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NATIONAL SYSTEMS OF WATER ADMINISTRATION

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Department of Economic and Social Affairs

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PREFACE

It is now 21 years since the Economic and Social Council in its resolution 417 (XIV) requested the Secretary-General of the United Nations, after consulting with the specialized agencies,

> "to report on activities of international organizations and national authorities relating to water resources (and) to assume responsibility for the promotion and co-ordination of international activities concerning water resource development and co-operative action among national authorities and international organizations in order to secure the maximum contribution to economic development through the effective development, control and use of water resources".

In the implementation of the Council's request, some of "the basic data, techniques, and problems" which concerned the Secretary-General were the so-called "legal and administrative aspects", including the "planning, execution, and operation of projects for water control and use" (E/2205). The establishment in 1959 of a Water Resources Centre in the Resources and Transport Division of the Department of Economic and Social Affairs of the United Nations Secretariat reflected further progress towards the developmental goal expressed in the Council's resolution. In 1964 the Centre was reorganized and was directed "to pay special attention to the administrative and legislative problems related to water resources development in developing countries" (E/3894/Rev.1).

Since that time, in the course of the United Nations' broadening programme of technical assistance (water resources development meanwhile having become a principal component thereof), there have been increasing requests from developing countries for advice on how to cope with institutional and policy barriers to, including administrative and managerial difficulties in, national water resources development. Most recently, the persistent problems facing the development process have pointed to the possibility, among other suggested remedial approaches of a fundamental character, that a comparative survey of water administration in developing countries might provide general ideas and new concepts that would be relevant to national efforts towards improved water policies and administrative reforms.

Hence, the experience of five countries has been examined in depth as a basis for arriving at some general conclusions for possible future elaboration and action in this field. The countries selected - Hungary, India, Israel, Mexico and Spain - represent various stages of development and have had a long-standing experience in many aspects of water administration; their combined experience reflects the major climatic, economic and social conditions in various world regions.

The Secretary-General requested Albert Lepawsky of the Department of Political Science of the University of California, Berkely, to take responsibility for co-ordinating the work on these country studies and preparing this general and comparative study. As a first step he formulated a common guide and outline for the country studies. However, in order to elicit a wide span of stimulating

comparative analyses, the authors of these country studies were also encouraged to pursue an independent line with respect to detailed coverage and interpretative comment.

Upon completion of the drafts of these national surveys, Professor Lepawsky visited the countries concerned and consulted with the individual authors in order to attain further comparability of information and analysis. The general survey presented here is therefore a result of this collaborative research and inquiry. However, as an analytical check upon the national patterns and practices surveyed, A. Lepawsky also incorporated comparative experience from other countries in the text of his report.

The present study is not intended as an organizational manual or procedural check-list for developing or reforming national systems of water administration. It is rather a general interpretation of contemporary experience, offering some tentative guidelines for the evolving body of comparative and international knowledge in this field of developmental science and technique.

The study has benefited from the review or comments of experts in public administration as well as in resource development, both outside and inside the United Nations. It is now being published for convenient reference by a wider audience as a statement of current principles and methods for possible future elaboration in the increasingly vital study of resources policy and the essential improvement of water administration.

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Part One

NATIONAL WATER SYSTEMS: A COMPARATIVE STUDY

I. NATIONAL WATER SYSTEMS: A COMPARATIVE STUDY

Water resources in the development process

In the changing context of contemporary world development, water resources continue to play a role of sustained significance. This is a reflection of the fact that, along with the determining impact of the varying economic and social forces involved, the natural resources or ecological factor persists as a basic developmental agent.

That natural resources generally, and water resources in particular, retain their importance as a fundamental component of national development is revealed in the evolving international outlook towards environmental standards and ecological balance. In his statement of March 1970 to the opening session of the Preparatory Committee for the United Nations Conference on the Human Environment, held at Stockholm in June 1972, the Secretary-General focused on the subjects of "air, sweet water, oceans and soils", thus stressing the natural resources factor and water resources in relation to the issues of environmental conservation (A/CONF.48/PC/2). As the preparatory arrangements for the Conference progressed, however, water resources began to occupy a more integrated position within the broader spectrum of both the global environmental challenge and the national development process. Some developing countries, in fact, expressed special concern lest the Conference deliberations should fail to link adequately their resource and water development programmes with the desired progress towards economic and industrial development, even at the expense of an expected degree of environmental disturbance or ecological disequilibrium. Reconciliation of development and conservation is of course indispensable, if not inevitable, but meanwhile it continues to complicate and challenge water administration and resources policy in both practice and theory.

Theoretical differences also persist among development experts as to whether the national supply of water and other natural resources should be treated as an essential prerequisite for development or as a calculable constraint upon it. 1/ Water shortage as a constraint was probably a more relevant factor, especially in arid regions, during the earlier stage of agricultural development. Now, in both industrially and agriculturally developing countries, an adequate supply of water is indispensable. Moreover, the previously polarized conception of industry versus agriculture has now subsided in favour of a more balanced approach to the total development process. In fact, the earlier dichotomy is currently finding its place within the more embracing world-wide concern for the environmental integrity and ecological equilibrium of the entire planet as well as of the individual or regional groups of nations as its administrable parts.

1/ Joseph J. Spengler, ed., Natural Resources and Economic Growth, papers presented at a conference held under the joint sponsorship of Resources for the Future, Inc. and the Committee on Economic Growth of the Social Science Research Council at Ann Arbor, Michigan, 7-9 April 1960 (Washington, Resources for the Future, Inc., 1961).

This continuing international quest for equilibrium and integration between the technologically developing environment and its human management will, however, incorporate earlier lessons already learned in the international exchange of knowledge concerning water administration. As early as 1949, on the occasion of the United Nations Scientific Conference on the Conservation and Utilization of Resources, the Secretary-General, in his general summary of the Conference, significantly commented: "No group of section meeting emphasized more the need for close co-operation between various specialists than those dealing with water resources and their control and use. The skills and knowledge of foresters, agricultural scientists, civil engineers, electrical engineers, administrators and economists were all required."2/ It is true that engineering techniques still outpace, in their sophistication, the managerial applications involved in contemporary water administration. Yet the prospects for more rapid advance have seldom been more promising.

Water resource projects today account for one of the largest single categories of ongoing developmental activity, whether financed internationally or bilaterally. While the developing part of the world continues to suffer from lack of financial and technological resources and from underproduction and underconsumption generally, this imbalance is beginning to right itself in selected countries as improved application of water resources starts to augment agricultural production. Despite recurring droughts and disappointing agricultural yields in some regions, the rising record of world food production is now being observed more hopefully, and a noticeable share of this increase is attributed to the enhanced use of water resources. Approximately one fourth of the world's agricultural crops are produced on the one seventh of the world's cultivated lands that are under irrigation. About half of these irrigated lands are now located in developing countries, and this proportion is rapidly growing. Beyond agriculture, water resources development is also beginning to embellish the national developmental record in various countries of the world in the fields of navigation, water power, flood control and recreation in more and more developing countries. 3/

As we exhaust conventional water supplies and move to new sources, whether derived from sea water conversion or other sophisticated technologies, the possibilities inherent in improved water administration will increase. Moreover, the economic potential, as well as the economic challenges, will cumulate as we stop thinking of water merely as a fixed quantity in the global hydrological cycle.

2/ See Proceedings of the United Nations Scientific Conference on the Conservation and Utilization of Resources, vol. I, p. xix. (United Nations publication, Sales No. 50.II.B.2).

3/ Proceedings of the International Conference of Arid Lands in a Changing World, Tucson, Arizona, 2-13 June 1969; "The Use of Arid Lands" (editorial), Science, 20 June 1969, vol. 164; World Bank staff, "Water and Economic Development", International Conference on Water for Peace, Washington, May 1967 (hereafter cited as Water for Peace, 1967), vol. 6, pp. 617-624; Floyd B. Taylor and Paul Hughes, "Water Systems Financing - Four Basic Approaches", Water for Peace, 1967, vol. 8, pp. 758-762; Food and Agriculture Organization of the United Nations, "Indicative World Plan for Agricultural Development to 1975 and 1985" (sections on the development and utilization of land and water resources), 1968.

This conception fails to take account of the effectually quantitative water supply, including its improved quality resulting from an enhanced system of water administration designed to curtail waste and pollution.

National water administration and international exchange of experience

Administrative attainment and national achievement go hand in hand in the realm of water as well as in other developing functions. Developmental status is defined in this study as the degree of operational modernization or adaptive maturity achieved by a nation for the administering of its public functions. The concept of public administration referred to here embraces not merely the organizational structure of governmental and quasi-governmental authorities and the publicly linked-in private sector, but also their various managerial systems and co-ordinative devices, particularly the prevailing processes of policy formulation and decision-making, and especially the related and relevant planning apparatus. With specific reference to water administration and policy, the topical outline which guided the national surveys contributing to this comparative study included, among other items, the economic and developmental role of the water resource; the national water supply and water needs both quantitatively and qualitatively; the legal and institutional foundations for the water function; the subnational and national agencies concerned; the fiscal and the planning functions involved; and the requisite personnel and manpower skills, including the role of water users and citizen participation in the related processes of consultation or decision. 4/

Especially encouraging from the national and international points of view is the fact that the management of the water resource is a catalyst of more extensive forms of socio-economic development and administrative policy modernization, largely because of the interdependence, in the course of national development, of the wide range of technical inputs required for an effective system of water administration. The chain reaction of the modernization process depends upon this stimulating impact of the administrative technology itself, and in this sense water administration becomes one of the most crucial building blocks of public administration. Moreover, despite their persisting defects and unsolved problems, national systems of water administration constitute one of the more advanced sectors of modern public administration. In fact, a prime factor in the comparative study of national water administration is the close relationship that exists between water administration and national development. To what extent this relationship is a causal one is another question, as we shall see throughout this study. Nevertheless, a developing country's prevailing system of water administration often reflects its basic developmental potential and offers certain models for possible emulation of the over-all national development process.

In spite of the fact that water as an international flow resource may call for certain transnational adjustments, and regardless of the administrative lessons that will be learned as our experience grows with emerging international river basin authorities, national experience still remains the prime level of concern for the administration of the world's water resource. With the doubling in the number of independent nation States since the end of the Second World War, it is true, formerly national rivers have now become international bodies of water, draining

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4/ The detailed topical outline may be found in annex I.

more than half of the world's land surface. 5/ In addition to this increased "internationality" of the world's river basins, there are growing transnational influences resulting from ground-water withdrawals, oceanic pollution and cloud seeding. And there is, of course, continuing evidence that national water administration suffers from failures to formulate common concepts or devise model subsystems. Nevertheless, although the international context is of increasing importance, the effectual level of administration for the world's water resources continues to be primarily national, and the emphasis, even at the international level, upon comparative national administrative experience is therefore well advised at this stage of the world development process.

Although restricted economic development is itself one of the constraints upon modernized water resources administration, there is some risk in exaggerating the distinctions in the administrative problem of potential as between the developing and the developed countries. On many matters of detail, the problems of water administration are equally serious and often similar in both, although it is true that water inefficiencies in the less developed countries do have a different magnitude of consequence than in the developed countries. In any event, it has been postulated - and this study helps to confirm this hypothesis - that all countries are potentially capable of national development and progressive maturation of their system of public administration generally and water administration in particular. It is for this reason that this study is as much concerned with the essential relationships between water administration and the process of national development as it is with the identification of the requirements of improved national water administration.

It is in fact a sign of the rise in their general level of administrative maturity that the specialized water administrators of developing countries, profiting from a growing body of comparative knowledge and international exchange of experience, are increasingly conscious of their failures as well as their achievements. If, for example, the question is asked, as it often was in the course of this survey, as to why national water administration has not been developing faster or more favourably or why a relatively progressive water system has not yet succeeded in counteracting a sluggish national development generally, the answers are readily and candidly given. Policy awareness and administrative knowledgeability among water administrators thus seems to be somewhat more widespread than in a number of other fields of development, and this is an encouraging sign of the maturation of national systems of water administration.

Among water administrators generally, there is a deliberate search for experience that is concretely applicable to their own immediate needs, but there is also among some a wide curiosity about more generalized and comparative concepts. For example, there now seems to be a widespread realization that the long-range mobilization and augmentation of the national water supply is fundamentally dependent upon more than mere technical mastery of hydrological science and hydraulic engineering, and requires sounder water economics, increasingly effectual water policies and more systematic administration and planning.

5/ Albert Lepawsky, "International Development of River Resources", International Affairs, October 1963, vol. 39, pp. 533-560; J. D. Chapman, (ed.), The International River Basin, proceedings of a seminar on the development and administration of the International River Basin, held under the auspices of the regional Training Centre for United Nations Fellows, Vancouver, September 1961 (University of British Columbia, 1963).

At the same time, national water administrators increasingly seek realistic answers to concrete questions of how to do better or more swiftly what they are beginning to realize needs to be done; more precisely what sequence to pursue in applying alternative solutions which increasingly come to their attention from other countries; exactly how to dovetail their water plans with their other developmental programmes; and especially how to weld them with the national development process as a whole. These men reveal an increasingly refined curiosity for the administrable application, approximate degree, appropriate timing and advisable adaptation of the various policies or alternative measures which are now becoming readily available to them from comparative and international sources, but which are at the same time, most pertinent for their own national circumstances or local conditions.

Comparative approach to the study of national water administration

Fitting such changes into the national context is an administrative challenge of major proportions. It raises for water administrators the recurring developmental question of how best to adjust borrowed or foreign patterns of public administration and decision-making to national habits of policy formulation and planning - persistent habits which themselves sometimes constitute the major constraint to national adaptation from international experience. On the other hand, being in the vanguard of the development process, exercising the power to provide visible evidence of their country's technological and administrative growth and possessing a relatively advanced capacity for improvising dramatic programmes and executing sizable projects, the water administrators of developing nations are more often in a specially advantageous position to obtain the essential developmental resources and accomplish the expected developmental results.

In the search for such adaptive answers, therefore, there is a genuine awareness among national water administrators of the stimulating possibilities inherent in the comparative study of their discipline. Indeed, something in the nature of an internationally conscious professional concern for water administration is emerging, 6/ comparable to the earlier rise of an international esprit de corps among the world's geologists. By now, there has been a full generation of international experience in water resources development emanating from bilateral and multilateral technical assistance projects and from international training programmes and regional and interregional seminars on hydrological subjects, especially the administrative and policy aspects. This is a favoured field in which Member States of the United Nations have collaborated most willingly in the world-wide interchange of knowledge and experience. International uniformity has its dangers in the water management field. Yet international borrowing of policies or techniques in respect to national water administration is relatively free of ideological preconceptions, and foreign experience on this subject generally has a receptive impact and experimental response in developing countries.

Moreover, there is a tendency in this field to proceed with a ready sense of self-criticism, which further facilitates the borrowing of experience from

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6/ Such a conscious professional concern is reflected, for example, in the presidential address by A. Volke at the Twelfth General Assembly of the International Association of Hydrology, Berne, September 1967, Bulletin of the IASH, vol. XIII, 1968.

comparative sources. It is not unusual to hear water administrators in developing countries say "We are doing pretty well on such and such, but country X is doing better, and we are going to try out their system here"; or "We think we are doing better than country Y in this or that respect and intend to adhere to our present practice, but will keep comparing results"; or sometimes "We ourselves did better in this particular regard previously and, as in the case of country Z, we now intend to restore with some modifications such or such practice, which we had formerly followed but mistakenly abandoned". National water administration in developing countries represents a cumulative growth, and this does not preclude reversals as well as advances in policy or methodology based upon the constant circulation of comparative experience and experiment.

In making such comparisons, however, there is no certainty that universal principles or uniform practices are globally possible or desirable. 7/ Still, international norms are assumed and world criteria are sometimes followed in respect to national water administration, often as a consequence of requirements laid down by international lending agencies. There thus tends to be a growing convergence of judgement among water administrators from the various developing countries as to which measures or practices are preferred and which ought to be rejected depending upon the differing national circumstances. There is some tendency in professional circles to rate certain policies and practices as being either more or less applicable, and as this is increasingly done with respect to identifiable components or so-called subsystems of water resources systems, it may be possible to begin to conceive of an incipient check-list or elementary scale for the inventory or evaluation of national techniques or national systems of water administration. This need not become a formal set of standards, but it could possibly function in future as a set of guidelines for the modernization and maturation of national water systems.

Applying the comparative method to six developing countries

This study applies the comparative approach outlined above to a body of experience with water administration contributed mainly by six selected countries: Algeria, Hungary, India, Israel, Mexico and Spain. These countries are located in a climatic belt representing major regions in Asia, Africa, the Middle East and Europe, and reflecting varying degrees of aridity and humidity. For the most part, they do not include tropical lands which constitute a noticeable segment of the developing world. Nevertheless, in relation to their hydrological requirements, the countries selected are either water-limited or contain major regions of water deficiency or natural desert. As an analytical control and research check upon the degree of representativeness of these selected countries, water management practices and administrative patterns from other countries, some with abundant

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7/ In considering this question within the Economic and Social Council, many delegations emphasized the fact that "formulation of global principles of water administration and water law were not always possible in view of the particular local conditions in each country" (Official Records of the Economic and Social Council, Fiftieth Session, Supplement No. 6, p. 7).

water supplies were additionally sampled and compared in the course of this analysis. 8/

The six selected countries are at different levels of development and represent various developmental histories of sequences. In addition, they have all had a historically unique experience with the human management of the natural water supply. Presumably this enhances their significance for comparative study, since the spectrum of analysis reflected in this study embraces an important part of the historical and hydrological experience of all mankind, with its richly variegated patterns of changing administration over time. What is most relevant about the sample of the countries selected, however, is the fact that all six in common face very substantial water problems, which stand out prominently in the context of their total national developmental requirements. Their specific water needs are distinctly related to their developmental status, and above all, in their significance, they particularly embrace the need for improved public administration.

In the light of these developmental and administrative requirements, this analysis will now be pursued under the following topics, expressed as questions, but designed to elicit criteria for effective water administration in developing countries.

(a) What is the condition of the economy and ecology of water resources and their administration in relation to the main sectors of the national economy and the nation's natural resources as a whole; in short, what is the economic and ecologic efficacy of the water system?

(b) What are the available decision-making and policy-formulating capacities and, more particularly, what is the programmatic potential and the planning capability of the national system of water administration?

(c) What is the role and status of the nation's water agencies and authorities, and in what respects does the organizational structure and function facilitate or impede water management; in other words, what is the organizational effectiveness of the water system?

(d) What is the degree of effectual devolution in the administration of the nation's water resources, especially with respect to the local, regional, subnational and private sharing of responsibility for water management?

(e) What level of technical proficiency, bureaucratic aptitude, professional prestige, developmental maturity and administrative drive has been attained by the nation's water system, as reflected mainly in the performance and prevailing administrative style of its administrators and personnel?

8/ The range of these additional sources is revealed in the various foot-notes to this study. Among the more general compilations which were used are the papers presented at the Interregional Seminar on Integrated Utilization of Water Resources held at Fergana, Uzbekistan, Union of Soviet Socialist Republics, August 1966, and the International Conference on Water for Peace held at Washington D.C., United States of America, May 1967.

II. ECONOMIC AND ECOLOGIC EFFICACY OF WATER RESOURCES

The web of economic and ecologic administrative relationships

In developing countries, there is an overriding need for tighter linkage between national goals for societal development, growing prospects for economic productivity, emerging challenges of ecologic equilibria and rising potentials of public administration. Among all the factors which might lead to attainment of the developmental ideal, however, the economic factor holds particular promise because it offers some of the most immediate and tangible possibilities for converting plans and policies into operable realities and for coming to grips with manageable projects and administrable programmes. In this economic sense, therefore, water projects bear the highest relevance to development policy and public administration, and the water economy and its related ecology constitute a most crucial link in the national economy.

Nevertheless, in so far as the dual goals of socio-economic development and administrative policy modernization are concerned, a viable water system now has to be more broadly conceived and managed than ever before so as to comprehend the following web of hydroeconomic and ecologic considerations: (a) the extent to which the water supply has been marshalled, the hydrologic régime regulated and the required hydraulic construction completed with the available technology, that is the engineering efficacy attained by the water system; (b) the degree of conformity or articulation between the water resources economy and the national economy, principally, but not exclusively, the ratio of water supplies and water investments allocated to the most inclusive sectors of the economy such as agriculture and industry - in other words, the over-all level of economic feasibility attained in water resources development; (c) the internal balance, including the regional and urban-rural ratios, of water supplies and water investments in relation to the total national development and demography - in other words, the system's socio-economic consistency; and (d) the unconventional and non-marketable economies and diseconomies, particularly those economic externalities which give rise to ecological impacts or environmental abuses in water resources administration - that is, the system's ecologic integrity.

Engineering efficacy

The most elementary test by which the efficacy of a nation's water economy and ecology may be gauged is the developmental level of that country's hydroengineering as a whole, and the extent to which the national water supply is committed to human use and the water régime is effectually regulated. In this respect, the six nations vary in the relative proportion of their hydrologic potential which has been subjected to systematic management.

Severely handicapped by deficiency in water, as in other natural resources, the limited Israeli supply is presently the most completely managed. It now comprises more than Israel's well-known National Water Carrier. This nine-foot channel with a capacity of 20 cubic metres per second, mainly diverted from the Lake Kinneset-Jordan River source, but running the length of the land from north to

south, accounts for only about one fifth of the national supply. The remainder consists of ground water, spring water, intermittent flood reclamation and reclaimed sewerage. All these water supplies are marshalled and stored not solely for immediate draft, but also for flow regulation purposes. This relatively comprehensive Israeli development was based on conventional hydroengineering applications as well as fundamental researches in the interdisciplines of hydrochemistry and hydrobiology, just as basic geological and physical investigations underlay the initial stages of the Israeli water development. 1/

Having exploited virtually all the available water supplies during the first two decades of development to the limit permitted by existing technology, Israel will henceforth derive additional fresh waters from its already operative system of sea-water conversion, other developing technologies and the upgraded administration of water economies and water savings of various kinds. There has thus been a tendency to phase the development of Israel's bulk water supplies in some sequential relationship to the total national supply - present and potential, regional and local. No doubt an internationally integrated system roughly coterminous with the Jordan Basin and its contiguous areas would be hydrologically more productive in this Middle Eastern region as a whole. Nevertheless, Israel now presents an operating model of a relatively integrated national system from the point of view of hydrology and engineering as well as economics and administration. 2/

Drastically reduced in territory and population following the First and Second World Wars to a point where over 95 per cent of the water flow now comes from the surrounding countries in the Carpathian and Danube basins, Hungary nevertheless offers a model of comprehensive water management. Moreover, in adjusting its naturally swampy lands and flood plains, Hungary has in the course of its history remodelled and reconstructed much of its natural drainage and water courses. Having exploited much of its river runs, extensively and intensively, Hungary has also subjected as much as one half of its land surface to artificial drainage, while one quarter of its territory containing one half of its inhabitants has been protected with levees.

Hungary's systematic water management is reflected in the relatively advanced development of its ground waters. Despite the country's low slope and small run-off, which has proven to be a decided topographic barrier to hydroelectric development, 200 new reservoir sites have been opened up in the last decade alone, mainly for other water uses. Hungary is also increasing its reclamation and treatment of used and waste waters. Moreover, long-range waterways development has already occurred on the Danube as part of Hungary's membership in the multinational Danube Commission, and large-scale planning is going forward on the Hungarian sector of the Danube-Main-Rhine navigation network to be completed during the 1970s. 3/

1/ L. Picard, Outline of Groundwater Geology in Arid Regions: the History of Groundwater Exploration in Palestine, inaugural lecture, section 4, UNESCO Symposium on Hydrology in Arid Zones, Ankara, May 1952; also presented at the International Geological Congress, Algiers, September 1952; also in Desert Research, Proceedings of the International Symposium, Research Council of Israel, in co-operation with UNESCO, Jerusalem, 9-14 May 1952.

2/ Aaron Wiener, "Irrigation Water System - Israel's National Water Grid", Water for Peace, 1967, vol. 7, pp. 195-205; Nathan Buras, "Operation of a Complex Water-Resources Utilization System", ibid., vol. 6, pp. 464-472; Saul Aloni, "Modern Water Legislation and Development", ibid., vol. 5, pp. 538-541.

3/ Hungary, National Water Authority, Magyarorszag Vizgazdalkodasa (Budapest, 1965).

Despite a low and erratic river run-off, Spain has been favoured in its hydraulic development by a unique, though not profuse, natural endowment of water. Its prevailing mountainous land forms and its peninsular position provide elevated plateaus and fertile plains, varying regional climates, seasonal variations and unique combinations of Mediterranean and Atlantic aridities and humidities. All this allows a system of hydraulic planning and development which lends itself to alternate choices and increasing stabilization in an otherwise erratic and moderate supply.

The Spanish water system has subjected 50 per cent of the existing river flow to regulated use, as compared to the potential of 75 per cent under present technological conditions. Less developed are the promising Spanish ground waters, which are estimated to be 15 times the surface waters. Regionally, however, ground waters are more heavily exploited, as in the case of the intensively developing Barcelona industrial area. Spain's irrigation system has long been one of the most extensive in Europe, totalling some 5 million acres. Yet, in the last 20 years, Spain has brought under irrigation approximately one million of these, besides providing supplementary irrigation waters to approximately 100,000 acres. At present, somewhat over half of the country's irrigable area is irrigated. With respect to hydroelectricity, Spanish development is more prominent, having doubled its capacity in the last decade. In fact, Spain now operates some of the world's most ingenious hydraulic structures, 4/ and its national landscape is dotted with attractive dams and lush reservoirs. Although her hydroelectric system is already one of the largest in Europe and has a substantial multipurpose potential lying ahead, the bulk of its utilizable hydropower still remains undeveloped. As a whole, Spain's national water system is thus in a comparatively well-developed state.

India's water system is one of the world's largest and most imposing. Stretching form the Himalayas to the Equator, the Indian subcontinent offers a profuse though geographically badly distributed water supply. Yet India possesses some areas in which the problem is a superabundant supply. Conscious of the fact that in some countries more land is going out of production through waterlogging than is brought into production through hydrodevelopment, India's Minister of Agriculture informed the 1968 annual conference of its Central Board of Irrigation and Power: "Abundance of water may cause more damage to mankind than lack of water". 5/ Nevertheless, India's surface waters are still only about one third developed and her ground waters only about one fifth. Furthermore, although India is a country of floods and monsoons, only about 10 per cent of her territory has so far been protected from serious inundation. Also, only 15 per cent of its extensive hydroelectric potential is developed, and its existing navigable waterways represent only a small proportion of its potential navigable mileage. India's fisheries, both inland and oceanic, are relatively untapped, but they constitute a potential food supply for considerable proportions.

In contrast with these relatively under-developed water resources, India's

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4/ Floyd C. Dominy, Water Resources Development in Spain, United States Department of the Interior, Bureau of Reclamation, 1965, Eighty-ninth Congress, First Session, Senate document No. 40.

5/ Jagjivan Rao, Indian Minister of Food, Agriculture, Community Development and Co-operation, before the Forty-second annual Session of the Central Board of Irrigation and Power, New Delhi, 22 September 1969.

agricultural waters are notably developed. 6/ Its irrigated acreage increased phenomenally during the last decade, from 55 to 90 million acres. This is only one half of its irrigable acreage, but it constitutes one fifth of the world's total irrigated acreage. There are now in operation in India 100 major water schemes or projects and 500 medium ones, some of them linked up regionally into well-integrated systems and subsystems. While insufficient in terms of its minimal requirements, India's water supply is developing at a most impressive rate.

Mexico is a land dominated by mountain ranges and high plateaux as well as level plains and lush coastlines, but the bulk of the population lives in arid and semi-arid regions. As much as 90 per cent of Mexico's area is the source of only 10 per cent of its water, but 75 per cent of its total population is concentrated on the drier plains and higher plateaux. Despite this counterproductive pattern of population distribution, Mexico has increasingly subjected her waters to systematic regulation. Mexico nearly quadrupled its irrigated area during the last 30 years, raising its irrigated acreage from 2.5 million to 9 million. Mexico's hydroelectric development has attained 25 per cent of potential, and the rate of increase, paralleling her rising industrial-urban development, is growing faster than the other components of the national water system. 7/

Centrally located and the largest country on the developing African shore of the Mediterranean basin, Algeria's geographic position is enhanced by its rich store of petroleum and mineral supplies and good soils, but modest water supply. Still, much of Algeria's unexploited territory lies in its spacious Saharan hinterland behind the Atlas mountains, from which there is a potentially favourable outflow of exploitable waters to the coast and to some desert regions. 8/ Groundwater exploration lags, but the pace of development is picking up in the case of irrigation waters. Hydroelectric development, though not extensive, is receiving proportionately increased emphasis.

The natural water supply in the six countries under consideration is far from favourable. For the most part it is clearly deficient, regionally if not nationally. In the three countries where the supply may be rated as comparatively developed - Israel, Hungary and Spain - the degree of actual hydraulic development relative to potential is inversely related to size. However, the opposite tendency

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6/ K. P. Mathrani, "Construction and Management of River Valley Projects in India", Water for Peace, 1967, vol. 5, pp. 321-329; K. L. Rao, "Planning and Development of Water Resources in India", ibid., vol. 7, pp. 390-400.

7/ Adolfo Orive Alba, La Política de Irrigación en México (Mexico City and Buenos Aires, Fondo de Cultura Economica, 1960).

8/ Ministère des Travaux Publics et de la Construction, Direction de l'Hydraulique, Service des Etudes Scientifiques, "Etablissement du Bilan Hydraulique, Note sur la Partie Ressources en Eau Souterraine" (Algiers, 1967). For the problems of water balance as between the core and periphery of arid regions, see also Paul Gallez, "Problems of Regional Planning in Semi-arid Countries", Annals of Regional Science (Bellingham, Washington, December 1970); see also Aaron Wiener, "Water Development Procedures in Arid and Semi-arid Regions", United Nations Conference on Application of Science and Technology for the Benefit of the Less Developed Countries, Geneva, 1963 (E/3832).

is found in the three developing countries with the less developed water supplies - Algeria, Mexico and India - where the comparative degree of hydraulic development is directly related to size. Consequently, it cannot be concluded that either national territory or hydrologic potential alone provides a predictive index for the rate of water development or the level of hydroengineering efficacy.

Nevertheless, there may be some evidence that the make-up of the national water supply by broad category, such as surface water and ground water or reclaimed water and sea water, might offer a more promising guideline for hydrological planning than does the gross national supply. In other words, for developmental purposes, the internal composition of a nation's hydrological régime, considering its available combination of geomorphology and hydrotechnology, may offer a usable set of indicators as to the advisable sequence and optimal rate for the development of the gross components of its national water supply.

As for the effect of different national levels of water resources technology, more detailed study would seem to be necessary concerning the promise of comparative engineering techniques. However, it already appears that standardization and internationalization of such engineering techniques has progressed further than similar interchanges in water resources economics and administration. Structural and project efficiencies are less likely to be more differentiated from country to country than are subsystem or system efficiencies. However, even with respect to engineering techniques, comparative international norms need further clarification. Fortunately, so far there does not seem to be in the countries studied much evidence of a predilection for impressive water projects that are grandiose in size but dysfunctional in design, a tendency which might have substantially negative side effects. On the other hand, concentration on even balanced forms of irrigation agriculture does not preclude the possibility that unconventional but promising techniques, whether engineering or agricultural, may fall by the wayside. Thus aquaculture, 9/ including the artificial propagation of fish and thereby the enhancement of the essential food supply, remains unexploited, although it has long been a recognized technique in developing countries.

Economic feasibility

The prime criterion of effective water administration is considered to be economic in the sense that economics deals with the optimum allocation of resources, both natural and human, for the production and delivery of the good in question. Economically determined water decisions are especially attractive to policy-makers and politicians, administrators and economists, because economic indicators tend to be exact, quantitative, objective and comprehensible. At the same time, economic criteria, by virtue of their adherence to these rigorous forms of analysis, reveal the usual tendency among decision-makers to remain "value-free", a most difficult objective since economic decisions deal essentially with human choices, alternatives, allocations and priorities. Understandably, there is a disciplinary inclination among economists to prefer those concepts and emphasize those variables which can

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9/ John E. Bardach, "Aquaculture", Science (Washington, D.C.), 13 September 1968, vol. 16, pp. 1098-1106.

be expressed with economic exactitude, even though these often fail to reflect other policy considerations. Consequently, in making decisions and formulating policies economists and administrators must pay deliberate attention to the more neglected and less measurable elements of welfare economics and socio-economics, not to speak of equally enigmatic considerations.

The empiric realities, as well as the analytic concepts and theoretic frameworks, which are now emerging in a new interdisciplinary field such as resources administration, and particularly water administration, provide the opportunity for the kind of disciplinary adaptation here needed. Such interdisciplinary adaptation is required because the alternative uses to which water resources can be put and the versatile objectives to which water administration can be applied are so numerous and varied as to defy mere monomethodology; they therefore require more balanced and interrelated methodologies in the course of analysis.

On the other hand, it should be recognized that the largest investments and longer-term amortizations involved in hydraulic as compared with other development projects, offer economists a wider empirical base for discovering the more workable rules of fiscal decision and economic behaviour. It is no wonder that economists have drawn heavily on the field of resources administration, and especially water administration, in formulating their favourite concepts such as "multipurpose use", "benefit-cost ratio", and "economic feasibility". During the last two generations, in fact, water administrators have worked closely with economists in improvising and refining these useful concepts. Also significant has been the fact that these sharper implements of economic analysis, which are so relevant to water resources planning and other developmental decisions, have evolved in the developing economies as well as in the developmental stages of mature economies. In both it has been increasingly essential to find more discerning ways of fitting the so-called "water economy" to the total national economy. 10/

The problem is not only one of conformity between a given water project and the rest of the water system, as might be the case with the conventionally limited objective of a single water resources development project. The issue is actually a more inclusive one, as between the proposed investment in a given water resource and some other possible investment in the rest of the national economy. The specific questions now calling for alternative decision are thus more in the field of economic feasibility (including ecologic integrity), and often in the realm of socio-political advisability. In seeking for the optimal economic results involved, new and broader choices now also have to be made as to the proper priorities and correct mix of the various combinations of possible water investments for irrigation, hydropower, agriculture, grazing, industrial supply, municipal supply, forestry, soil conservation, navigation, flood control, recreation and fisheries.

10/ Nathaniel Wollman, The Water Resources of Chile, An Economic Method for Analysing a Key Resource in a Nation's Development (Baltimore, Johns Hopkins Press, 1968); see also H. P. Michael, "Criteria for Decision-Making" in Water Development in Less Developed Areas, transactions of an international conference under the auspices of the German Foundation for Developing Countries, Berlin, 17-21 May 1963 (hereafter cited as Transactions of Berlin Conference, 1963), chap. III, p. 15.

The economic decisions may be readily arrived at when the intended water use is non-consumptive or when it is readily adjustable to multipurpose schemes, as in hydropower and navigation. But when water use is consumptive and competitive, and especially when the available funds for public investment are limited, alternative choices have to be made and an order of economic priorities has to be arrived at. This is especially true in the developing economies, which are particularly short of both capital and water, as is the case in the several countries covered in this study.

The water resources economy of developing countries

Spain is one of the more developed of our six countries, possessing an actively growing industry and, in addition, the highest hydroelectirc component. Spain's current hydroelectric construction programme is exceeded only by those of Japan, the Soviet Union and the United States, and she has also begun to plan her atomic energy system. As for the longer-established irrigation function, Spanish law assigns a higher priority to irrigation in the granting of water concessions than to hydroelectric and industrial uses. However, as a matter of economic practice, Spanish hydropower is given considerable emphasis in multipurpose projects.

Irrigation still continues to be a principal component of the Spanish agricultural economy, the importance of which is attested to by the fact that irrigation agriculture accounts for almost half of the Spanish export trade. One fourth of Spain's population still depends on agricultural employment, even though employment in agriculture is in a relative decline owing to the improvement of Spain's agricultural technology and the rise of its per capita productivity. Moreover, consumption of water for the agriculturally related production and processing of food and drink constitutes the largest category of industrial uses of water in Spain, accounting for more than one fifth thereof. In this broader sense, Spain's agroindustry is heavily dependent upon the water supply, and Spanish water administration has been relatively far-sighted in supporting this significantly developing intersector of the national economy.

In Hungary, the agricultural and industrial sectors consume about equal amounts of water. Within the agricultural sector, grazing consumes moderate amounts, fishing a smaller amount, but irrigation uses as much as 30 per cent of the total national water supply. Although Hungary is the country in our sample of six with the most adequate rainfall, she represents the unusual case, now arising with greater frequency in other agricultural economies, of an increasing emphasis upon supplementary irrigation for the special benefit of high-value or export-crop production. Indeed, it is with this objective in view that Hungarian law assigns a high priority to irrigation use, along with water uses for livestock production.

The comparatively high agricultural emphasis of Hungarian water use is underscored by the contrasting fact that as a consequence of her flat terrain, Hungary generates only a meagre amount of hydroelectricity, approximately 2 per cent of the national power supply. Consequently, there is an unusual drain on the remaining industrial water supply for power production purposes, since as much as 80 per cent of the total industrial water use must be devoted to the cooling of thermal power plants. Although the economic efficiency of the industrial uses of water is generally higher than the agricultural, the management of the irrigation

distribution systems on Hungarian farms is changing and improving, and agricultural standards continue to be stressed in the water economy. Thus, although the efficiency of Hungarian water projects of all kinds is carefully calculated in terms of the monetary costs and contributions they make to national development generally, it is interesting that Hungarian water costing, even in non-agricultural fields, continues to employ such traditional agricultural standards as "wheat production equivalent per cubic metre of water consumed".

Israel reflects an even greater sensitivity to and discriminating search for constantly readjusting marginal water uses to the highest economic yields, thus responding to hydroeconomic realities in the realm of agriculture. Its industrial output now exceeds its agricultural output, yet its agricultural water consumption remains at 75 per cent of the total national supply. Although Israel is now reaching the limit of its irrigable waters and although the relative agricultural contribution to the national product will continue to shrink, its irrigated area has increased 12 per cent during the last five years, and the product of its irrigated lands has increased 30 per cent. This relatively mature state of the agricultural economy has been made possible by Israel's meticulously managed irrigation system, backed up by high inputs of scientific research and planned administration, including the application of quality controls to the foreign marketing of agricultural goods, both raw and processed. Here too, therefore, agroindustry is recognized as a major intersector.

One of Israel's unfulfilled needs for a more vigorous industrial development is power. Hydroelectric power is non-existent, and thermal power is based largely on residual oil, but plans are under consideration for a large-scale plant on the Mediterranean coast for the dual-purpose production of atomic energy and desalted sea-water. All in all, therefore, Israel's economy can be described more in terms of agriculture and industry rather than agriculture versus industry. One of the legal and administrative devices which encourages this mixed water resources economy is the granting of water rights, not in the usual quantitative terms of a given amount of water, but in the quantitative-qualitative terms of a given amount of water for a certain specified use. Thus, Israel's economic development generally, whether in the agricultural or other sectors, continues to be directed towards increasingly intensive economic yields, stimulated, along with other measures, by a constant reallocation of her limited water supply to increasingly higher value production.

Not only has irrigation agriculture been a most vital element of Indian economic activity, but water projects generally have continued to be one of the largest components of this nation's total development budget. 11/ At the same time, the Indian water economy has been largely a matter of subsistence and survival. Under conditions of demographic pressure, the relief of famine has in

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11/ Although water projects accounted for 28 per cent of total expenditures for developmental purposes under India's first five-year plan, World Bank reports during the period 1951-1962 indicated an even higher percentage of capital expenditures for water development projects in Ceylon (now Sri Lanka), Guatemala and Surinam. (Gilbert F. White, "Water Development as Part of Development Aid Policy" in Transactions of Berlin Conference, 1963, p. 46).

the past had to take precedence over the relief of poverty. 12/ Indian agricultural production still has about three times the value of her industrial production, and although industrial production is rising noticeably, the Indian agricultural or irrigation economy continues in an intensive state of development.

In the last generation, food production had doubled in India, and in the past few years India has experienced the consequences of an innovative and productive "green revolution". This was attributable in part to the far-sighted planning and widespread construction of irrigation works. There is now, indeed, hope not merely for domestic self-sufficiency in food, but also anticipation of a continuing surplus for export. Although irrigation appears to have played a decisive role here, there is still insufficient evidence, in weighing all the causal inputs to the green revolution, about other new agricultural technologies in India, such as improved seed, use of fertilizer and pesticide control, not to speak of the institutional and administrative advances which have occurred in Indian agricultural credit, community development, university extension and personnel training programmes for the country's modernizing agricultural and irrigation system. Special weight should also be assigned to the planting of new grains such as pearl millet or triticale, the latter being a cross between wheat and rye, cultivation of which helps to relieve the stress upon the high water consumption now required for the production of rice.

In India, therefore, it is almost possible to speak truly of an irrigation economy and an administered agriculture, which reveals some hope of speeding up the emergence of a regional and national agroindustrial economy. As a major means of supplementing irrigation agriculture, there is already a notable development in the exploitation of ground waters by the use of tube-wells, a technology which can now be supplied from indigenous production as well as international sources. However, this is a development in which the bottle-neck may prove to be insufficient electric power rather than the mechanism itself. Nevertheless, more than a million pump sets have by now been energized, and rural electrification programmes are going forward. Atomic energy research and development are also proceeding notably. However, this advanced technology will continue to affect water administration both ways - intensified consumption of water for atomic energy generation, but a need for relief from the excessive use of water for thermal plant cooling. An abiding question in India as elsewhere, remains the internal distribution of the increased product from its burgeoning water development, as between the various requests of the population, especially, but not exclusively, in rural areas.

Mexico has made its way among the most rapidly developing countries of the world, and this was accomplished with a substantial contribution from its irrigation and hydroelectric development. Through the 1950s, irrigation development predominated, but the comparative rate of growth in Mexico's irrigation plant then began to decline, and since about 1959, irrigation has been subordinated to the accelerated industrial and hydroelectric development now prevailing. In fact, economic priorities as legally defined in Mexico give specific precedence to

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12/ See Philip D. Harvey, "Development Potential in Famine Relief: the Bihar Model", International Development Review (Washington, D.C.), December 1969, pp. 7-10; "Water, Source of Life", Ceres, May-June 1970, p. 64; see also R. P. Ahuja, "Problems of Semi-arid Zones", Water for Peace, 1967, vol. 1, pp. 117-125.

hydropower. It is interesting that of the total $US 400 million which the World Bank has lent to Mexico, one half has been for electric power development.

Still, almost 90 per cent of Mexico's water is presently used for agriculture because of the country's widespread aridity. As in other countries, some doubt has been expressed about the proportion of Mexican agricultural growth which can be attributed to irrigation development as compared to improved seed, fertilizers, pesticides and other technical or managerial improvements in crop cultivation. Nevertheless, the cumulative economic impact of Mexico's earlier irrigation emphasis has continued to be felt, even in respect to foreign trade. The country's exports are primarily agricultural products. Although irrigation prevails in only 15 per cent of the cultivated area of the country, it accounts for more than half of the export agriculture. There is also an increased production of livestock, as part of the Mexican tendency to devote the best of its irrigated acreage to high-yield export crops.

Nevertheless, the agricultural sector of the Mexican economy has not flourished lately compared to other parts of the national economy. If the irrigated acreage has risen, so has the farm population. Consequently there has been a residue of unsolved national problems affecting half the country's population. There is underconsumption and undernourishment, as well as unemployment and low productivity in many parts of rural Mexico. It is becoming increasingly apparent that Mexico's main problem does not now venture solely on the water economy as much as it does upon certain interrelated land questions. 13/ Land reform has a long history in Mexico, and the country has experienced some 40 years of oscillation between cooperative and individually farmed ejidos. Studies are now proceeding on the relative productive efficiencies of these different land tenure arrangements, but meanwhile the question of how to resolve conflicts of interest as to land use and land ownership generally, in both the private and the public subsectors of the agricultural economy, remains a major policy issue.

As the nation among the six now under consideration which has most recently attained independence, Algeria is more representative of the world's newly developing societies. Yet with her relatively late start and with a comparatively modest developmental level, Algeria has now entered a period of intensified development which is more resource extractive than agricultural in character. Nevertheless, Algeria's indigenous industries are designed to serve agriculture by providing, among other manufactures, domestically produced fertilizers and tractors. These industries are in turn based economically and technologically on a vigorous exploitation of the nation's rich petroleum resources and an accelerated petrochemical development.

As a result of this relatively retarded agricultural growth, the Algerian socio-economic development has generally been slower than is required for its domestic demographic development. Yields of staple crops also remain relatively low and those of export crops lag behind potential productivity. Irrigation, as well as hydroelectric power, is given priority in the design of water projects,

13/ Salomon Eckstein, El marco macroeconomico del Problema Agrario Mexicano, Centro de Investigaciones Agrarias, Comité Interamericano de Desarrollo Agricolo, documento preliminario (Mexico City, D.F., 1968).

but construction programmes of secondary irrigation works involving farms and the essentially related agricultural training schemes for farm labour in the skills of irrigation are not fully synchronized with the advancing water construction schedule. The cultivation of Algeria's irrigated lands for necessarily higher yield and more competitively valuable export crops is also in need of swifter transition and more flexible adjustment, for example, from an over-emphasis on grapes and wines to more widely demanded products such as beef and sugar.

Algeria is experiencing a noticeable beginning of more balanced production planning in some of its selected regions, for agricultural purposes as well as for industry and agroindustry, and this has both stimulated and been stimulated by increasing experimental attention to local and regional water supplies and water administration. However, these experiments require more experience and expertise than has so far been available. In the course of Algeria's commitment to these more elaborate programmes, there has necessarily been some tendency to neglect the simpler technologies involved in the more easily exploitable groundwater supplies and in other more immediately workable though less sophisticated water projects.

Taking the six countries as a whole, it appears that agriculture remains the major consumer of water, and that investment in irrigated agriculture, though often subordinated to investment in hydropower and industrial water supply, is generally being sustained or enhanced. Moreover, although industry is now the main economic sector in Hungary, Spain, Mexico and Israel, agriculture still remains the leading sector in India and Algeria, both of which, however, are also witnessing industrial growth. Far from being a constraint therefore upon development, irrigation agriculture has generally been a distinct stimulus not only to the agricultural and agroindustry but to industrial development and to the national economy as a whole. 14/

In the course of economic development, it is therefore possible that agricultural and irrigation investment can continue to be employed as a deliberate factor in helping the total economy to "take off" toward development and modernization. It is, in fact, economically dysfunctional to polarize agricultural development from industrial development in so far as water administration and planning are concerned. Not only do both agriculture and industry involve interrelated questions of domestic policy and foreign trade, but selective economic decisions in both sectors can continue to increase yields to the national economy and to each other. For this reason, balanced and selective water investment and water development for agriculture and industry, as well as for their combination under the rubric of agroindustry is one device for achieving desired results in the realm of economic development. In making the necessarily balanced plans and decisions to bring this about in developing and developed countries, water authorities are becoming increasingly aware of the essential relationships between the economic and administrative aspects of water resources management.

14/ Eric Thorbecke, ed., The Role of Agriculture in Economic Development (New York, Columbia University Press, 1969).

Socio-economic consistency

Among the various criteria for the allocation of a nation's water supplies and investments is the socio-economic. 15/ Here the stress is upon the allocation of potential benefits to income classes or regional groupings rather than merely to economic sectors such as the industrial and agricultural, although the two approaches often coincide. One version of the socio-economic approach is the search for urban-rural balance. Related to this is the goal of a balanced regional distribution or redistribution of population and enterprise. The issue of regional competition for national water supplies and national water investments is also one of the most warmly contested policy and political questions in the more developed societies, including the United States of America and the Union of Soviet Socialist Republics. 16/ Nevertheless, the seriousness of the issue is increasingly felt in the developing economies because of their relatively rapid rates of urbanization.

Legally, water use for municipal or community purposes is generally given the highest priority in the developing as in the developed countries, sometimes under the category of domestic or household use. As a matter of actual administration, however, domestic or municipal water supplies are often delayed and subordinated in favour of water projects more specifically earmarked for agriculture or industry. The latter has particularly profited from water priorities assigned to individual manufacturing enterprises. In some developing countries, moreover, these are often permitted to establish their own wells and other private supplies outside the municipal or public systems.

The lower priority which is sometimes assigned to municipal and even domestic water supplies in developing countries arises also from the fact that the prevailing

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15/ Internationally, the Lower Mekong River Basin provided an early opportunity to systematically inject socio-economic considerations into river basin surveys. See United Nations Survey Mission, Programme of Studies and Investigations for Comprehensive Development of the Lower Mekong River Basin, 1958 (the Wheeler Report, TAA/AFE/3); W. R. Derrick Sewell and Gilbert F. White, "The Lower Mekong", International Conciliation (Carnegie Endowment for International Peace), No. 558, May 1966; Gilbert F. White and W. E. Garrett, "The Mekong River of Terror and Hope", National Geographic (Washington, D.C.) December 1968, vol. 134, pp. 737-787; see also Stephen L. Brower, "Integrating Human-Social Resources into the Water Resource Development Process", Water for Peace, 1967, vol. 6, pp. 454-462. See especially United Nations Economic Commission for Asia and the Far East, "Social and Non-economic Considerations in Water Resources Planning and Development", part II, document No. 7, report and background papers of the Working Group of Experts in Planning Water Resources Development, Bangkok, 29 August-9 September 1968.

16/ James W. Fesler, ed., "Government and Water Resources: A Symposium", American Political Science Review (Washington, D.C.), September 1950, vol. 44; League of Women Voters, The Big Water Fight, 1966; see also United Nations-Union of Soviet Socialist Republics, Interregional Seminar on the Integrated Utilization of Water Resources, Fergana, Uzbekistan, Union of Soviet Socialist Republics, August 1966. The technical papers presented here by the American and Soviet participants dealt with the common regional and national problems of water balance.

technology for such so-called local or private projects involves the construction of wells and reservoirs which are smaller and simpler to finance and manage locally or privately. Such community self-help projects and individualized efforts are highly rated as part of the development process in developing countries. However, as water development proceeds, local or regional administration becomes more effective and community water supplies in the developing countries are absorbed by the municipal or metropolitan systems. In time, these water systems take on more responsibility for the industrial supply, and sometimes water systems designed purely for irrigation assume responsibility for supplying water to rural areas or even generally to neighbouring urban communities. By the time this stage of economic development is reached, the growing concentration of population often requires a still heavier investment for the increased industrial water demand and for the additional burden of treating urban sewage on a wider, often regional basis.

India, for example, still lacks adequate water supplies for half her population, whether rural or urban, and as much as three fourths of her non-farm population is still without sewerage. In so far as her rapidly rising metropolitan cities are concerned, the situation is even more serious. The problem ranges from New Delhi's currently rapid development of water and sewage facilities to the slower water development and more perilous condition in Calcutta, where there are still 120 miles of open city sewers. 17/ Related to India's difficult problems of internal migration and resettlement, the nation's public health and socio-economic pressures have not been eased by the problem of "oustees" from the rural areas, an entirely new and unique class of displaced transients created by the construction of projects presumably undertaken to relieve the economic plight of this large segment of the Indian population. 18/

In Mexico, where rural water supply systems for purposes other than irrigation are also seriously lagging, there are equally severe urban problems. The result is a compounding of the problem of urbanization and industrialization. A substantial amount of Mexico's economic investment, it should be noted, is devoted to the manufacture of products for distinctive urban use, such as automobiles. The major urban and industrial concentration is in the Federal District and the surrounding "suburban" State of Mexico. At the heart of the Federal District is Mexico City, which is truly the most metropolitan or "mother" city in the six countries in question. It is not only the nation's capital and commercial centre, but with its developing metropolitan area it accounts for much of the country's industrial development. As such, it suffers most of the ills of the modern metropolis, including an intensely congested traffic in automobiles of increasingly domestic manufacture.

Mexico City's water problem is a projection of the kind of long-standing difficulties which are brought to a head by intensified development. Dating back to pre-Columbian days, it was built on a spacious and splendidly mountain-ringed arid plateau, superimposed upon what is essentially a prehistoric lake. Throughout

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17/ Calcutta Metropolitan Planning Organization, Master Plan for Water Supply, Sewerage and Drainage: Calcutta Metropolitan District, 1966-2001 (Calcutta, 1966).

18/ Morris Juppenlatz, Cities in Transformation: The Urban Squatter Problem of the Developing World (St. Lucia, Australia, University of Queensland Press, 1970).

its history, it has ingeniously marshalled its basin waters. Now, the city prides itself on having recently supplemented its Lerma River project with a flow of 15 cubic metres per second. Its underlying water table has been severely overpumped for urban-industrial uses and as a result some of its buildings, many of them models of contemporary architecture, are settling slowly but steadily. However, indigenous Mexican innovation continues into the urban era. One of the nation's most recent and sizable investments has been Mexico City's splendid underground subway transport system, which is impressive, among other reasons, because it is built so as to float on a uniquely watered but recalcitrant subsoil base. 19/

Although Spain has made more progress with respect to municipal and domestic water supply, 40 per cent of her population still remains unserved by community facilities and 75 per cent lacks sanitary sewage. However, Spain is now engaged in raising the level of community water and sewage systems and enhancing the conditions of rural life. In many of her multipurpose water projects, land settlement is facilitated by rather comprehensively administered programmes for encouraging and financing family-sized farms. Nevertheless, even in Spain, the population portrays signs of transiency and mobility as between the rural and urban districts. Over one million persons in a total population of 20 million were displaced during the last decade alone, 85 per cent having moved from rural districts to urban places in the three provinces of Barcelona, Madrid and Valencia.

The three remaining countries are also experiencing a degree of developmental competition as between urban and rural water supply and investment. Algeria's modernizing and developing capital of Algiers is experiencing chronic water shortages, and its sewerage requirements exceed demand. In Hungary, the domestic and municipal supply is adequate, but only 30 per cent of the population is now served by sewerage, and 75 per cent of the nation's sewage remains untreated. Although community water systems are administered advantageously in Israeli articulation with the nationally integrated water system, the major water problem remains of how to sustain and enhance the supply of agricultural waters.

Considering the experience of these developing countries as a whole, much as is the case in developed countries, the intense pressures of accelerated urbanization, the resulting urban-rural imbalance and the associated socio-economic development question constitute serious problems, and they have direct and substantial impacts upon water administration. In view of the need for possibly strengthening the holding power of the resource-based countryside against premature industrialization and excessive urban migration, and certainly in order to avoid the threat of merely exchanging rural poverty for urban misery, all these problems would seem to call for more vigorous nationwide decision-making in developing countries, especially in respect of the issue of local water investments and expenditures and the associated question of central grants-in-aid.

Ecologic integrity

Not one country among our sample of six has laid claim to having made a wholly satisfactory start upon its water pollution problems, including the highly relevant

19/ W. Bion Moore, Industry and Water for the Valley of Mexico, A Study of the Effects of Water Resources on Industrial Development in the Valley of Mexico, 1975-2040 (Mexico City, Departamento de Investigaciones Industriales, Banco de Mexico, 1968).

problem of degraded agricultural waters. Yet the ecological trend is so kaleidoscopic that every country in the sample has reported that it is already beginning to experience an air pollution problem. In some of these countries there is, as a more immediate matter, a growing realization of the need for monitoring water quality and taste, for more careful administration of recreational or medicinal waters and related water functions, and for giving more attention to such unconventional and "uneconomic" considerations as aesthetics and other amenities.

However, few water programmes in these developing countries are administered with an eye to sustaining the wider ecologic balance of the land as a whole, conserving the national stock of natural resources, and preserving the entire national estate. While soil productivity is being maintained through increased use of fertilizers in some developing areas, the deterioration of fertility in other areas calls for careful and timely study if soil degradation is not to become ecologically irreversible. Worse still, ecologic imbalance in the soil is paralleled by economic instability on the land. A prime expression of this is the intractable question of land reform involving unresolved conflicts of individual and social interests over land ownership or land use. 20/ From this standpoint, land reform may be regarded as a salient ecologic, and not solely economic issue for mankind, since it persists as a tenacious problem in developed as well as developing lands.

Ironically, some of this ecological deterioration results from the substandard management of the water resource itself as well as from the deleterious use of the land in the water basin. In respect to water mismanagement, it takes such forms as over-irrigation, sedimentation, salination and algaefication. Thermal pollution from atomic plants is a new problem, and its correction is likely to be unduly delayed, while beach pollution and erosion is an expensive problem and will necessarily be one of the last to plan for. As water administration and water investment begin to take account of some of these dysfunctional consequences of development, however, the water economy will have to bear a greater proportion of the costs of environmental conservation and ecological preservation, and this will no more brook delay in the developing than in the developed countries.

In the course of these events, the evolving art of water administration in the developing countries will play a decisive role. This is already evident in current decision-making with respect to the engineering, economic, socio-economic and ecological aspects of water resources development. In all these fields, the administrative implications have proven to be basic because, in the process of decision-making and policy formulation, water facilities and water services, as measured by both capital invested and developmental impact, constitute one of the most expensive but essential sectors of the total national economy.

It is significant from both the economic and environmental points of view that water administration - and more specifically water administrators - are

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20/ See the several articles by Solon Barraclough, Ernest Feder, Arthur Gaitskell, Dante Caponera, Jerzy Tepicht, Rodolfo Stavenhagen, Sayed Ahmed Marei and V. M. Dandekar in "Land Reform", Ceres (FAO review), November-December 1969, vol. 2, No. 6.

beginning to play a key interdepartmental and interdisciplinary role in resource policy and national development. Increasingly, water administration acts as one of the principal catalysts in relation to economic development generally, largely because of the forehanded attention that must be given to the investment process. In these respects, water administrators in developing countries can help to avoid costly economic mistakes which were made in developed countries and virtually skip the stage of systemic diseconomy which the latter are now experiencing. Thus, water administrators are also in a most strategic position to help their developing nations make the necessary policy and technical transitions from sheer engineering and economic to the more comprehensively based socio-economic decisions.

III. PLANNING CAPABILITY AND POLICY-MAKING CAPACITY

The planning process in water administration

To translate wise policy into workable plans preliminary to their proper execution is now generally recognized to be an integral part of the modern process of public administration. In countries which are in the course of development, the planning function understandably tends to predominate over management or operating activities, and as plans are translated into functioning projects, operations and management would normally be expected to displace the planning emphasis. In actual fact, however, planning functions continue to expand, in both under-developed and developed systems of administration, and to mingle with management duties. In water agencies, particularly, the planning function continues to be so pervasive that, even as specialized planning staffs and branches arise within the general system of water administration, certain planning responsibilities on the part of operating water branches tend to magnify and multiply.

Popular explanations for bureaucratization aside, the reason for this cumulative tendency resides in the intrinsic character of the contemporary planning function. Planning consists not merely of long-range decisions and far-sighted arrangements for a completed system of administration for the future, but also of the constant preparation and cumulative formulation of sectoral plans, complementary programmes and constituent projects, which, when added up and linked together over time, constitute the ongoing and administrable system. Planning is especially important in the field of water administration because of the involvement with long-term construction commitments, the constantly phased-in incremental requirements of distribution or secondary facilities and the continual adaptations that have to be made between physical plant and socio-economic plan.

Water administrators in developing countries are aware, moreover, that when they plan the water system or its various parts, they are planning a good part of the national infrastructure - economic and social. This requires continuous restudy, re-emphasis, rethinking and rescheduling of institutional as well as technical arrangements, so that in effect, the empirical feedback and corrections from operating experience (including test procedures or demonstration projects) become as essential as the original foresight required in the planning process itself. Consequently, although there are certain stages or branches of the over-all water system in which planning functions predominate and others in which management operations prevail, both planning and management continue to commingle throughout the whole system, and the higher the administrative level or the more complex the administrative responsibility, the more does planning become essential to keep operations going.

Planning thus takes many different forms in the various national systems of water administration. Even the higher policy role played by the political, legislative and executive authorities will vary from country to country, although this authoritative level of policy-making generally retains the ultimate power to decide among major alternatives and priorities and frequently reserves the right to get involved in minor planning decisions as well, especially if they concern

politically sensitive questions. However, the higher political and policy authorities in modernizing countries are increasingly influenced by the kind of planning, thought and expertise that is contributed by specialized and sectoral administrators, planners and economists. Especially is this the case where the goal is national development and where water development parallels, or often sets the pace for, the national development process as a whole.

Although water planning thus embraces a good degree of comprehensiveness and its scope tends to be extensive, it also incorporates a large degree of detail, and thus the range of planning activities becomes especially intensive at the level of the concrete projects and specific installations concerned. Indeed, while comprehensive in context, the actual content of most systems of planning generally remains realistically practical or incremental, even though this ad hoc approach seems, on its face, to violate the planning doctrine of comprehensiveness. It is thus possible for such partial or so-called "facet" planning, especially in the realm of water resources, to be comprhensive in effect without appearing to be so in content.

However, the essential value of constantly sustaining this comprehensive view in the planning process, even while pursuing sectoral or segmental parts of it, rests in the fact that the far-sighted and comprehensive approach to planning embraces and subsumes all of the many relevant factors that have to be considered. At the same time, this comprehensiveness permits concentration on individual programmes and particular projects in some selective order, which in turn fulfils the over-all planners' sense of priority and, in effect, helps him to put first things first. For, whether planning is systemwide or subsystemic in its coverage, it has to be pursued in accordance with some time schedule or at least with some preconceived sequence in mind. Such timing must be synchronized, and the several constituent programmes and interrelated projects must be staged in relation to one another so as to contitute some kind of an administrable plan.

Optimal timing is especially significant for water resources planning because of the essentially sequential character of the characteristically multipurpose, multistage, multifacility projects here involved. This relates not merely to physical project planning, but also to the sequential planning of the functional phases or administrative stages of a developing national water system. Thus for each function - from flood control or irrigation to recreation and wildlife - national water planning and administration proceed by their own major stages, such as over-all planning, investigations, construction and operation. 1/

Although in actual practice comprehensive water planning generally takes place after sectoral plans or incremental decisions have committed the evolving water system along certain lines of development, increasingly in developing countries a general master plan or so-called "framework" plan of a preliminary or

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1/ For a comprehensive table of the various phases of the water planning process in relation to the different water functions and to the supplementary phases of administrative arrangements and procedures, see Canadian Council of Resource Ministers, The Administration of Water Resources in Canada, 1965 (Ottawa, 1966).

"reconnaissance" nature is prepared or conceived. 2/ Such framework plan, in its broader dimensions, might consist of an inventory of the nation's water resources by major components and regions; an analysis of the technical possibilities for developing the national water supply; a preliminary check-list of projects and programmes to be pursued; a tentative listing of possible priorities; an organizational scheme including the allocation of functions between the national or central and the subnational or regional agencies; and a management plan covering the remaining major administrative arrangements, including personnel and manpower plans which are so essential for the realization of the programmes and projects undertaken. 3/ In all these respects, as the following analysis reveals, the planning system of the six countries studied vary widely in specificity of priorities, extent of comprehensiveness and degree of far-sightedness.

Hungary's water planning system

Hungary's water planning system is the most comprehensive and has had the longest history. After many years of a slow but steady modernization of its water system, Hungary in 1930 charted its anticipated water resources development for several decades ahead and set forth the prerequisites and priorities for realizing this far-sighted development plan. None the less, it was a succession of economic five-year plans during the last 20 years that brought to a greater state of maturity the entire national planning process in Hungary. This had the result of intensifying and elaborating Hungarian water planning, although there is also some evidence that, owing to its earlier development, the prior system of Hungarian water administration contributed reciprocally to the improvement of contemporary Hungarian economic planning.

Certainly Hungarian planning has contributed technical improvisations to the planning process in collective economies generally, including some of the statistical or conceptual breakthroughs in the specific realm of development planning. The nation's planning experience has also been specially stimulated by its association with hydroengineering, which over the years had enjoyed high prestige in Hungary and which developed early links with the field of hydroeconomics. By the time national and economic planning of the more current and comprehensive type arrived on the scene, the ground in Hungary was well laid in a professional and technical sense.

What is known today as the Hungarian water plan is, from the point of view of its formal documentation, an elaborate compilation of 19 sections or chapters. These range all the way from an enumeration of general propositions and concepts

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2/ For a detailed definition of the so-called "framework studies", see United States Water Resources Council, The Nation's Water Resources, the First National Assessment (Washington, 1968), vol. 2, part V, chap. 6, p. 8. An earlier but equally basic explanation of framework planning is contained in Interdepartmental Staff Committee, Ad Hoc Water Resources Council, "Guidelines for Framework Studies", 10 June 1968.

3/ See also Harold R. Shipman, "Considerations Involved in the Planning, Organization, Management and Design of Public Water Supply", Water for Peace, 1967, vol. 8, p. 713.

governing the planning process in the field of water to a setting forth of the operating relationships for co-ordinating water management with the other branches of the national economy. In between are sections, with continually up-dated statistics, priorities and guidelines, dealing with water inventory, flood protection, drainage, river control facilities, control facilities for the hilly and mountainous regions, irrigation, fisheries, domestic and industrial water supply, municipal supply and industrial plant supply (including provisions for the necessary quality controls), water power, waterways and harbours, water storage and its multipurpose utilization, mineral and medicinal waters, recreational waters, other major multipurpose water installations, international water flow, the over-all national water balance and miscellaneous functions and facilities related to water management.

Despite the extensive detail incorporated in the Hungarian master plan, there is a supplemental series of particularized plans covering other facets or aspects of the national water supply. Throughout the master plan and its parts, the methods and techniques pursued are advanced and sophisticated, yet clearly and graphically presented so as to facilitate deliberative and alternative decisions. For example, in balancing potential agricultural and irrigation waters with municipal and industrial waters, the available indicators and parameters are combined under various computational schemes which produce 34 alternatives in terms of their "most expectable" quantitative values.

All such planning is projected forward for different periods of time depending on the subject-matter concerned. Thus, certain major water schemes are planned for periods of 80 to 100 years, since the combined ecology and technology involved justifies such a long-range period for investment and construction, while water facilities for ordinary domestic and industrial supply purposes cover shorter spans of about 20 to 25 years, since the combined demography and technology involved here is more transient. Still other water programmes, where the technologic and demographic, or the economic and ecologic, variations may be subject to swifter trends, are projected for only a 10 to 15-year period. Most long-range economic planning covers periods of 15 to 20 years, and in this sense Hungarian water planners often speak of "the 15-year plan". The most immediately administrable parts of the plan are projected for a typical five-year period, broken down still further into one-year intervals for budgetary planning, but keyed-in with the five-year economic plan.

Despite these various time spans, the normal processes of annual budgeting and the related system of administrative decision-making constitute the prevailing means for translating plans into realities. An additional means of keeping water plans updated with ongoing developments is the publication of Hungary's Water Resources Yearbook. Continual feedback of this kind is especially instrumental in facilitating the realization of concrete economic plans. Integration of the water and economic plans has not yet been satisfactorily achieved in Hungary, but there is a constant effort to increase the degree of articulation between the two. It is significant that the president of the National Water Authority, under whom much of the Hungarian water planning conducted by the several semi-autonomous planning and research centres and institutes is co-ordinated, participates directly in the economic policy-making functions of the Government.

Indeed, the Hungarian water planning process has gone far enough in dovetailing with the national economic planning process to lead to the designation

of the so-called "water economy" in Hungary as a specifically budgeted and separately administered subsector of the total economy. As one general grouping of the national economy, "water management" is combined with agriculture and forestry under the broad category of "agriculture, forestry and water management". For operational planning and budget purposes, however, the entire economy is regarded as comprising nine branches: heavy industry, metallurgy and major industry, light industry, construction, transport, post and telecommunications, internal commerce, external commerce, agriculture, forestry and food industry and water resources administration.

Within the National Water Authority, there is a Department for Planning and Economy, but the ministries and other governmental agencies which are more formally responsible for the five-year plan continue to pursue their directive functions of policy-making over water as well as over the other sectors of the national economy. This includes the allocation of investment funds under the five-year plan, as well as certain controls over the annual maintenance and management budgets. Within these broad directives, however, the detailed funding for the water system is accomplished through financial allocations and budgetary transfers usually made by agreement among the ministerial operating agencies themselves.

Although central planning directives prevail in Hungary, there is a distinct effort to adhere to the ideal of planning "from the bottom up" as well as "from the top down". In the water field, regional plans are particularly emphasized for basins and sub-basins and are, in fact, called "key water plans" in Hungary because of the increasing urge to link them into the national "master water plan". 4/

Water planning in Spain

There are striking similarities in the details of the planning system which has emerged in Spain in the course of that nation's development since the late 1930s. There was some incipient experience with a form of developmental planning as far back as the 1890s, and even before then a Ministerio de Fomento (Ministry of Development) had been established. Shortly thereafter, there also followed in Spain a relatively early appearance of modern engineering and economics applied to water resources development. This was strengthened by the association with Spanish water administration of that country's burgeoning public works planning in the related fields of highway and bridge engineering.

Apart from this historic indigenous background to Spanish planning, there have been more recent international impacts. For example, the World Bank's loans for various hydroelectric projects in Spain were preceded by development studies during the early 1960s which stressed socio-economic criteria for planned water investments and associated land development programmes and related projects.

Spanish data collection and hydrological research, beginning with the work of such early agencies as the National Meteorological Service, have had a noteworthy

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4/ See also D. Bözsöny and J. Bekesi, Long-Range Water Management Planning in Hungary (Budapest, National Water Authority, 1966).

record as measured by international norms. 5/ There have been, however, certain technical divergences in Spanish planning from comparative practices elsewhere. Thus, the basic planning period is four years instead of five. Spanish planning is also somewhat more centralized, residing at the national level in the Ministry of the Presidency, and the Commissariat of Development Planning. In national water planning, the Centre for Hydrographic Studies plays a basic role, although there are also planning staffs located within the principal water agencies which operate under the Ministry of Public Works. By these means, political consistency and policy co-ordination are achieved in Spanish water administration in its relation to the nation's centralized planning system as a whole. There is also in Spain somewhat of a tendency to plan from the top down, although an increasing degree of regional and basin-wide planning is apparent.

Water planning in India

During the last generation, the five-year plan has become a principal instrument of national planning in India, and one of its major components has been water planning. Indian water administration, including several modern planning aspects, had already emerged during the years before independence and this was readily blended with the Indian economic planning system as it has evolved more recently. A major stimulant to Indian planning has been the serious support and personal involvement of some of the nation's highest political authorities and most experienced civil servants. The Prime Minister of India is Chairman of the Indian Planning Commission and the Minister of Finance is one of its members. This links the planning process directly with the goals of economic development and national budgeting on the one hand, and with the detailed requirements of financial and fiscal direction on the other.

The procedures of Indian planning are among the more elaborate in the developing world, and the guidelines laid down by the Planning Commission for all the agencies concerned, both at the centre and within the individual states, have been cumulatively detailed. There is an emphasis upon those procedures necessary for effective control, not only over the long-range public investments laid down in the five-year plan, but also over the annual allotments for such capital improvements.

India is especially well staffed not only with planning and development economists, but with econometricians and sociometricians, many of whom are internationally outstanding. Benefit-cost analysis is elaborate and is supplemented by analytics involving social indicators transcending traditional economics. This trend is having its influence not only at the centre but in the states, where statistical cells are being established to fit financial expenditures and fiscal targets into economic priorities and social benefits.

The Indian Planning Commission thus draws into its work planners and administrators of several specialties and skills. At the various levels of Indian government, the rich professional experience available in the field of Indian

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5/ For the quantitative base of Spanish water planning, see J. M. Pliego, J. M. Pagos and J. Pasdo, "Spain's General Directorate of Hydraulic Works", Water for Peace, 1967, vol. II, pp. 500-509.

hydroengineering has for some years included a wide range of economic, administrative and planning skills. Indeed, the duties and the position classification of Chief Engineer in the field of Indian water administration, both at the centre and in the states, has been enlarged over the past several years to include the duties of the Secretaries in the various water departments and agencies, and these men have also increasingly exercised planning responsibilities. Since independence, there has also been some countertendency, in response to what is often regarded as the modern theory of public administration, to separate administrative responsibilities from the engineering function and to assign them to Secretaries wholly specialized in administration. Nevertheless, the combined Chief Engineer-Secretary post in India is often retained now under the classification of Joint Secretary. This preserves, in part, the typical Indian pattern of a Chief Engineer-General Manager, thus combining the skills of administrative direction and operational responsibility with the several planning functions involved.

Parallel with these elaborations and refinements in the national planning process, there has been a related and steady rise of research and development in Indian water administration. Official research and higher education in this field has had a distinguished history in India. This development goes back to the original creation by the Indian Central Board of Irrigation of a Central Research Committee, consisting of the professional researchers, research user and consulting engineers. It was followed in the 1930s by the establishment of the Provincial Research Station, later called the Central Research Station, at Khadakwasla (Poona), with its continuing annual research budget. This also facilitated India's elaborate system of basic hydrologic data collection. Evidence of India's attainments in water resources research ranges from her recognized leadership in the general field of arid zone research, some of which has been sponsored by UNESCO, to research in municipal water resources administration and related problems of metropolitan government reorganization, as reflected in the comprehensive Basic Development Plan for the Calcutta Metropolitan District (covering the period 1966-1986), produced under the direction of the Calcutta Metropolitan Planning Organization.

The extent to which Indian planning is actually attuned to effectual water administration is a question that is more dependent upon the prospects of intergovernmental relations within the evolving Indian federal system than upon the refinement of professional skills and planning procedures, which are admittedly undergoing rapid modernization. None the less, solution of the overriding problem of political and administrative centralization and decentralization in India may be facilitated by a continued reconciliation among alternative plans and a clearer identification of policy priorities in the realm of water resources. Specifically, such integrated planning at both the centre and in the states requires interrelated decision-making as to investments in irrigation and industrial waters and related demographic issues of rural and urban growth. Furthermore, these need to be phased-in, with the emergent problems of basin, sub-basin, and even interbasin water transfers and balances now facing a nation that is clearly passing from a sheer developing into a distinctly developed status.

In respect to irrigation alone, a special Irrigation Commission was recently established in India for the purpose of reviewing the country's water development needs for the remainder of the present century. Its terms of reference stressed the need to re-examine the "administration and organization set-up for planning, executing and operation of irrigation works". In a still broader approach to India's water planning problem, Chairman G. A. Narasimha Rao of the Central Water

and Power Commission significantly announced at New Delhi in December 1969 to the forty-second annual session of Indian water engineers, administrators and planners:

> "We are also considering in terms of lift irrigation whereby available surface waters from rivers will be diverted from surplus regions to deficit regions. Also the concept of re-use of drainage waters is gaining ground. Our project planners should seriously consider changing over from traditional ways of framing projects to modern ways, where availability from all types of water resources is assessed by a single agency and allocation of the entire water potential is made according to requirements of various areas or regions, taking into consideration the present or future growth."

Mexican water planning problems

Starting with an emphasis on irrigated agriculture 50 years ago, Mexico moved to equally intensive planning of her hydroelectric and industrial sector in the 1940s and, most recently, she has become concerned with more advanced industrial and urban water planning. National economic planning generally is carried on in Mexico at the highest governmental level of the secretariat of the Presidency, but there is collaborative participation from the various agencies charged with water administration. Regional and basin planning has been moving forward slowly but steadily, and there are also signs that the formerly quiescent states of the Mexican federal system are beginning to be used in the planning process.

Nevertheless, basic data collection both on the regional and national scales still lags behind needs, as does development research, including socio-economic studies, in the field of water and related land resources. At the same time, there is a tendency towards statistical refinement and even computerization of data in Mexico, and the country's water administration is assuming an increasingly favourable position from which it can make more systematic choices among socio-economic alternatives and investment priorities, both with respect to urban-industrial and rural-regional water supplies. Mexico thus presents further evidence that planning skills and planning machinery can bear fruit, but that they cannot alone provide the viable substantive decisions which are required for an effective development policy. 6/

Planning progress in Algeria

Comprehensive Algerian planning of water resources is in its beginning stages, but it is carried on with increasing participation of various policy and administrative branches of the Government. This includes especially the Prime Minister's office, where national priority-setting and economic decision-making generally resides. It is supplemented by data-gathering and planning contributed by the various water agencies. Thus, individual projects, selected programmes and sectoral plans are going forward simultaneously in Algerian water development, and some of them have moved into the operational stage.

6/ Manuel Aguilera Gomez, La Reforma Agraria en el Desarollo Economico de Mexico Mexico City, (Instituto Mexicano de Investigaciones Economicas, 1969).

Employing international aid, Algeria is also building up a series of regional water plans for future application. Meanwhile, its own Hydrologic Service of Applied Scientific Studies is intensifying the regional and national collection of basic information, establishing data banks, pursuing benefit-and-cost analyses, constructing hydrographic models and building up the country's capacity to apply mathematical methods and models to the planning process. These efforts are being extended from sheer water resources planning to the planning of the interrelated land, mineral and energy resources. Algeria has also begun to do economic planning of the agri-business type based on hydropower and irrigation, as well as related socio-economic planning on such questions as manpower employment and nutritional standards.

Planning practices in Israel

Israeli planning may offer relevant experience for new and developing countries if it is carefully analysed and selectively applied. Early comprehensive planning was carried out by Tahal, an Israeli consulting firm that was responsible for various engineering and development tasks. However, primarily plans are preconceived and framework plans are prepared, and Israeli planners and administrators prefer to pursue a continual and adaptive process of projection and feedback. As a consequence, Israeli plans are typically incremental in character though comprehensive in concept. Despite the adoption of a general draft plan for water development as early as 1950, two years after Israel was established as an independent State, the revision of the water plan has been constant and extensive. Employing this form of so-called "facet" or incremental plan-making, the planning habit was cumulatively ingrained at the more operating levels of water administration. Although the national water plan is now in an advanced stage of implementation, Tahal continues to prepare both general and detailed engineering plans for all major water supply facilities, supervises plans for sewage collection, disposal and reclamation, and carries on general environmental control studies. Tahal is also concerned with scaling down planning procedures and subdividing planning for their absorption by the operating levels of the water system.

Thus, Israeli plans have expressed themselves on the borderline between the over-all planning process and its detailed administrative implementation. The concrete plans evolved and their phased execution emerged primarily in sectoral, regional and project instalments. In physical terms, and from the standpoint of the hydroengineering and hydroeconomic considerations involved, the planning sequence proceeded from rather elementary projects depending upon local ground waters to regional projects which supplemented the ground-water supplies with surface run-off, spring waters and reclaimed waste water. A major objective of these projects was to spread local surpluses regionally as they became operationally available. The national planning and development process went forward as the national water supply was augmented. There was constantly an effort to make the newer local and regional projects operative as soon as possible after nationally available waters began to flow, thus avoiding wastage in the increasingly heavy national investments which were outlaid.

The preferred criteria for establishing project priorities often incorporated some rather elementary but quite pertinent planning concepts, such as: low technological complexity of the project; minimum investment per unit of water supplies; possibility of subdividing the investment into separate stages; maximum potential for spreading production inputs and water costs as well

as for optimizing water supplies and economic yields; sufficient flexibility of the project to meet future uncertain and possibly incompatible conditions; and low sensitivity of the project to possible future deviations from the available but possibly mistaken basic data.

Planning priorities and programme scheduling thus moved from quick-effect and low-cost projects to more long-term and expensive ones. This preferred pattern arose from the fact that the first imperative was to supply water to many far-flung settlements on short notice and with least expenditure of scarce resources. It was for this reason, too, that the solution was adopted of early exploiting the more readily available ground waters, followed by the more complete exploitation of other local supplies, then by district distribution and regional hook-up, and finally completing the national network which now takes the form of the National Water Carrier. For similar reasons, and also in order to minimize the risk of mistaken investments in projects which might suffer from construction based on incomplete data and from lack of sufficient time for pre-testing, Israeli planners adopted the concept not merely of a project-ranking sequence, but of aggregating projects by so-called "generations". Under this approach, "first generation" projects were undertaken with a view to their completion in phased relationship to anticipated "second generation" projects, while the latter were sequenced in relation to future "third generation" projects. However, althought Israeli water planning and development may have appeared to be piecemeal, it was not bound to a project-by-project approach. Water projects in different stages of realization progressed at unequal rates of development in various parts of the country, although they were "generationally" well phased.

Such flexibly timed and limited-scale planning also made it possible to utilize sparse water supplies and restricted investment funds when the demand for national economic development was most pressing, but when the available time and capital were scarcest. Moreover, it reduced the inherent risk of inevitable mistakes, which would have been more serious if the projects had been ordered on a larger scale, mistakes that became more easily rectifiable by subdividing developments into their separate yet integrable parts. Such a system of planning is also more capable of deferring technologically more complex and economically less attractive developments, such as those involved in large-scale quality control, and of absorbing possible emergencies, including climatic shocks which are likely to occur in areas of characteristically unpredictable rainfall. While pressed by time, therefore, such a system in effect bides time.

Israeli water planning and development was also designed to fit the rate at which some of the necessary manpower skills became available. Thus, there was an attempt to complete the secondary and distribution installations in relation to the arrival and settlement of the immigrant population and to their essential training as agriculturalists and irrigators or as water technicians and water users. In so far as the rarer skills of the planning technology itself were concerned, these were apparently made available in good time. As time went on, the more sophisticated practices of contemporary planning were increasingly applied. It would be revealing to reconstruct in more detail the actual sequence and source of these innovative aspects of Israeli planning, which were expressed in the avant-garde conceptual terms of systems analysis and cybernetic modelling, as well as in the workaday terms

of the adaptive planning practices which prevailed and which largely explain the evolution of the Israeli water system. 7/

7/ An earlier sequence of ideas and insights is suggested in Aaron Wiener, "Institutional Aspects", First International Conference on Water Law, Buenos Aires, 28 August-2 September 1968. For other methodological developments in Israeli planning, see also Aaron Wiener, "Comprehensive Sectoral Planning of Integrated Agriculture in Developing Countries", Water for Peace, 1967, vol. 7, pp. 206-215; "Integral Planning and Engineering Planning of Water Development", a paper presented to the International Conference on Science and the Advancement of New States, Rehovot, 1960 (Tel Aviv, Tahal, June 1960); and "A Comprehensive Development Programme for Urban Water Supply and Waste Disposal: A Tentative Methodology" (Tel Aviv, Tahal, June 1960).

IV. ORGANIZATIONAL STATUS AND ORGANIZATIONAL EFFECTIVENESS

Some fundamental organizational problems

The institutional and organizational arrangements for the water function, like those for other major public services, are an essential part of a developing nation's socio-economic and policy-administrative infrastructure. No less than technological renovation, institutional and organizational adaptation is a necessary concomitant of, if not an indispensible prerequisite for, the process of modernization and development.

One such elemental institution is the prevailing body of water legislation. As a device for both enumerating and establishing the basic water rights and regulations governing the ownership and use of the water resource, the formal body of water law is of course fundamental. 1/ It is also essential for adjudicative as well as administrative purposes, especially since contests and conflicts over the ownership and use of water have been a continual source of litigation throughout the history of mankind. Consequently, the compilation or codification of water laws and regulations may be regarded as an earmark of development and modernization. 2/ On the other hand, the history of water is replete with evidence that water law alone is as much a reflection as it is a determinant of public and private practice in the use and control of this resource. It is not therefore surprising that the employment, as a technical assistance measure, of the device of a specially formulated water code for a developing nation or of national ratification of some internationally modelled water charter does not solve the

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1/ See, for example, Sebastian Martin-Retortillo, Aguas Publicas y Oburas Hidraulicas: Estudios Jurídico-Administrativos (Madrid, Editorial Technos, 1966); and Mordechai Virabambaki, "Water Legislation as an Instrument of National Development Policy", Ammales Juris Aquarium, Asociacion Internacional de Derecho de Agua, 1968. For another example of codification in the broad context of administrative and organizational considerations, see Milton H. Nathanson, "Report on Local Water Resources in Guyana and the Formulation and Drafting of a New Comprehensive Water Code", United Nations, Bureau of Technical Assistance, 1967; and H. P. Michael, "General Principles of Water Legislation at Different Stages of Development", Transactions of Berlin Conference, 1963, p. 179.

2/ United Nations, "Legislative and Administrative Provisions in European Countries to Ensure Proper Distribution of Water Resources", working paper prepared for the second session of the Working Party on Water Resources and Irrigation of the European Commission on Agriculture, Floriana, Malta, 26 May-1 June 1966 (ECA/W66/2(10); and Guillermo J. Como, "Gobierno y Administración de los Recursos Hídricos de Peru", First International Conference on Water Law, Buenos Aires, 28 August-2 September 1968.

substantive problem of actually achieving adaptive water policy or effective water administration. 3/

Actually, the trend towards "legal" codification in the water field has transcended the mere enumeration of water doctrines and laws or water rights and obligations. One of the first to pursue the legal approach to the institutionalization of water management was the Food and Agriculture Organization (FAO), reflecting the United Nations earliest response to the enhanced application of the water resource to the world's developmentally crucial agricultural potential. But from the beginning, the FAO conception of "water law" was a broad and flexible one. When the United Nations surveyed the interests and activities of international organizations in the realm of water and other resources, as a background to (the initial) Economic and Social Council resolution 346 (XII) (1952) on the subject, it found that the FAO was already "concerned with the form and improvement of national organizations, laws and international agreements for the development of such programmes and policies". 4/ Thus, in its widest implications, legal and institutional codification of comparative and international standards and norms in the water field has embraced organization and administration, legislation and policy.

Without exaggerating the organizational input into modern administration, therefore, it is quite possible to agree with the finding of the Conference on Water Development in Less Developed Areas, which convened in Berlin in 1963 under the auspices of the German Foundation for Developing Countries, that

> "the main problems in the field are not technical, but are of an organizational, administrative, political, managerial or financial nature. They often constitute unexpected and difficult barriers in the developing countries, and assisting nations may often be more helpful in solving these problems than in providing either engineering or financial aid". 5/

One of the essential reasons for this organizational emphasis, especially in rapidly developing countries or in newly established nations, is the apparent advantage of a separate and distinctive institutional status. In the competitive atmosphere which inevitably arises among the burgeoning bureaus of a developing

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3/ See Council of Europe, European Water Charter (Strasbourg, 1968); and Transactions of Berlin Conference, 1963, pp. 79, 180. The legal-formal approach to developmental modernization generally has been criticized by Robert Pakenham, "Approaches to the Study of Political Development", World Politics, vol. 9, pp. 110-120.

4/ United Nations, "International Co-operation on Water Control and Utilization - Report of the Secretary-General under Council resolution 346 (XII)" (E/2205), p. 46. The administrative in contrast to the legalistic emphasis is more currently revealed in Guillermo J. Cano, "A Functional Approach to Water Resources Administration", First International Conference on Water Law, Buenos Aires, 28 August-2 September 1968, p. 9; see also Juan Dalbagni, La Administracion de los Recursos Hídricos en la Argentina (Buenos Aires, Professional Centre, 1971).

5/ H. P. Michael, op. cit., annex D, p. 193.

nation, an independent and "visible" structure, apart from its operating advantages, automatically carries with it a certain political prestige and a special administrative thrust. Clearly, water organization has symbolic as well as operating values.

On the other hand, there is some tendency in development circles, and even in the scientific literature concerning developmental administration, to treat organizations largely, and sometimes exclusively, in its narrower structural manifestations, rather than in its broader functional or operational role. Undoubtedly, sheer organizational or structural considerations are crucial in the administrative process, but the structural over-emphasis in contemporary organizational theory, and the conceptual rigour with which the related sciences have not paid off in terms of either a fruitful interchange of international ideas or a successful application of administrative theory to the process of modernization. This failure is especially noticeable in so far as administrative reform in the water and other resource fields is concerned.

Nevertheless, common organizational problems and solutions recur in the field of applied national water administration, and these are properly subject to generalized conceptualization and formulation. One such organizational thesis and finding, on which there seems to be a considerable degree of unanimity, is the universal need for an effective administrative agency (a) to assume the main initiative in water planning, policy-making and development; (b) to maintain or see to the maintenance of a current inventory of water and water-related resources, problems and programmes; (c) to operate or see to the operation of the water supply system and in this respect to enforce or see to the enforcement of water laws and regulation; and (d) to discourage and police or to see to the policing of damaging or polluting practices concerning water and related resources, and in this connexion to take positive steps to assure the maintenance of an acceptable level of water quality. 6/

It has been correctly pointed out that in some developing countries, specific water programmes may be well-conceived and concrete water projects may be well planned, but that often the available organization is unprepared to properly execute and construct or maintain and operate them. In such instances, what often proves to be lacking is not so much the machinery for action as the requisite personnel or some other essential administrative ingredient within the organization. Consequently, no mere addition of organizational entities to the administrative chart can fulfil such a need. As a matter of fact, there is evidence that developing countries, like developed countries, sometimes suffer from a surplus of organization. Thus, the International Bank for Reconstruction and Development (IBRD) has found it advisable, as a prerequisite to some of its loans for water development, to require the identification of one administering organization among the several existing ones. It sometimes recommends the establishment of a new and independent water agency, but this is far different from asserting a lack of organization as such. On the contrary, over-organization is as much a danger to effective water administration in developing countries as is insufficient organization.

6/ Ibid., p. 179.

The fact is that there may be alternative kinds of feasible organizational schemes and structural devices for different countries in view of the contrasting kinds and combinations of water functions exercised at varying stages of administrative development - construction and maintenance, planning and operations, budgeting and spending, funding and vending, scientific and technical, service functions and regulatory functions. And the organizational models which are available for the carrying out of these several and separable functions (and also for their comparative study or possible imitation) are numerous.

For this reason, there has been considerable hesitancy to arrive at organizational models in the realm of water administration. The earliest United Nations inquiry (1957) into the related subject of river basin development concluded that:

> "there is certainly no single correct way to organize and administer a river basin programme. The plan of organization must in each case be fitted into the general governmental structure and into the cultural patterns and political traditions of the countries and regions which are involved". 7/

Perhaps the safest international advice as it relates to organizational models and experimentation for the conduct of the water function, whether in developed or developing countries, comes from FAO. According to long-range experience emanating from this source,

> "... conditions are not always more satisfactory in highly developed countries. Various solutions have been tried out, not always with success. Special authorities have been created for large projects or for entire regions or countries. Whilst these authorities presented certain operational advantages against more cumbersome procedures of government departments, it often cut the project away from contacts with existing services possessing practical experience as well as research facilities ... In developing countries, the lack of contacts and coordination in the planning as well as in the operational stage between the various ministries can be very harmful". 8/

Most often, in fact, the prime "organizational" problem is co-ordination as process rather than organization as structure. Regardless of the kind of organizational theory which may prevail, there is a widely persistent need for co-ordinating habits and devices - not necessarily integrating mechanisms and structures - in the administrative systems of developing countries. In the search for effectual co-ordination of policies and operations, the structural choices are quite varied and the organizational alternatives cover a broad range of possibilities.

7/ Integrated River Basin Development (United Nations publication, Sales No. 58.II.B.2), p. 27.

8/ Andrew de Vajda, "Factors Influencing Planning and Operations of Irrigation and Drainage Projects in Developing Countries" in Transactions of Berlin Conference, 1963, p. 96.

Some basic organizational applications

Turkey, for example, possesses eight different water directorates among her four independent ministries of public works, agriculture, rural affairs and reconstruction and settlement, including the directorates of hydraulic works, soil conservation and farm irrigation, agricultural affairs, forestry, electric power resources, surveying and development, rural electricity and water supply, regional planning and reconstruction and natural catastrophes. 9/ However, it is anticipated that the salient issue of administrative co-ordination would continue even if these several significant directorates - some with essential non-water as well as water functions - were brought together in one ministry, or even if all the ministries concerned were bulked into a cuperministry. Botswana has virtually done this in having established a combined Ministry of Commerce, Industry and Water Affairs, and having created, under the chairmanship of this Ministry, a co-ordinating Water Development Committee consisting of the representatives of all the agencies concerned with water functions of any kind. Uganda, on the other hand, shares the function of water development and administration among two co-ministries, mineral and water resources on the one hand, and works and communication on the other. By contrast, Ethiopia has integrated most of its major water functions in the Water Resources Department of its Ministry of Public Works, while Kenya has gone still further towards integration. It has set up a Ministry of Natural Resources and, within it, an elaborate Directorate of Water Development, employing among its various branches almost 1,000 personnel, about half of whom perform the elaborate professional, technical, executive and administrative duties required in a modernized and consolidated agency of this kind. 10/

A common trend seems to be the creation of more and more generalized agencies with co-ordinating functions at higher and higher organizational levels, and, as part of this trend, an over-all ministry of resources is sometimes established. 11/ Such a new ministry may absorb agencies from existing ministries, especially from agriculture, heretofore responsible for older and more established water functions such as irrigation. There is a simultaneous trend toward the establishment in such a consolidated resource ministry or in similarly integrated water agencies at the subministerial level of an organization responsible for hydropower or for all energy functions. When the multipurpose development involved here subsequently calls for a further reallocation of organizational relationships, as is sometimes the case, there is an associated inclination to incorporate with the hydropower agency functions such as industrial water planning and administration. Moreover, there is some tendency for such hydropower and industrial water agencies to rise in organizational status at the expense of the older irrigation and agricultural agencies.

It is because of such rapid and varied organizational changes that a serious search is taking place of co-ordinating devices in water planning management,

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9/ Sabahattin Sayin and Huseyin Yegin, "Organizations Concerned with Water Resources and Problems of Water Co-ordination in Turkey", Water for Peace, 1967, vol. 5, pp. 236-246.

10/ Ibid., vol. 1, pp. 220, 356-363, 478.

11/ Shu-tsien Li, "A Unified Cabinet-Level Department of Water Development and Operation Having Fully Co-ordinated Functional Services to Meet Modern Needs, National and International", ibid., vol. 5, pp. 365-369.

beyond the mere organizational mechanisms themselves, directed towards the achievement of a genuine multipurpose administration of the water resource. 12/ Nevertheless, structural or organizational solutions can occasionally be a spur and sometimes constitute a necessary substitute for alternative co-ordinating practices. If structural solutions cannot solve the problem immediately, they may nevertheless embody some new administrative ideas and skills which ultimately facilitate procedural changes that result in effectual administration.

From all this, it appears that an organization's status reflects, although it may not necessarily determine, its effectiveness. That this is likely to mean a relatively restricted role for structural refinement in developing countries is suggested by the indecisive organizational experience of the larger and more developed countries in the field of water administration. Thus, despite a long and rich organizational experience, Canada, the United Kingdom, the Union of Soviet Socialist Republics and the United States of America have not yet arrived at an ideal set of solutions for their problems of water structure. It is revealing, however, that they have all recently set in motion, on top of their existing elaborate organizational apparatus, high-level investigatory bodies or special inquiries charged with keeping under continuing review the nation's water resources and water agencies, including particularly the need for interagency or interlevel co-ordination.

The experience of the developing countries covered in this survey will further reveal that although few model solutions to problems of water organization are available, international comparisons of organizational experience nevertheless stimulate constructive approaches to the solution of both structural and other administrative problems. For example, it is possible to conclude from the experience of the six countries studied here that organizational diffusion in water administration is often a liability, and that some kind of structural consolidation adopted early in the history of the water system or at some other strategic point of development can serve to strengthen the co-ordinated functioning of a water agency. On the other hand, it is also possible to confirm from this comparative experience the lesson that organizational integration in itself sometimes accomplishes little in the way of administrative co-ordination, since functional co-ordination is a process that is often independent of structural consolidation.

The integrated Hungarian system

The Hungarian system is structurally and functionally the most intact and integrated. 13/ Although not a separate ministry, the Hungarian National Water Authority reports directly to the Council of Ministers. Two of the regular ministries retain correlative jurisdiction with the National Water Authority over designated water questions. These are the Ministry of Agriculture and Food Supply on questions of irrigation, and the Ministry of Mining and Power Supply on matters of mine waters and energy. In addition, there is a National Water

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12/ A modernized effort in this direction is described in Canadian Council of Resources Ministers, Administration of Water Resources in Canada, 1965.

13/ The Hungarian structure is also described in detail in National Water Authority, Twenty-Five Years of Development of Water Management in Hungary (Budapest, 1970).

Management Commission, under the chairmanship of the president of the National Water Authority, which maintains a consultative relationship among these or other ministries concerned with particular water problems as they may arise.

Since its establishment in 1953, the National Water Authority has brought under its supervision most of the formerly independent agencies engaged in planning and directive functions related to water administration. At the same time, it has decentralized to or devolved upon its subordinate branches, or upon other independent or quasi-independent agencies, certain operating and technical functions. The Authority's organizational check-list actually enumerates as many as 63 "water administration organs", and the Authority generally keeps these entities working together mutually and effectually whether they are independent or integral parts of the Authority. Those entities which are integrally part of the Authority function under the over-all direction of its president, but are structured so as to operate under the authority of three deputy presidents: one supervises the national planning, operational, management and research activities for the whole range of national water functions; another supervises the district, watershed and regional offices and agencies of the Authority; and a third supervises the construction and related functions and enterprises in the water field. Because of the predominantly nationalized character of the Hungarian economy, the latter activities include the country's hydraulic construction as well as the nation's manufacturing and distribution enterprises for hydraulic machinery and equipment.

In addition to its various organs of water administration, including the hydraulic enterprises, the Hungarian National Water Authority is noted for its several semi-autonomous organizational entities engaged in research and development activities. These include the Research Institute for Water Resources Development and the Water Resources Centre. The Institute specializes in engineering and mechanical research related to water resources in surface and subsurface water studies and in other applied research dealing with water quality, waste water treatment, and water management. The Centre, on the other hand, devotes itself mainly to geological, economic and administrative investigations, including inquiries about water balances and construction of planning models for alternative decision-making and future programming. There are some 50 additional Hungarian official agencies and professional organizations engaged in hydrological research, development, education and related professional specialities. These collaborate continually with the National Water Authority, for which they conduct much research and many services on a contractual basis. There are also several other technical and operating organizations which have certain linkages with the Authority with respect to international co-operation in the water field, particularly but not exclusively in eastern and central Europe (such as the Danube Commission or the Council for Mutual Economic Aid). Hungarian water expertise also maintains a distinguished membership in international technical and world professional organizations dealing with the various hydrological specialities.

By these means, Hungarian organizations concerned with water administration have reached a relatively substantial degree of professional attainment, technical performance, policy effectiveness and administrative maturity. Although many organizational and operational problems remain unsolved, Hungary comes about as close as modern experience can bring us, either in the developing or in the developed countries, to the centralized and integrated model of water administration, well-tempered, however, with a degree of decentralized or devolutionary features.

Mexico's organizational experience

Mexican water organization is nominally also of the consolidated type, but in practice it is less integrated. Since 1946 Mexico has had an independent Secretariat of Hydraulic Resources - one of the first such unified ministries to be established in the developing or, for that matter, developed world. The Secretariat absorbed the pre-existing responsibilities of the National Irrigation Commission and a number of other water agencies. In actual practice, drainage, domestic water supply and sewerage problems have been added to the Secretariat's major preoccupation.

Responsibility for preparing water plans rests in the Secretariat of Hydraulic Resources, but approval of the broad fiscal implications concerned, like macro-economic planning generally, takes place in the Secretariat of the Presidency. The Federal Electricity Commission operates virtually independently on hydroelectric matters; the Department of the Federal District exercises responsibility on industrial and municipal water supply matters for Mexico City and its developing metropolitan region; and the Secretariat of Health and Welfare is charged with water supply problems of municipalities of 2,500 inhabitants or less. In a more limited sense, the Secretariat of Industry and Commerce retains consultative powers concerning industrial water supply; the Secretariat of Agrarian Affairs and Colonization takes part in allocating irrigation waters to the ejidos; and the Secretariat of Agriculture and Grazing continues to function in some irrigation matters.

Mexican administrators are weighing the extent to which structural integration automatically provides genuine co-ordination of policy decisions or administrative activities, even from the viewpoint of a relatively consolidated body such as the Secretariat of Hyraulic Resources, with its well-defined and integral grasp of a function like irrigation. The Seventh Congress of the International Congress of Irrigation and Drainage held in Mexico in April 1969 adopted the following interesting but restrained recommendation on this whole subject:

> "It is essential to have the means of proper co-ordination of all agencies required for successful irrigated agriculture - namely the farmer, the irrigation engineer and the agricultural or agronomic officer. Once co-ordination has been established, it must be increased by building up ways and means to improve operations of the co-ordinating agencies at all levels. There must be one single authority to whom the farmer should turn to smooth out his problems and difficulties and learn the surest means for successful irrigated agriculture on his part." 14/

Thus, in the establishment of similarly centralized organizations in Latin America and elsewhere, the long-range Mexican experience, with its nominally integrated Secretariat of Hydraulic Resources, thus remains one possible model for international aid.

Spain's organizational problems

Although lacking a comparable degree of structural unity, the Spanish system

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14/ Proceedings of the Seventh International Congress of Irrigation and Drainage, Mexico City, April 1969.

produces some evidence of integrated administration and balanced development in the water function, with certain problems of organization and co-ordination still remaining unsolved. The ministries of Agriculture and Industry share power over water administration and co-ordination, while water planning in relation to economic development, like other macro-economic functions, is carried on mainly at the higher level of the Secretariat of the Presidency and the Commissariat of Development Planning. With increasing centralization of the planning function, some degree of centralized research has also developed under the integrated Centre for Hydrographic Studies.

Taking Spain's water system as a whole, however, the usual range of organizational problems arise and, understandably, interagency co-ordination is often the missing key to the smooth functioning of the water structure. With respect to the irrigation function alone, a supervisory commission for the planning of public works, land settlement, industrialization and electrification in the major irrigable zones of the country had to be established in 1958. Recently, consideration has been given to the more complete structural consolidation of water functions along the integrated lines of a unified ministry of water resources.

The organizational pattern of India

India's organization for water administration is the most elaborate and complex, resembling in this respect the structural development in some of the largest and most developed countries. Since the establishment of its first modern Public Works Department in 1854, when all such construction work was placed under the direction of a military board then known as the Royal Engineers, the organization and reorganization of India's central water functions has been a continuous process. The general tendency has been to subsume these water functions under and to merge them with the responsibilities of ministries whose jurisdiction tended to transcend the mere subject of water.

Just prior to Indian independence, the Waterways, Irrigation and Navigation Commission occupied the central role, but after independence the first widely empowered agency in the water field was the Department of Works, Mines and Power. Thereafter, the ministry responsible for water functions has been subject to the periodic changes which occurred in respect to Indian ministerial and cabinet portfolios. In 1951 the water function was assigned to the Ministry of Natural Resources and Scientific Research, but in 1952 it was reassigned to a respecialized and reintegrated Ministry of Irrigation and Power, where it still resides. The Ministry of Agriculture retains some interest in minor irrigation matters, and the Ministry of Health continues to be concerned with domestic water supply, sanitation and sewage disposal.

Among the most prestigious Indian organizations active in dealing with water functions on a more autonomous or semi-autonomous basis are those charged with technical and research responsibilities, such as the Central Board of Irrigation and Power. Although this agency does not occupy the mainstream of water administration, it continues to channel essential skills into the process of water development and planning, thanks to its own experienced combination of engineering and planning talent on the one hand, and to its customary linkage of expertise at the centre with that in the states on the other. In this process of scientific interchange of the kind which abounds in Indian professional life generally, Indian non-governmental organizations specialized in water resources matters are also active.

In view of the proliferating and overlapping of water authorities in India, the planning powers and investment functions exercised by the Indian Planning Commission provide certain administrative solutions to the still unreconciled complexities of water organization on the operational side. It is also possible that organizational consolidation becomes less urgent as a consequence of the relatively forceful planning apparatus which exists in India. Although the Indian federal system of water administration is a complex one to operate, it widens the national range of technical experience and the professional perspective of Indian water administrators at all levels. This factor has undoubtedly enabled Indian water administrators to undertake international aid and training assignments of importance. India thus shares its expertise on water matters with other developing countries through its specially organized Water and Power Development Consultancy Service. India has thus also been able to assume leadership in institutionalizing such international bodies as the UNESCO Institute of Arid Zone Research. 15/

Israeli water organization

Israeli water organization is far less elaborate, but it is not necessarily more streamlined, nor does it remain much more constant over time. Its main characteristic has been the tendency to adapt organization to programme instead of adapting function to structure. As a result of the agricultural balance which has historically prevailed in the planning and administration of the Israeli national economy and national water supply, the Ministry of Agriculture has been the responsible agency for water affairs before Parliament and Cabinet. As part of the recent expansion of water uses from the agricultural to the agro-industrial and industrial realm, this Ministry has continued to exercise an active policy-making and consultative role. Where other ministries are concerned, such as labour in the case of industrial water planning, or health in respect to domestic water supply and drainage, co-ordination of policy decisions and arbitration of ministerial differences are reserved for an interministerial committee such as the Ministerial Committee of Economic Affairs. However, interagency conflicts are generally ironed out at the operative levels. Early in the search for viable organizational practices, the crucial point of Israeli decision-making and policy formulation was recognized to rest, at least in the first instance, at these operating levels of the administrative and planning agencies themselves.

The first operating agency that was active from the earliest well-drilling stage to the regional interconnexion of large-scale water projects was the Mekoroth Water Company, which had been responsible for constructing the Haifa municipal system just before the Second World War. After independence, Tahal became the first national planning agency, and it also performed construction functions on a national scale until 1952 when the National Water Project was established for the construction of the National Water Carrier. In 1952, the National Water Project was placed under a statutory body known as the National Water Authority, and construction functions were transferred to Mekoroth. While planning functions were retained by Tahal, administrative duties were assigned to a National Water Commission directed by a single commissioner. At present, Mekoroth is exercising the statutory role of the National Water Authority; now that the National Water Project is virtually complete, Mekoroth's major role will become more one of wholesale supplier of water and operating management agency under the

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15/ General Conference of UNESCO, Beirut, December 1948.

general jurisdiction of the water commissioner. The new demands of the Israeli water system for unconventional water sources and uses continue to enlist the extensive water research, educational, extension and related services of a number of separate and autonomous institutes and universities. All these developments have left Tahal as a planning "think-tank" type of organization, freer than previously to pursue its rising role of international consultancy on water and other resources and on developmental and related research.

Algerian water organization

The Algerian organization is presently in transition, moving toward modernization and pursuing the advantage of alternative choices offered by the comparative experience in the other developing countries. At the time of independence, the Algerian structure was more unified and consolidated than it is at present, centring largely in the Ministry of Agriculture. This was a workable arrangement, since water planning and development for industrial uses had not yet seriously arisen. Today the Ministry of Agriculture retains considerable responsibility for irrigation matters, but the Ministry of Public Works is active in construction and other functions of water resources engineering; the Ministry of Industry is responsible for hydroelectric functions which are operationally exercised through the Public Electricity Commission; and the Ministry of the Interior is concerned with municipal water supply.

Water planning in Algeria is generally exercised at the higher governmental levels of the cabinet. Although the problem of allocating funds and other priorities to various water investments is predominant, the usual issues of interagency co-ordination complicate the effort to maximize economic yields and fulfil socio-economic needs.

Algerian water administrators are well aware of this and are therefore thinking in terms of either a more consolidated structure or more co-ordinated relationships. Specifically available to them are interesting models from other North African countries with different organizational experiences. Thus, Libya* has placed its Supreme Water Board within the Ministry of Agriculture, but is now considering alternatives. Tunis also consolidated its hydrologic functions in the Ministry of Agriculture, and thereafter the Director of Hydrology became the Minister of Agriculture. After adopting the present Algerian organizational pattern, Morocco consolidated its water functions and, following a recurrence of earlier operational and planning problems, the Director of Hydrology became the Director of Planning. Such ingenious solutions, structural and nonstructural, testify to the abiding importance of organizational problems; yet they also demonstrate the uniqueness of individual structural solutions adapted to each particular country.

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* Now designated the Libyan Arab Republic.

V. DEGREE OF EFFECTUAL DEVOLUTION

Devolution and decentralization

From the standpoint of developing systems of water administration, the potentials of effective organizational structure are often more promising at the local or regional and popular or participatory levels than at the traditionally centralized or hierarchical levels. Decentralization and even regionalization of central government activities is merely part - sometimes the lesser part - of the general process by which modern organizations, both public and private, become deconcentrated and disencumbered. The main prospect for enlisting and involving human talent and creative enterprise lies in the wider employment of devolved, rather than purely decentralized, forms of organization. Devolution of decision-making and administrative activity, whether official or voluntary, makes direct use of local autonomy and "grass roots" participation as a deliberate device for achieving development and modernization.

A theory and practice of development which upgrades and inspires the performance of large numbers of people in the various subnational structures and local communities of a nation gives special expression to the latent developmental potential of arid and water-short regions. Even in the developed nations, the rate of development has often been higher in the arid regions of these countries, not to speak of the impressive developmental record of the historical river basin societies. The human initiatives and impulses for change which arise from dry-land conditions and desert-space circumstances, also provide one of the favoured explanations for such an accelerated and intensive development as that experienced, for example, in the western two thirds of the United States, much of which is arid or semi-arid. 1/

A prime item on the agenda of the United Nations Conference on the Human Environment in June 1972 called for all nations to "formulate national policies and guide-lines for the protection of the supply of water for human settlements" and emphasized that "particular attention will have to be paid to the creation of an infrastructure for the services necessary to ensure management of water to settlement areas", and that "such measures include legislative and other regulatory steps at the national level, accompanied by the setting-up of a water management authority and the integration of water resources planning for regional and national development" (A/CONF.48/PC.11, paras. 65, 66 and 185).

As part of such a recommended regional orientation at the national level, the stimulation of local initiative and the encouragement of active popular participation at the subnational level are being widely recognized as valuable

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1/ See Sho Sato, "The Diminishing Role of Traditional Water Rights Doctrines in the United States", Anuales Juris Aquarium, Asociación Internacional de Derecho de Agua, 1968; Ernest Englebert, "Regional Planning for Water Development in the Western United States - the Relevance of American Experience for Other Nations", Water for Peace, 1967, vol. 6, pp. 256-266.

impulses to effective planning and successful development. This has long been recognized in international development circles. In 1951, a United Nations report pointed out, with special relevance to developing countries:

> "Efficient management and national unity require ordered structure of government power and authority, but at the same time responsibility for administrative activity must be shared if it is to be effectively carried out. Such sharing may take the form of constant delegation of functions to subordinate administrative branches, to autonomous bodies or corporations, to private or co-operative institutions, to local authorities and to individuals at various levels of the administrative structure ... Sharing of responsibility among civil servants and participation by citizens tend to bring out the higher loyalties and the best administrative abilities of the nation." 2/

Another fundamental United Nations inquiry into the causal explanation for viable developmental planning in the field of water resources was conducted in 1968 under the aegis of the United Nations Economic Commission for Asia and the Far East (ECAFE), and the following was one of its principal conclusions:

> "... Another positive feature of the developed countries' powerful network of popular institutions and voluntary associations is that it has established the foundation for massive spontaneous development, outside the immediate framework of government planning, thus relieving Governments of responsibility for doing everything; in many highly developed countries today, as a matter of fact, 'national planning' signifies not so much a series of autonomous acts by government, as the process of co-ordination and reconciliation between over-all government direction and dynamic development initiated by the organized public. The existence of a flourishing profusion of popular institutions and voluntary associations may, on the strength of historical evidence, be regarded as a mainspring in those countries or - to change the metaphor - as the rich soil from which a bountiful harvest of peoples' initiative has sprung up under the fertilizing effect of broad socio-political reform." 3/

Although such development is frequently initiated and generally stimulated by national policy and central administration, the impact for development, if it is to be continuous and effectual, should be devolved in substance and decentralized in operation. Perhaps, therefore, one of the useful organizational generalizations that may be postulated from the special standpoint of water administration is the paradoxical one that centralized and decentralized administration are not necessarily antithetical, but rather are complementary.

2/ United Nations, Standards and Techniques of Public Administration with Special Reference to Under-developed Countries (United Nations publication, Sales No. 51.II.B.7), pp. 10-11; Integrated River Basin Development (United Nations publication, Sales No. 58.II.B.2), pp. 28-29.

3/ United Nations, Economic Commission for Asia and the Far East, "Social and Non-Economic Considerations in Water Resources Planning and Development", Planning Water Resources Development, report and background papers of a Working Group of Experts on Water Resources Planning, Bangkok, 29 August-9 September 1968, part II, doc. No. 7, p. 106.

Water and its related resource functions have lent themselves particularly to the combined organizational formula of decentralization and centralization. The universality of the devolutionary process in water administration is demonstrated by its revival even in the most unitary of modern states. Thus, recent British trends toward sub-basin water administration are beginning to transcend both the powerful traditions of Brisish local government and the persistent centralizing tendencies of British national government. 4/ Inherently, modern water administration remains primarily a local function, and the water-related function of sewage disposal is also conducted largely under the jurisdiction of local health or other independent authorities. To some degree, a similar centrifugal tendency prevails with respect to the administration of the interrelated hydroelectric supply under separate utility or other public service agencies. The resulting pattern of public service and public administration, subnational and national, works out differently from country to country, depending upon size and population distribution, allocation of public-private responsibilities and the central-local distribution of functions. However, the many problems which arise in the wake of these water and water-related demands constitute a considerable burden upon both the national and subnational governmental structure, and this can be more readily absorbed if the necessary institutional infrastructure is decentralized and deconcentrated rather than overly centralized and concentrated.

In short, subnational, regional, local and private forms of organization provide devolved, shared, voluntary and collaborative instruments of administration which often transcend the formal and functional limitations arising from centralized or hierarchical organization. This is fully illustrated in the devolutionary experience of the six countries studied here.

Hungarian centralization and decentralization

Hungary is a relatively small country geographically, potentially capable of exclusively centralized forms of administration. Historically, it has been amenable to similarly nationalized or centralized forms of policy-making and planning. Nevertheless, Hungary incorporates a large component of decentralization in its water administration, in its operational as well as in its planning phases. The organizational chart of the relatively powerful Hungarian National Water Authority - a chart which interestingly is entitled "Hierarchical Relationships: Supervisory Order of the Water Administration" - contains alomst twice the number of organizational units or "boxes" for decentralized and devolved functions as it does for the centralized functions; and the relative proportions of assigned personnel to the decentralized or devolved branches is even greater.

The most significant decentralized machinery in the Hungarian system consists of the "district water authorities". This "authoritative" designation does not exaggerate the substantial role of the decentralized Hungarian District Water Authority. From the formal administrative point of view, the district authority may be regarded as a regional branch of the National Water Authority (NWA), and indeed it often so operates; but in addition and in actual practice, the NWA operational functions and policy responsibilities are increasingly delegated and

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4/ Proceedings of the Seminar on River Basin Management (United Nations publication, Sales No. 70.II.E.17).

zoned out to these district authorities. This decentralized process is a standardized one for the 13 districts, but since district water authorities do differ in their hydrological and economic requirements and therefore in the character of their workload, the degree of independence from NWA headquarters takes different forms, depending upon the particular sub-basin circumstances and special regional needs. Thus, in the case of the Central Tisza or Trans-Tisza Region District Water Authority, irrigation functions and responsibilities predominate; in the Lower Danube District Water Authority, flood control and navigation maintenance prevails; and in the Central Danube Valley District Water Authority, industrial water problems are given the main emphasis.

District water authorities as a whole operate over the wider range of normal NWA functions including (a) administrative tasks; (b) tasks of co-ordination; (c) reporting functions; (d) budgeting functions; (e) labour recruitment; (f) organizational relationships involving subnational units of water administration; and (g) planning and design activities. Their decentralized planning functions alone include (a) over-all and comprehensive regional planning which attempts to fit the region's developmental targets with its natural resource potentials and its socio-economic needs; (b) concrete economic planning in the region in integrated relationship with the national economic plan; (c) regional hydraulic works construction programming, as well as regional scheduling of other technical developments and maintenance requirements; and (d) regionwide plannning for the subnational units at the county or local level which are responsible for water distribution functions.

Occupying a middle position between these local authorities and the central government, the district water authority engages in constant intergovernmental co-ordination. Besides the capital, Budapest, and a half dozen other large cities, there are 19 counties in the country, further subdivided into a total of 140 local government districts, each of which comprises numerous towns or villages with their own particular local water supply problems and responsibilities. Although the territorial structure of the water district authorities approximates the boundaries of the natural sub-basins, these district boundaries do not actually follow a strict watershed basis. Instead, the outside limits of the district tend to cc form to the boundaries of the smallest overlapping (or more accurately underlapping) administrative units performing water functions at the boundary line of the district, generally cities and villages.

There is, none the less, an increasing effort to equate the district water authority boundaries with the sub-basins or watershed areas. Whether the inevitable tug and pull which takes place between these "administrative" and "natural" areas can ever be fully reconcil d by complete regional congruence, even in a highly nationalized system like the Hungarian, is doubtful. Moreover, when it is realized that only two Hungarian water districts represent natural watersheds that are wholly within Hungarian territory, while the remaining districts cover natural watersheds which spill over into surrounding countries, it is clear that the Hungarian system must respond to various national and international considerations that necessarily transcend the potentially pure regional watershed approach. Nevertheless, creative Hungarian water administrators and planners are continually searching for innovative means of meeting the constant challenge of effective decentralization and effectual devolution. Thus, the country was recently divided into 13 hypothetical districts and 125 subdistricts for the experimental purpose of studying the various possible permutations and potentials for matching district boundaries more exactly with watershed or sub-basin boundaries. From this innovative study, the unexpected

conclusion was reached that an optimal decentralization of water administration in Hungary might now be seven regions.

Because the water users of Hungary are predominantly state-owned or state-controlled agricultural and industrial enterprises, and since the water economy is itself recognized as one of the nine economic sectors of the total national economy, there is a continuing effort to plan and administer the water system in increasingly closer relationship to the national productivity. In fact, in so far as industrial water is concerned, over 90 per cent of the supply is produced by user-owned and user-managed systems, with the remainder coming from municipal water supply systems. These industrial water distributors and users, along with the users of waters for irrigated agriculture (and related users involved in soil conservancy and drainage functions), are in turn organized into water management associations totalling 457 for the country as a whole. Historically, these voluntary water associations arose as it became necessary to solve certain common problems of adjacent users. However, with the increasing integration of the economy and the parallel rise of decentralized water administration, the Hungarian water management associations are beginning to cover the entire map of the country. During the last decade, in particular, these water associations have developed into strong subnational components of Hungary's national system of water administration.

Despite the rise of these varied kinds of decentralized administrative units, Hungary has not been able to avoid the overlay of special districts for such additional water functions as sanitary conservation, reclamation, water recycling and antipollution control. At the other extreme of the organizational scale, Hungary has also had to add centralized but semi-autonomous agencies for such functions as flood protection and navigation. These functions account for the continuing central responsibilities which the NWA has had to retain, for example, in relation to the Danube Commission, in the control of pollution coming from abroad and in the emergency functions resulting from floods. Thus, the NWA Flood Protection Centre is one of several semi-autonomous agencies within the centralized NWA headquarters. Semi-autonomous status is also possessed by the Centre for Hydraulic Documentation and Information; the Research Institute for Water Resources Development; the Technical College of Water Management; the Bureau for Hydraulic Computing; the Institute for Hydraulic Planning; the Investment Agency for Hydraulic Projects; and the Danube and Tsiza River Projects Investment Agency. All these operate under a generalized form of supervision by the Deputy President of the NWA, who exercises responsibility for water development planning, financing and international affairs, but they are largely autonomous and, in effect, "devolved" in their operations. 5/

Under the general administrative direction of another Deputy President of the NWA, but possessing even greater independent status, are the following enterprises: the Enterprise for Hydraulic Machinery; the Enterprise for Hydraulic Construction; the Enterprise for Waterpower and Well Drilling; the Trading Company for Hydraulic Spares and Materials; the Enterprise for River Regulation and Gravel Dredging; the Balaton Regional Water Works (there is also in the NWA regional set-up, a separate Lake Balaton regional hydraulic agency, which is engaged in experimental and developmental functions arising from the special ecological circumstances of the Lake Balaton region); the Sajo Regional Water Works; the East Hungarian Enterprise for Hydraulic Construction; and the Transdanubian Enterprise for Hydraulic Construction.

5/ See, for example, K. Stelczer, L'Institut de Recherches des Ressources Hydrauliques (Budapest, 1962).

For the purpose of enlisting the country's wider body of hydraulic skill, outside the formal structure of water administration, a Water Engineering Council has also been established in Hungary, which is linked with, though separate from, the National Water Authority. The Council is co-opted from the various technical and research institutions of the country, but its members are appointed not as organizational representatives, but rather because of their personal professional distinction. The 11 constituent societies of the National Union of Engineering and Scientific Societies having relationships to the water management field include the Hungarian Hydrologic Society, the Hungarian Association for Agriculture, the Hungarian Meteorological Society, the Hungarian Association for Forestry, the Hungarian Association for Mining and Metallurgy, the National Association for Karstic Research and Speleology, the Association of Structural and Construction Engineering, the Association of Transport Engineers, the Hungarian Geographical Society, the Hungarian Geological Society and the Hungarian Society of Geophysics.

Although Hungarian water users are frequently organized into active associations or are themselves economically powerful national enterprises, the requirements of administrative order in the realm of water and the inevitability of competing and conflicting water claims have resulted in the elaboration in Hungary of a long-standing water code and set of licensing procedures. These are administered by the NWA, but there is also provision for adjudication through the regular court system. Historically, legal codification and the attendant legitimation of water rights in Hungary have tended to conform with rather than constrain the nation's evolving administrative practices in the field of water administration.

The pattern of devolution in Israel

Similarly centralized in its major aspects, the Israeli organization reveals strong counter-tendencies towards devolved administration and decentralized enterprise. 6/ The central planning organization, Tahal (Water Planning for Israel, Inc.), is itself a separate public corporation in which 52 per cent of the shares is owned by the Government, 24 per cent by the Jewish Agency, and 24 per cent by the Jewish National Fund; but Tahal is now heavily engaged in international aid rather than exclusively national projects. In terms of operations, the Water Commission is acting centrally, while detailed managerial responsibilities are delegated to a public corporation, the Mekooth Water Company, Ltd. Mekooth is owned in equal parts by the Government, the Federation of Labour Unions, the Jewish Agency and the Jewish National Fund. Despite these involved organizational bonds, both national and international, the subnational and participating contributors to Israeli public administration are sufficiently substantial to suggest that, in a small and naturally centralized setting like Israel, decentralization and devolution receive more than the normal degree of emphasis.

6/ Aaron Wiener, "Irrigation Water System - Israel's National Water Grid", Water for Peace, 1967, vol. 7, pp. 195-205; see also Paul Juncker, "A Spatial Model for Systems Analysis", Annals of Regional Science, December 1970.

Another link in the Israeli system, though it is not necessarily the principal organizational mechanism, is the "regional project". There are 26 major regional projects operating in various parts of the country, but they do not cover the entire country, nor are they necessarily territorially exclusive from one another. The regional projects are tied in with the National Water System, and the law contemplates that regional water authorities may assume comprehensive duties of construction, management, operation and maintenance. Yet there is no definite programme for comprehensively regionalizing the present working combination of central and decentralized water administration.

Moreover, because of the peculiarly autonomous character of the Israeli socio-economic infrastructure - particularly as reflected in the role of the collective, co-operative and private agricultural enterprises and of the industrial and commercial establishments which involve a mixture of private, co-operative and labour-union federation ownership - the Israeli organization is effectually a decentralized one, in fact a devolutionary system to the point of being seemingly disorganized. Thus, of the 2,000 water consumer bodies of the nation to which Mekoroth distributes water, 1,500 are agricultural consumers (mainly kibbutzim and other agricultural settlements), while 500 are municipal and other local agencies, which often resell water to industrial estsblishments. In addition to the many consumer bodies, there are a number of regional drainage authorities consisting of representatives of both local authorities within the assigned drainage districts and representatives of the central ministries and agencies concerned with the water and drainage function. Also, as in the case of the Hungarian system, the technical societies and the scientific and scholarly community play an active and collaborative role in relation to the extensive national programme of water research and development.

The persistence in the realm of water administration of these decentralized bodies - professional and communal, non-governmental and quasi-governmental, regional and local - is evidence of the general preference in Israel for microforms of administration, despite simultaneous tendencies towards nationalization and centralization. Organizationally or administratively, Israelis apparently do not see a necessarily direct or intrinsic relationship between the size of the political or productive unit in their society and the over-all level of economic or social productivity or efficiency. In fact, there is a predilection towards the theory that the relation between size and performance may be inverse. This helps to explain in part the position still held in Israel by the small agricultural unit like the kibbutz. Although the tendency toward structural fragmentation is coming to be questioned, the kibbutz retains its status, economically, socially and politically. There is much resistance, for example, to the customary absorption by central government bodies of the experienced administrative personnel from these smaller enterprises.

It has been the objective of the Israeli system to nationalize and if necessary to centralize in the hands of the Government (nominally the National Water Authority) the administration of the national water supply. However, under the circumstances of scarcity from which the country suffers, the actual determination of water claims and water rights is hotly contested by the subnational organizations. In accommodating itself to the ensuing discussions and debates and to the necessary negotiations and compromises, the Israeli system has evolved a further array of official organizations to facilitate consumer and public participation in the various processes for the acquisition and allocation of water rights.

For the carrying out of this intricate consultative function, the organization of widest scope is the National Water Board. This consists of 39 members (chaired by the Minister of Agriculture and the Water Commissioner as vice-chairman), at least two thirds of whom represent the general public, while one third or less represent the Government and other institutions. Within this structure, the consumers are represented through their various local, legal, agricultural and industrial organizations. The Board deals with deliberations concerning national water policies; formulation of water plans; establishment of water standards; decisions involving changes in water plans and programmes; establishment of rationing zones; and rationing policy decisions. Nominally, the jurisdiction of the Board is consultative and advisory only, but its influence is decisive in shaping national water policies and water development programmes, and the Government seldom acts against the Board's consensus recommendations.

Since 1960 a form of water rationing has been practised in Israel. Beginning in eight of its most seriously water-deficient regions, much of the country's water is regionally allocated today, besides being strictly rationed to specific users and enterprisers largely in terms of their economic priority and productivity. The various water authorities are not always compelled to follow the norms of an advisory body like the National Water Board before issuing specific licences to users, but rationing standards worked out by the Board are having an increasingly binding effect. In addition, all plans for water development must be deposited for information purposes in each region before they can be finally approved by the competent authorities.

Water rights are under the general jurisdiction of the Allocation and Licensing Division of the National Water Commission. In addition to a careful water licensing procedure, a permit system for the control of sewage and effluent waters has been separately established and is undergoing continual elaboration. This aspect of the water pollution and water quality problem is essentially related to Israel's advancing plans and programmes for water recycling and recirculation.

The related function of establishing water tariffs and assessing water charges is tied in with the system of economic priorities and preferences. Because local, regional or special-use rates vary widely, and because water pricing must be articulated with water allocations for specified enterprises depending upon their marginal position in the total national economy, a special water fund has been established for the purpose of nationally equalizing and reallocating costs, as well as for the purpose of issuing loans to the local authorities, including loans for the installation of meters within their boundaries.

This metering system, which is jointly established and administered by the League of Local Authorities and the Ministries of Agriculture and Interior, represents a principal implement for the discouragement of water waste by individual consumers. The consumer is required to pay for the cost of the meter and the metering service in monthly instalments, which are assessed along with his water rates. Since the training of consumers in the art of unwasteful water use is a prime object at the grass roots level of the Israeli system, the National Water Commission administers a comprehensive and intensive programme of public education and information through school lectures, special training programmes, short films, radio talks, billboards, bus advertising and news releases. There are also "field days" for irrigators sponsored by the Instructional Directorate of the Ministry of Agriculture.

There is also substantial machinery for litigation among competing users, whether they be enterprises, co-operatives or individuals, and their various associations, leagues and organizational representatives. Much of this adjudication is of a quasi-judicial character conducted before administrative personnel, but their decisions are subject to review and control by the regular courts.

Thus the Israeli system provides an elaborate administrative, adjudicative, advisory and consultative organizational framework which allows for substantial devolution and decentralization in the various stages of planning, decision, implementation and revision of water policies, programmes and projects. Though widely overlapping, apparently cumbersome, often contentious and actually tedious, these devolved and decentralized forms of Israeli water administration seem to be fairly basic in accounting for the generally effectual system of national water administration.

Centralization and devolution in Spain

Spain has a long history of local water administration, and some of its regional water agencies date back to the Moorish period, as in the case of the still functioning Valencian Water Court. The contemporary trend towards national planning and other centralizing functions has been accompanied, however, by much reorganization and some strengthening of local and regional institutions. 7/

Irrigation communities, sometimes combined into syndicates of adjacent communities, constitute the most elementary, yet most important, level for administering the distribution and development of irrigation waters and for maintaining and managing the canals and other waterworks required. 8/ The irrigation community may be either a voluntary or statutory organization, but in either case it is subject to control by the water users in the area covered. Voting rights in the irrigation communities are allocated in accordance with the amount of irrigated land of each user-member of the community, thus employing the corporative principle rather than the traditional co-operative principle of one man-one vote. Although legally autonomous, irrigation communities are subject to a certain amount of technical supervision and derive increasing financial aid from the Ministry of Public Works. At a similarly basic level of water administration are the rural communities, villages and other towns and cities, which are responsible for local and municipal distribution and supply of domestic and industrial water, as well as for sewerage and related services. Supervision of these local water agencies is exercised by the Ministry of Public Works.

More influential than these local water-distributing organizations, especially for a country of arid and varied climatic zones and of rugged and varying terrain which requires extensive hydrological rebalancing and engineering reconstruction, is the broader regional or basin-wide structure and the related subbasin or subnational organization for water administration. During the last two generations, several new types of such devolved and decentralized regional

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7/ Thomas F. Glick, Irrigation and Society in Medieval Spain (Belknap, 1970).

8/ Sebastian Martin-Retortillo, Administraciones Autónomas de las Aguas Públicas (Instituto García Oviedo, Universidad de Sevilla, 1960).

authorities have therefore been added to the traditional communal and community water structure.

Foremost are the water confederations, conforming generally to subbasin boundaries. These consist of and are controlled by the water agencies and interests in the subbasin or region. Described variously as "little TVAs" or "regional ministries of development", the water confederations perform a wide range of water functions, operational and developmental, construction and maintenance, economic and socio-economic. Some of the confederations have been amalgamated into syndicates covering wider watershed areas. Although semi-autonomous, the confederation or syndicate is subject to national plans, fiscal limits, functional standards and financial controls emanating from the Ministry of Public Works.

The water confederations are also subject to some degree of supervision or co-ordination exercised by 10 regional and decentralized offices of the Ministry of Public Works, known as water commissariats, whose area jurisdictions tend to coincide with the main river basin areas of the country. Confederations and commissariats thus overlap to some extent, both regionally and functionally, and periodically the need arises to clarify their respective jurisdictions and assignments. Generally speaking, the trend seems to be away from the confederation and towards the commissariat.

One reason for this broadening trend is the simultaneous rise of other forms of both regional and subnational devolution, requiring reconciliation of responsibilities at increasingly higher levels of authority. Thus both privately owned hydroelectric enterprises and government-sponsored regional projects with hydroelectric, reclamation or multipurpose functions now play a principal developmental role - and in one sense an increasingly devolutionary one - in the Spanish water system. The Valdecanas-Torrejon power development involving the Tajo River, for example, has as its first phase of development a major hydroelectric component under the Hidroelectrica Española company serving one of the largest industrial, commercial and agricultural markets in Spain. On the other hand, the Badajoz economic development plan is based primarily on irrigated agriculture for the nation's largest province suffering from some of the most tenacious socio-economic problems, but it is also designed to provide improved farm settlement areas, reforestation, transportation development, industrialization and hydroelectrification. The Badajoz development, though regional in character, is proceeding under the joint supervisory efforts of the Ministries of Public Works and Agriculture and the National Institute of Colonization. Spain's most ambitious water development plan, that for adjusting the natural imbalance between her water-rich Atlantic watershed and her water-short Mediterranean watershed, will produce added problems, but also grander possibilities for regionally conscious national water planning and administration.

In realizing these impressive developments, Spain also employs her extensive organizations for professional, scientific, research, education and intellectual expression. This kind of organizational participation is considered to be an aspect of Spanish "corporative" theory in both state and society. At the same time, there is a sustained appreciation in Spain of the importance of what is characteristically regarded as the country's "regional infrastructure". Although the actual rate of regionalization has not kept pace with the growth of regional speculation along these lines, Spanish regional traditions and tendencies such

as those expressed in the historic regions of Valencia and Murcias, and in the more highly developed Barcelona area and Catalan region, constitute a stimulating body of combined traditional and innovative experience for any future forms of developmental devolution that may emerge. 9/

Mexico's subnational problems

Mexico's distinctive leadership in having re-established an integrated Secretariat of Hydraulic Resources, its early concentration upon fulfilling its national irrigation plans and the subsequent development of its hydroelectric and industrial water supply have been associated with a continuum of problems at the subnational and regional levels.

From the beginning of its modernized water resource programme, Mexico has made steady improvement in basic data collection in each of its 25 hydrological basins. This function was carried out, however, largely by the Secretariat of Hydraulic Resources and its regional personnel, just as the regionalization of national irrigation administration was partially decentralized to irrigation districts operating under the central Secretariat. There was also some interesting regional experimentation with representative councils responsible for certain aspects of irrigation district administration, and the regional council included representatives of the national as well as of the regional interests and agencies. Land reform, either of the ejido kind or of the rising type of Mexican commercial farm, has remained largely subject to the vicissitudes of national policy and administration. Subnational developments in this realm have not yet proven to be sufficiently standardized and regularized, either within the regions or for the nation as a whole, to permit the rise of a uniformly decentralized system of district or regional administration. Hydroelectric development, by contrast, has received from central sources both more regional attention and more financial resources, but the Federal Electricity Commission has generally favoured a centralized rather than decentralized structure for its own planning and operational purposes.

However, a degree of general multipurpose planning is arising in Mexico for large hydrographic regions, such as the north-west, central and Gulf regions. These macroregions also reflect the needs of their hydrographic subbasins or individual river basins. In the course of this experimentation with comprehensive regional planning and multipurpose development, four specially selected river basin regions in Mexico have been given even more concrete recognition during the last 25 years, namely, Balsas, Papaloapan, Grijalva and Fuerte. Some encouraging trends in regional planning and some developmental results are here being evidenced and they are most pronounced where the leadership has been outstanding. Thus, the late ex-President Cardenas contributed much to the development of the Balsas.

Since Mexico is nominally a federal form of Government with the states exercising delegated powers, it is understandable that the state level of

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9/ Pedro Voltes Bou, Historia del Abastecimiento de Agua de Barcelona (Barcelona, Sociedad General de Aguas, 1967); Sebastian Martin Retortillo and others, El Agua: Recurso Natural Escaso, Planteamiento Comarcal del Problema en Cataluña (Madrid, Editorial Moneda y Crédito, 1967).

Government is generally the least active of all subnational units in the water field. However, the states have assumed certain functions with reference to small local irrigation projects and minor water supply systems. Moreover, the local communities and their municipal water supply systems receive some degree of financial aid and technical guidance from the national secretariats concerned, and there is also a national trend toward the establishment of local water-users associations. The relatively quiescent condition of the local and state levels of water administration in Mexico results partly from the fact that the industrial waters are generally provided by user-owned wells, and these water supplies are managed either by the private industrial enterprises or by wholly or partially government-owned industries. There is, therefore, less of a tendency to mobilize these industrial water supply responsibilities by jurisdictional areas at the subnational level.

On the other hand, Mexican professional, scientific and university organizations and institutions are becoming aware of their opportunities and responsibilities, regionally and nationally, for basic and applied research and for demonstration projects in the water field. There has been a substantial amount of interchange of experience between Mexican and United States scientists in a field like sea-water conservation. This is in part reflected in the establishment in Lower California of one of the world's most modern and sizable plants serving the city of Tijuana, and also in a collaborative project carried on between the University of Sonora at Hermosillo and regional research bodies located in Texas.

International collaboration offers other unique forms of regionalization for Mexican water administration. The long-standing and successfully administered Mexican-United States International Boundary Commission, which performs substantial cross-boundary functions for the rivers draining both countries, conducts in the northern part of Mexico certain semi-autonomous water responsibilities, although some international water pollution problems originating in the United States remain and will have to be attacked more vigorously. Likewise, the Mexican Frontier Authority, which is responsible for economic planning and development in the cities and districts adjacent to the United States, is becoming concerned with the regional supply and administration of Mexican water resources in that borderline area. It is possible that unconventional regional developments of this kind will offer further stimulation to more decentralized forms of water administration throughout Mexico. 10/

Regional development in Algeria

The normally centralized features of the Algerian organizational system are being supplemented by studies and plans looking towards the economic and social development of presently marginal but potentially productive regions of that country. To illustrate, there is a series of half a dozen regional projects in which studies, with some international aid, have made progress towards applied development. Located mainly in the lesser developed western and southern part of

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10/ Albert Lepawsky, "International Development of River Resources", International Affairs, October 1963, vol. 39, pp. 540-543.

the country, these development regions include a comprehensively planned Titteri area in the department of Medea south of Algiers; the industrially planned city of Bechar, which is the largest city in south-western Algeria; the adjacent agricultural plain of Abadla; the lower Cheliff River Basin in its multipurpose dimensions; the remote border village of Tindouf, which is facing the characteristic problems of a tenuous local water supply; and the plain of Setif, which will tap the resources of the Souman River Basin. Because of the arid or semi-arid character of these regions, water is the developmental problem of first priority. The anticipated experience to be derived from the wide variety of conditions prevailing in these selected regions and localities reflects a fresh experimental approach to water development in Algeria.

There is as yet no single Algerian agency responsible for co-ordinating or interpreting these regional studies and projects, as is the case, for example, with the unique National Office of the Litani in the Lebanon Ministry of Water and Power Resources. However, the pursuit of these regional studies does reflect a semi-autonomous organizational approach in so far as they are sponsored by SONATRACH, which is Algeria's National Society for Transport and Commercialization of Hydrocarbons. SONATRACH has worked in collaboration with such survey and planning organizations as TEMPO, the centre for advanced studies affiliated with the General Electric Company at Santa Barbara, California. This type of regional planning and applied hydroresearch is supplemented by other survey and demonstration projects involving local and regional water development now being launched by independent university research organizations both in Algeria and abroad.

Indian administration at the centre and in the states

India's experience with the central and subnational structuring of her water administration reflects this nation's challenging problem of governing a society and polity of such enormous diversity and an economy and ecology of such versatile potentiality. In the particular instance of the water function, we have an essential infrastructural service, which, on the face of it, should involve fewer of the cultural or ideological divergencies which ordinarily resist reconciliation, and which ought, on the contrary, to enlist more of the systematizing and rationalizing ideas and practices in which Indian thought and to some extent the Indian discipline of public administration abound. As a matter of fact, of the various public services in India, water administration produces notable evidence of modernity and sophistication, and this suggests the possibilities as well as the problems facing the country. The situation is particularly promising in the realm of administrative organization below or rather beyond "the centre". Significantly, this is the chosen term by which the higher level of the Indian federal system of government is known.

India's experience with central and provincial government, let alone imperial or colonial rule, has a long history. Previous to independence, during the 1930s, a Central Board of Irrigation functioned. However, the depression of the latter decade led the Department of Industry and Labour of the then Government of India to cut its budget and decentralize this function. Irrigation was thereupon selected for provincial autonomy in 1935, and it became a "transferred" subject in 1937, from the central to the provincial and, after independence in 1945, to the state level.

Thus the trend from the beginning was generally a decentralizing one, and at the time of independence the centre was no longer to be responsible for irrigation development and administration except when disputes arose between states. Nevertheless, the emergence of national planning under the Indian Planning Commission and the related realities of national financing - and especially the required mobilization of foreign exchange resources, including defrayal of the essential imports of modern equipment and machinery necessary for water resources construction and power technology - made inevitable the trend towards centralization of the strategic aspects of the water function. On the technical side alone, the necessity merely of providing professional aid to the newly empowered state governments led to the setting up in 1945 of a central Waterways, Irrigation and Navigation Commission and a Central Technical Power Board, both of which were merged in 1951 into the Central Water and Power Commission.

This Commission, as we have seen, mobilizes India's professional hydroengineering talents, not only for the centre but, in practice, for the states as well. As might be expected, however, the Indian federal system, which is one of divided responsibility for planning and operating such a highly complex water structure on so vast a subcontinental scale for so diverse a set of hydrologic basins which seldom conform to state lines, can be neither standard nor smooth. Nevertheless, except possibly for the extraordinarily powerful pressures towards an accelerated rate of development, India's federal and pluralistic type of water administration is not essentially different, in its general character, from the central and decentralized type of water administration prevailing in other large and more developed nations like the United States of America and the Union of Soviet Socialist Republics.

One of the unique organizational devices by which the centre and the states jointly pursue their co-ordinate responsibilities in India is the Control Board or Construction Board. Such joint boards are established by agreement between the states and with the centre for direction and supervision of the individual water projects. These are generally chaired by the chief minister of the state in which the project lies. However, where the project is characterized by technical complexities or political complications, the competent minister from the centre is designated as chairman. The state is also generally represented by its chief minister or minister of the state department most concerned with the project, while the central Government is represented by senior officials of the Central Water and Power Commission or of the central ministry most concerned, as well as by the Ministry of Finance. Actually, the Board's work is carried out with the help of a full time superintending engineer functioning as Secretary of the Board, who generally comes from the state concerned. He is usually supported and staffed by the state administrative officials, just as the responsibility for actual construction and execution of works generally rests with the state government.

Essentially, this system of the project-by-project joint boards prevails whether the project is single purpose and involves only irrigation or electricity or whether it is multipurpose. However, in the latter case, particularly if state lines cut across subbasins and across water or power service areas, a greater degree of interstate collaboration and representation on the joint board is required. Where projects are interstate in scope and differences between states continue to arise, leadership on the joint board is assumed by members representing the central Government. Above all, the necessary financial commitments are coming to be shared on both an interstate and federal basis.

From the centre, moreover, a longer-term system is arising of financial loans or grants in aid, not only in support of the water or other specialized functions, but as general or block grants as well. One formula of this kind, which has been evolved by the Indian National Development Council, the country's highest policy body on this subject, lays down the following criteria for the distribution of the available funds among the states: 60 per cent based on population; 10 per cent based on the needs of important continuing schemes; 10 per cent based on the state's special requirements or "backwardness"; 10 per cent to be given to states whose per capita income is below the all-India average; and 10 per cent on the basis of per capita tax effort as a proportion of each state's per capita income.

For other important water functions that are transbasin in extent, national in significance, require interstate liaison and are in need of administrative continuity, central agencies such as the Interstate River Commission and the Flood Control Board have been established. Moreoever, current Indian planning for the transfer of water on a grand interbasin scale is concerning itself with broader water problems, such as land conservation, which transcend state as well as basin boundaries. For the solution of these problems which are now emerging on the nation's hydrological agenda, India should be able to make good use of its already accumulated body of experience with federal-state and interstate water administration.

It is at the local level, involving the agricultural village and the urban community, that a still greater complexity of problems confronts state and central water administration. 11/ The rather well advanced community development programme of India is extensively - and in some cases primarily - involved in water supply planning and development, particularly in rural areas. Fortunately, the special structure which has grown up for community development administration is tending to become integrated with the established system of local government, which is itself reaching the first steps of intervillage co-ordination or consolidation. One of the main instruments of this transition seems to be a more recently established apparatus of some 5,000 community development "blocks", each block comprising a number of village panchayats. At the village level and in the agricultural sector generally, the community development programme emphasizes not only water supply and sewerage development, but particularly the more efficient application of irrigation waters. Utilizing forums and other such popular devices for transmitting on a vast scale the necessary technical know-how, this programme has enjoyed a rising public response and in fact represents one of the major and most successful grass-roots efforts in India.

Another problem related to the devolutionary process, that of regulating and pricing water uses, is subject to the widest variation among and within the Indian states. Considerations of uniformity and equity here involved may call for national policy-making in the future, but state experimentation and administration could still contribute considerably if more initiative and innovation were assumed by this level of government. Another related process, that of legal codification at the state level or at the centre, has not been seriously undertaken in India, although water rights have been subject to local custom and community control from time immemorial.

11/ See, for example, D. B. Narnes, Evaluation Criteria for Village-level Water Projects in Developing Countries, project on engineering-economic planning, Stanford University, California, September 1968.

Indian cities, particularly the larger urban areas, are also experimenting with new forms of regional, more specifically metropolitan, integration of the water function. For example Calcutta, as India's largest city, is undergoing developmental planning on a metropolitan scale. In the course of this phase of regional development, water and sewerage plans predominate. However, despite the efforts of its own unified and experienced Water and Sewerage Authority, Calcutta's progress has not kept up with even the minimal requirements of the metropolis and its suburbs, and the situation there remains highly critical from the standpoint of public health. 12/

Of the six countries studied here, India's system of decentralized and devolved administrative organization probably faces the most intense pressures. India also reflects the greatest variations and complexities of subnational structure and federal-state relations, but this circumstance may arise from the country's magnitude and diversity rather than from any irremediable and inherent organizational defects. 13/ For despite its many problems and pressures, India offers a versatile record of local and regional, federal and state, intergovernmental and interstate organization and administration in the water field. If this rich background of experience is successfully applied to the challenges now facing India, it will provide a hopeful model in an equally and increasingly pluralistic world.

12/ Calcutta Metropolitan Planning Organization, Basic Development Plan, Calcutta Metropolitan District, 1966-1986; see also T. Dureiraj, "Problems of Community Wastes in Urban Areas", Nagarlok (municipal affairs quarterly, Indian Institute of Public Administration), vol. 1, 1969.

13/ Asok Chanda, Federalism in India: Study of Union-State Relations (London, Allen and Unwin, 1965); Richard L. Park, India's Political System (Englewood Cliffs, Prentice-Hall, 1967); Amal Ray, Intergovernmental Relations in India: A Study of Indian Federalism (Bombay and New York, Asia Publishing House, 1966).

VI. ADMINISTRATIVE DRIVE AND ADMINISTRATIVE PROFICIENCY

Administrative technique and administrative style

It is apparent from the foregoing that the degree of proficiency attained in administering national water resources is attributable not merely to organizational refinement but is even more explainable in terms of human performance. The human factor is reflected strategically in the contribution of the top water administrators, policy-makers and planners, and the performance of the professional, scientific and higher technical personnel; but it is also a product of the proficiency of the operating, technical and subprofessional personnel, and the collaboration of the consuming public whose informed behaviour as water users is of rising importance in the administration of a developing world. Consumers are further linked in through the promising organizational trend, already noted, towards the growth of devolutionary and participatory institutions. In contrast to these human demands, the requirements of technical proficiency are more dependent upon standards of management proficiency than upon norms of human behaviour, and this dichotomy raises many latent problems of bureaucratic responsibility and human alienation in a modernizing society.

It is assumed that in developed societies scientific technology is generally more advanced than managerial techniques, including the techniques of personnel management. In a recent review of the management and administration of water resources in European countries, the Economic Commission for Europe (ECE) reported that "emphasis must be laid on the need for greater efforts to combat the considerable lagging of water management techniques behind scientific and technological progress in application of management methods and tools". 1/ It is understandable that in developed countries technology in the realm of science might be more advanced than in the field of management. But what is more significant is that in the developing countries management technology, not merely scientific technology, is outpacing manpower proficiency. Although management and manpower should not be too holdly juxtaposed, it is tenable to argue that, certainly for developing countries, managerial and administrative proficiency presupposes, first and foremost, human capability. The experience of our six developing countries reveals this rising status of water resources personnel, along with the growing sophistication of water resources management.

Progress of personnel in Algeria

In Algeria, which is now experiencing the most accelerated rate of development, manpower resources at the key levels of the higher professional and higher administrative personnel are still quantitatively inadequate, but

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1/ United Nations, Economic Commission for Europe, "Present Situation and Major Trends in the Management of River Basins", introductory report, Committee on Water Problems, Seminar on River Basin Management, 24 April 1970, p. 26.

qualitatively improving. Transitionally, foreign personnel, chiefly from France, is available, especially for the scientific branches. 2/

Algerian higher educational facilities for the required basic training are also of marked and improving quality, but they too are growing too slowly to fulfil the needs of national development in a specific field like water administration. In particular, there is an unfulfilled requirement for more technical training, including intermediate and higher education in water resources economics and planning. There is an even greater deficiency of technically trained persons at the increasingly important regional and grass-roots level, although this may be a reflection of the mistakenly downgraded prestige of employment outside of the capital. In any case, there is a widespread need for better application of generally available talent and skills to concrete operational tasks, including the newer engineering and management specialities associated with evolving types of irrigation agriculture and especially agroindustry.

Algeria's national manpower is thus being consciously appraised and deliberately developed, and this is occurring in an increasingly knowledgeable setting involving international experience. At the strategic level of the higher professional personnel, results are already observable in such fields as water resource science, research and experimentation, but there is also some evidence of an emerging degree of indigenous administrative proficiency in water and soils administration and management.

Administrative talent in Hungary

The Hungarian water system employs some 100,000 persons inclusive of workers regularly engaged in hydraulic construction. This is approximately 3 per cent of the total work force, but it does not include numerous additional personnel indirectly active in technically applying the water supply to associated activities in irrigated agriculture and in agro-industry. The proportion of water personnel exercising higher professional and technical duties, including planning and administrative functions, is estimated to be about 10 per cent of the over-all figure, and this proportion has multiplied by four during the past 20 years.

An outstanding characteristic of the Hungarian system is its emphasis on personnel training. The vast majority of Hungary's personnel employed in the water function is trained both in the regular educational establishments and in training programmes which are administered on the job. There are particularly impressive educational facilities for professional personnel and for the technical specialists involved. The over-all annual training load for the national water system is estimated to be approximately 1,200 a year. Some 900 come directly from the regular secondary schools, where they have been exposed to technically oriented curricula, and are subsequently trained in on-the-job courses. Some 100 more are technicians trained in specialized secondary schools devoted exclusively to hydrologic and related subjects - schools which are administered by four of the 10 district water authorities, under the supervision of the National Water

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2/ United Nations Educational, Scientific and Cultural Organization (UNESCO), Département des sciences exactes et naturelles, "Enquets sur les principales organizations nationales des recherches scientifiques" (Algiers, 1963).

Authority, and which concentrate, among other subjects, upon the routine tasks of water resources administration. One hundred more are specialists and professionals trained largely in the basic sciences at the regular universities.

Additional in-service training opportunities at the postgraduate level are available in the Technical University of Budapest, and there are a few training assignments available abroad. Reciprocally, a semi-annual in-service training course in hydrologic methods for developing water resources management has been offered for foreign trainees at the Hungarian Research Institute for Water Resources Development. 3/ This course, organized by the Hungarian National Water Authority and sponsored by UNESCO, accurately reflects Hungary's advanced water resources technology. With regard to Hungarian postgraduate education, the thesis subject for the highest degree in the hydrological field is regarded as the major component of each student's training programme. It is expected to contribute to his disciplinary training in the basic sciences involved and generally deals with applied topics relating to the specific and strategic problems facing Hungarian water administrators. The president and other experienced personnel of the National Water Authority and of its semi-autonomous research and planning institutes and agencies participate as lecturers or research supervisors in these university courses. Thus Hungary reveals a serious educational and professional commitment to the science and art of water administration.

The over-all co-ordination of scientific research with higher education is the function of the Hungarian Academy of Science, but the National Water Authority is widely represented on the appropriate committees of the Academy. Another dimension of the scientific attainment and professional distinction of Hungarian water administration derives from the fact that some of its most accomplished staff play a leading role in the research and consultative work of the ECE and of various international hydrologic scientific organizations.

The Indian reservoir of manpower skills

In India the employment potential of the water resources is directly related to the larger national problem of absorbing the promising capacities of both the trained and untrained manpower of a populated and developing nation of impressive size. In the irrigation sector alone, construction and planning required 500,000 new employees during the last completed five-year plan, and 150,000 additional personnel in the power sector. This is exclusive of the personnel requirements for minor irrigation works and for canal and related construction on the individual farms and associated industries. In a nation like India, with a dense population on the one hand and a serious foreign exchange shortage on the other, there is a tendency to pursue a policy of labour-intensive rather than capital-intensive projects and processes. Thus, the job-generating capacity of a developing water system, with its economic spill-over into secondary and tertiary employment, is well appreciated in India as in other developing countries. However, it is also recognized that certain types of specialized training, especially for personnel exercising the increasingly technical and administrative functions necessary for a more fully productive hydrological infrastructure, will have to be increased.

3/ Research Institute for Water Resources Development International Postgraduate Course on Hydrological Methods for Developing Water Resources Management, Budapest, 15 January-15 July 1968.

The more highly and generally trained categories in India seem to be already provided for in sufficient number. In fact, India's advanced system of higher education in the basic and in some applied sciences seems to be keeping up with if not exceeding the demand. During the intensive period of irrigation planning and construction of the past two decades, a number of new engineering colleges were established, and there is now some evidence that there may have been some overtraining in certain professional categories. As a matter of fact, there has for some time been an extraordinary emphasis in India on academic degrees and professional diplomas.

Nevertheless, certain specific needs for more applicable training, even at advanced technical levels, like the requirements for intermediate technical and mechanical skills, still remain unfulfilled. Thus there is a need for swifter and better training of adequate numbers of operators and maintenance personnel for the massive machinery imminently required to speed up the conversion of modern construction methods associated with the transition from labour-intensive to capital-intensive projects. At the farm level, on the other hand, where upgraded personal know-how is also essential, irrigation-agronomic techniques and training have been improving noticeably: indeed, this fact partly explains the "green revolution".

More effort is also necessary in the technical retraining and in the combined in-service re-education of water resources engineers and administrators. There is some realization of the significance of a wider interdisciplinary approach in teaching and training, as well as in research and extension, now emerging at such Indian institutions as the Agricultural University, with United States governmental and university aid. 4/

There is current discussion in India about the relative responsibilities of general administrators and hydraulic specialists, a problem which has apparently not been completely solved by the unique Indian practice of combining, at the executive level, the duties of chief engineer and chief administrator of the various water projects and agencies. What is additionally needed, in order to better absorb these highly trained and talented Indian personnel, is concrete retraining courses which will enable water personnel to pursue the newly combined responsibilities of and the necessary teamwork involved in practical interdisciplinary duties on the borderline between fiscal, planning and administrative functions. In a federal governmental system like India, in which an overriding problem is that of intergovernmental relations, personnel can ill afford to remain academically provincial in relation to interdisciplinary matters.

Nevertheless, both interdisciplinary and intergovernmental efforts are being encouraged in India, and innovative forms of analysis as well as scientific refinement of concepts and norms are seriously pursued. This creative inclination is reflected in some particularly advanced practices within the Indian professional apparatus. Thus although retarded water management practices can still be found in some localities, there is little in developing countries to match the sophisticated papers recently presented, for example, before the Indian Society of Earthquake Technology and circulated among the leading Indian water engineers and

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4/ International Agricultural Institute, University of California at Davis, "The Indian Program", Annual Report, July 1969-December 1970, pp. 1-9; University of California, University Bulletin, 30 March 1970.

administrators. 5/ At the same time, a highly articulate and generally engaging reporting style often parallels this analytical sophistication in India.

In short, the essential and adaptable manpower talents and advanced and required professional skills are available for Indian modernization and developed in the field of water administration. Paradoxically, they are so profuse and plentiful in some selected fields that they sometimes seem to be unfocused and scattered. Generally speaking, India's administrative style is more encouraging than its concrete administrative application, and by the same token intellectual comprehension often runs ahead of incremental performance. Perhaps the greatest danger to be avoided in a humanly endowed but materially distressed land like India is the growing disparity between the already available trained intelligence and its specific socio-economic application. Because of the wide range of economic effects and social impacts, this shortfall seems amenable to improved administration by the able personnel of the nation's water system. For despite the difficulties and challenges of social adaptation and technological change, personnel performance is impressive in the administration of the Indian water system as a substantial component of the national administrative infrastructure.

The personnel factor in Israel

Israeli manpower in the field of water administration consists of some 2,500 engineers, managers, professionals, technicians and other staff employed by Mekoroth; 700 professionals and subprofessionals employed by Tahal in hydrology, agronomy, economics, social science, management science, mathematics and computer science; a somewhat smaller number of largely administrative personnel in the several branches of the National Water Commission; and a greater over-all total of scientists in the various research and educational institutions which, in Israel, service the water system with essential inputs of basic and applied knowledge. These include the Weizmann Institute, which is concerned with basic science; the more implementally oriented Lowdermilk School of Agricultural Engineering in the Institute of Technology, the so-called Technion; the Negev Institute for Arid Zone Research, now converted into the independent University of the Negev; and the Hebrew University's School of Agriculture at Rehovot, which has been transformed into the country's first independent School of Economics.

It is generally postulated that Israel's early and extraordinary immigration, consisting of a high proportion of scientists and professionals capable of productively merging the basic disciplines with the applied sciences, accounts for its swift rate of development, including the forehanded priority which its policy-makers and planners had assigned to the water supply problem from the beginning. This was no doubt a decisive input, but there are additional or at least interrelated explanatory elements. One of these is probably Israel's unorthodox administrative style. This seems to comprise two apparently contradictory but actually complementary elements: (a) a variegated pattern of public of private, collective and communal, competitive and co-operative enterprises; and (b) a stimulating milieu for individual expression, personal drive and behavioural diversity.

5/ P. M. Mane, presidential address, Third Annual General Meeting, Indian Society of Earthquake Technology, New Delhi, 23 January 1969.

Comparable combinations of national traits are found in other countries with high achievement goals, but it would be revealing to pursue this possible causal explanation for Israeli administrative development, since Israel seems to have been able to solve more of its water problems in less time than most other developing countries. Analysts who attempt to characterize Israel's administrative experience for possible application elsewhere are of two schools of thought on this issue. Each school presents both a critical and a constructive evaluation of the Israeli administrative style, but one stresses the limitations, while the other sees certain advantages, resulting from the country's continued reluctance to pursue a more conventional and systematic administrative style.

Akzin and Dror summarize Israeli public administration in the following terms:

> "(1) an atomistic attitude toward many problems, which militates against any effort at over-all solution; (2) low development of long-range thinking, crossing-the-bridge-when-it-is-reached often being the preferred strategy; (3) limited use of social science knowledge and a general tendency to regard experience as superior to academic training; and (4) almost unlimited elasticity, so that even when long-range plans have been prepared, they will often be readily abandoned for short-run advantages". 6/

On the other hand Caiden, who also advocates more systematics for Israel, describes its existing administrative style more sympathetically:

> "The key people in Israel are those who can work systems and make systems work. It is individuals, not group, classes or organizations who provide creativity, push innovation, persuade sceptics and critics, obtain general approval, search for resources, advise on implementation, teach colleagues, check operations, and do the hundred and one other things necessary to change existing systems. It is individual endeavour, supported by allies and opposed by rivals, conservatives, indifferents and perfectionists, that provides the energy. It is individuals who are fired by a total commitment to Israel, mobilized by mass movements and sought by charismatic leaders. Their motives, like their origins, are varied, but they survive only so long as they succeed. They are not defined by family, party, residence, wealth, club or other ascriptive criteria, but by their ability to manipulate systems and their recognition of similar ability in others. They are not yet organization men, but engineers who activate bureaucrats and technocrats. They are self-made leaders. They cannot always articulate why they are what they are. Because of this, they are sceptical of scientific management unless it proves itself in operation. They leave theorizing to professors." 7/

Nevertheless, one important contributing discipline in establishing Israel's successful pattern of water administration, as Caiden also recognizes, has been systems engineering. If there is an apparent contradiction here between a healthy scepticism towards scientific management and a devotion to systems (and not merely

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6/ Benjamin Akzin and Yehezkel Dror, Israel: High Pressure Planning (Syracuse University Press, National Planning Series 5, 1966), p. 16.

7/ Gerald E. Caiden, Israel's Administrative Culture (Berkeley Institute of Governmental Studies, University of California, 1970), pp. 100-101.

systematic) analysis, the contradiction may be reconciled by the injection, in the Israeli case, of a substantial commitment to inventive social arrangements and rearrangements. This elusive yet essential component of a successful "development" culture is well described in the following methodological conception formulated for the Economic Commission for Asia and the Far East (ECAFE), but also quite descriptive of the Israeli administrative style:

> "... granting the large scope for improvement in the quantification and analysis of social programmes, it still has to be recognized that, in all probability, their productive potential can never be fully appreciated in strictly physical terms and that decisions affecting their development must rest to a fairly large degree on imaginative judgement. The factor of judgement assumes almost total significance when we consider the other side of the issue of social progress, that is the question of planning for dynamic social change, because here most, if not all, of the measures required would seem to lie quite outside the realm of quantification and evaluation in terms of physical and financial costs and benefits. Putting this another way, it may be said that there are areas -- having to do with the restructuring of social relationships and the development of new institutions, for example -- in which change and reform are quite plainly called for in the cause of development, all the more so if really rapid development is wanted. These changes and reforms cannot be sensibly evaluated in quantitative or financial terms, since they are essentially of a qualitative kind, and as a rule require no direct or prior financial investment at all; what they call for are acts of judgement and will, before there is any question of the infusion of funds, and the fact that they may not lend themselves to strict economic analysis is irrelevant to their intrinsic importance for socio-economic development. The management of social change and reform, in short, is a legitimate component of the social aspects of development planning regardless of its econometric intractability, and to assume otherwise would constitute supreme short-sightedness." 8/

Thus does imaginative administrative performance help to produce dynamic social development.

An additional facilitating factor in Israel has been the close personal connexion which has existed between the water resources administrative and development agencies and the country's political leadership, who on their part have remained steadily conversant with the relevant water issues and modern water technologies concerned.

Mexico's administrative experience

As far as modernized public administration and accelerated hydraulic administration are concerned, the Mexican developmental experience was among the

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8/ United Nations, Economic Commission for Asia and the Far East, Planning Water Resources Development, report and background papers of a Working Group of Experts on Water Resources Planning, Bangkok, 29 August-9 September 1968, part II, document No. 7, "Social and Non-Economic Considerations in Water Resources Planning and Development", p. 106; "Review of the Social Situation in the ECAFE Region", April 1970.

most forehanded. Mexico began to transform its political system and to reconstruct its water system before the Second World War. In fact, Mexico gave even earlier expression to an indigenous school of "scientificos" as part of an internal revolution which originated almost a century ago. The more recent transition, which has now incorporated hydroindustrial with irrigation-agricultural development, extended this long-term Mexican pattern of technical and professional skill into the current period. Although the average irrigation project is handicapped for lack of adequately trained capacities at the ejido and local levels, the upgrading of irrigation techniques and related agricultural practices is going on apace. 9/ The same may be said of practically all levels of Mexican hydro-personnel. Among its other manpower prerequisites, Mexico is also moving ahead with respect to her trained and experienced water engineers and economists as well as her water administrators and planners.

In certain respects, Mexico's national administrative style has been enhanced by a tendency to recruit political and policy leaders, who have in some cases also had administrative or civil service experience in higher executive, including cabinet-level, responsibilities. This somewhat unique kind of personnel profile has emerged during the last generation even in the selection of Mexican presidents, in which case the most usual pattern of previous service has tended to include service as senator, governor, cabinet member (usually secretary of gubernacion). This trained and experienced capacity inherent in the presidency has played a noticeable role in the nation's governmental system. The initiatives and innovations in policy-making which are required to solve the country's absorbing problems of public administration, including water administration, can thus be enhanced by national consciousness at high levels to the administrative intricacies involved in the exceptionally complicated questions of political economy and "social politics" which face rapidly developing nations like Mexico.

Professionalism in Spain

Spain's distinctive record of water administration reflects the fact that, among the six countries here studied, she is one of the most developed generally. Although Spain's technical and professional achievements in water engineering appear to have exceeded her attainments in water resources administration more generally, its performance in the realm of water resources economics and planning also reveals an increasing proficiency. The country's basic scientific education and associated professional training are substantial in both quantity and quality. Technical education in the applied disciplines is catching up, though more slowly, and training in the realm of managerial operations, as well as technical training for irrigation agriculture, is developing more rapidly. Government research agencies, both basic and applied, are fairly well funded and well staffed, and the national scientific bodies are linked in with basic research. The socio-economic dimension is receiving more attention through the efforts of the Institute of Colonization, for example.

Nevertheless, there remain certain professional patterns in Spain that act as partial constraints upon the administrative interdisciplines and upon the nation's administrative reach. The traditional professions such as law and engineering

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9/ Amando Fuentes Flores, Benjamin Tellez Fuentes and Fernando Martinez Sainos, "Training of Users of Small Irrigation Systems", Water for Peace, 1967, vol. 5, pp. 983-984.

play a powerful role in Spanish society compared to the newer economic and social science professions and disciplines. Yet law and administration are coming to be more skilfully applied in Spain to modern hydrologic realities, and a special commission is now devoting some of the nation's outstanding talents to the comprehensive modernization of its water code and thereby its water system. Fortunately, too, Spanish education for the traditional professions is not lacking in economic or socio-economic content. It may possibly be said of Spain that her administrative methods and planning capabilities are still stronger than her techniques of socio-economic analysis and developmental planning. The necessary skills and talents are apparently available, but the problem seems to be one of narrowing the gulf between promising potential and optimal performance.

The special manpower requirements for development

Looking at the water systems of the six countries here studied, it may be concluded that they employ fairly adequate numbers of personnel generally, even if they fail to do so in specific categories. It may further be said that the water manpower resource generally represents a distinctive contribution to the administrative and developmental infrastructure of each of these countries. Moreover, the employment potential in water projects and especially in water-related activities is proportionately greater than is revealed by the numbers of personnel directly employed in water management. In terms of quality, the professional, scientific and higher technical and administrative posts are generally well staffed when compared with the personnel resources of some other functional fields of developmental administration. However, trained talent and proficient performance is comparatively lower where the training and transmission of skills would seem to be easiest, namely at the routine operational and intermediate technical levels, and especially in tasks where the required water techniques and procedures are applicable to marginal specialties, as in the case of established irrigation-agriculture or emerging agrobusiness functions. Here, indigenous and ingenious training schemes of a self-help and do-it-yourself nature may have something to offer along with more elaborate interdisciplinary or international training. 10/

As for the decisive level - that of policy-making and planning manpower - there still is some shortage of personnel who can combine policy-formulating capacities with general administrative skills, planning with research, techniques of programming with the essentially related capabilities for project design and management. In the lesser developed countries in particular there is an unfulfilled need for the kind of administrative talent and leadership skill which is versatile enough to apply wider ranges of interspecialized experience and interdisciplined knowledge to challenging resource development projects and especially to changing institutional requirements - economic and ecologic, social and political.

Although more of the essential experience and knowledge required for contemporary development in this realm is becoming available through various kinds of international exchanges and comparative lessons of resource technology and administrative performance, the essential and urgent requirements remain for more consciously cultivating national administrative styles which would be more sensitive

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10/ Edward F. Douglass, "Ingenuity and Water Supply, a Do-it-Yourself Approach", in ibid., pp. 998-1004.

to socio-economic problems and for more actively concentrating on strategic societal priorities. Admittedly, these administrative styles and policy priorities differ distinctly from nation to nation, yet they have much to contribute when observed and analysed across national lines.

VII. ADMINISTRATIVE PRIORITIES AND DEVELOPMENTAL DETERMINANTS

Ordering the criteria for effective water administration

The five criteria applied in this comparative study (see annex III) - economic and ecologic efficacy, planning capability, organizational viability, effectual devolution and administrative drive - may, in the light of the experiential evidence offered by the six national systems of water administration studied here, be ranked in some order of significance as possible determinants of the development process. Admittedly, these broad criteria may not provide a specific check-list for administrative modernization in some developing countries. However, such a check-list is a possible next step for further experimentation and elaboration. Meanwhile, the general approach pursued in this study may offer certain guidelines as to relative priorities - a sequence which might differ concretely from country to country.

In terms of our developmental objectives, the criteria of economic and ecologic efficacy and administrative drive may be given first and second rank respectively, even though the former would be a more likely consequence if the latter is sufficiently dynamic. There is also some evidence in this comparative study that special and incremental efficiencies in water resources development can be attained even with elementary forms of comprehensive planning or purposeful policy-making at central levels of administration; but genuine initiatives must also be forthcoming from the various subnational levels of administration if the water system is to attain a general and optimal degree of effectiveness. Consequently, although the elements of planning capability and effectual devolution may be considered to be mere reflections of a national and a grass-roots administrative drive, they should be ranked next in close order of importance. They are here placed third and fourth respectively, because the subnational framework of a modern nation is usually dependent on a deliberate central policy of devolutionary development. Finally, if the experience compiled in this study is sufficiently typical, the factor of organizational viability in its structural sense, while an impediment to workable water administration if it is lacking, may be regarded as a criterion of lesser, though by no means insignificant, comparative rank.

From a strictly defined administrative standpoint, it might be possible to further refine this analysis by dropping economic and ecologic efficacy as an independent criterion on the grounds that it is itself an end-product of efficacious planning, policy and administration. In this case, we might be justified in reranking the four remaining criteria as follows: administrative drive, planning capability, effectual devolution and organizational viability. This virtually ranks the prerequisites for a modernizing administrative system in order of their derivative relationship, and it leaves us with the descending order of significance we arrived at in the previous paragraph. Within these select and general categories, the more specific and in this sense possibly the more significant criteria may be allocated and applied in appraising administrative systems or subsystems. Thus, personnel and professional training requirements would be assignable to the quest for administrative drive; statistical and research standards could be treated under planning capability; public involvement or popular

participation would be an element of effectual devolution; and adequacy of co-ordination would be a subcriterion of organizational viability.

Although this rating expresses a qualitative order of emphasis that may be analytically valid, it does not necessarily reflect the temporal order in which developing nations actually do or necessarily should, for the express purpose of achieving modernization in their system of public or resource administration, pursue the prescribed developmental sequence. In this more practical or operational sense, nations might, with due regard to their prevailing conditions, be better advised to adhere to the original order followed in this study - economic-ecologic efficacy, planning capability, organizational viability, effectual devolution and administrative drive - because this is probably a better reflection of the relative ease of attaining results with the available stock of knowledge. It also has the advantage of reintroducing as a possible criterion, rather than as a sheer consequence, our combined substantive element of economics and ecologics, subjects which persist and recur in the contemporary analysis and appraisal of national policies and international programmes for resource development. This ranking, moreover, might be an advisable one for the practical purposes of developmental administration generally, because it tends to put first those elements which are the more obvious or applicable and the more definitive and dramatic. There is, after all, some validity to the simple precept that it is preferable to proceed from the elementary or known to the complex or unknown, that one should learn to walk before one can run and that nothing succeeds like success. It is in fact quite possible that experiencing the taste of achievement, however mild this alone may be, is more of an encouragement and enticement in the national development process than the more exhaustive but evasive search for attaining bigger and bolder objectives. It is for this reason that a modest, well-achieved programme is more advisable, particularly at the beginning of the national developmental process.

One of the difficulties with this theory of development is not only the possible neglect, in the course of achieving such a selected objective, of other and more fundamental national goals, but also the implied assumption that nations actually do have the choice of concentrating on simply one objective at a time. As a practical matter, nations seldom have this option of putting first things first. In the urge for modernization and development and in the struggle for stability and survival, nations undergo social crises and experience political pressures which often predetermine their selection of priorities and the sequence of developmental events. Consequently, it may well be that the most promising formula would be a strategic combination of a limited number of objectives within a context of basic national goals. As this study has shown, there are several desirable and definable aspects of water resources administration which make development in this realm an advisable objective for such refined selectivity and deliberative emphasis.

Regardless of their order of priority, all our developmental criteria or requirements for achieving modernized water administration share one characteristic. This is their potential transmissability. Particular conditions or transient circumstances prevailing in developing countries at different stages of their modernization will of course influence the degree and rate of transmissability of both administrative technique and substantive policy. But it should not be assumed that technique is always easier or more worthy of emulation than policy. For example, as an expression of technique, organizational structures may be readily copied without, however, being relevantly applicable because of the varying

substantive requirements of organization in relation to programmatic purpose and policy goal; and for this very reason organizational structures should be initiated with utmost caution. On the other hand, the procedures and processes of contemporary planning may often be more readily and relevantly borrowed than substantive plans, and they may therefore be worth some prior consideration in the search for comparative alternatives. By contrast, the prospects for achieving results in the realm of devolution, calling as they do for possibly greater application of the socio-political arts, are somewhat more evasive and less transmissable. Finally, prospects for successfully borrowing and adopting the more general administrative techniques would seem to be more promising; but unfortunately the least imitable or transmissable element is that administrative ingredient which is probably the most influential but elusive of all, namely, administrative drive.

By definition, administrative drive implies a certain innateness and uniqueness in relation to a nation's culture. Nevertheless, contemporary knowledge about cultural relativism and comparative sociology recognizes that the distribution of human talent is such that in all developing countries today a process of socialization and modernization is going on which quickens the sense of national pride, if indeed it does not spark some measure of international emulation. The impulse in developing countries, like the incentive for personal attainment, is to put the best foot forward. If properly nurtured, therefore, some measure of administrative drive can be converted into a genuine cultural trait for expressing national ingenuity, if not national genius.

Search for the fundamental determinants of water resources development

However, there may still be even more fundamental determinants to both culturally based and consciously planned administrative development. Indeed, we may well ask whether the developmental criteria selected in this study are sufficiently basic in the sense of their being genuinely causative. May not the selected criteria themselves possibly be derivatives from still more fundamentally determined facets of national character? Despite the operating assumption which continues in developmental circles today that, regardless of cultural heritage or current attainment, all countries are potentially capable of progressive modernization and national development - which is a valid assumption in so far as the objective criteria we have so far identified are concerned - it is nevertheless a possibility that the different levels and rates of administrative development achieved are manifestations of fundamental distinctions in national histories or national ecologies.

This can be argued especially in the case of water administration. As a collective function dating back to the birth of human communities and societies, and particularly to the earliest societies which took the form of the original river basin States, water administration is deeply engraved in human culture and history; and at the same time it reflects underlying ecological, geomorphological and meteorological conditions. Although our historical and ecological knowledge is still inconclusive, we may nevertheless observe some of this interplay between history and geography if we weigh the different degrees of national water resource development in the context of the over-all level of national development attained.

Spain is a nation which has been moderately favoured for hydrologic development by both its natural environment and historical experience. Over the

span of its history, this land has been a receptive frontier for the application of lessons derived from Afro-Asian as well as European hydraulic technology. A couple of Spain's still operating dams for water supply were built in Roman times. Some of its irrigation and related hydraulic experience is a legacy of Islamic rulers from North Africa who governed Spain in the pre-modern era and of similarly advanced capabilities historically contributed by the rest of the European continent. However, especially in the contemporary period, indigenous influences predominated, although modern Spain has skilfully continued to apply selected lessons learned from abroad. Sometimes the international impact upon internal policy has been decisive. As a consequence of her divestment of colonial possessions at the end of the last century, Spain found it advisable to compensate for these losses by applying herself more vigorously to the rationalized administration of her own national resources, with particularly positive consequences for the improvement of her system of water administration.

Hungary is a case where neither history nor geography have been benign, but where human talent and foresight have fashioned an advanced form of water administration, which offers valuable comparative models for other countries. Hungary's response to her continual water challenge has been one of careful planning and deliberative decision-making within a broad context of mature public policy and upgraded public administration. Her achievement in this regard is long range, having preceded the contemporary period of planning and development. Comprehensive planning was intensified in Hungary after the end of the Second World War, and in eastern European countries generally, but in Hungary it thrived by virtue of an extended history of administrative development going back 100 years. In their national tradition, as well as in terms of their contemporary policy-making, Hungarians have been conscious and proud of their historic water development, and this has cumulatively facilitated the relatively advanced administration of a distinctly modest water supply.

The historical effort to adapt to aridity in Israel, as in the Middle East generally, is recorded in the ancient classics and is reflected in contributions of Moslem and Ottoman origin. A modern version, in the fictional form of the utopian literature of the early twentieth century, presketched a planned irrigation development 50 years before it actually occurred in the contemporary State of Israel. The precision and quantification which this lacked was filled in during the 1940s by renowned foreign resource experts like Walter Lowdermilk. Meanwhile, experimental probes and scientific researches occurred into the natural and man-made water supply. This combination of contemporary science with historical insight was telescoped during the last generation, when the impulse which was most recently operative was the need to settle and absorb a contemporary immigrant population. The Israeli experience may thus be said to reflect an historical impulse contemporarily directed. Yet it may also be asked whether the particular Israeli result is not equally explainable primarily on ecological and environmental grounds. Even in ancient times, agriculture here was rain-fed, and irrigation depended upon a skilful combination of numerous water techniques, distinguishable from those practised in the rest of the Fertile Crescent. Special skills and techniques were required because the terrain was hard and rocky, and the evasive subsurface waters could not be readily exploited until more modern mechanisms and penetrative technologies appeared on the historical scene. Although one may hesitate to argue that this naturally water-deprived land historically constituted a "favourable negative" impulse to water development, yet one may still consider,

as a basic explanation for the Israeli experience, the positive ecological challenge which is paradoxically offered by such a specially limited, but administratively manageable resource base. 1/

India as a subcontinent provides a more imposing modern version of mankind's historic hydrological experience. Despite regional water shortages and continuing "federal" problems, Indian water administration is impressive for its range of achievement over the years and also for its contemporary rate of development in the face of colossal odds. Nevertheless, the Indian attainment has been no more remarkable in those of its regions which contain abaundant waters, than it has been in its water-short areas. The Indian experience therefore suggests that a naturally lush endowment of water may be as resistant to human administration as a severely short supply and that deeper national traits are operative here.
Prime Minister Nehru once characteristically described India's burgeoning water projects as "the temples of modern India". The steady development in the last 20 years, including the productive green revolution of the last few, seems to justify this view. Moreover, the present era is by no means the first or only period of phenomenal water development in India. Apart from the prehistoric and ancient legacy of Indian water administration, such as that which arose in the borderline Indus basin, there were other historical eras and areas in India of accelerated water development and advanced water administration. Indeed, during the entire previous century there had been an impressive growth in water facilities and institutions throughout India. A considerable part of this development received stimulation from abroad, chiefly during the period of British dominion, and some of it was motivated by the urgent need to relieve the threat of famine by providing drought-free supplies of water. The Indian record even then represented an impressive indigenous product of the land and its people.

Similarly, Mexico's system of irrigation agriculture had pre-Columbian origins, but as a modern system it developed largely over the past two generations and before the current world development process got under way. Mexico entered her period of accelerated agricultural development, including her initiation of associated land reforms, in the 1920s, and by the mid-1930s she was well embarked on her intensive programme of irrigation. Although international models of aid were available, the Mexican development was heavily indigenous from the very beginning.

Algeria's record of administering an essentially restricted water resource also springs from both historically indigenous and internationally derived sources. The prehistoric experince was itself supplemented by ancient Roman contributions to North African hydraulic development, while the modern experience enjoyed the stimulus of French administrative technique and hydraulic science. However, Islamic

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1/ Saul Aloni, "Modern Water Legislation and Development", Water for Peace, 1967, vol. 5, pp. 538-541; Theodore Herzl, Altneuland (Berlin and Vienna, B. Harz, 1902), tr. as Old-New Land by Lolla Levensohn (New York, Bloch Publishing Company, 1941); and cf. Joseph Wenkert, "The Water Works in Altneuland", Herzl Year Book, vol. 3, pp. 243-255.

geographers and scholars such as Ibn Battuta and Ibn Khaldun clearly document the native achievements of a thousand years ago. 2/

Interplay of natural ecology and national culture

As between the underlying historical or cultural and the geographical or ecological factors in these six countries, it would seem that culture as reflected in recent national history as well as in the longer-range accumulation of national experience offers more of an explanatory understanding of developmental achievement in the field of water administration than the ecological or natural endowment of the national water resource itself.

It is of course possible to invert this argument and say that the natural deficiency of the national water resource was the originating and is a lasting factor. This view, though still widely challenged, would in effect convert the geographical into a historical explanation. Should it prove to be valid, it would accord with the still accepted theory that the environmental and ecological challenge has always constituted a decisive cultural and historical impulse, a theory now rewinning support as a causal explanation for our more effectually administered resource systems.

Nevertheless, categories like history and geography are so broad that they often defy application to the discrete problems of presently developing societies. Under contemporary conditions of technological development on a global scale, geographical pressures and historical forces begin to merge. Ever on the alert for comparative knowledge and applicable experience relative to the successful management of their water resources, developing nations are more capable than ever before of making the most of their cultural heritage and indigenous resources. To this end, comparative and internationally available lessons of resource technology and administrative experience are becoming increasingly available and transmissible. Because of its catalytic or modellistic role in relation to the wider socio-economic infrastructure, national water administration may become something of a pace-setter for resources administration more generally as well as for the over-all process of administrative modernization in developing countries.

2/ The Travels of Ibn Battuta (2 vols., Cambridge University Press, 1950, 1963), ed. by C. Defremery and B. R. Sanguinetti, tr. by H. A. R. Gibb; and Ibn Khaldun, The Muquaddimah: An Introduction to History, tr. by Franz Rosenthal (3 vols., Princeton University Press, 1958).

Annex I

TOPICAL OUTLINE FOR THE NATIONAL SURVEYS

The prescribed scope of information upon which this comparative survey is based is indicated in the following topical outline:

A. Role of the water resource

1. Water in relation to national development
2. Water resources in relation to agriculture and industry
3. Geographical and historical pre-conditions

B. Water supply and utilization

1. Current supplies and water uses
2. Unfulfilled needs for water, quantitative and qualitative
3. National, international and regional balances and imbalances

C. Legal foundations

1. Water ownership and water stewardship
2. Private water rights and public responsibilities
3. Regulation of water and the adjudication of water rights

D. National and subnational jurisdiction

1. National powers, functions and services
2. Regional powers, functions and services
3. Local community powers, functions and services

E. The organizational and operational framework

1. The machinery for policy formulation and administration
2. Single-purpose and multipurpose administration
3. Exercise of the co-ordinating function

F. The planning function

1. The apparatus for planning
2. Water planning and development planning
3. The planning process and the research function

G. Fiscal administration

1. Investment in water facilities
2. Funding and vending
3. Budgeting and accounting

H. Expert administration and citizen participation

1. Manpower and skills
2. Training and education
3. The role of water users

I. Conclusions and recommendations

1. Achievements and deficiencies
2. Check-list of recommendations
3. Current priorities

Annex II

A FRAMEWORK FOR COMPARATIVE NATIONAL STATISTICS

The following list is presented for the future collection and refinement of internationally comparative statistics concerning national water systems, subject to further extension and elaboration as a basic tabular framework:

1. Population
2. Area
3. Per capita national income
4. Precipitation
5. Total volume of water resources a/
6. Percentage of developed water resources b/
7. Per capita investment in water resources development
8. Per capita annual expenditures for water administration
9. Personnel engaged in water administration

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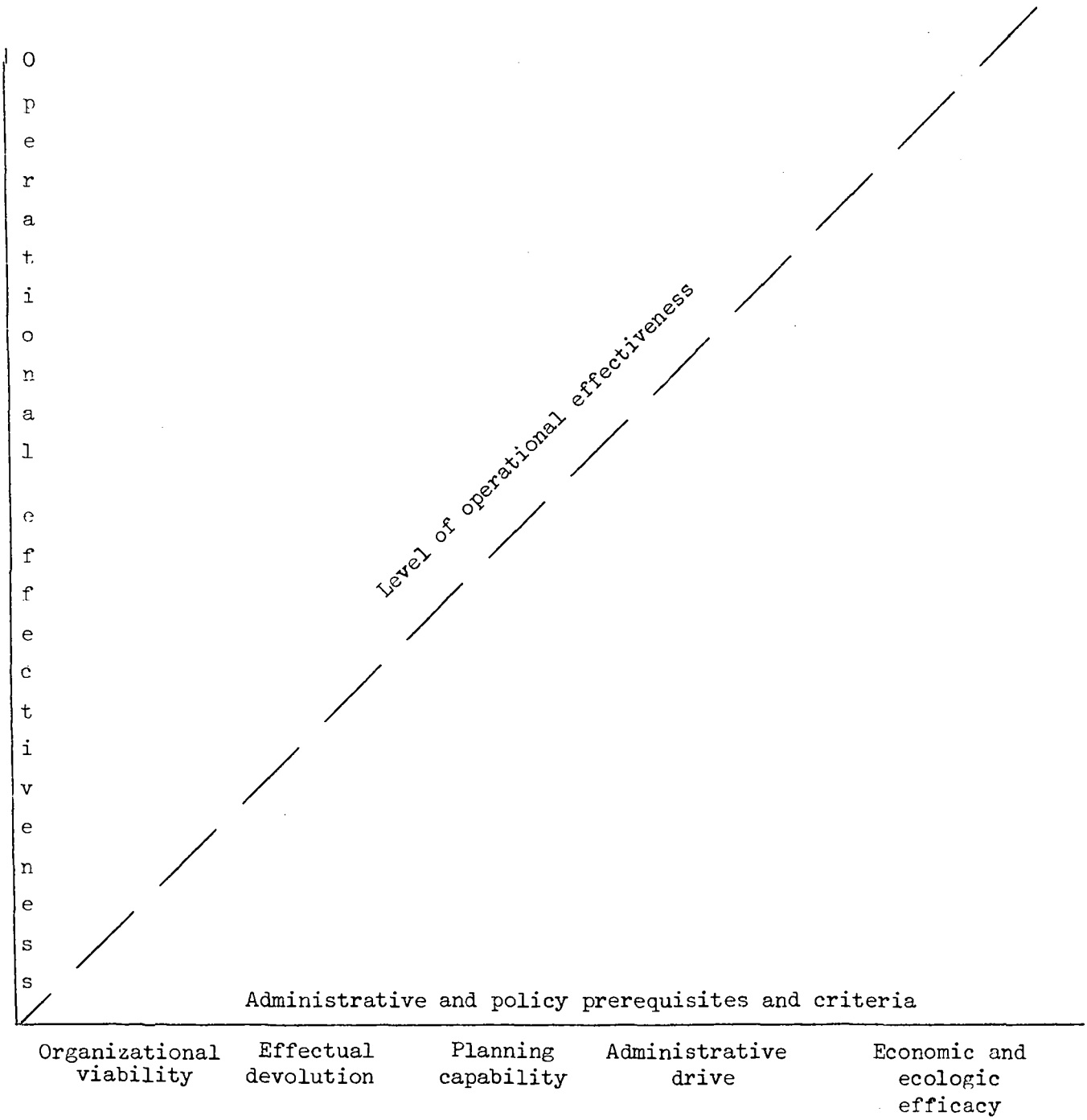
a/ Relevant factors, in addition to precipitation, might include river inflow and outflow, ground waters and, to be comparatively useful, a national aridity factor would have to be applied.

b/ To be characterized by comparative developmental indices, such as total annual amount of water withdrawn from rivers and ground waters, number and total capacity of storage reservoirs, total length of flood protection levees, number and total capacity of hydropower plants, number and total capacity of plants rechanging ground-water aquifers, types, number and total capacity of water-quality treatment plants and so on.

Annex III

CRITERIA OR PREREQUISITES OF OPERATIONAL EFFECTIVENESS
OF NATIONAL WATER SYSTEMS

The following is a conceptualized chart of the possible relationship between general operational effectiveness and specific criteria or prerequisites therefor:



Part Two

COUNTRY STUDIES

WATER RESOURCES ADMINISTRATION IN HUNGARY

I. Z. Balló and K. Szesztay*

ROLE OF THE WATER RESOURCE

Water in relation to national development

Construction of large-scale flood control and drainage systems in the eighteenth and nineteenth centuries was one of the first steps towards general economic development in Hungary. The middle of the nineteenth century was a turning point, when industrialization began and the age-old extensive system of agriculture changed to a more intensive one. In the present century, the two decades following the Second World War brought about basic changes in national development. The state-owned socialist sector became predominant in industry, commerce and banking, with the rapid development of heavy industry and the establishment of new branches of industry and large-scale management in agriculture through co-operatives and state farms. The need for an integrated and uniform water resources administration was recognized early in this period. It was brought about in a succession of steps as follows:

(a) Nationalization of the water resources administration (1948);

(b) Establishment of the National Water Authority under direct government supervision (1953);

(c) Working out of national and regional water plans and their approval by the Government (1952-1954 and 1964-1965);

(d) Codification of the new Water Act (1964);

(e) Establishment in 1968 of a new economic system (basically to increase indirect economic control and give more autonomy to regional and local economic units), whereby water resources administration became one of the nine branches of the national economy (the others are: heavy industry, metallurgy and machine industry; light industry; transportation, post and telecommunications; construction; agriculture, forestry and the food industry; internal trade; and external trade).

Geographical background

Hungary lies in the central part of the Danube Basin and is surrounded by the Carpatian Mountains. About 30 per cent of the total area of 93,000 km^2 is occupied by hills and mountains of between 200 and 1,000 m altitude, where precipitation

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varies between 600 and 800 mm and either equals or slightly exceeds potential evapotranspiration. The remaining 70 per cent of the country is flat lowland of between 70 and 200 m altitude, with a normal annual precipitation of 500 to 600 mm, which is considerably less than potential evapotranspiration.

There is a well-marked seasonal variation in potential evapotranspiration (roughly 90 per cent of the annual amount occurs between the middle of March and the middle of October), and this results in a regular yearly cycle in the water régime. The natural water balance of the "winter" half year is characterized by a surplus of 130 to 200 mm, whereas a deficiency of 150 to 320 mm occurs in the "summer" half year. In extremely dry or wet years, these average values may be doubled or even tripled, which is why both drainage and irrigation are of vital importance for agricultural development.

The usual snow-melt periods (end of February and March in the lowland, April and May in the Carpatian and Alpine regions of the Danube and Tisza basins) determine the "regular" floods, but heavy summer storms or intense snow melt may cause exceptionally high floods in any month of the year.

Situated as it is in the central part of the Carpatian Basin, all the major rivers originate outside Hungary, the total value of minimum river discharge from outside being some 2,200 m^3/sec (see figure I). The corresponding discharge originating from precipitation falling within the country is only 20 m^3/sec, i.e., one hundred times less, a fact which indicates that the basic water problems of this region (pollution and flood control, utilization of surface water resources) can be solved only through the close bilateral and multilateral co-operation of the countries concerned.

Given the natural resources of the country in general, the following conclusions may be drawn. Natural conditions are outstandingly favourable for agricultural production. Large parts of the lowland and hilly regions are covered by good chernozem and lithomorph forest soils. The local climate (due to the vicinity of water surfaces and high sunshine values) frequently offers particularly favourable conditions for raising grapes and other fruits. Supplementary irrigation, however, is necessary in most regions to increase reliability and yield. Mineral, metal, fuel and forest resources are in general below the global average level. Hence, industrialization is to a considerable extent based on importation of raw materials and energy. Lake Balaton (the largest lake in central Europe) and several other lowland lakes, as well as many mineral and thermal springs, offer good possibilities for recreational and health resort development.

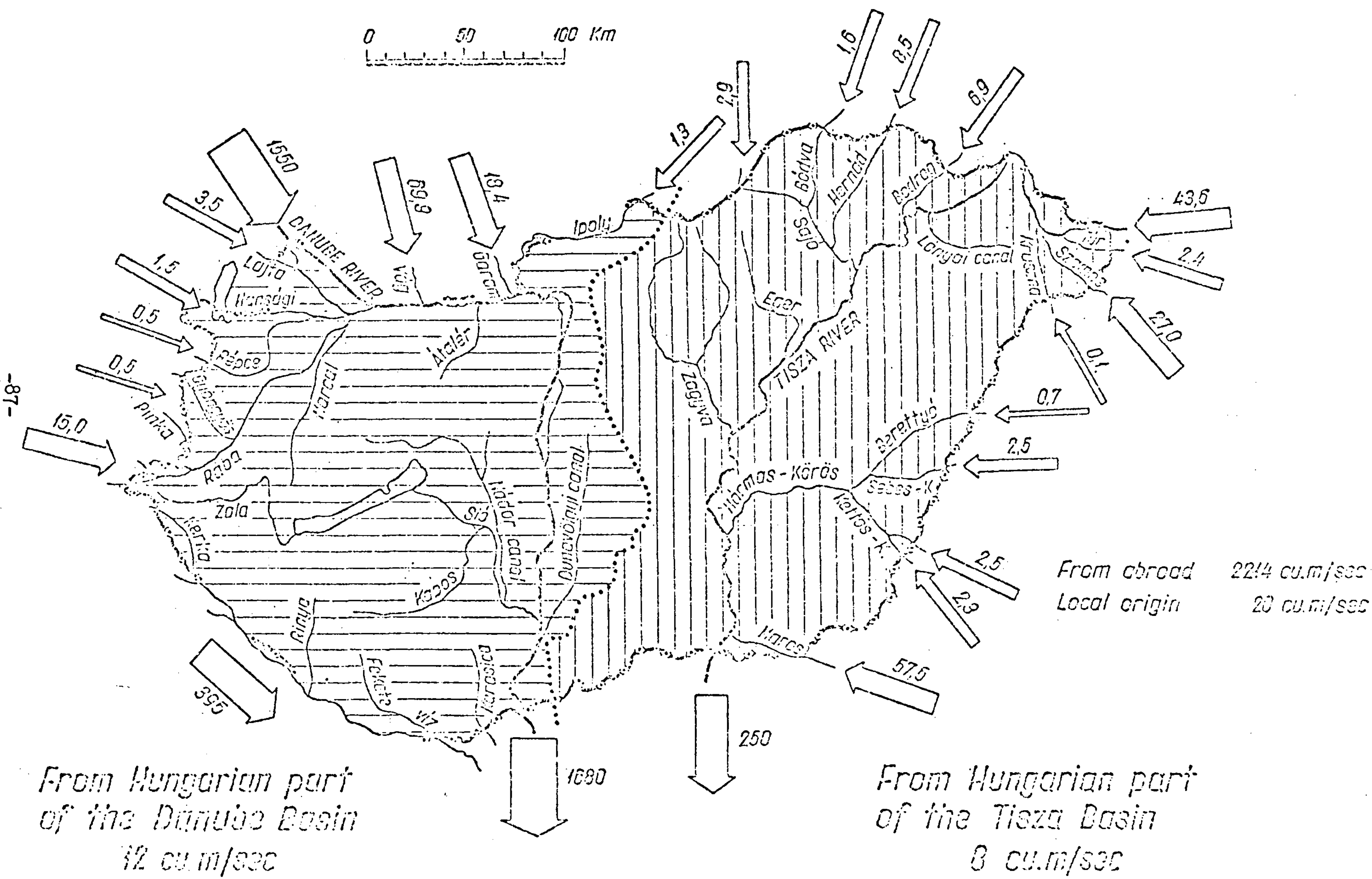
WATER SUPPLY AND UTILIZATION

Current supplies and water uses

Surface waters

In Hungary, as in many other countries, the natural hydrological régime is in the process of being transformed into artificially controlled water resources systems. Natural river systems cover only the mountainous and hilly regions. The

Figure I


0 50 100 Km
1550
3,5
1,5
0,5
0,5
15,0
69,9
13,4
1,3
2,9
1,6
0,5
6,9
43,6
2,4
27,0
0,1
0,7
2,5
2,5
2,3
57,5
395
1680
250
DANUBE RIVER
Lajta
Hanság
Rábca
Répce
Pinka
Rába
Zala
Marcal
Átalér
Vág
Garam
Ipoly
Sió
Kapos
Rinya
Fekete víz
Dunavölgyi canal
Zagyva
Eger
TISZA RIVER
Bódva
Sajó
Hernád
Bodrog
Lonyai canal
Tur
Szamos
Berettyó
Hármas-Körös
Sebes-K.
Kettős-K.
Maros
From abroad 2214 cu.m/sec
Local origin 20 cu.m/sec
From Hungarian part of the Danube Basin 12 cu.m/sec
From Hungarian part of the Tisza Basin 8 cu.m/sec

Great Hungarian Plain is drained by artificial canal systems with a total length of some 30,000 km. The total length of the 26 principal rivers within Hungary is roughly 3,500 km, and there are some 2,500 small watercourses with a combined length of about 18,000 km. As discharge data indicate, more than 90 per cent of the surface water resources are concentrated in the Danube, Tisza and Drava rivers.

A comprehensive survey of the hilly and mountainous parts of Hungary has identified more than 200 possible sites where small reservoirs (with storage capacities of between 2 and 10 million m^3) could be established. About 30 storage reservoirs have been constructed thus far in Hungary, and their number is growing from year to year.

Ground water

More than two thirds of Hungary is covered by sedimentary layers varying from a few hundred to 2,500 or 3,000 m in thickness, which store some 600 km^3 of water. About 15 to 20 per cent of the annual precipitation reaches ground-water aquifers by infiltration, and over the total area of the country (93,000 km^2, approximately) this infiltration corresponds to a natural ground-water recharge of 10,000 million m^3/year, i.e., 320 m^3/sec. According to present estimates, about 40 per cent of the natural recharge (or 132 m^3/sec) may be considered a utilizable resource (40 m^3/ sec from shallow ground waters, 12 from karst areas, and 80 from deep aquifers), while the remaining 60 per cent is returned to the atmosphere by evapotranspiration.

Water quality

A comprehensive review identifies four principal sources of pollution:

(a) Domestic sewage. An average of 0.62 billion m^3 of domestic sewage reaches the rivers every year, and only about 35 per cent is properly treated;

(b) Industrial wastes. A similar amount (0.57 billion m^3 per year on the average) of industrial wastes probably represents the greatest danger for the present because of the great variety and changeability of chemical pollutants and lack of treatment (again only about 30 per cent is properly treated);

(c) Pesticides, fertilizer and other chemicals applied in agriculture. These are rapidly increasing in use and may become dominant water pollutants in future if reasonable pollution control methods are not applied. The replacement of DDT by less harmful chemicals in recent years is only a first step in this direction;

(d) Pollutants from outside the country. Rivers entering Hungary from abroad (e.g. the Sajo, Bodrog and Maros) carry considerable amounts of industrial and municipal wastes and need improved pollution control particularly in low-water periods.

The quality of shallow ground waters was surveyed and mapped on a nationwide scale by the Water Resources Research Institute. In comparison with surface waters, pollution is generally less significant at this time in ground waters and is controlled mainly by the properties of the aquifers and overlying layers.

Water uses

Both consumptive and non-consumptive water uses have increased rapidly within the past two decades, the highest rate of increase being shown by the two principal water uses - irrigational and industrial.

Domestic water supply and sewerage

At the present time, about 55 per cent of the total population receives drinking and domestic water supply from public water works. Among cities and towns 84 per cent are thus supplied, whereas only 30 per cent of villages are supplied from public waterworks, although considerable efforts were made during the past decade to minimize the discrepancy between urban and rural areas. Average daily per capita water consumption is about 100 l for the country as a whole and 130 l in Budapest. Roughly 90 per cent of drinking and domestic water supply comes from ground water, although the contribution of surface waters has increased in recent years. For the country as a whole at the present time, domestic water supply amounts to 0.7 thousand million m^3/year, representing about 13 per cent of the total water supply (domestic, agricultural and industrial). Only 28 per cent of the total population has public sewerage systems. Through thepublic sewerage systems roughly 1.7 million m^3 of sewage waters pass per day over the long-term average, and as noted above, only about 35 per cent of this is properly treated.

Agricultural water supply and drainage

The increasing discrepancy between the areas installed and effectively irrigated may be explained to some extent by the precipitation régime of recent years, but it derives mainly from the failure of other factors (e.g. trained manpower, fertilizer and proper maintenance of the installations) to raise the level of agricultural production. According to recent economic evaluations, irrigation is economically feasible only if the production from 1 hectare by 1 mm of water surplus corresponds to 10 to 12 kg of wheat equivalent, a criterion which can be most conveniently fulfilled at present in the case of fruits and vegetables. For the country as a whole, irrigation water supply amounts to 1.7 thousand million m^3 per year and represents 29 per cent of the total.

Fisheries

The surface area of installed fisheries is now about 30,000 ha (hectares) with a water requirement of 0.6 thousand million m^3 per year (0.4 thousand million for filling the ponds in early spring, and 0.2 thousand million for replenishing evaporation losses during summer). Owing to lack of manpower (and automation), only about 80 per cent of the installed fisheries are actually in production. Their economic effectiveness is also hindered by delays in investment for storage and transportation of the fish.

Flood control and drainage

Roughly one third of the country's agricultural lands and half of its population are located within the flood plain, protected from regular inundations by a levee system more than 4,000 km long. Earlier in the century, the levee system considerably reduced flood damage, but owing to increased use of the flood plain and

changes in the flood régime, damages have tended to rise during the past three decades. Drainage systems cover some 40,000 km^2 of the lowlands, and 80 per cent of this area is under cultivation. Recent economic evaluations indicate that the total damage prevented by the drainage systems has amounted to about 330 to 410 million Ft (forints) yearly for the past 20 years, whereas the annual cost of the works during the same period has amounted to between 160 and 200 million Ft.

Industrial water supply

Total industrial water supply at present amounts to 5.2 thousand million m^3 a year, of which about 2.3 thousand million is virgin water withdrawn directly from surface (86 per cent) or underground (14 per cent) sources, and 2.9 thousand million is derived from repeat use (recirculation or multiple use). Power-plant cooling takes 84 per cent of the total supply, followed by metallurgy and the chemical, sugar and paper industries. Around 91 per cent of the virgin water supply is produced by the users' own supply systems, 7 per cent (a relatively high amount) is taken from municipal systems, and 2 per cent is supplied by public industrial water works. One of the most important tasks for the future will be to take all possible measures (technological and economic) to increase the ratio of re-use.

Minor water uses

Hungary's topography is favourable for the development of inland navigation through extension and interconnexion of the Danube and Tisza rivers, and for ocean-going navigation through the Danube-Black Sea route or the planned Danube-Main-Rhine canal. Present navigable waterways total some 1,600 km, and among them only the Danube has a traffic of any considerable importance (more than 14 million tons a year).

Hydropower production has and will have a minor role in the country's energy supply (some 2 per cent of the total). However, hydropower plants become relatively more important during periods of maximum consumption because of their flexible operational régime and their potential for peak production through reverse operation and hydraulic storage.

Hungary has a long tradition in the use of thermal and medicinal waters, but this could be greatly expanded. The 20 thermal spas with a national and international clientele and the 40 thermal spas of regional significance (with a total visitor attendance of some 40,000 a year) utilize only about one-fifth of the potential resources. Within the past decade thermal waters have begun to be used in agriculture (e.g. at Harkany and Czerkeszollo).

Particular problems of water supply and utilization

The vital importance of international co-operation has already been noted. Large investments are required to maintain a balance between demand and utilizable water resources in the eastern half of Hungary. Within smaller regions, imbalances have existed for a long time (e.g., in the basins of the Sajo, Körös, Gaja and Sed rivers). This gives particular emphasis to the conservation and most efficacious use of available supplies. Re-use of water in industry, for example, usually requires additional treatment and pumpage; hence economic and legal measures are required to promote it and, while a good beginning has been made, the large-scale

extension of repeat use is one of the most important tasks of current water policy. From the two alternatives (recirculation and multiple use), the former has the great advantage of concentrating all charges and benefits in one user. In a broader sense, the alternative of substituting other materials or other technological solutions for water should be mentioned here. The system of air-cooling power plants (developed by Mr. Heller) is a good example of such possibilities.

As a legacy of earlier years, when demand for domestic supply of good quality was not as great as it is now, some 7 per cent of the country's industrial water supply is still met by waters of excellent quality (e.g., karst waters). This represents about 40 per cent of the country's total municipal water supply. Such situations occur even where there is a serious problem with providing drinking water.

Economy in use is particularly relevant to irrigation. Irrigation norms do not properly take into account regional differences in climate and year-to-year variations in demand. This results in over-irrigation, with consequent rising ground-water tables and secondary soil salinization in certain areas (especially in the south-east, where rice fields have not been managed well).

Pollution control is also an important part of measures to protect or increase utilizable water resources. This was recognized and expressed in the establishment in 1967 of a special Water Quality Control Centre. One of the first tasks of the Centre is the creation of a special network of water-quality monitoring stations with adequate instrumentation and telemetering systems.

LEGAL FOUNDATIONS

Water law in Hungary is basically governed by the Water Act of 1964, which is the outcome of a codification process that began in the mid-1950s in certain branches of the Hungarian administration. It was preceded by a uniform water administration, gradually developed in the course of 15 years, and also by certain statutes of more limited scope regulating particular fields of water activity which had in a piecemeal way replaced former statutory provisions. Navigation fisheries, the use of mineral and medicinal waters, and geological activity, for example, are regulated by special statutory provisions in harmony with the Water Act. Water licences effective at the time of its enactment were maintained if they complied with its provisions; otherwise, they were revised within a three-year period following enactment, so that at present the regulation of all water uses in Hungary is in compliance with the Act.

Ownership and stewardship of waters

The Hungarian Constitution of 1949 proclaimed state ownership of waters in trust for the people, and this is reiterated and expounded in the 1964 Water Act. Rivers, permanent and temporary watercourses, canals for public purposes, natural lakes and the beds of all the foregoing, as well as abandoned river beds and newly formed islands, are state property. State ownership does not mean that the state has the exclusive utilization of waters; on the contrary, this is a safeguard to secure to everybody his share of water in accordance with the public interest, and it is also the basis of an organized defence against damage caused by waters.

The regulation of major waters and the construction and maintenance of major works, as well as their protection against damage from waters, are state tasks financed from state funds and are the duty of the water administration established for the purpose. The regulation of waters of local interest and the construction and maintenance of works thereon are state tasks, too, but these are performed partly by local organs of general administration and partly by water management associations formed on a voluntary basis at the initiation of interested parties. Though they are subsidized by the State, these associations charge most of their expenses to the parties enjoying the immediate benefits of water management.

Private water rights and public responsibilities

The Act of 1964 recognizes that water is a natural resource of limited availability, subject to a planned economy for the sake of society. It prescribes that, having regard to the protection of the quantity and quality of water resources, demands should be based only upon justifiable needs and should be satisfied according to their rank in importance within the national economy. Rights carry with them concomitant obligations. Water supply must be economized, and uses that pollute may be established and operated only if adequate treatment facilities are simultaneously installed. Plants that pollute are subject to the payment of fines, but such civil penalties do not exempt them from responsibility under the penal law and do not affect their obligation to treat their waters.

Owners (tenants and users) of river banks and of real estate adjacent to hydraulic installations may not interfere with the lawful use of waterworks and natural watercourses crossing or bordering on their property. The law also restricts the ways in which flood control works and flood channels may be utilized, so as to protect and keep them in a state of readiness, and the Penal Code contains penalties for injury to or wilful hindrance in the use of water management structures.

Public responsibilities encompass the sphere of activity and functions of the various organs responsible for state water management and the legal relationships between them. This area of the law covers technical problems of water management calling for official regulation (e.g. safety recommendations), direct economic activities (such as investment transactions) and regulations concerning the functions of management and investigation.

Under the heading "Tasks and Planning of Water Management", the 1964 Act makes provision for prospecting for water; producing and distributing water; ensuring an equilibrium between supply and demand; the planned utilization of waters and their conveyance to the consumer; disposal of used waters; protection of water quantity and quality; regulation of flow and protective measures against damage from water; construction, maintenance and operation of waterworks and installations; and the co-ordination of economic, technical, scientific and administrative activities within a planned and uniform framework. It identifies the National Master Plan of Water Management as the basis for uniform water management planning.

Regulation of water and adjudication of water rights

According to the Water Act, a licence is required for the execution of all works concerned with water, for the construction, modification and demolition of hydraulic installations, for their entry into operation and for any use of water.

A licence can be issued only if the works, construction or use fit into the scheme of water management, are not injurious to protection of the quantity and quality of water resources or to any other interests of the national economy, and conform to engineering and safety standards and other official provisions concerning hydraulic constructions and the exercise of water uses. Licences can be modified, suspended or revoked, either at the licencee's request or in the interest of the national economy.

At his own request the interested party is entitled by virtue of the water licence to perform a water management activity, to use water or to avert damage from water through works he has established.

A licence can affect water management relations not only through the licencee himself, but also through the interests of third parties, and the main aspects of this kind of regulation are set out in the Water Code.

The most important provisions concerning third-party interests refer to compensation. The water law provides for the restriction or revocation of existing water licences in favour of subsequently emerging interests of higher importance for water management and for the national economy.

One problem obviously differing from damage arising out of the water-licensed activity of others is that of flood damage. According to general principles of law, flood damage, being a vis major, must be borne by the injured party. Two factors, however, substantially restrict this interpretation. One is that flood control (preventive and operative) is the task of the State, financed from public funds and performed by state organs as far as technical preparedness (and this is constantly growing) and economic feasibility permit. The second is that when flood damage occurs, society hastens to give organized help and substantial financial aid to those who have suffered loss, and they therefore recover some portion of the loss even though they have no legal claim to indemnification.

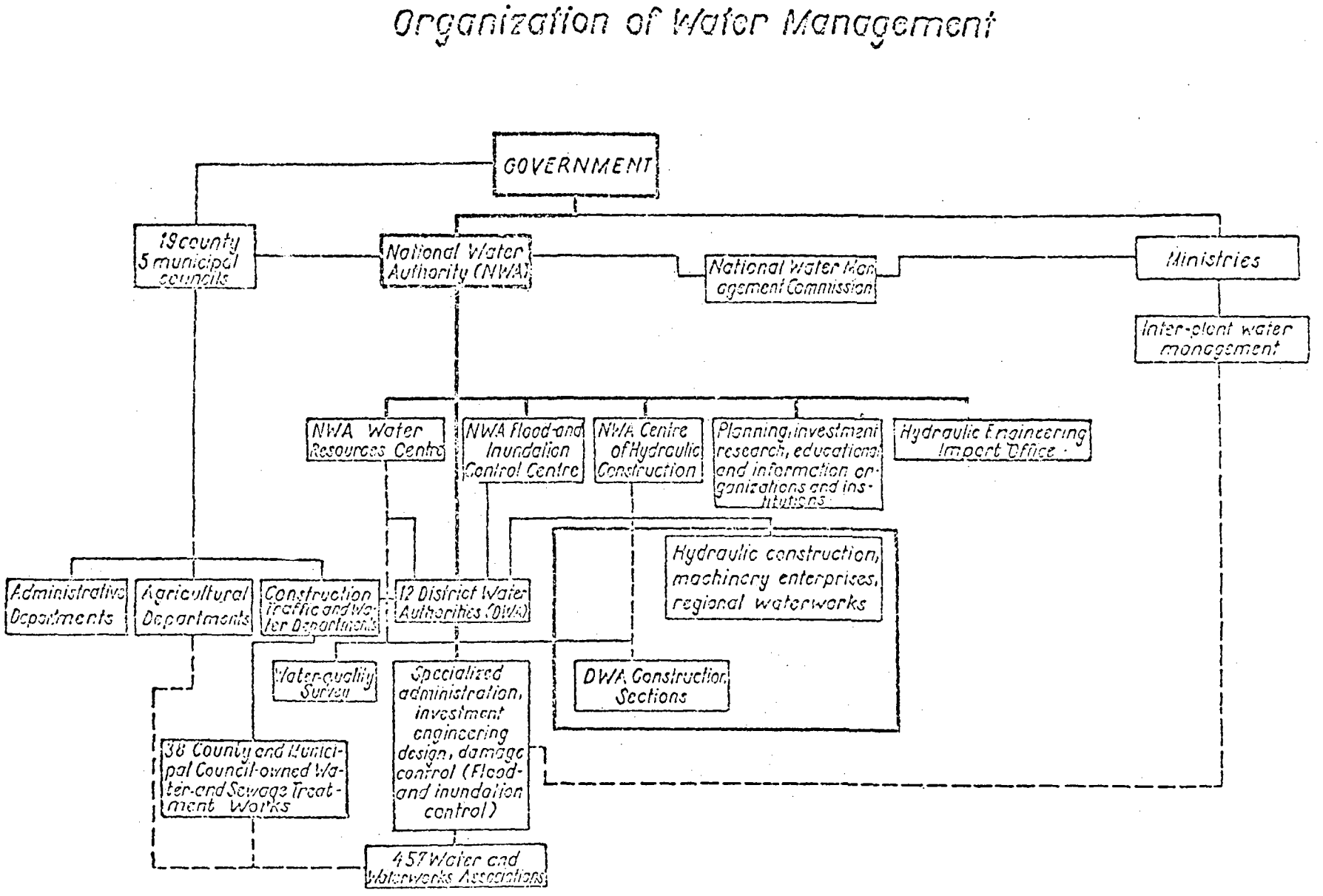
WATER RESOURCES ADMINISTRATION

National water administration provides for the direction of water management activities, centrally in the country as a whole and locally in any given area, regardless of the tasks to be performed. The issuing of water licences and decisions referring to obligations under the water law are referred by the law exclusively to the water authorities.

The water organization of the state comprises not only organs with authority but also state enterprises, engaged in engineering design, contracting and kindred activities, scientific research institutes, and institutions of professional education (see figure II). The executive function is performed by the general administrative organs of the State (councils), partly by the special organs of water administration, and partly by voluntary water management associations of interested parties, each within their designated area of competence and with well-defined spheres of activity.

Water management policy, medium- and long-range planning, the establishment of principles for national water resources management, the distribution of water resources, and the settlement of appeals made under the water law are the

Figure II


Organization of Water Management
GOVERNMENT
19 county 5 municipal councils
National Water Authority (NWA)
National Water Management Commission
Ministries
Inter-plant water management
NWA Water Resources Centre
NWA Flood-and Inundation Control Centre
NWA Centre of Hydraulic Construction
Planning, investment research, educational and information organizations and institutions
Hydraulic Engineering Import Office
Hydraulic construction, machinery enterprises, regional waterworks
Administrative Departments
Agricultural Departments
Construction traffic and Water Departments
12 District Water Authorities (DWA)
Water-quality Survey
Specialized administration, investment engineering design, damage control (Flood- and inundation control)
DWA Construction Sections
38 County and Municipal Council-owned Water-and Sewage Treatment Works
457 Water and Waterworks Associations

responsibility of the central organ, or of the interlevel organs immediately subordinate to it. Areally, water management policy is executed at the second level, by the district water authorities. There is no third-level authority in water administration, though an apparent third level is formed by the autonomous associations. These organizational units have no authority function and cover 87 per cent of the country only: they are created by voluntary union and cease to exist in the same way; therefore, they cannot be regarded as permanent in space or time.

In the course of specialization in water management, progress sometimes overtakes the division of certain activities. Multipurpose and regional waterworks often expand beyond the geographical boundaries of municipal water management tasks. Hence, certain enterprises of an areal and operative character have had to be subordinated directly to the National Water Authority, such as the Borsod, Northern Nograd and Lake Balaton regional waterworks, which operate in several counties.

National powers, functions and services

The National Water Authority is an entity of cabinet rank under the direct supervision of the Government. It has planning, organizational, administrative, co-ordinating, reporting and budgetary responsibilities.

The tasks of the National Water Authority are performed by its departments, the organization, number, operation and sphere of activity of which are determined by its chairman. Interlevel organs directly subordinate to the NWA prepare and execute decisions connected with central tasks of water management in accordance with pre-established goals. These special central organs with a national jurisdiction under NWA supervision are the NWA Water Resources Centre, the NWA Centre of Hydraulic Construction Industry and the NWA Flood Protection Centre.

Among its planning activities, the NWA Water Resources Centre performs central operational tasks in multipurpose long-range planning, analyses hydro-economic problems and proposals for the development of control devices in the economy and prepares certain administrative problems for decisions to be made at a higher level. It organizes publicity for water pollution control and directs areal water pollution control services and the work performed by pollution control committees. It performs tasks of a quasi-authority character through its subordinate organs, the Water Pollution Control Service and the Hydrogeological Service.

The NWA Centre of Hydraulic Construction guides construction activity and related operative functions at a national level. The NWA Flood Protection Centre is a central safety organ highly prepared for emergency tasks. Its duties include flood preventive action, permanent supervision of defence works, maintaining the professional skills of flood protection organizations at a high level, as well as the performance of highly specialized activities such as telecommunications, ice-breaking, blasting and diving, and the operation of the NWA Air Service. In time of emergency, it sends its specialized units to gravely threatened points at the request of the local head of flood protection or upon instructions from above.

Centralization was a continuous process determined by the character of water management and by the requirements of individual river systems. On the other hand, the multiplication of problems and their close relationship with natural conditions called for a decentralization of operational activity. The need for reorganization

was early recognized by specialists, but put into practice only after serious trouble had occurred - e.g. the uniform administration of whole river basins was not decided upon until after the disastrous 1940-1942 floods. Individual branches of water management did not develop uniformly, but rather in accordance with the shifting importance of problems thought to be most urgent at the time. Today it is obvious that water management policy can be developed only by central direction, and its execution can be entrusted only to an organization decentralized according to natural units (river basins) yet uniform as to the interrelationship of its branches.

Regional powers, functions and services

A substantial part of operative, administrative and production tasks of the water organization is performed by the 12 regional administrative organs, the district water authorities. From the point of view of traditional state administration, these are rather peculiar organs. Their areas of jurisdiction coincide at least theoretically with watersheds rather than with the boundaries of the civil administration. They are authorities of first instance in water administration, and their sphere of activity includes other tasks related to water management (engineering, design, construction, operation and maintenance). The district authorities also deal with the medium-range (five-year) planning and exploitation of centrally allocated local water resources and the prevention of water damage, coupled with technical and economic development, the development and maintenance of fixed assets and the preparation of budget proposals for the above items. The relative importance of special branches varies according to local circumstances. For instance, in the Upper and Lower Danube Valley, the water authorities' main concerns are flood control and the maintenance of the navigable channel, whereas industrial water problems are uppermost in the Central Danube Valley and irrigation problems in the Central Tisza and Trans-Tisza Region.

District water authorities are of equal rank with and independent from organs of local government (counties). Although the areal division of water administration hypothetically reflects watershed limits, in practice the boundaries of subunits of water resources management approximate those of the lowest-ranking civil administrative units, the villages. Nevertheless, water management is adjusted to river systems. The district water authorities are not simply provincial offices of a central management, but also masters of the water resources allocated to them and of a multipurpose regional management. Water resources have been allocated both according to regional units of water management and to county areas. Allocation by counties is unnatural but inevitable as long as the present administrative constraints continue to exist.

County councils perform certain water management tasks under the supervision of the NWA, with the professional assistance of the district water authorities. Tasks thus transferred to the public administration include: municipal water supply, sewerage, sewage treatment, surface drainage and flood control (carried out in accordance with standards of the central water management and from centrally allocated resources); construction, maintenance and operation of public baths; exploration and exploitation of thermal waters; operation, construction and maintenance of small watercourses and local water projects which have been transferred to the stewardship of a council; and direct supervision of the 38 council-owned water and sewage works (under NWA supervision).

Local community powers, functions and services

There are 457 state-subsidized autonomous water management associations working outside the framework of national administration, supervised by the NWA and local district water authorities. These associations were formed to perform public works of local interest through the common efforts and financial contributions of the interested parties. They are represented by 12 district panels and a central panel of water management associations. They may be distinguished according to their principal functions - water control, soil conservancy, irrigation, and water supply and sewerage. Although they have been in existence hardly more than 10 years, they have achieved remarkable results in raising community services in the villages.

Organs belonging to other ministries also perform water management activities (e.g. withdrawal of water, sewage treatment, prevention of water damage - all within the plant premises). Where water thus withdrawn is partly released by one organ to another, such ancillary activities form a component part of the water branch. The NWA exercises supervision through the reporting system of plant water management.

Co-ordinating functions

The aims of water management policy are co-ordinated at the highest governmental level with those of other sectors and branches of the national economy by the National Planning Board, which has a permanent character and deals with general problems. The co-ordination of water management development plans playing a crucial part in the national economy is the task of the National Water Management Commission, composed of representatives of the ministries involved and headed by the President of the National Water Authority. The Commission is permanent and is convened when necessary, upon the President's initiative, to formulate principles and make the necessary decisions concerning developments affecting several ministries.

The progress made in co-ordinating branches of the national economy, particularly with regard to location of means of production and to regional macro-economic development, has not so far been attained in water management. This is mostly due to the fact that the multipurpose science of macro-economics is still in its infancy, to the unsatisfactory development of methods, to the lack of sufficient evidence concerning the basic importance of water management as the organizing force in regional economy, and to the failure on the part of key decision-making organs to fully appreciate that importance.

At a regional level, co-ordinating functions are performed by the water management divisions of the district water authorities, based upon their allotted water resources and the guidelines issued by the NWA. The activity of council organs in charge of water affairs is professionally directed and supervised by the NWA, but as the councils grow more independent, this supervision becomes rather an advisory function, and eventually the water management policy of the councils will be shifted to the field of financial co-ordination.

The co-ordination of scientific research and higher education on a national level is the task of the Hungarian Academy of Sciences, on various committees of which the NWA is represented. Within the water branch, co-ordination of research and educational units is carried out by the NWA.

The duality of water management functions is a legacy of the traditional administrative (county) system, and most co-ordinating difficulties result from the lack of a workable chain of command. A similar duality exists with units of the organization whose activity pertains primarily to other branches of the national economy. These are under the double obligation of reporting to the water branch and to the other branch involved, which in its turn exercises a certain supervision over them.

Organized and permanent co-ordination has proved successful and is ensured by those provisions of the Water Act referring to the centralized management of water quality and quantity. The work done by the permanent co-ordinating committees is also substantial and satisfactory, but where the performance of tasks is a matter of interpersonal links, its efficiency depends very much upon personal contacts, owing to disproportions between spheres of authority, means and tasks.

THE PLANNING FUNCTION

Water management planning is proportional to national economic planning, on the principle that the national economy should be so structured as to achieve lasting harmony between the main processes of production. Planning requirements are met by long-, medium- and short-range plans, fitting into the national planning system.

In accordance with the fundamental character of water management, its prognostic investigations are extended 80 to 100 years ahead, and in the case of certain components, even further.

Planning within the branches is carried out on two levels. Development concepts - with regard to their economic and technical features and to their relations with other branches - are worked out by the branch ministries (or authorities of equal rank) in several alternative solutions. Proposed drafts of plans are compiled by the National Planning Board and approved by the Council of Ministers. The medium-range five-year plans are submitted by the National Planning Board to Parliament.

Apparatus for planning

The National Planning Board is Hungary's central planning organ. Its task is to maintain a due proportion between the National Water Authority's development plans and other branch plans of the national economy, as well as between demand and economic feasibility. In the case of topics requiring special technical development and knowledge, it is assisted by the National Commission of Technical Development (NCTD), which at ministerial level participates on an equal footing with the National Planning Board in working out long-range development concepts. If necessary, the NCTD not only employs its own staff, but sets up *ad hoc* committees through which it can tap the special knowledge of organs and experts of any economic branch.

A uniform and centralized water management planning is realized through the National Master Plan for Water Management and the Regional Water Management Key Plans. The planning work of the water management branch, whether long- or

short-range, is usually performed by its own organs, always in consultation with and considering the interests of economic branches having related interests.

Investigations and the formulation of projects in connexion with major water management activities are usually made by the NWA Water Resources Centre. The formulation of projects consists in identifying technically and economically feasible alternatives, comparing and characterizing them by index numbers, and submitting recommendations for the alternative or alternatives selected. Although on a national scale this is the task of the NWA Water Resources Centre, it is often done in collaboration with the National Planning Board and the National Commission of Technical Development.

The control and criticism of projects is done on a national scale through collaboration of the relevant NWA branch units, and on a local scale by the head of the district water authority concerned. Actual decision-making falls to the NWA for plans of national importance, with the National Water Management Commission intervening in some exceptional cases, and to the district water authorities for local plans.

Once the planning goal has been determined, the design units of the water management branch and other branches are available to carry out engineering design. The central design organ in water management is the Institute for Hydraulic Planning, and there are design units within each district water authority. They not only serve other organs of water management but, to the extent of their capacity, are accessible also to any customer.

Water management and development planning

The 27-volume National Master Plan of Water Management, which was enacted by legislation, together with the regional key plans of water management, aimed to establish what was then technically feasible without endeavouring to conduct a more detailed investigation into the economic aspects of demand or to establish their timeliness or priorities.

The national master plan deals with water management's role in the national economy and that of its branches, development goals, and international relations in water management. The 13 regional key plans are identical in structure to the national plan and deal with the situation, principles and aims of water management in the individual river basins.

Functions of the national master plan are to identify regions for the location of production according to whether this is favourable or unfavourable from the point of view of water management; to clarify relations between the various water management branches and harmonize them to serve as a point of departure for more detailed multipurpose regional plans; to aid in appraising the effects of investment upon water management; to afford the possibility of procuring land for storage projects and other projects with large space requirements, including, if necessary, previous bans on building; and to render assistance in technical and economic planning in various fields.

The national master plan and the regional key plans are primarily of an engineering character and have no specified time limits. They incorporate economic factors only in broad outline and aim at no more than a co-ordination of the main

goals. In the 15-year development plan, engineering-technological and economic analyses are of equal weight, and goals are determined by comparison of those two kinds of analysis.

The planning process and the research function

Hungary has a long and great tradition in the collection of data, both with regard to engineering hydrology and general statistics. The Research Institute for Water Resources Development and its predecessors have been issuing daily hydrological maps through the National River Forecasting Service since 1895, and the river stages of the more important waterways are broadcast daily. The Hydrological Yearbook contains daily data on 305 surface-water gauging stations, as well as ground-water observations on a network of 1,012 wells. It has appeared annually since 1887, and the first volume published data going as far back as 1876. Thus, for engineering hydrology purposes, the data series extends over 93 years and, in certain exceptional cases, for more than a hundred years. Other annual publications include the Water Resources Management Yearbook, published since 1962, and the Annual Report of the Research Institute for Water Resources Development, which began publication in 1952.

FISCAL ADMINISTRATION

The principal features of the fiscal administration of water management and development derive from Hungary's socialist economic structure and especially from the economic system introduced in January 1968.

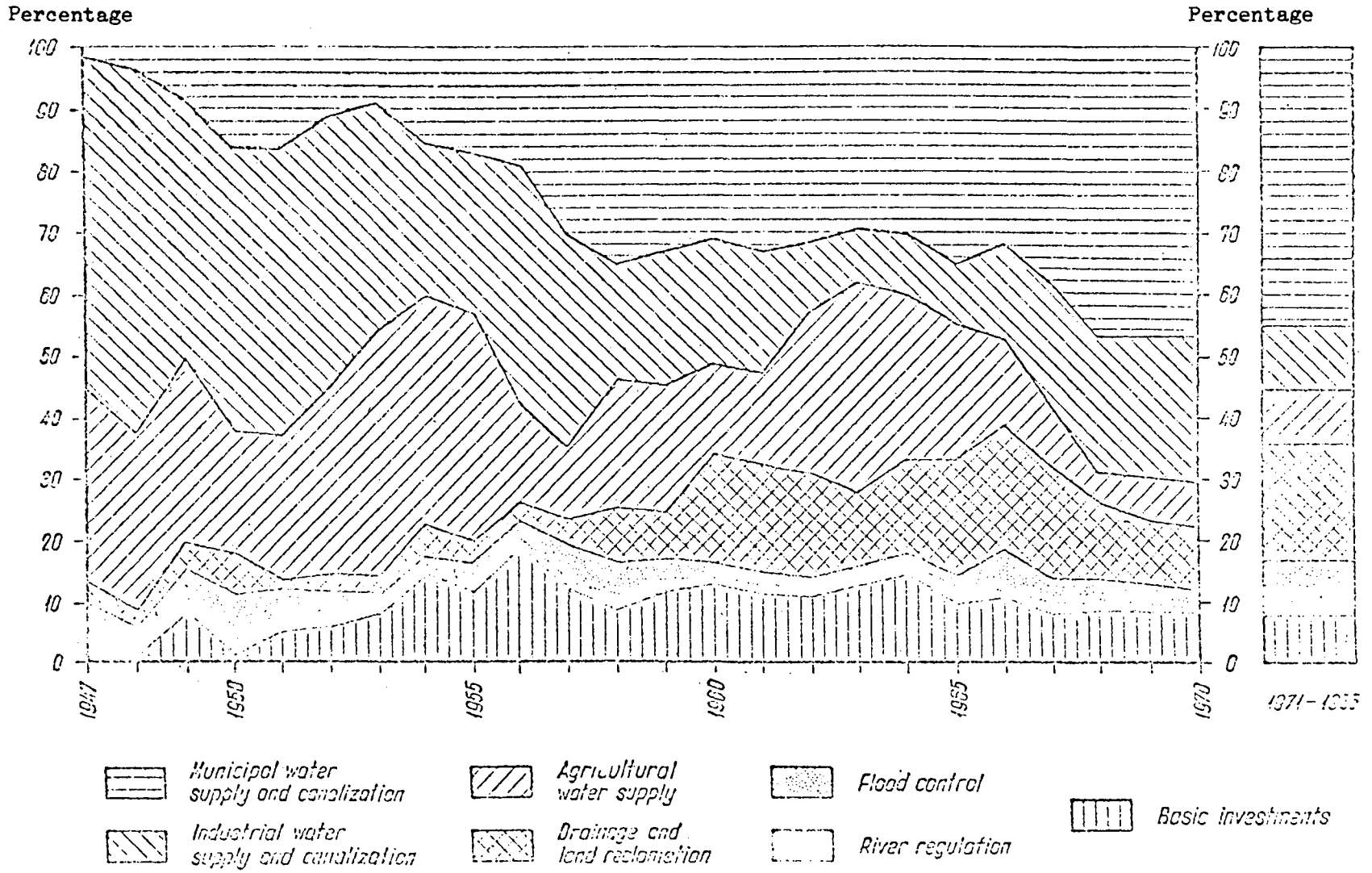
Financing is highly centralized. Infrastructural water management development is financed exclusively from central funds, managed centrally for projects and operations of national importance and by a decentralized administration for local, municipal schemes. Authorities receive their funds from the state budget, and enterprises work on a profit basis, but there are also mixed forms. Multipurpose projects are funded from appropriations for several branches of the national economy. Non-governmental organs raise funds for their own purposes by their own efforts, with a state subsidy if necessary. Danube Commission funds are raised by multilateral agreement of the member States, while operational funds of the bilateral Upper Danube Directorate are covered from Czechoslovak and Hungarian resources.

Investment in water facilities

In recent years the annual rate of investment in water projects has accounted for 6 to 7 per cent (between 4 and 5 billion Ft) of total national investment. The distribution of investment among the different water management branches over a period of two decades is summarized in figure III. Its chief characteristics and the conclusions to be drawn may be summarized as follows:

(a) Owing to urbanization and the general objective of minimizing differences between cities and villages, investments for municipal water supply and sewerage have been considerably increased and will constitute roughly half of all investment in water projects during the next 15 years;

Figure III



Distribution of the annual national investments among the principal water management activities during the 1947 - 1975 period

(b) Industry had high priority in the early part of the period;

(c) A shift from irrigation to drainage is expressed in the agricultural investment data of the second half of the period. Among the principal organizations, those belonging to the National Water Authority received 29 per cent of total investment in water projects; those belonging to the regional and local councils, 34 per cent; water management companies, 13 per cent; and organizations belonging to other ministries, 24 per cent.

Water projects are financed from the following main sources: from the national budget, through allocations (grants) and state and development debt; from the budgets of the regional and local councils through allocations and debts; from banking by means of long-term and medium-term credits; and from the water management branch's own resources. These last comprise the Special Water Management Fund and the development funds of the individual water management organizations and water management companies. Basic investments of national significance (such as flood control and channel regulation of the principal rivers, and regional water supply systems) are covered entirely from the national budget and obtained by the NWA. Urban water supply and sewerage systems are financed chiefly from budget allocations, supplemented by development funds. In financing local land reclamation and small water supply schemes, bank-supported local companies and developments of the local or regional councils predominate.

Within the framework of a recent comprehensive water resources development programme, the total amount of financing was estimated in two ways: (a) on the basis of per capita national income; and (b) on the basis of distribution of total national investment among industrial, agricultural and infrastructural investment. The first assumed that there would be a 3 to 5 per cent annual increase in per capita national income, that 22 to 27 per cent of total national income would be available for investment, and that 6 to 8 per cent of total national investment would be available for water management purposes. The second assumed that infrastructural investment would be 35 to 45 per cent of the whole and that water management would account for 12 to 20 per cent of total infrastructural investment.

The economic efficiency of the investments is estimated by first determining some basic indices: (a) the cost-benefit ratio for the project's useful operational life; (b) the amount of net income the investment is expected to achieve; (c) length of repayment period; and (d) differences in costs and benefits among various alternative solutions to the same problem. If total annual costs are involved, amortization percentages are introduced. For more detailed analysis, additional indices are determined, characterizing the economic and technological conditions of the investment from specific points of view, such as total investment cost in relation to gross annual product, value of anticipated total production and total net income during the entire operational period, and average annual water supply (in the case of water supply projects).

Economic efficiency is usually analysed on two levels. "Microeconomic" efficiency is based on values expressing costs and benefits by interpretation of local conditions, whereas national efficiency is computed on the basis of values characterizing costs and benefits of the project in its relation to and effect on national development. Owing to regional differences in price levels (particularly for agricultural products), values of economic efficiency computed for the two levels may deviate considerably from each other in a given instance.

Residual effects of the many different microeconomic situations, however, should coincide well with the national level's efficiency in properly oriented economic structures.

Social efficiency is a considerably broader term than economic efficiency because it involves such factors as employment mobility (inducing social and cultural change), the national balance between labour-intensive and capital-intensive programmes, and internal migration. The importance of these intangibles is generally recognized when considering various alternatives in water facilities investment, but there is no generally accepted or properly specified practice for taking them into account.

Funding and vending

Annual expenditures for maintenance and operation usually equal or slightly exceed those assigned to investment in Hungary's water management activities. The principal financial sources are the same as those for investment, but the distribution may be different. A recent financial plan may serve as an example in this respect:

Source	Investment (per cent)	Maintenance and operation (per cent)
Within the Water Management Branch		
Budgets	39	24
Development funds	24	45
Special Water Management Fund	7	3
Payments from direct interest	7	5
Organizations outside the Water Management Branch	23	23
	100	100

The new system of economic controls introduced in January 1968 has wrought considerable changes in pricing policy. Formerly the price system was based on the actual or planned expenditures involved in the preparation or supply of products. The new price system is a multichannel one and the various components of prices are analysed and determined differently. Three principal groups of prices are distinguished in the new system: (a) fixed prices (prescribed in different ways for different types of products); (b) controlled prices (e.g. the maximum is fixed, or both limits are prescribed, or the method of calculation is prescribed); and (c) free or floating prices.

On the basis of the above principles, the National Water Authority has begun step by step to introduce a new price policy such that only the non-divisible costs of the principal water resources development programmes should be charged to the national budget and that the price system should be an important tool to promote the following basic aims:

(a) Economical and efficient use of the limited water resources of the country and their protection against pollution and other types of deterioration;

(b) Identification, quantitatively measurable, of the contribution of water resources development to general national development; and

(c) Identification, quantitatively measurable, of actual and potential value movements between water management and other branches of the national economy.

One of the first steps towards realizing the above aims was the introduction in January 1968 of water availability fees. The intent was to charge to the users directly interested that part of the national effort geared to preventing flood damage and protecting the country's water resources against deterioration.

Prices paid by the population for drinking water and sewerage remain unchanged, but the price system applied by the 38 municipal water supply and sewerage enterprises has been considerably modified since 1968. Here too prices differ between areas according to regional peculiarities or the availability of water. When water of potable quality is used for industrial or agricultural supply, an additional price of 0.6 to 2 Ft per m^3 is payable.

The new national price policy permits three different price systems for planning and accounting in construction activities. The national norms identify 17 principal types of hydraulic construction for which principles and basic values in price calculation are prescribed. The NWA itself prescribes and controls the price systems of two particular types of hydraulic construction - river regulation and well-drilling.

As mentioned above, banking is related to fiscal administration of water management in several respects. Besides the long- and medium-term credits, short-term credits play a considerable role in the funding and vending systems and in the accounting system of water management activities. The principal elements of the new national price policy concerning debt retirement may be summarized as follows: For investment purposes the debt retirement rate is 7 per cent for long-term credit (10 years), and 8 per cent for medium-term credit (3 years). For agricultural and municipal water supply investments, a reduced debt rate of 5 per cent and increased return periods (15 and 4 years respectively) are specified. In the case of investments having particular significance from the point of view of international trade, a debt rate of 6 per cent and a 12-year return period are allowed.

Budgeting and accounting

The new policy of controlling the development of the national economy also brought important innovations to the budgeting and accounting systems. Formerly, budgeting, as a tool of investment planning and operational control, was based almost entirely on allocations from the national budget. Owing to the basically infrastructural character of water management activities, allocations from the national budget will remain an important factor in fiscal administration, but autonomous sources of funding and the application of self-supporting budget systems are considerably extended. The creation and extension of the Special Water Management Fund is of particular significance in this respect. Its principal sources are: water availability fees; supplementary water prices paid by industrial water users supplied from public waterworks; punitive tariffs paid by industrial water users having their own water supply systems based on water resources of potable quality; payments from public waterworks and sewerage

services which have had extraordinary profits owing to particularly favourable conditions of production and operation; fines paid on the basis of the National Water Pollution Control Act; and income from agricultural lands and forests owned and managed by the regional water authorities.

The total annual income of the Special Water Management Fund varies between 0.7 and 1 billion Ft and is used for the following main purposes: (a) research, planning or construction activities aimed at a more economical and efficient use of water; (b) promotion of water pollution control; (c) increased economic or social efficiency of flood damage prevention; and (d) compensation arising out of unforeseen hydrological conditions.

Budgeting and accounting are important tools also in controlling the distribution of income and profits of the agencies and enterprises. Formerly surplus income was cumulated almost entirely as contributions to the national budget. The new economic policy introduced in 1968 aims to increase the economic independence of the individual enterprises and institutions. For this reason, a considerable part of their net incomes (40 per cent or more) remains in the hands of the organizations concerned. Net income is used for three basic purposes: to increase the financial interest of the personnel in higher productivity through the Distribution Fund; for technological or structural development of the production processes through the Development Fund; and to accumulate certain reserves for covering unforeseen losses and equalizing fluctuations of income through the Reserve Fund.

The fiscal administration of Hungary's water management has relatively little international impact at this time. Principles and basic data of the fiscal administration of Danube navigation are laid down in the statutes and by-laws of the Danube Commission. Problems concerning fiscal administration of water management activities along frontier rivers and lakes are solved by bilateral or multilateral agreements and contracts with the neighbouring countries; and some research projects and an international postgraduate course in hydrology are financially supported by United Nations specialized agencies (IAEA, WHO, FAO and UNESCO).

EXPERT ADMINISTRATION AND CITIZEN PARTICIPATION

Manpower reserves are entirely exhausted in Hungary and, as in many other countries, the only way to increase total production is to increase productivity. This requires special efforts in manpower economy and training.

Manpower and employment

At the present time about 70,000 persons are employed in the water management branch and an additional 20,000 to 30,000 in water management activities in other branches of the national economy, together totalling some 100,000 employees, or 3 per cent of the employed population. The distribution of employees according to level of education and training changes from year to year. At present about 10 per cent have high- or medium-level qualifications (university, high school, technical school) and this figure is roughly four times as high as it was two

decades ago. A recent comprehensive evaluation estimates the annual demand for trained manpower for the 1970-1985 period as follows:

(a) Specially trained workers - 900 per year, most of them with technically oriented secondary school education, plus on-the-job training courses in water management;

(b) Technicians - 110 per year. The total capacity of the four water management secondary schools of the country is 205 per year, but 40 to 50 per cent of the students go on to a technical institute or university;

(c) Engineers from the Water Management School - 100 per year, the present capacity of the school being 70 per year;

(d) Specialists from the State universities - 60 per year, the present rate being about 45 per year.

The high relative share of water resources investments in total national investment (estimated at 7.6 to 8 per cent for the period 1970 to 1985) indicates that hydraulic engineering plays an important role in the national manpower economy. Employment potentials within the water management branch for this period are indicated by the following estimates for total work involved:

Mechanized earth work	500 million m^3
Manual earth work	240 " "
Concrete works	11 " "
Metal construction	70,000 tons
Hydromachine installation	45,000 tons
Pipelines	55,000 km

Training and education

The extent of specialization in technical institute and university training has been changed several times within the past two decades. The prevailing approach in recent years has been to give general training at the undergraduate level and to leave more specialized programmes for postgraduate studies. The Technical University of Budapest, where the majority of leading hydraulic engineers come from, has a civil engineering department where students of hydraulic engineering take a more or less common training programme, with structural engineering, railroad and highway construction, and geodesy.

The role of water users

One of the strong points of Hungarian water resources administration is the association of local initiative and efforts of water users with central national support and guidance.

The large-scale drainage and flood control programmes of the eighteenth and nineteenth centuries were initiated and directed to a great extent by local flood control and drainage companies, based on the voluntary co-operation of the

landowners concerned. The experience of the last two decades clearly demonstrates that this kind of co-operation also works very well under socialist conditions. At the present time, there are more than 400 different water management companies with roughly 400,000 private members and 6,000 corporate members.

Companies are differentiated according to their primary purpose: (a) domestic water supply by small water works; (b) construction, maintenance and operation of small irrigation and drainage systems; (c) watershed management (erosion and gully control and regulation of small watercourses) in hilly and mountainous parts of the country; and (d) construction and maintenance of flood control works of local significance. Companies of type (a) are based principally on private membership, whereas in the case of types (b), (c) and (d), corporate membership (agricultural co-operatives, state farms, local councils, forestry enterprises and so on) is dominant.

The activities of a company are managed by its executive committee, directed and supervised by the general assembly of the members and - in technical matters - by the relevant water administration bodies. Apart from payments and contributions by the members, the activities of the companies are supported to a considerable extent also from outside sources (allocations from the Special Water Management Fund and from the annual budget of the regional water authorities or councils, and long-term credits).

WATER ADMINISTRATION IN INDIA

P. R. Ahuja*

ROLE OF THE WATER RESOURCE

Water in relation to national development

India is a vast country, the seventh largest in the world; it covers an area of 3,276 million km^2, or 1,265 million mi^2. In population, it stands second in the world, with 547 million, according to the 1971 census - an increase of 108 million, or almost 25 per cent, in one decade - and is expected to reach 690 million by 1980. In spite of the country's vast resources, general poverty has been the characteristic of the Indian population. In the race between population growth and food production, the calorie consumption of an average Indian is only some 1,600 calories, which is far below the normal requirement. Hence, over-all planning for developing the country and establishing a stable economy is essentially based on agriculture - on intensifying efforts to harness river waters for irrigation and increasing the intensity of production from the available area by adopting scientific agricultural techniques.

While irrigation development is a prerequisite of attaining self-sufficiency in food - since about 75 per cent of the population depends on the land - the development of industry is equally important. Power consumption *per capita* is an index of industrial progress, and at present the figure for India is only a little more than 77 kwh, compared to 6,065 in the United States of America, 2,305 in the Union of Soviet Socialist Republics, and 1,740 in Japan. The demand for power is fast increasing, and there is great scope for expansion of hydroelectric capacity. The hydroelectric potential of India is about 41 million kw at 60 per cent load factor, and only a fraction of it has as yet been developed. Installed hydroelectric capacity in 1951 was 0.56 million kw. By the end of the third Five-Year Plan (1966) it came to 4.14 million kw, was raised to 6.03 million kw in 1968-1969, and is expected to reach 9.3 million kw by the end of 1974.

The large-scale programme of development called for in the field of water resources involves many problems, which vary widely from region to region; each has to be solved taking into consideration the local peculiarities and demands. Apart from regional disparities, the transition from an agrarian society to a balanced agricultural *cum* industrial one is beset with difficulties, from lack of social education to lack of foreign exchange. While the development of water resources plays an important part in building up the economy of the country, with their progressive utilization and with the passage of time, India's planners must look to other resources and envisage their over-all development.

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Geographical background

India can be divided into five well-defined physiographic regions: the Himalayas; the Indo-Gangetic plain; the Thar or Rajasthan desert; the southern plateau; and the coastal belts. The Hamalayas comprise three parallel ranges, interspersed with large plateaus and valleys, such as the Kashmir and Kulu valleys, which are renowned for their fertility and scenic beauty. Extensive glaciers and snow-fields in these ranges provide a vast potential reservoir of water. Between the Himalayas and the southern peninsular plateau lies the vast Indo-Gangetic plain, made of fertile alluvium brought down by the innumerable rivers and streams from the mountains. It is watered by three river systems, the Indus, draining into the Arabian Sea, and the Ganga and Brahmaputra, draining into the Bay of Bengal. This immense network of mostly snow-fed rivers has proved eminently suitable for canal irrigation, though the greatest perennial canal systems are now included in Pakistan. The southern tributaries of the Ganga system which drain the northern slopes of the Deccan plateau have no contributions from snow and are highly seasonal, running practically dry in the summer months.

The Thar desert extends over an area of 140,000 km^2 (54,000 mi^2) of Rajasthan and parts of Gujarat, in the north-western part of the country. Though the soil is fertile, streams here are few in number and small in size, and the only way of developing this arid area for irrigation is by bringing water from distant regions.

The coastal belt formed by the deltas of the east-flowing rivers is flat and fertile and has been brought under irrigation by means of a vast system of canals. That on the west is much narrower because of the proximity of the Western Ghats to the sea. Rivers here, except for the Narmada and Tapti, are small and fall steeply, with a flow that is flashy during the monsoon and practically non-existent the rest of the year.

During the months of June to September the south-west monsoon is very active and more than 75 per cent of the annual precipitation throughout most of the country occurs during this period. The exception is the south-east coast, which gets the major share of its annual rainfall during November and December from the north-east monsoon.

Administrative background of water resources development

In historical perspective, the non-perennial nature of the river system in peninsular and southern India brought to the fore centuries ago the fact that without some sort of storage it was impossible to raise crops satisfactorily. This explains why India has been a pioneer in the field of irrigation since historical times. In ancient India, irrigation was undertaken by rulers mainly as benevolent works. At the beginning of the British régime and right up to 1854, the construction and management of all public works was entrusted to army engineers under the direction of a military board. The expenditure incurred in the various projects was treated as a part of the ordinary budget, but later on it was realized that capital works undertaken to promote the wealth and prosperity of the country should be constructed from borrowed funds and treated as commercial undertakings. The Public Works Department thus came into being in 1854, and a number of military engineers were assigned to it on a permanent basis, their places later being taken by civil engineers as these became available.

The remarkable success of the works constructed during the first half of the nineteenth century created a boom in irrigation, and an experiment was made in 1858 to take up further works under private enterprise, known as the "guarantee" system, whereby the Government guaranteed a 5 per cent return on capital outlay. However, it did not succeed, and this led in 1866 to some important decisions: that irrigation projects should be constructed by the State; that they should be financed from public loans raised specifically for the purpose; and that political machinery should not be allowed to hinder utilization of water for irrigation.

Under the Constitution of independent India, irrigation continued to be a state subject, while the central Government was charged with responsibility for regulation and development of interstate rivers. The Central Water and Power Commission was formed in 1951, by the amalgamation of two older agencies, to advise on all problems related to water resources development and to undertake such investigations as might be entrusted to it by the central Government and the state governments.

WATER SUPPLY AND UTILIZATION

Current supplies and water uses

Only about 37 per cent of the utilizable surface flow and 20 to 25 per cent of the ground water have been exploited. Clearly India still has a long way to go in total development of surface and ground-water resources.

Of all the uses of water, the most important, because of the agrarian nature of the population and pressure on the land, is irrigation. To the total irrigated area of 22.6 million ha (55.8 million acres) in the era before the five-year plans, 13.4 million ha (33.1 million acres) were added from the first Five-Year Plan (beginning 1950-1951) to the end of the 1960s. The potential for irrigation when the fourth Plan is completed in 1974 is expected to be of the order of 46.5 million ha (107 million acres), leaving 35.5 million ha (88 million acres) still to be irrigated. Problems of salination have developed in some areas, but this is rectified by restoring the balance between surface irrigation, control of the ground-water table and drainage, as well as by the development of tube-well irrigation. Irrigation by ground water plays an increasingly important part, accounting for about one third of the total area irrigated, and plans are afoot for a proper survey of the vast resource available.

The use of rivers, expecially the Ganga and Brahmaputra, for navigation goes far back into historical time. With the advent of the railroad in 1860, decline set in, but the lower reaches of these two great rivers are still used, and a number of irrigation canals, e.g. the Ganga, Mahanadi, Godavari, and Krishna canals, cater to limited navigation. Since the inception of the Central Water and Power Commission, navigation has been re-emphasized and pilot projects have been initiated. All in all, the navigable waterways comprise some 1,746 km (1,085 mi) of navigation canals (tidal) and 2,422 km (1,504 mi) of irrigation cum navigation canals, plus another 303 km (188 mi) under construction.

Many of the rivers that rise in the Himalayas and those of the Deccan plateau that descend through the Eastern and Western Ghats offer a great potential for the production of hydroelectric power. This potential is of the order of 41 million kw at 60 per cent load factor distributed as follows: west-flowing south Indian

rivers, 4.35 million kw; east-flowing south Indian rivers, 8.63 million; central Indian rivers, 4.29 million; rivers of the Ganga basin, 4.83 million, rivers of the Indus basin, 6.58 million; and the Brahmaputra and others, 12.49 million. The first hydroelectric installation in India was established in 1897. Hydroelectric energy is one of the cheapest sources of power, and there is a very large demand for tube-well irrigation, domestic consumption, industry and mining. Great scope still exists for its exploitation, although the susceptibility of the Himalayan region to earthquakes and the large silt load carried by the rivers impose limitations on the construction of economical projects.

The many villages and towns on the banks of rivers and streams have taken their water supply from these sources since time immemorial. In larger urban centres, however, separate piped water supply schemes, either from surface or underground resources, provide filtered and chlorinated water. The consumption of big cities has been estimated at 205 thousand million m^3 (166 million acre feet), and all of these larger cities have been provided with sewerage and drainage.

Numerous artificial lakes and reservoirs have been constructed during the five-year plans, and total reservoir capacity now amounts to some 88 thousand million m^3 (71 million acre feet). Some of these and rivers also have been developed for recreational purposes, e.g. Wullar lake in the Kashmir valley, which is perennially fed by the Jhelum river.

National and regional balances and imbalances

Being a vast country, India has great regional disparities in topography, rainfall, soil conditions and climate, which planning must take into account. Every effort is made to plan for basin-wide development of water resources and to ensure with any particular project that the future development of the basin concerned will not suffer.

A large part of the Ganga basin, particularly in the states of Uttar Pradesh and Bihar, is prone to scarcity and famine conditions, while West Bengal and other areas on the eastern side have a more favourable climate. Planning for water resources development is therefore conditioned by this natural disparity. The northern tributaries rise in Nepal and have the advantage of perennial flow, owing to snow melt in summer. There is great scope for developing these rivers (already partly achieved) to the common benefit of India and Nepal, particularly for irrigation and hydropower generation.

The Rajasthan area, with the lowest rainfall, has no significant river system, and part of it receives irrigation waters by diversion from the Indus system via the Ravi, Beas and Sutlej. Another part is served by waters of the Chambal (a southern tributary of the Yamuna in the Ganga basin). There are proposals for the diversion of the Narmada, and when completed these projects will go a long way towards improving the unfavourable conditions in this area.

To satisfy needs, many states share their water resources with adjoining states by agreement. For instance, the waters of the Indus system are shared in India by Punjab, Haryana, Rajasthan, and Jammu and Kashmir, and the power generated is shared not only by these states but also by Himachal Pradesh and Delhi. Similarly, power produced by the D.V.C. (Damodar Valley Corporation) system is

shared by West Bengal, Orissa and Bihar. With the development of the zonal grid systems and the interstate grid system, it is becoming more and more possible to transfer power from one area to another.

Plans are being made for a grand canal to divert the surplus waters of the Ganga for use in areas as distant as the farthest south of the country. When this materializes, it will mark a fulfilment in the gigantic task of correcting regional imbalances in water resources and it will be a great deterrent to interstate controversies.

LEGAL FOUNDATIONS

Water ownership and water stewardship

In India, it is generally recognized that the waters of a stream and in some cases tanks and reservoirs within a state are public property and therefore subject to state laws. Beginning with the Northern India Canal and Drainage Act of 1873 and the Bombay Act of 1879, numerous enactments have established public ownership of surface waters and government control of their use, development and distribution. Control of surface waters by the individual states was retained when India became independent in 1948 and adopted its current federal structure; and, under the Constitution, irrigation likewise continued to be a state subject governed by different laws in different parts of the country.

Regulation of water for irrigation depends on many factors: nature and mode of supply, the period for which supplies are required, rainfall, soil characteristics and topography of an area, and the habits of its people. The average holding of a farmer in India is of the order of 2 to 5 acres, and water allotted to a single outlet must therefore be shared by a number of farmers. Different types of outlets are in use in different states. In ost cases, they consist of pipes or masonry barrles only. However, Punjab has made considerable progress in this respect and has evolved many types of module outlets which ensure full control over the distribution of water among various outlets on a channel.

In northern India, i.e. in Punjab, Uttar Pradesh and Rajasthan, irrigation is governed by the Northern India Canal and Drainage Act of 1873, as amended. Rainfall is scanty here, and almost all crops require irrigation. Water is allocated for the entire cultivable command area on a canal system, fixing irrigation intensities. Fields falling in these commands are normally eligible to get water from the canal outlets, but only a certain percentage of the commanded area is expected to be irrigated in each season, owing to limitation of water. Certain procedures have also been laid down whereby the day and night turns of each shareholder on an outlet change in alternate years. The sharing of an outlet is done privately by the beneficiaries themselves, but disputes among them must be referred to canal authorities for official apportionment.

The Central Provinces Irrigation Act of 1931, as amended, prevails in the state of Madhya Pradesh and the Vidarbha region of Maharashtra state, according to which water is supplied to irrigators against written agreements. If the permanent holders or occupiers of land in a village apply for water, and if the holders of at least two thirds of the land, or at least 95 per cent of the cultivators, give their

consent for entering into agreement, then the rest of the landholders are also considered to have given their consent. Under this Act, water can be supplied on demand to areas which are not covered in the agreements, if a surplus is available. But water rates for such supplies are generally higher than for those under lease agreements, under which charges are to be paid whether the land is irrigated or not. There is also a provision in the Act that no compensation is payable for non-supply due to reasons beyond the control of the state.

In the Bombay region of Maharashtra and in Gujarat, the Bombay Irrigation Act of 1879 operates, as amended. The land, which can be irrigated from an irrigation work even in drought years, is demarcated into blocks which, as far as possible, are located in the head reaches of the canal system so as to minimize percolation and transmission losses. Cropping patterns are determined depending on the volume of water available, and long-term agreements are entered into with the irrigators. In years of plentiful supply due to ample rainfall, water is supplied to other irrigators in the command area on demand. This system envisages assured benefits to selected irrigators and optional seasonal benefits to others. Cultivators in these areas are required to apply for water before every irrigation season. Water is normally supplied against permits issued to individual irrigators, indicating the quantity.

The basis and procedure for the assessment and collection of water rates and canal revenues vary from state to state and in some cases they are different for various categories of irrigation works within a single state. For example, in Uttar Pradesh, Punjab and Rajasthan, rates are charged for the actual areas irrigated under different crops (the rates varying with the crops), while in Bihar, Bengal, Maharashtra and Gujarat, the assessment is on the areas and crops entered into agreements for irrigation, irrespective of whether the areas concerned are actually irrigated or not. In West Bengal and Orissa there is another category wherein assessment at a uniform rate is made year after year for the entire command area of an irrigation work, and not by fields or crops. Madras and the southern states have a dry and a wet classification of lands. Assessment here is by crops, but subject to a certain minimum for the entire commanded area even for fields which are not actually irrigated. There is no assessment of water rates so far in Assam and Himachal Pradesh.

Besides water rates, there are special levies in some of the states, such as an occupier rate in Punjab, irrigation cess in Maharashtra and Gujarat, improvement levy in West Bengal, water cess in Orissa and maintenance cess in Mysore. Assessment may be made by one authority and collection by another, or both may be done by a single authority. In almost all the irrigation acts of the country there are provisions for assessment of levy for unauthorized use of water and/or for allowing it to run to waste. The penalty varies widely, in some states being equivalent to double the ordinary water rate, in Punjab six times the ordinary rate, and in Mysore as much as 10 to 30 times the ordinary rate.

In earlier days, private ownership played a very important part in the development of irrigation, but with various large developments taking place all over the country, public ownership has become more and more important. Private irrigation works are relatively small in scope and do not ordinarily involve complex engineering problems. Collectively, however, they account for a large part of the irrigated area in the country. They comprise wells, including privately owned tube wells, small irrigation tanks, minor canals, particularly in the upper,

hilly areas of the Himalayan rivers, and minor pumping from rivers and streams. The Government exercises little administrative control over wells which are built and developed by irrigators themselves.

Ownership of power, in general, belongs to the states and management works through a system of state electricity boards whose responsibility extends to the point of distribution.

Navigation, like irrigation, is a matter for the states, except where Parliament has designated any river as a national waterway, in which case it comes under central jurisdiction. It is the responsiblity of the states to provide navigation facilities and to enforce rules and regulations with regard to safety of travel and maintenance of structures.

Rights to the waters of rivers common to two or more states are apportioned between the states concerned, taking all the relevant factors into consideration.

NATIONAL AND SUBNATIONAL JURISDICTION

National and regional powers, functions and services

As previously noted, the central Government is constitutionally limited in the exercise of power by the fact that irrigation is in the hands of the states, though it does play a larger role with regard to power generation and navigation. Ultimately, however, it exercises control over any considerable development of water resources through the planning function. Since water has an important part in national planning, all major and medium-size projects must be examined critically before execution. The normal procedure is for the state governments to prepare project reports along detailed guidelines laid down by the Planning Commission, to consult with such other states as may be affected and to submit the reports to the Commission.

The total financial resources of the country and their allocation among the states are examined by the National Development Council every year. Each state receives its financial outlay from its own and central resources, but in addition, there are grants-in-aid as well as loans from the Centre. Depending upon the final position of the financial resources available to each state, the priority of a project is determined.

Certain so-called earmarked projects are accorded particular importance and priority with respect to national interests. While deciding on state resources and allocations to projects, a stipulation is made that the funds for such earmarked projects may not be diverted to other sectors, and that if there is a shortfall in utilization of these funds, there will be a proportionate reduction of central assistance in other sectors as well. This procedure has been helpful in maintaining sustained effort on important projects.

Although the systematic collection of hydrological data devolves on the states in accordance with the Constitution, the scope of state activity is limited to the political boundaries and often tends to vitiate the national objective of basin-wide development. Therefore, wherever it is found necessary to supplement a state's activity, the Centre takes the responsibility of setting up regional networks of hydrological observations.

Community and local powers

The Indian community is rural in character; 80 per cent or more of the population live in villages, which number over half a million. For the development of the vast rural community India has been divided into 5,265 blocks, each block comprising a number of village panchayats (local bodies elected to look after the village welfare). Groups of such village panchayats make up panchayat samitis, and these in turn make up zila (district) parishads. There is not much diversity in the functions and powers of the village panchayat samitis, but there is considerable variation in those of the zila parishads from state to state.

Each block has a block development officer with a team of extension workers. Their functions are to explain at the village level the implications of planning to achieve the development and progress of the community. They also provide the necessary technical assistance so that, in course of time, the community is able to take up the work of planning and execution for its own well-being. These community development activities include water resources development and management, e.g. renovation of tanks, management of small tanks, maintenance of repair works, and construction of check dams and contour bunds. Maintenance of tanks and repair works, when needed, is met from government or local funds.

Tube-wells and pumps are being increasingly used in the villages. They are owned and maintained individually or collectively by the farmers for irrigation purposes, with technical assistance provided by the block development teams.

ORGANIZATIONAL AND OPERATIONAL FRAMEWORK

Machinery for policy formulation

The Union Ministry of Irrigation and Power is responsible to the Parliament for general policy and technical assistance in the field of irrigation, power, flood control, prevention of waterlogging, drainage and erosion control, as well as for fundamental and applied research in respect of river valley projects and flood-control works.

The Planning Commission at the Centre is an autonomous body constituted in 1951 by act of Parliament. It is the supreme policy-formulating body for the development of all resources of the country, including water resources. The Central Water and Power Commission (C.W. and P.C.) is the technical adviser to the Planning Commission. The National Development Council is the highest body concerned with the allocation of funds among the states.

Single-purpose and multipurpose administration

For administrative purposes, projects can be divided into single- and multipurpose, and further subdivided into an execution stage and maintenance and operation stages.

Since the execution of projects located in a single state is carried out by that state, the administrative procedure adopted differs from one state to another,

but generally is in charge of a full-fledged department attached to a ministry which establishes policy.

Irrigation works in some states are under the management of the state public works departments, which may have different branches dealing with roads, buildings, electricity, flood control, and irrigation. In other states, there are full-fledged departments dealing with waterways, flood control and/or irrigation and power.

The construction of all the civil works of a hyrdoelectric project is generally done by the irrigation administration, but there are instances where such projects are undertaken directly by state electricity boards, which operate and maintain the power system in accordance with the prevailing rules and regulations.

The chief engineer/general manager exercises concurrent control with the audit officers and financial advisers over the accounts and regulations for disbursing money and custody of stores. He generally prepares the annual budgets and is responsible for the proper utilization of funds allotted to works in his jurisdiction. In some states he also supervises and controls the assessment of revenue from the irrigation works in his charge.

Each unit under the irrigation administration is called a circle and is in charge of a superintending engineer. There can be three to seven superintending engineers under the chief engineer for perennial canals in operation. A superintending engineer is generally in charge of one or more canals or part of a big canal, and deals with the distribution of about 140 m^3 per second (5,000 sec^3) of water.

The executive unit in the irrigation administration is a division, and a divisional officer of the rank of executive engineer is generally in charge of it. A division is divided into four to six subdivisions which are put in charge of graduate engineering officers or experienced diploma holders. Each subdivisional officer (SDO), of the rank of assistant executive engineer or assistant engineer, is responsible for the management and execution of works within his subdivision and is assisted by four to six supervisors (also called overseers or section officers), who are generally diploma-holders. The duties of an SDO include, besides the construction, maintenance and operation of works, the economical distribution of water so as to secure the largest area under irrigation.

Exercise of the co-ordinating function

The success of any project, whether single or multipurpose, depends upon the co-ordination that can be brought about between its various elements. When a project is under construction, the general manager/civil engineer is the administrative head, and all the officers working on that project - electrical and mechanical engineers, geologists, research workers, medical and revenue staff - are placed under his control. However, after the project is completed and taken over by the respective states, operation and maintenance are under the control of the regular chief engineer. Power is in charge of state electricity boards; pisciculture is controlled by the fisheries department; agricultural and soil conservation aspects are looked after by the agricultural department; afforestation by the forest department; and navigation by the transport department. Co-ordination is thus a rather complex matter, brought about both formally and

informally at various levels, ministerial, departmental and community. At the community level, co-ordination is carried out by encouraging participation through community blocks, and village and district elected bodies (panchayats, panchayat samitis, and zila parishads).

Interstate administration

Under the Constitution, the central Government is charged with the regulation and development of interstate rivers. The execution of all except minor projects on such rivers is carried out by a specially constituted agency. Thus the Damodar Valley Corporation was constituted on the lines of the Tennessee Valley Authority in the United States to promote the over-all development of the Damodar Basin.

The Damodar Valley Corporation (DVC) was set up by Act of Parliament in 1948 on the strength of resolutions passed by the provincial (state) legislatures, as required by the Constitution. The Corporation consists of a chairman and two other members appointed by the central Government in consultation with the state governments. The functions of the Corporation are to promote and operate schemes for irrigation water supply and drainage, power generation and transmission (hydroelectric and thermal), flood control and navigation in the Damodar River and tributaries (and in the channels, if any, excavated by the Corporation in connexion with navigation improvement in the Hoogly River) and to promote public health and agricultural, industrial, economic, and general well-being in the Damodar Valley and its area of operation in Bihar and Bengal. Funds for the activities of the Corporation are provided by the central Government, partly as a direct contribution and partly as loans through the state governments.

The DVC's functioning was not a very happy experience and was not repeated elsewhere. Instead, suitably constituted control boards were established for multipurpose and, particularly, interstate projects; these made possible quick decisions and a close watch over progress of the works, and ensured economic and expeditious construction.

The composition of a control board varies from project to project, depending upon the requirements in each case. Usually, it consists of the representatives of the state and the central Government and the chief engineers and/or the general manager of the project. The state is generally represented by the chief minister or the minister of the department concerned, and the Government of India is represented by senior officials of the Ministry of Irrigation and Power, the Ministry of Finance and the Central Water and Power Commission.

The general terms of reference of the control board are as follows:

(a) To scrutinize project estimates prepared by the state governments, suggest necessary modifications and recommend the estimates for administrative approval of the government concerned;

(b) To examine all proposals for obtaining expert advice;

(c) To examine and approve from time to time the delegation of such powers, both technical and financial, to engineers of different ranks, as it may deem necessary for the efficient execution of the project;

(d) To examine and lay down specifications schedules of rates for various classes of work; and

(e) To decide on the programme of resettlement of persons displaced as a result of project works, scrutinize and approve the estimates of land reclamation and the expenditures incurred in resettlement and rehousing of displaced persons, including land acquisition.

Responsibility for the execution of works rests with the state governments. The central Government's role is to provide funds and technical advice when called for, and to expedite decisions which would otherwise be delayed if normal procedures were followed. Issues are threshed out at the regular and frequent meetings of the Control Board.

THE PLANNING FUNCTION

Apparatus for planning

The Planning Commission is the supreme body for over-all planning for the development of the country, and in exercising this function it decides upon the various projects to be finally included in the five-year plans. As indicated above, although the Planning Commission's authorized role is advisory, it derives considerable power from the manner in which it is constituted, the Prime Minister of India being the chairman and the Union Minister of Finance a member. This ensures that its recommendations have the force of directive.

Some states have development commissioners and others have development boards. Thus, a nucleus for planning is coming into prominence in the various states. Water resources development in each state is planned by the chief engineer who is the head of the Irrigation Department. It is recognized that basin-wide planning for optimum development is a basic necessity, and a separate directorate for this purpose has been established in the CW and PC.

The ultimate aim of the five-year plans is that planning should commence at the village level by the direct participation of a community through local administration (village panchayats, panchayat samitis, and parishads). At present, the block development officers, with their technical and specialized staff, are trying to educate the people at the village level on the implications of planning and are helping them with technical assistance.

Water planning and development planning

National planning naturally takes into consideration the integrated planning of all resources, including water, and in the formulation of every plan very careful consideration is given to the priorities to be accorded to each sector. Water resources development finds a prominent place. Indeed, in the first two five-year plans (1951-1961), it received very high priority, though subsequently the emphasis shifted somewhat to industrial development.

Water planning is engineering to the extent that it involves an examination of

the feasibility of projects and the benefits expected. However, in the allocation of priorities economic considerations naturally play an important part, having regard to the needs of the over-all economy in the utilization of the nation's resources. Another important consideration is the attainment of social objectives, which is possible only through balanced regional development and the distribution of wealth to all sections of the community.

The planning process and the research function

India is fortunate in having a generally satisfactory hydrological network for over-all planning purposes. The present network of rain-gauge reporting stations under the Indian Meteorological Department amounts to one station for about 730 km^2 (280 mi^2), except in the mountain areas.

The occurrence of severe floods all over the country in recent years has emphasized the importance of the hydrological network not only for planning purposes, but also for assessing the intensity of rainfall which causes floods. Accordingly, in areas of intense precipitation, a number of self-recording rain-gauges have been established. This network is being gradually elaborated and augmented by the setting up of flood-warning and forecasting units in the various river basins in the country.

Like rainfall data, flow data were generally related to specific projects in the early days of planning. Whenever a project was considered, gauge and discharge observation sites were established to provide two or three years' data for planning purposes. Invariably, these observations were continued on a long-term basis. They help in reviewing designs and incorporating necessary changes. In recent years, great emphasis has been laid on the need for systematic hydrological observations on a basin-wide and sub-basin-wide basis. This objective has been partially achieved.

Research has been given a very important place in engineering planning and design. Each state has a research centre where the various problems arising during the planning, design and construction of projects are investigated with the help of hydraulic analogue and mathematical models. Besides research on specific problems of immediate application, certain basic and fundamental problems are also taken up. The cost of specific investigations is met from the projects in hand, and that of basic research is allocated from central funds by the Central Board of Irrigation and Power, which co-ordinates research activities throughout the country. The Central Water and Power Research Station at Poona is the primary research centre working directly under the central Government. Here model experiments are carried out on various specific problems of national interest.

Every year the Central Board of Irrigation and Power organizes a meeting of the Research Committee at which all the important investigations conducted in the various research institutions are documented and discussed. Zonal meetings are also arranged to bring together scholars working on basic research.

Investment in water facilities

To be economically justified, a project should usually ensure that the cost-benefit ratio is not less than 1.5. Indirect benefits are not taken into consideration in this assessment. Although it is recognized that a project may bring in very substantial social benefits, no standard rules apply since each case has to be viewed in the light of regional development requirements. Often, as in severely famine-stricken areas, projects are taken up as protective measures. Depending upon the location and type of project, investments have been made ranging from 200 to 3,000 rupees per acre benefited by irrigation.

With regard to power projects, however, clearer criteria have been evolved and the investment is justified when the financial return is a little more than the borrowing rate beyond a specified period after completion of the project.

Flood-control schemes generally have to be subsidized from other sources. In order to evolve viable projects, the tendency is to promote multipurpose development with elements of irrigation, power generation, flood control and in some cases also navigation.

While there is an abundance of labour in the country, dependence on this source alone for the execution of large-scale projects is bound to result in delay in realizing the targets. Attempts are being made to solve the problem by a judicious development of human labour and machinery.

Projects of great magnitude also involve human problems, which in turn involve additional investments. Where people are displaced and must be rehabilitated, the measures adopted are based on humanitarian considerations. Compensation takes the shape of money or land, or both.

In the case of large-scale water resources developments, many intelligent and skilled workers are also displaced. With increasing population, prevailing congestion in urban areas and limited employment opportunities, the scope of migration of such people from project areas to urban centres is getting more and more restricted. Emphasis is therefore now being laid on employing people so affected in suitable project-based industries and encouraging them to utilize their talents in the project areas.

Funding and vending

Projects throughout the country involve huge investments derived from central and state resources. The central Government's resources consist of its share of revenue, loans and aid from international agencies such as the IBRD, assistance - both monetary and in the form of experts - from friendly countries on a bilateral basis, and loans floated from time to time.

The revenues of the states consist of direct taxes and other receipts, such as irrigation charges, levied by the state governments. Another major source is the states' share of central taxes, the extent of which is determined once in five years by the Finance Commission.

The total amount of central assistance is to be distributed among the states as follows: 60 per cent based on population; 10 per cent based on the needs of important ongoing schemes; 10 per cent based on the special backwardness or special requirements of certain states; 10 per cent to be given to the state whose per capita income is below the all-India average; and 10 per cent on the basis of per capita tax effort as a proportion of per capita state income. Of the total amount of central assistance to an individual state, 70 per cent is given by way of a long-term loan and 30 per cent as a grant-in-aid. Loans are generally repayable over a period of 25 to 30 years.

Budgeting and accounting

After a project has been approved by the Planning Commission, the state ministry concerned issues the administrative authorization, copies of which are sent to the Accountant General and to the chief engineer involved. Thereafter, approval will be accorded to the detailed technical estimates by the competent authority in accordance with the powers delegated for the purpose. Copies of these authorizations are also forwarded to the Accountant General. These form the basic documents of the accounts department to exercise control over expenditure from time to time until the project is completed.

Each year the chief engineer draws up a budget incorporating anticipated expenditure during the year. This is generally within the framework of the plan expenditure approved by the Planning Commission. The budget from the various chief engineers is consolidated at ministerial level and put up to the Parliament or state legislatures for their approval. The budget is reviewed quarterly, and any excess or saving is explained and submitted to the Ministry. In some cases, supplementary demands are also made. Generally, departments are expected to keep as much as possible within the budget provision approved by the Parliament or state legislature.

EXPERT ADMINISTRATION AND CITIZEN PARTICIPATION

Manpower and employment

Manpower requirements during the Fourth Plan period in the irrigation sector were assessed at 500,000, and in the power sector, at 150,000. These figures do not include the manpower required for minor irrigation, which is almost equal to that required for major and medium projects. The annual output of graduate engineers has risen steadily within the past two decades, from slightly over 2,000 in 1950-1951, to some 4,000 in 1955-1956, 5,700 in 1960-1961, 10,300 in 1965-1966, and an estimated 17,000 by the end of the decade. Initially the output of diploma-holders kept pace with this rise and then, by 1960-1961, with an output of close to 7,700, began to draw ahead, so that by the end of the period, it had reached an estimated 26,000. Altogether, the manpower pool of graduate engineers is estimated to have increased from 58,000 in 1960-1961 to 134,000 at the end of the period, and that of diploma-holders, from 75,000 to 198,000.

A regional centre for postgraduate education and training (Water Resources Development Training Centre) was opened at Roorkee in 1956, with United Nations

assistance, to cater to the needs of African and Asian countries. Now it is financed and managed by the Government of India, and a number of working engineers from India and abroad receive training there.

Technical training is not at present widely represented at the higher levels of administration. Although the departmental head is the Chief Engineer, he is responsible to the Secretary to the Government, who is an officer drawn from the regular civil service. There is, however, a strong feeling that the posts of secretaries who are to advise ministers should be in the hands of technical people, in the interest of meaningful and efficient management.

The role of water users

It is recognized that the part to be played by farmers in deriving full benefit from government activities is of great importance, but the manner in which this is achieved differs from state to state and from project to project.

In the Punjab, the water users construct and maintain watercourses and field channels, and if they fail to do this properly the irrigation engineer has the power to have them constructed at the beneficiaries' cost. If water is wasted, he can guide and direct the user to use the water economically and also levy an appropriate fine in case of default.

By contrast, in Maharashtra, the Government assumes the responsibility of providing an assured supply all the way to the field, and the permit for irrigation is issued on this basis, with the quantity of water to be delivered decided in advance. During shortages and emergencies, the canal officers regulate water in such a way that water is economized to the utmost to avoid failure of the crop, and they get full co-operation from the users in this respect.

Various experimental farms have been established in project areas where the farmers receive education in the economical use of water, use of natural and chemical fertilizer, and the dangers of overirrigation and pollution. Progressive farmers are particularly encouraged to set examples for others to follow.

Water users are aware that the community benefited by a project should be involved even from the planning stage. To this end, village and district elective bodies are set up (panchayats, panchayat samitis, and zila parishads), and these forums are utilized for educating the people in various matters of direct interest to farmers.

Co-operatives established throughout the country provide seeds, fertilizer and pesticides needed for irrigation. They also provide the necessary market for the produce and make credit facilities available to the farmers. All these activities have proved extremely valuable, and a gradual green revolution is taking place in the country.

Research in the economical use of water finds great encouragement in India. For instance, special "modules" developed in the Punjab are widely used there and have proved extremely valuable in economizing water use. The idea is also catching on in other areas. Available individual and professional talents are also utilized through the constitution of special committees set up from time to time as problems arise.

CONCLUSIONS AND RECOMMENDATIONS

Since independence, and particularly since the first Five-Year Plan, over 500 projects have been taken up for construction. These projects were described by the late Prime Minister Jawaharlal Nehru as "temples" of modern India. More than 30,000 million Rs. (rupees) have been spent on irrigation alone - about 20 times the investment on water development during the preceding century in the whole of the undivided subcontinent. A number of big river-valley schemes have been completed, and many others are under construction. The works in hand will involve a further expenditure of 15,000 million Rs. Irrigation was extended from 55 million acres (22.5 million ha) in 1947 to nearly 95 million acres (38.5 million ha) by 1969, doubling the food production from 52 million to just over 100 million tons in that period.

Power development began in a small way, and not much progress was made until mid-century; since then installed capacity has risen from about 1.5 million to 15 million kw, for an expenditure of nearly 35 million Rs. It is hoped that by the end of the fourth Plan period in 1974, India will have increased this to 22 million kw. In the past, electricity was mainly used in the cities and for industry. Now it is fast spreading to the countryside, mainly because of a rural bias in the country's power development programme. Some 70,000 out of 570,000 villages have been electrified, and more than 1 million wells have been fitted with power-driven pump sets. Nearly a third of the rural population will be benefited in the near future.

India has also made much headway in the manufacture of power-generation equipment and in extending the transmission and distribution system to serve the rural areas. Regional grids have been completed in almost all states, and the formation of an all-India grid is the next step before the country.

As must be expected in any developing country, the undertaking of huge projects carries with it many technical and managerial difficulties. These have been faced with courage and determination with the result that, today, India can boast of having a large body of trained personnel in administration and a variety of technical activities in water resources development. With the experience thus gained, it is now possible for India to train people from other countries and share its technical expertise in the planning, construction and management of water resources projects. This has already found practical expression in the development of the Mekong basin and in Afghanistan.

The experience of the last two decades has also brought about changes in the outlook regarding water administration and water law. There has been considerable development in the rationalization of water rates, land revenue, betterment levies and flood cess. While the difficulty of training personnel and manpower has been overcome to a great extent, educating the large body of users is a slow process. This problem is of great significance in India, where it is difficult to force people to abandon traditional methods to which they have been accustomed through centuries. Legislation alone cannot bring about the desired change.

With the increase in population and the consequent pressure on land, the tempo of activity among the users is gaining momentum. This entails user involvement in planning and execution of projects; socio-economic awareness among users; the economical use of water based on scientific techniques; adoption of modern

agricultural practices involving quality seeds, chemical fertilizers and so on; the significance and limitations of multiple cropping; and involvement in family-planning, full co-operation in the utilization of facilities provided, and the willingness to work hard in constructive fields of activity.

The Government has done a great deal to inculcate a sense of involvement and responsibility among the people through the agencies of the Panchayat Raj, community centres and various local bodies. People have been helped to overcome their financial handicaps by providing easy credit facilities and power at subsidized rates for irrigation purposes, and by setting up experimental farms and co-operatives.

The basin-wide approach to water resources planning has assumed importance only recently. This will certainly make for optimum development of the country's valuable resources.

It is fully realized that there cannot be maximum benefits from irrigation projects without the use of chemical fertilizers, and the Government is making every effort to increase the present inadequate indigenous production.

Almost all the easier projects have been completed, and those of the future will undoubtedly be more difficult and more expensive. Moreover, with the known inadequacies and poor distribution of surface water resources, there is a growing awareness of the need for integrated development of surface and ground water. For this purpose, a scientific survey of ground-water resources has been undertaken.

In the context of land and water resource limitations, there is added emphasis on the development of pisciculture, in which the reservoirs created by various projects play an important part. This is generally taken care of through the participation of the Fishery Department in project management.

There is a well-realized need for a countrywide review of irrigation procedures and practices so as to ensure the rational and co-ordinated development of water resources, and for this purpose the Government of India has recently set up an Irrigation Commission headed by an eminent statesman, assisted by a group of specialists in irrigation, agriculture and irrigation economics. This Commission has been charged with reviewing the past development of irrigation and drawing up broad outlines for future development, with a view to achieving self-sufficiency in food and maximizing the production of other crops; examining the administrative and organizational set-up for planning, execution and operation of irrigation works; and suggesting criteria for the approval of irrigation projects. While framing its recommendations, the Commission will take into account the growth of population and the additional requirements for irrigation by 2000 A.D.

THE ROLE OF WATER RESOURCES IN ISRAEL

M. Virshubski*

THE ROLE OF WATER RESOURCES

Israel was never a classical irrigation region. Unlike their more fortunate neighbours in Mesopotamia and Egypt, the Israelites had no great rivers, and the terrain was too hilly for extensive irrigation by the methods then known. Only near springs and along the few and small rivers was it possible to water the soil through a system of ditches. Thus, in the arid south, the Negev, dozens of settlements including several cities were sited on winter streams and springs. All were maintained by conserving the scanty winter rainfall and applying it to the irrigation of small patches of fertile soil in wadi beds.

At the Paris Peace Conference in 1919, when the Palestine mandate was assigned to the United Kingdom, particular emphasis was laid on including the water resources in the north-east (the river Jordan and lake Tiberias) within the borders of Palestine so as to permit the development of country-wide irrigation projects. But it was not until the proclamation of independence in 1948 that detailed planning and execution of water resources development got into full stride.

Until then, only small-scale development had taken place, mainly in the coastal plain, where water was needed to irrigate orange groves. Towns like Jerusalem still subsisted, as they did long ago, on rain-water collected from the roofs in underground cisterns, although by the outbreak of the First World War, several settlements already had piped water supplies in their dwellings. In the 1930s new methods were adopted for well-drilling, pipe-laying and reservoir-making. The supply of electric power from the Jordan river hydroelectric power station (completed in the previous decade) and from thermal stations in Tel-Aviv and Haifa led to the introduction of electric drive and made pumping easy and dependable. Where needs could not be met within the confines of a single village, regional systems were created, and the Palestine and Mekoroth water companies were formed.

Under the mandate, interest was initially confined to sources found within or near the farmed land, and not until the future of Palestine became controversial was attention turned to over-all water potentialities. The administration's scepticism as to those potentialities, brought out by the Royal Commission of 1937, was a challenge to water resources research and agricultural planning and spurred preparations for an all-embracing plan of water development.

Once the State came into being, a water development division was formed in the Ministry of Agriculture, and the Government appointed an adviser on water development, with the task of drawing up the blueprint of an over-all irrigation and water development plan. In 1956 the board approved the plan, which had also been reviewed by an American board of consultants.

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During subsequent years, as the national water system came into being, the plan was subjected to periodic review, and in it were included further exploitation of ground water, interception of storm-water run-off, reclamation of sewage, utilization of springs and rivers, artificial rain and sea-water desalination.

Geographical data

Israel is a small country, with a total area of 20,700 km^2, situated at the eastern end of the Mediterranean basin, in a zone of transition from the temperate climate of the western Mediterranean to the aridity of the desert regions to the east and south. The variations of climate to be found are remarkable for such a small area, but only a few main features have an important influence on water supply.

Rainfall varies appreciably from year to year, and from region to region, the long-term average ranging from 1,000 mm (40 in) at Safad in the north, 200 mm (8 in) at Beersheba in the centre, and as little as 31 mm (1.5) at Eilat in the south. Shifts from east to west are also very pronounced, rainfall in the mountain range that runs midway between the Jordan river and the Mediterranean being much higher than in the plains and valleys on its flanks. These inequalities are aggravated by uneven distribution over the seasons. Rain falls mainly in the five winter months of November to March, and there is no precipitation during the rest of the year, except a little morning dew to refresh the land during the long dry spell from April to October.

Water resources in relation to agriculture and industry

Irrigation is the mainstay of Israel's agricultural production, and about 80 per cent of the water produced is supplied to the country's agriculture. Mekorot, the National Water Company, supplies water to approximately 2,000 consumer bodies, of which 1,500 are agricultural, 100 industrial and 400 urban. These consumers are mainly municipalities, local councils, village committees, kibbutzim, and other agricultural settlements.

Although the ratio of agriculture in the gross national product will become relatively smaller with the planned industrial development, the irrigated area is still increasing. The main reasons for further agricultural development in Israel are the need for additional food for the growing population; the high added value of agricultural exports and the increase in these exports; the availability of high-quality manpower in agriculture; and the scarcity of mineral resources in the country. Ensuring the supply of water to Israel's agriculture is thus a matter of great consequence to the national economy.

Water in relation to national development

Three periods in the history of water utilization in Israel can be distinguished: the British mandate; the period between the founding of the State and the enactment of the Water Law (i.e., 1948-1959); and the period since the enactment of the Water Law in 1959. The water law that the Mandatory administration inherited from the Ottoman rulers of Palestine was antiquated,

suited rather to a modest level of development than to a twentieth-century economy. It had practically no provisions relating to irrigation or industrial use and often frustrated attempts by the new settlers to develop agriculture according to modern concepts. Except for a few superficial amendments, there was no change in the water legislation during the period of the Mandate. The administration opposed mass immigration on the grounds that the country lacked additional absorptive capacity, the areas of land free for settlement being situated in the arid Negev, which could not support a farming population. This low evaluation of the Negev was at that time not unfounded, but was to a certain extent the outcome of the existing law, under which water could be applied only to local use and could not be diverted or conveyed from one region to another.

Independence brought many far-reaching changes of policy and a tremendous acceleration in the rate of economic growth. Immediately after the establishment of the State in 1948, water was given special and urgent attention, both by the country's planners and its legislators. In the sphere of planning, priority was given to the National Water Project, which was to carry water southward to the Negev. In legislation, work began on the drafting of a basic Water Law. This task took over seven years, but during the same period various special laws relating to specific aspects of water were passed (e.g. drainage, flood control, water metering, and the control of well drilling), and temporary administrative orders were also issued pending the enactment of the Water Law.

The third period began with the passing of the Water Law by the Knesset (Israeli Parliament) in August 1959. The basic concept embodied in it is that water is a means of production in limited supply, to be used in the most efficient manner for the common good. The fact that the water resources are concentrated in one part of the country made it necessary to include in the law a basic provision nationalizing all the country's water resources, so as to give the Government control over their use. In this case nationalization was not the result of an abstract social idea, but an outcome of existing circumstances, requiring adequate protection of the public interest.

During the early 1950s in particular, population grew very rapidly as a result of large-scale immigration, and there was a sharp rise in the area under cultivation and irrigation. The expansion of supply had not kept pace with the growth in demand for water, and the shortage was met by a policy of controlled overpumping and depletion of underground reserves. This was clearly possible only for a limited number of years without causing irreversible damage to the long-term supply potential.

The development of further sources of supply was thus a matter of urgency not only for the expansion of agriculture, but even for the maintenance of what had already been established. The problem was aggravated by the fact that what remained to be exploited of the known water potential of the country lay in the north, while the overpumping and the as-yet unexploited irrigable lands were concentrated in the south. The solution was construction of the National Water Carrier, a 108-inch pipeline linking the Sea of Galilee in the north to the existing water supply network in the south. It began operation in 1964, and today it supplies nearly one third of the water used in the southern half of the country. Most of the water supplied by it came to replace existing, depleted sources of supply; only a minor portion went to increase total capacity.

The completion of the pipeline brought the country very near to full exploitation of its total water potential. The sources of water remaining to be developed by conventional means are to a great extent problematic. Of the two major sources, storm-water catchment requires very large installations for use during the few weeks of the year when the normally dry river beds of the country are in flood, while the reclamation of sewerage poses difficult problems of quality. The development of both these sources has in fact been far slower than originally planned. The prospect for the future is that any major addition to the water supply will have to come from desalination, which in all its various forms is as yet very expensive.

A national policy of water thrift could save considerable amounts for application to expansion and development. Israel already uses or is on the verge of using many ways of saving water - urban installation of meters and payment per cubic metre of water used (which has worked wonders); in industry, the recirculation of cooling water or its potential replacement by sea-water, where feasible; in agriculture, drip irrigation and determination of the minimum amounts of water needed for different crops under different methods of cultivation and for applying fertilizers to the soil. The use of fresh water in fish-ponds will have to be circumscribed, and only brackish water, unsuitable for irrigation, allowed. New techniques are being used to reduce evaporation from open reservoirs and in water desalination.

WATER SUPPLY AND UTILIZATION

Current supplies and water uses

The average gross amount of contributing rainfall that replenishes Israel's water resources is estimated at 10,000 million m^3 per annum. Only about 14 per cent can be brought into regular utilization by the end of the 1970s; one third from surface flows, and two thirds from underground flows and springs. There is a secondary source due to human activity, namely irrigation surpluses and sewage effluent, which percolate into the ground and supplement its water. These secondary amounts, when fully utilized, are reckoned at a further one per cent of the total.

Detailed studies of the possible yield of water resources are still in progress, but it can already be affirmed with a fair degree of certainty that the average annual amount of water that can ultimately be brought into use by employing present-day methods is 1,500 million m^3 per annum. When the water development programme for the period ending in 1980 is implemented, the total amount of water under regular utilization will reach that figure, with irrigation (excluding fish-ponds) accounting for 1,040 million m^3; municipal uses, 330 million m^3; and industry, 130 million m^3. The major resources directly or indirectly interconnected by the national grid have a total average annual yield of about 1,400 million m^3.

Israel's annual water consumption has now already reached 1,300 million m^3, or over a million acre-feet, which is nearly 90 per cent of the estimated potential. Most consumption is measured directly by meters and similar devices installed in the supply systems, and in their absence indirect evidence is offered by records of

electricity or fuel used by the pumps that draw the water from its sources and deliver it to the consumer.

Development of water projects

The development of water resources has understandably followed a sequence from quick-effect, low-cost projects to more expensive long-term ones. To start with, it was imperative to supply water cheaply and at short notice to hundreds of far-flung villages, and the readiest solution was ground-water exploitation by drilled wells, first for local supplies and then for district irrigation systems.

Attention was then directed to the development of regional systems. The largest of these is the Yarqon-Negev project for diverting the water of the Yarqon from its sources, at the Rosh Ha'ayin springs near Tel-Aviv, to the northern Negev. This supply resulted in the foundation of some 75 farming villages on an area of 150,000 dunams (37,500 acres). A second line was also completed, which carries water from the Yarqon as well as water delivered to its head-works from the Kinneret-Negev project; the first section of this line supplies the area of greater Tel-Aviv with 45 million m^3 (12,000 million gallons) annually, and its continuation joins the first line further south.

Further works undertaken include projects for the interception of winter flood flows (some of which are already in operation), the reclamation of sewerage from the towns (realized so far only in part), and, first and foremost, the Lake Kinneret-Negev project, which has been in successful operation since 1964. The latter is the largest and most ambitious of the water projects of Israel, designed to carry 320 million m^3 (260,000 acre-feet) each year from the Lake (the Sea of Galilee) to the Negev, a distance of 150 miles. The main conduit of the project also co-ordinates and integrates all the regional water systems, which it passes en-route, into a national grid.

Limiting factors in development

To conserve water from winter to summer and from wet to dry years, suitable storage capacity must be provided. After thorough investigation and survey of alternatives, it was decided to use Lake Kinneret, in spite of its low elevation, as the principal surface reservoir. The lake's available storage capacity, however, is insufficient to prevent a spill-over into the lower Jordan of the winter inflow brought by the upper Jordan. To avert such losses and to provide a reserve of water in the south, use is made of the vast underground storage capacity available in the porous strata of the coastal plain. Thus, during the rainy season, surface water from Lake Kinneret is transferred through the national grid system to the south and injected underground through special wells for subsequent recovery by pumping during the dry season. Yet another indirect method of underground storage consists in allowing wells a period of rest in the winter, meanwhile substituting for their supply surface water brought from Lake Kinneret.

Similar measures of artificial recharge are being taken to conserve storm-water and keep it from running out into the sea. The difficulties are formidable. Enormous spates come down within very short periods and demand large structures for their instant reception. Impounding dams and reservoirs up in the limestone hills were tried and found both costly and ineffectual. The method now favoured consists

of building low dams across the streams and detaining the flow of single floods so as to allow the water to penetrate into the ground or be diverted to recharge nearby.

Sewage reclamation is very important as it can facilitate the expansion of irrigated agriculture as well as of industrial production. The aggregate that can be so reclaimed annually in Israel's principal towns alone is over 110 million m^3, and the costly but indispensable work of reclamation is included in the development programme for the coming years. Some progress has already been made towards the construction of sewage treatment plants in the major towns.

Other problems of water loss or deterioration are sedimentation and salinization, or salt-water intrusion. The exploitation of saline springs whose water is harmful to plants has been the subject of hydrological study in the western Galilee-Kishon project and elsewhere. In some cases, as at the Na-Aman spring, the study has led to interception of the underground flow by wells before it became salty, and there has ensued a useful accretion of fresh water.

In the Beit She'an Valley, prolific in saline springs, the water by itself is too salty for irrigation. To save it from being wasted, it has been found possible to dilute it in a special mixing plant with fresh water from other springs. The blend is satisfactory for irrigation, and thousands of acres of valuable crops benefit from it.

Other remedial measures were taken in the utilization of the coastal aquifer, which is now at the point of maximum safe yield and in some places has even gone beyond it. These remedial measures, incorporating artificial recharge, are in hand to correct such local overdrafts of ground-water, where the limit of safety has been overstepped and risk arises of salt-water penetration from the sea.

National and regional balances and imbalances

As a result of the steady decrease in rainfall from north to south, about 85 per cent of Israel's water potential is concentrated in the northern half of the country, which has only 50 per cent of the irrigable land. To offset this imbalance, water resources have been nationalized, water supply is rationed by a comprehensive system of licensing, and big transfer projects like the National Carrier (Kinneret-Negev project) and Yarqon-Negev project were built to bring water to water deficient regions. The "regional projects" concept has become the basis of water development, and 26 major regional projects are now operating in all parts of Israel. In the 30 years of its existence, the Mekoroth Water Company, responsible for most of Israel's water supply, has covered most of the country with a dense pipeline network to convey the vital supplies from their sources to the locations where they are needed. Mekoroth joined forces with the water users themselves to finance the water projects, which were to serve all consumers in the relevant regions without exception, far and near. These consumers contributed equal shares in the investments and paid a uniform rate for each class of use.

LEGAL FOUNDATIONS

Water ownership and water stewardship

As noted earlier, in the years prior to 1948 there was little law dealing with water specifically, except certain provisions scattered through the Megella (the Ottoman Legal Code), the Ottoman Land Law and the Safeguarding of Public Water Supplies Ordinance, passed in 1923 under the mandate.

The main Israeli laws concerning water (in addition to the Water Law of 1959) are the Water Measurement Law of 1955, the Water Drilling Control Law of 1955 and the Drainage and Flood Control Law of 1957. The first two were actually drafted as chapters of the Water Law, but since this law was long in preparation and the need for regulation in the respective fields was so immediate, it was decided to enact them separately. The Water Law was enacted in 1959 after seven years of preparation and, with the other laws, constitutes a complete and comprehensive water code.

In general, the Water Law vests in the public all ownership in water resources. It gives the State, through administrative, public and judicial institutions, broad powers to regulate the extraction and use of water as well as to plan and co-ordinate the design of water-supply systems, allocate water to various uses and users, and fix water charges. An administrative, consultative, and judicial framework is provided to protect individuals from the misuse or abuse of such powers and for the safeguarding of private rights. The Law allows individual or private use of water only in so far as such use falls within its provisions and regulations made thereunder. Therefore, any rights that may be inferred from these are subservient to the Water Law and the public interest as a whole.

The Water Law prohibits waste, empowers the authorities to make regulations for consumer use, provides government control over water production and supply, and gives the Government power to ration water.

As a necessary adjunct to regulating supply and establishing supply systems, the Water Law gives the Government the power to fix charges and prices. Furthermore, power is given to impose what are called "special payments" as penalties for violations of the Law or regulations made under it with respect to water use.

An interesting feature of the provisions dealing with water charges is the establishment of a Water Charges Adjustment Fund, the purpose of which is to equalize charges between various areas of the country. This is done by imposing levies in excess of water costs in areas where such costs are relatively low. These levies go into the Fund, from which subsidy payments are made to consumers in areas where water costs are relatively high. The Adjustment Fund is managed by the Water Commissioner.

The translation of the provisions of the Water Law into actual management and application of the State's water resources is the task of the Water Commission, whose function it is to provide the necessary technical knowledge for the formulation, implementation and administration of policies and regulations that will result in the satisfaction of Israel's basic goal with respect to its water resources.

Private water rights and public responsibilities

The nature of the right to the use of water in Israel is different from that in some other jurisdiction, e.g. the United States. It is not fixed to a particular source of point of diversion, but is a right to a certain amount of water for a certain use. A person's right to water must be linked to one of the water purposes enumerated in the Law, and the right ceases upon the cessation of the purpose.

Regulation of water use and adjudication of water rights

The decision to issue or refuse a license for abstraction of water is in the hands of the Commissioner, and the law sets up no standards, priorities or preferences aside from some very general statements. A license may be issued for a given period of time, after which the right expires, and may include conditions to ensure efficiency of the supply, storage, conveyance or distribution of water and prevent the depletion of water resources.

The Water Commissioner must take into consideration the hydrological situation of the region in question, the existing water rights, the most beneficial use to which the water should be put and special problems of the communities living in the region. He will be assisted by the plans and schemes of the various planning agencies of the State and by the over-all development policy of the Government. However, his discretion in implementing this part of the Law is very great, and only the water tribunals have the power to change, alter or annul his decision. The control of the courts is a most important safeguard against the abuse of power by governmental agencies.

Another function which is implemented regionally by the central water administration is rationing of water. According to the law, the Minister of Agriculture may declare areas in which the existing water resources are not sufficient for needs as rationing areas. Having done so, he has very broad powers to reallocate the water resources of such an area and to impose far-reaching regulations limiting production, distribution and use of water.

According to the existing municipal legislation, the local authorities have the power to regulate the distribution and consumption of water within their boundaries. In most of the towns and villages the waterworks and distribution systems are city-owned.

However, in all cases the local authority has control through its by-laws over the water supply within its boundaries. These by-laws regulate price, metering the prevention of waste and the maintenance of the distribution system.

Notwithstanding all its special problems, the local authority is regarded as a water producer and supplier according to the Water Law, and as such must produce and supply water under a production licence.

The concept of public interest mentioned in the water law, according to which the water resources of the State should be planned and allocated, goes far beyond water matters; in fact, their satisfactory organization and administration are only a part of it. "Public interest" in this context may be defined as the concentration and unification of national planning of all sectors of the society and economy of the State, which has been adopted by the legislature and by the Administration. It is thus the over-all approach which unifies all social, economic, security and political considerations existing in the society, in order to achieve the maximum social and economic advancement of the State. The water law is the means for carrying out water planning and, thus, indirectly for executing social and economic decisions relating to such matters as dispersion of population, types of settlement and the physical planning of the State.

The many benefits derived from the national water system (or project) cannot be fully enumerated here. Suffice it to say that it has turned great stretches of arid land into fruitful fields by bringing water to them. From the legal aspect, this could not have been realized if the legislators had not made a radical departure from the previous law, which tied water rights to the land where the water is found. This piece of legal history may serve as a striking example of how a country's water laws, guided by definite policies, can serve either as a spur or as a barrier to development.

ORGANIZATIONAL AND OPERATIONAL FRAMEWORK

In Israel, the water legislation provides the general framework of decision-making within the water sector, as well as the detailed arrangements for an efficient and streamlined decision-making process. Most of the co-ordination among the various competent agencies is also carried out within the framework of the law, but from time to time special co-ordinating committees are set up by general agreement of the agencies concerned or by order of the Minister of Agriculture.

The Water Commission

While the water affairs of the country are managed by a number of institutions and agencies, all of which are responsible to the Minister of Agriculture, the actual implementation of the water policies and governmental control over water resources are vested in the Water Commissioner, who heads the Water Commission. One of his most important tasks is the preparation of the water policy for introduction by the Minister of Agriculture, who is responsible before Parliament on behalf of the Government. The Water Commission collects the necessary data and, after co-ordinating with the other government departments and agencies and various public (non-governmental) agencies, proposes the water policy, which includes both the immediate steps to be taken and the long-range plans to be adopted.

Because of Israel's unique forms of settlement (kibbutzim and moshavim), in addition to all the problems of a water-scarce country in which available resources are maldistributed, the water policy has special features not be be found in any other country.

The proposals prepared annually by the Water Commission include the allocation and distribution of water during the coming year, the designation of water-rationing

areas, the fixing of maximum consumption quantities for the various uses and the fixing of priorities within those areas. Such proposals include a great many factors, hydrologic, economic, social and legal. It is therefore a collective undertaking in which all the units and sections of the Water Commission participate and in which the Commission co-ordinates among a great number of other agencies.

The Water Commission consists of the following divisions: the Allocation and Licensing Division (formerly the Water Rights Division); the Hydrological Service; the Water Use Division; the Drainage Division; and the Head Office. These divisions are further divided into departments with specialized units in each. The Water Commissioner exercises direct control over each of these divisions and is responsible for their actions to the Minister of Agriculture.

The Water Board

This Board exists to advise the Minister of Agriculture on questions of water policy, and its composition is fixed by law. It comprises 39 members, headed by the Minister of Agriculture and the Water Commissioner. Two thirds are representatives of the public (consumers and suppliers), and one third are representatives of the Government and the World Zionist Organization. At least one half of the members of the Board must be representatives of water consumers.

Consumers are represented through the various agricultural and industrial organizations and the League of Local Authorities, and suppliers are represented through the water companies, water co-operatives, local authorities and organizations of well-owners.

Much of the work of the Board is done in committees, which study in detail the matters in question and report back to the Board. The latter has advisory capacities only, but actually exerts tremendous influence on the shaping of national water policy and development. It must be consulted before any major decisions are made, and this gives it greater power than can be assumed from the provisions of the law since as a general rule the Government does not act against the Board's recommendations.

The Drainage Board

In addition to the Water Board, a National Drainage Board was established (under the Drainage Law), consisting of the Water Commissioner as Chairman, representatives of the Government (in the minority), and 12 members of the public, representing agricultural organizations. The functions of the Board are to advise the Minister of Agriculture in the approval of drainage schemes and any other matters of policy connected with the implementation of the law. Though its powers are advisory, the scope of this Board, like that of the Water Board, is very broad, since it has to be consulted on any major decision. Technical problems are dealt with by an engineering committee appointed by the Board and responsible to it.

The water tribunals

Each of these courts consists of three members, a professional judge and two representatives of the public (from a panel nominated by the Minister of Agriculture after consultation with the Water Board and with organizations of local authorities).

The water tribunals have the power to change, alter or annul the decisions of the Water Commissioner; they may order him to issue a license that he had initially refused or change the conditions and particulars of a license he has issued. The tribunals also have jurisdiction, over all disputes arising between the individual and the drainage authorities, e.g. over compensation for condemnation of land and other damages, and drainage rates. An automatic appeal from the decisions of the tribunals to the Supreme Court is allowed.

Mekoroth Water Company - the National Water Authority

The construction, operation and maintenance of Israel's public water supply schemes is the concern of Mekoroth. This is a public utility owned in equal shares by the Government, the Jewish Agency, and the Histadruth (General Federation of Labour). In 1937, its first year of operation, it supplied one million cubic metres of water to agricultural systems. Today it supplies nearly 1,000 million m^3 to most of the local authorities, agricultural settlements and many industrial undertakings.

The construction of the National Water Project began in 1952 and was then in the hands of Tahal, the water planning agency. Since through the years Mekoroth had expanded and erected large-scale waterworks to supply a growing number of consumers, it was decided in 1956 that the construction of the National Water Project should be carried out by Mekoroth, its planning by Tahal, and the over-all control by the Minister of Agriculture acting through the Water Commission. The Water Law created a statutory body, the National Water Authority, to be charged with the creation and maintenance of the National Water Project, and in 1960 Mekoroth was empowered as the Authority.

Mekoroth now operates in a dual capacity: (a) as a water supplier functioning as a public company whose activities are controlled by the Water Commissioner like all other water suppliers in Israel; and (b) as the National Water Authority, by special authorization of the Water Law. In this second capacity, its functions are to establish and manage the National Water Project. Once all the works are erected and operating, the Authority acts in its first capacity as supplier of water throughout the country. The supply of water and the regulation of prices are controlled by the Water Commission according to the Water Law.

The co-ordinating function

To co-ordinate the activities of the various water agencies, the Minister of Agriculture appointed a Co-ordination Committee, headed by the Water Commissioner, on which are included the Directors of the Joint Agricultural Planning Centre, the Ministry of Agriculture, Mekoroth and Tahal, the government

water-planning agency. The Committee meets frequently, and all activities requiring the co-operation of the agencies are discussed. Thus it plays an integral role in shaping water policy and creating the means for its execution.

The planning function

The Tahal organization, known variously as Tahal Consulting Engineers, Ltd., or Tahal-Water Planning for Israel, Ltd., is both the Government's water planning agency and the largest consulting engineering organization in Israel (specializing in other branches of engineering besides water resources development and associated irrigation agriculture). Actual execution of projects is done by other bodies, under Tahal supervision.

Tahal was originally founded as an organization for planning Israel's major water projects. It is constituted as a joint stock company in which the Government owns 52 per cent of the shares and the remainder is held in equal parts by the Jewish National Fund and the Jewish Agency. Thus, Tahal is fully controlled by public interests. Its work in Israel itself was initially carried out from government budgets. Later on, requests began to arrive from various countries for engineering consulting services and, for that purpose, Tahal established a subsidiary which is solely engaged in work for clients other than the Government, and mostly in countries outside Israel. In fact, most of its work is now connected with various projects abroad - in Latin America, Africa and Asia.

Although the planning of Tahal is quite exclusive in its field, it is controlled by various government agencies, even after its plans have been approved by the Minister of Agriculture. For example, the Drainage Division of the Water Commission supervises the erection and construction of drainage projects according to Tahal plans. This division is itself responsible to the Government, and Tahal is responsible to the Drainage Authority, which in turn is also responsible to the Government. A similar arrangement is being introduced for the control of all water projects. A special unit of the Water Commission will control construction; the particular water authority will be responsible to this unit; and Tahal in turn will be responsible to the Water Authority.

Economic planning with respect to the establishment of water supply systems is an important phase of the Water Commission's work. Successful planning of such water supply systems requires careful analysis of present and future demand, available supplies and the economic feasibility of exploiting them. To make these analyses, the Water Commission is engaged in studies of population, development of industry and industrial water use, financial analyses of proposed water supply systems and similar economic research. The Water Commission is also responsible for the gathering of basic data, accumulating knowledge on conditions prevailing in the country as they relate to water supplies and water use, and the application of economic principles to questions of water policy.

FISCAL ADMINISTRATION

Water-pricing policy

Until the mid 1950s the price of water was mainly a matter for negotiation between suppliers and consumers and was not subject to administrative intervention. By then, however, agriculture had extended into areas which were previously very sparsely settled and had little or no local water resources. Water had to be brought from considerable distances, and it was beyond the capacity of the newly settled and largely inexperienced farm population to bear the heavy costs. Since the settlement of these areas was part of national policy, government subsidies for water were forthcoming on a generous scale. These subsidies took two forms: (a) the granting of development loans on far better terms than those available on the open market; and (b) payment of direct government grants to water suppliers to cover deficits arising from below-cost prices in high-cost areas. This second measure was in the nature of a stopgap. The Government could not continue permanently to provide subsidies to cover the steadily growing deficits of water suppliers, while prices remained a matter to be settled between suppliers and consumers.

The Water Law provided the legal framework for central control and regulation of water prices and established the Water Prices Adjustment Fund for the payment of subsidies on high-cost water and the levying of taxes on low-cost water. The law brought order and logic to a field where rapid development and the anticipation of major legislation on the way had previously made piecemeal improvisation inevitable. However, it was only the first step, though a major one, in a continuing process. In drafting the law, there were few precedents on which to draw for no other country had envisaged such full use of its water potential or embarked on the large-scale development of irrigated agriculture with such a limited supply of water.

There is as yet no direct central price control of water, even though the law makes provision for it. The extensive control which does exist is exercised indirectly, chiefly through the Adjustment Fund, through the powers of arbitration vested in the Water Commissioner, and, in the case of municipal water supply, through the requirement that all municipal by-laws pertaining to water be approved by the Ministry of the Interior after consultation with the Minister of Agriculture.

Establishment of prices

The Minister of Agriculture has the power to fix prices by prescribing either the rules for their calculation or the price itself. The Water Law includes many provisions as to how the Minister may exercise his powers. He must take into consideration the profitability of the supply system on the one hand, and the paying capability of the users for the purpose in question on the other. Public hearings are needed before fixing the tariff. Water prices of private suppliers are also controlled by this law.

The Water Prices Adjustment Fund exists to equalize prices in different parts of the country, the rationale being that users who benefit by low prices should participate in carrying the burden of regions where prices are exceptionally high. The Fund derives its income from three sources - the national budget, taxes on low-cost water and the special levies on excess use of water. Most of the monies come out of the general budget, and no more than 20 per cent of all its income may accrue from levies on water used for agriculture and industrial production.

Administrative orders issued by the Minister of Agriculture after consultation with the Water Board, which are revised from time to time, regulate the procedures for levying the tax on low-cost water and for calculating the subsidies due from the Fund on high-cost water. Water supply costs for the purposes of the Fund are calculated in accordance with the "Rules concerning the calculation of water charges", which specify what items are to be included in the calculation - major items being costs of operation, maintenance and depreciation, and profit and interest. For some items, the rules specify the maximum level of costs which will be allowed; for others, they lay down the methods of calculation which must be used.

Drainage authorities may levy drainage rates on all the property owners in their area. These rates are fixed by the authorities and approved by the Minister of Agriculture, and must be based on various factors including the area and quality of the land in question, the extent to which the drainage project or alteration entails an improvement of the land, and the extent to which the need to establish the project has been created by enterprises or installations on the land.

The drainage rate can be either imposed to cover the full or partial expenditure incurred, or estimated in advance, if the rates are challenged, by an appeal to the Water Tribunal, whose discretion to decide inter alia if the rate assessment is unjust is very broad.

Local authorities are required to operate their waterworks as separate enterprises and to cover their costs out of income derived from the sale of water. This income should accrue from charging a price per unit of water supplied, without the levying of any lump-sum payments for various services such as the renting and inspection of water meters. The only lump-sum payments approved are those associated with the initial investment required for connecting consumers to the water main and installing water meters. Differential pricing according to the type of use is part of the standard scheme. The prices charged for consumptive as opposed to productive uses are graduated on a rising scale, except in those cases where the initial price is already very high.

Fiscal planning

Fiscal planning is an essential part of the water-planning and water-financing system. All the required information is collected, and a careful assessment of the relation of benefits to costs in a water project are made, but sometimes the social or national benefits justify it even if the investments or the fiscal benefits do not. Even so, the fiscal point is taken carefully into consideration, as well as such socio-economic consequences as employment mobility, internal migration and impact upon industrial development. Most of the investments are public, and there is full realization that because of Israel's water situation, they are a very important part of total national investment.

All water suppliers (and this includes the regional projects) must prepare annual reports and transmit them to the Water Commission. Accounting data and audit reports are presented, making it possible to prepare and control the over-all evaluation of the water resources and water administration as well as an audit of the fiscally identifiable components of the water system. This auditing makes possible current checking and future correction of water policies and water management.

EXPERT ADMINISTRATION AND PUBLIC PARTICIPATION

Manpower, employment and training

Planning manpower is mainly concentrated in the Tahal Company; the construction and operation manpower is in Mekoroth; and the administrative manpower (including the legal staff and economists) is mainly in the Water Commission. Tahal's staff includes approximately 700 professionals and subprofessionals, qualified in various branches of engineering agronomy, economics, sociology, mathematics and management sciences. Tahal also retains a panel of highly qualified outside consultants of international reputation in their special fields. Mekoroth today comprises approximately 2,500 workers, including engineers, technicians and professionals for the operation and management of the water supply systems.

The role of water users

Probably the most effective way to avoid waste of water in any community is by public education. The Water Commission has launched a comprehensive programme to this effect with radio talks, slogans on buses and billboards, short films and lectures in schools, and it has reduced to a considerable extent the wastage of water in all categories of use.

It is felt that the public at large should participate as much as possible in the administration and implementation of the rather strict water legislation, and many provisions of the Water Law are devoted to this. Public hearings are needed before fixing water tariffs and before approval of water projects and the introduction of rationing. The Water Board and its various committees must be consulted by the Minister of Agriculture on any matter of consequence in the field of water policy and administration. Representatives of the public also participate in the control and revision of the water administration's decision-making process through the water tribunals.

CONCLUSIONS

The point of departure of Israel's present planning is the prospect that by the mid 1970s practically all the country's potential water resources - including reclaimed wastes - will be in use. Any further economic development will therefore have to depend on intensifying still further the yield of the natural resources system; transfer of water in actual use from lower-value to higher-value products;

introduction of man-made water; or a combination of these approaches. Proposals to this effect have been incorporated in the elaboration of Israel's long-term water development plan for the fifteen-year period 1965-1980.

The plan adopts a systems approach comprising the following main areas of analysis:

(a) Selection of management patterns for natural water resources and the over-all water grid that will result in optimal water yields and quantities;

(b) Engineering intervention into the natural water cycle, which, within economic limits, will improve the yields and quality of the natural water resources;

(c) Shifting water allocations in keeping with anticipated rising water costs;

(d) Adjusting and changing water-application technologies so as to adapt them to meet anticipated higher costs of man-made water.

Cloud-seeding has so far proved to be the most successful of the experiments in intervention in the natural hydrological cycle. Sizable increases of rainfall have been statistically proved at satisfactory significance levels. Manipulation of the vegetative cover with the object of increasing run-off in uncultivated areas where the rainfall is between 300 and 600 mm per annum has also proved to be effective and will be expanded on a significant scale. Evaporation suppression, mainly from water areas, may possibly become economically justifiable in the none-too-distant future, and soil treatment to increase surface run-off may also have a sizable contribution to make in improving the yield from the hydrological cycle.

Adapting water allocations to anticipated rising costs will in the next decade become one of the principal means of releasing water for essential new economic uses. In municipal supplies, universal metering, combined with disincentive block rates (lying between average and marginal costs of water), has proved effective in reducing per capita consumption to economically justifiable levels. In the industrial sector, a realistic water rate may by itself be sufficient to introduce patterns of thrifty water use. Its application may have to be combined with adequate control over releases of toxic or highly mineralized industrial wastes into the sewerage system, where reclamation and re-use are intended.

It will probably prove most difficult to introduce reallocation dictated by purely economic considerations in the agricultural sector, since it is extremely difficult to raise the water rates for agricultural uses to anything approaching actual costs. Stringent allocation of water to the farmer, however, has proved a considerable economic incentive to raise efficiency in the use of water. This measure will, in all probability, become still more effective in the future, when the farmer will have to seek increased production and income from a practically unchanged water allocation. Statistics for the last few years prove the effectiveness of such stringency: there has already been a most significant shift of water use from low-value to high-value crops. The shift can be assumed to continue, with the exception of areas where freedom of crop choice is limited for agro-ecological reasons.

As for the introduction of high-cost man-made fresh water by desalting sea-water or brackish water, this will result in an abrupt jump in the marginal-cost

levels and lead to a reconsideration of water-application technologies in all uses, and especially in agriculture. Prevailing application techniques in irrigation based on low-cost water will no longer be satisfactory; they should be reconsidered and new techniques should be researched and developed.

WATER RESOURCES ADMINISTRATION IN MEXICO

A. O. Alba*

ROLE OF THE WATER RESOURCE

Water in relation to national development

Mexico is a country where great scarcity of water over 94 per cent of its area (63 per cent is arid, and 31 per cent is semi-arid) contrasts strongly with over-abundance in much of the remainder. Consequently, and because of the structure of the mountain ranges, most of the indigenous tribes before the coming of the Spaniards preferred to settle on the semi-arid plateaus. The population distribution hardly changed during three centuries of Spanish rule (1521-1821) and a century and a half of independence.

Despite the difficulties caused by its geography, the social and economic development of Mexico has proceeded very rapidly in the past 40 years, with an annual growth rate, both economic and demographic, higher than that of most developing countries. This accelerated growth is based upon four factors: (a) a massive agrarian reform carried out mainly in the second half of the 1930s; (b) the nationalization of power resources (petroleum in 1938 and electric power in 1960); (c) an intensive programme of population, and the construction of a large infrastructure after 1926, the year in which the National Irrigation Commission (Comisíon Nacional de Irrigación) and the National Roads Commission (Comisíon Nacional de Caminos) were set up; and (d) increasing industrialization.

The establishment of the National Irrigation Commission and its continuous activity until 1947, when it was replaced by a new body with broader objectives, the Ministry of Water Resources (Secretaría de Recursos Hidráulicos), show the great importance that has been attached by Mexican Governments to water as a natural resource essential to the country's development. Water has acted and continues to act as a catalyst in agricultural development, in industry (owing to the increased generation of hydropower and the harnessing of water for all industrial purposes), and socially by promoting public health through the supply of drinking water.

Even with vigorous state action in the past 40 years, however, it has been possible to supply water to not more than one-fifth to one-third of the total area regarded as feasible for irrigation, and that maximum area will certainly be expanded in future as technology progresses. Much remains to be done, therefore, to bring more land into cultivation by means of irrigation, while leaving enough water for industrial expansion and domestic uses. It is vital that this should be done, since 50 per cent of the population still lives on the land and there are some 4 million peasants, many of them heads of households, who lead a marginal existence for lack of land of their own or because they farm very small

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holdings where the rains either ruin the crops or, at the other extreme, produce extremely poor harvests. They cannot be absorbed speedily by industry or the service trades, and this acute social problem also has repercussions on industrial development, since so large an underprivileged sector of the population is unable to buy manufactured goods.

Water in relation to agriculture and industry

In the past 30 years in Mexico the most significant change, as in every developing country, has been the transition from an agrarian economy to one in which agriculture, though continuing to expand, plays a proportionately smaller part than industry, as shown in the following table. However, the increase in agricultural output, achieved partly through the creation of irrigation districts and partly through greater productivity brought about by technological progress, has raised or at least maintained the standard of living despite a population growth of 190 per cent within the same period. Moreover, it has had noteworthy results with regard to foreign trade. Mexico no longer imports agricultural commodities, such as wheat and even corn, and the principal exports are no longer minerals, as they were throughout Mexican history, but now include agricultural commodities as well.

There was no conflict between the use of water for irrigation and for industrial purposes until very recently, and then only in regions where water is scarce and industrialization has taken place on a large scale. There the Government has taken action, in accordance with Mexican law and relatively well-conceived development plans, to apportion the scanty supply between these two main uses. It is estimated that there will be ample supplies of water in four regions even after all the irrigable land has been irrigated; in those regions, central nuclei of industrial development will be formed. In the rest of the country, the problem of shortage has already risen in the three largest industrial centres, the Valley of Mexico, Monterrey and Guadalajara, and this acts as a brake on industrial development.

On a national scale, barely 9 per cent of usable surface and ground water is being used at present. Of that, 90 per cent goes to irrigation, 7.5 per cent to industrial, and 2.5 per cent to domestic uses. Bearing in mind that in countries which are highly developed industrially more water is used for industrial purposes than for irrigation, and that in Mexico water is scarce in precisely that part of the country in which the largest industrial centres and the majority of the population are concentrated, it is obvious that Mexico must plan its water resources in the light of its two main uses, agriculture and industry. The responsible administrative bodies are very much alive to this.

Geographic and historical background

The main features of Mexico, 1,967,200 km^2 in area, are two mountain ranges, the Sierra Madre oriental, which runs fairly close to the Gulf of Mexico, and the Sierra Madre occidental, which runs parallel and close to the Pacific and the Gulf of California. The two ranges come together near the Isthmus of Tehuantepec and then form a single range running south, the Sierra Madre del Sur. The other large range is the Cordillera Neovolcanica, which crosses Mexico from

Gross domestic product, at constant 1960 prices, by type of activity and population
(million pesos and thousand inhabitants)

	1940				1950				1960				1968			
	GDP		Population		GDP		Population		GDP		Population		GDP		Population	
	Value	%	Number	%	Value	%	Number	%	Value	%	Number	%	Value	%	Number	%
Total	45 411	100.0	5 858	100.0	86 973	100.0	8 272	100.0	150 511	100.0	11 332	100.0	254 443	100.0	14 861	100.0
Agriculture[a/]	10 226	22.5	3 831	65.4	15 442	17.8	4 824	58.3	23 970	15.9	6 144	54.2	32 665	12.9	7 391	49.7
Extraction[b/]	3 028	6.7	107	1.8	3 943	4.5	97	1.2	7 384	4.9	142	1.3	11 225	4.4	193	1.3
Processing[c/]	10 202	22.5	640	10.9	19 524	22.4	1 222	14.8	36 549	24.3	2 005	17.7	70 040	27.5	3 120	2.1
Trade and other services[d/]	21 955	48.3	1 280	21.9	48 064	55.3	2 129	25.7	82 608	54.9	3 041	26.8	140 513	55.2	4 157	28.0

Source: Annual reports of the Bank of Mexico.

a/ Agriculture, stock-breeding, game, fisheries and forestry.

b/ Mining and petroleum.

c/ Industry, construction and electric power.

d/ Trade, transport, communications, civil service and other.

east to west about half-way down. These ranges divide Mexico longitudinally into three main parts, all of them bisected by the Cordillera Neovolcanica:

1. The coastal plain of the Gulf of Mexico, stretching to the foot of the Sierra Madre oriental;

2. The Mexican plateau between the Sierra Madre oriental and the Sierra Madre occidental, divided into a southern part, lying at an average of 6,000 feet above sea level, and a northern part, which descends northward to about 3,000 feet at the United States border;

3. The Pacific coastal plain which extends from the coast to the foot of the Sierra Madre occidental, divided into a very narrow southern part, with room for only a few small valleys; and the northern plain, usually known as the Mexican northwest, 50 km or more wide, where there has been considerable development of agriculture owing to the irrigation works installed in the past 40 years.

Rainfall, to some extent, follows the topography. The humidity-laden Gulf winds precipitate their rains on the Gulf coastal plain or on the eastern flank of the Sierra Madre oriental, so that over the entire plain the rainfall varies from more than 2,000 mm annually in the south to some 1,000 mm in the north. The precipitation increases considerably when influenced by tropical storms in the Caribbean. Rainfall is scantier on the Mexican plateau, protected as it is by the eastern and western Sierra Madre. Cyclonic disturbances seldom reach that far. In general, the southern platuea is a semi-arid region with a rainfall of some 700 mm, and the northern is arid, with between 300 and 400 mm. In the far south of the Pacific coastal plain, the rainfall is over 2,000 mm because cyclonic disturbances in the Gulf cross the Sierra Madre del Sur, reach the Pacific and combine with the Pacific storms. It diminishes to about 1,000 mm immediately to the south of the Cordillera Neovolcanica. To the north, on the plain itself, the rainfall grows lighter from south to north until it is about 200 mm near the United States border. The Baja California peninsula receives only about 200 mm to 50 mm annually, so that the region is practically a desert.

River run-off of course depends on the amount of rainfall. The rivers in the south-east are the only ones with any really large flow, so that 50 per cent of the country's water runs off on 10 per cent of its area. On the plateau the rivers have little water and are seasonally erratic. On the Pacific coast, the river flows are quite large (though, with two exceptions, far less than in the south-east), but the extent of arable land in the north-western plain has led to the construction of works irrigating over a million hectares in this region alone. It should be noted, too, that except for the rivers in the south-east and two or three on the Pacific coast, the rivers dry up completely for about eight months in the year or are reduced to an insignificant flow. Run-off is thus restricted to the four months of the Mexican rainy season, usually from June to September.

WATER SUPPLY AND UTILIZATION

Current supplies and water uses

The Ministry of Water Resources has divided the country into 25 hydrological regions for the purpose of studying its water resources (see the figure, "Hydrological regions of Mexico"). Conditions in Mexico are hardly favourable to the existence of large rivers such as those in the United States or the eastern part of South America. Mexico's long narrow shape and high mountain ranges running parallel with the coasts mean that the rivers have small catchment basins, are short and fall steeply and that the inland rivers on the plateau which do not flow into the sea have a very sparse and irregular flow. The annual variations in the rainfall, concentrated in a few months, and the lack of snowfall make water flows extremely irregular and therefore hard to utilize in their natural state.

Total annual run-off amounts to 355,936 million m^3. Fifty per cent of the whole area accounts for barely 3 per cent of the total run-off of all the rivers added together. On the other hand, three regions - the Central Gulf, the Southern Gulf, and the Pacific South (southern zone) - which comprises 12 per cent of the country, produce 62 per cent of the total run-off.

The amount of water initially infiltrated that gradually rises into the surface flow is of vast importance both for its volume and for the fact that it is stored up or moving slowly in the upper parts of the basins where most of the population lives and the main industrial centres are situated. This ground water should therefore be exploited with great care. The volume that might be extracted by means of wells, filtration tunnels and the like by using the water-bearing strata as underground impounding reservoirs should be determined. Unfortunately, geohydrological research of this kind is very difficult, expensive and slow and can only be conducted in certain areas, and no general conclusions can be drawn from the findings that are applicable to large regions. In many cases ground water was not exploited because it was not known to exist. In others, it was over-exploited and the water-table lowered too far, making it prohibitively costly and finally impossible to pump up.

Since the Mexican rivers fall steeply from the plateau or the coastal ranges. they are suitable for generating electric power if their flow is regulated by storage dams. The early stages of industrialization in the 1940s were carried out primarily as a result of installing thermopower plants, but from the 1950s onwards, and especially at the present time, the main emphasis has been on hydropower stations. By 1966 total installed capacity was 5,884,000 kw, 43 per cent of it in hydropower stations. The hydropower potential of the Mexican rivers has been estimated at about 11 million kW, so that only about 25 per cent of this is being utilized at present.

Urged by the expreme shortage of fresh water in some regions, Mexico has been compelled to desalinate sea water to supply some towns with drinking water. The largest plant of the kind currently in operation is the thermopower plant which also desalinates sea water to supply Tijuana's 355,000 inhabitants.

The 100 dams and reservoirs built by the National Irrigation Commission and the Ministry of Water Resources between 1926 and 1966 have a total capacity of over 47,200 million m^3. The only fresh-water lake of any size is Lake Chapala (1,100 km^2 in area), but there are numerous small ones. Far more numerous, but small and of little use because of their salinity, are the lakes of inland basins with no outlet to the sea.

HYDROLOGICAL REGIONS OF MEXICO

Region No.	Location	Run-off volume in millions of m^3
1	Baja California, Northern Zone	312
2	Baja California, Southern Zone	262
3	River Colorado in Mexico	1,850
4	Pacífico Norte, Northern Zone	4,458
5	Pacífico Norte, Southern Zone	22,400
6	Río Mezquital or San Pedro	2,642
7-A	Río Lerma	2,561
7-B	Chapala-Santiago System	9,507
8	Pacífico Centro or Sur de Jalisco	9,469
9	Río Balsas and others	16,370
10	Pacífico Sur, Northern Zone	29,700
11	Pacífico Sur, Southern Zone	17,978
12	Río Conchos (Río Bravo Basin)	2,196
13 R.M.	Río Salado and others (Río Bravo Basin)	1,293
14 R.M.	Ríos San Juan and Alamo (Río Bravo Basin)	1,291
15	Golfo Norte	4,563
16	Río Pánuco	17,300
17	Golfo Centro	23,310
18	Golfo Sur	174,967
19	Campeche and Quintana Roo	5,615
20	Yucatán	NIL
21 and 21-A	Mesa del Norte – Interior basins, Northern Zone	556
22	Bolsón de Mapimí	SPARSE
23	Mesa del Norte – Interior basins, Southern Zone	1,661
24	El Salado	SPARSE
25	Valle de México	455
	TOTAL	355,936

The water used

There are no statistics which give even an approximate idea of the amount of water used in Mexico, though an estimate for 1960 showed that of the three main water uses, irrigation accounted for some 30,000 million m^3 or 90 per cent; industrial purposes for 2,240 million m^3, or 7.5 per cent; and domestic purposes for 760 million m^3, or 2.5 per cent. The amount of water used for grazing is negligible, except for the artificial pastures within irrigation districts, and so is the amount intended for the conservation of wildlife. It has not as yet been necessary to set aside water for navigation, pisciculture and aquaculture, sports such as swimming and boating, timber floatage and log driving, gravel dredging or salt extracting. In power generation the idea is to use the water from a river for irrigation or other purposes before it is discharged from the turbines in the last downstream power station, so that it is not simply lost in the sea after all the energy has been harnessed.

Though water should be used for artificial ground-water recharge, especially in the Valley of Mexico, to replace the amount extracted to supply the capital city with drinking water, this has not been done so far. Studies are now under way on the feasibility of rational water storage in the subsoil.

In a 1961-1963 study projections were made for 1980. In 1965 and 1966, the Ministry of Water Resources made other projections, but both these studies are statements of the targets which it would be desirable to attain rather than realistic projections of what is likely to happen. In a developing country with accelerated industrialization, however, everything indicates that while the amount used for irrigation, industrial and domestic purposes will increase quantitatively by 1980, the proportions will differ from those in 1960 in that the percentage of water used for industrial purposes will increase greatly, that for domestic purposes slightly and that for irrigation will decrease.

In irrigation, ever since the establishment of the National Irrigation Commission in 1926 the intention has been to charge rates that would not only cover the operating and maintenance costs of the irrigation equipment, but also compel consumers to use the available water economically. However, very low rates were in fact fixed in order to help poor groups of farmers with extremely small holdings, and often they were not charged at all, or long periods were allowed for payment. Since 1965 the Ministry of Water Resources has undertaken an exhaustive study of water use in irrigation districts and has found that, on the average, 50 per cent of the water that flows out of the headwaters of the irrigation systems is lost in conveyance (chiefly by seepage). But on the holdings themselves, only half of the 50 per cent which reaches them is used effectively. Hence, 75 per cent of all water supplied is wasted.

Except in a few special cases, no adequate control of pollution exists as yet, though studies have begun on methods of regulation of rivers flowing through densely populated areas. Towns are accustomed to discharge their untreated sewage into rivers, and national standards of drinking-water quality are only just beginning to be put into force in the largest urban centres.

Besides its own waters, Mexico uses those alloted to it under two treaties with the United States. The first, dated 1906, apportions the frontier waters of the Rio Bravo (Rio Grande); the second, dated 1945, the waters of the

Colorado and the Rio Bravo. The problem is that Mexico has at times received, instead of the waters of the Colorado to which it is entitled for the beneficial purpose of irrigation, salt-contaminated fossil waters pumped from the subsoil of the state of Arizona. The complaint lodged by Mexico was received by the Government of the United States with evident goodwill, but with only partial success. In the case of the Rio Bravo, where more than 70 per cent of the water comes from Mexico, the treaty led to a demonstration of co-operation between the two countries in the building of two large storage dams, Falcon and La Amistad, to harness the waters for power generation and for irrigation in both countries.

There are several international rivers on the southern borders of Mexico. Among the largest are the Usumacinta, which rises in Guatemala, serves as the frontier for more than 200 km and flows into the sea in Mexico; the Grijalva, which rises in Guatemala, though the greater part of its basin is in Mexico; and the Rio Hondo, which forms the frontier with Belize (British Honduras). These rivers should be regulated by international treaties, but none are contemplated at the present.

There are some disputes, happily of a minor character, about the distribution of water within Mexico between states. In such cases, the Mexican Federal Government has set up commissions with representatives from each of the states concerned to study the rivers and regulate their use. Installations are built in such a way that the benefits are distributed as equitably as possible among all the co-basin states.

LEGAL FOUNDATIONS

Water ownership and water stewardship

From the Spanish conquest (1521) to Independence (1821), lands and waters were owned by the Spanish Crown and disposed of by individual royal grants (mercedes) or collective royal grants for the benefit of towns which gave the latter preferential rights. For some time after Independence the laws of the Colony, and of Spain itself, continued to be applied in the new nation, and the earliest regulations of independent Mexico originated in the 1857 Constitution and the Civil Code deriving from it.

The first Waters Act, passed in 1910, was seldom applied because the Constitution of 1917 radically changed the bases on which the national economy was organized. Article 27 of the Constitution asserted that the original or ultimate title to all lands and waters was in the nation, which might transfer them to private ownership. It enumerated the waters declared public: of the fresh waters, these comprise natural lakes directly connected with streams having a constant flow; rivers and their tributaries (perennial, intermittent or torrential); interstate or international streams and lakes; springs rising on beaches and other areas of national ownership; and waters extracted from mines. Waters not enumerated are deemed private property, but if located on two or more properties, their utilization is considered of public utility and subject to such regulation as the states may make.

The 1910 Waters Act continued to be applied only where it did not conflict with article 27 of the Constitution, pending the enactment of a new law based upon

that article. But before such a new law could be enacted, the Irrigation Act of 4 January 1926 was passed, setting up the National Irrigation Commission (Comisión Nacional de Irrigación) to promote and build irrigation works, and making the Act applicable both to private agricultural property and to the rights of water users within the federal jurisdiction.

The Act Concerning Waters in National Ownership of 1929, drafted in conformity with the water provisions of article 27 of the Constitution, specified the conditions for granting concessions for the use of waters (including the issuance of a provisional permit until the concession holders completed the facilities to the satisfaction of the authorities); authorized the establishment of users' associations to manage the water system; and empowered the Federal Executive to regulate or modify the method of using the waters.

In 1934 a new Waters Act was passed, very similar to the 1929 Act, but with some additional features. It authorized the establishment of prohibited zones to protect the works constructed by the National Irrigation Commission and of water boards (juntas de aguas) to supervise compliance with the regulations governing the distribution of water. It also modified the rights and powers of the users' associations (juntas de usuarios) and provided for the creation of national hydropower reserves.

Towards the end of 1946, it was deemed essential to set up a single governmental body to exploit the country's water resources as effectively as possible, and on 31 December of that year was passed the Irrigation Act, which is still in force. Its objective is to develop and promote works for the irrigation, drainage and protection of lands, as well as the settlement of the improved lands, so as to increase and ensure agricultural production through maximum utilization of the country's water resources.

The Health Engineering Act of 30 December 1947 vests in the Federal Government the sole right to plan, design, construct and operate water supply facilities in towns and cities if these are financed wholly or partly from funds supplied, endorsed or guaranteed by the Federal Government. Supplementing this Act, the Act concerning co-operation in constructing drinking-water facilities came into force in December 1956, whereby the Federal Government meets part of the cost by reimbursable or non-reimbursable investments in an amount varying with the size of the population centre concerned.

Regulation of water and adjudication of water rights

Mexican citizens and corporations formed pursuant to the laws of Mexico may use or exploit surface waters in national ownership by any one of the following methods:

(a) By concession granted by the Federal Executive;

(b) By registration in the official registers of the national irrigation districts in the case of exploitation of an area which has been declared a closed zone because the Federal Executive, under the Irrigation Act, has approved a project for it. In these districts, users may be either private individuals or members of an ejido;

(c) By virtue of quiet and peaceful enjoyment of the water for five or more years without prejudice to third parties. The legal formalities for the regularization of the abstraction and use of the water must be complied with.

Under the 1934 Act the order of priority in the use of water is: (1) Domestic uses, public services, baths and cattle watering-places; (2) Water supply for railroads and other means of transport; (3) Industrial uses, other than power generation; (4) Irrigation of land; (5) Electric-power generation; (6) Land reclamation (silt and sedimentation clearance); (7) Other uses (pisciculture, timber floating, log driving and so on). The Act states that nationally owned waters may be freely appropriated by manual methods and for domestic uses, provided that the waters are not diverted from their course.

When the Ministry of Water Resources takes under consideration an irrigation project or group of projects which requires the maintenance of the existing situation, the Ministry issues a restriction order, and so long as this is in force, any permit issued for water use must be temporary. Persons holding temporary permits may not assert at law any right to the use of the water and are not entitled to make any claim for the recovery of damages incurred in suspending its use.

For ground-water exploitation, a permit is required only in prohibited zones or regulated areas, and it is issued without prejudice to third persons after completing the formalities prescribed in the Act Concerning Waters in the Subsoil and accompanying regulations. This Act specifies that a concession or permit is required for extracting and using thermal ground waters. Priorities are established for their use, and the Federal Electricity Commission has a right to the preferential use of such waters. All projects for extracting ground water must be registered with the Ministry of Water Resources, irrespective of whether they are located in a prohibited zone, a regulated area in which ground water may be freely extracted, or a national irrigation district.

Offences against the Act or involving civil liability are subject to the provisions of the penal code of the Federal District and Territories. Where land has been adversely affected by storage reservoirs or structures, agreements are negotiated with the users either on assessment or on compensation, if it is agreed that payment shall be made in cash or in kind. Expropriation is resorted to only if it is not possible to reach a settlement with the owners or in the case of ejidal lands.

NATIONAL AND SUBNATIONAL JURISDICTION

National powers, functions and services

With the establishment in 1926 of the National Irrigation Commission, a body endowed with very large financial resources and staffed by experts, there began a process of centralization of water resources development, which culminated on 1 January 1947 in the conversion of the Commission into the Ministry of Water Resources. The Ministry was given the functions of inventorying water and soil resources, developing irrigation and community drinking water supplies, land drainage, sewerage, flood control, navigational improvement and the granting of

concessions and regulation of the use of flowing streams. This involved taking over responsibilities previously exercised by many different government departments.

In addition to these functions, and in view of the interdependence of natural resources, the Ministry of Water Resources was given the task of setting up and presiding over semi-autonomous bodies, known as Commissions, to take charge of the integrated and harmonious development of all the natural resources, renewable or non-renewable, of river basins in which intensive development was considered desirable or necessary. This means that in dealing with water resources the Ministry acts directly and full powers throughout the country and only indirectly when dealing with other natural resources connected with water, except that in certain specific areas, through these semi-autonomous and decentralized bodies, it takes direct charge of the development of all natural resources. There were two such areas in 1947, the Papaloapan and Tepalcatepec basins.

Two functions, originally given the Ministry, were removed from its jurisdiction almost from the start. Electric-power generation was transferred to the Federal Electricity Commission, which has broad autonomy even though its president is the Minister of Industry and Trade. The second function removed from the jurisdiction of the Ministry of Water Resources was the supply of drinking water to the Federal District, in which the capital, Mexico City, is situated. In 1959, the Government decided that the supply of drinking water to population centres of less than 2,500 inhabitants should be a function of the Ministry of Health and Welfare. These measures, nevertheless, should not be regarded as indications of a trend toward diminishing the powers of the Ministry of Water Resources, but merely as originating in different government policies. The Ministry co-operates with the states, though in fact the only co-operation it receives from them is financial, for in constructing facilities for irrigation or drinking water supply it carries out all the planning, surveys, design and construction.

Regional powers, functions and services

As noted above, soon after the establishment of the Ministry, it set up river basin commissions, two in 1947 for the Papaloapan and Tepalcaltepec, and two more in 1952 for the Fuerte and the Grijalva. In their enabling decrees, these commissions were given very wide powers in the planning, design and construction not only of waterworks but also of means of communication (ports, roads, railways, telecommunications) and works connected with the creation and expansion of population centres. In addition, they were given full authority to take measures and make provisions pertaining to industry, agriculture and rural settlement in so far as these related to integrated basin development.

Local community powers, functions and services

Very few facilities for water development have been provided by local initiative; most of them were built by private persons or waterworks for supplying those industries which can afford to build and operate them. The majority of all works, as stated previously, are built and administered by the Ministry.

There are practically no corporations, limited companies, private utilities, mixed enterprises or independent public corporations in Mexico managing water, and

the only co-operatives in this field are those constituted by users of irrigation systems, which, strictly speaking, function under government control.

ORGANIZATIONAL AND OPERATIONAL FRAMEWORK

Apart from the Ministry of Water Resources, the following government agencies have to do with water at the national level: the Federal Electricity Commission, the Department of the Federal District, the Ministry of Health and Welfare, the Ministry of the Navy and the Department of Agrarian Affairs and Rural Settlement. The Federal Electricity Commission, with prior permission from the Ministry of Water Resources, constructs storage or diversion dams, channels and power lines to supply the hydropower plants it administers. The Department of the Federal District is responsible for all projects for industrial and domestic water supply to the District. Both for sources of supply within the District and even more for those outside it, the permission of the Ministry of Water Resources and co-ordination of plans with it are required. The Ministry of Health and Welfare must likewise obtain permission from the Ministry of Water Resources to use water for community supply to population centres with less than 2,500 inhabitants. The Ministry of the Navy controls navigation on Mexican rivers, but this applies only to very short stretches near the estuaries of large rivers which have an abundant perennial flow.

The Department of Agrarian Affairs and Rural Settlement intervenes with regard to water concessions to ejidos, in some cases independently of the Ministry of Water Resources. In mixed irrigation districts, however, in which there are ejidos and smallholdings (as is the case in almost all the districts set up by the Federal Government since 1926), the regulations are made by the Ministry of Water Resources after consultation with the Department.

The centralized organization for water control and management in Mexico was not established as a prerequisite for international or domestic financing, but arose from the importance which had necessarily to be attached to water development in a predominantly arid country. There is an unusual concentration of power in the Federal Government in Mexico in comparison with other countries with apparently similar political régimes. This relates both to the powers held by the Executive as against the Legislature and the Judiciary, and to the vast difference in resources and power between the Federal Government and the governments of the states. Given this type of national institutional régime, the establishment of the Ministry of Water Resources thus represented the most efficient way of planning, studying, designing, building and administering almost all the water supplies and works in the country.

Multipurpose administration - the basin commissions

The quasi-autonomous and quasi-decentralized commissions referred to earlier are of two kinds, executive and study. Executive commissions study, plan, construct and administer the water projects in a river basin. To this type belong the Balsas river, Papaloapan, Grijalva and Fuerte commissions. Study commissions, as their name implies, survey water projects in which several states participate or schemes which are studied for other political, social or economic reasons. They are

wholly agencies of the Ministry of Water Resources, although they operate with a certain degree of independence; and there are three of them: the Hydrological Commission of the Valley of Mexico, the Lerma River-Lake Chapala-Santiago River Commission and the Panuco River Commission.

The Balsas River Commission is in charge of the integrated development of all natural resources within the basin area of 117,000 km^2 (6 per cent of the area of Mexico). In addition to the work which it performs directly with the budgetary funds allocated to it and the internal credit it obtains, it solicits the co-operation of the respective ministries. It also receives the co-operation of the governments of the states in the basin, the many local authorities and the inhabitants personally.

The Papaloapan Commission, as mentioned before, operated with wide powers from 1947 until the end of 1952, and with a larger budget but smaller powers from 1953 to 1958. Since 1959 it has been given funds only to maintain what had been built up and to carry out work of very minor significance. The break in the programme's continuity was reflected in a devastating flood in the lower part of the basin in 1969, due to failure to build a second storage and flood control dam which had been planned almost 20 years previously.

The Grijalva River Commission, set up in 1952, also had its powers severely reduced, and this led it to concentrate mainly on building a storage dam to harness the Grijalva, the second largest river in Mexico.

The Fuerte River Commission, set up in 1952, has functioned since 1953 more or less as an irrigation project only. A large storage dam was built as well as channels to irrigate 230,000 ha.

Of the study commissions, the Hydrological Commission for the Valley of Mexico is to study problems of hydrology and water supply for domestic and industrial use in this area of 8,000 km^2, which lies at over 6,500 ft. above sea level, contains 16 per cent of the country's total population, and is the largest industrial area in Mexico. The Lerma River-Lake Chapala-Santiago Commission operates in a very important water system which traverses the most densely inhabited part of the Mexican plateau, flows into Lake Chapala, also ringed by very populous areas, and discharges into the Pacific via the Santiago river whose steep falls provide means for the generation of large quantities of electric power. The irrigable area on the coastal plain is so small that a great deal of the flow here remains unused.

The Panuco River Commission pertains to a river of considerable volume which rises near the Valley of Mexico and flows into the Gulf near Tampico. If it were harnessed, disastrous floods could be prevented, large quantities of electric power could be generated and vast stretches of land now unused or devoted to extensive grazing could be irrigated.

Exercise of the co-ordinating function

A good measure of co-ordination is generally achieved in everything relating to the study, planning and building of waterworks by agencies of the Federal Government other than the Ministry of Water Resources, owing to the legal requirement to consult and to obtain prior permission from that Ministry. The

Department of Agrarian Affairs should in theory take charge of the regulation and administration of irrigation districts which are wholly ejidal, but in most cases it is taken for granted that the Ministry of Water Resources actually performs this function. In irrigation districts set up by the Ministry, the executive committees settle any points in dispute at meetings presided over by the delegate or manager from the Ministry with representatives of all the other ministries concerned (including Agriculture and Stock-breeding and the Department of Agrarian Affairs). With respect to dams built by the Federal Electricity Commission and drinking water supply to Mexico City by the Department of the Federal District, there is effective co-ordination between them and the Ministry of Water Resources, to whose authority they defer as far as the water is concerned.

THE PLANNING FUNCTION

After some years during which the Ministry of Water Resources, for no very discernible reasons, devoted rather less attention to planning and the study of new projects, it began once more in 1964 to attach great importance to planning water resources and to better methods of utilizing and administering them.

The apparatus for planning

The Secretariat of the Presidency, another agency of the Executive, correlates the plans prepared by each of the ministries, including the Ministry of Water Resources. It also requires an economic assessment of the projects in order to relate them to those of other ministries and to any programmes for economic development at the national level prepared by the Office itself.

As the agency responsible for planning the use of water, the Ministry of Water Resources set up an internal Department of Planning in 1965. In some cases the Secretariat of the Presidency has not considered the Ministry's water development plans as meriting immediate execution, according them a lower priority than plans by other ministries and deferring them to a later date.

Water planning and development planning

Short- and long-term plans have been prepared to redistribute the available water supplies as far as possible by taking water from areas with an excess over demand and transferring it to areas where shortage is an obstacle to development. Thus, in 1947 emphasis was shifted from the single-purpose project to develop a particular flow, with which water policy began in 1926, to integrated development of whole river basins; and in 1967 the concept of the regional plan was established, which, without prejudice to previous activities, promotes the combined development of the water supplies of a number of river basins, thus opening up wider prospects for rational development.

Since large agglomerations of population are situated on the plateau at a height of 4,500 ft. or more above sea level, and since most of Mexico's industry is also concentrated there, the main trend in water planning is to ensure that the

waters which rise in the higher parts of the country are used to meet the requirements of the local population; that those which rise at an intermediate altitude are used at that level; and, lastly, that such stream flows as reach the coast unused in their own basins are channelled to other coastal areas.

Some of the more important regional and national plans are the water plans for the North-west, Centre and Gulf, the national plan for small-scale irrigation, and the plan for improved efficiency in the use of water. The water plan for the North-west (Plan Hidraulico del Noroeste, or PLHINO) was prepared on a medium- and long-term basis for medium- and large-scale irrigation under the new regional planning concept. When completed, it will promote the combined development of seventeen rivers in this area, with an aggregate run-off of 25,000 million m^3 annually, the total area of the basins being 350,000 km^2. The irrigated districts situated in this region, now covering 874,000 hectares, will be increased by 426,000 ha. to make up a single district of 1.3 million ha., with development of the ground waters as well. This unit will be more economical and flexible and will provide a more constant supply of water.

A water plan for the Centre is in preparation, not only to provide for the irrigation of a large number of rural communities with very scanty supplies, but also to solve the problem of the water supply of Mexico City and adjacent urban zones. In addition, it will make possible a better use of the increasing waste waters of Mexico City, which at present are being carried off to the sea. The linking of the water plan for the Centre with the Lerma Plan will transform the original concept of the integrated development of a single basin into a regional plan. Also in preparation is the water plan for the Gulf, making possible the combined development of four large river basins in the North-east, the Panuco, Purificacion, San Fernando and Bravo.

The national plan for small-scale irrigation is aimed mainly at units which cannot draw on a large irrigated area owing to their natural conditions - shortage of water, land or both. Projects have been prepared in two stages, which together can be carried out in 10 years, for irrigating 306,000 ha.

The plan to improve efficiency in the use of water, or Holdings Improvement Plan (Plan de Mejoramiento Parcelario (PLAMEPA)) was resolutely initiated. According to the Ministry of Water Resources, "the main reason for the present low level of efficiency is the great loss in conveying the water through the conduits to the channels from the sources of supply to the intakes on the holdings, and the very large losses when the water is distributed on the holdings themselves".

From preliminary results of water measurement in the principal Mexican irrigation districts, the Ministry has worked out a programme for recovering the water wasted, the target being to raise utilization performance from the present 25 to 49.5 per cent (made up of a conveyance performance raised on an average to 65 per cent, and a holdings performance raised to 70 per cent).

Though the plans mentioned above are primarily a matter of engineering, they are also based on important economic considerations. However, it cannot really be said that the water plans are part of or are closely related to any national economic development plan, for no such plan has yet been prepared in Mexico, where it is customary to prepare only one or two years in advance "programmes" rather than "plans" for the ensuing six-year presidential term of office. Since the

institutional régime in Mexico is essentially presidential, national development plans and long-range water plans are not closely adhered to from one government to the next, despite a notable continuity in performance, especially as regards water, but at best are simply regarded as useful guidelines, which change over the years in accordance with the programme each new President sets for himself and with social and economic problems as they arise.

Those responsible for water planning prepare the regional projects for water development with great theoretical expertise, but given Mexico's institutional structure, they have little or no contact with the sectors of the national economy concerned and the sectors which are eventually likely to be affected before they arrive at their decisions.

Owing to the continuous work on water development since 1926, and especially since 1947, Mexico possesses fuller data and statistics than most so-called developing countries, comparable to some extent with those available in more highly developed countries. More than 3,000 meteorological and 2,000 hydrometric stations have been in operation for many years, and statistics for agriculture, stock-breeding, industry population and the like are compiled annually and are checked against a decennial general census which is becoming fuller and more accurate from year to year, since its inception early in this century. Plans are prepared on the basis of this information by means of thoroughly devised and systematized programming on computers.

Agencies are now being set up in the public sector to devise integrated regional development plans, differing from those of the commissions responsible to the Ministry of Water Resources previously mentioned. On the basis of these plans pre-investment projects are prepared and decisions taken on what water management projects are to be carried out. One example is the Lerma Technical Assistance Plan set up in 1963, which has worked out specific development plans and investment projects for eight states with an area of 130,000 km^2 and a population of about 10 million. This agency is primarily concerned with providing the pre-investment factors for optimum regional use of land and water. It determines the criteria by which the public sector can best channel funds to rural areas in a co-ordinated scheme by stimulating the strategic participation of the leading agencies which lay down national agricultural, financial, irrigation and industrial policy. The Lerma Plan assesses its programmes by measuring the expected impact on the areas affected by them in terms of increased productivity, the formation of development nuclei, manpower training, farm mechanization, higher levels of living, the gradual incorporation of the peasant population into the market economy and the effect on the national balance of payments. A prominent position within the studies conducted by it is given to very complete programmes for the economic and social infrastructure; and several of the projects for irrigation works, electrification and drinking-water supply included in them have been carried out by the public sector, financed in part by funds from international sources.

FISCAL ADMINISTRATION

Investment in water facilities

The Government's policy for investment in water resources is based on social profitability as well as direct recovery of investments by virtue of their remunerative yield. Taking this view and adopting the highly conservative assumption that the farmers' total costs (including interest, insurance and taxes) absorb about 75 per cent of the productive value of irrigation works and that the remaining 25 per cent is net profit, we find that over a 40-year period (to 1966) net profits alone were larger than the investments in irrigation works. In addition, large population nuclei were created by these investments, owing to the attraction exerted by the economic activities developed around them, establishing a definite trend towards the intensive growth of urban or rural zones in the irrigated districts and helping to alleviate the problem of migration of labour to the great cities. In fact, irrigation areas have drawn a large, economically active internal migration, which would otherwise probably be relegated to the margin of society and become destitute. Generally speaking, the states which have obtained most irrigation have experienced a proportionately larger and more rapid population growth than those receiving less. Irrigation has also brought in new industrial and commercial activity, which has promoted urban growth, as in the case of Baja California, where the urban population rose from 54 to 77.7 per cent of the total between 1930 and 1960. It has also been found that, since levels of productivity and earnings are higher in the irrigated areas, the settled population can take advantage of welfare centres and the illiteracy rate falls. Peasant housing conditions, too, are better in irrigated areas than in seasonal farming areas.

The growth of the agricultural sector over a 40-year period (1926-1966) averaged 5 per cent yearly - higher than the rate of population growth, 3.1 per cent - and while this can be attributed to the establishment of a pricing policy, the use of improved inputs and the greater use of credit, machinery and technical assistance, it was more specifically due to the bringing of new land into cultivation by means of the public sector's intensive irrigation policy. The irrigation carried out in those years resulted in the irrigation districts producing about 30 per cent of the value of the harvests, even though they accounted for only about 15 per cent of the area harvested. Moreover, by increasing output and diversifying crops as a result of irrigation, it became feasible to increase exports of agricultural commodities and thus earn more foreign exchange, thereby carrying forward the process of industralization.

The harnessing of rivers for power dates far back. Power plants were installed for municipal supply as early as 1881, and the application of electric energy to industry began in 1889, when mining companies with United States capital introduced hydropower into Mexico. There have been several well-defined stages in the development of the national electric energy system. During the period 1933-1950, the fact that supply was lower than demand acted as a brake on economic activity, but by 1950 the Federal Electricity Commission had both stepped up its investments and improved operational co-ordination, and this induced other undertakings to improve their plants and distribution networks.

Funding and vending

Investment in irrigation is financed from internal and external sources. The internal sources are the water rates, the ordinary budget of the Federal Government, co-operation by state governments and individual users; and private companies, contractors, manufacturers and the like. Though the Agricultural Credit Bank, the Agriculture and Stock-breeding Bank and the Ejidal Bank are primarily sources of financing for agriculture and stock-breeding, the Agriculture and Stock-breeding Bank has recently begun to grant credits for the execution of water projects.

The external sources are the Inter-American Development Bank (IDB) and the International Bank for Reconstruction and Development (IBRD), which first granted Mexico loans for this purpose in 1961. These two banks together have granted Mexico a total of 2,683.55 million pesos (mn $) for irrigation, mn$ 78.75 million for pre-investment studies, and mn$ 175.3 million for the construction of drinking water supply systems. The loans granted to Mexico by the IBRD were used in their entirety for rehabilitating irrigation districts, which in some areas were in very bad condition from salinization.

The Federal Government's policy with regard to rates in the irrigation districts is designed to render them self-supporting as regards both operation and maintenance. The intention is that the users shall meet all the costs for water distribution, upkeep and management, as well as irrigation and drainage engineering. However, there has always been a considerable gap between users' rates and total costs of the irrigation districts, which gap has been met by government subsidies. Whereas the government subsidy to irrigation districts in 1950 amounted to only 5.5 per cent of total costs, it rose to over 50 per cent in subsequent years, reaching a high point of nearly 69 per cent in 1959. In the 1960s it averaged 40 per cent of total costs, the remainder being financed by revenue from users' rates.

The rates currently charged in irrigation districts are of four types: rates for irrigation service, used for operation and maintenance; offsetting rates, used for amortization of the structures; co-operation rates, used for the solution of problems which arise from time to time in the districts and in some cases for improvements; and rehabilitation rates, used for amortizing the cost of rehabilitation of irrigation districts. Sources of funds for debt retirement are mainly the offsetting and reclamation rates. The rates collected in irrigation districts are in no case used for reinvestment.

Government policy with regard to rate fixing has varied from one administration to another. Among the various methods of calculating rates for operation and maintenance are: a fixed annual rate per hectare to cover maintenance costs; a rate per thousand cubic metres of water to cover water distribution costs; a rate per hectare per irrigation operation; and a rate per hectare irrigated annually, irrespective of the number of irrigation operations and the volume of water used in them. The present tendency is to charge a rate based upon the volume of water used yearly, i.e. per thousand cubic metres, according to the following formula:

$$R = \frac{\text{Total amount of annual costs}}{\text{Volume of water per annum}}$$

This is called a self-supporting rate, but, as noted above, the rates are not high enough to cover costs, and the computation of the real rate is affected by such factors as the users' ability to pay. The subsidies paid to the state governments by the Federal Government vary considerably with current policy. As a general rule, the aim is to obtain the largest possible return on each peso invested, but in the case of very needy population centres the Government prefers to earmark part of the investment for procuring greater social benefits.

Under the Constitution the local authorities are primarily responsible for public drinking-water supply and sewerage. The Act Concerning Co-operation in Supplying Drinking Water to Municipalities provides that the Federal Government shall co-operate with the local authorities in constructing drinking-water supply installations by means of non-recoverable investments equivalent to one half of their cost in places with a population of less than 30,000 and one third in places with a population of 30,000 or more. This investment is granted as a subsidy if the Government has not already co-operated in financing water supply to a place, or as a recoverable investment if it has already done so.

Labour and local building materials for drinking-water supply installations are furnished by the users, and in some cases they pay cash. The Government's policy is not to provide financing if the users are able to meet the cost; if they cannot do so, they may apply to the state government or to a credit institution - usually the National Public Works and Services Bank, which is a state bank. (The private sector usually applies through its municipal representative for such credit, and the Bank charges 9 per cent interest per annum, the loan being repayable in 10 to 15 years. In such cases the state government is required to guarantee the loan out of its share of the federal taxes. Credits have also been obtained from contractors for shorter terms and at higher interest.) The Federal Government grants loans only if the costs cannot be met after application to all the aforementioned sources of financing, reserving its funds for poorer communities. Some years ago funds for constructing drinking-water installations were obtained from international financial organizations; but the criteria for the further allocation of funds in this area are currently under review.

Investments are recovered from the yield from the rates. These must be adequate, and their yield should cover current operating, management and maintenance costs, i.e. ensure that the system works properly. In addition, the yield should be large enough to make provision for the growth of urban development and for the formation of a reserve fund to cope with future needs for expansion. The rates must be fair in that users who consume the least water, i.e. those with the lowest incomes, should pay less than the average rate per cubic metre. The Ministry of Water Resources' policy thus differs from that in highly developed countries, where the more water is used, the less is charged. In Mexico the rates are progressively graduated in accordance with a concept of social justice and they are fixed by the following formula:

$$\frac{\text{Total cost of installation}}{\text{Volume of water salable during operating life}} = \text{Average cost per cubic metre}$$

The Ministry itself does not fix these rates; it only reviews them. The future users set up a Rates Committee (Comite de Tarifas) to set the rates after the average cost per cubic metre has been determined.

The basic objective of the National Plan for Supplying Drinking Water (1966-1970) was substantially to increase and improve drinking-water supply services so that the investment would both yield the largest possible return and produce a higher level of general well-being. In 1965 it was estimated that 8 million people (46.6 per cent of the urban population) had drinking water outlets at home. The Plan target was to extend existing systems and begin construction of new systems so that by 1970 a total of 15.3 million (or 70 per cent of the estimated urban population in that year) would be supplied at home from the mains and the rest of the population from public hydrants.

The Plan required an investment of mm$ 2,000 million (1966 rate) financed primarily out of contributions by the beneficiaries themselves, by local governments and by the Federal Government, amounting to 72.2 per cent of the total; the remainder was to be raised from internal and to a far lesser extent from external credits.

Budgeting and accounting

In most under-developed countries public investment generally tends to flow into superfluous works and is not governed by objectives set in long-term planning; moreover, there is a notable lack of continuity in carrying out projects for public works. Mexico has to some extent solved this problem as far as water resources are concerned.

Investments by the Ministry of Water Resources are financed largely from budgetary allocations, as well as from co-operation by private persons, credits from contractors and manufacturers, and external financing, the proportions in the 1960s being of the order of 50 per cent, budgetary allocations, 6 per cent, contributions from state governments, local authorities, and private sources, and the remainder from internal and external financing.

The Ministry's budget estimates show that a large proportion of its total expenditure goes for irrigation and flow control, drinking-water supply and sewerage, operation, upkeep and rehabilitation of irrigation districts, and executive and study commissions. This budget structure has a very positive effect, since water projects directly stimulate other sectors of the economy and yield ample returns both socially and economically. Though direct recovery through the offsetting rates does not bring in enough to cover the cost of the works, indirect recovery not only offsets, but actually yields more than their cost. For instance, the ad valorem and other taxes on agricultural commodities have enabled the Government to recover much of the money invested in water projects, and the tax on business earnings has also produced large revenues for the local state treasuries and the Ministry of Finance. Hydropower generation is an item of the utmost importance in helping to recover these investments. Lastly, the value of lands which before was virtually nil rises considerably, and they are taxed as highly productive, not as waste lands.

To establish criteria for investment in power generation, the procedure is to examine a set of alternative project programmes, each of which has to meet the minimum conditions for satisfying the systems' power requirements. The appraisals therefore include the investments planned and the costs arising from the operating programmes of all the plants concerned. In practice this is done by mathematical simulation including random factors of all the systems' operating conditions by the use of probability techniques.

With regard to the siting of multipurpose water facilities, the basic investment criterion in the construction of hydropower dams is the possibility of re-using the water for irrigation and to supply population centres. A further criterion, for setting up transmission lines and distribution networks, is the potential demand in the areas to be electrified. This indirectly brings in the question of the electrification of population centres of less than 500 inhabitants and entails consideration of the social aspect and the stimulus to national industrialization.

EXPERT ADMINISTRATION AND CITIZEN PARTICIPATION

The result of the development of irrigation projects, begun in Mexico in 1926 by the National Irrigation Commission, of hydropower and thermopower plants, begun in 1937 by the Federal Electricity Commission, and the integrated utilization of water, begun in 1947 with the establishment of the Ministry of Water Resources, has been the formation of a body of technicians with several decades of experience as hydrologists, designers of waterworks, builders of hydraulic installations, and managers of irrigation districts, hydropower plants and drinking-water supply systems.

The very complete water-supply programme developed in Mexico has made it necessary to call on a large number of trained personnel at each stage, and no fewer than one third of the engineers turned out at the Mexican universities work on water resources development. The domestic demand for these experts is so great that whenever the opportunity or need arises to send Mexican experts to work in other countries even for short periods, there is a real difficulty in finding people to go, since all of them have such ample opportunities to work in their own country. No manpower inventory of the number of experts needed for these stages exists, much less for water management. Demand and supply alone meet this requirement and do so fairly satisfactorily. All works since 1941 have been built on contract awarded by competitive public tender to increasingly capable and increasingly mechanized Mexican undertakings. For surveys and projects, the Ministry of Water Resources has for more than a decade availed itself of the services of two types of private bodies: (a) highly specialized Mexican firms of consulting engineers with many years' experience; and (b) institutes in some Mexican universities equipped with experts with the very highest qualifications, laboratories and electronic computers.

Training and education

Nevertheless, though there are highly specialized engineers and economists, there is some lack of engineers with economic training or management skills. Only in recent years have economic and administrative subjects been included in engineering courses, as well as specialized courses in hydraulic technology and water systems administration techniques. Hydrologists, who had been well versed in surface water phenomena but had left ground water to the hydrogeologists, have been making a real effort to become expert in both fields, and, similarly, engineers familiar with the construction of water installations are becoming better acquainted with the basic problems of water administration. What is most lacking in Mexico is training courses for the lay personnel working on water systems.

The role of water users

There are no public relations programmes as such involving the education of water users in the utilization of water which would be reflected in a more effective management of water systems. Down the centuries Mexicans have been only too well aware that the greater part of the country is arid, a circumstance which they confront resolutely, co-operating willingly in emergency measures.

The Ministry of Water Resources has, since its establishment, but more intensively in recent years, undertaken programmes inter alia to curb waste, counter the dangers of over-irrigation, recommend the advantages of water and soil conservation practices and draw attention to the pollution resulting from excessive use of agricultural pesticides and domestic detergents. But beyond the plans mentioned earlier, relating to water economy in conveyance to irrigation districts and on the holding itself (PLAMEPA), it must be admitted that very little has been done, for example, to prevent the silting up of storage dams by building small check dams or to counter the increasing threat of industrial pollution.

There are significant cases of water development by the users themselves, mainly of ground waters, and user co-operation is secured for drinking-water supply projects. In some instances a radical policy has been followed of refusing to construct works in large towns unless the users are informed of the project and signify in advance their consent to pay the appropriate water rates.

CONCLUSIONS AND RECOMMENDATIONS

Achievements and deficiencies

Chief among the many positive achievements are:

1. Irrigation. The Federal Government has succeeded in bringing under irrigation in a country which is 94 per cent arid or semi-arid, and within the space of less than half a century, more than 2.5 million ha. which produce 30 per cent of the national agricultural output although they comprise only 15 per cent of the total cultivated area. To this must be added another one million hectares which have been irrigated privately in the course of time.

2. Power-plant construction. Begun by the Federal Government in 1937, this has given Mexico a total installed capacity of more than 5,884,000 kw, 43 per cent of it from hydropower plants. The nationalization of the public service power companies by amendment of the Constitution in 1960 must be regarded as another extremely important achievement.

3. Promotion of water project construction for domestic and industrial uses. This was begun in 1947, with the establishment of the Ministry of Water Resources.

4. The almost total centralization of the planning, study, projecting, building and administration of water resources development in a single agency, the

Ministry of Water Resources. This Ministry has been, since 1947, one of the three government agencies with the largest budgetary allocation.

5. The Mexican people's full appreciation of the vital importance to national economic development of multipurpose water utilization, in accordance with carefully prepared and well-balanced technical, social and economic plans.

6. The high technological level achieved by Mexican engineers and economists with regard to water development, which has eliminated the need for foreign technical assistance.

The major needs and deficiencies are:

1. The lack of an amendment to the Mexican Constitution integrating ground waters, at present the property of the owner of the land beneath which they lie, with the other waters which are nationally owned.

2. The need to unify the many laws relating to water in a single code. The laws at present in force were enacted at widely different times, e.g. the Waters Act, in 1934, the Irrigation Act, in 1946, and the Act Concerning Subsoil Waters, in 1956. Because of the rapid growth of population and industry and the development and nature of the agrarian problem, many provisions in these Acts are obsolete, others need to be brought up to date and new regulations need to be introduced. Codification should include development of projects executed by the Federal Government, alone or with the co-operation of private persons, and projects carried out by private persons under federal concession. It should remedy the deficiencies noted so far and introduce any innovations calculated to make for better use and development of water resources and, above all, to ensure that these works are carried out with a very definite sense of social responsibility for the benefit of the poorest peasants as a factor contributing to the solution or alleviation of Mexico's serious agrarian problem.

The innovations should include inter alia: the establishment of basin-wide pollution control; the establishment of erosion control in river basins, in co-ordination with the Ministry of Agriculture, to extend the life span of dams; the utilization of tidal basins for growing and breeding marine flora and fauna.

3. The need for co-operation and co-ordination between the Ministry of Water Resources and the Federal Electricity Commission, or even their integration up to a point, in carrying out work likely to produce better results in irrigation and power generation alike and, if possible, in other uses of water as well.

4. The need to eliminate periods during which the Ministry of Water Resources either suspends its planning and surveying functions or, conversely, indulges them to excess, to the detriment of construction.

5. The avoidance of discrepancies between water plans and the Government's economic development programmes, and the desirability of closer contacts between planners, peasants and other sectors concerned so that plans will be more realistic.

6. The need for a new impetus in constructing irrigation systems. Whereas an average of some 107,000 ha. yearly were irrigated in the period 1941-1958, the yearly average since then has been less than 50,000 ha. Earlier, this was accounted for by the lack of surveys and projects for starting new work and by the

need to devote a large proportion of available funds to rehabilitating salinized areas in established irrigation districts. But surveys exist which should have enabled the construction rate to be stepped up so as to bring the yearly average back to its former level or even higher.

7. The need to use more manual labour and less imported machinery on public works, even though the cost would apparently be higher. This would create employment and provide a stimulus to national development, but it would require the enactment of a law and the adoption of a new socio-economic mystique to put it into effect.

8. The failure to use Mexico's natural lakes and artificial reservoirs for breeding fish for popular consumption, as is done in oriental countries.

WATER RESOURCES ADMINISTRATION IN SPAIN

S. Martin-Retortillo*

THE ROLE OF WATER RESOURCES

Water in relation to national development

One basic consideration must be kept in mind in assessing the system of water resources administration in Spain. This is the existence of ancient customs and traditions which are so deeply rooted in the lives of water users that, far from being of merely historical interest, they are still fully operative and effective. Various dams and reservoirs dating from Roman times are still in use, and because of the systems employed by the Comunidades de Regantes (irrigation associations), many of the forms of organization of users of publicly owned water are hundreds of years old and in some cases go back over a thousand years. Moreover, quite a few of the provisions of the current Water Act of 1866/1879 did no more than sanction certain principles which had previously operated by custom. The stability of these formulas is thus an established fact; they provide a structure whereby, especially in certain parts of the country, forms of water use are handed down in accordance with an unbroken tradition. Indeed, the validity of these communal formulas, under which the management of publicly owned water is in the hands of the users themselves, is further strengthened by their having been adopted as fully effective components of the latest irrigation schemes.

Of course, Spain's development needs and the progress of technology have necessitated many changes in the old systems. Moreover, the inevitable limits to the country's untapped water resources make it more or less essential to transform and adapt water utilization systems to meet modern requirements. At present, therefore, the most characteristic feature of water resources administration is the search for new methods and procedures to reconcile the continuance of a number of firmly established and fully operative formulas with the needs of development activity in which those resources, which offer finite and quite specific possibilities, play a very important part.

Present national water policy is characterized by concentration on two main objectives: irrigation development, coupled with an increase in hydroelectric potential, and the provision of urban water supplies and drainage. Although resources can be regarded as more than adequate to meet current needs on a national scale, their unfavourable geographical distribution means that some areas (the eastern Pyrenees basin, including the Barcelona metropolitan area, and the Júcar and Segura basins of the south-east, where there are irrigation projects) already face water shortages, and their future prospects are nothing short of critical. The correction of this imbalance is an urgent task, and its accomplishment is precisely the aim of the Rio Tajo-Rio Segura (Atlantic basin-Mediterranean basin) transfer project now under construction.

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Water resources in relation to agriculture and industry

The development of the agricultural sector is a basic determinant of the national economy. Twenty-eight per cent of the population still depends directly on the land, and agricultural exports account for nearly 50 per cent of total exports. The marked decrease in agricultural underemployment has been a salient feature of Spain's socio-economic evolution in recent years, the active agricultural population having fallen by 680,000 in a single three-year period.

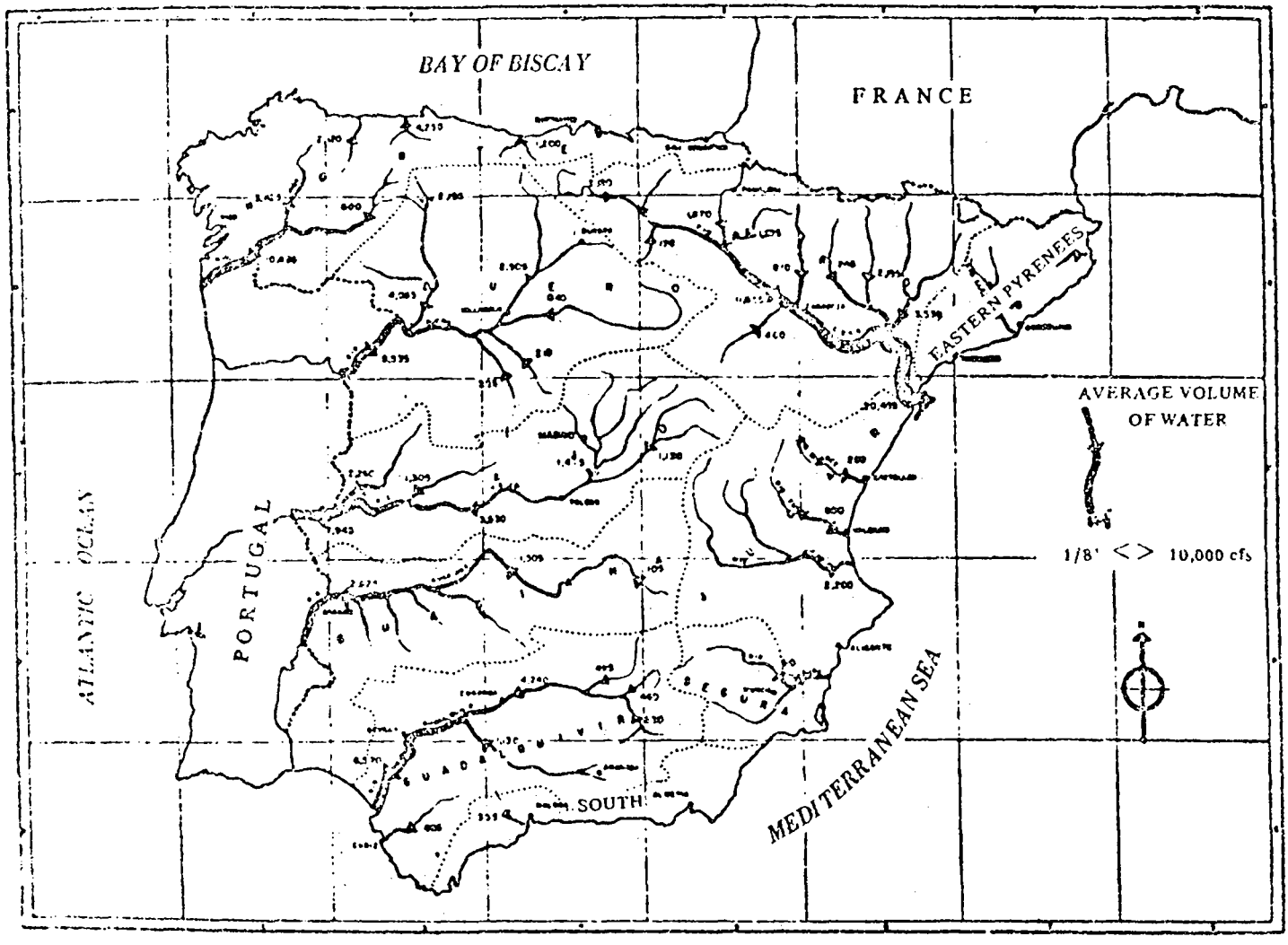
This shift from primary to other sectors clearly means that the structure of agriculture and agricultural production must undergo changes in order to raise the purchasing power of the agricultural sector and match output to the domestic demand for agricultural and livestock products. The elasticity of demand for irrigation-farming products makes crop conversion a vital aim.

Water supply for irrigation plays a decisive role in determining the structures of rural areas, which are undergoing far-reaching changes. Irrigation development, combined with an increase in water supply, will receive a powerful stimulus under the Second National Development Plan. In addition to private enterprise projects, it is hoped during the course of this plan to irrigate 289,000 ha. and to improve a further 91,000 ha. which are at present underirrigated. Within the past 30 years, State activities of this kind have resulted in the irrigation of 547,000 ha. and the improvement of a further 73,500 ha. Moreover, quite apart from the fact that ground-water knowledge and exploitation may advance, proposed regulating projects will increase storage capacity by approximately 15,000 $hm.^3$ (hectometres) and thus raise the existing supply by some 13,000 $hm.^3$.

In the industrial sector, considerable efforts have been made by private enterprise to expand the use of water resources. The Water, Gas and Electricity Federation estimates that 90 to 95 per cent of industrial water needs are met by industry itself, especially in high-water-consumption industries. Forecasts of national industrial water demand differ widely, depending on their origin, and tend to fluctuate between 1,500 and 3,000 $hm.^3$ per annum. This demand is heavily concentrated geographically, a fact which creates both quality and supply problems. The parts of Spain with the greatest difficulties are the Basque region and the eastern Pyrenees basin, which includes the metropolitan area of Barcelona. The latter with less than 1 per cent of the national territory and an existing supply of 700 $hm.^3$, accounts for no less than 20 per cent of Spain's industrial output. But there is a marked lack of data on the present industrial water supply situation, and this also prevents future prospects from being accurately assessed.

Geographical background

There are two main catchment areas in Spain, the Atlantic and the Mediterranean (see the map). The Atlantic catchment area consists of the central Meseta, the Guadalquivir depression and the seaward slopes of the Cantabrian Mountains. The Mediterranean catchment area comprises the Ebro depression, opening eastwards, and the seaward slopes of the Iberian Mountains and Betic Cordillera. Owing to the size of the Meseta, the primary heart of the peninsula, the Atlantic catchment area is far larger than its Mediterranean counterpart (311,897 km^2 as against 181,960 km^2. The Atlantic area has a greater abundance


BAY OF BISCAY
FRANCE
EASTERN PYRENEES
AVERAGE VOLUME OF WATER
1/8" <> 10,000 cfs
ATLANTIC OCEAN
PORTUGAL
SOUTH
MEDITERRANEAN SEA

of water resources, whereas the Mediterranean area offers greater opportunities for exploiting them profitably.

The country's relief largely determines its rainfall pattern. It is characterized by a gradual decrease in precipitation from north-west to south-east, with areas of abundant rainfall which emphasize the configuration of the mountain chains. This situation determines the division of the peninsula into two totally contrasting portions - the west and north, with abundant water and over 700 mm of rain, and the remainder with a rainfall which can drop to as little as 200 mm. Owing to the peculiar atmospheric movements over the peninsula, the precipitation is distributed very seasonally, with a winter maximum in the south and east, an autumn maximum in the Mediterranean catchment area, and two maxima, autumn-spring and spring-autumn, in the remainder of the peninsula, particularly on the Meseta.

LEGAL BASES

Spanish water law is deeply rooted in tradition. Historically, the use of water by private individuals was based on the grant of regalion rights, or privileges, which were similar to the present concessions. The need to enact general water legislation arose towards the middle of the nineteenth century because of the shortage of water and crystallized in a general statute, the Water Act (Ley de Aguas) of 1866, dealing with both the use and ownership of water and codifying the existing tradition on the subject as embodied in written texts and customary usage. In 1879, maritime waters were made the subject of a separate régime from inland waters, but as far as the latter are concerned the 1879 text is identical with that of 1866. The practice is therefore to refer to the Water Act of 1866/1879 to denote the basic legislation on inland waters. This legislation is still in force, and its revision is one of the main problems facing the Spanish authorities.

Leaving aside previous attempts to revise the Water Act, two sets of amendment proposals exist at present. One has been prepared by the Institute of Political Studies, at the request of the Ministry of Justice, and involves a complete revision of the statute; the other, sponsored by the Ministry of Public Works, is less radical in scope and merely suggests changes where they are most needed.

Water ownership

The present Act bases the fundamental régime for water on the distinction between ownership and use, established in respect of different kinds of water. Running water presents great problems, first because no absolute criterion is adopted, and secondly because a distinction is drawn between two kinds of water, public and private. The following are publicly owned:

(a) Rivers, from their source to their mouth;

(b) Continuous or intermittent water from springs and streams flowing in their natural beds;

(c) Water which rises continuously or intermittently in publicly owned land; water found in the working area of public works; and surplus water from fountains, sewers and establishments of a public nature.

On the other hand, continuous intermittent water which rises in privately owned property is privately owned while it flows through that property. Waters of natural lakes and lagoons are public or private according to whether the land they occupy is publicly or privately owned; they are presumed to be public if no adjoining owner can produce a title of ownership in his favour. Rain water is public or private according to the nature of the property on which it falls or through which it flows.

There are three kinds of ground water: ordinary, mineral-industrial, and mineral-medicinal. The first comes under the Water Act and the latter two under the Mines Act of July 1944. Ordinary ground water is governed by the principle of accession: the owner of the water is not the owner of the property under which the water flows, but the owner of the property in which it is discharged or the person who extracts it. Thus the Water Act distinguishes between two classes of wells: (a) ordinary wells, the purpose of which is "domestic use or ordinary needs of life", and the operation of which involves only the expenditure of human effort; and (b) artesian wells, the operation of which involves the expenditure of other than human effort, and which are obviously the more important. Article 22 of the Water Act provides that the ownership of ground water extracted by means of artesian wells belongs not to the owner of the property, but to the person who extracts the water.

Water use

One of the principles most clearly formulated in the Water Act is the difference between ordinary uses, which require no authorization and in which anyone can use water non-consumptively, and particular uses, or appropriations, in which the water is used consumptively and for which a concession or authorization is needed. Whereas ordinary use is free to all, particular use is a specific and exclusive real right.

In contrast to the general and special ordinary uses, the characteristic feature of the particular use or appropriation is that the water, whether consumed or not, is used to the exclusion of its utilization by third parties. This kind of use can be secured in two ways: by concession or by prescription.

Administrative concessions

Concessions must always be applied for; they are never granted automatically. They can be made only for appropriations applied for by private individuals and only in respect of the purpose specified in the application; in addition, they are made on the basis of the consideration of each use individually. The results of this system have been that some stretches of Spanish watercourses, which would certainly have been exploitable profitably if associated with other stretches, have remained unexploited; in other cases, exploitation is now creating problems and difficulties. The Spanish water law needs above all to be changed in connexion with this system of isolated concessions, which in practice are usually decided upon almost exclusively by private enterprise.

Like other concessions, concessions to use publicly owned water are granted without prejudice to third parties, so that private rights are safeguarded. Any person claiming to be affected must enforce his claim through the judicial courts. All concessions to use publicly owned water are granted for a specific use, with a controllable and specified flow (in litres per second per period of time), and for a specific purpose. The purpose of the appropriation cannot be altered without permission from the competent authority and a prior application procedure, as though a new concession were involved. In accordance with the principle that water rights run with the land, a property cannot be alienated separately from any irrigation water concession from which it benefits.

A concession granted to a mesne person (i.e., someone other than the person who directly avails himself of it) is for a fixed term, whereas a concession granted to a direct user is perpetual. The latter type includes irrigation water concessions granted to irrigation associations and concessions for urban water supplies granted to municipalities. On expiry, a concession granted to a mesne undertaking (such as a contractor) reverts to the direct users (e.g. irrigation associations or local communities) and not to the granting administration.

Prescription

Prescription as a means of acquisition by private individuals of the right to appropriate publicly owned water was intended simply to confirm the validity of de facto situations that existed before the Water Act was promulgated. In practice, however, administrative inertia and the shrewdness of water users have succeeded in transforming this method of acquiring rights, which under the Water Act is a merely accessory and temporary institution, into a system of considerable significance.

Prescription confers only the right to the use; the water continues to be publicly owned and must be used for the purpose and in the quantity which characterized its past use. It is therefore not a question of an abstract title, but of one governed in form, mode and extent by prior use.

Incidental appropriations

In addition to the two general formulas for appropriations of public water - concession and prescription - there is also the incidental appropriation, or aprovechamiento eventual. Though these appropriations are of slight importance in terms of the amount of water they use, they are quite numerous and are based on the law, and private individuals require no special title to enjoy them.

The concession procedure

Responsibility for considering and deciding on concessions and authorizations connected with publicly owned water lies with organs of the Ministry of Public Works and, under the applicable laws and regulations, the body competent to grant the concession is either the Area Catchment Office, the Directorate-General of Water Projects or the Ministry of Public Works, depending on the importance of the concession.

The various stages of the procedure include application by the interested party; publication of the application in the official press so as to ascertain who is affected by the applicant's scheme; a fixed period of time for the submission of other ("competing") schemes; the hearing of the applicant(s) for these schemes; and finally the decision.

ORGANIZATIONAL AND OPERATIONAL FRAMEWORK

Spanish administrative apparatus concerned with water is of two sorts. On the one hand, it is departmental and hierarchic, distributed among a number of ministries - Public Works, Agriculture and Industry. On the other hand, alongside this departmentalized administration, there is the autonomous institutional structure, comprising both the National Institute of Reclamation, responsible to the Ministry of Agriculture, and the Area Water Authorities and Irrigation Associations, responsible to the Ministry of Public Works.

The planning and execution of water projects come within the jurisdiction of the higher administrative organs at the ministerial level, i.e. the Ministry of Public Works and the Directorate-General of Water Projects, and of the Administration at the institutional level, i.e. the National Institute of Reclamation and the Area Water Authorities. The planning of the uses of public water and projects connected with some of these uses became linked with the general planning of national economic activities as soon as the First National Development Plan (1964-1967) was approved, particularly those which were to be carried out with public funds. One of the 16 items among which public investment was distributed in the four-year programme set out in the annex to the Second Development Plan (1968-1971) was irrigation and water projects, coming fifth in volume of investment allotted after transport, education and vocational training, urban construction and services, and housing. In policy making, therefore, Spanish authorities manifestly attribute a preferential position to irrigation and water projects in national economic development.

Management as such falls to the lower organs in the bureaucratic hierarchy, namely the Area Catchment Authorities, which also grant permits and concessions for the use of public water, and at the lower level, to the basic corporate bodies, the Irrigation Associations, which are genuinely autonomous associations of users managing public water. Thus the most important functions - the planning and execution of major economic projects - tend to become concentrated in the hierarchically higher organs or agencies, while there is a trend towards decentralizing the purely management functions. This dispersion of functions leads to frequent jurisdictional disputes since the competence of the various authorities is not always clearly delimited in the legal texts establishing and regulating them, especially where they are responsible to different ministries.

The three ministries - Public Works, Agriculture and Industry - are linked mainly through co-ordinating bodies, chief of which is the Steering Committee for Project Planning, Reclamation, Industrialization and Electrification for Major Irrigable Areas, set up under authority of the Office of the President, by decree, on 13 February 1958. For practical purposes, the Committee is now under the control of the Office of the Commissioner for the National Development Plan.

Regional powers, functions and services

At the regional level, the present administrative organization for publicly owned water in Spain is based on two institutions: the Confederaciones Hidrográficas (Area Water Authorities), generally established as institutionally organized autonomous public agencies, with one authority for each major catchment basin; and the Comisarías de Aguas (Area Catchment Offices), which are organs of the Ministry of Public Works and have the same territorial jurisdiction as the Area Water Authorities. Authorities and catchment offices exist for the North, Ebro, eastern Pyreness, Júcar, Segura, southern Spain, Guadalquivir, Guadiana, Tajo and Duero areas.

In principle, each area water authority is an autonomous juridical person of public law. As such, they were established in an attempt to break down to some extent the rigid uniformity of the administrative "divisions" as the sphere for execution and operation of various public services, as well as to overcome the politically inspired organization of regional activities. Broad functions were assigned to the authorities, which partake of the nature of small regional ministries of development, with a structure revolving around the catchment basin. The kind of water administration they represent follows tradition in not being limited to the bare essentials. It includes the building of public structures to improve the exploitation of irrigable areas, the implementation of reclamation plans, the construction of road networks and industrialization.

Local community powers, functions and services

At the local level, and more particularly for a given canal or watercourse, there are the Comunidades de Regantes (Irrigation Associations), which are a strongly traditional feature of the Spanish administrative system. The associations are autonomous agencies consisting of users of publicly owned water. An association may be formed voluntarily or compulsorily. The latter is the case, under the Water Act, (a) when the number of irrigators reaches 20 and there are at least 200 irrigable ha.; and (b) if, in the opinion of the administration, local agricultural interests require the formation of an association.

The irrigation associations have a juridical personality, by virtue of the provisions of the Civil Code, and this has been confirmed by the settled practice of the courts in a large number of decisions which have recognized the capacity of the associations to possess and enforce rights and bring lawsuits, provided they act through whichever of their organs are competent for the purpose under the existing legislation and the internal rules of the association concerned. They are corporate institutional entities of public law, and in addition they represent the state administration because they materially administer a state property, namely publicly owned water, and are subject to a state organ, the Ministry of Public Works. The irrigation associations merely have the right to appropriate public water; they do not own it.

Every association has three organs: the junta general or asamblea (general assembly); the sindicato de riegos (irrigation board); and the jurado de riego (water court). All interested parties are entitled to participate in the junta general, which takes major decisions, such as adoption of the budget and regulations, and election of members of other organs. Generally, voting rights are proportional to the amount of land irrigated, although other criteria still

apply in some cases, out of respect for customary situations in force prior to the passing of the Water Act. Sindicato de riegos is a somewhat misleading term, since the Water Act uses it to denote the executive organ of an association, whereas in some parts of the Levante and Aragon it is the name of the association itself. As executive organ, its task is to manage the association's interests; apart from the attributions conferred on it by the Water Act, its main function is water apportionment. The functions of an irrigation board are laid down in its rules. The jurado de riego is the association's jurisdictional organ, and there can be more than one court in a given association if the extent of the irrigated area warrants it. The functions of the water courts are: (a) to consider and decide questions of fact concerning irrigation water which arise between interested parties; (b) to punish offenders against the association's regulations in accordance with the penalties which the regulations prescribed. The court's proceedings are public and oral. Its decisions are enforceable, unappealable except for defects of form or incapacity of the court and applicable only to members of the association.

Under the Water Act, if a number of associations exist along the course of a river, one or more Sindicatos Centrales (River Federations) may be formed by agreement among the associations for the defence of the rights and protection and development of the interests of all. The federations consist of representatives of the associations concerned. Despite the provision in the statute, the river federations have not developed any extensive functions.

THE PLANNING FUNCTION

Among the major activities designed to improve the agrarian infrastructure, one of the basic directives laid down in the First National Development Plan is the preparation of a national programme for the exploitation of water resources to determine the needs of each catchment basin, the uses to which the water is to be applied and such transfers as are necessary. This programme has apparently not yet been prepared, or at any rate, has not yet been published. Furthermore, there are extremely few specific references to water exploitation in the Act approving the First Development Plan.

Confirmation that water projects are to be carried out during the period covered by the two national development plans is provided in the Plans themselves. The basic assumption has been that water projects are considered in the general light of a concerted economic policy and more particularly in the light of the funds available. Hence their financing is included in the public investments programme.

The development plans merely list and describe a set of projects. There is no properly drafted national plan for water projects which assesses the profitability, desirability and feasibility of projects; the methods for putting them into operation; the procedures for bringing them to completion; research on the markets likely to be affected by putting them into effect; and the whole range of demonstrations and data demanded by planning techniques.

There are virtually no planning authorities for water projects at the regional or subregional level, except a few of minor importance, such as the

local reclamation schemes regulated by the Act of 27 April 1964. Since the powers of the area water authorities were transferred to the state administration and some of their functions were transferred to the National Institute of Reclamation, the Institute and the Directorate-General of Water Projects in the Ministry of Public Works have become the authorities basically responsible for planning water projects.

Water planning and development planning

As an example of the way in which water planning was fitted into the framework of general economic development planning, an irrigation programme for the four-year period 1964-1967 was defined in the First Development Plan, preferably to revolve around the plans which were at the execution stage before the Plan was approved. This operating principle was justified by the need to obviate dispersing funds among the many plans being put into effect at that time, since that would lead to delay in programming.

Despite the selectivity which the First Development Plan attempted to enforce, it was recognized in the text of the Second Development Plan that undertaking an excessive number of plans in irrigation had led to the freezing of a large volume of investment over a long period of time and had thus deferred the start of project operations to the detriment of the capital-earnings ratio. To remedy this state of affairs, the Second Development Plan prescribed that "preferential attention shall continue to be paid to the conversion of dry arable land into irrigated land within a selective policy having due regard to market research, profitability and the rate of return on investments, so that 290,000 ha. may be irrigated in the four-year period and that, in addition, 90,000 ha. of existing irrigated land may be improved". A distinction was also made in the Second Development Plan, as in the First, between irrigation projects to be carried out by the Directorate-General of Water Projects, those to be undertaken by the National Institute of Reclamation, and the co-ordinated plans of the two authorities.

The planning process and the research function

Water resources planning in Spain suffers from grave deficiencies in basic data. In the text of the First Development Plan, it is positively stated that "no sufficiently thorough and detailed study for determining the inventory of the country's potential water resources with the desirable accuracy has yet been published". While surface water is fairly well understood, knowledge concerning ground water, as noted earlier, is still entirely approximate.

FISCAL ADMINISTRATION

The cost-benefit ratio has not been sufficiently taken into account in planning and executing water projects. Very often it is not until after a project has been begun or even completed that discussion arises as to how far the investment in it was remunerative. In a good many cases, e.g. projects for the irrigation of degraded areas, investment has been defended on social grounds which may indeed have been relevant at some periods.

Paradoxically, the state has been absorbing nearly the entire cost of putting into effect most of the water projects, while no move has been made simultaneously to put into effect schemes for incentives to and co-operation by private enterprises which could have made a very direct contribution to these undertakings.

Execution of irrigation projects

Construction of irrigation projects takes up the entire first chapter of the Act of 7 July 1911, which, following the model of the Public Works Act, draws a distinction between the study and design stage and the execution stage of irrigation projects. The Act provides for three methods of execution: (a) by the state with assistance from the users; (b) by the users with assistance from the state; and (c) by the state alone. To these must be added the execution of projects by the users alone, in which case the specific provisions for the concession of the water to be exploited by such projects apply.

The second of the three methods - execution by private users with state assistance - no longer has any practical application, owing to the limitation on the total figure for assistance specified in the Act. In no case may advances and subsidies exceed 275 pesetas per hectare of irrigable land for seasonal irrigation mainly for grains, or 400 pesetas for permanent irrigation mainly for intensive crops. The ceiling figures tell their own story. Established when the Act was passed more than 60 years ago, they bear no relation to contemporary realities.

Execution by the state with assistance from the users

The régime for joint execution distinguishes between new irrigation and the improvement or expansion of existing irrigation systems. In new projects the state in every case constructs the system, but the local authorities or private users concerned must undertake to contribute not less than 50 per cent of the construction costs, 10 per cent of which must be paid in cash while the works are being built. The value of the land on which the works are to be built and the construction costs of those parts of the works which the Government can leave to the users may enter into the calculation. The remainder, plus the interest, must be paid off in not more than 25 annual instalments beginning one to five years from the date of completion of the project - a period which may be far too short, especially if the system is not of any great size.

In the expansion or improvement of existing systems, the relationships between the state administration and the users mainly pass through the legally constituted irrigation associations, which guarantee to contribute 20 per cent to the state while the works are being constructed and to make a further contribution of not less than 40 per cent, which, together with the interest, must be paid off in not more than 20 annual instalments starting one year after the date on which the works are completed. The general principle is that payment shall be made in cash, but the Government may equally accept in payment the land on which the works are built or the part of the works constructed by the users. Regional and local authorities, municipalities, corporations and the like may contribute to the projects and thereby assist the owners of land and the irrigation users; but if they fail to provide actual assistance, the owners and users may not consider themselves as no longer bound by the undertakings they contracted with the state.

Execution by the state alone

These provisions deal mainly with the conditions and requirements for constructing irrigation projects, and the obligations incumbent on federations and associations of users or individual users to construct the additional works and irrigation structures within two years from the date on which the state-built channels and canals come into regular operation. It is stipulated that, irrespective of whether these secondary works are in fact constructed, the graduated charges on the lands must nevertheless be paid. The 1911 Act, too, expressly prescribes that any industrial users who benefit from the project must pay such charge as the Administration fixes.

Construction of irrigation projects by the state alone applies essentially to new irrigation systems, for the state may not legally construct secondary works on its own account, except where it is demonstrated conclusively that the works need to be built, will be useful in operation and cannot be carried out by any of the alternative methods mentioned in the Act.

The Decree of 4 June 1931 expressly prescribes that no proposal for the construction of a work at state expense shall be made unless each and every requirement laid down in the 1911 Act is fulfilled. In addition to the technical requirements, there must be a scheme prepared and approved in conformity with the terms of the Act, which states that the work must be specifically included in the plans approved by the Administration. For all that, the requirement has had little practical effect in most cases because, as noted earlier, no proper national plan for water projects exists as yet in Spain.

Execution of projects by the users

This does not really give rise to any major problems. Although this system has no general application as regards the execution of large water projects such as regulating reservoirs, it is generally applicable to the construction of both medium-sized projects and irrigation distribution networks. Also, it is naturally the method used for the extension and improvement of existing systems. In such cases the irrigation associations distribute the cost of the project among the users by means of individual payments.

Execution of urban supply and hydroelectric projects

Urban (including industrial) supplies have traditionally been one of the most controversial matters connected with water use. Apart from bodies with special characteristics set up in specific cases (the Isabel II canal for supplying Madrid, in the form of an autonomous agency) or the continued existence of concessions to private undertakings, these services have normally been regarded as strictly municipal and operated by the municipalities themselves, though the local authorities have usually lacked the funds to finance them. Financing was originally obtained mostly from state subsidies, a large proportion in the form of unrecoverable funds. State aid was contemplated solely for municipal authorities, not for concession-holders, in amounts varying up to 50 per cent in the form of a subsidy with unrecoverable funds, plus 40 per cent in the form of a "recoverable advance", both percentages related to the total cost. Each municipal corporation was considered responsible for its own water supply

services, and on this basis a service seldom paid its way since in the majority of cases a very low rate was fixed by the criterion of "political prices".

An entirely different approach was recently adopted, however. Services are not regarded as supplied to the specific area of each municipal district, but regionally, by an area board composed of the individual municipal corporations concerned. These establish the board themselves, usually in conjunction with the Area Water Authorities, and contribute an agreed sum. The amount subsequently remains with the board, which operates the service for profit or at any rate operates it so as to yield a large enough return to cover the investment. This leads to an appreciable rise in water rates, since they are no longer fixed in accordance with the "political price" criterion, but are determined by the actual cash cost of supplying the water.

The approach to hydroelectric projects differs again. The commonest example is where an undertaking holding a concession for water utilization finances the project, it being anticipated that the investment will be recovered from the proceeds of the rates charged to consumers. The amount of work done here by the private sector is very striking and includes many of the largest hydroelectric projects in Spain. In some specific instances, an unusual system for financing projects has been established by special agreement between the state and the concession-holder through the appropriate area water authority; one of the many cases in point is the integrated exploitation of the Upper Gallego.

In other cases, hydroelectric plants are combined with flow-regulation systems in projects executed by the state and are amortized by means of the regulation charge. The same conditions can to some extent be applied generally to accessory hydroelectric appropriations, which are usually very remunerative. A régime for these is laid down in the decree of 18 June 1943.

Amortization

Though the governing principle in Spanish positive law is that the amortization obligation falls upon the water users who benefit from the works, its application often causes difficulties, particularly where the works are the basis of multipurpose projects drawing on public water for separate and dissimilar uses. No generally applicable rules can be posited for the apportionment of costs among users exploiting water for such purposes as urban (including industrial) supplies, irrigation and hydroelectric power, because every such water system has characteristics of its own. The decision can only be left to the Administration. Once the amount of the amortizable, rather than the total cost, is established, the Administration acts as an impartial arbitrator between various concurrent interests in apportioning among them the shares payable by each on the basis of the type of use. In administrative practice, this is usually done by specifying the apportionment in the actual schemes for the various projects so that it is governed by the ordinary rules for publication, objection and approval common to all of them. As far as is known, the apportionment is not embodied in any provision, except the internal instructions issued by the Ministry of Public Works for computing the water-regulating charge.

The water-regulating charge (Canon de regulación)

Decree No. 144 of 4 February 1960 confers legal status on the regulating charge, which is applied to large reservoirs regulating watercourses. This charge is made for urban supplies and supplies for irrigation, hydroelectric power and industrial purposes provided by projects executed by the state, undertakings or private persons under concession, or taken over by the state or its autonomous agencies (through purchase, reversion, recovery and sequestration).

Irrigation charges (Tarifas de riego)

Decree No. 133 of 4 February 1960 confers legal status on irrigation charges, whose structure is similar to that of regulating charges.

Contractual amortization

The amortization method differs where the state builds works with cash contributions from the users and transfers their operation and management to the users when the works are completed. The costs then are usually amortized by aggregate annual contributions paid by the irrigation associations, which then require each user to pay his share of them. No express provision is made in the co-operation undertaking if the operation and upkeep of the works are not transferred to the users, but since the state has in fact provided a service, the users must obviously pay the appropriate charges, though manifestly only for the service provided.

These formulas represent considerable progress, but it is strange that their application should have been suspended almost as soon as they were initiated. The status quo ante has thus been restored, a situation which is unsatisfactory inasmuch as the users who pay for the amortization of works do not have any kind of control over either the costs or charges arising from them.

EXPERT ADMINISTRATION AND CITIZEN PARTICIPATION

Water experts have long maintained a tradition of excellence in Spain, working mainly for the state as civil servants. This tradition became institutionalized with the creation early last century of the Corps of Highway, Canal and Harbour Engineers (Cuerpo de Ingenieros de Caminos, Canales y Puertos) at the service of the former Ministry of Development.

The teaching of water technology is imparted both in the Higher Technical Colleges (Escuelas Técnicas Superiores) for highway, canal and harbour engineers, and in colleges of industrial, agronomic and mining engineering (primarily in connexion with ground water). The very recent educational reforms designed to combine the various specialized branches of engineering on comprehensive college lines, in particular the polytechnic colleges created at Barcelona and Valencia, represent further progress in the training of water experts.

A basic organization deliberately specializing in research on and the programming of water resources is the Hydrographic Research Centre, set up during the Second Republic to prepare its national water supplies plan, which, after

vegetating for some years, was recently given a very strong impetus. An agency of the Ministry of Public Works, the Hydrographic Research Centre, conducts an ambitious research and training programme by means of specialized courses, but, despite the autonomy it enjoys, it has also become the permanent advisory agency on hydrographic research to the Administration.

Manpower and employment

The execution of water projects is an industry which has one of the largest constant demands for labour and is one of the strongest poles of attraction for recent flows of directed internal migration. The level of labour demand by water projects already in operation naturally differs a great deal from one project to another and is highly selective. At the higher level of technical qualifications, there seems to be full employment for the time being, but this is very likely to change in the near future with the removal of the numerus clausus (quota system), which existed until recently for admission to the Technical College.

The training of specialized technicians has hitherto been confined almost exclusively to technical skills. It was much concerned with the physical structure, so that traditionally far more stress was laid on building than on operation, and, accordingly, more on engineering qualifications than on the economic, sociological and administrative skills equally needed for any system of using water effectively. Courses in the latter subjects were recently added to the technical training, but the root of the problem is the concept of a type of training in which construction as such outweighs concern with the uses to which structures can be put when built. Many engineers take courses in the economic sciences on their own initiative during or after their engineering courses, thus counterbalancing overspecialization by personal effort rather than through any interdisciplinary training.

Social implications and citizen participation

Spanish society is deeply aware of the implications of water supply. One often finds small towns and villages which have placed all their hopes on a particular water project since time immemorial. Everyone in the countryside, too, is fully aware of what drought means. This is not true of urban and industrial areas, where public opinion is hardly ever alerted to the water problem, except in emergencies, and even then the problem does not have as immediate an impact as in the country.

Future users take very little part in the planning of water projects, except in the projects they execute themselves. The planning is usually done primarily within the bureaucratic apparatus itself, but this does not mean that no regard is had for any genuine state of opinion which future users may have managed to express in one form or another. In every public-works project publicity is mandatory, and any persons who may be in any way affected by a scheme may freely avail themselves of access to the information. This procedure is expressly and legally recognized in Spanish administrative practice, and the right may be, and in fact is, freely exercised regardless of consequences. It does not seem, however, that any claims under this procedure subsequently have the slightest practical effect on proposals as originally set out in the corresponding schemes.

It is mandatory for future users of water to co-operate and participate financially in the execution and operation of water projects wherever the conditions for co-operation between the Administration and the future users are laid down by express agreement. User participation finds its major expression in the collective use of water for irrigation where an irrigation association has been formed. It is expressed through the organs of the association, which are responsible for such matters as flow apportionment, execution of works, allocation of charges, repairs and so on.

CONCLUSIONS AND RECOMMENDATIONS

Special attention should be drawn to one or two aspects of the subject of water resources administration in Spain. First, there is the gradual effort to adapt traditional principles of the statutory water régime to changing needs. This often gives rise to stresses and complications and lends weight to the argument that the Water Act should be revised. Despite these difficulties, however, the gradual approach is preferable to out-and-out reforms which involve drastic changes in existing systems and yet, because they operate at a purely formal level, fail to come to grips with the underlying social realities.

Another significant feature is the existence of the irrigation associations, an example of a decentralized system of administration under which water is managed by the users themselves, along fully democratic lines - a formula which has survived the many and varied political changes in Spain's recent history. It should also be remembered that the Water Act was very progressive for its time in giving such wide recognition to the public ownership of water. The fact that it did so has continually enabled the Administration to intervene with a view to improving the use and utilization of water resources. It is also relevant to stress the fact that many important engineering structures have been devoted to water regulation and abstraction in Spain. This is a logical consequence of the country's geography. Spain is one of the foremost nations in the world as regards the number and size of its large dams, and this has made it constantly aware of the importance of such structures and of their political, economic, sociological and legal implications.

A critical analysis of the present Spanish system of water resources administration raises a number of issues. Respect for a strongly rooted tradition and well-established formulas should not be allowed to prevent the existing legal system from being suitably adapted to present-day requirements. Certain situations which cannot be ignored any longer have been allowed to develop unchecked and are so firmly entrenched that it is difficult, if not impossible, to deal with them. A striking case in point is water pollution, a subject which was completely neglected until recent years. The same can be said of concessions covering stretches of river and comprising several appropriations, a formula which has occasionally been adopted, although without any legal justification, in an effort to supersede the formula of the isolated concession.

A further consideration to be borne in mind is the principle of the unity of the hydrologic cycle. Provision has to be made for the co-ordinated use of all water resources, including those which at present escape control because they are privately owned, in particular ground water, the potential of which is becoming increasingly apparent.

Social awareness and physical realities have also led to various important changes in the doctrinal approach to water use. These make it clear that the premises on which the legislators based the 1866 and 1879 Acts are no longer valid. There has, for example, been a radical transformation in the traditional concept of the consumptive use of water, a subject which cannot be overemphasized, and yet it is not covered by the Water Act. Water is consumed and existing water resources are depleted not only by domestic use and irrigation but also, and to a much greater extent, by pollution. Water pollution must be viewed strictly from the point of view of consumptive use. A waste water discharge must not be permitted without a concession for a sufficient volume of dilution water to ensure that the downstream flow continues to be usable. Without this, it will be impossible to conserve water resources and locate industry in areas where each industrial unit can abstract water without affecting the other uses for which the flow in question is destined.

A point of even greater significance arises in that the current Water Act of 1866/1879 is a statute for natural running water and not for regulated water, which is what the majority of rivers consist of today. Wherever possible, the highly complex situation this entails has been tackled at the administrative level, whereas it needs to be approached from a juridical point of view. That would involve the administration being given direct authority to apportion water supply according to the different kinds of demand, instead of it being allocated on the basis of old titles or concessions.

There should be a careful reappraisal of existing appropriations, which would doubtless show that considerable quantities of water could be made available. The first task is to overcome local prejudice against the comprehensive organization of water resources. Water is public property, and as such must be used where it is needed and can be most beneficial; due respect should be had for private rights, but only in so far as they really need protection. In that connexion, large-scale transfers of water are of crucial importance in the Spanish water system, a fact which lends great point to the question of legal instrumentation.

Today, the superior interests of the community necessitate various changes in the structural system governing appropriations of publicly owned water. This system was founded on rigidly individualistic principles; except where prescription has operated, it has grown up solely on the basis of the concession by petition. The results of this system have been that some stretches of Spanish watercourses, which would certainly have been exploitable profitably if associated with other stretches, have remained unexploited; in other cases, exploitation is now creating problems and difficulties. A further consideration is the need to adopt the formula of the multipurpose project wherever possible, which makes it imperative that planning be applied not only to the existing system of appropriations but also to their operation.

The division of water responsibilities among various organs of the Administration which are subject to the authority of different ministries - Public Works, Agriculture, Industry and so on - often leads to serious difficulties, and the co-ordination arrangements which have been instituted are clearly inadequate. There are no objective reasons why these functions should be thus dispersed. The idea of reuniting them in a single ministry must be pursued in the face of the considerable vested interests of the various groups in the Administration which are opposed to a unified system.

The broad outlines of present water policy generally reflect aims laid down many years ago, the most important of these being the expansion of irrigation. Today, however, when there is clearly a crisis in the agricultural sector, such an objective should be reconsidered. A primary need is to give pride of place to the economic profitability of water projects, something which has often been deferred in the case of state-executed projects to social considerations. Financing and economic return are aspects of water projects which have frequently been ignored, especially in the case of certain reclamation projects and new settlements, some of which have been built quite indiscriminately and moreover have not succeeded in checking the drift from the land.

The planning and development of water utilization requires active support from autonomous water-user bodies at various levels. This is the only real counterpart to an efficient system of water administration. Strictly technical aspects apart, there seems to be no good reason why users should be excluded from water management, especially when it is largely they who pay for the projects. The user bodies must therefore participate from the outset in the economic planning of the resources which they will later be using. However, the structures of the various area water authorities must be reorganized afresh if the authorities are to be representative, at the various levels, of the different users of publicly owned water, as was the original intention, and if they are to provide sufficiently flexible operating patterns to constitute the proper organic basis which the performance of the authorities' task necessitates.

These seemingly instrumental issues have a decisive bearing on the effective administration of water resources. To restrict the corporate form of water management to the limited sphere of the irrigation associations is to reduce water-user representation to a purely domestic level. Hence the need to revive the original features of the area water authorities in such a way that they represent all water users. This would accord with the traditional principles of the Spanish legal and administrative system and at the same time provide the most effective answer to the increasing bureaucratization of its water system.

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