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Characteristics and Problems Related to Rural Water Utilization in the Dry Zone of Sri Lanka

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Abstract
Water is the driving force of all life and nature. People can survive without food for few days but not without water. Even though our planet; Earth is covered with water, only a little amount of fresh water is available for the animals and other entities of the nature. Water scarcity is a major issue that is facing by the people living in the world. The main objective of this research is to identify the characteristics and problems related to rural water utilization in the dry zone of Sri Lanka. Two study areas were selected from the dry zone of Sri Lanka by considering the scarcity of water resources in those particular areas. Accordingly, more than 15 respondents were interviewed in Puttalam District during the rapid survey while 15 households were selected from Anuradhapura District for the field study. Primary sources such as observation, questionnaires, unstructured interviews and measuring method and secondary sources such as relevant books, reports, articles from the internet, maps and photographs were referred. The findings of the study indicated that the temporal and spatial variation in the rainfall pattern is the main factor leading to the scarceness of water. Problems related to rain water harvesting system, alkalinity of water, poverty and chronic kidney diseases were also identified as other issues and obstacles faced by the people living in the dry zone of Sri Lanka.

Keywords: Water resources, Water utilization, Water Scarcity, Dry zone

Introduction:

Water is the most essential resource and the driving force of all nature. Water resource is useful for the survival of humans as well as to other animals. Once the American oceanographer, Sylvia Earle stated as **"There's plenty of water in the universe without life, but nowhere is there life without water"**. Even by looking at this statement it is obvious that water is very much important because it is needed for life to exist.

Even though, 70% of the Earth or the planet we live on is covered with water, freshwater makes up a very small fraction of all water on the planet. Therefore, only a little amount of water is available for the 7.8 billion people living in the world. Due to geography, climate and technology, fresh water is abundantly available in some regions of the world, while others face drought, water scarcity and water pollution.

This situation is visible in Sri Lanka as well. Accordingly, the main objective of this research is to identify the characteristics and problems related to rural water utilization in the dry zone of Sri Lanka. According to the rainfall distribution, Sri Lanka has traditionally been classified into three climatic zones as the wet zone, dry zone and intermediate zone. This research is mainly focussing on the North Central and the North Western provinces of the dry zone. Even though the changeability in annual rainfall and water scarcity has increased in almost all over the country, it is much higher in the dry zone. Dry zone has been affected by the water stress and other related problems from the ancient time. Those problems are still clearly visible in the study area. Most of the southeast, east, and northern parts of the dry zone receive between 1200 and 1900 mm of rain annually and much of the rain falls from October to January. During the rest of the year there is very little precipitation; northwest and southeast coasts receive the least amount of rain, 600 to 1200 mm per year which is concentrated within the short period of time. Seasonal water scarcity is a major problem that can be identified from the study area.

This temporal and spatial variation in the rainfall distribution has led to scarceness of water resources in the dry zone. Even today, people living in this area have to wait until it rains to collect water for their domestic and agricultural purposes. People collect and store water in tanks, reservoirs, wells and using other methods. Even though they stored water, because of the adverse weather conditions it is easily dried up within a short period of time. Some times within 2 or 3 months. So, the main problem faced by the people living in this area is the lack of water resources.

Apart from that, water obtained from the aquifers using tube wells and dug wells is alkaline and contained fluoride. Therefore, the water is somewhat inappropriate for the human consumption, especially for drinking purposes. Another factor related with the water consumption is poverty. Majority of the people of these provinces live below the poverty line. Thus, the purchasing power is comparatively less than other provinces. Another problem in this area is water scarcity caused by physical constraints. Availability of water in these areas is seasonal as a consequence of the climate and topography. In addition to that, chronic kidney disease was identified as an issue faced by the people living in the study area.

Empirical Review

Scientists and other academicians have done numerous researches and investigations about characteristics and problems related to water utilization in dry environments of the world. A book named 'Water in drylands - Adapting to scarcity through integrated management' written by Jonathan Davies, Stefano Barchiesi, Claire J. Ogali, Rebecca Welling, James Dalton and Peter Laban in 2016[4] which is published by the IUCN presents some facts from dryland areas that have adapted to the conditions of drylands. This study is mainly focusing on water management to deal with scarcity and variability, challenges and opportunities for improving water development in drylands.

Research articles published in journals also reveal lot about characteristics of water utilization in dry areas in several countries and parts of the world. Research article named 'Improving water use efficiency in drylands' written by Demie Moore, Eli Argaman, Stroosnijder and Alharbi in 2012[11], 'Water supply challenges in rural areas: A case study from Central Kazakhstan' written by Marat Kalishev, Kamshat Tussupova, Peder Hjorth and Alua Omarova in 2019[10], 'Water harvesting in dry environments' written by Attila Yazar and Akhtar Ali in 2016[17] and 'Rural drinking water issues in India's drought-prone area: a case of Maharashtra state' written by Parmeshwar Udmale, Yutaka Ichikawa, Takashi Nakamura, Ning Shaowei, Hiroshi Ishidaira and Futaba Kazama in 2016[14] explain a lot about land and water management practices that improve water use efficiency in crop production in dry lands, water quality of various types of water supply in villages, methods and techniques of water harvesting to make more water available to humans, animals and for irrigation purposes and rural drinking water availability issues during droughts.

Several researches and case studies have done by Sri Lankans as well. A research report named 'Water scarcity variations within a country: A case study of Sri Lanka' written by Upali A. Amarasinghe, Lal Mutuwatta and R. Sakthivadivel in 1999[1] examines about the variations of water supply and demand and the differences of water scarcities between different districts in Sri Lanka under both the present conditions and projected conditions in 2025.

Apart from that, journal articles such as 'Water security and related issues in Sri Lanka: the need for integrated water resource management (IWRM)' written by Ananda Gunatilaka in 2008[5], 'Rain water harvesting in Sri Lanka' written by Dr. Tanuja Ariyananda and Prof. S. S. Wickramasuriya in 2009[2] and 'Rain water harvesting for water efficiency and management' written by T. Ariyananda, S. S. Wickramasuriya and D. S. Wijeyesekera in 2010[8] reveals about the water security and other related issues and rain water harvesting as a solution to overcome water scarcity in the country while a special attention has been given to the dry zone as well.

Literature Review

According to the words of Leonardo da Vinci, "Water is the driving force of all nature". It has been proven that water is the most vital constituent of all forms of living things and the life blood of all activities of mankind. It is the most important natural resource, that has been drawn a wide attention of the present world, for its temporal and spatial variations that caused serious problems for both the environment and humans. The surplus and the deficit of water visible in all around the world, have intensified the seriousness of these problems (Bandaranayake, 2007)[3].

Water covers 70% of the Earth while of all the water that exists on the Earth, roughly 97% is saltwater and only 2.5% is freshwater. Most of Earth's freshwater is frozen in glaciers, ice caps, or in aquifers; deep underground. Even then, only 1% of our freshwater is easily accessible to fulfill our needs. Basically, only 0.007% of the Earth's water is available for our consumption[9]. Unfortunately, this limited natural resource is being depleted at an alarming rate and gradually becoming a scarce resource. Most parts of the world are experiencing water scarcity due to the increased water demand.

According to the World Health Organization, 3 in 10 people worldwide or 2 billion people lack access to clean water and 1 billion people do not have enough to even meet their daily needs[18]. The water scarcity is directly impacted to arise many global scale environmental problems such as desertification, land degradation, famine, drought and crop failures. These crises at global level have been intensified as the results of many causes such as climatic changes, increasing demand on water, inappropriate technology of water use and improper water management systems (Bandaranayake, 2007)[3]. According to several reports it is stated that, by 2050 the number of people on the planet is projected to exceed 9 billion, and if current trends continue further useable water will be lost[15].

Sri Lanka is a country with tropical climate and highly influenced by mainly two types of monsoon rains; South-West monsoon (May to September) and the North-East monsoon (December to February) that bring rain throughout the year. Sri Lanka is blessed with different types of water resources including river basins, wetlands, groundwater resources, irrigation systems, marine resources, streams and lakes. According to the reports of Ministry of Forestry and Environment (1999), Sri Lanka has 103 river basins (total collective length of about 4560km) varying from 10km^2 to over 10,000km^2 in size[16].

However, in the recent past, both the surface and ground water resources have been subject to over-extraction and depletion due to increased population growth, excessive usage, irrigation systems and droughts. Therefore, the drying up of domestic wells during dry periods mainly in the dry zone has become more common in Sri Lanka.

Two third of the Sri Lanka is covered by the dry zone and it consisted of several provinces namely, Eastern, Northern, North Central and some parts of North Western, Uva and Southern provinces. Dry zone holds several kinds of water resources such as; ground water resources (mainly the Regolith aquifer), major and minor irrigation systems, reservoirs, river basins, wet lands, streams and other water ways[6]. Rain water is the primary water source of all these water resources and the life pattern of the people living in dry zone basically depends on the availability of rainwater. Rain water has been used for both domestic and agricultural purposes for many centuries by the people in these areas. Man-made irrigation systems also have scattered all over the dry zone mostly over the North Central and North Western provinces.

Annual rainfall variability is much higher in the dry zone although the annual rainfall variability has increased in almost all over the country. This situation has adversely affected to the water resources and to the water supply. Therefore, the water scarceness is a major problem faced by these areas. Sustainable water resources management is very much needed to overcome this problem and to fulfil the high demand for water.

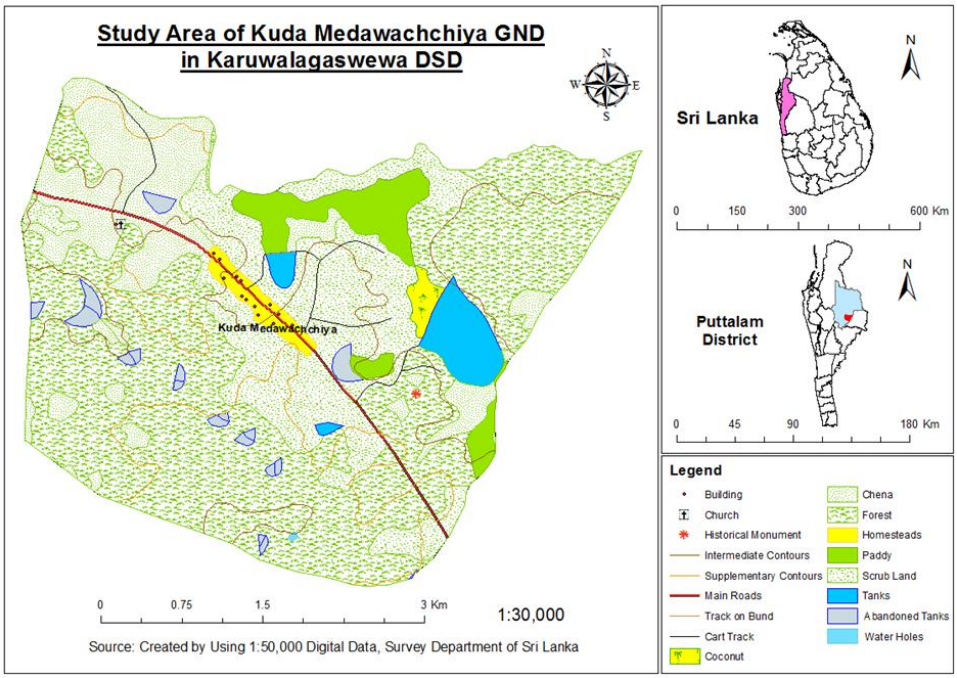
Methodology

Two provinces; North Central and the North Western provinces were selected as the study area of this research. Only Anuradhapura District was selected from North Central Province while Puttalam District was selected from the North Western province for further studies. A rapid survey and a field study were done in these two districts respectively.

- ❖ Rapid Survey - Kuda Medawachchiya Grama Niladhari Division in Karuwalagaswewa Divisional Secretariat, Puttalam District, North Western Province (Map No: 4.1)
- ❖ Field Study - Dematamalgama Grama Niladhari Division in Thanthirimale, Anuradhapura District, North Central Province (Map No: 4.2)

Rapid survey was done in the village of Kuda Medawachchiya GND in Karuwalagaswewa Secretariat Division which is located in Puttalam District. This area belongs to the low country dry zone and to the DL3 agro ecological region. The annual rainfall in this area is about 650 - 1100mm. Field study was done in the Dematamalgama GND in Thanthirimale which is situated about 40km north-west to the city of Anuradhapura. This area belongs to the dry zone of the country and to the DL1 agro ecological region. The annual rainfall this area receives is about 900 - 1100mm. These areas are the one of the driest parts in the country. Even if the water is a limiting factor in this part of the country, tanks or the reservoirs built during ancient times have made it possible for the paddy and other cultivations in these areas.

To achieve the main objective, which is to identify the characteristics and problems related to rural water utilization in the dry zone of Sri Lanka, primary sources and secondary sources were used. Relevant books, reports, articles from the internet, many kinds of maps and photographs (metric maps, Google Earth maps and Google images) were referred as secondary sources. As primary sources observation method, questionnaires and unstructured interview methods were mainly used to gather information more than 15 respondents were interviewed in Puttalam District during the rapid survey while 15 households were selected from Anuradhapura District for the field study. Depth, diameter, water mass and water level of wells and rain water tanks were measured using a measuring tape. Finally, all the tabulated data and information which were taken from the above techniques and methods were examined.



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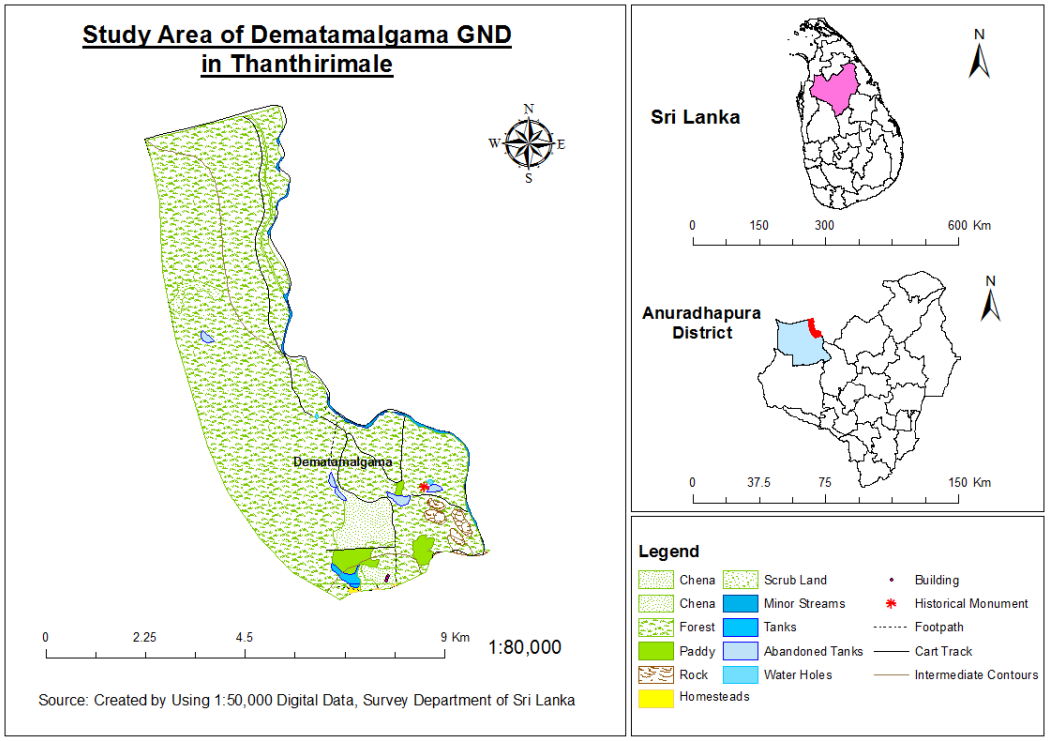

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Results and Discussions

Characteristics of the usage of water

Utilization of rain water stored in rain water storage tanks were mainly studied during the rapid survey. More than 15 households were surveyed and it was revealed that most of the people living in Kuda Medawachchiya area use rain water storage tanks for their domestic uses. Rural people in Sri Lanka use rainwater for domestic supplies during dry seasons or any other water scarce situations. There has been a significant increase in the use of rain water harvesting in Sri Lanka not only in rural areas and also in urban areas. Sri Lankan government with the help of several NGO's has implemented several rain water harvesting projects for communities which are scattered over a large number of districts.

Fig. 5.1: Diagram of roof rain water harvesting system (above ground tank)
Source: Adapted from Andrade (2016)

Rainwater harvesting refers to which catch rainwater and store it in underground or above-ground tanks for later use[12]. In rooftop rainwater harvesting, where any suitable roof surface tiles, metal sheets, plastics, but not grass or palm leaf can be used to intercept the flow of rainwater in combination with gutters and downpipes (made from wood, bamboo, galvanized iron, or PVC)[12]. If the water is collected properly, it can be used for all domestic purposes, even for drinking as well (Figure 5.1).

Availability of water is seasonal in this area. Some areas experience extreme dry spells or a period of droughts between monsoons or sometimes total absence of monsoonal rains. Likewise, people living in Puttalam District experience prolonged drought, causing tremendous hardships to people and in many cases, groundwater or surface water is unavailable for drinking as the groundwater level is too deep to extract and contaminated with minerals. Particularly, quantity, quality and availability of groundwater have been started to deteriorate due to the increasement of human activities. Therefore, the rainwater harvesting is the most effective and low-cost solution for these problems.

According to the findings, most of the water tanks were made of cement and only few were made of plastic (Figure 5.2). Basically, the capacity of the water tanks was 5000*l* and in some places it was 6000*l*. Respondents said that they are able to use rain water stored in the tanks for as long as 5-6 months during the dry period. Most of the respondents said that they use rain water stored in tanks only for drinking purpose while few of them said that the water is used not only for drinking and to prepare their meals as well. Accordingly, people use rain water stored in the tanks only for their domestic activities but not for washing linen, pots and pans and for bathing.

Fig. 5.2: Cement and plastic water storage tanks
Source: Field survey (2016)

Reservoir *(Wewa)* has been used for other purposes such as for agricultural activities from the ancient time (Figure 5.3). People even use water from the reservoir for domestic activities as well. Most of the respondents said that water stored in the tank is not sufficient for the consumption if the dry season prolonged. Not only that, other water source, the reservoir also dried up if the dry season extended further. Therefore, the people living in this area are facing terrific problems of water scarcity.

Fig. 5.3: Reservoir - Karuwalagaswewa
Source: Field survey (2016)

According to the information of survey, it could be identified that well maintained and covered rooftop tanks generally meet drinking water quality standards and provide the opportunity of collecting water without walking. Sometimes people have to walk long ways to the nearest source of clean water and as fetching water on dry or wet days are particularly hard and unpleasant. So, even this small yield is highly valued for them.

Some households use water taken from tube wells as well. When the water is tested, it could be found that water is little bit alkaline and contaminated with minerals and fluoride. Even so, the water is suitable for human consumption (even for drinking). But the process of drilling the ground water aquifer and taking water from it takes a long time and a huge amount of money. Some respondents said that they had to spend nearly Rs. 200,000 for the constructions and water quality tests.

Fig. 5.4: Using well water for vegetable and flower beds
Source: Field survey (2016)

People living in the area of Thanthirimale, where the field study was done, had to face to many more problems and issues regarding the water utilization. Accordingly, 15

households from Dematamalgama GND in Thanthirimale were surveyed. Water from the nearby reservoir, domestic well, purification center has been used by the people living in this area to fulfil their water requirements, mainly for domestic and agricultural purposes. During the research, it could be identified that most of the households have their own domestic well. Following table shows the characteristics of selected 12 wells located in Thanthirimale area (Table 5.1).

Table 5.1: Characteristics of selected 12 wells in Thanthirimale

Sample No:	Depth (m)	Water level (m)
1	9.1	3
2	10.6	4.5
3	16.7	6
4	8.5	5.4
5 (Tube well)	45.7	Not measured
6	9.5	4.8
7	6.3	2.9
8	3.5	2.5
9	4.9	1.6
10	4.3	2.3
11	5.7	Dried
12	6.2	5.2

Source: Field survey (2016)

Fig. 5.5: Protected wells, Thanthirimale
Source: Field survey (2016)

Even though 15 households were surveyed, only 12 wells were found from that area. Out of those 12 wells, one is a tube well which is 150ft (45.7m) in depth. One well has been dried up because of the adverse weather conditions. Most of the wells are permanent and built properly (Figure 5.5). Dimensions of wells range between 3m, 4m and 5m. In some places it is more than 5m. Somehow wells are large in size and showed the characteristics of agro-wells. Another several unprotected agro-wells were recognized from the home gardens as well (Figure 5.6). Most of the wells are situated 100m to 200m away from the houses. According to the respondents, well water is used only for washing linen, pots and pans, for bathing and for watering vegetable and flower beds in their home garden (Figure 5.4). Because it has been revealed that the well water in this area is not suitable for human consumption and the water is not used even in preparing meals and drinking. Water quality tests show that water of these wells is contaminated with minerals and if it is needed, water can be consumed only after boiling. Anyhow, people pump water using water pumping motors and draw water using pulley and bucket from these wells.

Fig. 5.6: Unprotected wells which are used for agro based activities, Thanthirimale
Source: Field survey (2016)

Some respondents said that they consume 100*l* of water per day.

Moreover, it could be recognized that the existing water level is lower than the depth of the well. In some places it was less than half of the total depth of the well. The reason for this situation is the drier weather condition of the area. It has led wells to dry and other water ways too. Accordingly, respondents said that during the severe dry periods; mostly during the months of August and September (Post-Monsoon Season or Retreating southwest Monsoon Season) water level of the wells lessen up to 12ft (around 3.6m) and sometimes water of the wells diminishes completely. Further, they said that it takes at least one month to refill the wells after rain falls. During the month of December this area receives a high amount of rainfall because of the Northeast Monsoon rainy season which occurs during October to December. Not only Anuradhapura District but also the entire dry zone gets high amount of rain fall during this period and it helps to replenish all the water ways including wells, aquifers, streams and tanks in the dry zone.

Fig. 5.7: Fluoride siltation inside a kettle after boiling the mineralized water (fluoride-rich water), Thanthirimale
Source: Field survey (2016)

According to the secondary data referred, it could be clearly recognized that the distribution of deep-water wells with fluoride-rich ground water has scattered over the dry zone[6]. Surprisingly, distribution has limited only to the dry zone. Several evidences (fluoride siltation) were also identified from the study area as well (Figure 5.7). The reasons behind this situation could be the characteristics of the aquifer and the dry weather condition of the dry zone.

Another characteristic related to the water utilization is using the reservoir to fulfil their water requirements (Figure 5.9). The reservoir is situated approximately 200m away from the village and the height of the water mass is about 10ft. Many issues and obstacles are arising when water level of the reservoir decreased during the dry season. Most of the villagers use reservoir for their agricultural activities and for domestic purposes. Their main occupation; agriculture is dependent upon the amount of water stored in the reservoir. During the dry period when the reservoir is dried out, peasants are left without any other option, not to cultivate their paddy fields. Therefore, paddy fields are abandoned during the during dry periods. It affects to their socio-economic stability and ultimately to their entire life style.

Fig. 5.8: Reservoirs have dried out due to the prolonged drought
Source: https://www.google.lk/maps (2016)

Fig. 5.9: Reservoirs in Thanthirimale (Kuda Malmaduwa Tank)
Source: Field survey (2016)

Apart from that, tap water and filtered water are also used by the people of this area mainly for drinking. Earlier, people have used tap water for drinking purposes, but now the situation has changed as the water quality tests revealed that the tap water is not appropriate for drinking. Therefore, the people eventually shifted to another source of drinking water, which is purified water (Figure 5.10). Consequently, water obtained from the purification station which is situated in the village is the ultimate option that people had. It was revealed that Rs.1 has to be paid for the purification station, to buy 1*l* of water.

Fig. 5.10: Water purification station and the equipment kept inside the station
Source: Field survey (2016)

During the survey three wells, which contain better quality water were identified (Figure 5.11). Villagers have done water quality tests for these wells and verified that these wells contain better quality water generally meet the drinking water quality standards. Most of these wells were not much deeper and the reason for this difference might be the location of the aquifer. Shallow Regolith Aquifer which is spread over the dry zone, serves as a water source for most of the water resources of this area. This aquifer in the hard rock region has no continuous body of groundwater with a single water table, but rather separate pockets of groundwater. The dug wells have been abstracting water from this basement regolith aquifer for domestic requirements for a long time. These aquifers have provided the basic water needs through bore wells or tube wells despite the relatively low yields. The recent development of agro-well farming in the North Central and North Western provinces is also dependent on this shallow groundwater resource. Recent studies have shown that there is a limit beyond exploitation of the regolith aquifer which would result in an unalterable depletion of this limited groundwater resource [6]. At last, it can be concluded that the difference between water of several wells is a result of the location of the aquifer as this aquifer is located as separate pockets of ground water.

Fig. 5.11: Better water quality wells
Source: Field survey (2016)

Conclusions

Water is the basic necessity of all life forms on the Earth, and one of the scarcest natural resources on the Earth as well. When considering about the research findings, it can be concluded that the water is alkaline and contained fluoride in most places of the study area and somewhat inappropriate for the human consumption (especially for drinking purposes) due to the hardness of the water. Accordingly, lack of water quality is the main problem faced by the people and the opportunity to consume better quality water is limited in these areas.

Seasonal water scarcity is a major problem faced by the people throughout this area. The temporal and spatial variation in the rainfall distribution has led to deplete the water resources in the dry zone. At certain times, as a result of the dry spells water is not sufficient to irrigate the agricultural lands and not enough even for drinking. Water is plentifully available only during the rainy season and water has to be collected during rainy season and have to depend on the stored water for the rest of the year until it rains.

One of the major problems of roof rainwater harvesting technology is it requires a higher capital investment initially for the construction of storage tanks and other

supplementary components. The cost is much higher when the rainfall is low and there is a longer dry period, which results in the need for a larger tank to ensure water security.
People living in these areas suffer from chronic kidney disease occurred due to consumption of mineralized and contaminated water. Previously it was limited to North Central and Uva provinces, but now it is prevalent in the North Western, Eastern, Southern and Central provinces, and parts of the Northern provinces as well (Sunil, 2014)[13]. Several people who are suffering from this deadly disease could be found in the study area also.
Another problem identified from these areas is water scarcity caused by physical constraints. It is mainly because of the climate and topography. The terrain of the dry zone is mostly flat. When it rains, water seeps into the underground easily and it leads to low moisture content in the top soil. Apart from that, high temperature, high wind speed, low water vapour content in the air, high transpiration and evaporation rates trigger the water scarcity. Typically, during the rainy season water is abundantly available while during the dry season water is scarce in the dry zone.
Another factor related with the water consumption is poverty. Majority of the people of these provinces live below the poverty line. So, the purchasing power is comparatively less than other provinces. They do not have considerable access to build infrastructure facilities, financial facilities to dig wells and to drill tube wells, or at least to purchase water from other areas. In addition, low socio-economic and infrastructural assets are a common factor that can be seen from these areas.

Recommendations

Using rain water for drinking purposes should be encouraged among the people in dry zone where the groundwater is both mineralised and contaminated, especially in the areas of high incidence of kidney problems occurred. Regular cleaning of rain water storage tank and gutters is very important and further treatment through boiling can be recommended to ensure the water quality.

Fig. 7.1: Traditional '*Pathaha*', a garden pond
Source: Adapted from Ariyananda, Wickramasuriya, Wijeyesekera (2010)

Most of the people of these areas depend on rainfall-based sources of income such as, agriculture. But, lack of a constant water supply has become a major limiting factor regarding this. Therefore, storing in tanks and reservoirs is an effective method as such tanks are abundantly available in the dry zone. Therefore, a special consideration should be given to Develop and rehabilitate such existing water resources such as springs, reservoirs, streams, rivers and other water ways.
Conserving run-off water in small ponds called *'Pathahas'* has been practised in some parts of the dry zone and it helps to replenish water during water scarce periods.
Another way of water conserving is collecting water fallen in to the home garden in to a tank located in the underground which is known as the underground rain water harvesting. This is somewhat effective than other methods as it limits the water loss from evaporation and is very common in India.
Implementing studies to monitor aquifer properties such as ground water quality, ground water level, recharge and discharge amount and other ground water properties should be carried out.
Awareness, training and education are very important strategies that should be spread among the community regarding rain water harvesting systems.
Introducing some supportive mechanisms such as loans and subsidies should be promoted to overcome financial hardships of the people when constructing rain water harvesting systems, wells (both agro and tube wells).

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