Research Possibilities in Rainwater Harvesting in Sri Lanka

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ABSTRACT

Both surface water and groundwater resources of Sri Lanka have been utilized to a large extent and the possibilities of further expanding them are limited. Nevertheless, a considerable amount of water received as rainfall escapes to the sea unutilized and there is a great potential in harvesting this resource for domestic as well as agricultural uses. As rainwater harvesting (RH) on an organized scale is a very recent development in the country, there is a lack of knowledge and information on several aspects of this very useful technology. Hence, many research possibilities exist to make RH worthwhile and acceptable to the people. The paper outlines five major areas under which numerous research studies can be pursued.

INTRODUCTION

Sri Lanka is endowed with much rain through which all sources of water supply in the country are sustained. Estimates reveal that the island's surface area receives an average of 131,230 million cubic meters of freshwater annually (NARESA 1991). Nevertheless, both spatial and seasonal distributions of rainfall show marked variations. Such variations have led to the growth of irrigation systems from ancient times.

The use of surface water for irrigation, particularly for paddy, has recorded a marked upward trend since Sri Lanka gained independence. The total area irrigated in 1948 by all methods was 241,100 hectares. Of this total, 34 percent was irrigated under the major irrigation schemes. By 1995, the total irrigated area under paddy rose to 673,300 hectares and the share of major irrigation schemes rose to 70 percent. Investment on irrigation also indicates a remarkable upward trend from Rs 18.11 million in 1948 to Rs 2,458.22 million in 1988 at current prices (Aluwihare and Kikuchi 1991). Because of the construction work associated with the Mahaweli scheme, new construction escalated from 1980 to the end of that decade but it began to wane thereafter. The possibilities of expanding major irrigation works in the future are restricted.

With the increase in population, there has been a rapid increase in the demand for water for both domestic uses and agricultural purposes imposing a considerable stress on conventional sources of water supply. In the dry zone of Sri Lanka, certain areas that could not receive the benefits of irrigation through surface gravity flow resorted to the utilization of groundwater through agro-wells. With the introduction of subsidies by the Agricultural Development Authority (ADA) and subsequently by the Provincial Councils and other agencies late in the 1980s, the number of agro-wells increased very rapidly. Haphazard construction of agro-wells without a proper understanding of the nature and extent of the groundwater re-

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sources has led to numerous problems, particularly with reference to drawdown replenishment, indicating an overexploitation of the resource.

Sri Lanka's total annual runoff is roughly estimated at 5 million hectare-meters or 50,000 million m^3 of water (approximately 40% of the mean annual rainfall) of which a substantial proportion is now utilized for irrigation and hydropower projects (NARESA 1991). The estimates also indicate that 3.3 million hectare-meters (33,000 m^3), i.e., 65 percent of the runoff to the sea, which is a vast potential, can be tapped. With the ever-increasing demand for water in the country there is an urgent need to harvest a proportion of this runoff through the introduction of appropriate collecting systems for domestic uses and agriculture. Nevertheless, rainwater harvesting (RH) on an organized basis is absent in Sri Lanka, except for the rainwater harvesting component of the World Bank-funded Community Water Supply and Sanitation Project (CWSSP). Hence, the launching of an effective program on RH on an island-wide basis depends on a number of considerations relating to technical, institutional, socio-economic, and policy aspects. However, there is a lack of knowledge relating to some aspects of RH while in the case of other aspects, available information is scanty and insufficient for planning exercises. The objective of this paper is to probe into the areas that need further studies and highlight research possibilities in RH with a view to promoting conservation of a part of the runoff, which could be utilized for productive purposes.

RAINFALL CHARACTERISTICS

As noted above, rainfall of Sri Lanka exhibits noteworthy regional and seasonal variations. On the basis of long-term rainfall records exceeding 100 years, numerous authors have studied the distribution and variability of rainfall over the island. A recent study by Chandrapala (1996) has identified eight coherent rainfall zones in Sri Lanka using monthly rainfall data from 41 stations spreading over a period of 100 years. The data clearly point to the fact that annual rainfall at any location in Sri Lanka is adequate to initiate RH when compared with African countries where successful schemes are run even with annual rainfalls ranging from 500 to 1,500 mm (Gitau 1995). However, area-specific studies relating to details of the rainfall pattern such as the number of rainy days, intensity of rainfall, and length of the dry spells will be invaluable in planning and commissioning RH schemes.

The concentration of rainfall during specific periods in different zones indicates that there can be considerable shortages of water during the months of low rainfall. It is evident that during these months water levels of the wells generally go down. At some locations wells dry up completely causing acute drinking water problems to the rural communities. With the increasing demand for water, the situation can be worse in the future. Projections of the Water Resources Secretariat indicate that the water deficit for the year 2000 varies from about 200 million cubic meters (MCM) per year in the Mahaweli Development Region to about 1,400 MCM in the entire northern dry zone. According to the same source, piped water supply to Colombo met an estimated demand of 97 MCM per year during the mid-1990s and the demand is expected to double by the year 2000. Hence, there is an urgent need to pursue research to explore the possibility of supplementing the conventional sources of water supply with RH.

Similarly, water-pumping systems supplying urban areas also face many problems. When supplies are drawn from rivers close to the points of discharge to the sea, the reduced seasonal river flow levels often cause backflow of sea water, increasing the salinity of water drawn by the central water supply schemes. In the crowded urban areas the chances of tapping groundwater for drinking are very remote because of the contamination caused by sewerage systems and septic tanks. In light of the above, RH for drinking purposes seems to possess a great potential that can be tapped through awareness programs and by introducing a technology that the people can afford. The need for RH should be further stressed in view of the sharp rise in demand for water that cannot be met solely by the conventional sources of supply.

TECHNICAL CONSIDERATIONS

As there is no tradition of RH for drinking purposes in Sri Lanka there is a need to disseminate knowledge particularly on the technical aspects pertaining to RH. The technical considerations relating to rainwater harvesting are many. Among the more important considerations are the mode of collection, type of tank, maintenance of the systems, and water quality.

The mode of collection, among other things, needs considerable attention of the researchers. When rainwater is collected for domestic use and when rooftops are used as catchments, amounts collected are restricted and storage is often confined to tanks. The average tank size for a family when worked out on the basis of 5 l/ person/ day stands at 5 m^3 in an area where the dry period does not exceed 50 days. When deciding the tank size, the affordability of the users is also considered. The Community Water Supply and Sanitation Project (CWSSP) of the Ministry of Housing and Urban Development has chosen 5 m^3 tanks as the norm. In other countries, especially when no defined wet seasons are found, larger tank sizes are recommended (Pacey 1986).

Surface catchment systems are also used to store water in areas with irregular or seasonal rainfall patterns. For instance, in southern Kenya, numerous rock catchment systems are used to store water. Excavated pits or ponds are used to collect water in countries such as Tanzania, Toga, Kenya, and Botswana (Lee and Visscher 1990). Earth dams are also used to impound water in small valleys or depressions. This is a very common system in the dry zone of Sri Lanka and in South India. Although water from these systems is drawn for domestic use in the village settlements, a major proportion of the water collected is used for agriculture. On the whole, surface catchment systems are often prone to contamination and adequate precautions are essential when such resources are tapped for drinking.

The type of tank should also receive the attention of the researcher as the storage tank is the most expensive component of the system. The choice of the type of tank should be made with recourse to a number of considerations such as the purpose for which collected water is used, total water requirement, technology suited to local conditions, availability of construction materials, and affordability of costs. In commissioning RH systems it is vital to ensure that all these factors are researched into with the active participation of the user communities. As these factors differ from one country to another and sometimes even within a country, area-specific research becomes much more significant. Research findings can profitably be used in determining the desired tank type and in designing the ancillary features of the water harvesting system.

A water harvesting system should be properly maintained with a view to ensuring sustainability. The condition of the tanks should be monitored at suitable intervals and necessary repairs should be effected. Similarly, gutters and pipes leading rainwater from rooftops to tanks and filters need maintenance. In tropical countries, the systems should be carefully protected from mosquito breeding. Constant scrutiny of the gutters for standing water and introduction of effective filtering at the points of water entry and at the outlets of the tanks are absolute necessities in order to prevent the bacteria or parasites entering the tank. Research can be directed to explore the most suitable low-cost methods acceptable to the people.

Another significant consideration is to ensure that the drinking water obtained through RH is not contaminated. When rainwater is collected through roof catchments that are exposed to numerous contaminants such as bird droppings, dust, etc., adequate precautions have to be taken to ensure that water collected is suitable for drinking. The often-suggested remedy is to divert the first flush away from the storage tanks and start storing water after about 10 minutes. Even if the devices to divert the first flush are used, such devices are mechanically controlled and should be operated at the commencement of showers feeding the tank. As has been already pointed out (Grove 1993), users are reluctant to resort to such cumbersome devices. The alternative is to add chlorine as a disinfectant. Both methods are difficult to popularize, especially in areas where people are more concerned about taste. Ahmed (as quoted in Pacey 1986) has reported that people prefer dirty pond water to pure tube well water because of the desired taste. The same source mentions about Soedjarwo's (1981) account of Indonesian conditions where mud is sometimes mixed with rainwater to give the preferred local flavor. No research whatsoever has been pursued in Sri Lanka to study people's perception of RH for domestic use. Such perception studies can provide useful insights into framing strategies and planning RH schemes.

COST FACTORS

There is much scope for research pertaining to costs of RH vis-à-vis the alternative systems of water supply. Major items of costs in a rainwater harvesting system constitute material costs and labor costs. In the case of community systems, supervision costs can also be added. Maintenance costs are minimal when compared with other water supply systems.

Most of these costs, excluding maintenance costs, are incurred at the initiation of a system. In the case of domestic water supply systems, construction of tanks absorbs a major part of the costs. These costs differ from place to place, depending on the materials used and how the labor is utilized. Low-cost, locally available materials are used in many countries to bring down the costs to the user. For instance *Ghala* (Granary basket) tanks in Kenya and cisterns built in Indonesia and Thailand use bamboo reinforcement instead of metal (Pacey 1986). Cement plastering is used inside, bonding sides with a concrete base. Bamboo guttering is also used to reduce costs.

In Sri Lanka, attention was paid to RH only during the second half of this decade. Sri Lanka Rainwater Harvesting Forum, a nongovernmental organization, was formed in March 1996 attracting interested parties from a range of government and nongovernment institutions. Simultaneously, RH became a water supply option in the CWSSP. Under this Project, 307 village water supply schemes were completed by February 1998, serving a population of 278,548 (Heijnen and Mansur 1998). Experience gained, particularly in the Badulla District, clearly indicates that RH for drinking purposes has gained wide acceptance among the rural communities facing drinking water problems. It has much scope for expansion as an alternative source of drinking water supply, especially on slopes where digging of wells is not possible and in areas where easy access to traditional sources of water is denied. Research is needed to identify such areas as well as to judge the perception of the local communities. As RH on an organized basis is not widespread, research and extension work will be invaluable to impart knowledge pertaining, among others, to suitable tank types and to precautionary measures to ensure water quality, installation of systems, and their maintenance.

Knowledge about the costing of the schemes in Sri Lanka is scanty. It is pertinent to note that the size of the tank should vary according to the amount of water to be retained to ensure a continuous supply. On the basis indicated earlier, the CWSSP has designed 05 m^3 tanks in which water retained will be sufficient for about 50 days. Costs are calculated on the basis of two labor supply options. With the use of skilled labor, a brick tank will cost Rs 6,445 and a ferro-cement tank Rs 8,075. If unskilled labor is used the costs for the two options would be Rs 8,245 and Rs 10,175, respectively (Heijnen and Mansur 1998). Under the CWSSP a subsidy of Rs 6,500 is made available to the beneficiaries. Depending on the progress of the RH, middle and upper income households in the areas of water scarcity will be prompted to build bigger tanks on their own.

Hapugoda (1998) who conducted a recent study in Divulapitiya and Mirigama areas in the Gampaha District, where the average annual rainfall exceeds 2,000 mm., has worked out detailed costing for household RH systems. According to this study a 5-m^3 tank and a roof catchment of 60–100 m^2 will cost Rs 10,000. This includes the capital cost for the tank and guttering. However, area-specific research is necessary before planning and installing the RH systems as the costs can differ according to the required tank size and mode of utilization of labor.

The possibility of utilizing community labor on a self-help basis should also be studied. When RH is introduced to the poor who cannot afford capital costs of the systems it is necessary to explore the availability of grants and subsidies both under government and NGO arrangements. Operation and maintenance costs as well as the sustainability of the systems should also receive the attention of the researchers. It is worthwhile, as a rural development exercise, to research into the economic impact of the systems by way of time saved in fetching water for domestic needs. Employment prospects, though not large, will contribute to increase rural incomes whenever labor is hired for construction purposes.

The use of local raw material to reduce costs should essentially be included in a research agenda on the RH. This is particularly important in popularizing the RH among the low-income receivers both in rural and urban areas of Sri Lanka.

SOCIAL ISSUES

There are many social issues of RH that require research attention. Research can be directed to find ways and means of motivating people for RH by making changes in attitudes among the communities and mobilizing beneficiary support for the programs. Experience in Kenya and Botswana suggests that incentives and subsidies to householders were necessary to encourage their involvement in developing RH systems (Lee and Visscher 1990). This usually happens when the technology being promoted is a departure from the normal practice or when the communities are not used to working with outside agents.

Among the social issues that need considerable research attention is land tenure. In Sri Lanka, many people have encroached upon government land without having any legal right to occupation and the majority of these people are poor. How they can be absorbed into an RH system in the absence of land rights will be problematic. The government will not advocate the inclusion of such people in subsidy schemes as it entails an official recognition of their tenurial status.

Gender issues also loom large in RH, particularly for domestic use. This is an area that has not received the attention of the local researchers. Impact of RH on rural livelihoods, especially on the plight of rural women who, in some cases, travel considerable distances to fetch water for domestic requirements, needs to be studied. It is common knowledge that a domestic water supply scheme established through RH can save time spent by women to fetch water. Saved time can profitably be used for economic pursuits such as agriculture, livestock farming, or any non-farm activity available in the area, thus enhancing family income.

RH needs a high level of community involvement. As projects advance, external agencies can withdraw if the local communities can develop planning capabilities and construction skills. This necessitates wider involvement of the community through capacity building. It has been observed that many programs in African countries have sacrificed capacity building for quick results, choosing to introduce alien and imported skills into local situations (Lee and Visscher 1990). Past experience in Sri Lanka shows that there are no proper guidelines for coordination of RH programs and for institution building. Although effective water user organizations related to irrigation are established in Sri Lanka, beneficiary associations for RH are yet to be formed. The necessity of researching into the ways and means of capacity building among the communities through organized collective efforts cannot be overlooked.

POLICY DIRECTIVES

In view of the existing constraints faced by the authorities in catering to the increasing demand for water, it is vital that RH be used as a new source of supply in the areas that cannot be serviced by the prevailing schemes. RH can also be used to supplement the existing water supplies when the traditional sources are overburdened or when inadequacies occur seasonally. There should be clear policy directives to promote RH vis-à-vis the other sources of water supply. Areas where RH should be actively promoted, institutional development to facilitate beneficiary participation, and costs to the user and the sponsoring agencies are important issues about which detailed studies should be promoted with a view to filling the gaps in knowledge. Such studies will be invaluable to the planners and policy makers in the field of RH.

Policy directives are absolutely necessary in making funding arrangements to the RH schemes. It is clear that the initial cost of a system cannot be borne by the poor. Hence, there should be a suitable way of providing funds through subsidies, credit schemes, or self-help arrangements. The means most suitable should be adopted through an effective dialogue with the beneficiaries. Social research will be invaluable to ascertain costs that can be borne by the local communities, to explore ways and means of mobilizing beneficiary communities to offer labor, and to assess the local raw materials that can be used in the construction of the system.

Policy support for an effective extension service is a vital need in popularizing RH among local communities. Establishment of suitable extension channels, structure of the people's organizations used as receiving mechanisms, and people's participation in sharing experiences with neighboring communities should be researched into with a view to providing inputs for policy formulation.

CONCLUSION

RH on an organized basis is a recent development in Sri Lanka. Many aspects relating to the subject are yet to be properly understood and popularized among the communities. Five broad areas for research are identified with a view to providing useful insights into planning and policy-making processes. Compared with many other countries where RH has been pursued, Sri Lanka is much better placed with the amounts of rain received, distribution of rainfall, and its variability. However, technical considerations relating to RH need research emphasis as neither the users nor the propagators are familiar with the systems. Similarly, research is vital to design the systems in such a way that the costs can be matched with the levels of affordability of the poor. Research can also provide valuable inputs to address social issues pertaining to RH and finally, research findings can profitably be used to formulate relevant policies.

LITERATURE CITED

Aluwihare, P. B.; and M. Kikuchi. 1991. *Irrigation investment trends in Sri Lanka: New construction and beyond.* Colombo, Sri Lanka: International Irrigation Management Institute.

Chandrapala, L. 1996. Long term trends of rainfall and temperature in Sri Lanka. In *Climate variability and agriculture*, ed. Y. P. Abrol; Sulochana Gadgil; and G. B. Pant. India: Narosa Publishing House.

Gitau, J. 1995. Rainwater harvesting in Kiambu District. *Rain Drop, Rain Water Harvesting Bulletin* 2 (3). U.S.A.

Grove, Sharon A. 1993. Rain water harvesting in the United States–learning lessons the world can use. *Rain Drop, Rain Water Harvesting Bulletin* 1.8. USA.

Hapugoda, K. D. 1998. Feasibility of rain water harvesting in the Divulapitiya and Mirigama areas. *Our Engineering Technology* 1.4 (1). Open University of Sri Lanka, Nugegoda, Sri Lanka.

Heijnen, Han; and U. Mansur. 1998. Rainwater harvesting in the community water supply and sanitation project. Paper presented at the Symposium on Rainwater Harvesting for Water Security organized by the Sri Lanka Rainwater Harvesting Forum, February 28, 1998.

Lee, M. D.; and J. T. Visscher. 1990. *Water harvesting in five African countries.* Occasional Paper 14. The Hague, The Netherlands: IRC International Water and Sanitation Centre.

NARESA. 1991. *Natural resources of Sri Lanka: Conditions and trends.* Colombo, Sri Lanka: NARESA.

Pacey, Arnold. 1986. *Rainwater harvesting: The collection of rainfall and run-off in rural areas.* Intermediate Technology Publications.