Section 2

Narratives of RWH

Chapter 1

Rain: Water for health, livelihood and self-reliance

H. A. Heijnen

International Rainwater Harvesting Alliance (IRHA), Geneva, Switzerland
han.heijnen@irha-h2o.org

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1.1 INTRODUCTION

The WHO UNICEF Joint Monitoring Report on the *Progress on household drinking water, sanitation and hygiene 2000–2017* states that 90% of the world population has access basic or safely managed water supply. By 2030 global coverage will be around 96%, falling short of the universal access agreed under the Sustainable Development Goals (JMP, 2019). Water supply is deemed to be safely managed if the water is provided through an improved water supply source, available on the doorstep, anytime when needed, and safe to drink. Properly constructed and maintained treated piped-water supply, boreholes, protected springs, protected dug well and domestic rainwater harvesting are technologies that qualify.

To date some 10% of the world population is still lacking a decent water supply service. As all the 'easy' water supply services have been provided, servicing the last 10% is getting harder because of issues of a technical, water resource, social or financial nature. However, SDG6 stipulates universal access and solutions need to be found to develop adequate services, even if these are somewhat more

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expensive than usual. Note that the observations made in this chapter will implicitly refer to low and lower middle income countries where the provision and extension of services such as water supply is often financially, socially and technically challenging.

While most people would prefer a centrally serviced piped water supply reaching their home, this is not always possible. Remoteness, topography or very low population density may make such a supply too costly. Globally 64% of the population enjoys access to a piped supply (JMP, 2019). The rest of the population has a protected dug well on the premises or a rainwater harvesting system, or has to collect water from community standposts, wells or boreholes. Those who have no such facility nearby are forced to collect their water from a stream or pond. Clearly water quality and convenience diminish rapidly through this summary.

In many parts of the world, central supplies now also face seasonality of water sources, forcing reduced consumption during several dry months. Households try to overcome such periods of shortage by managing their consumption, but also by employing additional water sources. For instance, regular droughts have encouraged Australian households to install rainwater harvesting systems in urban homes, making the water for all last longer. In Sri Lanka, many homes in the Western and South Western part of the island have protected dug wells which can be used to back up the central supply or even, with a small electrical pump, fill up a roof-level storage tank and facilitate internal water supply. This is as good as a centrally managed piped supply.

The effects of climate change are gradually being noticed everywhere. Dry periods are lasting longer and when it rains, it comes in shorter, intense showers. Run-off is high due to dry soils and to urban paving and the water that is needed to bridge the dry season disappears quickly. Climate change forces society to change its habits and adjust its physical planning to ensure local and regional water security while managing reduce flood risks.

1.2 HARVESTING RAIN, GOING GLOBAL

From time immemorial people have been managing rain. Availability of water and water sources determined where people would be able to live. Adequate rainfall decided on the quality of pasture or the ability to grow grain. Technical advances and finance may have enabled societies to inhabit big cities and expand agriculture into dry areas, but only because of the resource rain provided through the water cycle.

Today, some 1.3% of the world's population uses rainwater as its main source of domestic water. In developing countries, this may be up to 2.4% of the rural population (JMP, 2017a). In Australia 26% of households use rainwater at the home, while for 23% of those living outside capital cities it is a common source of drinking water (Australian Bureau of Statistics, 2013).

Where water has been traditionally scarce or difficult to retain due to a karstic geology, as in Jamaica or parts of the Adriatic Coast, people have found ways to collect and store rainwater. As a city-state, Singapore manages the rainwater that falls on its territory to the full, to raise its water security. Since the mid-nineties, Germany has taken the lead to decouple rainwater from the sewerage system, initially to postpone the costs of renewing the sewerage systems in its growing towns by reducing run-off peakflows, but later also to develop safer solutions to use the rainwater mostly for non-potable purposes in the home. The appreciation of the potential to use rainwater harvesting and reduce flooding risks has led many countries to implement policies to encourage better management of rain water in their cities. These initiatives go by various names, but the Sponge City concept in China is evocative as it creates the mental image of absorptive capacity in the city during rain events and subsequent use of the retained water in drier periods. Encouraging use of rainwater as a complementary source of water makes a difference to the household and the city.

This book contains narratives of domestic rainwater harvesting initiatives in Asia (Bangladesh, Japan, Korea and Sri Lanka), Africa (Guinea Bissau, Malawi, Senegal and Uganda) and the Americas (Brazil, Colombia, Hawaii, Mexico and the USA). It is but a selection of successful programmes and leaves out, for instance, Thailand and Kenya, both with substantial rainwater harvesting expertise and continued progress. Thailand was an early adopter in the 1970s and '80s, developing more affordable storage reservoirs for the dry North East of the country. Today it still claims 15% national domestic RWH, rising to 23% for the rural areas (JMP, 2017a).

The interest in rainwater harvesting grew in the 1980's when it became clear that important areas of the world would start facing water stresses that would reduce their capacity to achieve food security. The International Rainwater Catchment Systems Association (IRCSA) was launched in 1991 as an outcome of the *4th International Rainwater Cistern Systems Conference* of 1989 in Manila. Its membership was mainly academic and for some three decades it informed the water development sector through regular scientific conferences. Through the IRCSA conferences practitioners around the world learned from the work of Prof. Zhu Qiang of the Gansu Institute of Water Conservancy, China, and have adapted this experience to overcome their problems from Africa to North Eastern Brazil.

The interaction with the International Rainwater Catchment Systems Association (IRCSA) at the 2nd Brazilian Rainwater Catchment Symposium, in July 1999, demonstrated to Brazil the importance and potential of rainwater harvesting. The Conference led to the creation of ABCMAC: Associação Brasileira de Captação e Manejo de Água de Chuva (Brazilian Association for Rain Water Harvesting and Management). Since then, Brazil has launched the P1MC domestic RWH programme: Programa um Milhão de Cisternais rurais (the One Million Rural Tank programme) in the vast dry North East of the country. It was later reinforced by a programme that augmented rainwater harvesting for agriculture as well: P1+2: Programa uma Terra e duas Águas (Programme One Piece of Land and Two Sources of Water) (Heijnen, 2013). So far the two programmes report to have facilitated the construction of some 730,000 rainwater harvesting systems in homes, farms and schools (asabrasil.org.br). Really getting towards the one million systems!

In the water thirsty world of today RWH can support livelihood through rainfed agriculture. This is practiced in a very high percentage of farm lands: 95% in Sub-Saharan Africa; 90% in Latin America; 75% in the Near East and North Africa; 65% in East Asia; and 60% in South Asia (IWMI, 2010). The World Agroforestry Center in Kenya builds on this by promoting the Billion Dollar Business Alliance for Rainwater Harvesting towards food and water security urging farmers in Sub-Saharan Africa to construct farm ponds and harvest water during the rainy season (kenyacic.org/news/billion-dollar-business-alliance). Kenya and Ethiopia are known for the development and the use of sand dams in dry rivers, a system that captures and stores the occasional bursts of rain. In addition, domestic rainwater harvesting is spreading, with Kenya nationwide having 5.4% of users.

Advocacy for rainwater harvesting has branched out to argue for improving the health of watersheds through retention and slowing down the run-off of water to encourage restoration of aquifers through managed aquifer recharge and so coax wells to gradually become perennial again, e.g. in India, Ethiopia, China.

Following recommendations formulated during the *World Summit for Sustainable Development* in Johannesburg in November 2002, the International Rainwater Harvesting Alliance was established to advocate and inform about rainwater harvesting. It is mainly active in support of regional and national rainwater organizations in developing countries (irha-h2o.org/0).

The interest in domestic rainwater harvesting in countries like Australia, Germany and the United States has financed research and product development with respect to optimization of filters to remove dirt e.g. Leaf Beater Downspout Filter; first flush diverters; storage tanks and rainwater harvesting fittings, etc. In Western Europe and the UK, municipal governments, researchers and entrepreneurs are increasingly engaged in bringing local and domestic rainwater harvesting within the water resources management continuum (Melville-Shreeve *et al*., 2016).

The German Ministry of the Environment states on its website on the use of rainwater in the household that '*the technology and products for using rainwater in the home have now matured. Technical standards are available … However, rainwater systems need regular check-up and care. This is the duty of the user*'.

Now that the world is facing the effects of climate change, requiring ever more water for its cities and committing itself to the Sustainable Development Goals of providing, among other, all people with a safe water source for drinking and personal hygiene, it is worth examining rainwater harvesting as an instrument to help extend a safely managed water supply service.

1.3 RAINWATER HARVESTING FOR DOMESTIC WATER SUPPLY

Rainwater can be harvested as a domestic supply, for use as drinking water and for food preparation, as well as for a variety of other household chores. In addition, rainwater and wastewater may be used for maintaining a vegetable plot, some small livestock and productive trees.

1.3.1 Why collect rainwater for drinking and domestic needs?

Where water supply is not available, not sufficient or safe to drink, harvesting and storing rainwater may be part of the solution. Households living in such areas are already frugal with water and will not allow it to go to waste. Efficient water use comes with lifestyle, for personal hygiene, ecological sanitation or gardening with mulching and planting drought resistant crops.

1.3.1.1 In semi-arid areas or at an uphill elevation

Retention, storage and conservation of rainwater is a matter of survival, water security and self-reliance, for the household and for (minor) agriculture, to tide over the dry period.

1.3.1.2 When ground water has a bad taste

In coastal areas and small islands, but also in some inland aquifers, water can be saline and not fit for drinking. Groundwater may have a high iron or manganese content that people may find objectionable and is difficult to remove.

1.3.1.3 Substitution

Where boreholes yield water with excess levels of arsenic or fluoride, or in situations where people suffer from chronic kidney disease of uncertain etiology (CKDu) as in Sri Lanka or Central America, consumption of ground water would eventually lead to serious health consequences. Consumption of rainwater would be a safe alternative.

1.3.1.4 Rainwater may bring a better service

In urban areas where water supply is under stress and costly, rainwater harvesting will augment the existing service, reducing consumption from the public supply and assuring greater water security at home. Uncoupling the rainwater downpipe from the city sewer and slowly draining the rainwater on unpaved premises allows for infiltration improving the aquifer.

Figure 1.1 Leaflet from Lanka Rainwater Harvesting forum (Dissanayake, 1996).

1.3.2 Managing the stored water

In terms of quantity, there is sufficient water during the rainy periods, but when the rain stops management of the rainwater store is needed. It has often been a reason for planners to disregard rainwater harvesting as it is not reliable in terms of a perennial supply.

However, for the households that practice rainwater harvesting this is hardly ever a concern. With rain, the household will have several months of excellent service during the rainy periods, while in the intervening months or the dry season the use of rainwater should be managed for quality purposes, as it is normally a safe source, or for accessibility, e.g. for a system serving an elderly couple.

People in vulnerable households already manage their water from several sources depending on the season. The women have an understanding of the availability, quality and preference of water sources and have learned to live with it. However, the installation of a rainwater harvesting system raises water security and ease of access at least for drinking water. The storage that a rainwater system brings, would also allow for a water tanker to fill up the reservoir during the dry period. Even in urban areas, harvesting rainwater can very well enhance service levels by augmentation of a city supply that is insufficient or erratic.

1.3.3 Quality of harvested and stored rain water

The quality of the rainwater collected and stored depends on the cleanliness of the catchment area (roof); the application of a first flush to divert the first, potentially dirtier water; the use of an entry filter and the inlet–outlet system used in the tank (Pathak & Heijnen, 2007). When properly managed, rainwater is of good quality and mostly better than public supplies that are inadequately treated (World Health Organization, 2017).

Epidemiological studies show that consumers are not at greater microbial risk than users of piped systems (Heyworth *et al*., 2006). Nowadays good and affordable household filters are easily available to make the collected rainwater completely safe. When lead flashings and roofing paint are not used, chemical risks are also minimal (enHealth, 2010).

In 2017, a *Review of Roof Harvested Rainwater in Australia* looked at 148 studies and reported on the use of rainwater harvesting in Australia from the perspective of chemical and microbial health. It concluded that chemical constituents were generally within accepted health guidelines, except where due to past mining or industry activities dust blown onto the catchment area may cause exceedences. Rainwater can easily be microbiologically contaminated if the first flush is not used properly. Even then, the review stated that the epidemiological evidence in Australia does not point to consumers being affected by drinking untreated rainwater. At the same time, the study advised for household water treatment to ensure the water is bacteriologically safe (Chubaka

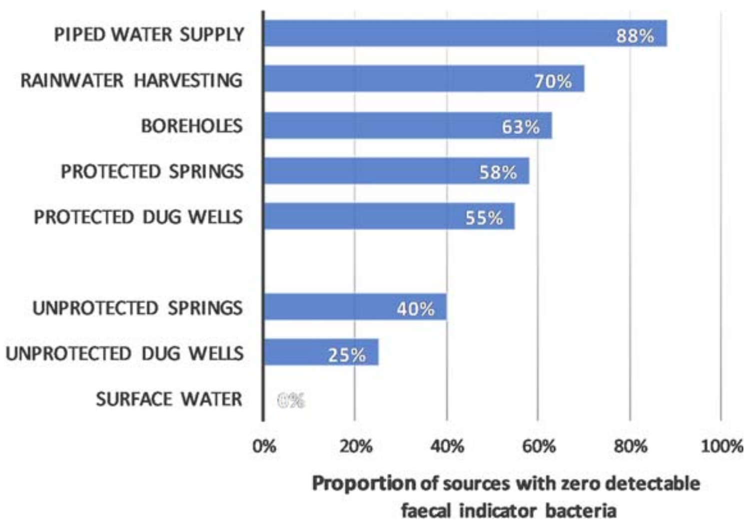

Figure 1.2 Comparative water quality realized among technologies. Studies from low and middle income countries by R. Bain *et al*. (WHO, 2017).

et al., 2018). Note that when water is stored in the tank for a while, as will usually be the case, the water quality will improve due to die-off of bacteria in a low-nutrition environment and the effect of biofilm on the inside of the tank. The biofilm will also absorb heavy metals (Evans *et al*., 2009).

Figure 1.2 shows a comparison between technologies in use in low and middle income countries against their safety as a drinking water source. It shows that in 70% of cases rainwater is a safe source even when it usually not treated before drinking (JMP, 2017b).

1.3.4 Initiating rainwater harvesting programmes

When alternative water supply solutions are not available, rainwater harvesting implementation programmes should be considered. Domestic rainwater harvesting systems are obviously household based and this may lead government and agencies to consider that investment costs should be borne by the householder. However, getting a connection to a piped scheme in the city or the installation of a borehole in the community are most often subsidized. As the water storage tank is expensive, building your own system may be impossible without government support or a bank loan.

So, from a perspective of equity and promoting universal access to safe water supply, government support for rainwater harvesting system development would be justified. Moreso, as in most developing countries the beneficiaries of the rainwater systems would mostly be the poorer sections of society.

The large majority of rainwater harvesting systems (as described in this book) are directly subsidized by the government or its agents. In the case of developing countries, sponsors may provide non-governmental organizations (NGOs) financial support to undertake the implementation. In Australia application of rainwater harvesting is encouraged or mandated through a mix of subsidy and rules. That situation has also led to a vibrant rainwater harvesting market with associated regulatory and public health guidance (Chubaka *et al*., 2018). In Germany and the Netherlands, the focus has been more on decoupling of rainwater from the sewer line and using the rainwater at home for flushing or gardening, but also here, households are encouraged to take the first steps through attractive offers and subsidy through the municipality.

1.4 USE OF RAINWATER FOR DOMESTIC USE

Data have been obtained from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) in late 2017 to make an assessment of how far rainwater is currently being used as a source of drinking water. On the basis of the data received, 98 countries were included in the sample. Member countries of the Organization for Economic Co-operation and Development (OECD), except Australia and Mexico and Russia were not included in the sample. Data are from the updated 2015 reporting by JMP, as used for the publication on ‘Progress on

Drinking Water, Sanitation and Hygiene: 2017 update and SDG baselines' (JMP, 2017a).

Countries that reported less than 0.1% usage of rainwater as a drinking water supply or with data from before 2010 are excluded from the sample. This resulted in 115 countries, of which again 17 were eliminated as data were not available or unclear. As a result, most countries included are from Latin America, Africa and Asia. That is not to say that there are no rainwater users in the Northern hemisphere, but the data are as yet not available and users are not likely to use rainwater for drinking because their economies and infrastructure are more sophisticated.

The JMP lists rainwater harvesting as an improved water source, however as it is supposed to be a small contributor to the goal of universal water supply, it is at this time not making a separate assessment of rainwater use in the world.

The data do show some interesting results. Presently some 86 million people (say 17 million households) state in surveys that they are using rainwater for human consumption, or 1.6% of the 5.3 billion people included in the sample (or 72% of the world population). Considering only the rural population, the usage figure goes up to 2.4% of the 2.8 billion rural population.

Obviously many more collect rainwater for other domestic purposes. The data from Australia indicate that more than twice as many households use collected rainwater for other purposes around the home. If that would be more generally true, 3 to 3.5% of the population living in non-OECD countries and Russia would be familiar with rain-water harvesting.

It is likely that we see an up-tick in the number of households in Europe that will adopt rainwater harvesting at least for non-potable applications. In Australia this already the case, as Figures 1.3 and 1.4 show.

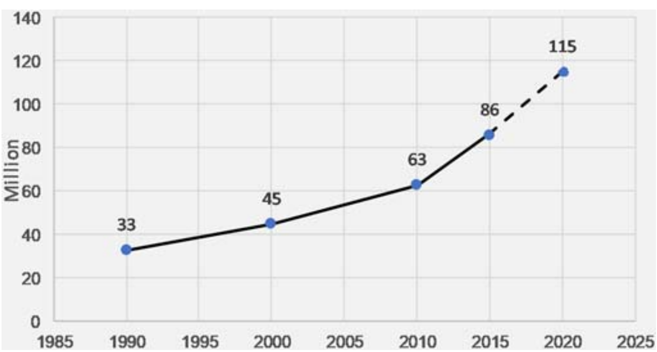

Figure 1.3 Growing use of domestic rainwater harvesting for drinking water in 2015 (JMP, 2017a), without OECD countries and Russia, incl. Australia and Mexico, in million people served.

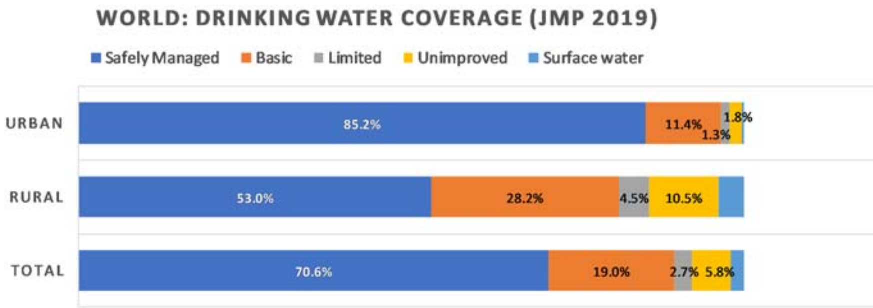

Figure 1.4 WHO/UNICEF JMP (2019) Progress on household drinking water, sanitation and hygiene 2000–2017. Special focus on inequalities.

1.5 SUSTAINABLE DEVELOPMENT GOAL (SDG) 6

Harvested rainwater can play an important role in improved water supply, in particular support for a well constructed and operated system meets the criteria for a safely managed supply set forth by SDG 6.1: '*By 2030, achieve universal and equitable access to safe and affordable drinking water for all*'.

Until 2015, the Millennium Development Goals were in use as the international targets. These stipulated relative simple and clear services in water supply using an improved source and in sanitation for safe removal of faeces. For hygiene, handwashing with water was sufficient to meet the standard. The adoption of the 2030 Agenda for Sustainable Development changed the baseline for WASH.

New, more stringent 'technical' indicators for WASH-related Sustainable Development Goals have been introduced. Table 1.1 'provision of safe drinking water' this means that: the water supply tap point should be near the home, in effect on the premises; it should be available when it is required (from a city-network tap, or a storage tank); and it should be free from contamination.

In 2017 10% of the world population still waits to access a safe water supply. Overall 3 out of 10 people were waiting for safely managed drinking water

Table 1.1 Progressive realization of Sustainable Development Goal 6.1.

Service Ladder	Progressive Realization of Sustainable Development Goal 6.1 by 2030
Safely managed drinking water supply	Improved facility located on premises, available when needed, and free from contamination
Basic water supply: continuation of MDGs	Use of improved water source, within 30 minutes round trip collection time

Source: JMP (2017b)

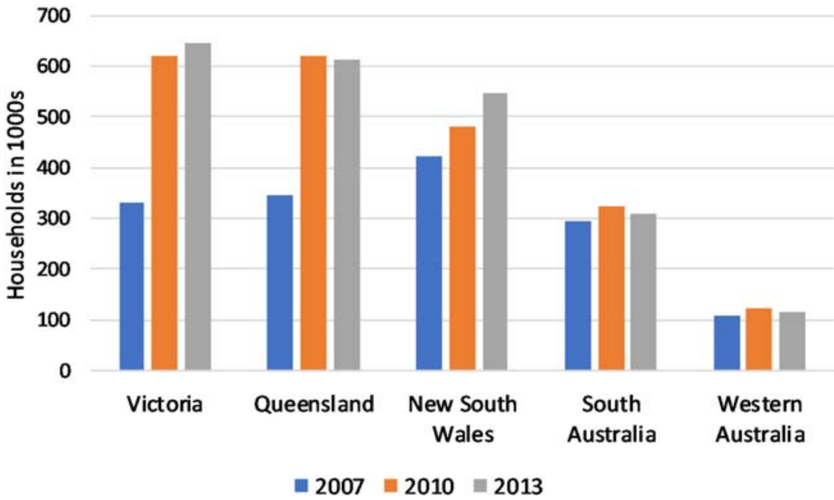

Figure 1.5 WHO/UNICEF (JMP, 2017a) Progress on household drinking water, sanitation and hygiene 2000–2017. Special focus on inequalities.

services in 2015. Those that are unserved are mostly in low and lower middle income countries, and mostly in Figure 1.5.

In achieving the SDGs, greater emphasis is placed on realizing equity of access and inclusion. This is also expressed home in Target 1.4: 'Achieving universal access to basic services', which aims to ensure all that men and women, in particular the poor and vulnerable, have equal rights to economic resources, as well as access to basic services [including WASH]. Other SDG6 targets raise the importance of water efficiency, integrated water resources management and ecosystems.

1.6 HOW TO PROVIDE WATER SUPPLY SERVICES TO THE LAST 10% OF THE UNSERVED?

How can we tackle the remaining SDG water supply challenges? The straightforward, easier and less costly water supply projects have been completed. And even these now face maintenance problems, upgrading and water shortage episodes, so more work is needed to keep these in good shape.

From now on, all water supply projects will be more difficult as water requirements by different parties at local, regional and national level require more negotiation, technical and hydrological know-how, policy agreement on water resources management, etc. Not all the unserved communities and households will be affected by these constraints as they may have traditionally been relying on local sources and agreements. But those who live in the periphery of cities experience shortages every day, as the cities grow and the capacity of water utilities to provide basic water services does not keep pace.

In addition to the 10% of the world population still without an acceptable service, 19% have a basic service. Apart from water quality, water quantity is a concern for these two categories. Additional alternative sources may be needed to meet the increase in demand. In urban settings, additional water sources need to be found or secured (at times with ecosystem charges to be paid to the guardians of the source area), to ensure that the growing city can provide adequate water to its citizens. To manage such a process requires a clear policy, public information campaigns, and extensive communications with consumers. Clarity of purpose and enabling municipal policies in Australia convinced authorities to invest in additional rainwater solutions that work for everyone, do not break the bank (even though the solutions may require a substantial financial commitment) and enhance water security all round.

What options are available to provide a service to the last 10%? Technical solutions such as desalination are expensive to run, thus, would attract a subsidized environment, which would not be sustainable. Similarly, lift-pumped supplies to serve households in hill areas do not come cheap in recurrent charges either. So how long can a rural community manage without having to beg support from the local government? Diverting water from another river basin is only for the desperate, and at a serious cost. Also, the cost of transporting the water is clearly adding a substantial recurrent expense due to the depreciation of the pipeline and the cost of pumping charges. Thus households can resort to bringing water by tanker. This is costly and may well be tricky with respect to quality and regulation.

1.7 BE READY TO COLLECT AND STORE RAIN

A functioning, well-managed rainwater harvesting system fulfills the SDG 6.1 criteria nearly in full: it provides a water supply service on the premises, it is available anytime and the water quality is very good. If in doubt, one can treat the water through a household water treatment system. Rainwater harvesting faces the problem that the quantity of water may not be adequate all year round, but that could be overcome by increasing storage if rainfall and roof collection area allow this.

Rainwater harvesting meets several other SDG criteria. It will fulfill the right to water for the household and lead to sharing of water collection tasks in the household. The reduced time spending on daily water collection will afford a woman opportunities to engage socially and raise her status by taking on some income generating productive work, for instance in growing and selling vegetables. Kitchen farming will improve nutritional intake, health is better protected and children have less water carrying tasks, so they will be in school on time. A rainwater tank in the yard will also satisfy the needs of elderly people or persons living with a disability (Jones, 2013).

Through rainwater harvesting, users will develop a better appreciation of climate change and this will probably raise interest and capacity to improve household and community climate change resilience. At any rate, water security in the home will improve substantially. It may well be that water will be scarce during the dry season, but women have proven to be good managers using various strategies to keep water in the rainwater tank longer. If all else fails, and if the road allows, water can be tankered in to make up for a shortfall. In Hambantota, a drought prone southern district in Sri Lanka, those with rainwater tanks, do usually not need a top up with tankered water distributed by the local administration. People manage.

It is true that climate change has created new challenges. Historical precipitation data are no longer that reliable, as rainfall has become more erratic. Delays of the onset of the expected rainfall create problems for farmers sowing crops or transplanting rice seedlings. When the rains come, it is more often a burst of water overwhelming the collection systems. Key words are erosion control, ponding and storage, managed aquifer recharge, restoration of wetlands and promotion of viable ecosystems, managed for water conservation, etc. Research, piloting and effective monitoring will help to develop the most practical solutions for affordable, incrementally upgradable rainwater harvesting systems that will serve households and institutions such as schools and health care facilities, and ensure that rain is increasingly seen as the invaluable resource that it is.

Depending on local conditions, rainfall and local capacity and political interest, it should now be possible to accelerate the uptake of rainwater harvesting solutions for domestic and community water supply in situations where otherwise, for technical and management reasons, a service is not feasible. The technology is, with different levels of technical sophistication, increasingly available in the market and it will be possible to adopt solutions that will work. To serve those who reside in remote, dispersed hamlets, on hill sides, or in the un(der)served periphery and slums of cities governments should be prepared to provide additional financial and technical support to reach out to the last unserved.

Rainwater is a valuable resource, which should be exploited in the most efficient way. Governments should explicitly recognize rainwater harvesting in their water supply policy to encourage and promote rainwater harvesting for human consumption and domestic use, to protect the people's health and livelihood, and ensure good utilization and conservation of water resources.

1.8 CONCLUSION

Currently, RWH for domestic use and for human consumption is a reality for many households. It is estimated that around 6–8% of the world population could be served substantially through improved RWH as a drinking water source and for other domestic usage.

Where rainwater harvesting is feasible, it addresses the human right to a water supply service, can provide a safely managed service with limited extra costs, frees women from drudgery and raises their independence (Rautanen *et al*., 2015). It improves water security, and sanitation and hygiene in the household.

Without proper use of rainwater, universal access to safely managed water supply as defined under the Sustainable Development Goal 6 will not be achieved.

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