Rainwater Harvesting: A Community's Technology for Coping with Climate Change.

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Abstract

When climate changes, water movements change and human technology adapts. Studies at the International Rainwater Catchment Systems Association (IRCSA) for the last 25 years seem to prepare the mind, the practice and the business for the coming of such event. The paper shall give a short introduction on how climate change may impact on the lives of people and how does the variation challenge water resource management. The experience of climate variability and the prospect of climate change may change key hydrological variables which could turn to be non-linear and therefore bring surprises to unsuspecting communities. Knowledge that somewhere in the world such extreme event is a regular happening survived by communities, allays fear. This paper will tell the stories and will highlight the use of rainwater catchment systems.

Flood and drought are extreme variations in the water regime and these have posed problems on drinking water, food security, health and sanitation, and poverty alleviation. IRCSA's international, regional and national conferences sponsored by members have produced papers and reports on local actions that demonstrate the capacity of RWCS in coping with the extreme climate variations. When drought and flood take turns in battering villages and cities, people begin to grapple and scramble for mechanisms that will help them protect life, and property first of all. The present experience of many communities in climate variability and the looming climate change has become not just a perceived threat but a real one measured in terms of losses.

It is appropriate to situate the technology search within a framework of a broader coping strategy. It is helpful to see such technology in the test of the worst scenario and the test of time. Trends and predictions could shed light. As coping is a behavioral and emotional response, expressed hopes and fears, and both local and expert opinions are valuable leads. Realizing the impact of climate change on the world water regime, the rainwater catchment system is given a second look in this paper.

Water and Climate Variability.

The Dialogue on Water Climate reports disaster statistics and trends that show precarious situation of the impact of climate extremes on water.

A report on average precipitation and river flow changes in Sahelia countries for the last 20 years show a range of 16% to 25% reduction in precipitation and 30% to 50% reduction in annual flow of the river. The reductions are substantial and consistent.[1]

While climate variability has always been with us, like the El Nino, Southern Oscillation, or ENSO phenomenon, there are evidences showing a dramatic shift to a different climate which can occur in a matter of years or decades. A report on a comparison of paleoclimatic records shows that changes in the greenhouse gas CO_2 and methane CH_4 run parallel with the changes in temperature. From 1860 to 1999, global annual emission of carbon dioxide has increased from 0.1 gigatonnes of Carbon (GtC) to almost 10 GtC. Furthermore, The IPCC or the Intergovernmental Panel on Climate Change predicts that from 1990 to 2100, the surface temperature of earth will range from 1.4◦C to 5.8◦C. The mean sea level shall increase between 9 and 88 cm.[2]

It is important to heed the prediction of climate change because losses are associated with variable weather and climate. Examples are the 11% decline in GDP of Zimbabwe during the year of its drought. The drought in Brazil resulted in unrealized 50% of the projected economic growth. (World Bank Water Resource Sector Strategy). The increasing climate variability in the Philippines for the last decade showed a loss of 4.1 million hectares of prime rice and corn farmlands. Losses for the period amounted to P16 B for rice farmers and P7.2 B for corn growers. These losses come from weather variability brought by the ENSO which visited the Philippines every year for the last ten years either the warm or the cold phase. For the last 300 years, the ENSO visit used to occur in an interval of 2 to 7 years.[3]

Coping Steps

The following steps are used in looking at rainwater catchment systems or rainwater harvesting (RWH) as a technology that helps cope with the impact of climate variability.

1. Recognition Of The Possible Impact On Quality Life Or The Targets For The Millennium Development Goals.

Rainwater Harvesting (RWH), the more popular name for rainwater catchment system, has been identified as a key factor in reaching out to developing countries and help them attain MDG targets. Rainwater Harvesting is at least relevant to three (3) MDGs as discussed below:

Goal 1. Eradicate extreme poverty and hunger. By 2015, reduce by half the proportion of people living on less than a dollar a day and those who suffer from hunger.

More than one billion still earn a dollar a day. Water is inextricably linked to poverty. It is projected that by year 2015, 40% of the population in sub Saharan Africa will still live in poverty while there will be 45 million more poor people than in 1999.

Current experience showed effectiveness of RWH in poverty alleviation. Prof. Qiang Zhu explained in his paper "Rainwater Harvesting – a Best Practice for Poverty Alleviation"[4] that people usually think of big dams and large water diversion projects or ground water mining when talking about water. He said that in China, the poor people do not even have access to these infrastructures inasmuch as they are located in the most unfavorable geographical and topographical conditions. The experiences, not only in China, but also in Sri Lanka, India, Brazil and Kenya showed that with rainwater harvesting, even the poor can have water because rain falls everywhere.

The loess plateau of Gansu province has an annual precipitation of 330 mm while potential evaporation is marked at 1500 to 2000 mm. Drought occurs frequently. There were 36 droughts in the past 40 years. Income of the population is below 40 US cents a day. To intervene in the situation, a Rainwater Harvesting Project was introduced. At the end of the experiment, investigation showed that yield increased 20%-40% in the normal weather and much higher in the dry year. Water supply efficiency was 2 or 3 times higher than conventional irrigation. By the end of 2000, there were 2.18 million of storage tanks built supplying water for domestic use of 1.97 million people and supplemental irrigation of 236,400 hectares of land. Importantly, as farmers see food security in their land, they stopped reclaiming land from slopes and forestland and convert them back to trees and grass, thus giving back the land to nature.

Thailand became the first developing country for meeting the goal of UN in 1981-1991 in water supply and sanitation decade because of its use of Thai jars for rainwater harvesting.

Goal 3. Promote gender equality and empower women. The target is to eliminate gender disparities in primary and secondary education preferably by 2005 and at all levels by 2015.

In Kusa Village, Kenya, annual rainfall is 900 mm. Rainwater Harvesting was started by women groups. At the time of project evaluation, there was one tank for every three homesteads or a penetration level of one tank for every 20 people. Over 800 5m^3 of rainwater tanks were constructed which supplied 20% of the water needs in the area. This is more than the government projected provision of 10%. Attainment of MDG Target in Kenya government on provision of water is 8.5%. Rainwater Harvesting contributes 20% far beyond the government target[5]

Twenty years ago, at the other side of the globe, in Capiz, Philippines, ferro cement rainwater tanks were called the tank for the rich. The cost of material to build the tank was P4,000 for a 4,000 liter tank and the average monthly cash income was around P2,000. Investment as big as P4,000 cannot just be spent for a water tank construction. The head of the family, usually a man, makes the decision.

To make the rainwater tanks available to the low income households, the idea of a revolving fund was started in 1985. Women were the usual project participants as men were busy in the rice fields. The cost of material was borrowed with no interest from the project, payable in 2 years. The households were able to set aside 5% to 9% of their income to pay for a rainwater tank. The first group in the village trained in constructing the ferro-cement tank by the project engineers became the trainers of the next groups of women in the village or in the next village.[6] In 2002, the Planning and Development Office of the provincial government of Capiz reported that of the 10 towns in the province, 3 towns have 90% of its households use and the rest of the towns have no less than 60% of its households use rainwater.[7] Various types of tanks, not just the ferro-cement tank, were used to catch the abundant rain which is about 2,260 mm annual rainfall average. Before RWH, households had the perennial problem of water supply during the six-month long dry season.

Goal 7. Ensure Environmental Sustainability. Targets: By 2015, integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources. By 2015, reduce by half the proportion of people without sustainable access to safe drinking water and sanitation.

The world's wetland has been reduced by 50% since 1900. Groundwater fell at a significant rate. Rainwater Harvesting in the watershed will retain more water on land and will assist tree planting activities, help maintain biodiversity and recharge ground water resources.

The use of RWH is not only prevalent in developing countries. To protect the environment, many European countries are using rainwater harvesting for water supply for non potable use and irrigation and for ground water seepage. In fact, UK prides of reporting that the value of RWH industry doubles every year for the last 3 years. And Germany reports 50,000 RWH professionals supporting the RWH industry. Ing Klaus Koenig showed many examples in his handbook on Rainwater Technology.[8] An example is cited below.

In a town in Germany called Remshalden. It is the policy of the town to require the installation of seepage and percolation systems for rainwater from roof gutters in all new buildings. The incentive is that discharged water from the building is not taxed. The owners of Remshalden townhouses installed rainwater utilization systems in two buildings. There were 3 buildings each with 4 townhouses for rent. All roof areas were used to catch rain but because of low precipitation, the third building could not be supplied with rainwater utilization facilities. The building with out rainwater rents lower than the other two.

Thousands of examples of rainwater utilization in Europe for ecological reasons are fascinating to read about. A statement for local authorities, the Department of Environmental Management in Luxembourg will add credence to how several countries in Europe values Rainwater Harvesting. He describes how unmanaged rain could contaminate streams and surface water: (Koenig 2001)

> "Most communities do not have separate sewer and storm water systems. The result is the excessive amounts of clean rainwater are discharged into wastewater treatment plants, exceeding their volumetric treatment capacity; then, in turn, untreated effluent overflows and contaminates streams and surface water.
>
> … the only remedy [to the economic damage of this anthropogenic intervention in the natural hydrological cycle] is to decentralize rainwater management. To limit further damage, the private and public sectors … implement innovative techniques such as rainwater utilization, rainwater percolation and curtailment of surface sealing. Local authorities must set an example …"

2. Preparation

One obvious action necessary for coping with climate change is preparation. Preparation starts with an assessment of vulnerability of the community. Is it then possible to study the effectiveness of rainwater harvesting in preparation for climate change and know what steps may be taken to prepare for its onset?

Prof. George Kuczera of the School of Engineering, University of Newcastle studied the impact of roofwater harvesting used to supplement public water supply in an urban setting.[9] He stressed the fact water reservoirs are vulnerable to prolonged drought and climate change which reduces rainfall in catchments as the consequence for a large urban area could be catastrophic. The City of Sydney, Australia was used as a case study. The annual rainfall average is 900mm to 1200 mm. Using the Monte Carlo simulation model, the study wanted to generate some insights on the drought security performance of integrated regional water supply system and roofwater harvesting.

Three scenarios are given:

1. Base scenario with 800 GL/year annual demand. There is restriction on domestic usage when total storage is less than 50%. With 40% to 50% storage, reduce demand by 10%. With 30% to 40% storage, reduce demand by another 10%. With storage less than 30%, reduce demand by 30%. In addition to restrictions on demand, water maybe pumped from another storage system up to 2000 ml/day if the main storage drops below 60%.
2. The second scenario is Base scenario plus 50% of households install a 5KL rainwater tank.
3. The third scenario is Base scenario plus 50% households installing 5 kL rainwater tanks plus back up desalination. When storage drops below 30%, run desalination plant at 500 ML/day.

The base scenario with 4,424 replicates illustrated a prolonged 10-year drought that brought about a complete failure of the system. However, with 50% of the household having a 5kL rainwater tank, the probability that there will be a restriction on demand is 8.5% to 5.2% in any year. The scenario assumes a domestic demand of 2.7 persons per household and 285 litres/person/day. The probability of any household running out of water at any year is .05% to .02%. With backup desalination plant, the integrated system survives the 10 year drought. The study arrived at the conclusion that roof-water harvesting can make a substantial contribution to security of urban water supply.

Aside from vulnerability assessment, other preparatory tools include early warning systems, hazard maps and disaster preparedness strategies.

3. Adaptation

Research is not enough, though. There should be movement from research findings to adaptation.

The Global Water Partnership Associated Programme, a Network for Greenwater Harvesting in Eastern and Southern Africa and South Asia reported one activity – GIS mapping of RWH Potentials in ten African countries. The maps will be used by decision makers for planning. Ethiopia, for example, is thought to be a very dry country but its rainfall show that it has more rainwater per person compared to that of Europe. Given, RWH techniques which adapted farming systems to the bio physical and agro-climatic condition of Ethiopia, there is more hope and preparedness as this country faces climate change.

In Ethiopia, only a fifth of its estimated 77 million people is connected to a public water supply. In addition, 46% of its population frequently experience food shortage. Ethiopia has rainwater harvesting potential of 11,800 cubic metres per person compared with the annual renewable - river and groundwater - supplies of about 1,600 cubic metres. The result of the study was announced by Achim Steiner, UNEP's Executive director during the Conference on United Nations Framework Convention on Climate Change in Nairobi. (www.alertnet.org) He said,

> "As we look into what Africa can do to adapt to climate change ... rainwater harvesting is one of those steps that does not require billions of dollars, that does not require international conventions first - it is a technology, a management approach, to provide water resources at the community level."

On March 22, 2007, SwissRe, a large re-insurance awarded the Ethiopian Rainwater Harvesting Association, for its innovative rainwater harvesting project. The project aims to improve water availability for household activities and productive use. Ivo Menzinger, Head Sustainability & Emerging Risk Management for Swiss Re commented: (www.swissre.org)

> "The project distinguishes itself through combining the implementation of a straightforward and proven technology with an approach involving all local stakeholder groups. It thus creates strong emotional ties and local support while providing access to a reliable source of water for more than 10 communities."

As this information of water availability is realized, rainwater harvesting techniques can be adapted to meet the needs of the African people.

4. *Knowledge Sharing*

And what rainwater harvesting techniques have reached the people of Africa? How? It must be through knowledge sharing.

In a place at the other side of the globe, there was a conference in the year 2000 sponsored by the East Asia Rainwater Catchment Systems Association. One paper presented was about a study of water harvesting practice in dry land. The authors proved in their study that the practice directly improved the efficiency of rainwater harvesting. They say, soil is an efficient storage medium.[10]
For wet places, those with rainfall of more than 2,000 mm annual average, another paper presented the wisdom of paddy fields as rainwater harvesting technique. Using a 2-D Flood simulation model, benefits of paddy fields in Changhwa County, Taiwan was done by increasing detention capacity of paddy fields.[11]

This last example may not fit Africa but it is needed in South East Asia where rain comes a plenty.

On February 23, 2007 ,the Ministry of Environment and present administration of Indonesia called for the use of a percolation system in all buildings regardless of size, “as part of the effort to reduce flood risk in the capital.” In 2005, a gubernatorial decree was passed requiring all buildings to construct a percolation pit according to the size of the roof. For a $50m^2$ roof, the owner is required to have a tank of 2,000 ltrs. This new call to implement the decree was sparked by the flood that covered 45 to 75% of Jakarta. (Jakarta Post)

The Prime Minister of Malaysia followed with a similar announcement in April, 2007. In addition to the concern of city flash flood brought about by rapid urbanization and increase of impervious areas, the city was concerned of the drought event in 1998 which created water shortages and water supply disruptions for 1.8 million people. The looming climate change expects more events of this nature. NAHRIM or the National Hydraulic Research Institute of Malaysia and Ministry of Natural Resources and Environment conducted a Rainwater Colloquium attended by all the local government units as required by the Prime Minister.

For the Pacific Islands Countries (PIC), there is only 550,000 km2 of land for 7 million inhabitants spread across 180 million km2 of ocean. Climate variability, torrential rainfall, higher level of storm water runoff and increasing demand for water are so significant to their economic development and the health, safety and well being of their people. (Dialogue on Water and Climate) For Pacific Islands, the University of Hawaii and University of Guam have been reaching out to share skills in managing rainwater collection system.

Philippines, an archipelago has 7,100 islands. The rainwater harvesting movement in the country is led by the private sector. The Philippine Watershed Management Coalition conducted the first national Philippine Workshop on rainwater harvesting in Iloilo City in 2001. The national government has not responded but the movement is entrenched in the private sector. Without support from the national government, except in the agriculture sector, private households re-establish their old rainwater systems adding a few tips here and there. But the surprising response comes from the business sector which started using rainwater as they recognize its economic benefits. Just recently, the Tigum-Aganan Watershed Management Board (a river basin organization) decided to campaign among its local government members for rainwater harvesting facilities in government buildings. Multi stakeholders' dialogue, as exemplified in a watershed/river basin management board is an excellent way of knowledge sharing.

While most South East Asian countries suffer and worry a lot about flood, there is a neighbor country, Taiwan, which uses rainwater harvesting for flood mitigation. The report of Prof Chao-Hsien Liaw showed that with the use of genetic algorithms to optimize spatial distribution of runoff retarding facilities, "high percentage of flood peak reduction is obtained after installing runoff retarding facilities in the upper and middle portions of the watershed."[12]

In another paper, Prof Andrew Lo showed that low-impact runoff retardation technology upstream of the watershed could aid flood mitigation. AGNPS, a computer simulation model capable of evaluating non point source pollution at any point within a watershed, was used.[13]

5. Agreeing On A New Basis/Framework For Planning

The new situation posed by the expected climate change highlighted the need to have new basis or framework for planning, one that rests on exposure to new and changing information and knowledge and one that gives priority to adaptive actions. Public awareness is of prime importance as individual responsibility in the end will be crucial to facing the impact of fierce weather. Information for the public should be enriched by experience exchange. Top down plans on vulnerability, sensitivity and capacities should be shared and complemented by communities.

Investments in early warning system, in more reservoirs/ catchment/ storage units and better flood control should be made. The recommendations of the 4th World Water Forum on the issue of water and poverty are: "early and extensive investment in water resources institutions and infrastructure to achieve water security and growth."[14]

Africa is one country which has contributed the least to the onset of climate change and yet will suffer severely the brunt of its impact; and so are many developing countries in South East Asia. Many groups have argued for the Polluters' Pay Principle. It is time for the developed countries which have been spewing greenhouse gases to pay back their polluting acts by investing in water security measures, particularly the low cost rainwater harvesting facilities in the developing world.

The Future of Rainwater Harvesting.

Two significant statements are offered here to summarize the content of this Paper.

> *Rainwater Harvesting has been identified as a technology with the potential of contributing immensely as a coping mechanism for climate change and variability. This is through increasing the quantity of green water flows via evaporation and transpiration in order to improve food production and ecosystem support. … This system captures, conveys, stores and releases green water in-situ* (Prof. Chin Ong, Preface to Technical Report No. 32 of RELMA-in-ICRAF)

The second statement came after the result of a Delphi Study for "Water Technology" was formulated in 1999. The study was commissioned in order to make reliable predictions about water technology in the next 10 to 15 years to provide a perspective for new markets in the next millennium. The prediction stated that as the groundwater will continue to be polluted because of farming, public water from a centralized system will be less important and replaced by a decentralized system as the high degree of hygiene could be attained. Rainwater utilization is socially acceptable, backed up by a state of the art technology.

An overwhelming majority in the study team estimated that the percentage number of households which will be connected to the central process water system in 2010 will be from 5 to 20% maximum. Fifty two per cent of the experts believe that only 10% of newly installed toilets will be flushed by service water. By 2020, it will be possible to build houses that are self-sufficient in water usage.(Koenig, 2001) Martin Bullerman, member of the Water Working Group, made this following statement:

> *"The future belongs to a decentralized infrastructure which is flexible enough to adapt to technical progress when environmental policy, local conditions and/or individual needs change."*

Rainwater Harvesting is a traditional practice picked up by a group of scientists and development practitioners, as a focus of their interest, study, and practice to help poor and rural communities in their quest for water to drink. The work was carried on for 25 years. IRCSA became an international platform of exchange until regional and national conferences were formed and other water bodies accepted Rainwater Harvesting in their agenda. Today we see the usefulness of the technology not only for the poor communities. It has made itself relevant in other aspects of living – flood/ disaster mitigation, food and water security, environmental rehabilitation and now, in coping with climate change. As ancient wisdom meets science, Rainwater Harvesting is born.

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