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13-17 September, 1971

AID/Csd-1122-GTS.

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This is a report on the Workshop, "Water in Man's Life in India," held in New Delhi, September 13-17, 1971, under the auspices of the National Academy of Sciences (Board on Science and Technology for International Development, Office of the Foreign Secretary) and the Indian National Science Academy. The staff report is submitted to the Agency for International Development under contract AID/csd-1122, Task Order 12.

A record of the proceedings is to be published by the Indian National Science Academy and will be transmitted to AID when available.

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I

INTRODUCTION

The National Academy of Sciences - Indian National Science Academy (NAS - INSA) Workshop on "Water in Man's Life in India," held in New Delhi September 13 - 17, 1971, represents the second in a series of such gatherings undertaken by the two institutions on a cooperative basis.

The first, held in Baroda, March 2 - 6, 1970, and preceded by a week of travel and consultation in India by NAS participants, addressed itself to "The Organization and Management of Industrial Research."

The intent of the NAS - INSA program is to bring distinguished U.S. specialists in various fields together with their Indian counterparts, joined by senior government officials from planning and technical departments as well as leaders from the scientific, educational, industrial, and other interested communities, for the purpose of discussing significant problem areas in the relationship of science and technology to economic development. Aside from the inherent value of such binational gatherings--especially at the level of participation suggested above--the two Academies envisaged that joint deliberation would bring to light various policy options that might usefully be considered by the Government of India and Indian institutions, as well as external assistance agencies concerned with Indian development.

The Workshop was of special interest to the co-sponsoring institutions insofar as it was among the very first, in their experience, to address itself to a critical point of intersection of two major worldwide

preoccupations: economic development and environmental protection. The choice of the Workshop theme resulted from consultations held with INSA by NAS Deputy Foreign Secretary Thomas Malone, Chairman of the NAS Committee for International Environmental Programs, in mid-August, 1970, and by NAS Deputy Foreign Secretary Roger Revelle, Chairman of the NAS Board on Science and Technology for International Development, in January, 1971. These discussions revealed that Indian scientific and governmental circles had a strong interest in the problem of environmental protection because of its relevance to the formulation of India's development strategy and its urgency for India's preparation of its position for the 1972 U.N. Conference on the Human Environment at Stockholm.

Water, in quality and in quantity, is the most pervasive and fundamental resource constraint in the Indian subcontinent; therefore, INSA proposed that the two Academies focus their initial attention on this problem. Should this first exercise produce satisfying results, the co-sponsoring institutions would proceed in succeeding workshops to examine other major environmental issues affecting India.

The NAS panel of twelve specialists and one staff officer, led by Dr. Revelle, spent 2 weeks in India. They devoted the first week to single or group visits to many parts of the country, seeking out individuals, institutions, and sites relevant to the Workshop theme and to their respective interests; and the second week to the Workshop proper, at INSA headquarters in New Delhi. Further information on these activities and on significant Workshop side-events is provided in Chapter III.

Before their departure, the NAS panel gathered in Washington for a 1 day briefing session attended by representatives from AID, the Department of State, the Environmental Protection Agency (EPA), and the World Bank (agenda and participants in Appendix A).

The NAS - INSA Workshop in mid-September was the second phase of a substantial effort by INSA to prepare the Indian side for effective interaction with their American colleagues. A month earlier, INSA gathered some 120 Indian technical specialists in various fields bearing on the subject of water for a 2-day preparatory meeting, to which most participants contributed technical papers. This gathering gave INSA the opportunity to identify the best Indian scientific talent to be invited for participation in the Workshop with the NAS, and to utilize the considerable data and analysis made available at this meeting for the preparation of a second set of papers specifically oriented to the issues constituting the agenda of the NAS - INSA Workshop. INSA intends to publish both collections of papers in two volumes; the one containing the NAS - INSA proceedings will include a resume of the discussions as well as conclusions and recommendations. Both volumes were to become available before the end of 1971. This interim report by NAS to AID, accordingly, will be limited to certain highlights and essential information of interest to AID.

II

WORKSHOP CONCLUSIONS AND RECOMMENDATIONS

The final Workshop session, presided over by Mr. C. Subramaniam, Union Minister for Planning and Minister for Science and Technology, adopted a statement of conclusions and recommendations drafted by the Indian and U.S. Workshop co-chairmen. This followed the hearing of individual session reports, prepared by the respective co-chairmen and co-rapporteurs, summarizing discussions on each of the agenda topics. These reports, presented preliminarily in somewhat rudimentary form, are to be redrafted and amplified for inclusion in the Workshop Proceedings; they are not reproduced here.

The concluding statement, essentially an outline identifying overriding "needs," was intended for the general benefit of central, state, and local bodies with interests and responsibilities for the issues cited, but without specific designation. Probably a majority of these bodies were represented by participants in the Workshop. In addition, Minister Subramaniam and K.L. Rao, Minister of Irrigation and Power, who also attended the final session, assured the assemblage that their respective ministries would give the statement careful study to determine its implications and to formulate appropriate follow-up action. In view of the high-level attention that is to be given to the Workshop statement, it was felt that the two Academies should postpone the identification of areas for further joint follow-up activity until government authorities had sorted out priorities and ascribed responsibilities

for implementation. Accordingly, the statement remains silent with regard to further NAS - INSA efforts concerning the problem of water in India.

Herewith the text of the statement as presented and adopted:

I. Development of health education extension system

A. Objectives

1. To teach rural people the value of a safe water supply

2. To help villagers to provide themselves with safe water for drinking, cooking, and bathing, by covering wells, using simple chlorination devices in the wells, and other means

B. Accomplishing Objectives

1. Family planning workers, village-level workers, and agricultural extension workers might be given additional duty as public health extension workers

II. Development of joint union - state management policy for water quantity and quality

A. The following appear to be the most urgent needs

1. To plan for the development of surface water and ground water resources of India in an integrated manner

2. To expand the existing capability for modern methods of ground water exploration and appraisal

3. To establish a national hydrological network for surface water by identifying a national set of hydrological stations

4. To establish a national data storage and retrieval system for hydrological information

5. In planning the development of India's water resources, to apply multidisciplinary systems-analysis techniques, that combine economic, hydrological, agricultural, and engineering considerations. Such planning analyses are particularly needed when water is used for multiple purposes--water power, irrigation, domestic and industrial water supply, waste disposal, navigation, and fisheries. The objectives should be to reconcile conflicting uses and to make the most of complementary uses. These analyses are especially needed when ground water and surface water are used conjunctively. Problems of mining ground water, among many others, also need such analysis.

6. To expand and develop monitoring systems to keep track of possible changes in quality of ground water from such causes as salinization of wells by overpumping, increasing sodium content, etc.

III. Education of civil and sanitary engineers

A. There should be increased emphasis on economics and other social sciences, including consequences of population growth and change for development of water supplies and waste disposal

B. To ensure that engineering education is practical and relevant to Indian needs, both faculty members and students should be encouraged in every way to consult and work on water-resources development projects of central, state and local governments, and those for specific industries

IV. Research and development requirements

A. The economic implications of a safe, potable water supply for the urban and rural populations

1. Problems to be studied include not only the cost of providing such a water supply but also the economic benefits in

a. prevention of food wastage by reduction of gastroenteric infection which lessens the ability of people to digest their food

b. improving the health and therefore the potential productivity of the labour force

c. improving the ability of students in the critical years from 1 to 6 to respond to the external stimuli that are basic to their educational development

B. The implications for economic development of water-pollution control and abatement

1. Factors to be considered

a. The balance between industries requiring clean water, such as chemical and food processing industries, and other industries, such as paper, steel, textiles, and sugar, which tend to pollute water

b. The possibility of planning the location of industries so that those requiring clean water are upstream of those which tend to pollute water

c. The relative degree of pollution abatement that can be attained by controlling pollution from municipalities and large industries in presence of very many small sources of water pollution. In the aggregate, these may be much more important than the large sources

C. The development of methods and programs to greatly increase the recharge of ground water during the monsoon season of high river flow. One possible method might be drastically lowering the water table near the river channels by pumping during the low flow season.

D. Development of nonpolluting means of pest control. Pesticides are now essential for the control of certain agricultural pests. In the future, nonchemical techniques should be employed as the primary means of pest control.

E. Development of water quality criteria to serve as the basis for the establishment of local standards. Such standards should serve the needs of India both for industrial development and for protection of public health, agricultural water supply, and the harvest of fresh water, estuarine, and marine fisheries.

F. Studies of the relative economics and effectiveness of water carriage and alternative systems of waste disposal in urban areas. This might involve studies of systems now used in Tokyo, Bangkok, and other large Asian cities as well as development of new technology.

G. Development of effective survey techniques for ascertaining the requirements and the potential of supply of water of desired quality in rural areas for planning and programming purposes.

III

HIGHLIGHTS AND COMMENTS

Indian Participation

Altogether some 90 Indian specialists and Government officials participated in the Workshop, a total that was more than three times larger than originally anticipated. This increase resulted from INSA's decision, late in the planning stage, to involve all key elements of the nation likely to benefit from the exercise. Indian participation was consequently national in scope and included virtually all heads or leading members of institutions and agencies at central and state levels concerned with one aspect or another of the water problem in India. The high number, and the caliber, of the participants showed that INSA's purpose in reaching outward was achieved.

It bears noting, also, that three sessions of the Workshop were attended by two Government Ministers: Irrigation and Power Minister C.K. Rao, who gave the opening keynote address and hosted the entire American group at a reception in his Ministry; and, as already mentioned, the Minister for Planning and Minister for Science and Technology, C. Subramaniam, who gave a very perceptive closing address.

In light of the then already strained diplomatic relations between the U.S. and Indian Governments, it should be added that the NAS group was received everywhere with great cordiality. Of the various receptions organized in their honor, that of the New Delhi Municipality, hosted by the Mayor and all the City Councilors, deserves particular mention.

Pre-Workshop Visits

In the week before the Workshop, members of the NAS panel, singly or in small groups, made over 60 visits to Indian scientific, educational, and governmental institutions, and had contact with a much larger number of Indian scientists, educators, and government officials at central, state and local levels. Altogether, NAS panel members visited individuals, institutions, and sites of scientific interest in some 15 cities and other locations throughout India. In many cases, the Americans were invited to give lectures or seminars. As a consequence of these contacts, several NAS panel members have established personal collaborative linkages with Indian colleagues, which they propose to pursue by correspondence and further visits in both directions.

Workshop Structure and Organization

The design of the Workshop was formulated on the initial assumption that Indian participation would number no more than 20 to 25, and that all, by virtue of their professional interests and responsibilities, would find it useful to be present for the entire proceedings. Consequently, the Workshop was structured as a continuous plenary meeting, each agenda topic to be treated in a single session. It was envisaged that joint study groups, meeting subsequently, would carry the analysis of specific problems to much greater depth.

This approach proved to be mistaken because of the much larger Indian group that eventually attended, with interests far more heterogeneous than had been anticipated. As a result, many of the Indians took part in only two or three sessions bearing directly on their professional work. Over half of the sessions were attended by a fraction of the total registered Indian participants, and for them as well as for the American participants, who were similarly highly differentiated in

their interests, a 3-hour session proved insufficient to give each subject full justice.

Thus the Workshop structure, the particularity of interests manifested by the participants, and the great variety of major problem areas chosen for discussion were not conducive to the most effective use of the American participants or the fullest satisfaction of the professional expectations of the Indian participants. Clearly, a division of the Workshop assemblage into working groups, meeting concurrently for two or more sessions, would have allowed more in-depth discussion and made for better involvement and interaction of the participants. As it was, two or three working groups did get established on an improvised basis, meeting on the margins of the plenary. More along these lines would have been possible had the magnitude and character of the attendance that the Workshop would evoke been known sufficiently in advance.

A note on INSA performance: The large Indian representation, combined with the logistical support requirements of the NAS panel, strained INSA's administrative capabilities to the limit. Suffering from lack of professional staff and material resources, the Indian Academy moreover has little experience with conferences designed to yield policy conclusions from scientific or technical discussions. Its present leadership, however, is determined to turn INSA into a more vital and relevant institution, playing a role in Indian society somewhat akin to that of the NAS in the United States. As INSA undertakes more such exercises, and obtains the professional staff it is now seeking, many of the problems facing it will undoubtedly disappear. However, that the Workshop and the visit of the NAS panel gained the success that they did is in large measure due to the USAID Education Staff, who gave unstintingly of their time to buttress INSA's efforts.

Press Coverage

The Workshop received unusually wide coverage in all Indian media. Almost 40 articles on the Workshop were published within 10 days. Most New Delhi dailies, both English and Hindi-language, carried daily accounts of the proceedings, and several of the weeklies and monthlies had longer articles in preparation. (Two of these articles are reproduced in Appendix B.)

The extensive coverage resulted in part from the special arrangements made by INSA, with assistance from the USIS Press Service. Formal press conferences for the NAS panel members and key Indian participants took place before, and immediately after, the Workshop. Informal press interviews took place daily as reporters sought out individual members of the panel. The NAS panel chairman appeared in a televised interview.

The quality and accuracy of Indian daily press reporting of the proceedings was highly variable, reflecting the technical nature of the discussions and the limited backgrounds that the reporters assigned to this event brought to their task. Some of the finer technical points may have been garbled, but there is little question that the chief issues highlighted by the Workshop were brought to the attention of a large reading public.

Parliamentary Testimony

Nine members of the NAS panel were invited as individual experts to testify over a period of 2 days (each absenting himself from the Workshop for the duration) before the Joint Select Committee of Parliamentarians of the Lok Sabha (Indian Parliament), which since 1969 has been considering a water-pollution-control bill. Although the Lok Sabha was in recess, the Committee gathered in extraordinary session to take advantage of the

Americans' presence in New Delhi. (It should be noted that testimony by foreign experts before a Lok Sabha committee is a fairly rare occurrence.)

The interest of the Parliamentarians in the Americans' evaluation of their draft legislation, which was given to them to analyze, stemmed in good part from the fact that both India and the United States face similar problems in their federal system of government. The division of responsibilities for water resources between federal and state authorities engenders great difficulties for integrated management and planning. As a consequence of the testimony, the Indian Parliamentary Committee concluded that their deliberations would be aided greatly by a subcommittee on-site study in the United States. It is understood that a request for assistance in this regard was to be made through appropriate Government of India channels to the USAID Mission.

Ford Foundation Seminar

Five members of the NAS panel also took part in a special evening seminar organized under Ford Foundation/New Delhi auspices in connection with a new project being developed jointly by the Foundation with the Indian Planning Commission and the states of Maharastra, Rajasthan, and Punjab for integrated regional water-resources planning. The American group had the opportunity to study the preliminary planning papers developed by the Indians with assistance from Ford Foundation consultants. With benefit of further details provided by the Indian planners at the seminar, they presented a critique of the plans from the standpoint of methodology, approach, etc. The Americans' overall assessment of the plans for the two principal schemes was positive, and they contributed several points of advice which are to be incorporated in the planning papers.

Consultations with Government Officials

The NAS panel was in India at a moment of intense discussion among local ground-water specialists concerning the disposition of the ground-water research services between the Geological Survey of India and the Central Board of Irrigation and Power (Ministry of Irrigation and Power). The interest of Minister R.K. Rao in this matter was such that he requested a special working session with several members of the NAS panel to solicit their views.

In addition, one panel member, from the U.S. Geological Survey, spent several hours with Minister Rao in consultation on sediment deposition problems in the Kosi River Project, for which he had served as a consultant some 15 years earlier. Following his return home, he wrote the Minister a technical report elaborating recent research work in the United States bearing on sedimentation problems.

Finally, the chairman of the NAS panel had extensive private discussions with Dr. Pitambar Pant (Member of the Planning Commission, Chairman of the Indian Preparatory Committee for the United Nations Stockholm Conference, and head of a new Indian Government unit on the environment) regarding organizational and policy measures for governmental action in this area. These conversations were to have been pursued in Washington later in the fall on the occasion of a projected visit by Dr. Pant. The NAS proposed to facilitate Dr. Pant's contacts with key Washington officials in the Council on Environmental Quality, the Environmental Protection Agency, the Department of State, relevant committees of the NAS - NAE, and other public and private bodies concerned with environmental issues. Unfortunately, the visit did not take place.

IV

WORKSHOP AGENDA AND PARTICIPANTS

Agenda

The Workshop theme, "Water in Man's Life in India," was treated in nine substantive half-day sessions and a summation session, in accordance with the following agenda:

Monday, 13 September

Session I Availability and Human Use of Water in India
Co-Chairmen: Roger Revelle and K.R. Ramanathan

Session II Economics of Urban Water Supply
Co-Chairmen: Harold A. Thomas and R.B. Chakravarty

Tuesday, 14 September

Session III Economics of Village Water Supply
Co-Chairmen: Nathaniel Wollman and J.P. Naegamvala

Session IV Appropriate Technologies for Water Supply Treatment and Distribution
Co-Chairmen: Robert L. Smith and N. Majumdar

Wednesday, 15 September

Session V Appropriate Technologies for Waste Collection, Treatment, and Disposal; Waste Disposal for Future Urbanization
Co-Chairmen: John C. Geyer and T.R. Bhaskaran

Session VI Agricultural Pollution and Water Degradation--Pesticides, Fertilizers, Siltation, and Salinization
Co-Chairmen: Donald W. Pritchard, S.P. Ray Chaudhuri

Thursday, 16 September

Session VII Industrial Pollution and Water Degradation
Co-Chairmen: Perry L. McCarty and Jagjit Singh

Session VIII Public Health and Sanitary Engineering Education and Research--Use of Systems Analysis and other Optimizing Techniques
Co-Chairmen: Harold A. Thomas and J.B. Srivastava

Friday, 17 September

Session IX Public Information and Extension in Water Use Hygiene
Co-Chairmen: Gerard A. Rohlich and M.V. Desai

Session X Priorities and Programs
Co-Chairmen: Roger Revelle and B.R. Seshachar

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APPENDIX A

Briefing Session for NAS Panel, Washington, D.C., August 4, 1971

Agenda

MORNING

Introductory remarks to NAS panel members by Roger Revelle, Panel Chairman, and John Fry, Office of Science and Technology, AID Bureau for Technical Assistance (Workshop observer)

Current U.S.-India relations and Indian political situation, Anthony C.E. Quainton, Department of State India Desk

U.S. aid program in India and current economic situation, Paul Isenman, Head, India Desk, AID

Remarks on public health aspects of Workshop, Lee Howard, M.D., Director, Office of Health, AID Bureau for Technical Assistance

Potential use of PL-480 funds for water-related activities in India, Fitzhugh Green, Associate Administrator for International Affairs, Environmental Protection Agency

Remarks on technical nature of environmental problems in India, Ramachandran Pitchai, The Center for the Environment and Man, Hartford, Connecticut

AFTERNOON

Remarks on pertinent IBRD projects in India and new environmental evaluation criteria, Matsumata Kato, Office of Director of Projects, World Bank

Workshop documentation; discussion on Workshop approach, formulation of detailed draft agenda; travel plans for pre-Workshop week and other arrangements

Other Persons Attending Briefing Session

Surendra A. Raje, Environmental Systems Analysis Laboratory, General Electric Co., Philadelphia (observer)

Julien Engel, Head, Special Studies, Board on Science and Technology for International Development (BOSTID) (NAS panel staff officer)

Cecilia Allman, BOSTID Staff (Program Coordinator)

Tresa Bass, BOSTID Staff (Secretary to Mr. Engel)

APPENDIX B

Indian Press Articles

Wanted : More Fresh Water

About seventy-five per cent of the earth's surface is covered by the waters of the sea. Besides there are large quantities of water in the polar caps, in the innumerable lakes, rivers canals and ponds, not to speak of the huge volume hidden undergorund, and suspended in gaseous form in the atmosphere. One would think there is enough water on earth for human use. But the great paradox is that there is already a global water shortage for human use. In many countries water is in short supply for industrial use, for irrigation and even for domestic requirements. Several of the world's large rivers which used to be symbols of prosperity of the people living on their banks and which used to be adored and sung about present today a sorry look with nauseating industrial effluents, and are practically dry.

The curious fact is that only three per cent of all available water on earth is fresh. Nearly three quarters of even this meagre three per cent is in the form of permanent ice in the polar regions and on mountain tops, and hence out of bounds for man. A large percentage of the remainder is stored underground. It is estimated similarly that at any one time the lakes and the rivers of the world hold only one-third of one per cent of the total fresh water supply and the atmosphere contains only a tenth of this percentage. So, although there is some scope for improving the present fresh water supply by exploring and exploiting the resources more systematically the ultimate answer seems to be desalination of sea water on a large scale.

ENORMOUS WASTE: If the prospects of fresh water supply are thus disturbing on a global level, it is even more so in the case of India where some geophysical and geographical factors have conspired to make the situation somewhat more complex. This fact is illustrated amply well by the present paradox of high floods and severe droughts existing in India at the same time. While more than three-fourths of UP, Bihar and West Bengal are being ravaged by one of the worst floods in recent decades, a large part of Andhra and certain pockets of the adjoining States are experiencing severe drought and famine. Often the north-east and south-west parts of India have average or above average rains, but parts of Tamil Nadu, southern Andhra and western Rajasthan have little or no rain at all. Similarly, while the northern rivers fed by rains or melting snow have plenty of water all the year round, southern rivers depending on the monsoon are practically dry during summer when the need for water is the greatest. As an expert put it if India can be represented by a circle the ends any one of its diameter will show the extreme weather conditions at two places at any time.

But taken as a whole India does receive a fair amount of rainfall which should meet atleast its present requirements. It is estimated that on an average it receives about 370 million hectare-metres of precipitation, but the tragedy is that a substantial part of this is wholly wasted. Of about 168 million hectare-metres available as surface flow after allowing for seepage and evaporation, only 78 million hectare-metres is available for human use. The rest of the available and potential supplies flows to Sea. Unfortunately even this small quantity available is not evenly distributed in space and time. For instance, while the southern slopes of the Khasi hills, the Brahmaputra valley and the Western Ghats receive 'very heavy rainfall' amounting to over 400 cm and the whole of Assam and the west coast of the Peninsula get 'heavy rainfall' aggregating to over 200 cm, the western part of Rajasthan and Gujarat receive only 'low rainfall' ranging between 10 and 50 cms. Similarly more than 75 per cent of the annual rainfall is received during the south-west monsoon over practically the whole country excepting Assam, Jammu and Kashmir and the southern Peninsula. In Tamil Nadu, 47 per cent of the rainfall occur during the post-monsoon season. In Jammu and Kashmir about 20 per cent

INTEGRATED APPROACH: But these figures give only an average years picture--it may vary from year to year because no two years have exactly the same rainfall. Some years like the present one stand out as exceptional years when the rainfall is very much in excess, and some others very much in deficient. The variability is least over the north-eastern parts of India and South-western coast of the Peninsula, being only 15 to 20 per cent. But the variation exceeds 30 per cent over large areas of the country and is over 40 to 50 per cent in parts of Saurashtra, Kutch and Rajasthan. As a rule areas which have scanty rainfalls are also those in which the rainfall is the most irregular.

Dr Roger Rerella inaugurating the conference

These natural anomalies make it imperative for India to adopt certain integrated measures which, while eliminating annual visitations of floods as well as droughts, will conserve the precious water for our expanding domestic, industrial and agricultural requirements. Experts committees have at various times suggested remedial measures, to solve the flood problem in a region, or how to tame a river, or even how to tackle frequent droughts in a pocket. But it has not been felt necessary to make an integrated approach to tackle the imbalance in the nature's bounty. Previously dams were built merely to help irrigate large tracts of culturable land; later on irrigation and power projects were combined. It was only much later that flood control was recognised as an important additional aspect that could be combined profitably with river projects. Even then several other vital aspects which either followed the execution of the project or preceded it were neglected

or missed For instance, the problems of salinity and water-logging which arise on account of accumulation of excess irrigated water, spreading of water-borne diseases, silting of reservoirs, water pollution, rural sanitation etc received little attention. But it is now realised that all these are different aspects of the same main problem —the problem of scientific water management—and that they should be tackled in an integrated manner for getting optimum results.

POSSIBLE OPTIONS: Recognising the urgent need to make a comprehensive study of the problem with due weight to all aspects of water management, the Indian National Science Academy (INSA) early last month organised a two-day national conference on "Water in man's life in India" Several eminent experts in geology, hydrology and allied sciences participated in the conference. The subjects of their discussions ranged from water resources, floods control, economics of rural and urban water supply, river water pollution, silting of dams, sewage and industrial effluent disposal, etc., so much so, the conference was able to identify the major problems involved in scientific water management. Armed with a wealth of data from the conference INSA last week convened jointly with the US National Academy of Sciences, a five-day workshop on the same subject. Twelve distinguished American scientists joined about one hundred Indian experts in re-examining the problems and reassessing the possible options available to the country. There was no reading of any papers and no long lectures. Key papers prepared by INSA in the light of the two-day conference last month served as the basis of workshop divided into ten sessions. The participants, each of them selected for their specialised knowledge in a particular field, contributed weight and direction to the discussions. Each of the ten sessions co-chaired by one American and one Indian expert, took up for discussion such questions as: How can losses due to floods in India, estimated this year at Rs 400 crores, be minimised? Must increasing water pollution be an inevitable price of industrial advancement? How can pollution of rivers, lakes and sea coast from urban domestic sewage and toxic industrial effluents be avoided? Must scientific disposal of waste matter be a burden on communities? If water-borne diseases like cholera and typhoid are preventible, why do they continue to be major killers in this country? Can economic development and environmental cleanliness go hand in hand?

GROSS UNDERESTIMATE: It must have been just a coincidence, but the workshop could not have been more appropriately timed. All of the northern rivers were in high spate inundating vast areas: crops worth several hundred lakhs were destroyed and innumerable houses damaged or washed away. At least 200 people lost their lives in the devastation. There has been no estimate of the number of cattle killed, but easily they could run into thousands. Patna and Lucknow were among the many towns threatened with complete destruction. It was only the Herculean efforts of the Army and thousands of civilians that saved them. Considering the scale of havoc and the area involved, the cost of the flood put at Rs 400 crores may be a gross underestimate. The fact is nobody is as yet in a position to give a correct idea. In any case, the figure does not include the cost in terms of the misery and anxiety suffered by lakhs of people who spent several days on the roofs of buildings and tree-tops without food or sleep.

The grim northern scene served as a sinister contrast to the plight of Andhra where large irrigation ponds and canals have dried up. Hundreds cattle have perished or are starving to death. People in their thousands are leaving their homes to far away places in search of food and work. It is a tragic sight. While one end is suffering from excess of water, the other side is gasping for a mouthful of it. While one end is wasting the entire downpour, the other side is waiting for a trickle. The two sights however helped to bring home to the workshop delegates the problem India is facing. The contrasting sights also highlighted our ineptitude, our lack of initiative and the opportunites we have not cared to utilise. How else will we explain the co-existence of droughts and floods when we have thousands of civil engineers begging for jobs? How else will we explain the shameful inter-State water dispute?

Dr K. L. Rao, Union Irrigation and Power Minister, who inaugurated the workshop, dwelt at length on this unfortunate chapter of our national life and said that water should be considered as a national wealth although our States refused to see it as such. He said the bane of floods in the north and droughts in the south could be removed only through a massive transfer of water by a combination of lift and gravity canals over a distance of about 3,200 km involving a lift of over 600 metres. Such a transfer was not inconceivable because it had been done successfully in the United States. In fact the proposed national water grid envisages the linking of some of the diversion of surplus monsoon flow in major rivers in the north and south and the Ganga to the Krishna and the Godavari. But so long the States fight one another without realising the national interest, no progress could be made. He however, said that adoption of a national water policy might pave the way for this water conservation measure. He hoped such a policy would be evolved in the next five years. Anyway, Dr Rao was emphatic that there was no way out for India except this. If a national water grid was not evolved now, it had to be done sometime in the immediate future.

GRIM WARNING: Dr Roger Revelle, director of Harvard University's Centre for Population Studies and Chairman of the American Academy's Board of Science and Technology for International Development (and who headed the 12-man American scientists to the workshop), said that unless man learned to conserve and manage water in a most scientific way, he might reach a crisis point in the near future where from his struggle would be for survival. Dr Revelle emphasised the imperative need for integrated systems for developing water resources and for ensuring supply of safe water because the health and prosperity of the people depended so much on water.

According to the key paper on "Availability of water in India and its human use" even in the future, as at present, the major share of the water resources has exclusively to be earmarked for irrigation. It is estimated, however, that even if all the available water resources are harnessed for irrigation, it will not be enough to bring under irrigation all the land resources. In fact at the present rate of water use, a major portion of the land potential will be left uncovered by irrigation ultimately. The only remedy (and it is being attended to) is to conserve the water by reducing consumption to optimum levels through modern scientific management of land and water resources.

The case for irrigation where large quantities of water are required is understandable. But even in the supply of fresh water for domestic consumption conservation measures are becoming imperative. Already many Indian cities are experiencing severe water shortage. The situation in Delhi is typical of this disturbing feature. So far Delhi's water requirements have been met from the Yamuna's surface flow. A stage has now been reached whereby the surface flow in the river has been fully utilised. Now they are thinking of getting water either from distant sources, or tapping an ample supply reportedly available in the Yamuna's bed, at 20 or 30 times the present cost.

POOR QUALITY: Even this eventuality has not, however, compelled the civic administration to effect some economy in the use of water. A recent survey of Delhi water supply by the National Council of Applied Economic Research indicated that leakage and

wastage of water accounted for 42.5 per cent of the total distribution. Allowing 15 per cent as normal wastage, it still leaves 27.5 per cent uncovered, representing a revenue loss of Rs 7 million annually, or a loss equal to about 25 per cent of the present revenue of Delhi's water supply division! But this kind of unpardonable wastage which could otherwise be used to meet the needs of 25 per cent more people, is not confined to Delhi.

Apart from availability of water in sufficient quantity, another serious problem confronting urban water supply is quality. For, it is said that sources of water themselves are severely contaminated. The open wells in rural areas are invariably polluted by agricultural and animal waste products. According to Mr Pitamber Pant, chairman of the Committee on Human Environment, 80 to 90 per cent of India's villages are served by contaminated water. In the Delhi region itself over 93 per cent of the 300 wells recently examined had "very high" proportions of intestinal bacteria and parasites. Besides, in many village wells the fluoride content was found to be as high as 16 to 24 parts per million whereas the maximum permissible limit for potable water was less than 1.5 part per million. According to US standards, only 4 per cent of the ground water in Barmer, 21 per cent of the water in Jaisalmer, 10 per cent in Jodhpur and 1.2 per cent in Bikaner (all in Rajasthan) is potable. Even river waters are not free from such contamination. The fact is that passing near cities they get contaminated to a greater and greater extent. In the case of the Yamuna, for example, while it flows from Delhi to Agra, the coliform bacilli number starting with 150 just above Delhi becomes as high as 24,000 near Okhla, 48,000 at Mathura and 240,000 at Agra.

CHEMICAL POLLUTANTS: In a large number of cases river pollution is the result of callous dumping of industrial wastes and effluents. For instance, the Hooghly, the Damodar and the Ganga now receive huge quantities of untreated industrial wastes and sewage, drastically lowering the quality of their otherwise fine water. The Hooghly receives wastes from jute mills.

As a result of discussions in the workshop a more realistic view of our priorities and programmes for better water management seems to have emerged. It has certainly succeeded in its aim of providing a better understanding of the Indian situation and the evaluation of possible options available to the country. Arranged as part of INA's programme of inter-academy exchanges, the workshop is said to be a preparatory step for the first UN conference on Human Environment scheduled to be held in Stockholm in June next.

Safe Water for Nation's Needs

By B. S. Padmanabhan

The Indo-American workshop organised in New Delhi recently spotlighted attention on the many problems to be faced in the task of providing safe, potable water all over the country, and inducing policy-makers to change their attitude towards water supply and sewerage schemes.

IT does not need much persuasion to realise the value of water. The main achievement of the five-day workshop organised in New Delhi recently by the Indian National Science Academy in association with the National Academy of Sciences of the U.S. lies not in reiterating the importance of water in the life of man, but in focussing attention on the innumerable problems that come in the way of providing safe potable water throughout the length and breadth of the country.

The workshop was unique in that it brought together representatives of almost all agencies involved in one way or the other with water and specialists from both India and the U.S. The base for this binational meeting was prepared a month earlier when a national seminar was organised by INSA to review the present state of water management and identify areas which require immediate attention. The working papers for the binational meeting were the outcome of the national conference.

American Experience

The participation of American scientists should not be taken to mean that India has no expertise in the field of water management. In fact, it is recognised even by the American team that India has a much longer tradition of water management and there is nothing much which India can learn by way of expertise. But the American participation, from all accounts, has helped India to draw lessons from American experience in this sphere.

Pollution of water by pesticides is an instance in point. The American delegates made pointed reference to the use of pesticides in large quantities in America which had led to serious problems of water pollution and said this should serve as a warning to India. The level of pesticide application in India is not much compared to other countries. As one delegate, representing Hindustan Insecticide pointed out, India spends Rs. 150 per acre on pesticides against Rs. 35 in the U.S. and Rs. 110 in Japan. He was at pains to dispel the impression that the use of pesticides has polluted water in India. But still the American warning seems to have gone home as can be seen from one of the conclusions of the workshop that non-polluting means of pest control should be developed and in future non-chemical techniques should be employed as primary means of pest-control. The implications of this in terms of agricultural production may need deeper study.

Pollution is of course an important issue. But the larger issue that dominated the discussion related to overall assessment of water resources, and the need for a comprehensive assessment of resources of surface water and ground-water was underlined. The magnitude of the problem is highlighted by the startling figures that were given during the discussion. Of the 550 millions population only 22 millions have protected water supply. In terms of villages, one in every five villages enjoys the basic amenity of drinking water supply. One-third of the remaining 450,000 villages has water supply but not adequate enough. Another one-third of the villages has water supply but it is not hygienic. The remaining 150,000 villages have no water supply at all. In regard to urban water supply the picture is not so gloomy. Over 60 per cent of the urban population has been covered by protected water supply. With the growth of population and industrialisation, the demand for water for drinking as well as other purposes is bound to go up.

Limiting Factor

According to one estimate the present utilisation of water works out to 34 million hectare metres. This includes requirements for irrigation, domestic needs and livestock, industries and thermal power stations. Based on Plan projections, the total requirement of water is expected to go up to 52.7 million hectare metres by 1980-81, and to 78.6 million hectare metres by the year 2000. Against these requirements, the utilisable quantum of total water resources is estimated at 82 million hectare metres. One conclusion drawn by the experts from this is that water would be a limiting factor in future economic growth. It is, however, conceded that the present assessment of water resources is only approximate and that an assessment based on sound data is necessary as a first step for water resources development.

A significant factor brought out in this context is that even the existing resources are not evenly distributed with the result that there is surplus water in one region and scarcity in another. Dr. K. L. Rao, Irrigation Minister, and Mr. C. Subramaniam, Planning Minister, underlined in this context the need for a National Water Grid to take water from surplus regions to scarcity areas. The consensus at the workshop is that there should be a joint effort by both the Central and State Governments to secure an effective water management policy. In planning the development of water resources, multi-disciplinary systems and analysis techniques which combine economic, hydrological, agricultural and engineering considerations should be applied as water is used for multiple purposes. The objective should necessarily be to reconcile conflicting uses and make the most of the complementary uses.

Water-borne Diseases

It is not enough to make water available if it is not safe for drinking. This was one of the points on which there was a frank exchange of views. Even before the conference began the American specialists highlighted this point while giving their impression of a tour of some rural areas. The U.S. specialists relied on the data collected by the Central Public Health Engineering Research Institute at Nagpur and said 30 to 60 per cent of villagers had intestinal parasites at any one time. In one group of villages 13 per cent of the people were suffering from dysentery at the time of the survey. From this the leader of the American team, Mr. Roger Revelle, concluded that perhaps 50 per cent of the people are ill from gastro-intestinal infection during the course of a year. He translated the implications of this in economic terms to drive home the point that pro-

vision of safe water cannot brook any delay. Water-borne diseases, he said debilitated and weakened the person, seriously affecting his capacity to work. Secondly, it lessened the ability of the person to absorb food, thereby leading to wastage of perhaps 15 per cent of the food.

Economic Benefits

The consensus was also on these lines and it was felt that research should be conducted on the economic implications of a safe, potable water supply. The experts probably felt that once sufficient awareness is created about the economic benefits, funding of water supply schemes may not pose a problem. At present the general feeling is that water supply schemes are pretty low in the order of priorities. In fact, it was stressed by the American specialists that if the villagers were convinced that safe water had economic benefit, they would be willing to invest on water supply schemes. To achieve this the village level workers should be entrusted with the additional duty of public health education.

One of the prerequisites for safe water supply is a proper system for collection, treatment and disposal of domestic waste and night soil. This was brought out effectively in the conference. Pollution from domestic waste is found to be the worst form of water pollution. The subsoil water gets contaminated in areas not served by a sewer system. Only 33 millions out of the total population of 550 millions is served with sewers. This represents 30 per cent of the urban population and 6 per cent of the total population. About 30 years ago, the population served by sewers was 3 per cent, and this shows the slow pace at which the sewerage system has expanded.

The only consolation India can derive is that it is not the only country with an inadequate sewerage system. A survey by the W.H.O. has shown that a number of countries in Asia, Africa and Latin America have no adequate sewerage systems although they have adequate water supply systems. Whether there is lack of awareness of the importance of a sewerage system in India or not, it has received low priority all along. The workshop can be considered a great success if a change for the better in the attitude of the policy-makers towards water supply and sewerage schemes is brought about.