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Water Scarcity in Urban Water Supply System: A Case of Thirukkovil, Sri Lanka

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Abstract

The water scarcity becoming challengeable phenomenon for water security of people across global. Environmental changes, growth of population, socio-economic development have led to escalate the higher water scarcity crosswise the countries. People athwart Sri Lanka are facing critical drought conditions and water scarcity disputes, in particular, people living in Thirukkovil region faces huge difficulties in getting safe drinking water especially during drought season. This study sets out to identify the influencing factors headed for water scarcity and to propose alternative strategies to minimize this issues faced by Urban Water Supply System (UWSS) in the study area. The primary data collection tools; field visit observation and Key Informant Interviews (KII) by using unstructured open ended questions were conducted. And secondary statistical data including time series data from respective departments also were administered. The study established that many challenges faced by UWS scheme in producing and supplying drinking water services, due to the extreme scarcity of water sources in Thrukkovil. It found that there is a great demand for drinking water as the population has been increased and water requirement has also been measured in a huge quantities. It is observed that the climate changes and draught season influenced as key factors of unavailability of raw water in the Sagamam reservoir, which is the basic water source in the study region. However, the alternative arrangement need to be taken and implemented by the government and other donor agencies, which could be the permanent solution to provide uninterrupted, pressurized and safe drinking water to meet the requirement of people in Thirukkovil UWS scheme significantly. Thus, this study suggested the Catastrophe theory to assess water security and adaptation strategy in the context of environmental changes including hefty draught in the study area. Preparing coping strategies with existing global and national challenges would substantially contribute to reduce the vulnerabilities of many urban sectors across the nations.

Keywords: Water scarcity, water sources, water reservoir, climate change, draught

1. Introduction

The water sources and its availabilities are becoming dwindled all over the world, especially in developing countries. It has taken into account as an essential requirement for organize or implement projects to utilize water resource efficiently for ensuring sustainable development. In Sri Lanka 10% of people who depend on unprotected water sources, use well, tube well, steam and rivers etc., as their main water source. Although the country identified as self-sufficient in its water requirement, 47% face scarcity of water (Gunatilaka, A., 2008). Increasing salinity in water contains close to the coast, contamination of raw water source due to inappropriate disposal of waste and extreme abstraction of ground water are some of the threats for water

security in Sri Lanka (Hettiarachchi, C. 2011. As cited by Ahmed D.N. et.al. 2018). Water scarcity has also been identified as a serious concern in urban areas particularly in Sri Lanka, as it is one of the leading urbanization country. Due to the urbanization, many problems and challenges experiencing by the human in various ways.

The drinking water is a basic requirement in everywhere, especially in the urban sector. The main target of water supply system is to distribute an uninterrupted services of safe drinking water with sufficient and pressurized capacity and adequate value to all consumers (Dissanayake, D.M.S.S., et.al. 2017). The fast growth rate of population density in the study area, expanded number of connections, increased demand, etc., in combination with several other restraining causes could lead to many challenges of inadequate supply and low pressure. Piped water coverage supplied to 51.9% (coverage by the NWSDB 37.9% and coverage by the rural piped-borne scheme 14%) of the population in Sri Lanka at present, which is over 10.5 million people in the island (Statistical Guide Book, NWSDB, 2017). However, inequalities in service coverage throughout the region are still conspicuous, although the huge financial capacity invested (over rupees 30,000.00 million per year) in the water sector in Sri Lanka, in the recent past.

According to the census report - 2012, the total population is 20.30 million in Sri Lanka (Census & Statistic Department, 2012). Out of it, 18.3% of population are living in urban sector, which totals 3.7 million. Presently, it amounts 43.7% of pipe-borne water supply provided in the urban sector, and apart from that 36% of piped scheme has managed by the National Water Supply and Drainages Board (NWSDB) to provide uninterrupted 24 hours water supply, while majority of the other schemes have a 12 hours continuous water supply on average basis (Urban Water Supply Policy, NWSDB). Meantime, every year 100,000 new consumers are added to the NWSDB database and request for pipe-borne water is being increased (Dissanayake, D.M.S.S., et.al. 2017). Therefore, the water source and sustainability of the projects are very vital factors which demands due attention in the planning and designing of urban water schemes.

In Sri Lanka, there are two major types of drinking water supply systems have been implemented by the government namely; Rural Water Supply (RWS) and Urban Water Supply (UWS) systems which provide safe drinking water service to the public, in collaboration with government, donor agencies and international organizations. The NWSDB is an authorized body which has established UWS system as sustainable and permanent solution to provide safe drinking water in Sri Lanka. According to the policy of UWS, the minimum number of household required not less than 2500 in an area where the NWSDB can establish UWS to extend the service. The Thirukkovil area is also having the capacity for implementing UWS scheme. Figure 01 shows the map of the study area.

Figure 01: The Map of Study Area (ArcGIS 10.5)

Thirukkovil is one of the Divisional Secretariat Divisions (DSDs), which located in Ampara district, the Eastern coastal part of Sri Lanka. It comes under the Akkaraipattu regional water supply entity. Supplying sufficient quantity of safe drinking water supply has been the need of the hour in the study area, however the Thirukkovil UWS scheme has unable to supply the required quantity of water to the people due to the water scarcity prevailing in the water sources. Thus, there is an excessive need to identify the nature and root causes of water scarcity and bringing out potential solutions for mitigating the issue of scarcity by suggesting measures for enough water productivity and supply. The Sagamam reservoir is the main water source for operating Thirukkovil UWS scheme. This reservoir is used by both NWSDB and Department of Irrigation (DI)

for drinking and agriculture purposes accordingly. Much quantity of water used for Agriculture since this reservoir is mainly owed by the Irrigation body. It has studied that quantity of water extracted from this reservoir, especially during the draught season, which is not enough to meet the daily water requirement of the people in this area.

Meantime, Thirukovil Predeshiya Shaba delivers the 'Bowser Supply' to relax this water scarcity issues, especially during the drought season in Thirukkovil area. But this Bowser supply also not sufficient to fulfil the water requirement. So, it has studied that there is no enough water quantity in the reservoir, particularly during the draught season. The scarcity lead for creating many difficulties in getting water from proper sources, which is located far away from their settlements, thus, much time is spent on going to this place for fetching water. This issue of water scarcity has been aggravated in the study area, because the wells and dug-wells have already been contaminated. The water scarcity is the key issue in UWS system of this study area. Thus, this study tries to identify the nature and root causes for water scarcity, and aimed at understanding various challenges being faced by Thirukkovil urban water supply scheme, Sri Lanka.

2. Water scarcity: A conceptual frame

Water scarcity can be defined as the non-availability of a required amount of water of useable quality at the required time and location, for human and environmental use (Somaratne, P.G., 2007). Water scarcity is an actual problem in Sri Lanka's case as well, and there is an excessive need to develop coping strategies. In fact, more importantly, it is necessary to build strategies around the softer element of governance, our institutions, how we would manage intersectional power plays, how we would manage scarcities arising from inequities and poverty (Abayawardana, S., 2007). Water scarcity prevails due to populations increase and economic growth and standards of living improve, this is immediately reflected in the per capita use of water. Humans need a staggering amount of water to feed and clothe them in a lifetime (Gunatilaka, A., 2007. as cited by Ahmed D.N. et.al. 2018). The scarcity of water has identified in different dimensions, perhaps the environmental arrangement need to be constructed by the government in order to mitigate this issue in the Thirukkovil UWS region, with the participation of local communities and other relevant stakeholders.

3. Objective

This study sets the overall objective as to understand the nature of water scarcity and to identify the factors influencing headed for water scarcity in the urban water supply system in Thirukkovil WS scheme and the specific objective is to find out an alternative strategies to minimize the existing water scarcity issues in the urban water supply system in the study community.

4. Materials and methods

Thirukkovil UWS scheme supplies safe drinking water to 20 Grama Niladhari Divisions (GNDs), out of 22 GNDs with 2,357 households (HH) water connections. Out of that 2,251 are indicated as individual (domestic) connections while 18 are quantified as industrial (commercial) connection, and 88 are other connections accordingly. Population in this scheme is estimated 31,064 (Census & Statistics Department, 2012). The individual connections are growing rapidly at a rate and demand for drinking water is increasing. Assessment of water supply service and connected coverage data were collected from 2018 to 2019 in order to indicate the consumer assessment. The details of treatment plant / sump / tower, transmission and distribution mains of pumping / gravity transmission were collected. The data of new connections and details of coverage villages and actual connection data from 2010 to 2017 were also collected. Further, action plan 2019 of UWS scheme, Thirukkovil, and details of tank, channels and reservoir, and layout plan, detail of affected areas during the draught season, and breakdown of water supply data from 2013 to 2017 were also collected to present the analysis of finding.

In addition to this, the data have been gathered from Field Observation (FO) and Key Informant Interview (KII) which was held with selected individuals who have sufficient knowledge about the study area and drinking water system, and who could provide an impartial opinion through their capability and expertise. Such personals include Regional Sociologist from NWSDB, Regional Manager (RM), Engineer from operation and maintenance division of water board, Officer In-Charge (OIC) UWS, Thirukkovil, CBOs members in the area were involved in the data collection methods. The semi structured open ended interview were used to elucidate the information on the nature of water scarcity, from the view point of informants. Subsequently, the secondary data were administered and analyzed using descriptive method and presented through percentage, frequencies and cross tabulation. The data gathered from KII were used to extend and validate results qualitatively.

5. Results and discussion

In order to deliver the results of this study, it is necessary to analyze the requirement of water supply and details of the coverage of drinking water supply executed under the Thirukkovil UWS scheme, which will realize the fact of water shortage prevailing in the study area. Drinking water service coverage has detailed in the following Table 1.

Table 1. Urban Water Supply Coverage in Thirukkovil Area

S/N	GN Division	Population in GND	Household	Water Connection Coverage	
				Numbers	Percentage
1.	Thampaddai 01	706	233	42	18.0%
2.	Thampaddai 02	403	131	65	49.6%
3.	Thambiluvil -01E	1,987	645	140	21.7%
4.	Thambiluvil -01W	1,769	539	125	23.1%
5.	Thambiluvil -01S	1,585	435	60	13.7%
6.	Thambiluvil -02E	1,379	442	135	30.5%
7.	Thambiluvil -02W	1,334	429	42	9.7%
8.	Thambiluvil -02N	1,375	415	132	31.8%
9.	Thirkkovil 01	1,380	456	57	12.5%
10.	Thirkkovil 02	1,336	422	106	25.1%
11.	Thirkkovil 03	1,622	537	75	13.9%
12.	Thirkkovil 04	4,348	1,088	287	26.3%
13.	Vinayakapuram 01	1,185	366	62	16.9%
14.	Vinayakapuram 02	1,596	498	79	15.8%
15.	Vinayakapuram 03	2,389	770	63	8.1%
16.	Vinayakapuram 04	2,107	604	107	17.7%
17.	Sagamam	822	269	208	77.3%
18.	Kanchirankudah	617	163	33	20.2%
19.	Thandiyady	628	173	158	91.3%
20.	Sangamankiramam	1,126	285	275	96.4%
21.	Kanchikudiyaru	568	218	Uncovered	Uncovered
22.	Thangavelauthapuram	802	314	Uncovered	Uncovered
	Total	**31,064**	**9,432**	**2,251**	**23.86%**

Source: Connection Coverage Report, Thirukkovil WSS, May 2019.

The total GND divisions are 22 in Thirukkovil DSD, out of it 2 GNDs namely; Kanchikudiyaru and Thangavelauthapuram have identified as water uncovered divisions in the study region. Pathetically those areas do not have any piped water coverage system though these GNDs belong to Thirukkovil UWS scheme. The other 20 GNDs having the amount of 8,900 households, out of it, only 2,251 households have been provided with piped water coverage under NWSDB service. Overall, it stated that only 23.86% households having the water supply service. Remarkably 7,181 households have not been provided pipe-borne water connections in the study area, which shows 76.14% in Thirukkovil UWS scheme, even though NWSDB has been equipped with technical and human resources, the large number of households have not been received water connections due the serious water scarcity. According to the above table, out of 22 GNDs, only two GNDs have water connection below 10%, while the other seven GNDs have water connection between 10-20% comparatively. Though, there are eight GNDs have been covered with piped water in the range between 20-50%. But, only three GNDs namely; Sagamam (77.3%), Thandiyady (91.3%) and Sangamankiramam (96.4%) have recorded higher average of water connections, however, 17 numbers of the GNDs have recorded the water connection in between the range of 0-50% in Thirukkovil WS scheme.

However, the aforesaid beneficiaries also receive limited water supply with time restriction due to the inadequate water sources. And it found that scarcity of water became as serious public concern, and it creates socio, economic, educational and livelihood problems among pubic. The demand for water connection has been increased in the study area, because they do not have alternative way to get fresh drinkable water. The UWS scheme is not in a position to provide drinking water for their requirements as it is already scuffle to provide uninterrupted water supply due to the current dearth of water sources in the area. The major root cause of Sagamam reservoir has lower quantity of raw water, especially during draught season in the recent past due to many factors that need to be addressed. The following figure 2 shows the map of reservoir.

Figure 2. Sagamam Reservoir, Thirukkovil DSD, 2019

The water consumed by the Department of Irrigation (DI) and NWSDB from Sagamam reservoir. The DI uses larger amount of water and distributed for agricultural purposes, the rest of the water is utilized by the NWSDB since they do not have proper legislative arrangement to use this raw water source. Both DI and NWSDB maintain mutual bond on water sharing of Sagamam reservoir, which led for limited supply and insufficient water quantity to provide drinking water to the consumers. It was specifically noted that the Pannalagama reservoir already had distributed water source to the agriculture sector in Thirukkovil area covering 2,500 acres of paddy land in Mondal Kandam and Senakkadu areas. Then the utilization of water source was required for Pannalagama farmers to fulfil their agricultural purposes. The agricultural farmers from Pannalgama area, who built a bund and diverted water for paddy cultivation during 2017, thus the Thirukkovil farmers have not been received sufficient over flow or drain water from it, as they received earlier. Hence, due to the blockage of drain water from Pannalagama reservoir, water supply for farmers was inevitable from Sagamam reservoir, where approximately 3,000 acres of paddy land has been cultivated with the support it. In this situation, farmers compelled to fully-depend on the Sagamam reservoir for their paddy production. So, the quantity of water is not enough to get for drinking purpose since the larger amount of water being used for paddy cultivation in Thirukkovil area. However, water source from Sagamam utilizes for both drinking and agriculture purposes, which made a great challenges in the UWS system in the region. This situation was highly affected drinking water supply system transversely Thirukkovil WSS scheme.

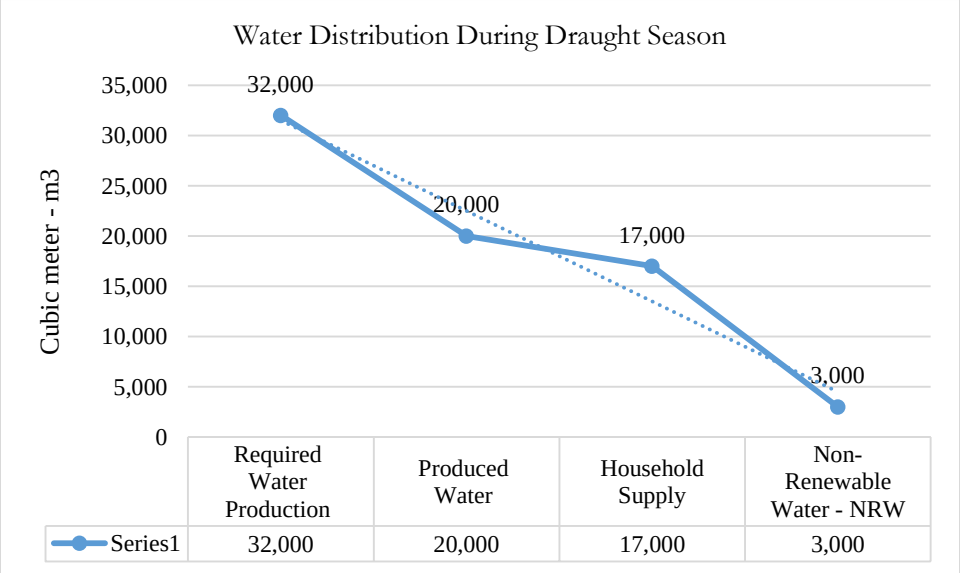
The heavy draught season also has identified after 2017, and it highly affected water sector in the study area, subsequently, the blockage of the channels of the Pannalagama reservoir were determined the shortage of raw water source. In this setting, it was studied that the priority has been given to irrigation department, rather than water authority for providing safe drinking water supply to the consumer, though it is a very basic requirement or necessity of life. The study found that a legal arrangement has to be formulated and implemented for the smooth function of both DI and NWSDB.

Figure 04. Pannalagama Reservoir

An interview had with the Regional Sociologist Ishaq, P., who pointed out that; *"It's necessary to maintain a horizontal and inter sectoral coordination among service providers on water to mitigate water scarcity dispute experiencing in Thirukkovil area. The Sagamam reservoir need to be excavated and rehabilitated to store adequate water to use in the drought condition. And the same time, a cordial coordination on the basis of legal agreement to be made and maintained between NWSDB and Irrigation Department in this area" (Interviewed on 10.09.2019).*

So, the lack of legal procedure also identified as one of the key factors inclined the UWS issues. It was studied that the quantity of 32,000 cubic meter is required for providing uninterrupted 24 hours supply in 20 GNDs in order to satisfy 2,251 consumers in Thirukkovil region, through Sagamam treatment plant. The following chart 1 elucidates the water distribution flow during the draught season.

Chart 1: Water Distribution in Thirukkovil WSS during Draught Season



Source: Thirukkovil Water Supply Scheme, 2019.

During the draught season especially from May to November every year, the Thirukkovil WS scheme produced 20,000 cubic meter from raw water, out of that 17,000 cubic meter are being used for household supply, while 3,000 cubic meter became non-renewable water (NRW), due to the low quantity and paucity of water in the draught condition. In this ailment, the WSS provides drinking water supply for 24 hours only in Thampattai division, 06 hours in Thambiluvil area, 03 hours in Thirukkovil GND and only 01 hour supply

providing to all the other GNDs in the study area. This limited supply occurred in the study community due to the scarcity of water, as result of heavy draught and lack of availability of raw water sources.

On the other hand, it was observed that, during the draught season it is very difficult to get water from Sagamam tank and the water also contaminated with oil and other chemical organics. In this situation, the Sagamam treatment plant was closed-down its function due to the water scarcity. And the operation cost also were high in this drought season. The followings figure 3 clearly shows the situation of Sagamam reservoir due to draught and climate changes.

Figure 3. Sagamam Reserviour during Draught Season

Although, the local government authority called; Thirukkovil 'Pradeshiya Sabha' (PS) has initiated the bowser supply daily and weekly basis in order to reassuring the stressing water issue. This effort is just a counterbalancing operation especially during the draught season, but it is not sufficient and stable measure to mitigate the water scarcity. Due to the water service interruption and limited supply, the consumers are also not satisfied with the service and, tariff payment behavior also not effective, thus the NWSDB facing lot of challenges to collect the bill arears from consumers (Interviewed with OIC, Thirukkovil WSS).

This study found that, the extreme draught and changes of climate also identified as key factors of this heavy water scarcity in the study region. Meantime, to tackle this scarcity issues, the Thirukkovil scheme utilize an alternative water source (pipe-line and pumping) from Akkaraipattu WS network through two temporary boosting pump stations, one located in 40th mile post and other one fixed in Vakirasa area, and receiving water in the capacity of 15,000 cubic meter.

But it has created many interruptions for continuous water supply to Akkaraipattu WSS and, so it has technical challenge of low pressurized water supply (due to reverse flow water injection) to Thirukkovil scheme as it is located in the higher elevated landscape. According to the interview had with a key informant (Engineer, operation and maintenance), who stated that; *"Supplying water from Akkaraipattu network to Thirukovil area during the drought season creates many technical challenges such as; pressures drop, high electricity cost, since the water supplies in Reverse Flow Injection way (bottled-necked method). The pipe diameter is not technically supported. To minimize this water scarcity of this area it's necessary to relay about 12 km pipe with suitable pipe diameter to avoid the back flow injections" (Interviewed on 12.09.2019***).**

According to this statement, it can be argued that the production and distribution of safe drinking water is not an easy target, but it's a serious public concern, due to the heavy scarcity. The finance, time, ecological and technical factors have been played an important role to operate the water treatment plant especially during draught season. To mitigate the issue of water scarcity, solution mechanism has to be formulated to manage urban water supply system quality and efficient for fulfilling the requirement of consumers. The water security and water management are necessary components of the Thirukkovil WSS, which need to be considered to ensure the future demand of drinking water requirement and sustainability of this UWS scheme.

6. Conclusion and suggestion

Climate changes, particularly heavy draught season influenced as a key factor for shortage of water source in Thirukkovil UWS area. The blockage of raw water from Pannalagama has been identified as key issue of water scarcity, due to lack of legal bond between NWSDB and DI in the region. Since the paper revealed the current practical water issues which has been linked to climate change and environmental aspects. Therefore, this study recommend Catastrophe theory to assess water security and adaptation strategy in the context of environmental change. The theory built on the basis of multi criteria appraisal to manage the water security and control the scarcity issue in the drinking water supply systems. This theory has been used as a model in Yulin city of North West China to assess water security and water management (Xiao-jun, W. et.al. 2014). So, this strategy can be considered as suitable approach to measure the requirement of consumer and evaluate the quantity of water or water sources in the existing context of climate changes. So, the paper proposes the suggestions as follows;

- Legal arrangement or law enforcement need to be done by the government properly on the usage of raw water from Pannalagama reservoir. The legal definition should be defined for both government bodies namely NWSDB and DI.
- Water sources have to be reconstructed in larger extension to accumulate more water, and new strategies can be adopted to maximize the reservoirs, saving rain water and increase the availability of water source(s).
- It can be applied Catastrophe theory to ensure water security and water management effectively.
- There should be given priority to drinking water supply rather than irrigation sector, as the drinking water usage is the basic requirement and it is very necessity for life.
- So, the DI, NWSDB, Forest department and other organizations connected with water source, should build a horizontal coordination to work collaboratively in order to provide all services to the consumers in a proper or capable and positive manner.

This study is very imperative to find better result in order for enhancing the existing water supply system. It should be carried out continuously in the other regions of the country to assist to apprehend the urban water supply system and its challenges to mitigate the shortage of drinking water sources. This study will provide a platform to plan new strategies and approach to design a suitable guideline to the imminent schemes with similar problem. And it is a crucial source for future researchers to explore further facts and produce new findings in order to adopt with policy formation in connection with water scarcity of UWS system.

Note: The key findings of the paper has presented at the National Seminar on 'Smart, Sustainable and Inclusive Cities: Changing Urban Dynamics', organized by the Department of Sociology, University of Kerala, held from 16-18 October 2019, at Department of Sociology, University of Kerala.

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