utilized by the IIASA Water Resources Group in the construction of complex models of river basins.

DEPARTMENT OF ENVIRONMENTAL SYSTEMS ENGINEERING

CLEMSON UNIVERSITY

(CLEMSON, SOUTH CAROLINA)

During the Symposium, we met Prof. John F. Andrews from Clemson University, who was the representative from the International Association on Water Pollution Research. Prof. Andrews is a well known specialist in biological treatment of water. His main area of research is in the construction of dynamic models for operational strategy of management of treatment processes (See [51] - [60]). It seems to us that the problems of water pollution and treatment of it in the river basins will be an essential question in future complex modelling of river basins. Therefore, we consider contacts with Prof. Andrews useful and the utilization of some of his results in our future activities desirable.

HAVARD UNIVERSITY CENTER FOR POPULATION STUDIES

(CAMBRIDGE)

After the Symposium, we met Professor Peter Rogers at the Center of Population Studies at Harvard University. Prof. Rogers' group is composed mainly of post-graduate students and young research fellows. Planning and development of water and other natural resources, including labor force resources, are the main direction of their research.They have had considerable experience in dealing with the problems of the Indian sub-continent (See [62]). Their spectrum of research is very wide. They have conducted research on hydrodynamics from water in river systems to the political aspects of water distribution. They also direct some research to the application of linear programming for description of different water resource systems and have attempted to formulate some methods for decomposition of large dynamic water resource systems.

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SYMPOSIUM ON THE USE OF COMPUTER TECHNIQUE AND AUTOMATION FOR WATER RESOURCES SYSTEMS (WASHINGTON, D.C.)

The symposium was widely represented (See list of participants [63]) and included in their program a very broad spectrum of reports (See the list of seminar documents [64]). At the Symposium many vital problems connected with the mathematical modelling of complex water resource systems were considered. The Symposium offered some recommendations (See [65]). We hope these recommendations will expedite the solution of water resources problems in many countries and will enable the experiences of one country to aid others.

The scientists who deal with the water resources systems realize that effective international collaboration is necessary if they are sincerely interested in solving problems of magnitude to the common interest.

The Symposium was well organized and included in their program travel to various places to familiarize the participants with water resources programmes and water resources facilities in the United States. It is important for people involved in water resources modelling to know how problems are solved by engineers, how the information is collected and distributed, how it is stored and how it could be used. We were very impressed with the Tennessee Valley Authority facilities and also with the Ohio River Basin Commission. We received many documents and descriptions while at these two places. (See [66] - [82]).

Before our trip and later in Washington, D.C., we met Dr. Henry David. His advice and recommendations were very beneficial during our visit to the various organizations and we are quite grateful to him. We also wish to thank Mr. A. Nasmith who was eager to help us organize our program and visits to the different organizations in the United States. We would also like to thank all of the people there who made our trip interesting and productive.

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