

Climate Technology Centre and Network (CTCN) Technical Assistance
for the Development of an Urban Adaptation Plan for Kurunegala

Consultant Workshop Report

“Report on the Mini-workshop and Field Visit”



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The Climate Technology Centre & Network (CTCN) has provided Technical Assistance through pro-bono support from Korea Environment Institute (KEI) Korea Adaptation Center for Climate Change (KACCC) and Green Technology Center (GTC) to prepare an Adaptation Plan and to assess climate change vulnerability and risk of the Kurunegala city.

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1. Executive Summary

Kurunegala city is one of the most intensively developing economic and administrative capitals, located in the North Western Province of Sri Lanka. Urban systems in Kurunegala city are facing climate vulnerabilities and the most crucial impact is the extreme heat conditions. They experience decrease in drinking water supply due to drought and gradually diminishing urban biodiversity. The city needs a broad range of feasible climate adaptation measures in terms of integrated planning for climate change adaptation. The current measures are limited to the existing governance system and lack of appropriate urban planning considering climate change adaptation measures.

As the result of the inception workshop, it was decided to prepare an adaptation plan by setting up an urban action plan based on the assessment results due to the financial and time constraints. To tackle these challenges, the Ministry of Mahaweli Development and Environment of Democratic Socialist Republic of Sri Lanka and Municipal Council Kurunegala requested CTCN Technical Assistance (TA). The main climate change issues highlighted for Kurunegala city are heat stress and water scarcity. Therefore, these are prioritized among other climate issues with key stakeholders in Sri Lanka.

This report describes the findings from the half-day training & expert workshop and the field visits. In order to conduct the CTCN TA project, the consultant workshop focused on mini-training, stakeholder workshop, and field trip. The workshop was held with the relevant government agencies and private stakeholders. The presentations and discussions within experts have been provided in this report.

2. Background

Climate Technology Centre and Network initiated a Technical Assistance (TA) entitled “Development of an urban adaptation plan for Kurunegala” in response to a request from Municipal Council Kurunegala through the Ministry of Mahaweli Development and Environment of Democratic Socialist Republic of Sri Lanka. Republic of Korea NDE (Ministry of science and ICT) accepted and decided to support this TA as Pro bono. It was assigned to the Korea Adaptation Center for Climate Change (KACCC) in Korea Environment Institute (KEI) to work on this TA as the implementer.

The activities of this TA include: i) conducting climate change vulnerability and risk assessment for the prioritized sectors (water management and heat stress) in Kurunegala; ii) proposing an adaptation action plan at those sectors; and iii) building the capacity of city planners and policy makers to transform Kurunegala city into a climate-smart city.

3. Mini-workshop

3.1 Welcome Address

Mr. Thushara Sanjeewa Vithanage,

Hon. Mayor of Kurunegala

The Hon. Mayor, Mr. Sanjeewa welcomed the Korean Mission to Sri Lanka. He acknowledged their efforts to design an Adaptation Plan for the Kurunegala Climate Smart City. He also thanked the CTCN, Ministry of Science and ICT of the Republic of Korea, Korea Environment Institute (KEI) and Green Technology Center (GTC) for providing pro bono assistance for this project.

The Hon. Mayor stated that Kurunegala has undergone a drought and a scarcity of drinking water during the past three months. The citizens could feel the negative impacts of climate change.

He stated that this was the second visit of the Korean Mission. He hoped that they will be able to coordinate with the Kurunegala Municipal Council (KMC) and provide the assistance needed to complete the project successfully.

He hoped they would enjoy their stay in Kurunegala.

3.2 The CTCN Climate Smart City Programme

Ms. Dakshini Perera,

Assistant Director, Climate Change Secretariat, Ministry of Mahaweli Development & Environment

Ms. Dakshini Perera welcomed the Korean Mission on behalf of the National Designated Entity, the Climate Change Secretariat, Ministry of Mahaweli Development and Environment.

Sri Lanka's Greenhouse Gas emission is 0.03 CO₂e. The country is experiencing the effects of climate change. With prolonged droughts, floods and landslides, Sri Lanka has been ranked in second for the most climate-vulnerable countries in the world.

Therefore, in the face of disasters it is necessary to take adaptation measures to counteract the negative effects of climate change.

Under the United Nations Framework Convention on Climate Change, developing countries have an opportunity to obtain assistance from developed countries through technology sharing, funding, and experience sharing to prepare and implement mitigation and adaptation measures.

Kurunegala is a rapidly developing city. Therefore, it is necessary to make Kurunegala a Climate Smart City.

At the inception workshop held in January 2019, at the Stakeholder discussion, it was highlighted that water Scarcity and heat stress were two main issues that should be addressed in the Adaptation Plan for the city.

At the National level, a National Adaptation Plan (NAP) was developed. We are now in the process of developing Provincial Adaptation Plans. The Kurunegala Provincial Council has expressed their interest in establishing a 'Climate Cell' in the Province and to develop their own Provincial Adaptation Plan.

It is also possible to establish a Climate Cell in the Kurunegala Municipality to link with the Provincial Climate Cell. The development of an Adaptation Plan and Roadmap for the Climate Smart City will assist in the overall development of the Provincial Adaptation Plan for Kurunegala.

3.3 Report on Progress

Dr. Shishiroda Ratnayake,

Chief Medical Officer of Health, KMC Project Coordinator, Kurunegala Climate Smart City Programme.

Dr. Shishiroda Ratnayake reported that the inception report and literature review report were submitted. These work were underway to obtain household and business institute data for the baseline survey.

The reports and questionnaires were developed with the assistance of the Climate Change Secretariat.

3.4 CTCN TA Pro bono Support of Korea NDE and Overview of Adaptation Plan Establishment

Dr. Hanna Cho,

Research Fellow, Korea Adaptation Center for Climate Change (KACCC), Korea Environment Institute (KEI)

Dr. Cho introduced the KEI as the leading think tank on environmental policy and environmental impact assessment, which is a part of the National Research Council for Economics, Humanities and Social Sciences under the Prime Minister's Office of the Republic of Korea. The KEI was established in 1993 with the purpose of preventing and solving environmental problems by environmental policy research as well as a professional and fair review of environmental impact assessment.

Dr. Cho thanked the Government of Sri Lanka, the Ministry of Mahaweli Development and Environment and the KMC for facilitating the Climate Smart City programme. She thanked everyone for the support all the way from the inception workshop to present. She stated that the Korean Mission consisting of adaptation and water experts would conduct a questionnaire survey to figure out the main issues and adaptation measures for the heat stress and water scarcity. Further, the team will visit relevant institutes and sites to collect the necessary data for the development of an Adaptation Plan.

She stated that the final mission will be from the 2nd to 6th September 2019. She hoped that all the data collection and analysis would be complete by that time to enable to present three

options as Adaptation Plans. Dr. Cho thanked all the stakeholders for being present and for their professional contributions.



Figure 3-1) Dr. Hanna Cho's Speak

3.5 Introduction of Potable Water Treatment Technology and Discussion on Adaptation Options for Risk Assessment

Prof. Kyoung-Woong Kim,

Chief of International Environmental Research Institute, Gwangju Institute of Science and Technology (GIST)

Prof. Kim explained that the GIST is a research-oriented university supported by the Korean Government. It ranked the 3rd in the world for the citations per faculty in World University Rankings, 2018. The Institute conducts lots of research related to water and technologies for water purification at low cost for developing countries.

He stated that the Asian region faces wide range of climate disaster issues. Most of the disasters such as cyclones, floods and droughts lead to the lack of and contamination of potable water used for communities. He also stated that the Institute addresses issues such as the arsenic

disaster in groundwater along the Mekong River and the Chronic Kidney Disease of Unknown Etiology in Sri Lanka. The spread of these diseases is promoted by climate change.



Figure 3-2) Prof. Kyoung-Woong Kim's Speak

The Gravity Driven Membrane (GDM) system is a small unit consisting of panels with micro-pores. This unit could easily be fitted into a plastic tank. It requires no electricity but only gravity to drive the water through the membrane. The membrane requires no maintenance and only simply need to be cleaned up with soap and a brush if it gets clogged. There is no recurring cost.

The equipment was demonstrated using the Kurunegala Lake water. After filtration, the turbidity level was reduced and contaminated bacteria were filtered. The Council members drank the filtrated water. Furthermore, no chemical treatment was necessary for the purification of water.

Prof. Kim further stated that they had another equipment which was a micro filter followed by a nano-filtration membrane whereby hazardous heavy metals found in artificial fertilizer such as arsenic and chemicals could be filtered from any source of contaminated water. The filtered water could be drunk directly. Prof Kim donated two GDM Units to the KMC for use at the Municipal Clinic.

3.6 Procedure on Korean Adaptation Plan

Dr. Hanna Cho,

Research Fellow, KACCC, KEI

Dr. Cho presented the procedure of the Korean Adaptation Plan. The 2nd National Climate Change Adaptation Plan was adopted in 2016-2020. The vision of the plan was to ensure a ‘Safe Society and National happiness through Climate Change Adaptation’. It consisted of 5 years short and 20 years medium-long term goals.

The 2nd Local Adaptation Plan has also been adopted in South Korea. All of 17 regional governments and 226 local governments completed the preparation of the 2nd Local Adaptation Plan. This plan contains comprehensive measures including guidelines and strategies for the changes made by climate change and adaptation sector-specific action plans.

Dr. Cho explained the procedure on the Korean Adaptation Plan and stated that it is a process to be used to formulate the Kurunegala Adaptation Plan.

She further mentioned that Risk is defined as ‘the combination of the likelihood (probability of occurrence) and the consequences of an adverse event (e.g. climate hazard)’.

The methodologies that will be used include both quantitative and qualitative approaches. It is necessary to communicate with the stakeholders. Then, it is necessary to identify the risks, analyse the risks, evaluate the risks and thereafter treat the risks (short term and long term).

At the inception workshop and stakeholder meeting, the urgent and crucial need for adaptation measures was highlighted to address the issues of water scarcity and heat stress. The respective risks for both issues were identified. In this workshop, the risk would be analysed by the questionnaires filled in by the water and heat experts. Further, a gender analysis would also be conducted. The next steps would be to evaluate the risk and thereafter treat the risk.

Table 3-1) Procedure on Korean Adaptation Plan

Stage	Step	Details
Stage A		
Preparation	<i>Step 1</i> Preparation of the adaptation plan	1) Building awareness of climate change adaptation 2) Organizing a task force (TF) team for the adaptation plan
Stage B		
Planning	<i>Step 2</i> Identifying climate change risks	1) Understanding of the general local characteristics (e.g. city) 2) Current status and future outlook of climate change 3) Climate change impact and vulnerability/risk assessment 4) Comprehensive analysis and selection of key areas
	<i>Step 3</i> Setting goals	1) Setting vision and objectives 2) Setting strategies for each key area
	<i>Step 4</i> Finding and selecting measures & Establishing the plan	1) Selecting adaptation measures for each key area 2) Preparing a detailed implementation plan
	<i>Step 5</i> Preparing action	1) Developing foundation for implementation 2) Building monitoring and evaluation system
	<i>Step 6</i> Confirming and sharing the plan	
	Stage C	
Implementation	<i>Step 7</i> Monitoring & Evaluation	

3.7 Korean Cases of Adaptation Measures on Water and Heat Stress

Dr. Hanna Cho,

Research Fellow, KACCC, KEI

Dr. Jong-ho Ahn,

Senior Research Fellow, Division for Integrated Water Management, KEI

Rainwater harvesting is a key adaptation measure in South Korea. There are many types of rainwater harvesting tanks designed for households, schools and business institutes. There are rain gardens and sidewalks that drain the surface water and filter it horizontally to the soil beneath. There are also rainwater storage green hose types that are designed for irrigation and drainage canals. There are many rainwater detention systems such as the eco type, sports facility type, underground type, and hybrid type.

Algal blooms are present in water bodies during the drought when nutrients from fertilizers are washed into water bodies. An alga warning system has been developed, which is an early warning system to control the algal blooms and to avoid the contamination of water

Drought Information Analysis Systems and Flood Warning Systems are being used as early warning systems and adaptation measures of climate change.

As adaptation measures for heat stress, Heat Wave Shelters, Cool Pavement (built with heat reduction materials), Cool Roof, Cooling Fog, Awnings, Shade Curtains, Green Curtains, Green Roof, and Solar Control Film (for windows) are recommended to be used.

As 'Mixed Measures', a 'Water Circulated City' is envisaged for cooling and storing water, which is an 'Integrated Water Resources Management' system for reduction of urban flooding, replenishing groundwater, prevention of water pollution and protection and restoration of water environments. Furthermore, the International Union for Conservation of Nature (IUCN) model 'Natural Infrastructure for Water Management' (<http://www.iucn.org/theme/water/our-work/wise-climate>) was discussed.

3.8 Climate Change Risk Assessment Result

After the questionnaires for water scarcity and heat stress were analysed the following result was obtained.

The stakeholders and experts were divided into two groups. One group consisted of members of technical units of the KMC. The other group members are technical experts of other institutes.

Table 3-2) Climate Change Risk Assessment Result

Indicator	First risk factor
Drinking water resources risk/vulnerability to drought	Lack of drinking water resources due to drought
Water management risk/vulnerability	Drying streams and water bodies (natural and artificial) due to drought
Water quality and aquatic ecosystem risk/vulnerability	Water quality deterioration due to temperature increase
Water resources risk/vulnerability	Lack of water for building maintenance and management
Sanitation risk/vulnerability of drought and flood	Increase of water borne/ vector borne diseases
Health risk/vulnerability to flood	Increase of water borne diseases through water and food
Health and infrastructure risk/vulnerability to heat stress	Reduced function of green space and increased loss of green cover due to heat stress



Figure 3-3) Group Survey about Water Scarcity and Heat Stress

The technical experts of the KMC highlighted the issues such as:

1. Lack of drinking water during the drought season
2. The need for repairing and maintenance of Wendaru Wewa
3. The need to identify new water sources
4. The use of potable water for washing of cars, laundry, etc since there is only one tap line which provides treated drinking water to households
5. The lack of water for construction

They suggested remedies such as:

1. Identify new water sources that can be used during a drought
2. Install two pipelines for households (one with potable water and the other with partially treated water) even though it is costly
3. Repair and maintain the already existing water sources, by dredging and repairing bunds and weirs
4. Identify abandoned paddy fields and construct them as water retention areas during the rainy season
5. Introduce rainwater harvesting. But it is necessary to supervise the maintenance
6. Provide raw water through bowsers for construction. Need to charge extra
7. After the treatment of water, there is a part which is not used. This could be sent through another tap line for households.
8. The use of recycled water for construction purposes is also a possibility.

The technical experts of other institutes highlighted the priority issues such as:

1. Drying streams and water bodies
2. Lack of new water sources

They suggested remedies such as:

1. Watershed management and introducing a cascade system for tanks
2. Increasing green coverage
3. Law enforcement to install rainwater harvesting systems to newly constructed buildings
4. Water recycling plants
5. Methods to reduce water loss (pipe system etc)
6. Diversion of water from other hydro projects such as the Mahaweli

3.9 Gender

There was not much response for gender. The participants stated that in the cultural context of Sri Lanka, families are the social unit. We often have extended families living with us.

In the Kurunegala urban area there are tap lines. Water is stored in small plastic tanks for use during water cuts. The Municipality provides treated water from bowsers to households during the drought. In peri-urban areas, there are wells in households for drinking water and common wells for bathing purposes. Money is not charged for using these facilities. Water obtained from wells is boiled in wood stoves before drinking.

Generally, the entire family including the males assists to collect and bring in water from the bowsers in the city area.

It is in the northern, eastern and southern provinces and in the extremely interior villages that there are gender issues in terms of collection of water. There is a principal that the head of the household (male) has to go in search of work to the city when there is a drought and the crop failure, and, during the time, the woman is left to look after the household. In these provinces, sometimes access to water can be very difficult.

4. Field Trip

4.1 Day 1 (18th July 2019)

1) National Water Supply and Drainage Board- Regional Support Centre



Figure 4-1) Discussion with Ms. Thanuja Premaratne, Manager (O&M)

The National Water Supply and Drainage Board (NWSDB) and the KMC jointly secure the supply of safe drinking water to its community. The NWSDB was first established as a department in 1965 and converted to a board in 1974. The NWSDB is responsible for the abstraction and treatment of raw drinking water, and the KMC is the responsible for water distribution and revenues collection. The current water demand in the city is about 8,000m³ per day. Currently, the total length of the water distribution is about 82 km.

The Kurunegala Municipal Area obtains water from the Deduru Oya, Wendaru Wewa and during periods of droughts from the Kurunegala Wewa. These are the main sources of water for the Kurunegala City. The KMC uses a small reservoir called Tampana which originates from a catchment, but which dries up during the drought.

The water supply capacity of the NWSDB is 7,200 m³ per day from the Deduru Oya and 1,000 m³ per day from the Wendaru Wewa. This raw water is pumped into the Water Treatment Facility that sells the water in bulk to the KMC. The KMC supplies the pipe borne water to the city.

Gas chlorination is used in the treatment of raw drinking water. In the case of the Tampana's water supply, the water quality is good as it is from the catchment. Therefore, pressure filter and disinfection are the treatment only needed to be given. The Kurunegala Wewa has a water storage capacity of 1,750m³ per day. But, this lake is used only in periods of drought. It has a channel linked to the Deduru Oya and can store water for up to 21 days requirement.

It is estimated that the water demand will be 19,000m³ per day by 2030. Under the Greater Kurunegala Water Supply and Sewerage Project, the present water treatment facility is expected to be upgraded to approximately 14,000m³ per day. It is expected to develop the Wandurapinu Ella Water Supply scheme with the collaboration of TATA (India) in order to meet the additional requirement.

The operational and maintenance cost for 1m³ of water is Rs. 52.00. The bulk selling price to the KMC is Rs. 18.00 per 1m³ of water. For commercial and construction requests the NWSDB sells water at Rs. 70.00 per 1m³.

The major challenges faced by the NWSDB and the KMC include the lack of reliable water sources, high amount of non-revenue water (NRW) consumption percentage, contamination of natural water resources by human and industrial waste, and the inadequate resource availability for the operation and maintenance services. The NRW is approximately 45% which is well above the national average. The primary reason for NRW is to the frequent leakage caused by the aged distribution pipe network and defective domestic meters.

2) Water Treatment Plant

Mr. E.M.J.K.Ekanayake, Officer in Charge



Figure 4-2) Water Treatment Plant (1)



Figure 4-3) Water Treatment Plant (2)

There are two Water Treatment Plants in operation. The newly constructed Water Storage Tank was funded (loan) by the Chinese Government. Raw water is pumped and treated here. There is a Chinese fund spent for SCADA computerized system to monitor the plant efficiency.

The period of drought this year was from June to August. But, there was a rise in ambient temperature since April. Last year, the dry period was only for two months. It seems that the duration of dry weather extends each year.

The principal issue in water availability is that there is no reliable water source. Deduru Oya provides irrigation (paddy) schemes as well. The Irrigation department has built a weir in Deduru Oya to provide water for agriculture. During the dry periods, the KMC, the NWSDB and other related institutes have monthly discussions with the District Secretariat to assess the situation of the drought, and the availability and distribution capacity of water sources.

The water level in the Deduru Oya and other water tanks are monitored daily so that it is easy to forecast the water storage capacities.

3) Greater Kurunegala Water Supply and Sewerage Project

Eng. Pathum Lakmal

The source of funding for the project is partially from the Chinese Government loan (USD M77.3) and partially from the Sri Lankan Government funding (Rs. M 3,200).

There are two main parts of the project;

a) Water Supply Project

The water supply facilities which are at present limited to KMC area are going to be expanded up to some extent to the Kurunegala Pradeshiya Sabha areas. 30 Grama Niladhari Divisions will be covered under this project. Total new beneficiaries would be 71,000 people. Furthermore, they will provide an uninterrupted water supply (24 hours) to the Kurunegala Teaching Hospital and the 35,000 people living in the municipal area. They will also provide drinking water to the floating population of approximately 100,000 people daily.

The main components of the Water Supply Project are;

- Construction of a dam across Deduru Oya
- Improvement of the existing pumping station and construction of a new pumping station
- Laying of new transmission lines
- Improvement and development of catchments
- Improvement of existing water treatment plant with capacity of up to 9,000m³/day
- Construction of new water treatment plant with capacity of 5,000m³ / day
- Expanding the water distribution system to three zones
- Providing 6,500 new water connections

This component has been completed and the plant is in operation.

b) Sewerage Project

A sewerage system will be constructed to cover 43,000 residents in the municipal including Kurunegala Teaching Hospital.

The main components of the Sewerage Project are:

- Construction of sewerage treatment plant (4,500m³/ day) and 5 pumping stations
- Connection of all environmentally problematic locations in the city to sewerage network
- Construction of 3,500 household connections
- Improvement of sewerage network of Kurunegala Teaching Hospital

The sewerage from existing lines are collected and treated here. After treatment, the residue water is treated and released to the Boo Ela that flows adjacent to the Sewerage plant. Treated water flows into irrigation field. Compost is made from the remaining sludge, which is a form of excellent fertilizer and much in demand from plantations.

The laboratory conducts daily check on the influent and effluent parameters such as temperature, pH, DO, TSS, NH₃-N and COD, and E coli is also checked regularly. There is no bad odour from the sewerage treatment plant.

The newly built sewerage plant is in operation. The sewerage is treated at 300m³ per hour. And a capacity of 1,700 -2,000 m³ is treated daily. Currently, there are 3,500 sewerage connections.



Figure 4-4) Sewerage Treatment Facility (1)



Figure 4-5) Sewerage Treatment Facility (2)

4.2 Day 2 (19th July 2019)

1) Greater Kurunegala Water Supply and Sewerage Project

Mr. Kolitha Atapattu, O.I.C Sewerage Treatment Plant and email communication with Eng.I.R. Gamage (Head of the Plant)



Figure 4-6) Discussion with Assistant Commissioner (Mr. D.P.S Kumara), Engineer (Eng. D.R.W.W. Kaluarachchi), Dengue Unit personnel (Ms. Menaka Herath and Mr. Gayan Chaturanga) and Senior Public Health Inspector (Mr. W.A.G. Upatissa) of the KMC

Mr. Kolitha stated that the treated water of the sewerage plant is released to the Boo Ela. This leads to an anicut (narrow canal) which provides water for irrigating the paddy fields. The paddy fields are located 5km away from plant. He also stated that there is a high demand for compost produced by the sewerage plant. 138.5km of sewer network has been completed. Secondary network is available for 75% of the total households (about approx. 6,000) in the Municipal area. It is necessary to find a funding source to complete the laying of lines for the entire city. The NWSDB will be the responsible institute after the completion of the project. An Operational and Maintenance setup has already been established for continued maintenance and finding leaks.

April is one of the hottest months of the year in Kurunegala. The temperature rose to 42°C within the city in April-May this year. Kurunegala City has been experiencing a drought for the past three months. The catchment area of Tampane has totally dried up. Deduru Oya water levels have

declined. The Kurunegala Wewa is being used to provide water for the city. This water is treated and sent to areas by engaging bowsers.

Some of the wells within the city have also dried up. People in the peri-urban areas use the common well for bathing and washing purposes and use the household well for drinking water purposes. Most of the wells are also contaminated by runoff from fertilizer and sewerage pits. Most of the groundwater wells have also dried up, and the Municipality does not encourage the digging of groundwater wells. There are daily water cuts. People fill their plastic tanks with water as storage. Currently, there is a slight increase in the incidence of dengue although no mortality has been reported. This is due to the fact that the dengue mosquito lays eggs in the containers used for water storage. The Public Health Inspectors engage in visiting households twice a month to ensure that the premises are kept clean and free of potential breeding sites for dengue mosquitos.

Unlike other Municipal Councils (MCs), the KMC buys water in bulk from the NWSDB and distributes it into the residents. The KMC has fixed 8,273 water meters, including 5,671 for houses, 1,898 for the commercial, 266 for outside houses (outside the Municipal town area) and 31 for outside commercial tap connections. Considerably less is charged for water units in comparison with electricity units. There is a proposal for the next budget to provide tap connections to 16,000 households, but there are financial constraints.

Table 4-1) Number of Dengue Cases Reported during 2017-2019

	J	F	M	A	M	J	J	A	S	O	N	D	Total
2017	27	27	21	57	170	117	57	48	11	30	38	14	617
2018	12	4	2	0	2	1	8	2	0	0	0	0	31
2019	3	5	0	1	0	1	2						

There is an App. for smart phones. This is a complaint line, where the public can inform if there are any leaks or burst pipes. The pipe system is very old and needs to be replaced. There are many noted leakages from the pipe system (NRW). A procedure is being set up to check for water pipe leaks, but this is a very expensive procedure, and there are financial constraints.

Despite the fact that there are constant complaints for heat stress and discomfort, it has not been documented. There are no factual reports of health problems associated with heat stress.

If the sewerage system can be completed for households, the household wells can be used as a steady source of water. There is a proposal to dig the identified abandoned paddy fields and use it for rainwater collection. There is a necessity to introduce rain water harvesting systems to households.

There is no digitized system for data collection and storage in the KMC. It is necessary to design databases for the data collection and dissemination of information.

It is necessary to digitize the number of bulk waters bought from the NWSDB and categorize how the water units have been utilized (household, commercial, etc.). It is required to map the distribution of wells, groundwater wells and common bathing wells as well as monitor whether they are in use or not during drought. There is a need to map the land use of the Kurunegala City.

2) Visit to Sites Containing Wells

a) Household Well

A visit was made to see a drinking water household well which is 16 feet deep. It is observed that the well was covered by a metallic frame with a green wire mesh to prevent leaves and other debris from falling in. The well contained guppy fish and was used to pump water up to a rooftop cement tank. This tank was demolished and replaced by a plastic shell tank. The current cement storage tank had a storage capacity of 400 gallons. The household also was able to access to municipal piped water. They stated that this source was used for drinking water and they shared well with the next door neighbour who was not able to access to pipe borne water. The household boiled the water before drinking. Currently, they experienced daily water cuts. Water is supplied only from 5pm to 8.30a.m. Therefore, they need to store water for daily usage especially toilets. There was a sewerage pit in the garden. They hope to connect it to the main sewerage line soon.



Figure 4-7) Sewerage Pit in the Garden

b) Common Bathing Well

It was a large well of 30 feet in depth, which was dug 75 years ago. It contained guppy fish and used for bathing and washing clothes in the community. For the past couple of years, even though the water level diminish, the well does not dry out completely. It is currently being used.



Figure 4-8) Common Bathing Well

c) Groundwater Well

The pipe system for the groundwater well we visited had been removed since it dried up. It seems that the groundwater well is approximately 50 feet deep. There was another groundwater well nearby which is not dried out yet. But, the people in the community was not sure whether it had been contaminated by sewerage pits in the adjacent areas.



Figure 4-9) Groundwater Well

3) Visit to Ethugala

It is a granite rock surrounded by sparse vegetation. It gets heated up during the day making it uncomfortable within the city. School children find it uncomfortable especially in the months of April to July and constantly complain of headaches and discomfort.

The town consists of less green spaces and concrete paved walks, concrete buildings and high traffic congestion. Therefore, the heat is felt more.



Figure 4-10) Visit to Ethugala

5. Discussion

The main water source for the KMC is Deduru Oya, Wendaru Wewa, Tampane and Kurunegala Lake. Kurunegala Lake is used as an extreme source. Water is treated at the Water Treatment Plant and supplied to households. The current main issue is that water demand is high and there is no other source to obtain water. There is also a feasibility study going on to assess the possibility of tapping another water source in Wandurapinu Ela.

There are proposals to build rainwater storage areas in abandoned paddy fields and check out the feasibility for rainwater harvesting. At present, some of the household wells are contaminated. It is thought that if the city sewerage programme works, the wells will become less contaminated and be an additional source of water supply.

There is not much green area in the Kurunegala city since much of the city area is covered by the rock. There are lots of buildings and no parking space resulting in vehicles being parked on the road causing more traffic congestion. Due to the high floating population which either arrives in Kurunegala for education or medical facilities or drives through Kurunegala since it links four main towns the need to operate water treatment facilities and provide treated water is high. Other than the area around the lake, it is difficult to find areas to build green space to cool down the hot environment. Lack of funds to carry out proper planning and implementation of projects is a primary issue. A high-resolution GIS map is necessary to mark the land use in the KMC.

There is no digitized system or database in the KMC to record the water units collected and distributed each month for the various categories. A baseline survey is necessary to document the public utilities and usage to design and monitor adaptation and mitigation plans in the future.

6. Reference

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Annex A. Information on Status of Sri Lanka and Kurunegala City

According to the last census in 2012, the population of Sri Lanka was 20.359 million people, including 3.704 million urban residents (18.2% of the population) living in 64 municipal areas (Table A-1). It means that Sri Lanka ranked as the 11th least urbanized country in the World in the 2018 United Nations World Urbanization Prospects (UNISDR, 2018). The official (defined as) urban population data does not show the true extent of the country's urbanization. But, in accordance with the agglomeration index, an alternative measure of urbanization that uses multiple indicators, Sri Lanka's urban population is between 35 and 45% of total while recent policy documents estimate 50% urban population (Government of the Democratic Socialist Republic of Sri Lanka, 2018).

Table A-1) Sri Lanka's Urban Areas in 2012

	No. of Municipalities	Urban Population	Provincial Capital	Population of Capital
Western	21	2,272,194	Colombo	561,314
Eastern	8	389,687	Trincomalee*	48,351
Central	10	270,971	Kandy	98,828
Southern	7	261,677	Galle	86,333
Northern	6	176,808	Jaffna	80,829
Sabaragamuwa	4	115,444	Ratnapura	47,105
North Western	4	97,294	Kurunegala**	24,833
Uva	3	69,800	Badulla	42,237
North central	1	50,595	Anuradhapura	50,595
Sri Lanka	64	3,704,470		

Note: In the following cases the Provincial Capital is not the largest town in its Province;

* The largest town in the Eastern Province is Kalmunai (pop. 99,893), followed by Batticaloa (pop. 80,227);

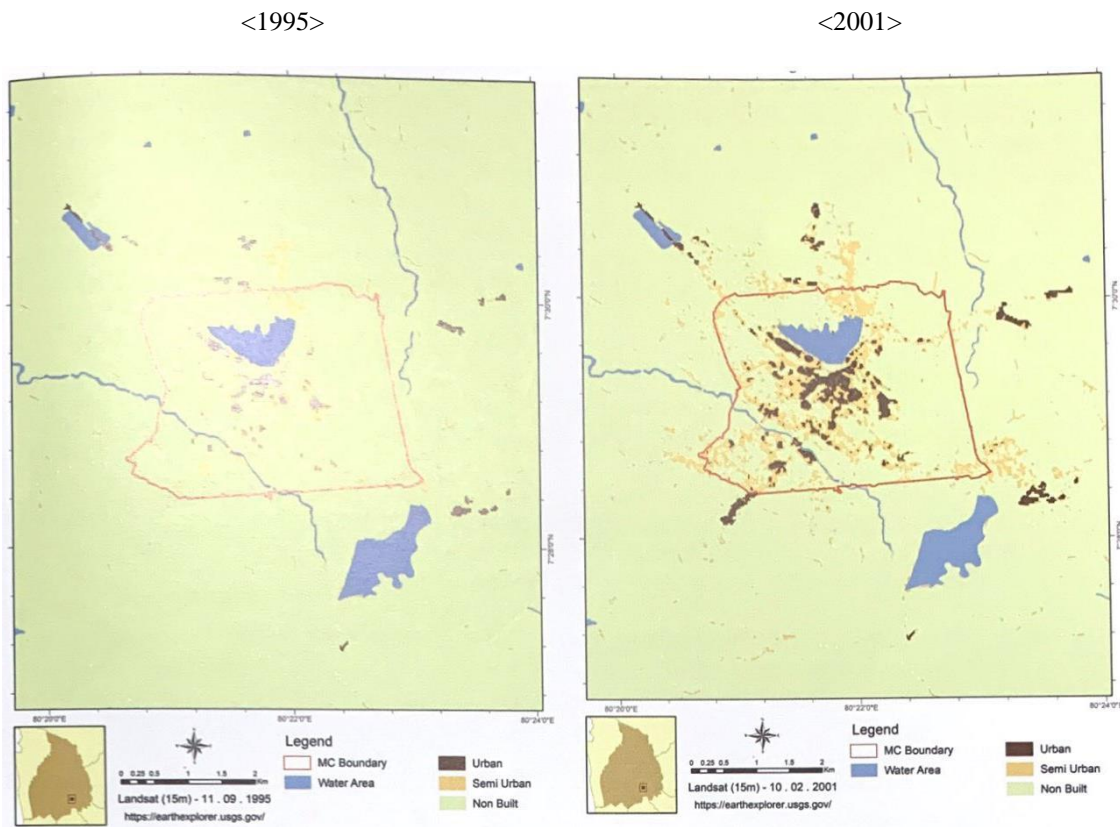
** The largest town in the Northern Western Province is Puttalam (pop. 45,511).

Source: Government of the Democratic Socialist Republic of Sri Lanka (2018)

Kurunegala District is located in the North Western Province of Sri Lanka. The Kurunegala City is located topographically in a plain surrounded by the Ethugala which is a large granite rock outcrop. The northern part of the town is slightly higher than in the south.

The local residential population within the municipality is approximately 33, 500 and the foot traffic is approximately 200,000. Kurunegala can be considered as central to Sri Lanka especially since it connects the North and South of the country. Currently, the Government of the Democratic Socialist Republic of Sri Lanka is developing the Central Corridor, linking Colombo to the eastern port city of Trincomalee via Kurunegala, kandy and Anuradhapura.

Ribbon development turning into urban sprawl is shown in the expansion of the city of Kurunegala (Figure A-1, A-2).

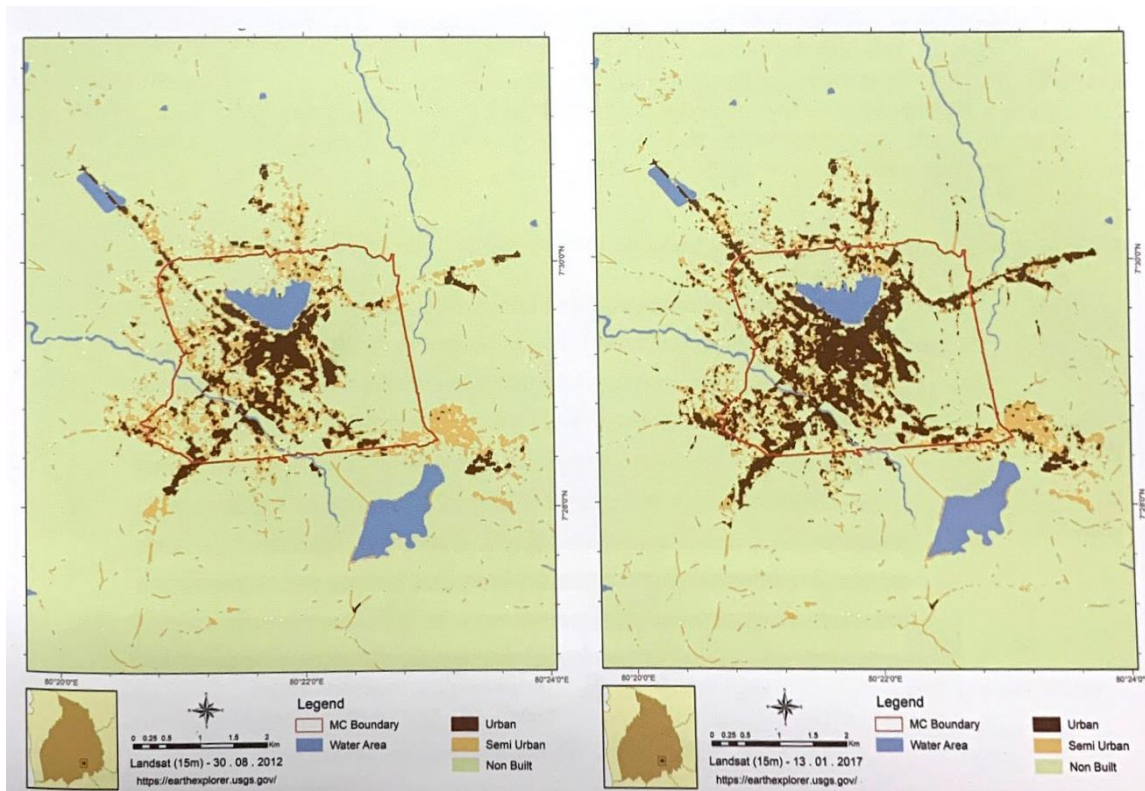


Source: Government of the Democratic Socialist Republic of Sri Lanka (2018)

Figure A-1) Ribbon and Sprawl Expansion in Kurunegala

<2012>

<2017>



Source: Government of the Democratic Socialist Republic of Sri Lanka (2018)

Figure A-2) Ribbon and Sprawl Expansion in Kurunegala (continued)

Water

Water scarcity can be defined as the non-availability of a required amount of water with usable quality at the required time and location, for human and environmental use. A more accurate assessment of scarcity therefore focuses on relating available water to the demand for water, rather than to the population. The International Water Management Institute (IWMI) categorized the reason for water scarcity into three types, which are a) absolute or physical scarcity b) economic scarcity and c) institutional/ political scarcity. These three types reflect the different reasons for water scarcity to occur (Somaratne and Ariyaratne, 2007).

In ancient times, Sri Lanka used traditional micro watershed management systems which is referred to as the Tank Cascade Systems (TCS) to irrigate the vast dry low-lying plains. Reuse of water through a network of small to large scale tanks is the main principle behind the TCS. The ancient Sri Lanka had unique channel technology. The feeder channels had only one embankment which was constructed long contour lines. Therefore, the channels were able to store a small

amount of water. This system reduced the devastating effect of storm water during the rainy season. All components of the TCS are the artificial infrastructures. This system provided water for human consumption as well as supported the existence of local biodiversity, ecosystem services and irrigation (Geekiyanage and Pushpakumara, 2013). Kurunegala situated in the intermediate zone of the island had an ancient cascade system as well. As time went by, the tanks were filled up with soil so that the channels were blocked and then used for other purposes.

Water in Sri Lankan culture is considered precious, not to be wasted and to be protected. It is thought to achieve merit when water is given free -especially at a time of dire need.

The '*pinthaliya*' is a huge water pot which is kept outside houses so that tired travelers can drink from it and quench their thirst. Household wells provide drinking water for neighbors and charitable people construct 'common wells' for bathing purposes. This well is shared and looked after by the community.

The '*gasmuttiya*' is a clay pot which always has boiling water and kept under a tree in a huge yard. There is a bottle of sugar, a couple of mugs, a jug and a cloth strainer containing tea leaves. A stack of fire wood lies alongside. People who work in the yard make themselves a cup of tea and fill the pot from a nearby well.

During the drought, when a particular area or district has been hit hard and there is extreme water scarcity, many volunteers and charities, buy bottled water and transport them in trucks. Owners of Bowsers voluntarily provide water to those drought-stricken communities.

Table A-2) District Climatic Zone and Risk Exposure in 9 Provincial Capitals

City	Climatic Zone	Exposure
Jaffna	Dry	Drought, flood, cyclone
Anuradhapura	Dry	Drought
Kurunegala	Intermediate	Drought
Trincomalee	Dry	Drought, flood, cyclone,
Kandy	Wet	landslides
Ratnapura	Wet	Flood, landslides, drought
Galle	Wet	Flood, landslide
Badulla	Intermediate	Flood, landslides
Colombo/WRM	Wet	Flood

Source: Government of the Democratic Socialist Republic of Sri Lanka (2018)

Table A-3) Climate Risk Exposure in 9 Provincial Capitals 1974-2017

	Flood		Landslide		Drought		Cyclone	
	Affected	Deaths	Affected	Deaths	Affected	Deaths	Affected	Deaths
Badulla	2,251	–	6,424	41	–	–	–	–
Galle	27,206	–	23	4	–	–	–	–
Ratnapura	113,260	9	6,969	47	4,313	–	–	–
Jaffna	40,268	–	–	–	2,150	–	–	–
Kurunegala	2,774	2	–	–	141,074	–	–	–
Anuradhapura	4,030	–	–	–	19,645	–	–	–
Trincomalee	33,535	–	–	–	18,187	–	75,000	–
Kandy	505	–	2,615	7	–	–	–	–
WRM	3,807,394	223	2,084	36	530,763	–	9,355	3
TOTAL	4,031,223	234	18,115	135	716,132	0	84,355	3

Source: Government of the Democratic Socialist Republic of Sri Lanka (2018)

Kurunegala city has experienced water scarcity during three to four months of the year during the past decade. With the increase in urban population and commodities, the demand for water is high. The sources that provided water are not adequate to supply the demand. The KMC is currently trying to come up with interventions to solve the issue of water scarcity.

Heat

Unplanned, rapid urban growth causes traffic congestion, overcrowded urban public space with concrete buildings and lack of green space. In Sri Lanka, most of the green space is being replaced by impervious surfaces such as buildings, parking lots, roads and pavements.

The Urban Heat Island (UHI) phenomenon is a major negative impact of rapid urbanization. It was first described in 1818 as a phenomenon that urban areas have a higher atmospheric and surface temperature than their surrounding rural areas. In general, there is a 3-5°C variation observed between urban and rural areas in the daytime. However, during the nighttime, a high 12°C variation can be observed due to the gradual emission of radiant heat from the urban surface. There are two types of UHIs including Surface Urban Heat Island (SUHI) and Atmospheric UHI. Atmospheric UHI is observed based on air temperature, and SUHI is measured based on land surface temperature (Ranagalage *et al.*,2017).

In a study conducted in the Colombo Metropolitan Area (Ranagalage *et al.*,2017), it was revealed that there were intensifying SUHI effects during years of 2007-2017. In another study conducted

by Ranagalage *et al.* (2018), the mountainous region of Central Hills showed an increase from 3.9°C in 1996 to 6.2°C in 2017 along the urban-rural gradient. This implies that most of the existing rural landscape had been increasingly covered by impervious surfaces resulting in a high SUHI in Kandy City.

Kurunegala which is located in a low elevation region has a hot, humid climate. Heavy rain is expected from May to August and from October to January each year. The average annual rainfall is 2,000mm. The mean annual temperature is approximately 28°C. January is the driest month of the year, but April to May experienced high temperatures in 2019. With the rock heating up during the day, congestion of traffic and increase in paved areas and buildings, Kurunegala City becomes unbearably hot during the daytime.

The environmental consequences of climate change affect directly and indirectly the physical, social and psychological health of humans. Prolonged exposure to extreme heat can cause heat exhaustion, heat cramps, heatstroke and death as well as worsen pre-existing chronic conditions such as various respiratory, cerebral and cardiovascular diseases. Changes in temperature and precipitation directly affect vector borne and zoonotic diseases pathogen–host interaction, resulting in the spread of diseases such as dengue, malaria and leishmaniasis (Kalubowila, K.C, 2017).

Annex B. Workshop Program



Workshop

Development of a Climate Smart City in Kurunegala

Date: 17th July 2019

Time: 9.00a.m.

Venue: Viveka Hotel, Kurunegala

- 9.00 a.m. Welcome Address
Mr. Thushara Sanjeeva Vitharana, Hon. Mayor of Kurunegala
- 9.15 a.m. The CTCN Climate Smart City programme
Ms. Dakshini Perera (Asst. Director, Climate Change Secretariat, Ministry of Mahaweli Development & Environment)
- 9.30 a.m. Remarks on the progress of the Climate Smart City Programme
Dr. Shishiroda Ratnayake, Chief Medical Officer of Health/ Project Coordinator, Kurunegala Municipal Council
- 9.45 a.m. CTCN TA Pro bono support of Korea NDE and Overview of Adaptation Plan Establishment
Korean Environment Institute Dr. Hanna Cho
- 10.15 a.m. TEA
- 10.30 a.m. Introduction of potable water treatment technology
Prof. Kyoung woong Kim
Chief of International Environmental Research Institute, GIST
- 11.00 a.m. Survey -Questionnaire of Experts
Chaired by: Dr Hanna Cho
- 12.30 p.m. LUNCH
- 1.30 p.m. Sharing risk assessment result for qualitative analysis
Dr. Jong-ho Ahn, Director of Office of Audit, KEI
- 2.30 p.m. Presentation on adaptation measures and Drought Response
Dr Hanna Cho, KEI and Dr. Jong-ho Ahn, Director of Office of Audit, KEI
- 4.30 p.m. Vote of thanks, Ms. Dakshini Perera, Climate Change Secretariat

Annex C. List of Workshop Participants

No	Name	Designation	Institute
1	Hon. Sanjeewa Vithanage	Mayor	KMC
2	Sumith Kumara Udawasala	Deputy Mayor	KMC
3	Dr. Shishiroda Ratnayake	CMOH	KMC
4	D.P.S.Kumara	Asst. Commissioner	KMC
5	Chintha Vithana	Asst. Director (Planning)	District Secretariat
6	Bandula Warnakulasooriya	Disaster Relief Officer	District Secretariat
7	R.D.D.Rajapaksha	Public Health Inspector	KMC
8	B.M.I.Obeysekera	Public Health Inspector	KMC
9	K.M.I.T.Wijerathna	Development Officer	KMC
10	D.P.S.Kumara	Disaster Management Centre	Kurunegala
11	R.A.M.A.Bandara	Municipal Engineer	KMC
12	K.L.R.Somaweera	Administrative Grama Niladhari	District Secretariat
13	Hasula Wickremasinghe	Programme Assistant	Climate Change Secretariat, MMDE
14	Dakshini Perera	Asst. Director	Climate Change Secretariat, MMDE
15	Kumudini Vidyalankara	Asst. Director	Climate Change Secretariat, MMDE
16	M.D.Chandradasa	Development officer	KMC
17	E.M.J.K.Ekanayake	Senior Engineering Asst.	Water Treatment Plant
18	Dhammika Konara	T.O	KMC
19	Gayana Chaturanga	Health Supervisor	KMC
20	A.D.Ranjith Jayakody	Health Supervisor	KMC
21	R.P.D.Kumarathilake	Health Supervisor	KMC
22	D.P Sumith Jayarathna		
23	W.M.Neil Priyantha		
24	HyeLim Jeong	Researcher	KEI
25	Kyoung-Woong Kim	Professor	GIST

26	Hanna Cho	Research Fellow	KEI
27	Jong Ho Ahn	Senior Research Fellow	KEI
28	Young Goung Kim	Researcher	GIST
29	Sameera Kahadagamage	Govt. Surveyor	Divisional Survey Office
30	H.N.B. Abhayawardhana	Asst. Director	Dpt of Local Government
31	D.R.W.W.Kaluarachchi	Municipal Engineer	KMC
32	H.M.N.C Herath	Land Use Planning Officer	Land Use Planning Office
33	E.M.P.K.Ekanayake	Prog. officer	UDA
34	J.A.M.D.Jayakody	Consultant	Industrial Services Bureau
35	A.C.Vidanapathirana	Director	Industrial Services Bureau
36	M.M.S.Herath	DO	
37	Himali Hewawasam	DO	