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Water resources in Sri Lanka: Availability, scarcity and sustainable water management

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ABSTRACT

Water is an essential resource and a basic element for the existence of the earth. World water now becomes under serious threat due to the rapid growth of population, the negative impacts of climate change, and the highest demand for water in the agricultural sectors. Water scarcity has extremely been observed in Sri Lanka in the last three decades. Perhaps, effective and sustainable water management or water governance is more essential in the present context, and relevant policies and guidelines need to be adhered to overcome water scarcity. Some initiatives were taken into account in the recent past, but those attempts were not reached its successes. Thus, this study broadly reviewed various secondary sources and presented its discussions regarding the availability of natural water sources, climate and rainfall, water resource management practices, and the status of water scarcity and sustainable issues for administering and managing water resources in Sri Lanka. Alternative strategies should adhere to the existing water governance system to mitigate water scarcity, manage water availability and ensure sustainable water resource management at present and future in a successful and sustainable manner.

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1. Introduction

Water is the most plentiful resource that is distributed on earth; it is appraised to be 70.78 per cent of the whole quantity of water resources globally (UN, 2006). However, this amount of available water does not help and use for every purpose because it contains chemical components and salinity which are mixed within it. All people expect fresh and sufficient water to drink, but only 3 per cent of the earth's total quantity of water comprises ground water, ice, rivers, lakes, etc. (Arnel, 2004). As a result, people are facing serious problems with their existence. Moreover, water scarcity has already affected each continent globally, and an estimated 2.8 billion people are exaggerated every month in each annum due to a water deficiency (Kummu, Guillaume, De Moel, et al. 2016).

Across the globe, around 1.1 billion people worldwide do not have access to enriched or upgraded clean water supply, and almost 2.6 billion people live without proper sanitation facilities (Rieu-Clarke, Allan & Hendry, 2017). This situation mostly happened in the rural sectors; however, many urban people also face challenges of insufficient water and sanitation facilities, which have increased rapidly (Kummu et al. 2016). Most people from regions like Asia and Sub-Saharan Africa face poor basic sanitation services (UNICEF, 2009). On the other side, there is an association between water contamination and waterborne diseases; waterborne diseases occur in many regions globally due to a deficiency of quality water and poor sanitation services. Around 4 billion cases are reported yearly due to diarrheal illness or diseases; 2.2 million died (5,000 each year), typically children below age five. Likewise, 1 million people every year (below five years old) die due to malaria, and millions are affected by intestinal worms, filariasis, schistosomiasis and other waterborne diseases (WWF, 2013). Also, many women and girls are suffering from chronic skeletal damage by fetching heavy amounts of water daily from various places which are very far from their residences (UN-Water, 2006).

Meanwhile, the population growth is estimated to rise from 7.7 billion (in 2018) to 9.4 and 10.2 billion by 2050, with the two-third population living in cities (WWF, 2013). Therefore, the demand and mandatory requirement for global water has been increasing by 1 per cent per year as a result of population growth, consumption pattern changes, economic development and other factors, and this situation will continue for another two decades, significantly creating water dearth in many regions of the globe (Kummu et al. 2016). The disasters associated with climate change experienced in Sri Lanka between 2013 and 2014. Extreme floods and drought, as well as minor earth slips, also experienced and these hazards intensely affected water, sanitation and hygiene services in the previous two decades. Though Sri Lankan government has taken many steps to overcome these critical situations and to provide suitable solutions for this environmental crisis (WHO, 2015). Against this backdrop, this study aimed to examine the existing water resource and issues of water shortage, and the possible steps and challenges of sustainable water resource management practice in Sri Lanka.

The key intentions of this study are; *(1)* to expound on the availability of water resources in Sri Lanka, *(2)* to address the nature of water scarcity that is experienced in Sri Lanka, and *(3)* to understand the existing water resource management practices toward sustainable nature in Sri Lanka.

2. Materials and Methods

To reach the above three objectives, this paper mainly employed qualitative methods and mostly used secondary sources. Mainly, this study reviewed research articles, reports, and web sources to gather information and presented all discussions and arguments in a descriptive manner. As it is purely an exploratory reviewed article, any data from fieldwork and direct observation have not employed in this study. However, the quantitative data, such as annual and seasonal rainfall and capacity of dams, rivers, and river basins, were numerically presented in the article using data from previously conducted studies and reports. The argument of scholars and experts, quantitative data, charts, and figures were used in this study to interpret and validate the discussions broadly.

3. Sri Lanka: Climate and Rainfall

Three climate zones are classified in Sri Lanka based on annual rainfall obtained in every zone. Climate zones are specified as; a *dry zone*, *intermediate (transitional) zone* and a *wet zone*. The seasonal and spatial differences in rainfall experienced by the country are due to the impact of extreme weather conditions and climate changes. Annual rainfall differs from 900 mm (in the dry zones of southeastern and northwestern) to above 5000 mm (in wet zones of western slants of the central highland). The annual rainfall and monsoons in climate zones are given in Fig. 1. and 2, respectively.

Sri Lanka receives its annual rainfall throughout the below four different seasons, influenced by the two monsoons;: first inter-monsoon (March to April), southwest monsoon (May to September), second inter-monsoon (October to November) and northeast monsoon season (December to February). According to the rainfall and climate factors, two major cropping seasons are practised in Sri Lanka: ‘ *Maha’* (Major) and *‘Yala’* (Minor). The Maha season falls from October to March, and Yala from April to September accordingly. Due to climate change, most farmers cultivate rice in the rural sectors during both the Maha and Yala seasons to avoid environmental challenges.

Sri Lanka receives around 130 billion cubic meters of water, with 40 per cent of runs-off annually from these monsoons. Out of 40 per cent, nearly 35 per cent of water used for irrigation as well as generating hydropower, and the balance, which is overwhelming most of the run-off water, escapes to the sea. Hence, around 26 billion cubic meters of water is wasted (Ediriweera, 2020; Chandrasekara et al. 2021). The overall tendency of rainfall and spatial variations are given district-wise in the following Fig. 3.

The rainfall tendency and its spatial variability in Sri Lanka from 1989 to 2019 has been observed as an indicator for environmental transitions, climate change and its impacts etc. Besides, Aheeyar (2015) estimates that the average rainfall per year is around 1,860 mm, renewable water source yearly is 45 km^3, and per capita water availability is 2,150m^3, it is likely to be reduced to 1,950 m^3 per annum in 2030. Agriculture withdrawal is 85 per cent of the total water shortage, which is the foremost development restraint in the dry zone, almost two-thirds of the country. To meet this water demand, supply augmentation needs to be set, but there are some challenges or limitations to executing demand management. At the same time, the climate has already changed in the South Asian region. The total amounts of rainy days have been declined, the rainfall has not reduced, and thus, floods, landslides, drought and other environmental hazards occurred frequently. Meanwhile, rainfall inconsistency has been augmented annually throughout the country, particularly in the regions which belong to dry zones.

Further, regulations, policy formation and legislation want to report or present the impact of environmental hazards, including climate change. Because there is an absence of policy strategy, poor awareness among many sectors,

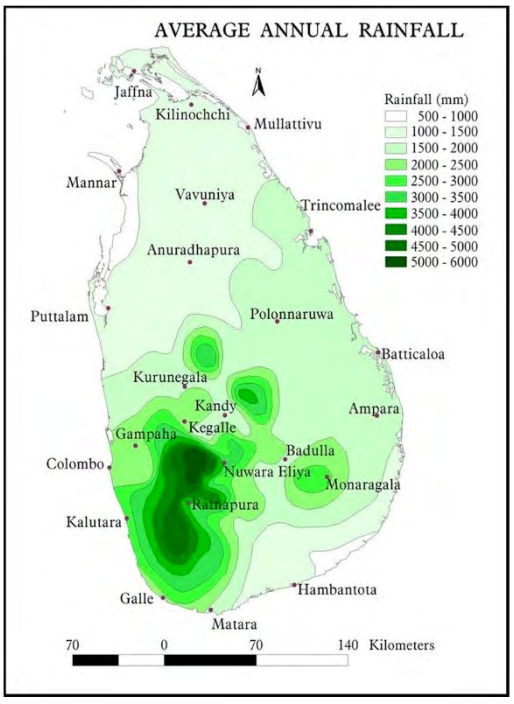

Fig. 1. Annual Rainfall in Sri Lanka

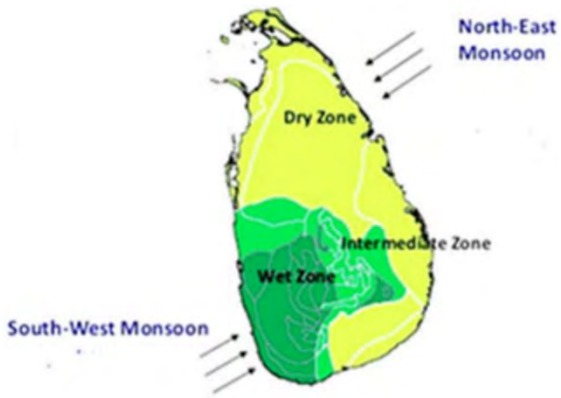

Fig. 2. Monsoons of Sri Lanka

Source: (Fig. 1 & 2.) - *Sri Lanka Climate Profile, 2017 & Ediriweera, 2020*

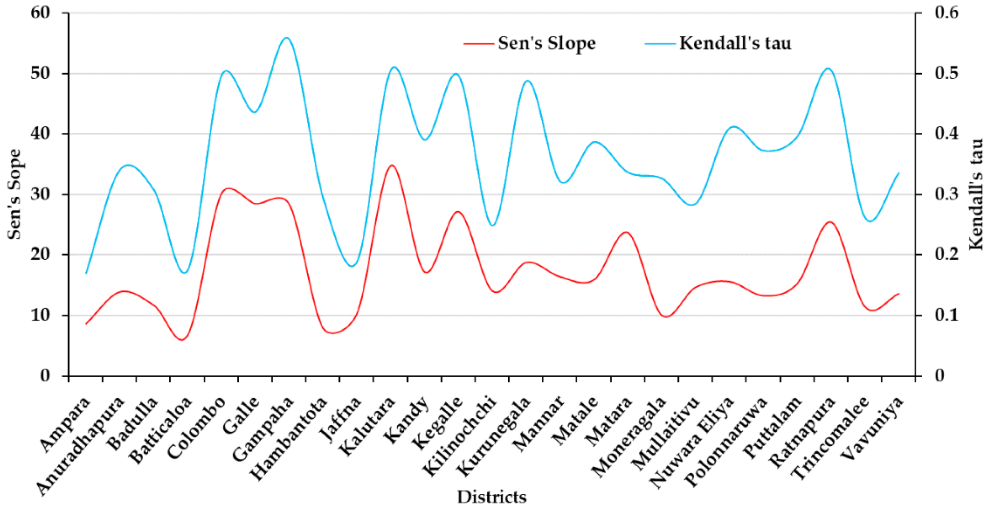

Fig. 2. District-wise variation of rainfall during 1989-2019 in Sri Lanka
Source: *Alahacoon & Edirisinghe (2021).*

and priority for other development initiatives have led to climate risk that needs to be considered and adaptive capacity should have adhered to government policies and legislation. Participatory mechanisms and accountability in water governance are major tools for sustainable water management (Aheeyar, 2015).

Conversely, Ediriweera (2020) argues that 50 per cent of the population living in rural sectors is mostly involved in farming or engaged in employment in farming. Thus, the livelihood of the majority of rural people has more sensitivity to these climate differences. On the basis of this current agricultural and irrigation setting, many districts in dry areas will face serious water scarcity seasonally or annually. Though, many health problems are faced by women and children due to this seasonal climate change. This situation also distresses their livelihood, including food security and better health conditions. In rural sectors, the demand for water has increased due to the higher demand required in irrigation systems of the dry zones.

4. Water Resources in Sri Lanka

Sri Lanka is an island that has a plentiful quantity of water resources which is an ample asset, too (Samad, 2005). The country is consecrated with 103 rivers (total length of 4,560 km) and river basins which cover 90 per cent of Sri Lanka (ADB, 2014; UNEP, 2005; Ministry of Forestry & Environment, 1999). Twenty river basins are perennial and the other rivers are seasonal in nature (UNESCO, 2006). Mahaweli is the lengthiest river in Sri Lanka, and its basin covers nearly one-sixth of the country (Silva, 1985). Besides, there are no large-scale natural reservoirs in Sri Lanka; however, approximately 14,000 ancient human-made reservoirs are available with waterfall system in Sri Lanka, which are interconnected with many reservoirs in the irrigation network in the dry zone of the country (Bandara, 1995 as cited in Chandrasekara et al. 2021). Different sources used by Sri Lanka for drinking water, such as; piped water (49.2%), unprotected well (4.4%), protected well (36.4%), rainwater harvesting (1%) reservoirs or rivers (5.4%), and tube well (3.2%) (Fan, 2015).

Sri Lanka is located in a rich tropical region in the Indian subcontinent of South Asia. The climate, soil type and water availability have made agriculture, especially paddy cultivation as the main economic sector in the country. Almost 25 per cent of employment and 7 per cent of gross domestic production (GDP) derive from the agriculture sector. The production of rice is a major source of agriculture. The country is also famous for its plantation segment and ample fruits and vegetables. At present, around 80 per cent of people depend on agriculture in the rural regions of the island (Ediriweera, 2020).

The country Sri Lanka is a well-known and famous island with a rich network of rivers that starts from the central highland. As mentioned above, around 103 different river basins cover 90% of the island. There are major basins with catchments in Sri Lanka, namely; Kelani Ganga (2,292km^2), Kalu Ganga (2,719km^2), Maha Oya (1,528km^2), Attanagalla Oya (736km^2), Gin Ganga (932km^2), Nilwala Ganga (971km^2), and Bentota Ganga (629km^2). The Mahaweli river has the largest basins of 10,448km^2, after leaving from the central highland, and it runs north (from Minipe to Manampitiya – 90km) and then an additional 70 km through Verugal and Mutur on the east coast (Water Action Hub, 2020).

Nevertheless, since the ancient period, groundwater has been used very broadly by the public for domestic purposes in every region of the country using shallow open wells. The bigger aquifer in Sri Lanka ranges more than 200 km in the northern coastal and northwestern parts of the country. Almost more than 15,000 tube wells are available in Sri Lanka. Basically, the groundwater in the country is quite better but fairly constant throughout the year. In some regions in Sri Lanka (northern and northwestern coastal regions), extreme amounts of nitrate and iron have been found and reported as a result of the higher usage of agrochemicals and fertilizers. Moreover, due to higher usage of groundwater consumed for agricultural and domestic purposes, salted water interruption has befallen in the coastal seashores. Internal renewable groundwater was quantified as 7.8km^3 in 1985 and estimated in 1991 as 50km^3 per annum (Water Action Hub, 2020). Population stress, social and economic development, emerging demand

for the production of food, hydropower (electric power), sufficient water, sanitation as well as hygienic facilities are forcing more burden on the groundwater resources.

The dams are major sources for cultivation, hydropower, and other purposes. Dams in Sri Lanka are mainly earthen, rock-fill or concrete. Earthen dams are the more common type, the longest one is Parakrama Samudraya dam (13.5km long with a storage capacity of 0.12km^3), and the highest one is Senanayake Samudraya dam (44m height with a storage capacity of 0.95km^3), and Victoria dam (106m height with a storage capacity of 0.73km^3). The gross hydropower in Sri Lanka is valued at 8,000 GWh per year. Almost 16 hydropower plants were established with an installation capability of 1,103 MW, and the hydropower covered 81% of the power and energy generation in Sri Lanka (Water Action Hub, 2020).

Water Action Hub (2020) details that, in Sri Lanka, irrigation and hydropower generation from water resources has been notably improved for the last fifty years. Water resources for domestic use and industrial purposes are required in a very lower percentage, but a higher amount of water resources is required for maintaining irrigation systems and hydropower (Wijesekera, Kamaladasa, Nanayakkara et al. 2020). During the 1990s, water extraction for agriculture was valued at 9.38_ km^3, and it was estimated at 0.195_km^3 for domestic purposes and industrial activities. On the other hand, groundwater is an essential resource for domestic use and irrigation activities. Groundwater is gradually used as drinking water, particularly in rural and semi-urban areas. But, this water requirement was estimated at 10.92km^3 in 2000, and 90% was for agriculture, 7% for domestic use, and 3% for industrial purposes. In total, 53% of the people had access to clean water, and others used rivers, tanks and unprotected wells. Thus, a higher prevalence of waterborne illness occurred due to severe water quality problems. Every year, it is estimated that 120,000 cases reported hospitalizations for diarrhea due to a lack of water quality (Water Action Hub, 2020). The government has taken more steps to provide clean and affordable water to both rural and urban sectors where groundwater is polluted. The government invests around 45 million US dollars every year to provide piped water to the people.

It is very significant to understand the current standard of water resource management in Sri Lanka. The NWSDB provides drinking water in Sri Lanka on two levels. One is the urban water supply which covers 31.5 per cent, while the other rural (community water) supply system using available natural sources like streams and wells covered 18 per cent of the total population in 2010. Besides, the Ceylon Electricity Board (CEB) generates hydropower for the country, and therefore, it influences water resource management practices in Sri Lanka. Likewise, Gunewardena (2013) presents the water demand, which was estimated in 2010. It is shown in the table 1.

Further, Gunawardena (2013) illustrated that the water liability for paddy and other field crops per season is considered as 1.5 m and 1 m, respectively, based on present land use. The per capita consumption of drinking water is considered as 200 l/p/d and expected to cover the entire population and hence slightly overestimated. Conversely, it is found that Sri Lanka has many decades of hydraulic civilization. Because the rulers contributed to developing and upgrading the reservoirs and agriculture-based dams, and other infrastructure facilities. The existing institutional system has been ruled and regulated with rights, taxes etc. the local community were responsible for managing the water operations in the past decades (Palitha & Bandara, 1999). Thus, new mechanisms need to be developed to ensure sustainable water resource management in the rural as well as urban sectors in Sri Lanka.

5. Water Scarcity: Experience of Struggle

Improved and cleaned water is the most wanted and basic requirement for all the primary features of life. Water is considered extensively as the most necessary among the natural resources; hence every living being depends on water for survival. Thus, scarcity of water is the primary issue which automatically leads to conflicts among numerous water users around the globe, and the agricultural-based countries are experiencing its severest very badly. Water scarcity has been observed in Sri Lanka in the last two to three decades (Chandrasekara et al. 2021).

Water scarcity is defined in many ways. Generally, water scarcity is indicated as an unsatisfactory nature of having water for people, and it impacts everyday life and economic condition and reflects the demand for water in all sectors, including environmental aspects (ADB, 2007). Water scarcity has a close association with the level of water demand and water supply (Gasteyer, 2009). The concept 'water scarcity' denotes a socially constructed ideology that is interlinked with people's behaviour, wealth, and expectation and the significance of the water supply system or pattern (UN-Water, 2006). Water scarcity has its root of water shortage in developing countries severely affected by the huge climate change and drought coupled with population growth and economic development (World Bank, 2021; Berrittella, Hoekstra, Rehdanz, et al. 2007).

Berritella et al. (2007) define that water scarcity has its own symptoms, such as groundwater level reduction, environmental degradation, and challenges in water

Table 1. Water Demand - Estimated by Gunawardena (2013)

Segments	Water Demand (MCM)	Percentage (%)
Paddy (irrigated)	19,334	86.87
Other Field Crops (irrigated)	1,432	6.43
Industrial Sector	15	0.07
Livestock Sector	15	0.07
Drinking and Sanitation	1,460	6.56
Total	**22,256**	**100.00**

Source: *Gunawardena, 2013*

distribution. Due to this critical climate change, sudden decrease in groundwater levels, and environmental hazards, water shortage has become a more controversial issue worldwide. It is reported that 1.2 billion people (globally, one-fifth of the population) are experiencing physical water shortage, and 500 million people are awaiting the same condition in future. Further, 1.6 billion people (global one-quarter of the population) face economic water scarcity in countries where there is a lack of infrastructure and technical facilities to look into this water shortage problem (WWF, 2013; WWAP, 2012).

Water scarcity was discussed in various interests among scientists between 2000 and 2010, and it has been widely debated in many disciplines due to rapid climate change and extreme levels of environmental threats. The term 'water scarcity' coupled with different concepts like water poverty, water stress, water and vulnerability, water shortage, water contamination, water conservation, water protection, environmental security and more often with sustainability and sustainable development challenges (Wickramasinghe, 2018; Chandrasekara et al. 2021).

The term water scarcity designates long-term water imbalances or poor status of water availability when water demand is high (WWAP, 2012). Water scarcity affected agricultural sectors like livestock, crops, farming, forestry and so on (Asian Institute of Technology, 2009). The Middle East has been identified as one of the affected regions in the world due to climate change, increased drought and a higher range of warming (Allan, 2001). Many countries in the Middle East have been seriously affected due to water shortages (Gichki, 2002). Freshwater availability has been reduced by 75 per cent and is likely to be expected by 50 per cent in 2030 (UNICEF, 2009). This situation has been extremely felt in many agricultural sectors and other segments of the world.

Water scarcity creates many challenges for food security, health, sanitation, nutrition and the natural ecosystem (UN-Water, 2006). Around 1.4 billion people live in countries where severe water shortage is experienced and it will be more serious and dangerous in the next century (WWF, 2013). Globally, climate change continuously occurs every day and distracts nature and human life; thus, water resources are also gradually decreasing in quality and quantity (Sharma & Bharat, 2009). Today, billions of people have poor access to sufficient drinking water (UNESCO, 2009) and more than 40 per cent of the global population lives in countries where people are affected by water stress (Arnel, 2004). The World Health Organization (WHO, 2014, as cited in WWF (2013), reported that over 750 million people live without sufficient drinkable water, and nearly 2.5 billion people do not have proper facilities for better sanitation services.

Some scholars argue that more than one billion people will face severe water scarcity in 2025 (Bhattacharya and Bijon, 2013). These nations don't have adequate water sources to produce food, maintain agriculture and irrigation systems, and meet the requirements of water for household use, industrial needs and environmental protection (Korc & Ford, 2013). With this prevailing situation and predictions, it is evident that water scarcity has become a more critical issue that confronts the survival of people and the earth. The Disaster management center estimated that 337,000 people are facing a water crisis in two districts (out of twenty-five administrative districts) in Sri Lanka due to the dry incantation and the invasion of ocean water into the surface water. This problem typically affected Ratnapura, Kalutara and Kegalle districts. Therefore, local government authorities are taking steps to overcome this issue by tampering and fixing water tanks and water purification plants in inflated regions (Disaster Management Centre, 2020).

Further, Water Action Hub (2020) indicates that the land degradation in the coastal regions and mining activities increased pollution, soil erosion, deforestation, wildlife population exposed by poaching and urbanization, pollution of freshwater, sewage runoff, industrial waste and waste disposal and air pollution have been observed as environmental hazards particularly in the metropolitan city Colombo in Sri Lanka. On the other hand, water source losses to the sea without any usage from river basins; it is also another factor that influences water shortage in the country, even though more resources are available. Dharmasena (2019) exemplifies how water source losses to sea and indicates how water shortage occurred in Sri Lanka, based on major river basins. The details of the water source losses are shown in table 2.

Moreover, water scarcity has increased due to poor maintenance of the existing (especially rural) water system and more and more drought; this case is seriously observed in Anuradhapura district, the largest district in the North-Central Province. Jayawardena (2019) explores that the existing cultivation system in the district is also having a lack of water availability for more than two years, which results in many social and economic problems among

Table 2. River Basins – Water Losses to Sea

Name of River Basins	River Basin Area (km^2)	River Length (km)	Rainfall (million m^3)	Drainage to Sea (million m^3)	%
Deduru Oya	2,616	142	4,794	1,608	34.0
Kala Oya	2,772	148	4,424	587	13.0
Malwathu Oya	3,246	164	4,592	568	12.0
Yan Oya	1,520	142	2,269	300	19.0
Kelani Ganga	2,278	145	8,692	5,474	62.0
Gin Ganga	922	113	3,039	1,903	62.0
Kalu Ganga	2,688	129	10,122	7,862	77.0
Walawa Ganga	2,442	138	9,843	2,165	22.0
Mahaweli Ganga	10,327	335	26,804	11,016	41.0
Meeoya	1,516	109	2,176	338	16

Source: *Dharmasena, 2019*

rural communities. To manage this critical situation, the government of Sri Lanka has introduced various projects for establishing sufficient infrastructure facilities. The government implemented the construction of a larger drinking water supply project, ' rainwater harvesting', a large-scale project that cost over 11 million dollars. This system is planned to be functional by 2021. This new project is named as *'Gammedda'*, which is a door-to-door scheme designed by the government to find out social, financial and environmental challenges across Sri Lanka (Jayawardena, 2019).

Perera (2016) was undertaken a study on water shortage in Mahesanpura village, located in Hambantota district of Southern Sri Lanka, and stated that the water shortage problem not only in Hambantota but also in nine other districts of Sri Lanka, including Northern and southern, Southeastern, Uva and Northeastern provinces which have been experienced by severe drought and other extreme weather conditions. The National Disaster Management Centre of Sri Lanka reported that more than 875,000 people were being provided water from government tankers to manage the situation of drought. More than 160,000 people still depend on water from outdoors, particularly in the Polonnaruwa district in the North-central province (Perera, 2016). As weather conditions become so serious in Sri Lanka, the government finds a suitable way for the capacitance of the water system to manage both drought and flood, which are highly influential on the scarcity of clean water.

6. Sustainable Water Resource Management

UNDP (2006) stated that providing pure and adequate water for all is considered as one of the more crucial components of Sustainable Development Goals (SDGs). Many countries are experiencing low water availability, especially in African, Asian and Middle Eastern nations (Allan, 2001). Also, it is clear that most people are living in unsustainable conditions in consuming clean water, and that has two aspects; one is there has been an increase in the climate disaster, and another one is the pollution of water sources which supply the most expensive manner (Irshad et al., 2007). In Sri Lanka, Water resource management and its sustainable nature have been identified as important factors for social and economic improvements, and the users also face several struggles and seasonal variations. Sustainability of the water resource allocation is the only suitable mechanism for the present and future for protecting water-based resources. However, sustainable development in water resource management in Sri Lanka has become challenging due to population growth, climate change, increasing demand for water consumption and burdens on economic growth (Senevirathne, 2015). All these factors lead to increase water demand, competition and water contamination.

Sri Lanka has water resources (in quantity), but the availability of water has become a more crucial aspect owing to environmental problems and climate changes in terms of seasonal variation and demand for water use among all sectors. However, Sri Lanka has 103 rivers and 20 river basins (UNESCO, 2006) that have more than 1000 sq. km, and the per capita water supply per annum states as 2.4 thousand cubic meters, which is the fourth lowest among the Asian and Pacific countries. The existing pipe-borne domestic water supply shows 42 per cent of the entire population based on 320 water supply schemes (Senevirathne, 2015) and around 4717 piped water systems (Statistical Guidebook, 2017) operated by NWSDB and CBOs, particularly in the rural sectors. Further, community participation (bottom-to-up participatory approach) has been adopted for upgrading water facilities in Sri Lanka with the monetary support of the World Bank, Asian Development Bank and Japanese-funded projects.

Water plays a crucial role in securing lives and helping an ecological system for an extensive range of flora and fauna. The water helps us for better well-being and leisure activities. Therefore, it is essential to set up an appropriate water management approach that must be interlinked with the sustainability policy of water resource management (Senevirathne, 2015). In Sri Lanka, well-planned projects ought to be financed to overcome the effects on water quality and quantity. Also, there are some new programs that insist on adopting sustainable practices to mitigate the negative impacts. On the other side, the growth of the population is continuing, and it is likely to be a common and serious problem. So, a required amount of water should be provided for human welfare and to ensure a sustainable ecosystem and the protection of water resources.

Senevirathne (2015) further discusses that the livelihood condition may be affected by the lack of quality water and unstable water provisions. Thus sustainable approaches are interconnected with an environmentally approachable system that can promote natural water resources and water demand management and establish a larger effective process to meet existing water demand based on water availability. Because available water is a key phenomenon, particularly in the dry zones of Sri Lanka. Also, sustainable water management strategies should be educated among the public in order to understand water shortage and limited natural resources. To promote sustainable water management, it is very important to undertake relevant research on problems and challenges associated with water management (including water quality and quantity management). Alike, many applications, policy implications and methods should be examined related to water management practices. It will provide effective outcomes for human society, livelihood and the natural environment in the country.

Ediriweera (2020) details that these problems of future demand for water and food are mainly faced by the districts, namely; Trincomalee, Polonnaruwa, Puttalam, Mannar, Kurunegala, Vuvuniya and Anuradhapura. There should be a sustainable solution to overcome this issue to ensure the availability of required water throughout the highly vulnerable areas. Therefore, with technical support from UNDP, the Ministry of Mahaweli Development and Environment has executed a seven-year project named 'Climate Resilient Integrated Water Management Project'

(CRIWMP) to emphasize the challenges connected to water availability and agricultural productivity in the dry zones. Besides, as a responsible national institution, the National Water Supply and Drainage Board (NWSDB) plays a significant role in advising the projects on drinking water and groundwater management amongst the selected rural segments and helps the project to perform effectively for providing safe and reliable water supply services to the beneficiaries (Ediriweera, 2020).

Bakker (2003) explains that stakeholders are responsible for ensuring legal provisions to manage water resources, and the decision-makers have accountability to manage and develop water resources and provide effective water supply facilities equally (Bakker, 2003). In 1992, the Dublin conference identified the higher demand for water use to exaggerate water inadequacy and recognized the Integrated Water Resource Management (IWRM) concept. As a result, most of the donor agencies are keen on approving funds and introducing new technologies in the development project for developing nations by amending the concept of water governance policy to meet the SDGs as well.

To handle this issue, Senevirathne (2015) suggests some strategies to ensure sustainable water management system; such as, Water resource management can be done; by gathering and storing water in an adequate amount to meet the demand throughout the year; by treating used water for reuse; by introducing and managing main policies and approaches on sustainability; by carrying out researches to address the facts on water demand and find mitigation measure to resolve the problems of water consumption; by receiving institutional support for undertaking researches and experiments; and by setting a framework to ensure ecologically sustainable water resource management plan for a long period. By considering these facts, the researchers have undertaken this study to address the issues related to the water source, its availability, and water scarcity that create a huge deadlock for social, economic and environmental development in Sri Lanka.

7. Conclusion

Water covers two-thirds of the earth's surface, so it is clear that water is essential and a key element for the earth's existence (UNESCO, 2003). It is not only for the survival of the lives but also for developing socio-economic activities (UN, 2006). Water is a valuable gift and natural asset used for many years for human development in every place in the world. The water resource has become contaminated and, as a result, water scarcity is experienced in many countries in this century, especially in developing and underdeveloped regions. Approximately 2 billion people live in countries where water stress is experienced at higher levels; it will be more than half of the world population by 2050 if the same situation continues without taking any proper actions. The world will experience a 40% shortfall in clean water supply within ten years as climate change is already seriously worsening the global water crisis, escalating floods, drought and other climate hazards. All these climate-related issues directly affect water, and these effects will continue and worsen in the coming years and decades in severe conditions until proper action is taken to end this crisis (Water Resilience Coalition, 2020).

World water has become dangerous due to the rapid growth of population, the negative impacts of climate changes and the highest demand for water in the agricultural sectors. About 29 per cent of the global population did not have access to drinking water in 2017, and the water was not contaminated and it was available in close proximity, while only 11 percent of the world population lacked accessibility to receive safe water in the rural sectors. This situation is currently experienced in Sri Lanka with various struggles. Currently, only 57.7 per cent of the global population has access to get water from a piped network system, while the remaining population fetches water from other ways such as; rainwater harvesting, protected dug wells, and the nearest public water point, thus access to clean water remains to be a risk and challengeable issue. The dry zone in Sri Lanka is facing extreme effects like the worst drought due to climate change, the 2016 drought continuing for nearly five years. To overcome this issue, the Integrated Water Resource Management (IWRM) strategies followed by the government, and also the United Nations Development Program (UNDP) associated with the Sri Lanka government, funded by the Green Climate Fund (GCF) to implement new projects throughout the country (Ediriweera, 2020) in order to diminish the issue related to the water crisis for a long period with sustainable manner.

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