

RESEARCH AND DEVELOPMENT OF WATER RESOURCES OF THE PHILIPPINES

by

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Generally, many people have taken water for granted. "How many of them know what water is about?" asked Dr. William E. Warne, Director of the California Department of Water Resources. "Not one in a million." Yet the people who use water, who pay taxes and vote on the bond issues for water development and conservation, must make the political and economic commitments that will ensure a steady flow of water. Though it may be considered a gift of God, water must be properly harnessed and husbanded by the people(1).

In a country like the Philippines located within the region of tropical rainy climates and in the tropical rainforest areas(2) water is abundant throughout the year. Rainfall is high — its annual mean ranging from 77.26 inches (197.24 cm.) in the Cagayan Valley (Northern Luzon) to 128.08 inches (315.32 cm.) in the Bicol region (Southern Luzon) and in Western Visayas (Central Philippines). In general there are two seasons—the wet and dry. (Wet in summer and autumn, and dry in winter and spring(3). In spite of these, however, the water resources problem in the country is becoming more serious.

The population of the Philippines as of July, 1965 was 32,345,000 (4). It is increasing by about a million people a year. There is a good deal for people needing additional domestic supply of water, perhaps at an average of 50 gallons per person. While we have to increase our domestic water use by 50 million gallons per year, yet we have not done much to solve the problem of increasing the supply. The other problem is whether we are trying to utilize the same water supply wisely, without impairing the normal requirements of the people.

With one million people added every year, substantial amounts of food, clothing, and shelter have to be provided. To produce these requirements would mean either increasing the productive capacity of our soil by improved agricultural technology on the same area of land, or increasing the area to be cultivated. In either case moisture requirements and irrigation facilities are cardinal necessities.

Consideration to these questions can be done through regimented scientific researches on the water resources of the Philippines and the proper coordination of research activities of the country.

SCIENTIFIC RESEARCHES AND TECHNOLOGICAL DEVELOPMENT IN THE PHILIPPINES

We have in the Philippines the National Science Development Board whose charter provides, among others, the support of research activities in the following areas under the concept of contractual service. These areas are: (5) (a) Industrial Research, (b) Agricultural and Natural Resources Research, (c) Medical and Pharmaceutical Research, (d) Biological Re-

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search, (e) Atomic Energy Research, (f) Food and Nutrition Research, (g) Engineering Research, (h) Research on Social Science, Humanities and Statistics, and (i) Pure and Fundamental Science Studies. Research activities in these areas are undertaken by the implementing agencies of the Board—namely, the National Institute of Science and Technology, the Philippine Atomic Energy Commission, the Philippine Inventors Commission, the Textile Research Institute, and the Philippine Coconut Research Institute. The last two agencies were organized only recently and their research activities are pending until funds are made available. The agencies of the government that are not directly under the supervision of the National Science Development Board conduct specific research projects through grants-in-aid funds provided for by the Board. Water resources falls within the area of Agriculture and Natural Resources under the direct supervision of the Division of Agricultural and Natural Resources Research of the Board.

PRIORITY IN WATER RESOURCES RESEARCH

Prior rights to the use of water according to Western US Standard is arbitrarily listed as (a) Domestic use (including normal farm and stock use), (b) Municipal use, (c) Irrigation use, (d) Industrial use, (e) Water Power use, and (f) Recreational use. This order of priority is dependent upon geographical location, such as centers of population, activity, and distance from such centers.

In the utilization of our water resources, there is a great need of understanding the interrelated patterns which involve three intertwined dimensions or fields of endeavors which, when put together, consist of a unified framework for water management policies and decisions(6). The exponent of this principle also stated that water as migratory resources dependent upon the character of the hydrologic cycle can well be studied and researches conducted on the basis of the synthesis of geographic, economic, and legal disciplines.

GEOGRAPHIC ASPECTS OF WATER RESOURCES RESEARCH

The geographic dimensions of water research points out the range and bounds of physical possibilities in terms of resources and uses of water. Physical facts concerning the rate at which the hydrologic cycle creates water products of a specific quality at a particular time and place are urgently needed in order to evaluate the cycle itself. Geographical data regarding the intensity and variability of precipitation, the water-holding capacity of individual soil type, and the capacity of ground-water storage are of paramount importance.

Eugenio E. Manalo, Chief, Climatological Division, Weather Bureau made a good study on the distribution of rainfall in the Philippines(7). Data gathered in this kind of work are needed for the interpretation of precipitation pattern in the Philippines. Since 1918 it has been accepted that there are four types of rainfall in the Philippines, namely (8):

- Type I — Two pronounced seasons: dry in winter and spring, wet in summer and autumn. (There is pronounced rain period in summer and autumn).
- Type II — No dry season with pronounced maximum rain period in winter.

Type III — (Or Intermediate A type) no very pronounced maximum rain period with a short dry season lasting from one to three months.

Type IV — (Or Intermediate B type) no very pronounced maximum rain period and no dry season,

Cruz and Mendoza reclassified the rainfall in the Philippines with emphasis on Agricultural Meteorology(9). They came out with seven types of rainfall.

Agriculture and engineering projects can not be designed without appropriate geographic and physical data on quality of soils and capacity of ground water. Infiltration studies on a grassland watershed in northern Nueva Ecija, Philippines as reported by Angeles(10) is worthy of consideration in developing a hydroelectric project. Similar research should be conducted in other parts of the country. Sonido's(11) application of geophysical exploitation to hydrological and engineering projects is significant.

In irrigation agriculture, researches on irrigated rice have been done by many agricultural engineers particularly in the College of Agriculture, University of the Philippines at Los Baños and similar studies conducted in other regional stations of the Bureau of Plant Industry, Department of Agriculture and Natural Resources. Rice irrigation research in the College of Agriculture and Central Experiment Station at Los Baños as reported by Aglibut, et al(12) records, among others, a number of studies on duty of water for rice in communal irrigation systems and survey of irrigation practices.

Valuable contribution to water research can also be made by cultural geographers. Watershed management problems often involve human problems arising from such action as the destruction of valuable recreational facilities which are used against a background of old-fashioned customs and conducts. Mariano and Ursua(13) made observations of the attitude of the farmers utilizing pump irrigation waters to increase the yield of rice per unit area in the Bicol Regions of Southern Luzon.

ECONOMIC ASPECT OF WATER RESOURCES RESEARCH

The economic dimension of water research is aimed at knowing how to minimize the satisfaction of human want. The range of economic practicability is made wider by technological innovations, changes in costs and revenue, and is contingent upon what is physically and institutionally possible. The contribution of economics towards achieving this goal should largely be a matter of collecting and interpreting basic data. Many of the basic facts needed in the determination of the value of water for various purposes are not yet available in our country. However, Cruz and Laudencia(14) in their "Irrigation of Rice by Pumping" give us an idea of the cost of irrigating rice crops by pump irrigation system and the estimated income for one dry season crop operation. Due to regional variability of labor cost, transportation, and prices of prime commodities, similar work should be conducted on a regional basis.

The economic advantage of adding an inch of water to specific standing crops has not as yet been ascertained; and, therefore, many irrigators are unable to evaluate properly the desirability of establishing water control facilities. Economics contribute in a large measure to cost-benefit studies. As a matter of fact this is one aspect of research work which should be

given prior attention. This type of research is often used in evaluating the economic feasibility and scale of development of water management structure.

For the last 14 years, pump irrigation systems in the Philippines show that pump irrigation on rice and other crops pay. Rosell(15) in his "Two Years of Philcusa-FOA Pump Irrigation Progress in the Philippines" pointed out that pump irrigation pays.

To realize the maximum benefits in the use of water, researches on losses due to seepage in canal has been worked out using lined canals constructed out of materials procured locally.

INSTITUTIONAL AND/OR LEGAL DIMENSIONS IN WATER RESOURCES RESEARCH

This aspect of water research indicates whether or not human behavior will allow measures that will meet the physical and economic tests. At present, property rights in water and water rights in common usage need to be defined clearly in order to provide the stability necessary to justify long-term investment in water management facilities provided in Philippine water rights laws. They have to be re-examined to allow amendment to conform with the present rapid trend of water use in our growing population. Hutchins(16) in his "Water Rights Doctrines in the Western States" defined a number of doctrines which are applicable to the Philippines. Hutchins stated: "Rights to the use of water of water course both surface and subterranean, are governed by Appropriation and Riparian Doctrines." The Appropriation Doctrine gives a prior right to the person who first diverts water and puts it to beneficial use on or in connection with the land whether adjoining or many miles away from the stream. In the Riparian Doctrine, the owner of the land adjoining a water course has right to use the water for beneficial purposes on such land. Ellis(17) in his "Water Rights in the Eastern States," stated that in the case of the Eastern States, Prior Appropriation Doctrine generally has not been applied. The "Riparian Doctrine" is usually applied by Eastern Courts to the use of national water courses. For irrigation purposes and other consumption purposes water use is governed by one or other doctrines such as the Natural Flow Doctrine and the Reasonable Use Doctrine.

These and other laws or doctrines in water use should be studied in the Philippines to update our statute and avoid conflict in the use of water for varied purposes.

Another problem facing our country today is the lack of adequate water terminology. For example, what is a navigated river? What is the riparian rights of an owner of land by the lake, bay shore or by the river bank? These and many other problems in water resources use and conservation should be answered through research on a legal dimension.

THE NEED FOR RESEARCH COORDINATION

In war or in peace, coordination is a vital factor in any operation designed to achieve any desired objective. In research where there is freedom of thought and action, it is even more important to have coordination. "Coordination involves the catalysis and facilitation of the research endeavor through various means of assistance, provisions, and exchanges of information. Necessary tools and utility equipment are secured and supplied to pave and ease the path towards the smooth pursuit and solution of prob-

lems thereby posted." (18). Realizing the importance of this fact, the Science Act of 1958 created the National Science Development Board primarily for the purpose of achieving coordination of scientific researches and technological development of the country.

The National Science Development Board, besides having under its direct supervision five implementing agencies, coordinates research activities of several technical bureaus, corporations, agencies, and offices of the various executive departments of the Philippines. The University of the Philippines, likewise, has established in 1961 the Office of Research Administration in order to coordinate and supervise all research activities in the University. This was later reorganized and named "Office of Faculty Research and Extension Service."

Coordination of scientific researches and technological development, therefore, was achieved after the establishment of the National Science Development Board. The need for full and complete coordination is necessary to achieve economy, effective control, and efficiency.

Researches on Domestic and Municipal Use of Water Resources

No country can be healthy and happy if it is thirsty. It is incumbent therefore of that country that its government provides ways and means of making available at all times sufficient quantity of quality water for domestic and municipal use. The demand for water and its effect on total water resources is likely to become a major problem. In the City of Manila and its environs, for instance, the water shortage problems during the dry season has become quite serious.

Increasing population demands an increasing amount in the use of water. This is a normal consequence. A rise in the standard of living also increases our water consumption.

The per capita water requirement in the Philippines has been conservatively estimated at 50 gallons a day. For 32 million people in the country about 1,600 million gallons of water are required every day. This amount does not include water used in agriculture, manufacturing, and mining industries.

It is possible that the problems involving domestic and municipal use of water resources can be resolved through coordinated research. Problems such as increasing population, inadequate facilities, and availability of water supply on certain times of the hydrologic cycle can be resolved if we coordinate a research program. The National Science Development Board can provide the leadership and financial assistance of a research program in this area and aspect of water utilization.

Researches on Water for Irrigation Agriculture

It has been proved that irrigation increases the yield of crops by as much as 50 to 100 percent. Hence, the demand for irrigation facilities in agricultural areas has increased. Today, there are more people requesting irrigation facilities for their lands than there are water available in the river and other sources.

Aglibut (19) stated that research is essential for improving irrigation facilities and techniques. "Irrigation is a basic factor in increasing the pro-

ductivity of Philippine agriculture. Research on the use of local materials and on proper methods of lining canals is called for to reduce seepage in conveyance and distribution channels. Research data are needed for the economical delivery of water and its efficient application and the prevention of waterlogging of valuable fields especially those along canals. The best methods of applying water to the land under different soil conditions and stages of crop growth have to be determined. The merits of flooding, furrow, sub-surface, and sprinkler methods under different environments have yet to be evaluated both quantitatively and qualitatively. The practices followed for certain crops in other countries may not be suitable in the Philippines. The results so far obtained in a few research institutions and agencies are still too inadequate for general use. Additional data on crop requirements are needed to enrich existing knowledge on the proper amount of application at the appropriate time and for the specific environment would redound to more efficient use of irrigation water."

The Ad Hoc Committee known as National Committee on Irrigation Research has recently published the *Irrigation Guide for the Philippines* (20). It contained valuable information put together by members of the committee. Recently, Lee Chow, Technical Officer, Irrigation Engineering FAO/UN reported a brief study on Irrigation in the Philippines (21). Problems and solutions on irrigation of the country were summarized.

The basic and applied research on water resources in irrigation for maximum development have to be coordinated and integrated with the National Science Development Board as the focal point of work. The appropriate agencies to be involved are the (a) College of Agriculture, University of the Philippines, (b) Irrigation Service Unit, (c) Bureau of Public Works both of the Department of Public Works and Communications, (d) National Irrigation Administration, (e) Weather Bureau, Department of Commerce and Industry, (f) Bureau of Soils, (g) Bureau of Plant Industry both of the Department of Agriculture and Natural Resources, and (h) Central Luzon State University.

It is indeed important that such forms of water as gravitational water, capillary water, and hygroscopic water in relation to their availability for plant growth be studied. The program of research in irrigation agriculture has a wide scope that will involve the governmental agencies mentioned elsewhere in this paper. This will result to integrated and coordinated research activities. This teamwork approach will give more work done at a minimum cost.

Researches on Water Resources for Industry

The social and industrial problems of water have been the subject of public discussion due to widely publicized recurring water shortages especially during the dry months of the year. This situation arises simply because of our characteristic climatic conditions of wet and dry seasons. During the dry season, especially when it is prolonged, water shortage causes extensive destructions to crops and livestock, and an uncomfortable stoppage of daily activities which lowers production in industries. Our rapidly expanding industries and the yearly increase in population are sufficient reasons for the scientists and the government to act accordingly.

How much water does industry need to produce a unit of product? This question has been answered already in many parts of the world where manufacturing industries are in advanced stage. We can start from that

point and proceed to program our researches. A number of government agencies and private sectors can very well coordinate and organize research teams. Technical men of the following agencies can compose the research team: (a) National Waterworks and Sewerage Authority, (b) Bureau of Public Works, (c) Irrigation Service Unit, (d) National Power Corporation, (e) Bureau of Mines, (f) Private Wells Drillers Association, and (g) Weather Bureau.

COORDINATED RESEARCH PROGRAM ON WATER RESOURCES IN THE PHILIPPINES

On the basis of the observation mentioned earlier, the following facts are presented to illustrate how water research in the Philippines is to be carried under a coordinated research program.

- I. Institutions and agencies that should conduct researches
 - A. Government agencies
 1. Bureau of Public Works
 2. Irrigation Service Unit
 3. National Waterworks and Sewerage Authority
 4. Department of Health
 5. National Power Corporation
 6. Weather Bureau
 7. Bureau of Mines
 8. National Irrigation Administration
 - B. Private agencies
 1. Private well-drillers
- II. Some of the major areas of research
 - A. Water utilization
 1. Geographic and physical aspect
 2. Economic aspect
 3. Legal aspect
 - B. Priority in use of water
 1. Domestic use
 2. Municipal use
 3. Irrigation use
 4. Industrial use
 5. Water power use
 6. Recreational use
 - C. Hydrologic aspect
 1. Regional study of hydrologic cycle.
 2. Hydrological cycle and vegetation of the area.
 3. Precipitation intensity and flood frequency of an area
 4. Revision of the climate types of rainfall of the Philippines
 - D. Survey of surface fresh-water areas.
 1. Navigable and non-navigable rivers
 2. Possible supply of fresh water from lakes
 3. Rivers and their water potential
 - E. Survey of underground water
 1. For shallow wells
 2. For deep-wells
 3. Deep-wells for industries

- III. Some of the specific subjects of water resources research
- A. Geographical utilization of water for industry, irrigation, and water power
 - B. Economic aspect of irrigation by gravity and pump systems
 - C. Study of water rights problems in agriculture and in manufacturing industries
 - D. Hydrologic cycle and flood control
 - E. Micro-climate studies
 - F. Underground water surveys of Central Luzon and in population centers
 - G. Studies on per capita consumption of water in Manila and metropolitan areas and in other centers of population
 - H. Water pollution and the manufacturing industries
 - I. Water pollution and the agricultural chemical industries
 - J. Water for recreational purposes

SUMMARY

Water at the command and control of man to produce food, to sustain lives, to run mighty engines that provide power and light, to clean the hands of surgeons that save lives, and water that plays an indispensable part in the processing of millions of industrial products enters an era of complicated use. Once considered a valueless commodity, water is now becoming precious as the world's population increases tremendously. The water problem, therefore, becomes more complicated every day.

Realizing this grave situation the developing countries have enlisted the cooperation of the more developed countries through the United Nations in the water program as International Hydrological Decade (1965-1974). During this time the scientists of participating countries will coordinate their search for ways and means of utilizing more efficiently and effectively the earth's water resources.

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Effects of Excessive Cultivation

Excessive cultivation reduces soil organic matter content. Waite Agricultural Research Institute, Adelaide, South Australia, experiments show that a rapid breakdown in soil structure, together with a reduction in organic matter, occurs under excessive cultivation, applying particularly to orchard culture. "Care in using implements for adequate working, avoiding excessive cultivation is good soil management."

—Anonymous.