SOME ECONOMIC ASPECTS OF GROUND WATER PROJECTS EXECUTED BY THE UNITED NATIONS IN DEVELOPING COUNTRIES

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ABSTRACT

In the course of the last 25 years, the United Nations has been involved in the execution of some 150 projects for ground water exploration, development and management in about 70 countries around the world. The paper tries to draw some conclusions on the economic aspects involved in the activities of the last two decades, for the benefit of the international community. The supply of water to communities on the edge of survival and settled on the finges of dessert areas cannot be weighed in economical terms only. Fixing population in their homelands is a major issue. In that case economics must phocus on getting maximum benefits from the scarce resources available and avoid major losses through mismanagement and soddy construction. While the cost/benefit ratio cannot really be ascertained, it can be substantially reduced when costs are put under control and minimized.

1. INTRODUCTION

In the course of the last 25 years, the United Nations has been involved in the execution of some 150 projects for ground water exploration, development and management in about 70 countries around the world. It is now appropriate to draw some conclusions on the economic aspects of these projects for the benefit of the international community. This paper will concentrate on the activities of the last 10 to 15 years.

In 1973, the first "oil-shock" changed considerably the perspectives of ground water utilization, as the cost of a barrel of oil increased ten-fold within two years, thus increasing costs of drilling and pumping. As a result, some countries changed their ground-water development policies, especially regarding large-scale irrigation which was no longer economically feasible for crops of moderate market value such as cereals. It must be borne in mind that energy costs may constitute as much as 50% or more of the cost of ground water delivered at the pump and that

the cost of water for irrigation purposes cannot normally exceed one U.S. cent per m^3 in conventional irrigation (flood or furrow type, according to U.S., U.K. and Commonwealth sources). This was the case in the Philippines where the idea of developing ground-water resources for rice irrigation was abandoned, while surface water irrigation projects were given increased attention. Conversely, in the North China Plain where ground water is the only water resource available, some 800,000 pumping stations have continued to operate, yielding large amounts of ground water for the irrigation of wheat and corn. Economic considerations were of little importance there when compared with the vital characteristics of the operation. Moreover, since the stations are primarily equipped with electric pumps, fueled by coal or hydropower, the oil-shock had little impact.

In the India peninsula also, large scale ground-water irrigation continued for similar reasons. In oil and gas-producing Arab countries ground-water irrigation projects developed, limited by the availability and the quality of the ground water resource. Since the purpose of these projects was to attain self-sufficiency in cereal production, economic considerations were largely forgotten.

In many developing countries and especially in Africa, the hopes of large-scale ground water irrigation projects did not really materialize. In this connection, it is well known that agriculture is heavily subsidized in industrial countries. To maintain the prices of certain agricultural commodities. To level acceptable for farmers, large amounts of surplus products are purchased by governments, especially in Western Europe and in the United States. In Japan, rice is produced at a cost which is said to be several times that of California. In Saudi Arabia, agriculture is subsidized by the oil industry. The wheat produced near Riyadh, using sophisticated pivot-wheel irrigation technologies, is produced at a cost which is several times higher than current world market prices. On the other hand, in many developing countries agriculture is the main economic activity, and therefore cannot be subsidized. It must be self-supporting and, as a result, irrigation from ground-water sources can hardly be considered. There are, however, some notable exceptions, related to the production of high value cash crops including counter-season produce such as green vegetables, salads, green beans, tomatoes and also certain fruits, especially citrus. From this point of view,

the areas bordering the Mediterranean basin, parts of California and Florida, and some parts of Central America, enjoy a prosperous ground-water irrigated agriculture. The main problems are the degradation of water quality.

Apart from irrigation, ground-water is mainly used for:

- Industry;
- Municipal water supply including tourism and recreation;
- Rural water supply, including cattle watering.

Industry is a major user of ground water. In industrialized countries uses have emerged such as cooling water related not only to the industrial processes themselves but also to the operation of air-conditioners, and heat pumps. In France, some 30 years ago, the steel industry absorbed enormous quantities of ground water, amounting to more than 50 per cent of the ground water developed in the country, which resulted in depletion of the chalk aquifers in the North.

Municipal water supply systems are also major ground water users, not only in arid countries. For example, the Hamburg Metropolitan area, in Federal Republic of Germany uses mainly ground water for municipal supply. Industrial and urban consumers can generally afford to pay a relatively high price for water. In fact, the production of raw water does not cost much if compared with treatment, storage, conveyance and the minimal treatment if any (mostly chlorination), has proved in many cases more economical than surface water.

2. ACTIVITIES OF THE UNITED NATIONS DEPARTMENT OF TECHNICAL CO-OPERATION FOR DEVELOPMENT

As an agency of the United Nations family engaged in development activities in developing countries, the Department of Technical Co-operation for Development, with few exceptions, has not been involved in projects dealing specifically with ground water development for agriculture, industry and municipal water supply, which normally fall within the competence of other United Nations Agencies. Its activities have concentrated mainly in the following areas:

- Ground water resources surveys, exploration, and assessment for multi-purpose uses, as aspects of a natural resources inventory.

- Ground water development for rural water supply, including water points in rangelands, mainly for drought relief operations.

- Maintenance and rehabilitation of wells and pumping stations.

- Ground water resources planning and management projects.

All of these activities have included the strengthening of government and other public organizations, the transfer of technologies and the training of personnel. Some economic aspects which emerged from these activities are presented below.

2.1. Surveys, exploration and assessment

Most of the ground-water projects which were carried out in the 1960s and the first half of the 1970s concentrated on these activities. Some examples from recent on-going or forthcoming projects are:

(a) Exploration of shallow ground water: Djibouti; Timbuktu region, Mali; Nepal; Viet Nam;

(b) Exploration of deep ground waters: Morocco;

(c) Monitoring and control of salinity: Qatar, Pakistan;

(d) Karst aquifers: Turkey;

(e) Water resources assessment and ground water balance studies and modelling: the Northern China plain; three selected areas in the Republic of Korea; Islands of the Caribbean, of the Atlantic Ocean (Cape Verde), of the Pacific Ocean; Nubian sandstones (Egypt and Sudan); and Bangladesh;

(f) Cartography of ground water resources: the Yemens, Zanzíbar;

(g) Artificial recharge in India.

The economic aspects of such projects were not overlooked. First, they were or are being carried out at the lowest possible cost; thus, the services of expatriate personnel have been minimized to a few man-months of high level specialized expertise to advise countries such as Turkey, China and the Republic of Korea. Equipment inputs have been reduced to the minimum compatible with the requirements of the transfer of technology, using as much as possible equipment already available in the country and arranging for its rehabilitation (e.g., drilling equipment in Djibouti).

Second, a socio-economic component has been introduced into such projects in order to determine, after assessment of the water resources, what socio-economic benefits could be expected from ground water development. For example, in the Timbuktu

region an agro-pastoral study was carried out in co-operation with FAO, while a similar study is to take place in the Sudan and Egypt within the framework of the "Nubian sandstone aquifer" project. In Morocco a preliminary economic feasibility study will be carried out on the development of deep ground water resources which will be assessed in project areas.

The economics of water resources development and conservation in smaller islands of the Caribbean and the Pacific will also be closely examined.

2.2 Rural Water Supply

In 1973-74 a major drought struck sub-Saharan Africa. Since then, a number of drought crises varying in amplitude have occurred not only in sub-Saharian Africa but also in East, Central and Southern Africa. The crisis of 1984 which affected in particular Ethiopia, Somalia and the Sudan, generated around the world a vast solidarity movement.

These crises demonstrated the vulnerability of traditional water supplies in rural areas of Africa. In times of drought, surface water supplies such as natural or artificial ponds or alluvium water, which depend directly upon rain, dry up. Traditional wells also dry up if, under normal circumstances, they contain less than one to two metres of water. The need for permanent water points unaffected by droughts appeared then a priority to avoid loss of life and widespread migration to urban areas. The creation of reliable water points would make it possible to maintain populations in rural areas, and, therefore, preserve the social fabric of the countries concerned. In support of such policies, the United Nations has developed a number of rural water supply projects in several African countries and especially the sub-Saharan countries of Burkina Faso, Chad, Gambia, Mali, Mauritania, Senegal, Somalia, and the Sudan, as well as Benin, Central African Republic, Guinea Bissau, Liberia, Sierra Leone and Togo, and also Cape Verde and the Comoros Islands. Many other donors and lending institutions have been involved in such operations in most African countries. New water points have been thus created by the thousands, according to two different concepts, as follows:

(a) The modern open, large diameter concrete lined dug well is excavated by machines, or "by hand", but in this case through the use of mechanized derricks, jackhammers and explosives. Such wells hold four metres of water or more, and can last for centu-

ries. Water can be extracted by hand. The major drawbacks are their vulnerability to pollution if they remain open, the slowness of construction (at a rate of .25 to .40 metre per day), and the high cost.

(b) The drilled "tubewell" can be completed in one or two days at depths exceeding that of water static levels of 10 to 20 metres or more. The main drawbacks of tubewells are the relative fragility of the pumps, whether mechanical or hand-powered, their vulnerability to corrosion, to the collapse of the casing, to wear and tear; and to breakdowns due to mishandling. Indeed the main problem is to keep the hand pumps, which are now a common feature of the rural landscape of Africa, in working condition. The life expectancy of such pumps is about 10 years at most; repair and replacement of this equipment is in a number of cases beyond the financial means of the local population and governments.

A rural water supply project in Africa is in most cases relatively costly. The lowest investment costs are found in countries such as Rwanda and Burundi where minor works to improve the yield of small springs amount to a few dollars per capita. Conversely, the cost of an 80 metre tubewell in hard rock expected to supply some 200 people is now in the range of $US12,000 with annual recurrent costs amounting to 10 per cent or more of this amount. In rural areas of the sub-Saharan belt, the average per capita annual income may be in the range of $100 or less.

The situation is even more critical in areas where ground water is to be reached at sizable depths and where mechanically-powered pumping installations are needed. In many areas of Somalia, ground water is not reached at less than 150 to 200 metres and static levels are more than 100 metres deep. The cost of a tubewell equipped with a submersible pump and a generator capable of delivering 10 to 20 cubic metres per hour is in the range of $US100,000.

In the execution of rural water supply projects, the United Nations has attempted to reduce the costs through the following:

(a) The Africanitzation of technical personnel: the expatriate expert component has been reduced to a minimum; the professional capability of African technicians has been upgraded through in-service training and fellowships abroad. A school for water well drillers is being established.

(b) Savings in equipment costs: through the use of lighter drilling rigs, and of pumps manufactured in developing countries,

especially in Africa, such as the "India Mark II" pump, which is now manufactured in several countries including Mali, and by means of improvement in the maintenance and repair of equipment, especially the pumps.

Besides the health and social benefits derived from rural water supply development, the evaluation of the economic benefits of such development is another aspect being examined. Particular attention is being given to the economic feasibility of small-scale irrigation projects in the vicinity of village pumps.

Major bilateral and international funding institutions give consideration to small-scale ground water irrigation projects, which aim to increase food production and improve nutrition, and by raising income may finance in part rural water supply systems, especially in Africa. However, the economic feasibility of such projects depends on a number of conditions, such as: ground water at shallow or moderate depth; acceptable water quality; good soils; adequate climatic conditions; and favourable market conditions for the crops.

2.3. Maintenance and rehabilitation of wells and pumping stations

In some of the least developed African countries, the United Nations has provided assistance in the operation, maintenance and rehabilitation of motorized pumping installations. This has involved: the training of pump operators, as in Somalia; the rehabilitation of pumping stations which have been damaged or destroyed, or which had fallen into a state of disrepair such as in Chad and Southern Sudan; the organization of a service for the operation and maintenance of pumping stations in remote areas of Mauritania, including the delivery of fuel. In Malawi, a project team was organized and provided with equipment to clean tubewells clogged with fine sand.

Normally, the maintenance of equipment, including its replacement after amortization and the supply of spare parts-and its operation, including the supply of fuel, are the responsibility of the countries concerned, whether at the government or at the local community level. The few cases in which the United Nations has been involved in such operations were basically emergency or humanitarian in nature and cannot be considered significant in economic terms.

Nonetheless, it appears as if the maintenance, and even the operation of some installations, not to mention the creation of

new water points, are beyond the means of certain areas in some countries. Conversely, as far as village hand pumps (or foot pumps or animal-powered pumps) are concerned, great progress has been made. By and large the population has taken charge. The services of competent mechanics are available in many villages and the populations are willing and able to buy necessary spare however, not be so feasible if resources at the village level do not increase significantly. The cost of a pump may be equivalent to the per capita income of half a dozen people for one year and its relative importance for the village is even greater in proportion to the effective cash flow.

2.4. Ground Water Resources Planning and Management

With the ever increasing number of water projects in Africa, especially rural water supply projects benefiting from the assistance of many international, bilateral and non-governmental organizations, the need for rational, long-term planning and for co-ordination of activities for on-going projects is imperative. The United Nations has entrusted the Department of Technical Co-operation for Development with the task of formulating and executing projects aimed at the preparation of water policy guidelines and preliminary master plans for water development. Countries in which such projects had been initiated as of 1987 were: Benin, Burkina Faso, Cape Verde, Central African Republic, Guinea Bissau, Mauritania, Niger, Mali, and in the Caribbean, Haiti and Jamaica.

In general, the projects are centred around the organization of data banks including such categories as: potential water resources, water needs (at the level of villages), existing water points with their hydrological characteristicas and priority needs to be met. These listings cam be interlinked, thus allowing an identification of future actions needed or desired. The basic elements of future projects can therefore be identified almost instantly through the computer.

The projects also assist inter alia, in the collection of data, the monitoring of ground water levels, the assessment of water resources and the preparation of sectoral reports on water resources, water uses and water technologies; the identification of socio-economic aspects of water projects; the training of personnel; the preparation of water planning exercises; the drafting of water legislation; and the co-ordination of activities of various water agencies. The final aim of such projects is to

improve the efficiency of water programmes by reducing delays in implementation, risks of overlapping, investment and recurring costs, and eventually the cost of water delivered at the pump or the well.

All such projects are in their earliest stages of implimentation and no conclusions have been drawn yet regarding the economic aspects, that es, how and to what extent water costs can be reduced.

3. CONCLUSIONS

Considering the nature of the projects in which the United Nations is involved, mainly in the least developed countries, no far-reaching conclusions may be drawn from them in strict economic terms and from a global perspective. However, two major observations emerge.

First, the supply of water to communities on the edge of survival, and settled on the fringes of deserts cannot be wieghed in economical terms only. A parallel situation exists for education an health for which a benefit/cost ratio cannot be established through orthodox economics. If the provision of basic water supplies helps in maintaining population in its ancestral lands, where some local resources such as arable soil and rangeland are still available, then a massive exodus, uprooting and destitution under sub-welfare conditions can be avoided or at least slowed down: large tracts of land will not be abandoned. Eventually, some economic benefits will be drawn, and major losses avoided.

Second, although the benefit/cost ratio cannot readily be quantified, it can be substantially affected by a reduction in costs. To this end, investigations should be kept to a minimum while acquiring a high degree of efficiency through the use of adequate technology and methodology; local human and physical resources need to be utilized to the utmost extent possible. The same considerations need to be applied to well construction equipment and methods, and to ground water extraction devices. Considerable success has been achieved along those lines in Africa in recent years, especially in United Nations-assisted projects. Also, the importance of keeping equipment in good operating and working condition, and of having adequately planned projects which fit into a rational master plan for water resources development, cannot be underestimated, if a satisfactory level of economic development is to be attained and maintained.

The department of Technical Co-operation for Development (DTCD), is among the agencies of the United Nations family which carry out most of the activities related to economic planning and ground water exploration and development.

It was therefore appropriate for TCD to help in the organization of this symposium and to try to go beyond the limited scope of its operational activities consisting of ground water projects fielded mainly in the least developed countries. In this venture, through the action of the organizing Committee and the contributions of Spanish proffesionals, the co-operation of the Government of Spain, a country in which ground water development has for centuries been given much attention, has proved extremely helpful.