Water as a Resource in the Third World

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I. Introduction

Since his beginning, man has tenaciously strived to promote his well-being by fulfilling five basic wants. First, by overcoming the elements of his environment, man has struggled to satisfy his material, or economic needs. Second, he has relentlessly searched out and èxplored new and broader frontiers of science in order to maintain and improve both his material an biological well-being. Third, he has discovered the means to set aside valuable time for leisure and recreation, affording him mental tranquility and bodily rest.

Fourth and related to the third, because man's psyche has hungered for spiritual sustenance, with a passion tempered by humility, the *homo sapien* has looked within and without himself in order to satisfy his spiritual needs. Fifth, curiosity and necessity have prodded man to acquire knowledge and skills to deal with a constantly evolving environment — changes which in a large measure have been caused by man.

In retrospect and by present-day standards — however rudimentary may have been the means by and however inadequate the extent to which our progenitors may have accomplished their fivefold mission of providing for human needs — we are deeply indebted to them. As each generation made its pilgrimage

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Consequently, the material benefits derived from the scientific and technological revolution of this century have left much of the world population untouched. As commonly recognized, of some 4.3 billion people in the world, approximately 3 billion reside in the 110 nations which, notwithstanding their individual differences, are often classified as "the less developed economies," or LDCs.

Since 1950, it has become increasingly clear that most nations, advanced and developing, will be compelled to cope with certain real, or threatening, problem areas related to resource scarcity; among them are education, energy, food, population, and water. In no small way, the emergence of these problem areas is both directly and indirectly related to the rapid scientific and technological progress made over decades. Furthermore, in the case of Third World countries, the dimension of those problems magnify in the light of the accelerated scientific and technological achievements of the industrialized economies since the conclusion of World War II. Especially challenged will be about thirty nations, which some economists prefer to call the Fourth World, i.e., the poorest of countries in Black Africa, the Carribean, and Southern Asia where one-fourth of the world's population resides.

The purpose of this paper is threefold. First, its main focus will be on one of the problem areas which demands the attention of a good share of the developing nations: water scarcity. Second, some attention will be given to the problems of food supply and hydropower in the light of their unique interrelationship to water supplies. Third, as Third World case studies, five nations which — in varying degrees — are suffering from water and food scarcities will be considered: Egypt, Ethiopia, The Mongolian People's Republic (MPR), Pakistan, and Paraguay. In each case, attention will be given to: (a) the extent to which the problem of water scarcity exists, (b) some of the steps taken to resolve or alleviate the problem, and (c) the extent to which success has been achieved. The five nations have been selected because, as developing nations, they are both similar and dissimilar. On the one hand, they are similar because they possess a number of those characteristics common to the LDCs. On the other hand, they differ because they are not only spatially dispersed but they also differ demographically, in economic and political organization, ethnically, in physical environment, and in social organization.

various parts of the world may be ascribed to the uneven distribution of water from season to season, inaccessibility of water supplies, and spasmodic distribution from region to region.[5] To these, we may add other causes: (1) the unpardonable violence done by man to his environment, including the pollution of valuable resources such as water to a point where (a) the damage is permanent and/or life-threatening or (b) the damage is reversible, the extent of damage is such that the water is uneconomically reclamable and (2) the disutility of water supplies which in their natural state are unfit for human consumption. Briefly, then, the problems associated with water supplies are problems of quantity and quality.

Distribution of Water

The uneven and spasmodic distribution of the world supply of water becomes most evident when we consider the hydrologic process. Of 530,000 cubic kilometers of water evaporating annually, 70,000 cubic kilometers originates from land areas, the balance from the sea. Yet, the hydrologic process restores 110,000 cubic kilometers to land surfaces, while 390,000 cubic kilometers falls into the sea.[6] And although the earth's land surface actually undergoes an annual net gain of water, only by chance is rainfall optimally — or nearly so — distributed.

Where a sufficient supply of water exists, human intervention in the water cycle is essential: (1) in order to effectively use and conserve the water resources, flow and stock and (2) to insure an adequate supply to the various consuming sectors. However, as witnessed in the post-1950 period by nations such as Italy and the People's Republic of China, intervention to achieve the accessibility and to improve the distribution of water can require considerable cost in capital outlay. The construction of artificial lakes, irrigation projects, reservoirs, dams and dykes, canals, embankments, and deep pumping wells are typical infrastructural investments. Reforestation and the re-routing of rivers and streams are often an essential part of a comprehensive national plan of water conservation, prevention of land erosion, and

[5] See Ambroggi, p. 39.
[6] See Ambroggi, p. 39-40.

$$(2) \quad k_w = \frac{1}{1-r}$$

Given the RFM, the total volume of water generated is equal to:

$$(3) \quad V_w = k_w\ (W_w)$$

In advanced economies, next to industry and people, agriculture places the greatest demand on water resources. Also, due to losses by surface evaporation, through plant transpiration, and to underground acquifiers not linked to an original return, flows from the agricultural sector are likely to be less than that involving use by industry and people.[8] Clearly, then the magnitude of k_w is much influenced by the end-use of the water supply. The aforegoing formula can easily be elaborated by taking into account sectoral end-use, i.e., use by agriculture, by industry, and by households, or people.[9]

IV. Water Supplies of the Case-Study Countries

Obviously, an ample water supply, qualitatively as well as quantitatively, is essential to all economies, notwithstanding where they may rank as developing nations. Besides for human consumption, the uses of water are almost infinite: as a cleansing, lubricating, and cooling agent in industry, in agriculture, in numerous ways within households, etc. Its vital importance to the argicultural sector — as an input in the production of food and

[8] True, the loss by evaporation would in time be returned through the hydrologic process but not necessarily to the source-area, as explained earlier. Some uses in industry result in total or almost total return, such as water drawn for cooling purposes in generating electricity.

[9] Assume r_a is the fractional consumption of withdrawals by agriculture, r_i in the case of industry, and r_p by people, or households. The RFM may then be computed as follows:

$$K_w = \frac{1}{1-(r_a + r_i + r_p)}.$$

The aggregate multiplied effects of the sectoral withdrawals would be expressed no different than that shown in Formula (3) of the text, given an average propensity to consume, i.e.:

$$V_w = k_w W_w$$

Mongolia and Pakistan

Although Mongolia (the MPR) suffers from insufficient precipitation — varying from 4-14 inches annually — it is fortunate in being able to rely on other sources, realized and potential. River flows in Mongolia may be divided into two classes; those which (a) drain into the derserts, plains, and interior lakes, and (b) flow into the Arctic and Pacific Oceans. The majority of rivers are of the former class. They are swift and threatening; under more favorable weather conditions, they would be a national resource of far more value. Among the various rivers, the Selenga, Kerulen, Hara, and Onon Rivers are considered important surface flows. Although the Gobi region has few rivers, the 275 mile-long Ongin Gol is a resource of some importance. But more importantly, surveys conducted in the Gobi serveral years ago by Hungarian geological teams revealed considerable reserve stocks, sizeable reservoirs of quality water — some located as little as ten feet below the surface. Ninety percent of these reserves are believed to be no more than 500 feet deep. Lakes number into the hundreds, of which the Upsa Nur and the Khubsugul are the most important.

Despite adequate surface and sub-surface supplies of water, the Mongolian poeple for decades have suffered from water shortages for two principle reasons: (1) much of the exploitable water resources have remained untapped and (2) the bitter winters have consistently caused surface supplies to freeze for periods of as much as six months of a year. But since 1950, in cooperation with the U.S.S.R. and several Eastern European nations, ambitious water projects have been undertaken. Unruly streams have been rerouted and dammed, numerous irrigation projects undertaken, dozens of wells drilled, and several thousand old wells replaced or redrilled. A major share of pasturage land in the Gobi is now watered and productive. The national goal since 1950 has been to provide every *Aimak,* or province, with ample supplies of water.

Not unlike Mongolia, Pakistan has managed to more aggressively exploit a good share of its water resources, even though rainfall is sparse and seasonal. The national average for rainfall approximates 10 inches annually. The Punjab in eastern Pakistan (where the most productive agricultural lands are to be found) has an annual rainfall of over 20 inches. The Thar Desert, in south-

V. Food, Energy, and Water

The close relationship of water to world food production and to electric power requires that these subjects be given some treatment, particularly as related to the five countries observed in this paper.

Food

The outlook for global food supplies for the remainder of the current millennium is mixed. A perusal of the record over the past decade reveals some negative aspects; a period of shrinking world grain reserves, rising prices, and severe short-term food crisis in some part of Asia and East Africa. Moreover, approximately 70 million people in 30 LCDs exist on a diet considered marginally nutritional, and almost 2 billion people in 86 countries are undernourished. In addition, during the period spanning from 1960 to 1975, the annual food output in some 90 developing nations increased by 2.6 percent, just enough to match their population growth. On the positive side, of the 90 nations 24 increased food production at a rate faster than their population growth. Globally, the marginal increase in food production in recent years has been greater than the marginal rise in population. In the 1970's, some observers had predicted that a food crisis would ensue in the 1980's and that hunger and starvation could become widespread. As pointed up earlier, the Ethiopian food shortage has reached a crisis stage. It is estimated that 6-8 million will perish of starvation in 1985. With exception of parts of Black Africa and Asia widespread misfortune has not as yet befallen us. Certain anticipated adverse developments have been averted, or at least stayed temporarily.

First, recent evidence points to improved agricultural productivity in Third World nations. Second, numerous LDCs such as Mongolia, Pakistan, and Paraguay have enjoyed considerable success by expanding irrigation projects. Third, since 1973, agricultural trade has structurally changed in many cases, suggesting that the LDCs have become more specialized in agricultural production. A study of world grain imports reveals that of 110 million tons imported in 1970, LDCs imported 8 percent of the total; in 1980 of 228 million tons, LDCs imported 3

Egypt's commendable progress in augmenting food supplies, the rate of population growth in Egypt continues to increase somewhat faster than that of food output. Egypt is still compelled to import considerable quantities of wheat and flour from abroad, 6 million metric tons in 1981 alone. The U.S.D.A. estimates that by 1983 Egypt could become an annual importer of $1 billion of American agricultural products. Fortunately, substantial exports of Egyptian crude oil and cotton help offset the adverse trade balances caused by food imports.[12]

Ninety percent of Ethiopia's population of 31 million relies on agricultural and pastoral pursuits as a means of subsistence. A 1979 per capita income of but $130 by those engaged in agricutural pursuits reflects the lack of productivity in the agricultural sector. Moreover, agricultural and pastoral pursuits account for only 50 percent of the nation's Gross Disposable Income.[13] Although 70 percent (200 million acres) of the total land area is cultivable, only 16 percent (32 million acres) is actually cultivated. According to the Food and Agricultural Organization, the production of maize has generally fallen off since 1975 when 1.47 million tons were produced. Due to the war with Somalia in 1977-78 plus the droughts of the late 1970's, output fell to a low of 929,000 tons in 1977. Some recovery has taken place since 1977-78, 1.144 million tons were harvested in 1980. Coffee, the most valuable crop, has generally risen in output from 174,000 tons in 1975 to an all-time high of 203,000 in 1980. The cattle population in 1980 numbered 26 million head, hardly showing any change in size over the past two decades. The war with Somalia as well as the droughts suppressed the growth of herds and adversely affected the output of crops.

The Mongolian case is indeed unique, for with the birth of socialism in 1921, the revolutionists under Jebtsun Damba

from which a good share of the data in this and the three preceding paragraphs have been drawn, pp. 101-10.

12 This data relative to Egypt was drawn from the *Quarterly Review of Egypt*, The Annual Supplement 1980 (London: The Economist Intelligence Unit Ltd., 1980), pp. 9-11; Ikram, p. 42; and U.S.D.A., *Foreign Agriculture; Egypt a Growing Market*, August 1981, pp. 5-8.

13 Statistics on agricultural production originated from *The Quarterly Economic Review of Uganda, Ethiopia, Somalia, Djibouti*, Annual Supplement 1981 (London: The Economist Intelligence Unit Ltd., 1981), pp. 16-17.

crease production by successfully promoting the widespread use of fertilizer, high-yield seeds, and farm machinery. Moreover, the investments in infrastructures plus a greater emphasis on technical training in the schools have brought positive results.

According to a 1979-80 count, livestock population numbers 86.8 million head, some 54 million head are about evenly divided between goats and sheep, 15 million are cattle, and 11.5 million are buffaloes. Horses and camels account for the reamining 3.9 million. The poultry flock approximates 58 million. Numerous fisheries, both inland and maritime, are being developed, for fish is popularly consumed domestically as well as being exported. Inland and maritime fishing, which provided a catch of 174,000 tons in 1975-76, increased by 70 percent over the subsequent five-year period.[15]

Agriculture constitutes the backbone of the Paraguayan economy, accounting for one-third of the nation's GDP and 60 percent of the employed labor force. Of 198.66 million acres, 79.46 million acres, or 40 percent, is devoted to grazing cattle. Of 20 million acres of potential crop land, only 2.5 million has been cultivated. The remaining 98 million acres consists mostly of the scrub and forest land. In their order of importance, maize, soy beans, cotton, and sweet potatoes are the chief agricultural products. The production of maize increased from 301,000 tons in 1975 to 585,000 in 1979; a three-year moving average for 1975-79 appears favorable: 341,000; 359,000; and 437,000 tons. Soy beans output rose from 216,000 tons in 1975 to 547,000 in 1979, a moving average of 256,000; 295,000; and 393,000 tons. Cotton and sweet potatoes reached 230,000 and 124,000 tons respectively in 1979, a threefold increase over 1973 in each case. On the whole, Paraguay is self-sufficient in basic food supplies, despite a deficiency of wheat. Other than wheat, Paraguay produces sufficient export surpluses among a diversity of products: coffee, cotton, hides, meat, soy beans, and tea. Timber exports somewhat exceeded U.S.A. $65 million in 1980. Livestock numbered almost 6 million head in 1978; of these pigs accounted for 1.2 million, sheep 374,000 and horses 322,000. In recent years the foreign

[15] For this and the preceding paragraph, the author has in a large measure relied on *The Quarterly Economic Review of Pakistan, Bangladesh, Afghanistan,* Annual Supplement 1981 (London: The Economist Intelligence Unit, Ltd., 1981), pp. 9-10.

1974 compared to $4 billion in 1973 (a 275 percent increase) — this despite their efforts to cut back on oil consumption.

The price of crude progressively increased over the subsequent 6 years, to a then all-time high of $26.50 per barrel by 1980. The sharp price increases not only disrupted the NODs international balance of payments but also accelerated inflationary rates. Furthermore, besides the vulnerability accountable to their reliance on oil-producing countries, the NODs continued to be exposed to the chronic problem of cyclical variations characteristic of the advanced economies. During the period of 1973-80, Pakistan and Paraguay were listed among some 40 LDCs most disadvantaged by higher energy costs. Of the five case countries considered in this paper, only Egypt is self-sufficient in oil, and this is a very recent development. Because the remaining four case-countries have traditionally relied on oil to satisfy at least 50 percent of their total energy needs, the oil crises of 1973-74 and 1978 left them with few short-run alternatives; they were forced to continue importing costly oil. In their search for alternative sources of energy, the NODs have experienced varying measures of success. Some, such as Egypt, Pakistan, and Paraguay have achieved a reasonable measure of success in harnessing water power and transforming it to electric power.

Egypt's conventional hydropower resources, which are on the Nile, have been considerably developed over the past thirty years. The main stations are at the Aswan Dam and the Aswan High Dam; their combined capacity varies from 800 megawatts during the winter to 1,400 megawatts in the summer. Known coal deposits are limited to some 80 million tons in the Sinai, and to date, little information has been released as to its quality. Some deposits of uranium (U_3O_8) and thorium (ThO_2) exist, but the very low content of uranium and thorium per-ton renders the mining of these deposits uneconomic. Nevertheless, on the whole, Mother Nature has not been parsimonious in granting Egypt energy resources. Given the necessary capital, financial, and human resources, the nation is likely to meet its energy requirements for several years to come.[18]

[18] In passing, it ought be mentioned that presently Egypt has undertaken the installation of four offshore platforms in the Belayim oil field at a cost of $50 million. Also, Egypt has applied for a World Bank loan to expand its facilities at its Abu Qir fields in hopes of

The Great Rift Valley, although one of the world's most promising sources of geothermal power, has hardly been explored.

Unfortunately, recent data on energy resources of the MPR are sparse.[20] Coal is the most important source of energy; most of the coal mined is brown lignite. The principal mines, the Nalaika and Sharyn, have been modernized with Russian materials, machinery, and manpower. The two mines accounted for some 80 percent of the 1975 output, which exceeded 1.5 million tons. Domestic wells provide about one-half of the MPR's petroleum needs; domestic output in 1975, as estimated by this author, approximated 50,000 tons. The discovery of oil in the Gobi in the early 1940's, bought considerable Soviet assistance in the post-World War II period. Soviet engineers, geologists, technicians, plus machinery and equipment played a major role in the development of the industry. The MPR relys on the U.S.S.R. to supplement its domestic output of oil, having purchased $220 million worth from 1965 to 1977.

The Salenga, Kerulen, and the Dzabkhan are the major water flows. Although surveys indicate that several rivers in the MPR may well serve as potential sites for the construction of hydro stations, other potential sites are excluded due to their being frozen as much as 6 months of the year. To date, no reliable information is available relative to any plans to exploit feasible sites. Nevertheless, the Mongolians have been successful in utilizing thermal energy. In the order of their importance, the main thermoelectric stations are those at Ulan Bator, Sukhe Bator, and Choibalsan. It is estimated that the MPR in 1975 generated 450-550 million kwh of electric power.

Relative to energy resources, Paraguay bears some similarities to Ethiopia. Like Ethiopia, the outlook for domestic supplies of crude oil is dim. Some traces of oil were uncovered in the Chaco region by the Union Oil Company during the late 1940's and some by the Placid Oil Company in 1961; however, none of the finds were considered economically exploitable. Paraguay's only oil refinery at Asunción has a daily capacity of 7,500 to 10,000 barrels. Imported crude oil constitutes as much as 30 percent of the

[20] Because of the MPR's geographical isolation and because the nation is a closed society — not unlike its socialist sister-states — data flowing to the democratic nations of the West is limited and often unreliable.

with inadequate water resources can find some solace in two respects: (1) the RFM acts upon a given withdrawal from the water supply in such a way as to increase utility severalfold over that derived from the initial withdrawal and (2) water need not be potable for use in certain water related projects, e.g., irrigation and the generation of electric power.

However, in areas chronically suffering from water shortages the cost incurred in providing the necessary infrastructure to maximize use of the limited water supplies is often prohibitive in cost to UDCs. Moreover, planning and constructing multipurpose complexes — especially those appropriate for LDCs lacking energy resources — require numerous engineers, technicians, and skilled laborers; human resources which are in short supply in LDCs. Although financial and technical assistance may be available from foreign governments and international organizations (the Agency for International Development, U.S. Export Import Banks, World Bank, and United Nations), it must be recognized that their resources are limited and applicants for financial and technical assistance are many. The Sarir Project in the Libyan desert has been cited as a model project in (a) making use of whatever limited resources are available and (b) constructing the infrastructure to make previously useless land productive. However, many LDCs do not have sufficient natural resources in kind or number which have command over the hard currencies of the industrialized nations; therefore, they are unable to finance ambitious programs, as did Libya. Certainly, Ethiopia, Mongolia, and Pakistan do not.

However, as pointed up earlier in this paper, Egypt has made impressive progress in exploiting its water resources in a diversity of ways. And should its oil drilling prove successful, additional hard currencies would help immensely in improving and expanding its hydro infrastructures. Paraguay also receives good marks for its accomplishments in agricultural, hydro, and related projects. Moreover, Paraguay in embarking on a program of electrification with its neighbors well demonstrates what LDCs can do collectively.

Clearly then, the problems created by water shortages in LDCs are pluralistic, and althugh each LDC must formulate its own solutions taking into account for their individual differences,