

Chapter 2

Harvesting the potential

B. Kniffen

*American Rainwater Catchment System Association, Menard, Texas,
United States*

Keywords: harvest, rainwater, stormwater, sustainability

2.1 INTRODUCTION

The title of this chapter, ‘Harvesting the Potential’, relates to the possibilities that can be achieved by a unified organization such as the Mexico Rainwater Harvesting Association (Asociación Mexicana de Sistemas de Captación de Agua de Lluvia A. C., AMSCALL) through combining energy, talent, experience, and a desire to help one another, and is most important not only for this generation but even more so for the generations to come. This means not only harvesting the rain in containers, but also on the land, soil, and aquifers. The management of our watersheds affects the health of our cities and nations. Water is life and the ability to effectively manage our water resources is essential for personal, national and global sustainability. Without water there is no life. And on the flip side, too much water at one time impacts cities with floods and destruction.

In physics, for every action there is an equal and opposite reaction, but in nature, for every action there are many reactions. The impact of influencing natural processes has many rippling effects. Managing forests, savannahs, grasslands, and croplands is essential for health and sustainable processes on this planet. Landowners and controlling authorities of open space must be trained to care not

only for productivity but the long-term sustainability of the land, riparian areas, and the whole watershed. There is potential and opportunity to educate people that the small things they do in a united effort can have a huge impact on the environment in addition to policies made by governing authorities.

In urban and suburban areas, one rain garden and one rain barrel multiplied by many homes and businesses can have a huge effect on the watershed. Aquifers will be recharged.

With regard to the land, the health of a community is dependent on the health of the water and by reducing runoff one reduces pollution in our communities, streams and rivers. There is strength in numbers. Harvesting rainwater can be used to grow food, care for the native vegetation or rebuild forests. As a result of managing our watersheds one strengthens the health, wealth, and survival of those living in those communities. Growing some of our own food may mean food security in times of emergency, stress, or disasters. Collecting the rain to grow food makes us realize where food comes from and the importance of rainfall for the environment and our world's survival. In more arid locations harvesting rainwater may be a way for people to have better quality water to use and extend the life of a limited supply of water.

The knowledge of understanding how the rain can be captured, stored, filtered, and treated to make a potable drinking water supply can have a huge impact on families, their health, safety, and improve their quality of life.

Education may be the greatest need and opportunity the association can provide. Developing training programs to teach designers, installers, and decision makers as well as individual home and farm owners the processes, knowledge, construction techniques, and products available to capture, filter, and disinfect rainwater may have a huge impact on every person in the nation. Training individuals on processes needed to produce an effective rainwater harvesting design or installation, as well as teaching youth, volunteers, and groups, will spread the knowledge on the value of harvesting rain as well as help decision makers in make sound decisions.

2.2 HARVESTING RAINWATER FOR ENVIRONMENTAL STEWARDSHIP

The effects of climate change will impact us all. Most locations will face changes in rainfall patterns, rain amounts and intensity due to changing global conditions. Extended drought and dried up water supplies in arid and semi-arid locations affect survival itself. Growing forage for livestock and vegetables to feed a family, and having a product to sell all depend on water. Livestock and wildlife grazing have a significant impact on plant survival and overgrazing has a huge impact on vegetation survival and resilience such that when it does rain its ability to capture and infiltrate rainfall is affected.

Rangelands and forests must be managed properly. The Society for Range Management (SRM, <https://rangelands.org>) is a great resource to help one understand plant growth, effects of overgrazing and how to manage rangelands. SRM believes that the goals of maintaining the health and productivity of rangeland should supersede other management goals for long term ranch benefits. You can get eggs from a laying chicken for years, but you can only eat the chicken once. Rangeland is much the same, if it is not managed properly the more productive vegetation that sustains land health, water capture, and forage production is lost, often reverting the land to desert conditions that may never be restored in our lifetimes. Clearing forests also changes the direction of rainfall movement. Forests absorb water, recharge aquifers, cool, and protect the forest floor and the watershed. Quick dollars made from the destruction of forests may result in short term gains followed by negative impacts lasting generations.

The effects of climate change will impact us all. Many locations, croplands, and food production are greatly influenced by the amount of water captured in the soil. Rainfall leaving as runoff not only reduces the amount of water infiltrating and being stored in the soil for plant growth and food production, but runoff water contains not only the water itself but also topsoil, seeds, organic matter and nutrients which helps in food and crop production. Inorganic soil or soil without organic matter has minimal water storage ability. Organic matter is the sponge and keeper of water, nutrients, and biological life in the soil that supports healthy plant production. It must be maintained as is now seen in the USA in 'cover crop' promotion in the offseason to protect the soil, store, and hold water and add organic matter to the soil so crops grown for harvest are higher yielding. A nonprofit organization, Healing Hands International, (<https://www.hhi.org/fighting-hunger>) and other organizations teach how to utilize both organic matter from leaves and manure, and in combination with drip irrigation can help make food crops grow even in extreme situations.

Populations are growing in every major city in the world and most locations, this growth is on the fringes of our cities and on top of water infiltrating watersheds and recharge zones. Every meter of land impacted by urban sprawl has a compounding effect on everyone in the city and downstream. There are those visionary people and those willing to open their eyes can see the impact of this wound on the landscape that will leave a long-lasting scar. The more meters wounded, the greater the scar and the resulting impact.

'That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics'. – Aldo Leopold.

Our decision makers, as well as everyone who has raindrops fall on their place, has a responsibility. They and we have an ethical responsibility for future generations and the life of our cities for the next hundreds of years.

Aquifers all across Mexico and the world are being depleted. Almost 20 percent of the aquifers in Mexico are endangered or lost. That loss of stored aquifer water

impacts water wells, springs, streams, and rivers and the quality and amount of water in our reservoirs and lakes. Water management must start at the top of the watershed. Clear streams, flowing springs, and healthy forests and lands depend on nature's ability to manage every drop of water. Water must be allowed to infiltrate which requires vegetation in its healthiest state. The vegetation softens the impact of raindrops, leaves, stems of grasses and forbs and trunks of trees all slow water movement and filters the rainfall moving downhill. This allows rainfall time to infiltrate. The parts above ground are easy to recognize, but just as important are the roots below the ground. Roots die over time and plants replace them leaving channels for water movement. Organic matter is transported down into the soil by many creatures in a healthy environment, storing carbon, creating a sponge and pathways for water to move into this massive storage bank. Without care to the environment and vegetation, there is nothing to soften the impact of a raindrop, nothing to slow its movement across the watershed, and no help to allow infiltration and storage of the rain. Soil without organic matter becomes an impermeable barrier thus forcing water to runoff. This not only starves that land as it is not able to utilize that rainfall, but forces water away carrying topsoil, seeds, and nutrients with it. Every location must care for its raindrops for a healthy planet.

2.3 HARVESTING RAINWATER FOR STORMWATER REDUCTION

We all live in a watershed. Many cities are built near the bottom of a watershed and near a river, lake, or other reliable source of water. The increasing population around the world, expanding city population and expanding impervious area all result in increased stormwater, flooding, and disastrous situations on a larger and more frequent basis. As we seal over recharge zones, not only do we prevent water from infiltrating into the soil but we create human hazards of flooding, polluted streets, and rivers. Water which should infiltrate is forced to run off and impacting those below in the watershed. As the recharge zones and watersheds are sealed over with impervious roads, houses, and developments, and valuable forests, savannahs, and grasslands are abused or destroyed. In consequence, rainfall has no place to go but downhill with little to slow it down. The runoff creates energy as it moves downhill and rivers of concrete and pavement now replace filtering vegetation of a healthy ecosystem.

With urban development, aquifer recharge areas are sealed over which both decreases recharge of aquifers and increases the amount, speed and contaminant load as runoff moves down the watershed. City planning must involve protecting recharge zones. These areas are valuable assets that recharge underground supplies of freshwater and the best storage containers for our water needs, designing streets on a contour while developing infrastructure and greenspace which slows stormwater runoff and aids in water infiltration. There are many

tools available to do this, but in residential areas, simple rain gardens are something every city can promote. American cities like Kansas City, Puget Sound, and San Francisco have promoted the construction of 10,000 rain garden projects in residential areas to reduce runoff. These were projects to help everyone understand that they are part of the problem and need to work to be part of the solution.

There are new innovations in water management that every city and individual can include to traditional stormwater management plans currently in place to reduce runoff. A term used for these practices is 'Low Impact Development' (LID). Each practice or multiple practices can be included in any location depending on the amount of impervious and pervious area available in the infiltration process, slope, local rainfall events, amounts and rain intensity. The key to their success depends on starting near the top of the watershed. That means everyone is in a watershed and everyone needs to be involved in its management. There is too much water even in desert locations to begin managing stormwater at the bottom of the watershed. Unfortunately, this is where many of our cities exist. It is too easy for city water planners to push runoff into the rivers, lakes or oceans as fast as they can while leaving aquifers dry. This causes municipalities to seek other sources of water outside their immediate area, robbing water from other areas to meet the needs of their growing base of customers which is not a viable long-term solution.

There are many processes often called 'Decentralized Urban Best Management Practices' (BMPs) which are designed to reduce the stormwater volume, reduce the stormwater flow rate, and reduce the pollutants in stormwater. There are tools and products available to tailor a process for most situations. Examples include curb cuts which allow water to exit our streets, permeable paving, water detention ponds that release water slowly, green roofs, rainwater harvesting, drop-in boxes, and many others. Applied at the point of stormwater generation and all along the downward slope of the watershed these tools will reduce or prevent flooding at the bottom of the watershed.

A rain garden is a tool that homeowners and businesses alike can install. It is a beautiful landscape feature consisting of a planted shallow depression that collects rainwater runoff from roofs, parking lots and other impervious surfaces. It is often the easiest homeowner storm-management tool. Kansas City and Marin County California have both implemented a program to construct 10,000 rain gardens in their area as a major tool to reduce stormwater runoff.

2.4 HARVESTING THE OPPORTUNITY TO INFLUENCE DECISION MAKERS

There is power in numbers. A united effort in rainwater harvesting from academia, manufacturers, designers, installers, researchers, users, and students will influence political affairs and policies. Policies that affect the watershed, environment,

stormwater, and providing a sustainable source of water for every person in Mexico and the world. There need to be goals and a vision for a sustainable country, cities and rural areas. Education is powerful and adopting these tools will help move policy to care for Mexico's future.

As an organization grows and numbers of diverse individuals and companies increase, the impact the association will have will increase. Knowledge is powerful and knowing the problems, needs, and possible solutions will help influence those making critical decisions on a nation's future. Knowing issues locally and the magnitude of those issues can be a powerful tool to help decision makers make wise choices. Issues on water management are diverse. Some of those issues include the following.

Increased demand for a decreasing supply of water in both aquifer or surface water – In Texas, 40% of the springs once flowing have stopped which decreases base flow in the rivers, suppresses available water for humans, livestock, crops, and wildlife. In the USA lakes are filling from the bottom up with sediment which reduces the water storage capacity of lakes, the temperature of the lakes rise, evaporation increases and the value as a water supply or stormwater retention resource decreases.

Escalating environmental and economic costs in the face of an aging infrastructure, leaking and broken pipes, environmental repair or protection of sensitive areas – As cities grow, the increased demand for water requires infrastructure to deliver clean water while removing wastewater. Most cities are aging as is the infrastructure. Most cities were not designed for the growth they have seen in the last 100 years. The aging pipes, streets, buildings, and ignored natural waterways cause untold damage while leaking pipes increase waste and contamination in the cities. Replacing and repairing these issues is expensive and often there is not enough money to rebuild systems only exacerbating the problem.

Climate change, drought, flooding – What does the future hold? Drought, floods, and seasonal changes in rainfall? Combining this with a growing population makes current methods of meeting water needs, while protecting water sources, impossible. There must be a paradigm shift in managing rainfall. Rainfall is the free gift of nature and to be cherished.

2.5 HARVESTING RAINWATER FOR LIFE

The association can also help harvest the potential and opportunity to capture rain for people without a good water source. Many places in the world in the arid or semi-arid regions, as well as regions with short monsoon seasons followed by several months without any significant rainfall, may run out of water and sources dry up or may be or become contaminated as the supply dwindles and/or utilized by livestock and wildlife who also uses these supply sources. By harvesting the rain in containers when it does rain and either using that harvested rain first (or last) can extend the life of a limited supply of water. Providing a reliable source

of good quality water is one of the most important gifts an association can give people. The collected rain could be used as a family's non-potable source where a limited but quality supply exists like in a water well or borehole. Harvested rain can be filtered and treated so it is a safe source of potable water available for families. There are several methods available not addressed in this chapter which may be applied to reduce or eliminate the risk of water carrying contaminants which may make people and animals sick.

Food production requires water. Capturing and storing water in the soil is the cheapest and most important source of water to grow crops, native grasslands, savannahs, and forests while recharging aquifers. But harvested in containers there is little evaporation or loss and every drop can be directed for its intended need. This is particularly valuable in growing vegetables with drip irrigation, hydroponics or hand watering. Many of these techniques may be found in the efforts of NGOs such as the Rain Foundation (<http://www.rainfoundation.org/>).

Desertification of our semi-arid areas where water once was and areas with seasonal extremes of a monsoon season followed by many months without rainfall are ideal candidates for harvesting rainfall when it comes. Rooftops that only contribute to runoff can be converted to rain-harvesting mini watersheds for collection for later use.

Many places in the world in the arid or semi-arid regions, as well as regions with alternating monsoon seasons followed by several months without any significant rainfall, may run out of water and sources dry up or water may be contaminated or becomes contaminated as the supply dwindles and/or utilized by livestock and wildlife who also uses these supply source. By harvesting the rain in containers when it arrives and either using that harvested rain first (or last) can extend the life of a limited supply of water. Supplying clean water to a family living with contaminated water as their only source is one of the most important gifts an organization can provide. We say 'water is life' but for many people, the only source of water is contaminated with all kinds of pathogens. Untreated water can cause sickness, unproductivity, and too often death to the youngest and oldest in a population. Harvested rainwater may be the best water source available to many in the world.

In Texas, rainwater is becoming the 'Gold Standard' for water in our homes. Without salts, minerals, and most other impurities, rainwater is ideal for home devices and our bodies. It leaves water heaters, washing machines, and dish-washers. The soft water is ideal for bathing and washing dishes. Harvesting rainwater for in-home use has increased, the rainwater is ideal for house plants and all daily uses.

2.6 HARVEST THE POTENTIAL TO PROVIDE EDUCATION

Education may be the greatest need and opportunity an association can accomplish. Developing training programs to teach designers, installers, and decision-makers as

well as individual home and farm owners the processes, knowledge, construction techniques and products available to capture, filter, and disinfect rainwater may have a huge impact on every person in the nation. Training individuals on processes needed for effective rain harvesting design or installation, as well as teaching youth, volunteers and groups, will spread the knowledge on the value of harvesting the rain as well as help decision makers in making sound decisions.

2.6.1 The American Rainwater Catchment Systems Association (ARCSA)

The American Rainwater Catchment Systems Association (ARCSA) has the stated mission 'to promote sustainable rainwater harvesting practices to help solve potable, non-potable, stormwater and energy challenges throughout the world'. Efforts to accomplish this are achieved through an annual National Conference, training programs, regional representatives and a website with a resource directory, project gallery, and much more. ARCSA had its beginning around 1985 in Austin, Texas but struggled to find its purpose until 2003 when it held its first national conference.

That one-day conference of presentations, vendor displays, and an open planning meeting led to its second conference in Seattle in 2005. Speakers, vendors, a second-day tour of existing systems and discussion on how to expand the association's efforts led to the formation of regional representatives, a slate of officers and officer planning meetings.

The third national conference in 2007 was held in Hawaii and it was there that the organization found direction, meaning, and manpower. The educational program was born and training sessions began. The first training was a full-day training program but it soon expanded into a two-day program with two primary instructors, Billy Kniffen, with Texas A&M University and Tim Pope, an ARCSA past president, and installer in the Seattle area. In 2010 a second two-day program was added and called the 'Design and Construction Workshop' and was a hands-on section to implement the knowledge gained from the first two-day lecture program. Students are divided into groups or small companies of 2–4 people, given a project and have to design a rainwater system to meet the needs of the project including managing the overflow water. This becomes a peer training program as students teach each how to do the work, solidifying the previous classes training. They must calculate sizing requirements, potential rainfall, make sketches and present their proposal in a mock bidding war, presenting their bid and sharing their design. Students then critique each proposal. Students then construct two smaller systems to get familiar with tools, supplies, products used in constructing systems with the second including a pump which is installed and tested. A third project is a class effort to install a much larger more complex system and students then develop a start-up, operation, and maintenance manual for the operator/owner of the installed system.

The third phase of the program began in 2011 with the addition of a one-day show to a training program on how to inspect an existing rainwater system. Those who wanted to be recognized as a ‘Rainwater Inspection Specialist’ must have gone through the first four days of training and passed a written test and provided to ARCSA information on five systems they have been involved with, reviewed and approved. The inspection program begins with a review of system requirements, calculations, review of a checklist, evaluation protocol, and checklist on parts inspected. There is also a written test for this recognition.

The first training manual (Kniffen et al., 2012) was developed through the Biological and Agricultural Engineering Department at Texas A&M in 2009–10 and has been translated into Spanish by Professor Arturo Gleason in 2014. It has been used in training programs all across the USA until 2018 when ARCSA developed their own training manual (Audrey, 2015) through the efforts of volunteer members writing sections in their field of expertise. The educational program has grown into three major sections:

- (1) ‘Accredited Professional’ rainwater harvesting course is designed for industry professionals and those individuals desiring to pursue a career in rainwater management. The completion of this course is one of the requirements for attaining recognition as an ARCSA Accredited Professional. An alternative to traditional water management systems.
- (2) The ‘Master’ level in rainwater harvesting is ARCSA’s highest level of recognition. 42 hours of additional training is required and many of those can be gained through ARCSA webinars which are also open to anyone seeking more information on specific topics. The Design and Construction (D/C) Workshop and Inspection Specialist courses are also required.
- (3) ARCSA ‘Inspection Specialist’ program for ARCSA APs (others may attend the class) is designed to develop a formal inspection of systems to assist the industry and individuals. Must also have attended the D/C Workshop to be an IS.

A Design/Construction Workshop is set out to give hands-on experience in both design and construction of basic systems and procedures for developing operation manuals and troubleshooting problems. All these courses can be found on the ARCSA website (www.arcsa.org). The Accredited Professional is also an online course.

2.7 CONCLUSION

Sustainable high-quality water supply needs to be provided to every person in the world. Certainly aquifer, river, and lake water will supply the needs of most people. The cheapest and best option should be used, but not at the cost of destroying aquifers, polluting rivers and lakes, and destroying the health and

well-being of future generations. Every city must look long term and make sound decisions for our future. There are options, and these options should include rainwater harvesting, which is a viable potable water source that can solve many other environmental challenges. Captured rainwater is also a valuable necessity in sustainable agriculture which will help replenish aquifers rather than deplete them, extending food production for everyone, whether on rooftop gardens or larger commercial operations. The quality of rainwater has been declared the 'Gold Standard' for irrigation.

Pope Francis urged world leaders at the United Nations to act as compassionate custodians on issues including Europe's migrant crisis, world conflict and climate change. 'We human beings are part of the environment', Francis said. 'We live in communion with it, since the environment itself entails ethical limits which human activity must acknowledge and respect ... Any harm done to the environment, therefore, is harm done to humanity'. On the environment, Francis said 'Christians believe with other religions that man is supposed to take care of nature. He is not authorized to abuse it and much less is he authorized to destroy it'.

May God bless the efforts of so many whose hearts reach out to care for making Mexico and the world a sustainable planet that has a compassion not only for every citizen today, but children of generations to come. Sustainable decisions are not easy. The united efforts of people learning from others and applying this knowledge in a united effort of the organizations like the Mexico Rainwater Association (AMSCALL) will truly ensure the future looks bright for Mexico.

REFERENCES

- Audrey A. (2015). Rainwater Harvesting Manual. American Rainwater Catchment Systems Association, Tempe, AZ, USA.
- Kniffen B., Clayton B., Kingman D. and Jaber F. (2012). Rainwater Harvesting: System Planning. Texas AgriLife Extension Service, B6240, USA.