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

Report on the Result of Climate Change Risk and Vulnerability Assessment

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The Climate Technology Centre & Network (CTCN) has provided Technical Assistance (TA) to Kurunegala Municipal Council (KMC) and Ministry of Mahaweli Development and Environment (MMDE) in Sri Lanka through pro-bono support from Korea Environment Institute (KEI) Korea Adaptation Center for Climate Change (KACCC) and Green Technology Center (GTC) in Republic of Korea.

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1. Introduction

Climate Technology Centre and Network (CTCN) initiated a Technical Assistance (TA) entitled “Development of an urban adaptation plan for Kurunegala” in response to a request from Municipal Council of 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) decided to accept and support the TA as Pro bono. It was assigned to Korea Adaptation Center for Climate Change (KACCC) as the key implementer, which is a sub-division of the Korea Environment Institute (KEI).

The primary roles of the TA are as follows: 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.

Analysis of climate change impact, vulnerability, and risk are key processes to develop a climate change adaptation plan. They inform policy decision-makers of the potential effect of climate change, and their results could be used to choose the available strategies and associated technical and social measures for climate change response.

The assessment and analysis of the current and future climate change risk and vulnerability are required for the development of robust climate change adaptation policies. These are aimed to inform policy decision-makers about the potential risk of climate change and provide a means to evaluate its impacts along with the evidence for the comparison of possible strategies and policy options. Assessments can produce a wide range of knowledge and information depending on the target audience, usually policymakers.

The most common output from risk and vulnerability assessments is to summarize the assessment methodology, results, and relevant policy recommendations. They will be an asset to inform the development of policy planning processes and documents, such as National Communications, National Adaptation Programs of Action (NAPAs), National Adaptation Plans (NAPs), or a country’s own national climate strategy or action plan. For the regional risk and vulnerability assessments, the outcome will be included in local government’s own national climate strategy or action plan.

The risk and vulnerability assessment are necessary to take decisions in the preparation of adaptation plans and early warning systems as well as to fertilize climate change adaptation action plan for Kurunegala. This report provides the results of the risk assessment carried out for Kurunegala City. The results will be used for the development of an adaptation action in Kurunegala City.

2. Data for Risk and Vulnerability Assessment

For the assessment of climate change risk and vulnerability in the community level, it is required to have both quantitative and qualitative data and information to characterize socio-ecological systems. This is because, in the assessment, the current and predicted risks and vulnerabilities caused by climate change should be included.

However, Sri Lanka is a developing country which is currently building their infrastructure and national/local data collecting system. To analyse climate change risk and vulnerability in Sri Lanka has been struggled due to lack of data availability (e.g. lack of data for the Grama Niladhari Divisions (GNDs), which is a community unit of Kurunegala Municipal Council (KMC) and lack of infrastructure that can support climate data). Some of the data is available in hard copies or in ways that it takes time to extract. Some data has not been collected while some consists of either annual figures or figures for the entire district. Moreover, accurate GIS maps were not available for the city as they are required for indicator-based approach assessment.

Although it was not possible to conduct a quantitative risk assessment (indicator-based approach) due to a lack of data, indicators were set up, and existing data were collected. A qualitative risk assessment (survey-based approach) was adopted based on opinions from local experts. Survey was conducted in July during workshop where local experts and stakeholders participated.

3. Overview of Methodology

Both quantitative and qualitative approach were used for risk assessment. Details on each approach were described in the Deliverable 4 (Climate Change Risk Assessment Guidelines) of this technical assistance.

3.1 Indicator-based Approach Assessment

The purpose of the indicator-based approach (quantitative risk assessment) is to identify the most vulnerable areas and indicator by data analysis. The risk assessment was carried out by following steps as below:

- **Step 1: Set objective and scope of risk assessment**
- **Step 2: Selection of conceptual framework**
- **Step 3: Review of available data and selection of indicators**
- **Step 4: Data collection & Standardization**
- **Step 5: Risk calculation and assessment**

3.2 Survey-based Approach Assessment

The purpose of the survey-based approach (qualitative risk assessment) is to prioritize the risk factors that present the most UpToDate problems on water scarcity and heat stress in Kurunegala. The risk assessment was carried out by following steps as below:

- **Step 1: Establish the context**
- **Step 2: Identify the risks**
- **Step 3: Analyse the risks**
- **Step 4: Evaluate the risks**
- **Step 5: Treat the risks**

3.3 Climate Change Awareness Survey

The aim of the awareness survey is to identify the impact of climate change on residents living in the city of Kurunegala. It collects the opinions on the adaptation measures needed by residents. In particular, the separate survey was conducted for women to find out the impact of climate change and prepare the reduction plans of the impact. The procedure is the same as the survey-based approach assessment.

4. Result of Risk and Vulnerability Assessment

4.1 Indicator-based Approach Assessment

- **Step 1: Set objective and scope of risk assessment**

In this project, the target area for risk assessment is Kurunegala Municipal Council (KMC) where is limited to the risk assessment for the water management and heat stress.

- **Step 2: Selection of conceptual framework**

According to the risk assessment framework of the IPCC AR5 (2014), UNISDR (2017), the framework can be revised as below. This framework is updated based on the risk assessment in Copenhagen (2011) and Vancouver (2012).

$$\text{Risk} = \frac{Hazard \times \text{Exposure} \times Vulnerability}{Capacity} = \text{Hazard} \times \frac{Impact*}{Capacity}$$

$$*Impact = Exposure \times Vulnerability$$

(Constraint: wH = wV = wE)

- **Step 3: Review of available data and selection of indicators**

Considering local context of risk and geographical characteristics, the possible indicators of risk assessment is listed by Kurunegala Municipal Council (KMC). The indicators are reviewed by risk assessment experts in KEI. For more information, please refer to Assessment Guideline.

1. Drinking water resources risk/vulnerability to drought
2. Water management risk/vulnerability
3. Water quality and aquatic ecosystem
4. Water resources risk/vulnerability
5. Sanitation risk/vulnerability of drought and flood
6. Health risk/vulnerability to flood
7. Health and infrastructure risk/vulnerability to heat wave

Sub-factors for each indicator are categorized into hazard, exposure, vulnerability, and capacity for climate change risk assessment. The list of each classified factors is provided in Annex A. These factors should be quantifiably defined as those that can represent the status of climate change of the Kurunegala.

- **Step 4: Data collection & Standardization**

The table below shows the list of the data collected. Data status indicates whether the data is completely collected (O), the data collection is underway (I) or the data is not collected (X). Out of 38 indicators, only 16 indicators are acquired data. The data for 10 indicators were obtained but the further processing is required such as entering the data in spreadsheet. Due to time constraints, not all of the collected data could be processed; thus, they were removed from the preliminary risk assessment. It should be noted that once the data are properly processed, they can be easily reflected in the risk assessment, as the methodology is very flexible. 12 out of 38 indicators were failed to collect relevant data.

Table 4-1) Hazard

	1. Drinking water resources risk/vulnerability to drought	**2. Water management risk/vulnerability**	**3. Water quality and aquatic ecosystem risk/vulnerability**	**4. Water resources risk/vulnerability**	**5. Sanitation risk/vulnerability of drought and flood**	**6. Health risk/vulnerability to flood**	**7. Health and Infrastructure risk/vulnerability to heat stress**	**DATA STATUS**	**REMARKS**
	Indicator	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**		
1	Consecutive dry days	Consecutive dry days (days)	Consecutive dry days	Consecutive dry days	Consecutive dry days		Consecutive dry days	O	COMMON/UNRELIABLE VALUE
2	Occurrence of extreme rainfall anomalies - Stranded Precipitation Index (SPI)	Occurrence of extreme rainfall anomalies	Occurrence of extreme rainfall anomalies		Occurrence of extreme rainfall anomalies	Occurrence of extreme rainfall anomalies		O	COMMON/UNRELIABLE VALUE
3		Consecutive wet days	Consecutive wet days		Consecutive wet days	Consecutive wet days		O	COMMON/UNRELIABLE VALUE
4	Change in maximum temperature			Change in maximum temperature			Change in maximum temperature	O	COMMON/UNRELIABLE VALUE
5	Monthly Average Evaporation	Number of flood events			Number of flood events	Number of flood events		O	COMMON/UNRELIABLE VALUE
6			Occurrence of extreme rainfall anomalies - Stranded precipitation Index (SPI)	Occurrence of extreme rainfall anomalies - Stranded precipitation Index	Occurrence of extreme rainfall anomalies - Standard precipitation Index (SPI)		Occurrence of extreme rainfall anomalies - Standard precipitation Index (SPI)	O	COMMON/UNRELIABLE VALUE
7				Monthly Average Evaporation			Monthly Average Evaporation	O	COMMON/UNRELIABLE VALUE

Table 4-2) Exposure

	1. Drinking water resources risk/vulnerability to drought	2. Water management risk/vulnerability	3. Water quality and aquatic ecosystem risk/vulnerability	4. Water resources risk/vulnerability	5. Sanitation risk/vulnerability of drought and flood	6. Health risk/vulnerability to flood	7. Health and Infrastructure risk/vulnerability to heat stress	DATA STATUS	REMARKS
	Indicator	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**		
1	Population Density	Population Density		Population Density	Population Density	Population Density	Population Density	O	
2	Livestock population	Livestock Population	Livestock Population	Livestock Population		Livestock Population	Livestock Population	O	
3	Population receiving government assistances	Population receiving Government assistances		Population receiving Government assistances	Population receiving Government assistances	Population receiving Government assistances	Population receiving Government assistances	O	
4	Tax Units			Tax Units	Tax Units			X	
5		Water supply						X	
6		% of area of lowland area	% of area of lowland area			% of area of lowland area		I	NEED TO BE CALCULATED FROM DEM
7					Average number of sanitation facilities			I	WITH PROPOSED ALTERNATIVE (DATA IN SURVEY QUESTIONNAIRE)
8						Population aged 14 or younger	Population aged 14 or younger	I	DATA IN SURVEY QUESTIONNAIRE
9						Population aged 65 or older	Population aged 65 or older	I	DATA IN SURVEY QUESTIONNAIRE
10						Recorded water bone diseases		X	
11							School, daycare centers and Kindergarten	O	NO. OF DAYCARES ONLY/ TO BE TRANSLATED

Table 4-3) Vulnerability

	1. Drinking water resources risk/vulnerability to drought	2. Water management risk/vulnerability	3. Water quality and aquatic ecosystem risk/vulnerability	4. Water resources risk/vulnerability	5. Sanitation risk/vulnerability of drought and flood	6. Health risk/vulnerability to flood	7. Health and Infrastructure risk/vulnerability to heat stress	DATA STATUS	REMARKS
	Indicator	Indicator	Indicator	Indicator	Indicator	Indicator	Indicator		
1	Number of female lead house holds	Number of female lead house holds		Number of female lead house holds	Number of female lead house holds	Number of female lead house holds	Number of female lead house holds	X	
2		Availability of secondary water sources (well water)						O	NO DESCRIPTION & UNIT
3			Different type of aquatic eco systems					I	NEED TO BE CALCULATED FROM DEM
4			Cover of sewerage connection					X	
5				Tax units which haven't secondary water sources				X	
6				Number of casualties by floods for recent 3 years				I	DATA IN SURVEY QUESTIONNAIRE
7				River levee (bank) area ratio (%) need to calculate				I	NEED TO BE CALCULATED FROM DEM
8					Dependency ratio – income need to calculate			X	
9					Number of schools and welfare facilities for the aged	Number of schools and welfare facilities for the aged		X	
10							Population receiving Government assistances	O	

Table 4-4) Capacity

	1. Drinking water resources risk/vulnerability to drought	2. Water management risk/vulnerability	3. Water quality and aquatic ecosystem risk/vulnerability	4. Water resources risk/vulnerability	5. Sanitation risk/vulnerability of drought and flood	6. Health risk/vulnerability to flood	7. Health and Infrastructure risk/vulnerability to heat stress	DATA STATUS	REMARKS
	Indicator	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**	**Indicator**		
1	Water supply ratio	Water supply ratio(%)	Water Supply ratio	Water Supply ratio	Water Supply ratio		Water Supply ratio	X	
2	Access to information	Access to information	Access to information	Access to information	Access to information	Access to information	Access to information	O	
3	Tax amount	Tax amount	Tax amount	Tax amount		Tax amount	Tax amount	X	
4	Number of hospitals, day care, schools	Number of hospitals, day care, schools	Number of hospitals, day care, schools	Number of hospitals, day care, schools	Number of hospitals, day care, schools	Number of hospitals, day care, schools	Number of hospitals, day care, schools	O	NO. OF HOSPITALS & DAY CARES ONLY
5	Availability of secondary water source		Availability of secondary water source	Availability of secondary water source				O	NO DESCRIPTION & UNIT
6	Bowser water supply		Bowser water supply	Bowser water supply				I	DATA IN REPORT
7			Average number of sanitation facilities					I	WITH PROPOSED ALTERNATIVE (DATA IN SURVEY QUESTIONNAIRE)
8					Number of public official for sanitation	Number of public official for sanitation		X	
9					Cover of sewerage connection			X	
10						Education level	Education level	I	DATA IN SURVEY QUESTIONNAIRE

- **Step 5: Risk calculation and assessment**

Observations for the Quantitative Risk Analysis

The data they provided for the quantitative risk assessment was the main issue we need to deal with. It is the unorganized and unprocessed data that need to be cleared and processed for the usage. Moreover, the set of indicators were not properly tabulated and organized. This led to confusion of whether the data needed for a specific indicator has been collected or not. In addition, upon reviewing their collected data, some values were incorrect and unclear (e.g. Number of consecutive dry days, Number of consecutive wet days, Change in maximum temperature, etc.). Since the reliability of the quantitative risk assessments highly depends on the input values from their collected data, uncertainty will clearly be observed in the results when these incorrect data are used.

Another problem we have is the inconsistent boundaries of the 12 wards. The responses in their survey forms that were answered by the 12 wards must represent the actual data within each ward. However, KMC has different boundaries which should be settled first, as the boundary map will serve as the base for the expected quantitative risk assessment.

Recommendations:

The following recommendations are suggested in order to aid their quantitative risk assessment:

- **Systematic organization and identification of the indicators**:
  Key persons involved must provide the complete definition for each indicator. This will help them in collecting the CORRECT data needed.

- **Identification and verification of the ward boundaries:**
  The shapefile for their ward boundaries contains more than 12 wards. Moreover, their boundary map and land use map are not properly projected (wrong coordinate system).

- **Investigation of the geographical effect:**
  Upon site visit, it was observed that KMC has abundant greeneries and a lake. The problem of water scarcity could be caused by their geographic feature which is mostly rock. (Rocks does not allow infiltration and recharge of aquifer. Instead, it accelerates runoff to lower elevation.)

4.2 Survey-based Approach Assessment

- **Step 1: Establish the context**

In this project, the target area for risk assessment is Kurunegala. The water management and heat stress are the major topics that will be evaluated based on the stakeholder's feedback and field observations.

- **Step 2: Identify the risks**

In order to identify the most serious risk in the area of water management and heat stress, a detailed indicator should be set up. Based on the Korean cases, KMC developed their own indicators considering the current situation of KMC. The indicators developed by KMC are;

I. Drinking water resources risk/vulnerability to drought
II. Water management risk/vulnerability
III. Water quality and aquatic ecosystem risk/vulnerability
IV. Water resources risk/vulnerability
V. Sanitation risk/vulnerability of drought and flood
VI. Health risk/vulnerability to flood
VII. Health and infrastructure risk/vulnerability to heat stress

- **Step 3: Analyse the risks**

Detailed risk factors for each indicator should be analyzed to determine the most urgent priority for risk of climate change in KMC. The 84 risk factors for indicator were collected from the Korean national and municipal climate change assessment. KMC reviewed the list of risk factors and revised. After the review, the risk factors are finalized with 57 numbers.

- **Step 4: Evaluate the risks**

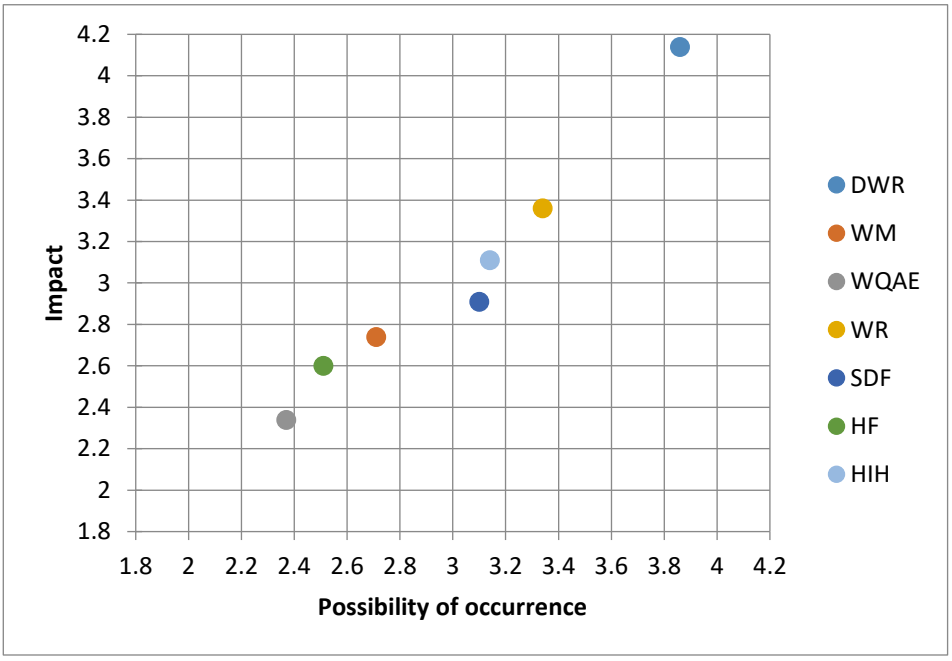
For planning adaptation action plan for KMC, we should prioritize the risk and identify the most urgent and serious climate change impact. A survey was conducted to evaluate the priority of the risk factor. The draft one was prepared by the KEI, which is based on the risk factors reviewed by the KMC. The survey was conducted by 35 experts on climate change adaptation in the KMC. The full version of the questionnaire is attached in Annex B

Based on the results of the survey, we have some coordinate plots including climate change risk factors of Kurunegala. Full version of result in tables and coordinate plots are attached in Annex C.

At the first, the table and coordinate plot of assessment result are following below. As we can see in the figures, 'Drinking water resources risk/vulnerability to drought' is considered as the riskiest indicator. And then 'Water resource risk/vulnerability' is followed. It's clear that the drinking water resource is the most important issue in Kurunegala.

Table 4-5) Results of risk assessment

Code	Category	Number of items	Avg. possibility of occurrence	Avg. Impact	Score	Rank
	Total	**57**	**2.99**	**2.97**	**8.88**	**-**
DWR	Drinking water resources risk/vulnerability to drought	3	3.86	4.14	15.98	1
WM	Water management risk/vulnerability	11	2.71	2.74	7.43	5
WQAE	Water quality and aquatic ecosystem risk/vulnerability	11	2.37	2.34	5.55	7
WR	Water resources risk/vulnerability	11	3.34	3.36	11.22	2
SDF	Sanitation risk/vulnerability of drought and flood	3	3.1	2.91	9.02	4
HF	Health risk/vulnerability to flood	7	2.51	2.6	6.53	6
HIH	Health and infrastructure risk/vulnerability to heat stress	11	3.14	3.11	9.77	3



The result for ‘Drinking water resources risk/vulnerability to drought’ is shown in below and it for ‘Water resources risk/vulnerability’ is following. ‘Lack of drinking water resources due to drought’ is exceptionally considered as a risk factor in ‘Drinking water resources risk/vulnerability to drought’ indicator. Its impact is highly concerned by local experts in Kurunegala. In ‘Water resources risk/vulnerability’ indicator, ‘Lack of water for building maintenance and management’ and ‘Decrease of national water supply capacity due to rainfall pattern change’ are higher risk factors. On the other hands, ‘Loss of fishery according to increase of harmful organisms (i.e. red tide, jellyfish, etc.) due to average water temperature rising’ and ‘Fluctuations in spawning habitat and season of fish and molluscs and crustaceans due to water temperature rising’ are low-effected risk factors because Kurunegala is an inland region.

Table 4-6) DWR (Drinking water resources risk/vulnerability to drought)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
DWR01	Lack of drinking water resources due to drought	3.86	4.14	15.98	1
DWR02	Disruption of drinking water facilities	2.71	2.74	7.43	2
DWR03	Hindrance to water treatment efforts	2.37	2.34	5.55	3

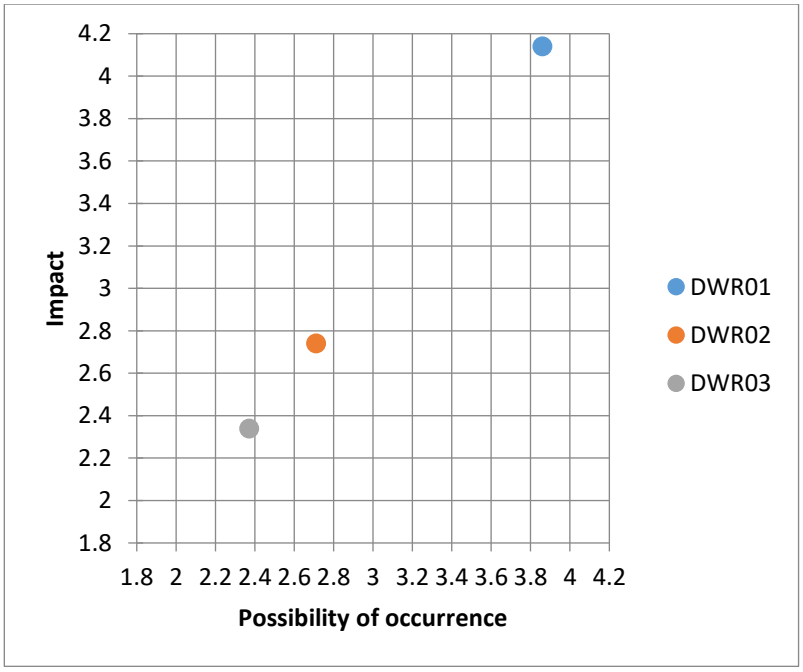
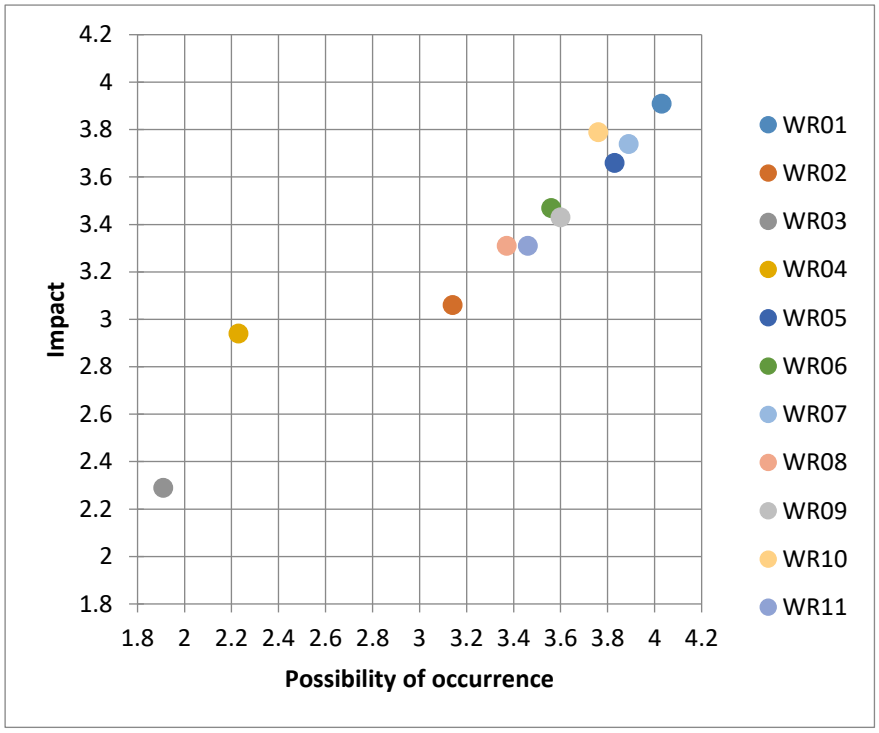


Table 4-7) WR (Water resources risk/vulnerability)

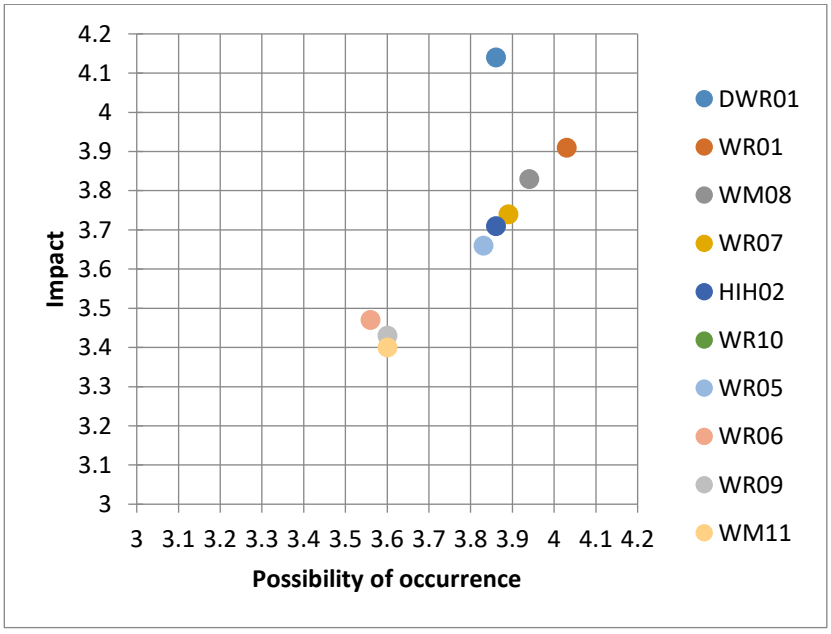
Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
WR01	Lack of water for building maintenance and management	4.03	3.91	15.76	1
WR02	Change in habitat of aquatic flora and fauna	3.14	3.06	9.61	9
WR03	Loss of fishery according to increase of harmful organisms (i.e. red tide, jellyfish, etc.) due to average water temperature rising	1.91	2.29	4.37	11
WR04	Fluctuations in spawning habitat and season of fish and molluscs and crustaceans due to water temperature rising	2.23	2.94	6.56	10
WR05	Increase of water demand due to increase of crop evapotranspiration	3.83	3.66	14.02	4
WR06	Increase of water demand for livestock and animal husbandry due to drought	3.56	3.47	12.35	5
WR07	Decrease of national water supply capacity due to rainfall pattern change	3.89	3.74	14.55	2
WR08	Lack of water for SME industries due to drought	3.37	3.31	11.15	8
WR09	Un-controlled use of groundwater due to lack of water	3.6	3.43	12.35	6
WR10	Increased gap of water supply among regions due to drought	3.76	3.79	14.25	3
WR11	Change in groundwater level due to increase of groundwater use	3.46	3.31	11.45	7



We reviewed 'Top 10, riskiest factors.' Since these factors are considered as top tier risk, the coordinate plot scale is adjusted to 3.0 – 4.2 while the plots above are scaled from 1.8 to 4.2. With the result, we can make a conjecture drought and climate change are big concerns of Kurunegala water and heat stress experts and policy makers.

Table 4-8) The riskiest factors

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
DWR01	Lack of drinking water resources due to drought	3.86	4.14	15.98	1
WR01	Lack of water for building maintenance and management	4.03	3.91	15.76	2
WM08	Drying streams and water bodies (natural and artificial) due to drought	3.94	3.83	15.09	3
WR07	Decrease of national water supply capacity due to rainfall pattern change	3.89	3.74	14.55	4
HIH02	Reduced function of green space and increased loss of green cover due to heat stress	3.86	3.71	14.32	5
WR10	Increased gap of water supply among regions due to drought	3.76	3.79	14.25	6
WR05	Increase of water demand due to increase of crop evapotranspiration	3.83	3.66	14.02	7
WR06	Increase of water demand for livestock and animal husbandry due to drought	3.56	3.47	12.35	8
WR09	Un-controlled use of groundwater due to lack of water	3.6	3.43	12.35	9
WM11	Increased frequency of drought due to persistent non-precipitation days	3.6	3.4	12.24	10



Lastly, we want to figure out what is the first risk factor for each indicator.

Table 4-9) First risk factor for each indicator

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 ecosystems 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 waterborne/ 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

5. Result of Climate Change Awareness Survey

To analyse climate change awareness, two types of survey were conducted. One is the 'Other experts survey' conducted as a view of general residents in Kurunegala while water and heat stress experts proceeded qualitative assessment. The other one is 'Climate change awareness survey for women' aiming at investigating differences in perceptions of climate change focused on women.

5.1 Climate Change Awareness Survey – Other Experts

Climate change awareness survey for other expert was conducted that of 23 other experts who are public workers in Kurunegala. Detailed respondents' information is well-described in *Annex E*.

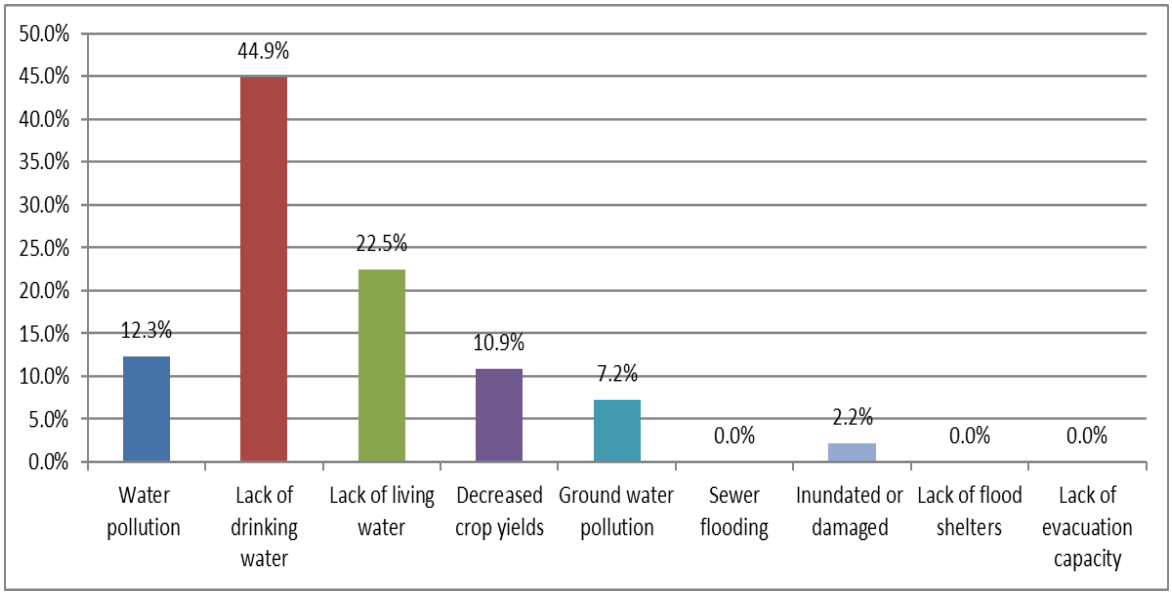


Figure 5-1) The most affected climate change risks - water

Most of the surveyed picked 'Lack of drinking water' (44.9 percent) as the most serious climate change risk followed by 'Lack of living water' (22.5 percent). This result shows that many respondents are in big concerns on scarcity of water resource. The level of awareness among the survey about flooding and evacuation was relatively low (0 percent).

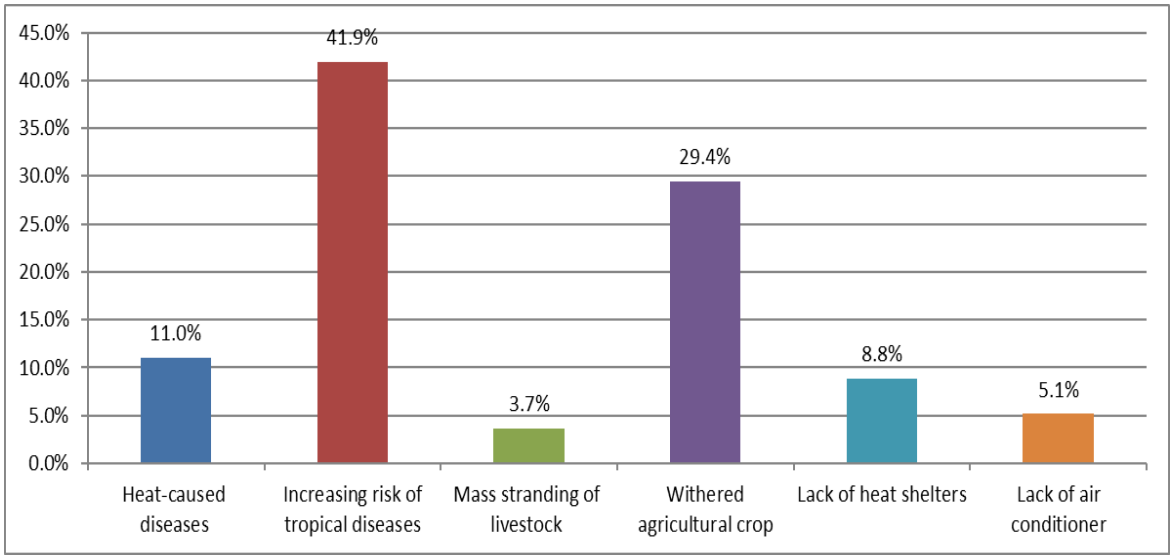


Figure 5-2) The most affected climate change risks - heat

Most of the surveyed selected 'Increasing risk of tropical diseases' (41.9 percent) as the most serious climate change risk, and 'Withered agricultural crop' (29.4 percent) followed. According to response, many respondents belong to health department of KMC that may have huge interests in tropical diseases.

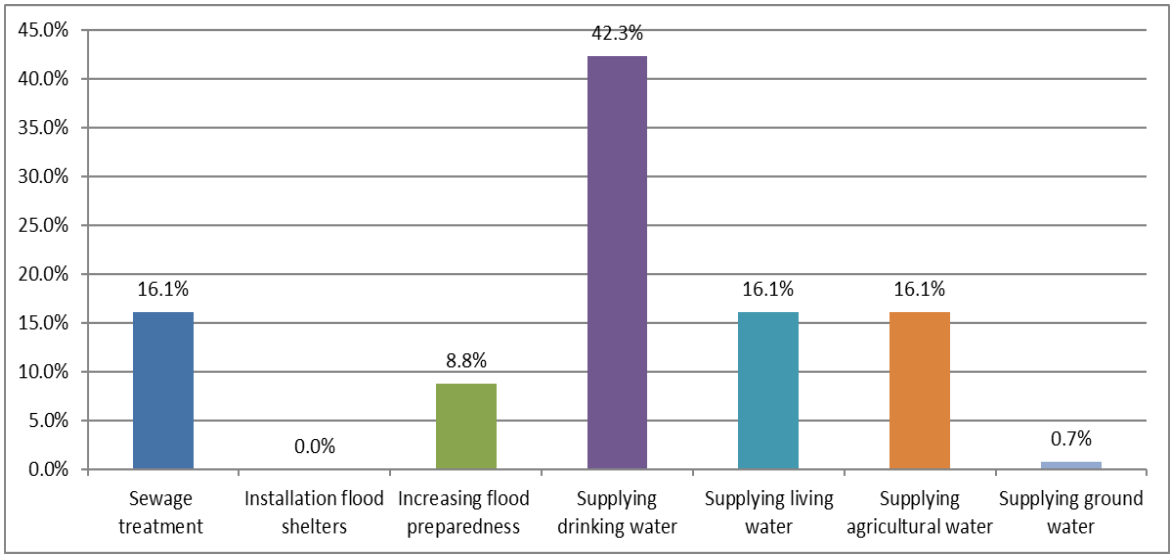


Figure 5-3) The most desirable climate change measures - water

In terms of climate change measures in water, most of the respondents requested water supplying, such as 'Supplying drinking water' (42.3 percent), 'Supplying living water' (16.1 percent) and 'Supplying agricultural water' (16.1 percent). People in Kurunegala also asked 'Sewage treatment' (16.1 percent) while there were few demands for 'Installation flood shelters' (0 percent) and 'Supplying ground water' (0.7 percent).

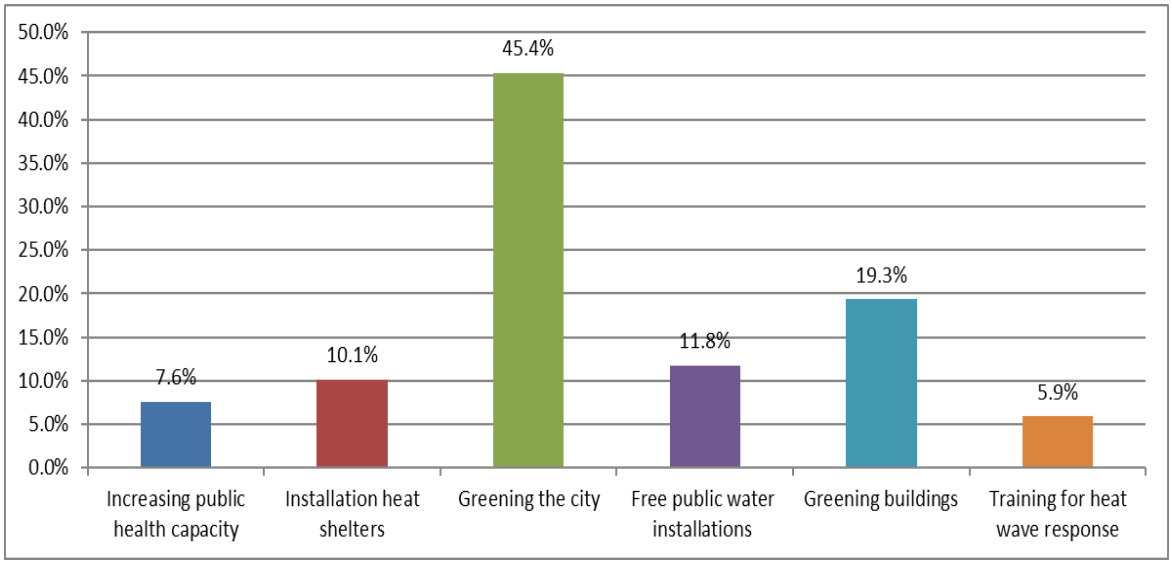


Figure 5-4) The most desirable climate change measures - heat

Almost half of the surveyed desired 'Greening the city' (45.4 percent) as a climate change measure in heat, followed by 'Greening buildings' (19.3 percent). This result shows that Kurunegala wants to have more green area in the city.

5.2 Climate Change Awareness Survey – Women

For the gender equality, CTCN projects need to focus on female specific subject and gender issues. In this paper, we also analyse climate change awareness in the perspective of women. For the 'climate change awareness survey – women' was conducted by 40 females in Kurunegala aged 16 ~ 75. Detailed respondents' information is attached in Annex E.

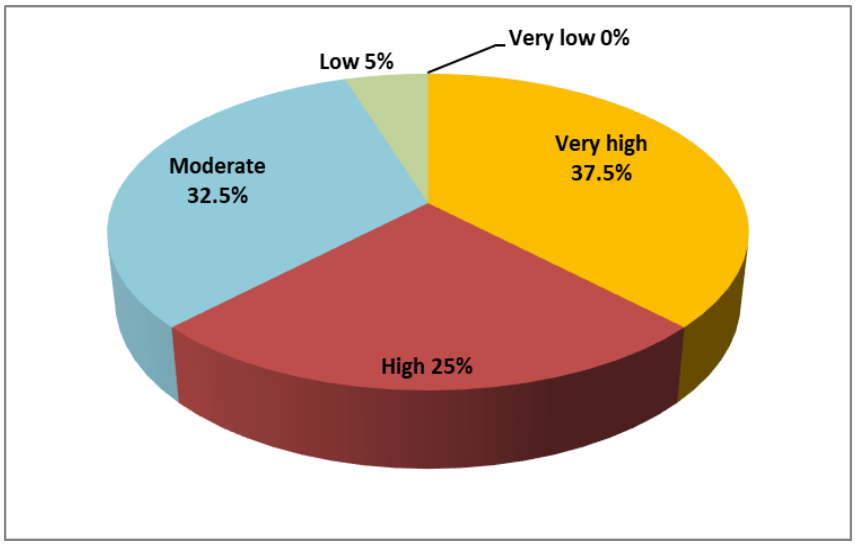


Figure 5-5) Question 1 - How much is climate change influencing the quality of your life?

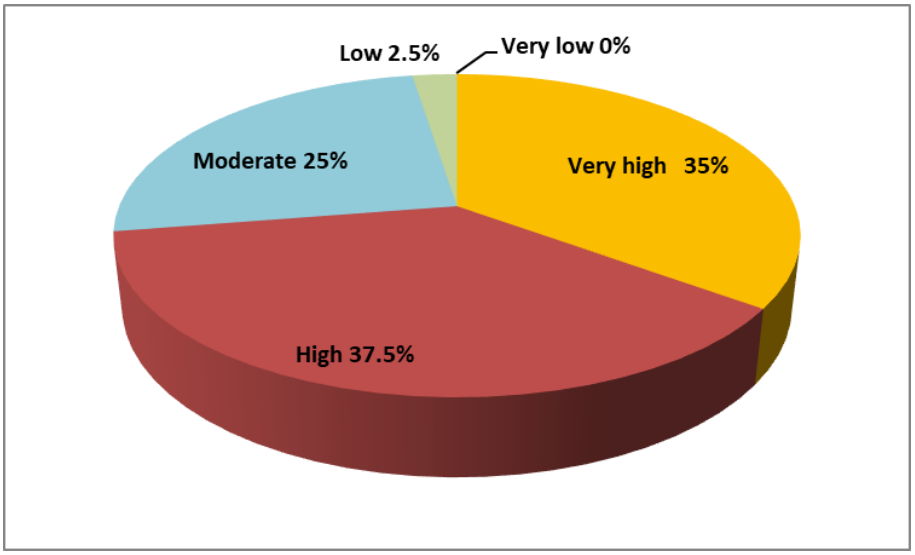


Figure 5-6) Question 2 - How much do you think climate change will influence your life in the next 5 years?

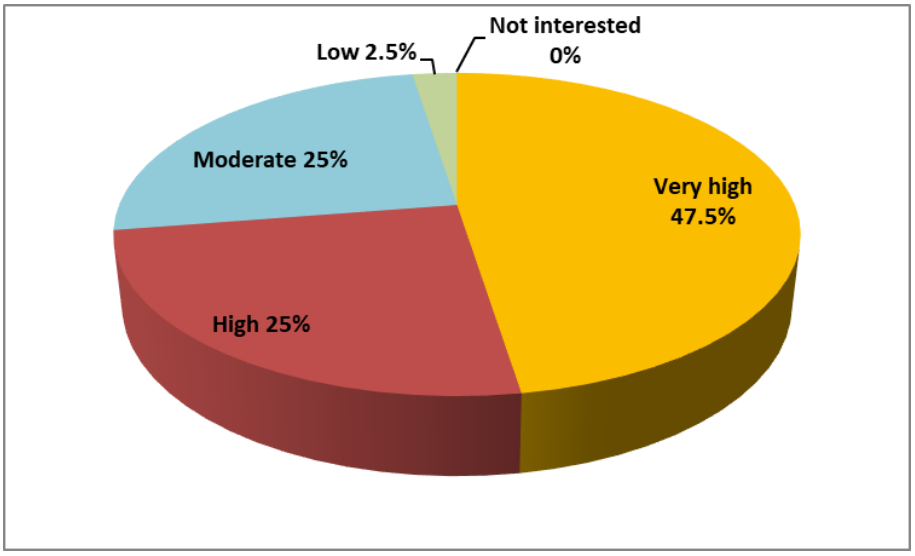


Figure 5-7) Question 3- How severe do you think the climate change impacts are in Kurunegala?

Three questions mentioned above are the main questions to analyse climate change awareness for women in Kurunegala. The first question is asking 'level of climate change influence', and 62.5 percent of the respondents were aware of climate change as high risk of their life ('Very high' – 37.5 percent, 'High' – 25 percent). Meanwhile climate change is considered as huge risk currently, 72.5 percent of the surveyed concerned about climate change in near future (Question 2, 'Very high' – 35 percent, 'High' – 37.5 percent). Moreover, most of respondents identify climate change impact is a severe risk of their

society, Kurunegala. Almost half of respondents, 47.5 percent, thought climate change impact is 'Very high' risk and 25 percent agreed that it is 'High' risk.

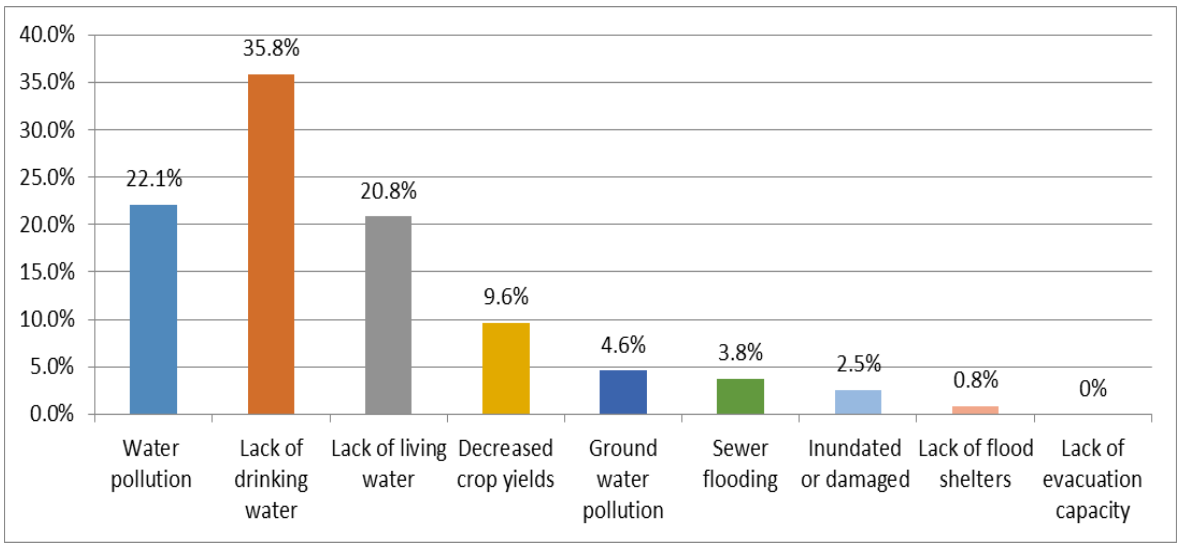


Figure 5-8) The most affected climate change risks - water

Like as other experts survey, most of the surveyed selected 'Lack of drinking water' (35.8 percent) as the most serious climate change risk, followed by 'Lack of living water' (20.8 percent).

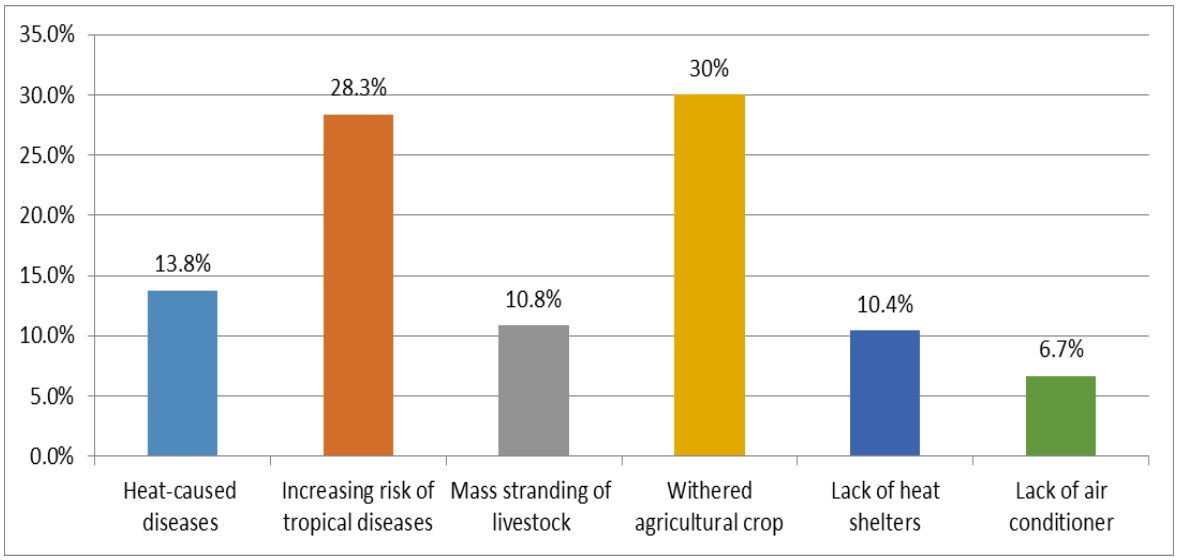


Figure 5-9) The most affected climate change risks - heat

Most of the surveyed selected 'Withered agricultural crop (30 percent) as the most serious climate change risk, followed by 'Increasing risk of tropical diseases' (28.3 percent).

6. Conclusions

This report covered the process of risk and vulnerability assessment in Kurunegala and its result. It is important that the information delivered to the general residents about climate change and its associated risks is correct and clear. People in Kurunegala are highly concerned climate change although most of them are lack of awareness on water resources and health including heat waves and tropical diseases.

Heat stress has been experienced by the residents in communities but there is no published information related to health hazards due to heat stress. No records are available with the Medical Officer of Health indicating the relationship between heat stress and health.

Water scarcity due to prolonged drought which may be exacerbated by anthropological interventions is not documented.

Findings from surveys of people's awareness of climate change and adaptation needs should be taken into account in climate change adaptation action plan.

7. References

City of Copenhagen (2011) Copenhagen Climate Adaptation Plan. [COWI, DELOITTE, RAMBØLL, DMI, KU-LIFE, DHI AND GRAS (eds.)]. City of Copenhagen, Denmark.

City of Vancouver (2012), Climate Change Adaptation Strategy. Vancouver, Canada. https://vancouver.ca/files/cov/Vancouver-Climate-Change-Adaptation-Strategy-2012-11-07.pdf

IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.

UNISDR (2017) Annual Report 2017. 2016-17 Biennium Work Programme Final Report. United Nations, Geneva, Switzerland.

Annex A. List of Indicators and Data Sources for Quantitative Analysis

(1) Drinking water resources risk/vulnerability to drought

Category		Factor	Data Source
Risk (AR-5)	Hazard	Consecutive dry days	Department of Meteorology, Colombo
		Occurrence of extreme rainfall anomalies - Stranded Precipitation Index (SPI)	Department of Meteorology, Colombo
		Change in maximum temperature	Department of Meteorology, Colombo
		Monthly Average Evaporation	Department of Meteorology, Colombo
	Exposure	Population Density	Through Grama Niladhari and Questionnaire survey
		Tax Units	Kurunegala Municipal Council
		Population receiving government assistances	Through Grama Niladhari and Questionnaire survey
		Livestock population	Questionnaire survey
	Vulnerability	Number of female lead households	Through Grama Niladhari and Questionnaire survey
		Tax units which haven't secondary water sources	Questionnaire survey
		Monthly water usage	Questionnaire survey
		Number of household who are getting medicine through regular clinic	Questionnaire survey
	Capacity	Water supply ratio	Kurunegala Municipal Council
		Bowser water supply	Kurunegala Municipal Council
		Access to information	Questionnaire survey
		Number of water bottles used (purchased) per day	Questionnaire survey
		Availability of secondary water source	Questionnaire survey
		Tax amount	Kurunegala Municipal Council
		Number of hospitals, day care, schools	Through Grama Niladhari and Questionnaire survey

Drinking water resources risk/vulnerability to drought (*as an example)*

Category	Factor	Data/Variable	Rational	Data Source	Functional Relationship (+or -)
Hazard	Consecutive dry days	Maximum number of consecutive days when precipitation is less than 1mm-1990 - 2015-time series.	An increase in this indicator suggests an increase in the duration of droughts. Reservoirs and ground water levels drop and caused decreasing water supply.	Department of Meteorology, Colombo	+
	Occurrence of extreme rainfall anomalies - Stranded precipitation Index (SPI)	Depending on the drought impact in question, SPI values for 3 months or less might be useful for basic drought monitoring, values for 6 months or less for monitoring agricultural impacts and values for 12 months or longer for hydrological impacts-1990 - 2015-time series.	Longer the SPI may contribute to metrological drought. This contributed to maximum length of drought period.	Department of Meteorology, Colombo	+
	Change in maximum temperature	Average Number of days of which exceeds the day time temperature of 34^0C-1990 - 2015-time series .	Loss of water in surface waters due to rapid evaporation. Increasing magnitude of the offset increases the vulnerability/risk.	Department of Meteorology, Colombo	+
	Monthly Average Evaporation	Monthly average evaporation-1990 - 2015-time series in dray period	Higher the surface area exposed higher the risk of evaporation during droughts.	Department of Meteorology, Colombo	+
Exposure	Population Density	Most reason population density (number of peoples/km^2)	Higher the population density (number of peoples/km^2) will highly demand for the water.	Through Grama Niladhari and Questionnaire survey	+

	Tax units	Total number of tax unit for /km^2	Higher the number of tax unit for /km^2 will impacted to drought	Kurunegala Municipal Council	+
	Population receiving Government assistances	Percentage (%) of population receiving Government assistances, subsidies etc.	Better identification of real vulnerable groups based on more comprehensive factors (political rigidity, population growth, poverty, culture, dependency, geographic isolation and activities etc.). Increased poverty, there is a move towards high risk/vulnerability to water during the drought period .	Through Grama NIladhari and Questionnaire survey	+
	Livestock Population	Total number of livestock (checken+cow+pig)population in each GND	Higher the livestock number may have impacted due to drought.	Questionnaire survey	+
Vulnerability	Number of female lead households	Number of female lead house holds	Higher the number of female led household the risk due to (access to water) drought hazards is higher as limited access to sources outside their premises	Through Grama NIladhari and Questionnaire survey	+
	Tax units which haven't secondary water sources	Total number of tax units does not have secondary water sources	Tax units which haven't secondary water sources lead to higher vulnerable during the drought period	Questionnaire survey	+
	Monthly water usage	Monthly average water usage	Monthly average water usage	Questionnaire survey	-
Capacity	Water Supply ratio	Water Supply ratio (%)	Higher the water supply ratio will reduced the water scarcity	Kurunegala Municipal Council	-

	Bowser water supply	Water supply through bowsers during the drought period	Amount of water supply through bowsers during the drought period will reduce the water stress	Kurunegala Municipal Council	-
	Access to information	Number of families/ persons with modern communication facilities	Increase access to information facilitates affected families to be better prepared	Questionnaire survey	-
	Number of water bottles used (purchased) per day	Affordability and effectiveness of delivery system	Indicator to assess water stress	Questionnaire survey	-
	Availability of secondary water source	Total number of unit which are available with the secondary water source	Higher the number of availability of secondary water sources may reduce the water scarcity during the drought	Questionnaire survey	-
	Number of house hold who are getting medicine through regular clinic	Total number of people who are getting medicine through regular clinic	Higher the number of people who are getting medicine through regular clinic may highly vulnerable to drought	Questionnaire survey	+
	Number of hospitals, day care, schools	Maximum capacity of hospitals, day care, schools	Higher the number of proportion of, hospitals, day care, schools lead to higher risk/vulnerability	Through Grama NIladhari	+
	Tax amount	Total number of tax revenue in each word (alternative indicator for GRDP)	Higher the number of tax revenue in each word may lesser vulnerable	Kurunegala Municipal Council	-

** Prepared by KMC*

(2) Water management risk/vulnerability

Category		Factor	Data Source
Risk (AR-5)	Hazard	Occurrence of extreme rainfall anomalies	Department of Meteorology, Colombo
		Consecutive wet days	Department of Meteorology, Colombo
		Consecutive dry days (days)	
		Number of flood events - 1986 to 2017 (1986 -2000, 20%; 2001 -2017, 80%)	Disaster Management Center- Disinventa database
	Exposure	Population Density	Through Grama Niladhari and Questionnaire survey
		Water supply	Kurunegala Municipal Council and Water board
		Livestock Population	Questionnaire survey
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
		% of area of lowland area	LUPPD
	Vulnerability	Number of female lead households	Through Grama NIladhari and Questionnaire survey
		Availability of secondary water sources (well water)	Questionnaire survey
		Industrial water usage (thousand m3/y)	
		Agricultural water usage (thousand m3/y)	
		Living water usage (thousand m3/y)	
	Capacity	Access to information	Questionnaire survey
		Number of water bottles used (purchased) per day	Questionnaire survey
		Availability of secondary water source	Questionnaire survey
		Water purification cost	Questionnaire survey
		Tax amount	Kurunegala Municipal Council
		Water supply ratio (%)	
		Reservoir capacity for water supply per unit of area (thousand m3)	
		Number of hospitals, day care, schools	Through Grama NIladhari
		Inland drainage facilities	Water board

(3) Water quality and aquatic ecosystem risk/vulnerability

Category		Factor	Data Source
Risk (AR-5)	Hazard	Occurrence of extreme rainfall anomalies	Department of Meteorology, Colombo
		Consecutive wet days	Department of Meteorology, Colombo
		Consecutive dry days	Department of Meteorology, Colombo
		Occurrence of extreme rainfall anomalies - Stranded precipitation Index (SPI)	Department of Meteorology, Colombo
	Exposure	% of area of lowland area	LUPPD
		Aquatic Fauna and Flora recorded	Biodiversity Secretariat
		Land Management ratio	LUPPD
		Different type of aquatic eco systems	
	Vulnerability	Area of special ecosystems	Through Grama NIladhari and Questionnaire survey
		Cover of savage connection	Water Board
		Threaten aquatic Species	Biodiversity Secretariat
		Monthly water usage	Questionnaire survey
		Livestock Population	Questionnaire survey
		Number of household who are getting medicine through regular clinic	Questionnaire survey
	Capacity	Water Supply ratio	Kurunegala Municipal Council
		Bowser water supply	Kurunegala Municipal Council
		Access to information	Questionnaire survey
		Number of water bottles used (purchased) per day	Questionnaire survey
		Availability of secondary water source	Questionnaire survey
		Water purification cost	Questionnaire survey
		Number of hospitals, day care, schools	Through Grama NIladhari
		Tax amount	Kurunegala Municipal Council
		Average number of sanitation facilities	PHI
		Sealed shops due to poor sanitation	Questionnaire survey

(4) Water resources risk/vulnerability

Category		Factor	Data Source
Risk (AR-5)	Hazard	Consecutive dry days	Department of Meteorology, Colombo
		Occurrence of extreme rainfall anomalies - Stranded precipitation Index (SPI)	Department of Meteorology, Colombo
		Change in maximum temperature	Department of Meteorology, Colombo
		Monthly Average Evaporation	Department of Meteorology, Colombo
	Exposure	Population Density	Through Grama Niladhari and Questionnaire survey
		Tax units	Kurunegala Municipal Council
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
		Livestock Population	Questionnaire survey
	Vulnerability	Number of female lead households	Through Grama NIladhari and Questionnaire survey
		Tax units which haven't secondary water sources	Questionnaire survey
		Monthly water usage	Questionnaire survey
		Cost of flood damage for recent 3 years (USD or LKR)	
		Number of casualties by floods for recent 3 years (number of people)	
		Average slope (degree)	
		River levee (bank) area ratio (%)	
		Number of household who are getting medicine through regular clinic	Questionnaire survey
	Capacity	Water Supply ratio	Kurunegala Municipal Council
		Bowser water supply	Kurunegala Municipal Council
		Access to information	Questionnaire survey
		Number of water bottles used (purchased) per day	Questionnaire survey
		Availability of secondary water source	Questionnaire survey
		Number of hospitals, day care, schools	Through Grama NIladhari
		Tax amount	Kurunegala Municipal Council
		Reservoir capacity (Thousand ton)	

(5) Sanitation risk/vulnerability of drought and flood

Category		Factor	Data Source
Risk (AR-5)	Hazard	Consecutive dry days	Department of Meteorology, Colombo
		Stranded precipitation Index (SPI)	Department of Meteorology, Colombo
		Occurrence of extreme rainfall anomalies	Department of Meteorology, Colombo
		Consecutive wet days	Department of Meteorology, Colombo
		Number of flood events - 1986 to 2017 (1986-2000, 20%; 2001-2017, 80%)	
	Exposure	Population Density	Through Grama Niladhari and Questionnaire survey
		Tax units	Kurunegala Municipal Council
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
		Average number of sanitation facilities	PHI
	Vulnerability	Number of female lead house holds	Through Grama NIladhari and Questionnaire survey
		Dependency ratio - income	Questionnaire survey
		Number of household who are getting medicine through regular clinic	Questionnaire survey
		Number of schools and welfare facilities for the aged	
	Capacity	Water Supply ratio	Kurunegala Municipal Council
		Sealed shops due to poor sanitation	Questionnaire survey
		Cover of savage connection	Water Board
		Access to information	Questionnaire survey
		Number of hospitals	
		Number of public official for sanitation	

(6) Health risk/vulnerability to flood

Category		Factor	Data Source
Risk (AR-5)	Hazard	Occurrence of extreme rainfall anomalies	Department of Meteorology, Colombo
		Consecutive wet days	Department of Meteorology, Colombo
		Number of flood events - 1986 to 2017 (1986 -2000, 20%; 2001 -2017, 80%)	Disaster Management Center- Disinventa database
		Population Density	Through Grama Niladhari and Questionnaire survey
	Exposure	Population aged 14 or younger	Through Grama Niladhari and Questionnaire survey
		Population aged 65 or older	Through Grama Niladhari and Questionnaire survey
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
		Recorded water bone diseases	PHI
		% of area of lowland area	LUPPD
		Livestock Population	Questionnaire survey
	Vulnerability	Number of female lead households	Through Grama NIladhari and Questionnaire survey
		Number of household who are getting medicine through regular clinic	Questionnaire survey
		Number of schools and welfare facilities for the aged	
	Capacity	Access to information	Questionnaire survey
		Tax amount	Kurunegala Municipal Council
		% of rain water collection (including detention facilities)	Questionnaire survey
		Educational level	Questionnaire survey
		% of health insuranced population (%)	
		Number of hospitals	
		Number of public official for sanitation	

(7) Health and infrastructure risk/vulnerability to heat stress

Category		Factor	Data Source
Risk (AR-5)	Hazard	Consecutive dry days	Department of Meteorology, Colombo
		Occurrence of extreme rainfall anomalies - Stranded precipitation Index (SPI)	Department of Meteorology, Colombo
		Change in maximum temperature	Department of Meteorology, Colombo
		Monthly Average Evaporation	Department of Meteorology, Colombo
		Temperature Humidity Impact	Department of Meteorology, Colombo
		Urban Heat Island	UHI study
	Exposure	Population Density	Through Grama Niladhari and Questionnaire survey
		School, daycare centers and Kindergarten	Through Grama Niladhari and Questionnaire survey
		Population aged 14 or younger	Through Grama Niladhari and Questionnaire survey
		Population aged 65 or older	Through Grama Niladhari and Questionnaire survey
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
		Livestock Population	Questionnaire survey
		Road and Rail road	Questionnaire survey
	Vulnerability	Number of female lead households	Through Grama NIladhari and Questionnaire survey
		Tax units which haven't fans or AC	Questionnaire survey
		Number of household who are getting medicine through regular clinic	Questionnaire survey
		Urbanization rate	
		Population receiving Government assistances	Through Grama NIladhari and Questionnaire survey
	Capacity	Water Supply ratio	Kurunegala Municipal Council
		Availability of Fans and, AC	Questionnaire survey
		Access to information	Questionnaire survey
		Health Insurance	Questionnaire survey
		Tax amount	Kurunegala Municipal Council
		Educational level	Questionnaire survey
		Forest cover (green area)	LUPPD data
		Number of shelters and cooling centre	
		Number of hospitals	
		Number of public official for sanitation	

Annex B. Survey Lists

(1) Expert Survey

Climate Change Risk Assessment – Water and Heat Stress Experts

First of all, thank you for participating in the survey.

This time, the KEI (Korea Environment Institute) and KMC (Kurunegala Municipal Council) are conducting a research to support the establishment of Climate Change Adaptation Plan in Kurunegala, Sri Lanka.

The purpose of this survey is to identify and assess the risks caused by climate change and to support the establishment of Climate Change Adaptation Plan.

Risk assessment in climate change provides an opportunity to systematically and comprehensively look at the risks that may arise from climate change.

Your response will be used as a basis for establishing Climate Change Adaptation Plan, and your responses will be kept strictly confidential.

Please take a moment to respond. Thank you.

2019. 07.

Korea Environment Institute & Kurunegala Municipal Council

* If you have any questions regarding this survey, please feel free to contact us.

Principal Investigator	Hanna Cho	**Researcher**	Hyelim Jeong
e-mail	hncho@kei.re.kr	**e-mail**	hljeong@kei.re.kr

Respondent Information

1) Name		
2) Title, Organization		
3) Professional field	a. Water	b. Heat stress and health

Please rate the possibility of occurrence (percentage) and impact (scale) of each sector risk item in Kurunegala within the next 5 years according to the rating standard below.

Risk is the combination of the likelihood (probability of occurrence) and the consequences of an adverse event (e.g. climate hazard). It is interrelated with 'Vulnerability', 'Exposure' and 'Hazards', being calculated as the following formula. - ***Percentage of its possibility of occurrence x Impact***

Table 1 Guidance on Possibility of Occurrence (percentage)

Category	Score	Evaluation Criteria
Possibility of Occurrence	Very Severe (5)	• Very likely to occur
	Severe (4)	• Likely to occur
	Moderate (3)	• May occur
	Low (2)	• Low possibility to occur
	Very Low (1)	• Not likely to occur

Table 2 Guidance on Impacts (Scale)

Category	Score	Evaluation Criteria
Impact (scale)	Very Severe (5)	• Severe and repeated damage on infrastructure and property • Serious disruption in providing community services • Overall impacts on vulnerable classes of the society • Extensive damage to the ecosystem • Influence the personal identity of individuals • Detrimental influence on all parts and sectors of the society
	Severe (4)	• More severe than 'Moderate', yet less intense than 'Very Severe'
	Moderate (3)	• Damage to infrastructure or property • Expanded social Inequality • Serious disruption in providing community services • Mobilization of emergency services • Damage of ecosystems • Slight influence the personal identity of individuals • Detrimental influence on all parts and sectors of the society
	Low (2)	• More severe than 'Very Low', yet less intense than 'Moderate'
	Very Low (1)	• Mild impacts • Minor impacts on the economy • Short-term, recoverable impact on the ecosystem • Damage on not many personnel • Tolerable damages

※ *Please answer the following risk items.*

■ Drinking water resources risk/vulnerability

: Risk or vulnerability on sources of useful or potentially useful portable water.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
DWR01	Drought	Lack of drinking water resources due to drought										
DWR02	Flood	Disruption of drinking water facilities										
DWR03	Flood	Hindrance to water treatment efforts										

■ Water management resources risk/vulnerability

: Risk or vulnerability on water management that is the control and movement of water resources to minimize damage to life and property and to maximize efficient beneficial use

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
WM01	Flood	Disruption and functional degradation of river facility (i.e. embankment, bridge, etc.)										
WM02	Flood	Influence on the operation of waterworks facilities (i.e. less access to operational mechanism)										
WM03	Flood	Economic loss due to impact from interruption of transportation and industry related with rivers and canals										
WM04	Flood	Increase of damaged irrigation facilities due to flood										
WM05	Flood	Increase of property assets loss due to increased frequency of flood										
WM06	Flood	Damage to drainage facilities (i.e. storm sewer system, etc.) due to increase in urban sediment drainage and high volume of water										
WM07	Drought /Flood	Increased cost risk due to lack of industrial water and water treatment due to water quality deterioration										
WM08	Drought	Drying streams and water bodies (natural and artificial) due to drought										
WM09	Flood	Decrease of safety and increase of destruction risk of water supply and repair facilities										

WM10	Flood	Change in flooding occurrence and floodplains due to flood										
WM11	Drought	Increased frequency of drought due to persistent non-precipitation days										

■ Water quality and aquatic ecosystem risk/vulnerability

: Risk or vulnerability on water quality that the condition or health of waterways, like rivers, wetlands.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
WQAE01	Drought	Water quality deterioration due to pathogenic bacteria by temperature rising										
WQAE02	Storm	Increase of water pollution risks due to excessive inflow of land pollution source (i.e. living sewage, industrial wastewater, etc.) by heavy rain										
WQAE03	Drought, Flood	Fluctuations in water ecology according to rainfall pattern change										
WQAE04	Drought, Flood	Water quality deterioration due to rainfall pattern change										
WQAE05	Ambient Temp.	Increase of algal blooms and deterioration of aquatic ecosystem due to average water temperature rising										
WQAE06	Avg. water temp. rising	Increase of diseases and new pathogenic microorganisms occurrence due to water temperature rising										
WQAE07	Avg. water temp. rising	Acceleration of extinction of endangered species and endemic species by climate change										
WQAE08	Storm	Effluence increase due to fertilizer, pesticides and animal wastes according to rainfall intensification										
WQAE09	Temp. rising	Increase of abnormal reproduction of alien invasive species										
WQAE10	Avg. water temp. rising	Fluctuations in species composition and spawning season of fish										
WQAE11	Avg. water temp. rising	Fluctuations in species composition and spawning season of mollusca and crustaceans										

* Avg. = Average, Temp. = Temperature

■ Water resources risk/vulnerability

: Risk or vulnerability on resource of water that is useful or potentially useful, for agricultural, industrial, household, recreational and environmental activities.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
WR01	Heat stress, drought	Lack of water for building maintenance and management										
WR02	Avg. water temp. rising	Change in habitat of aquatic flora and fauna										
WR03	Avg. water temp. rising	Loss of fishery according to increase of harmful organisms (i.e. red tide, jellyfish, etc.) due to average water temperature rising										
WR04	Avg. water temp. rising	Fluctuations in spawning habitat and season of fish and molluscs and crustaceans due to water temperature rising										
WR05	Drought	Increase of water demand due to increase of crop evapotranspiration										
WR06	Drought	Increase of water demand for livestock and animal husbandry due to drought										
WR07	Drought	Decrease of national water supply capacity due to rainfall pattern change										
WR08	Drought	Lack of water for SME industries due to drought										
WR09	Drought	Un-controlled use of groundwater due to lack of water										
WR10	Drought	Increased gap of water supply among regions due to drought										
WR11	Drought	Change in groundwater level due to increase of groundwater use										

* Avg. = Average, Temp. = Temperature

■ Sanitation risk/vulnerability of drought and flood

: Risk or vulnerability on sanitation that is the process of keeping places clean and healthy, especially by providing a sewage system and a clean water supply, due to drought and flood.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
SDF01	Drought, flood	Increase of waterborne diseases										
SDF02	Flood	Overflow of toilet										
SDF03	Drought	Lack of water for toilet usage										

■ Health risk/vulnerability to flood

: Risk or vulnerability on health that is impacted by flood.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
HF01	Flood	Increase of mortality rate due to disaster										
HF02	Flood	Increase of injury rate due to disaster										
HF03	Flood	Lack of Focused management on health vulnerable groups (i.e. infants and the elderly)										
HF04	Flood	Increase of medical demand and lack of medical supply due to disaster										
HF05	Flood	Increase of waterborne diseases (i.e. typhoid, cholera, bacterial heterogeneity, etc.) through water and food										
HF06	Flood	Increase of health problems (i.e. falls, trauma, etc.) due to safety accidents with flood										
HF07	Flood	Increase of vector borne diseases										

■ Health and infrastructure risk/vulnerability to heat stress and drought

: Risk or vulnerability on health and infrastructure that is impacted by heat stress and drought.

Code	Cause	Risk Factor	Possibility of occurrence					Impact (scale)				
			①	②	③	④	⑤	①	②	③	④	⑤
HIH01	Avg. water temp. rising, drought	Increased intensification of the Urban Heat Island (UHI) phenomenon										
HIH02	Heat stress	Reduced function of green space and increased loss of green cover due to heat stress										
HIH03	Avg. water temp. rising	Increase of waterborne diseases such as diarrhea caused by drought										
HIH04	Avg. water temp. rising	Increase of morbidity and infectious diseases (i.e. infectious diseases, etc.) due to average temperature rising										
HIH05	Heat stress	Increase of mortality due to heat wave										
HIH06	Heat stress	Increase of cardiovascular diseases due to heat wave										
HIH07	Heat stress	Increase of impacts on vulnerable groups due to intensification of Urban Heat Island (UHI) phenomenon caused by heat stress										

HIH08	Heat stress	Decrease of labor productivity and labor time due to heat stress											
HIH09	Heat stress	Increase of demand for consumer goods suitable for heat stress											
HIH10	Heat stress	Increase of medical demand due to heat stress											
HIH11	Heat stress	Increase of limited outdoor activities tourisms due to heat stress											

* Avg. = Average, Temp. = Temperature

(2) Other Expert – Climate Change Awareness

Thank you for participating in the survey.

The purpose of this survey is to identify and assess the risks caused by climate change and to support the establishment of Climate Change Adaptation Plan. Your response will be used as a basis for establishing Action Plan, and your responses will be kept strictly confidential. We would appreciate it if you could please take a moment to answer the questionnaire.

2019. 07.

Korea Environment Institute & **Kurunegala Municipal Council**

* If you have any questions regarding this survey, please feel free to contact us.

Principal Investigator	Hanna Cho	**Researcher**	Hyelim Jeong
e-mail	hncho@kei.re.kr	**e-mail**	hljeong@kei.re.kr

Climate Change Awareness Survey – Other Experts

Respondent Information

1) Name	
2) Title, Organization	
3) Professional field	

Please rank the top 3 climate change risks affect you.

Category	Climate change risks	Rank
Water	Water pollution	
	Lack of drinking water	
	Lack of living water	
	Decreased crop yields due to lack of agricultural water	
	Ground water pollution	
	Sewer flooding	
	Inundated (flooded) or damaged houses and victims by flood	
	Lack of flood shelters	
	Lack of evacuation capacity	
Heat wave	Heat-caused diseases such as heatstroke	
	Increasing risk of tropical diseases such as dengue	
	Mass stranding (died en masse) of livestock caused by heat	
	Withered agricultural crop	
	Lack of heat shelters	
	Lack of air conditioner	

We would be very grateful if you could be able to provide your additional thoughts of the climate change risks affect you.

(_____)

Please rank the top 3 climate change measures that need to be prioritized.

Category	Climate change measures	Rank
Water	Sewage treatment	
	Installation flood shelters	
	Increasing preparedness for floods	
	Supplying drinking water	
	Supplying living water	
	Supplying agricultural water	
	Supplying ground water	
Heat wave	Increasing public health capacity (e.g. installation of health centers)	
	Installation heat shelters	
	Greening the city	
	Free public water installations (e.g. (drinking) fountain)	
	Greening buildings (e.g. green roof)	
	Training for heat wave response	

We would be very grateful if you could be able to provide your additional thoughts to adapt to climate change.

(_____)

(3) Survey for women – Climate Change Awareness

Thank you for participating in the survey.

The purpose of this survey is to identify and assess the risks caused by climate change and to support the establishment of Climate Change Adaptation Plan. Your response will be used as a basis for establishing Action Plan, and your responses will be kept strictly confidential. We would appreciate it if you could please take a moment to answer the questionnaire.

2019. 06.

Korea Environment Institute & **Kurunegala Municipal Council**

* If you have any questions regarding this survey, please feel free to contact us.

Principal Investigator	Hanna Cho	**Researcher**	Hyelim Jeong
e-mail	hncho@kei.re.kr	**e-mail**	hljeong@kei.re.kr

Climate Change awareness survey: Kurunegala (for Women)

1. Respondent Information

1) Age		2) Residence	District:
3) Occupation	① Government Official ② Office worker/ Technician ③ Sales/Marketing ④ Freelance ⑤ Production/transportation ⑥ Self employed ⑦ House wife ⑧ Student ⑨ No job ⑩ ETC (_____)		

2. How much is climate change influencing the quality of your life?

① Very much ② A lot ③ Moderate ④ Not quite ⑤ Not at all

3. How much do you think climate change will influence your life in the next 5 years?

① Very much ② A lot ③ Moderate ④ Not quite ⑤ Not at all

4. How severe do you think the climate change impacts are in Kurunegala?

① Very much ② A lot ③ Moderate ④ Not quite ⑤ I don't know/ Not interested

5. Please rank the top 3 climate change risks affect you.

Category	Climate change risks	Rank
Water	Water pollution	
	Lack of drinking water	
	Lack of living water	
	Decreased crop yields due to lack of agricultural water	
	Ground water pollution	
	Sewer flooding	
	Inundated (flooded) or damaged houses and victims by flood	
	Lack of flood shelters	
	Lack of evacuation capacity	
Heat wave	Heat-caused diseases such as heatstroke	
	Increasing risk of tropical diseases such as dengue	
	Mass stranding (died en masse) of livestock caused by heat	
	Withered agricultural crop	
	Lack of heat shelters	
	Lack of air conditioner	

6. We would be very grateful if you could be able to provide your additional thoughts of the climate change risks affect you.

(_____)

7. Please rank the top 3 climate change measures that need to be prioritized.

Category	Climate change measures	Rank
Water	Sewage treatment	
	Installation flood shelters	
	Increasing preparedness for floods	
	Supplying drinking water	
	Supplying living water	
	Supplying agricultural water	
	Supplying ground water	
Heat wave	Increasing public health capacity (e.g. installation of health centers)	
	Installation heat shelters	
	Greening the city	
	Free public water installations (e.g. (drinking) fountain)	
	Greening buildings (e.g. green roof)	
	Training for heat wave response	

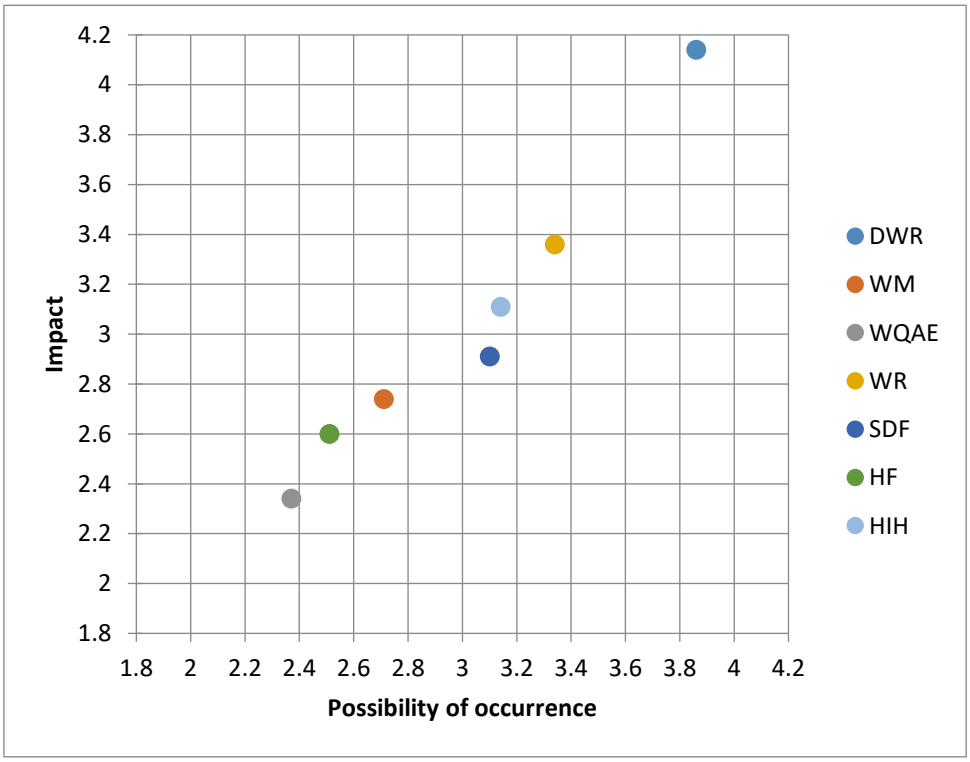
8. We would be very grateful if you could be able to provide your additional thoughts to adapt to climate change.

(_____)

Annex C. Result of Qualitative Risk Assessment

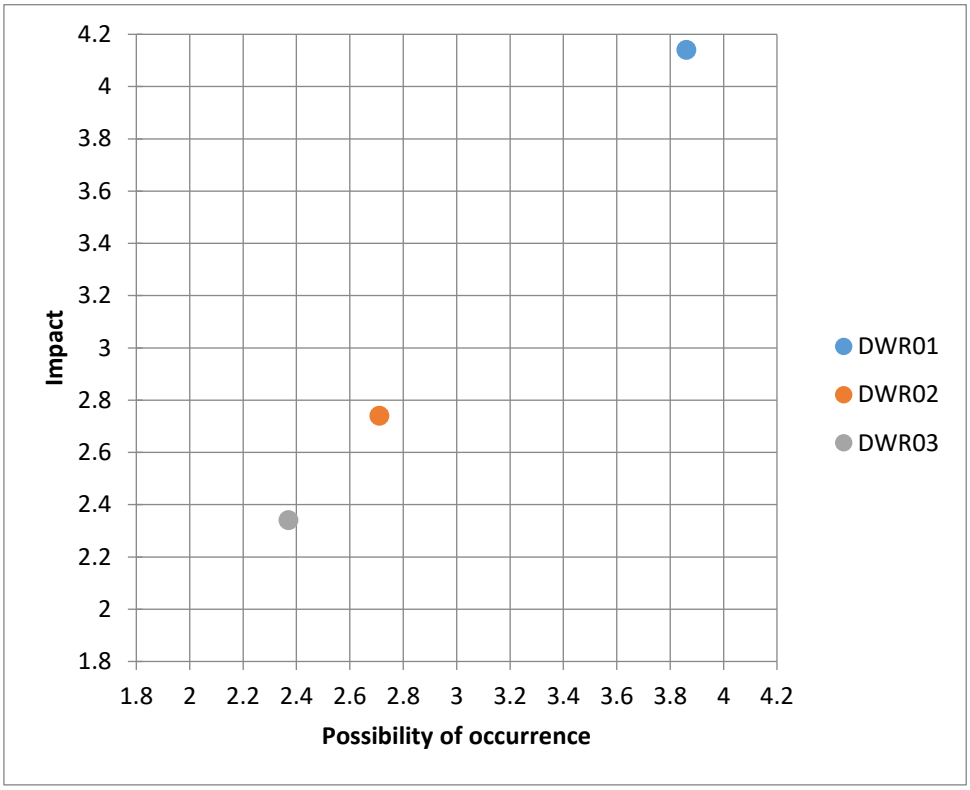
1. Results of qualitative risk assessment (in total)

Code	Category	Number of items	Avg. possibility of occurrence	Avg. Impact	Score	Rank
	Total	**57**	**2.99**	**2.97**	**8.88**	**-**
DWR	Drinking water resources risk/vulnerability to drought	3	3.86	4.14	15.98	1
WM	Water management risk/vulnerability	11	2.71	2.74	7.43	5
WQAE	Water quality and aquatic ecosystem risk/vulnerability	11	2.37	2.34	5.55	7
WR	Water resources risk/vulnerability	11	3.34	3.36	11.22	2
SDF	Sanitation risk/vulnerability of drought and flood	3	3.1	2.91	9.02	4
HF	Health risk/vulnerability to flood	7	2.51	2.6	6.53	6
HIH	Health and infrastructure risk/vulnerability to heat stress	11	3.14	3.11	9.77	3



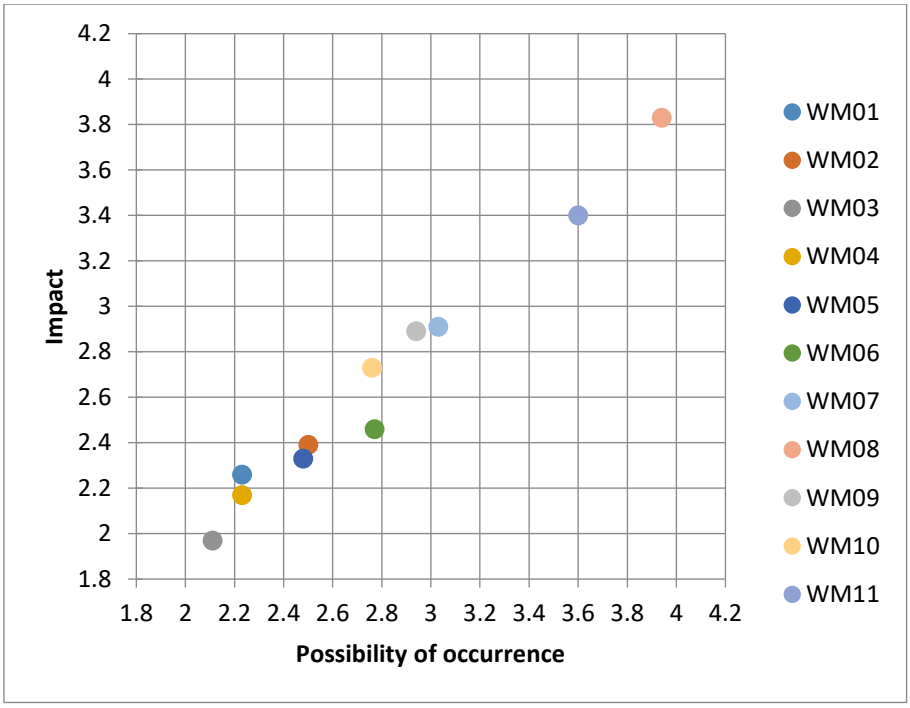
2. DWR (Drinking water resources risk/vulnerability to drought)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
DWR01	Lack of drinking water resources due to drought	3.86	4.14	15.98	1
DWR02	Disruption of drinking water facilities	2.71	2.74	7.43	2
DWR03	Hindrance to water treatment efforts	2.37	2.34	5.55	3



3. WM (Water management risk/vulnerability)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
WM01	Disruption and functional degradation of river facility (i.e. embankment, bridge, etc.)	2.23	2.26	5.04	9
WM02	Influence on the operation of waterworks facilities (i.e. less access to operational mechanism)	2.5	2.39	5.98	7
WM03	Economic loss due to impact from interruption of transportation and industry related with rivers and canals	2.11	1.97	4.16	11
WM04	Increase of damaged irrigation facilities due to flood	2.23	2.17	4.84	10
WM05	Increase of property assets loss due to increased frequency of flood	2.48	2.33	5.78	8
WM06	Damage to drainage facilities (i.e. storm sewer system, etc.) due to increase in urban sediment drainage and high volume of water	2.77	2.46	6.81	6
WM07	Increased cost risk due to lack of industrial water and water treatment due to water quality deterioration	3.03	2.91	8.82	3
WM08	Drying streams and water bodies (natural and artificial) due to drought	3.94	3.83	15.09	1
WM09	Decrease of safety and increase of destruction risk of water supply and repair facilities	2.94	2.89	8.50	4
WM10	Change in flooding occurrence and floodplains due to flood	2.76	2.73	7.53	5
WM11	Increased frequency of drought due to persistent non-precipitation days	3.6	3.4	12.24	2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Possibility of occurrence
WM01
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WM04
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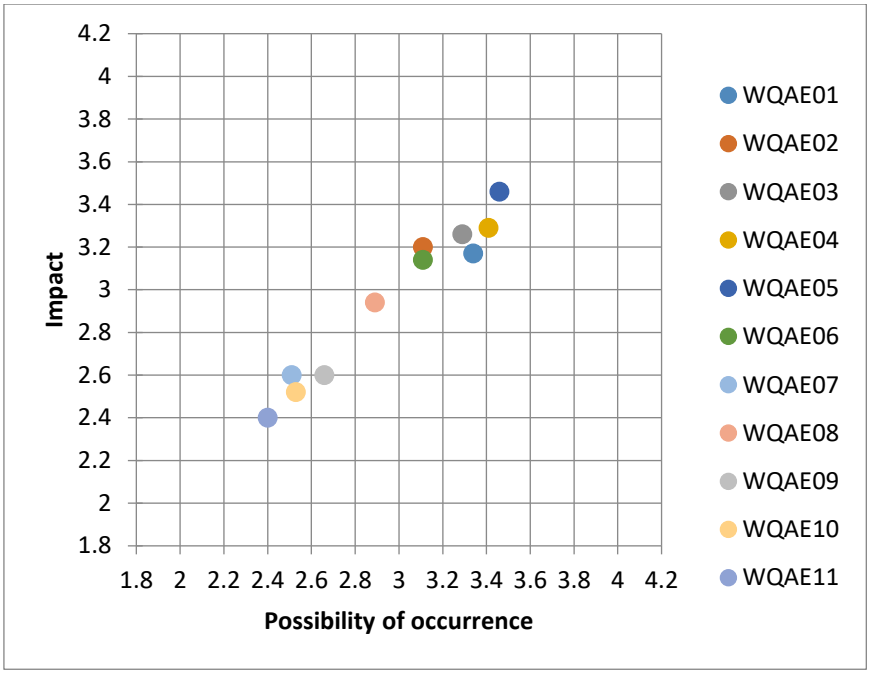
WM09
WM10
WM11

4. WQAE (Water quality and aquatic ecosystem risk/vulnerability)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
WQAE01	Water quality deterioration due to pathogenic bacteria by temperature rising	3.34	3.17	10.59	4
WQAE02	Increase of water pollution risks due to excessive inflow of land pollution source (i.e. living sewage, industrial wastewater, etc.) by heavy rain	3.11	3.2	9.95	5
WQAE03	Fluctuations in water ecology according to rainfall pattern change	3.29	3.26	10.73	3
WQAE04	Water quality deterioration due to rainfall pattern change	3.41	3.29	11.22	2
WQAE05	Increase of algal blooms and deterioration of aquatic ecosystem due to average water temperature rising	3.46	3.46	11.97	1
WQAE06	Increase of diseases and new pathogenic microorganisms occurrence due to water temperature rising	3.11	3.14	9.77	6
WQAE07	Acceleration of extinction of endangered species and endemic species by climate change	2.51	2.6	6.53	9
WQAE08	Effluence increase due to fertilizer, pesticides and animal wastes according to rainfall intensification	2.89	2.94	8.50	7
WQAE09	Increase of abnormal reproduction of alien invasive species	2.66	2.6	6.92	8
WQAE10	Fluctuations in species composition and spawning season of fish	2.53	2.52	6.38	10
WQAE11	Fluctuations in species composition and spawning season of mollusca and crustaceans	2.4	2.4	5.76	11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Possibility of occurrence
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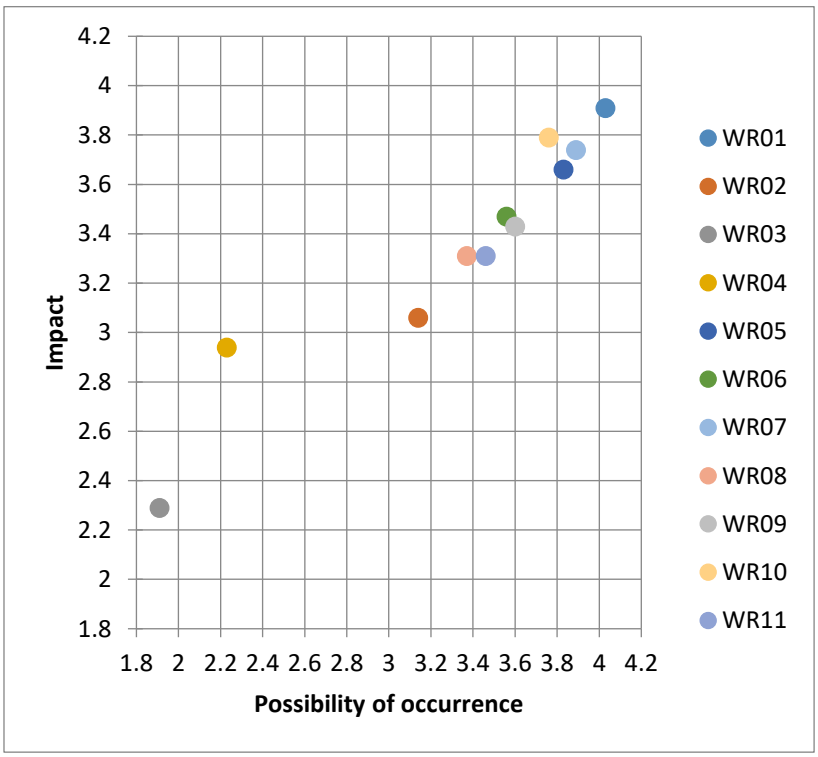
WQAE04
WQAE05
WQAE06
WQAE07
WQAE08
WQAE09
WQAE10
WQAE11

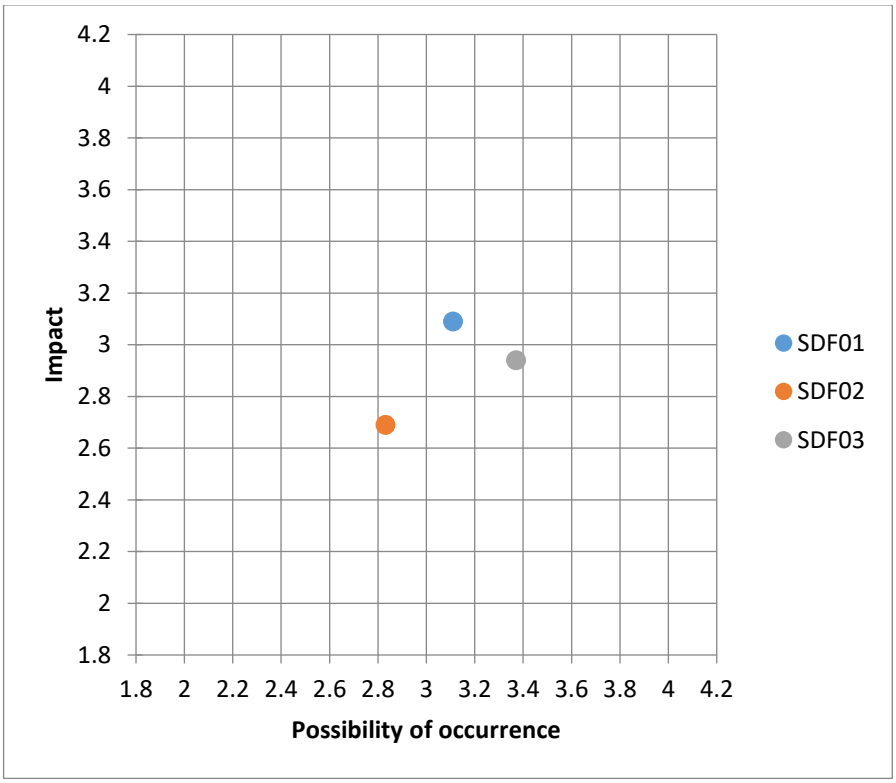
5. WR (Water resources risk/vulnerability)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
WR01	Lack of water for building maintenance and management	4.03	3.91	15.76	1
WR02	Change in habitat of aquatic flora and fauna	3.14	3.06	9.61	9
WR03	Loss of fishery according to increase of harmful organisms (i.e. red tide, jellyfish, etc.) due to average water temperature rising	1.91	2.29	4.37	11
WR04	Fluctuations in spawning habitat and season of fish and molluscs and crustaceans due to water temperature rising	2.23	2.94	6.56	10
WR05	Increase of water demand due to increase of crop evapotranspiration	3.83	3.66	14.02	4
WR06	Increase of water demand for livestock and animal husbandry due to drought	3.56	3.47	12.35	5
WR07	Decrease of national water supply capacity due to rainfall pattern change	3.89	3.74	14.55	2
WR08	Lack of water for SME industries due to drought	3.37	3.31	11.15	8
WR09	Un-controlled use of groundwater due to lack of water	3.6	3.43	12.35	6
WR10	Increased gap of water supply among regions due to drought	3.76	3.79	14.25	3
WR11	Change in groundwater level due to increase of groundwater use	3.46	3.31	11.45	7



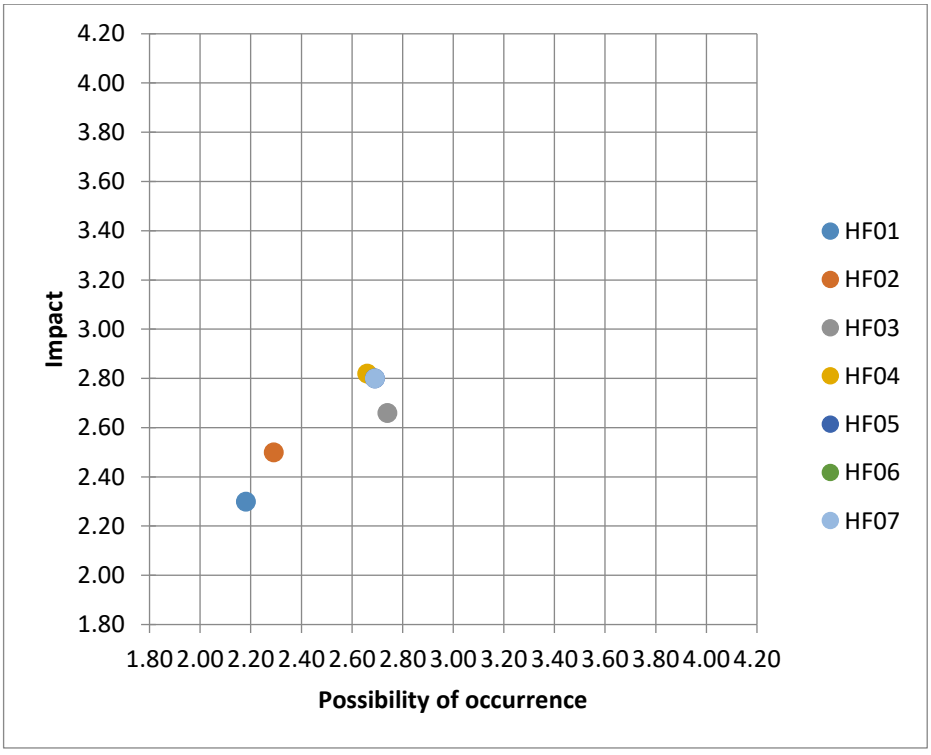
6. SDF (Sanitation risk/vulnerability of drought and flood)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
SDF01	Increase of waterborne diseases	3.11	3.09	9.61	2
SDF02	Overflow of toilet	2.83	2.69	7.61	3
SDF03	Lack of water for toilet usage	3.37	2.94	9.91	1



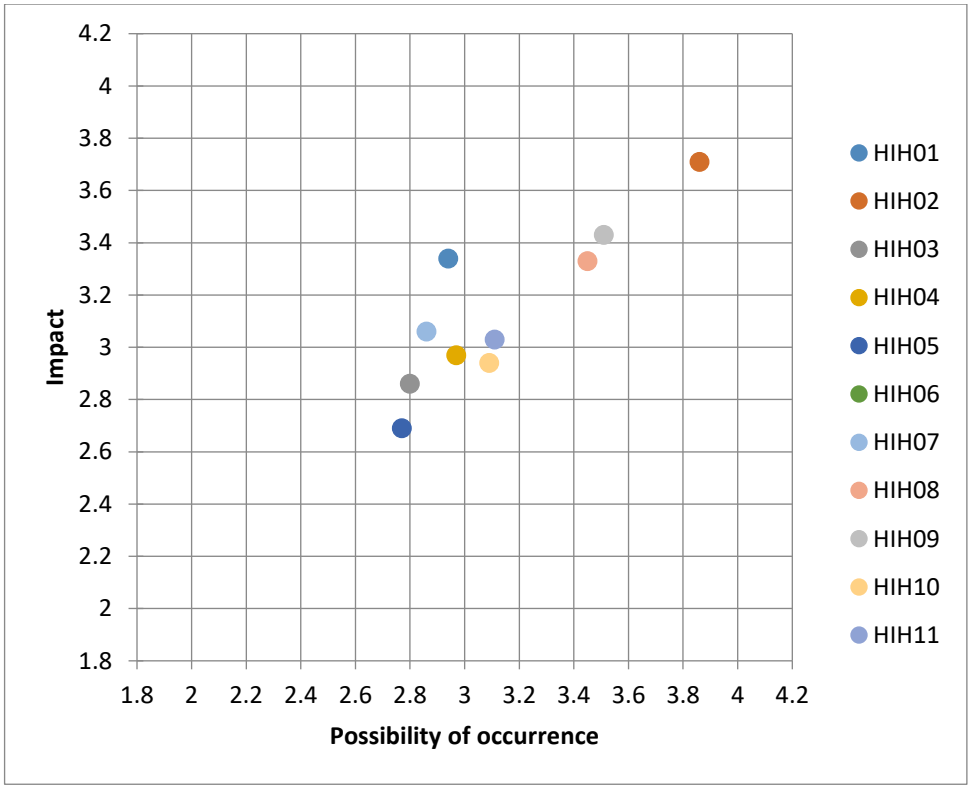
7. HF (Health risk/vulnerability to flood)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
HF01	Increase of mortality rate due to disaster	2.18	2.30	5.01	7
HF02	Increase of injury rate due to disaster	2.29	2.50	5.73	5
HF03	Lack of Focused management on health vulnerable groups (i.e. infants and the elderly)	2.74	2.66	7.29	4
HF04	Increase of medical demand and lack of medical supply due to disaster	2.66	2.82	7.50	3
HF05	Increase of waterborne diseases (i.e. typhoid, cholera, bacterial heterogeneity, etc.) through water and food	2.69	2.80	7.53	2 (tie)
HF06	Increase of health problems (i.e. falls, trauma, etc.) due to safety accidents with flood	2.31	2.34	5.41	6
HF07	Increase of vector borne diseases	2.69	2.80	7.53	2 (tie)



8. HIH (Health and infrastructure risk/vulnerability to heat stress)

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
HIH01	Increased intensification of the Urban Heat Island (UHI) phenomenon	2.94	3.34	9.82	4
HIH02	Reduced function of green space and increased loss of green cover due to heat stress	3.86	3.71	14.32	1
HIH03	Increase of waterborne diseases such as diarrhea caused by drought	2.8	2.86	8.01	10
HIH04	Increase of morbidity and infectious diseases (i.e. infectious diseases, etc.) due to average temperature rising	2.97	2.97	8.8209	8
HIH05	Increase of mortality due to heat wave	2.77	2.69	7.4513	11
HIH06	Increase of cardiovascular diseases due to heat wave	3.13	2.9	9.077	7
HIH07	Increase of impacts on vulnerable groups due to intensification of Urban Heat Island (UHI) phenomenon caused by heat stress	2.86	3.06	8.7516	9
HIH08	Decrease of labor productivity and labor time due to heat stress	3.45	3.33	11.4885	3
HIH09	Increase of demand for consumer goods suitable for heat stress	3.51	3.43	12.0393	2
HIH10	Increase of medical demand due to heat stress	3.09	2.94	9.0846	6
HIH11	Increase of limited outdoor activities tourisms due to heat stress	3.11	3.03	9.4233	5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Possibility of occurrence
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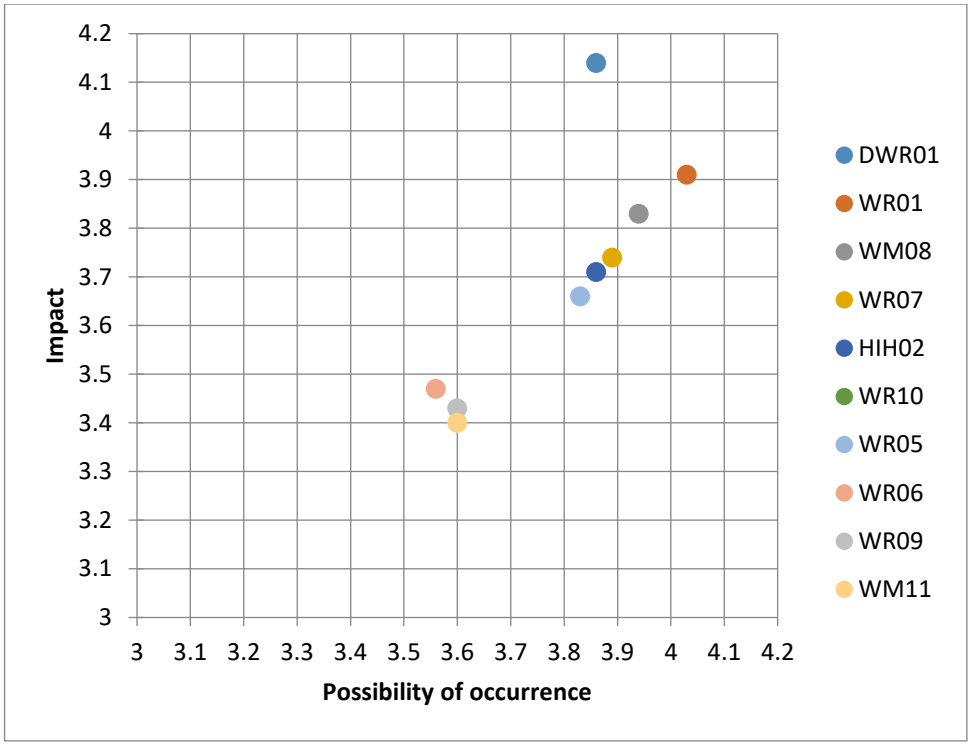
HIH11

9. Top 10, The riskiest factors

Code	Category	Avg. possibility of occurrence	Avg. Impact	Score	Rank
DWR01	Lack of drinking water resources due to drought	3.86	4.14	15.98	1
WR01	Lack of water for building maintenance and management	4.03	3.91	15.76	2
WM08	Drying streams and water bodies (natural and artificial) due to drought	3.94	3.83	15.09	3
WR07	Decrease of national water supply capacity due to rainfall pattern change	3.89	3.74	14.55	4
HIH02	Reduced function of green space and increased loss of green cover due to heat stress	3.86	3.71	14.32	5
WR10	Increased gap of water supply among regions due to drought	3.76	3.79	14.25	6
WR05	Increase of water demand due to increase of crop evapotranspiration	3.83	3.66	14.02	7
WR06	Increase of water demand for livestock and animal husbandry due to drought	3.56	3.47	12.35	8
WR09	Un-controlled use of groundwater due to lack of water	3.6	3.43	12.35	9
WM11	Increased frequency of drought due to persistent non-precipitation days	3.6	3.4	12.24	10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Possibility of occurrence
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WM08
WR07
HIH02
WR10
WR05
WR06
WR09
WM11

Annex D. Result of Qualitative Risk Assessment (Sum)

Experts Survey Result				
Code	**Possibility of occurrence**	**Impact**	**Score**	**Rank**
Drinking water resources risk/vulnerability to drought				
DWR01	3.86	4.14	15.9804	1
DWR02	2.71	2.74	7.4254	2
DWR03	2.37	2.34	5.5458	3
Water management risk/vulnerability				
WM01	2.23	2.26	5.0398	9
WM02	2.5	2.39	5.975	7
WM03	2.11	1.97	4.1567	11
WM04	2.23	2.17	4.8391	10
WM05	2.48	2.33	5.7784	8
WM06	2.77	2.46	6.8142	6
WM07	3.03	2.91	8.8173	3
WM08	3.94	3.83	15.0902	1
WM09	2.94	2.89	8.4966	4
WM10	2.76	2.73	7.5348	5
WM11	3.6	3.4	12.24	2
Water quality and aquatic ecosystem risk/vulnerability				
WQAE01	3.34	3.17	10.5878	4
WQAE02	3.11	3.2	9.952	5
WQAE03	3.29	3.26	10.7254	3
WQAE04	3.41	3.29	11.2189	2
WQAE05	3.46	3.46	11.9716	1
WQAE06	3.11	3.14	9.7654	6
WQAE07	2.51	2.6	6.526	9
WQAE08	2.89	2.94	8.4966	7
WQAE09	2.66	2.6	6.916	8
WQAE10	2.53	2.52	6.3756	10
WQAE11	2.4	2.4	5.76	11
Water resources risk/vulnerability				
WR01	4.03	3.91	15.7573	1
WR02	3.14	3.06	9.6084	9
WR03	1.91	2.29	4.3739	11
WR04	2.23	2.94	6.5562	10
WR05	3.83	3.66	14.0178	4
WR06	3.56	3.47	12.3532	5
WR07	3.89	3.74	14.5486	2
WR08	3.37	3.31	11.1547	8

WR09	3.6	3.43	12.348	6
WR10	3.76	3.79	14.2504	3
WR11	3.46	3.31	11.4526	7
Sanitation risk/vulnerability of drought and flood				
SDF01	3.11	3.09	9.6099	2
SDF02	2.83	2.69	7.6127	3
SDF03	3.37	2.94	9.9078	1
Health risk/vulnerability to flood				
HF01	2.18	2.3	5.014	7
HF02	2.29	2.5	5.725	5
HF03	2.74	2.66	7.2884	4
HF04	2.66	2.82	7.5012	3
HF05	2.69	2.8	7.532	1.5
HF06	2.31	2.34	5.4054	6
HF07	2.69	2.8	7.532	1.5
Health and infrastructure risk/vulnerability to heat stress				
HIH01	2.94	3.34	9.8196	4
HIH02	3.86	3.71	14.3206	1
HIH03	2.8	2.86	8.008	10
HIH04	2.97	2.97	8.8209	8
HIH05	2.77	2.69	7.4513	11
HIH06	3.13	2.9	9.077	7
HIH07	2.86	3.06	8.7516	9
HIH08	3.45	3.33	11.4885	3
HIH09	3.51	3.43	12.0393	2
HIH10	3.09	2.94	9.0846	6
HIH11	3.11	3.03	9.4233	5

Annex E. Results of Climate Change Awareness Survey

(1) Climate Change Awareness – Other Experts

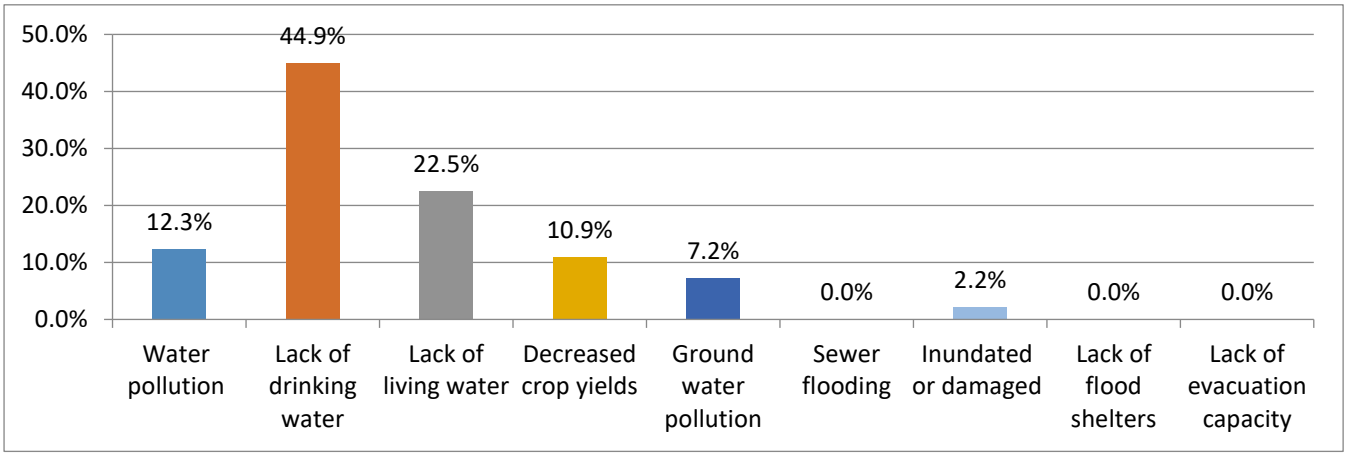
a. Respondent information

	Respondent Information		
	Name	**Title, Organization**	**Professional field**
1	L.Sameera Kahandagamage	Govt.Surveyor, Survey Department	Land Surveying
2	D.R.W.W.Kaluarachchi	Municipal Engineer, KMC	Water supply
3	H.M.N.C.Herath	District Land Use office	Land Use Plaaning
4	Bandula Warnakulasooriya	Disaster Relie Officer, Divisional Secretariat	Disaster Management
5	R.P.D.Kumarathilaka	KMC	
6	D.M.I.Ubeysekera	PHI, KMC	Public Health Inspection
7	Menaka Herath	KMC	Health and Environment
8	S.Ratnayake	Asst. Director, MMDE	Environment
9	Deepashika Chandradasa	Development Officer, KMC	Environment
10	R.D.D.Rajapaksha	PHI, KMC	Public Health
11	-	-	-
12	-	-	-
13	W.R.Samaranayake	Asst. Director, District Land Use Office	Land Use Planning
14	Thanuja Karunasena	Asst.Commissioner, Department of Local Government,NWP	Administration
15	J.M.W.K.Hunakumbura	Executive Engineer	Civil Engineer
16	Chintha Vithana	Asst. Director, District Secretariat	Planning
17	A.T.I. Dayananda	Asst.Director	Planning
18	Dr. A.M.N.K. Atapattu	Medical Officer, PDHS office	Health
19	K.A.M.Gnanathilaka	Provincial Environment Authority	Environment
20	A.M.M.D.Arampath	Engineering Assistant, Ceylon Electriciy Board	Engineering
21	Eng.Kumudinie Dheera	Chief Engineer, Irrigation Department	Civil Engineer
22	H.L.A. Gamage	DFO, Forest Department	Forestry
23	E.M.P.K.Ekanayake	Urban Development Authority	Town Planning

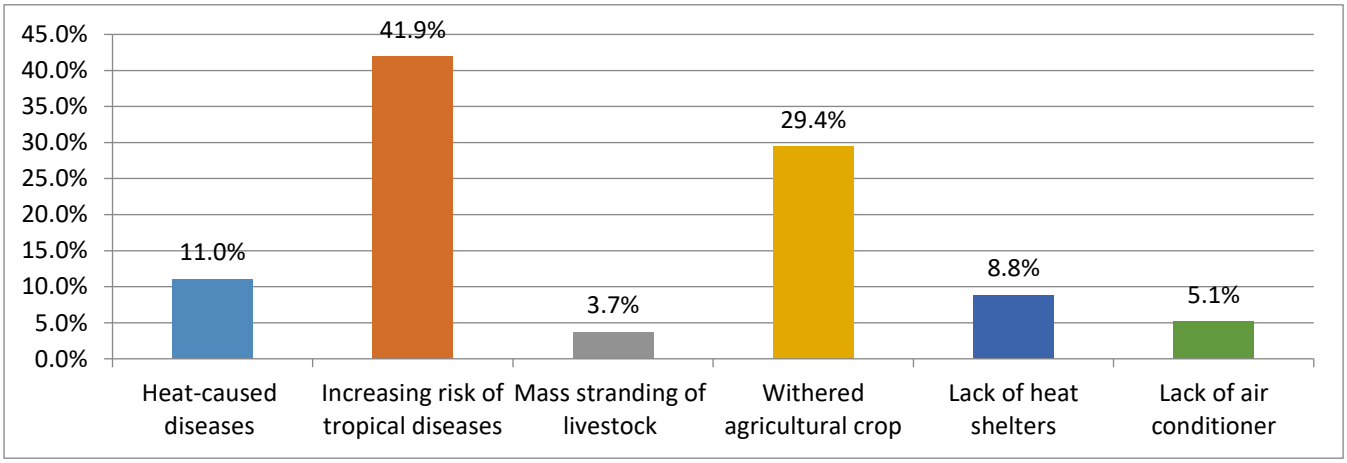
b. The most affected climate change risks

	Index	Num of respondents	Percentage
Water	Water pollution	17	12.3%
	Lack of drinking water	62	44.9%
	Lack of living water	31	22.5%
	Decreased crop yields	15	10.9%
	Ground water pollution	10	7.2%
	Sewer flooding	0	0.0%
	Inundated or damaged	3	2.2%
	Lack of flood shelters	0	0.0%
	Lack of evacuation capacity	0	0.0%
Heat wave	Heat-caused diseases	15	11.0%
	Increasing risk of tropical diseases	57	41.9%
	Mass stranding of livestock	5	3.7%
	Withered agricultural crop	40	29.4%
	Lack of heat shelters	12	8.8%
	Lack of air conditioner	7	5.1%

i. Water



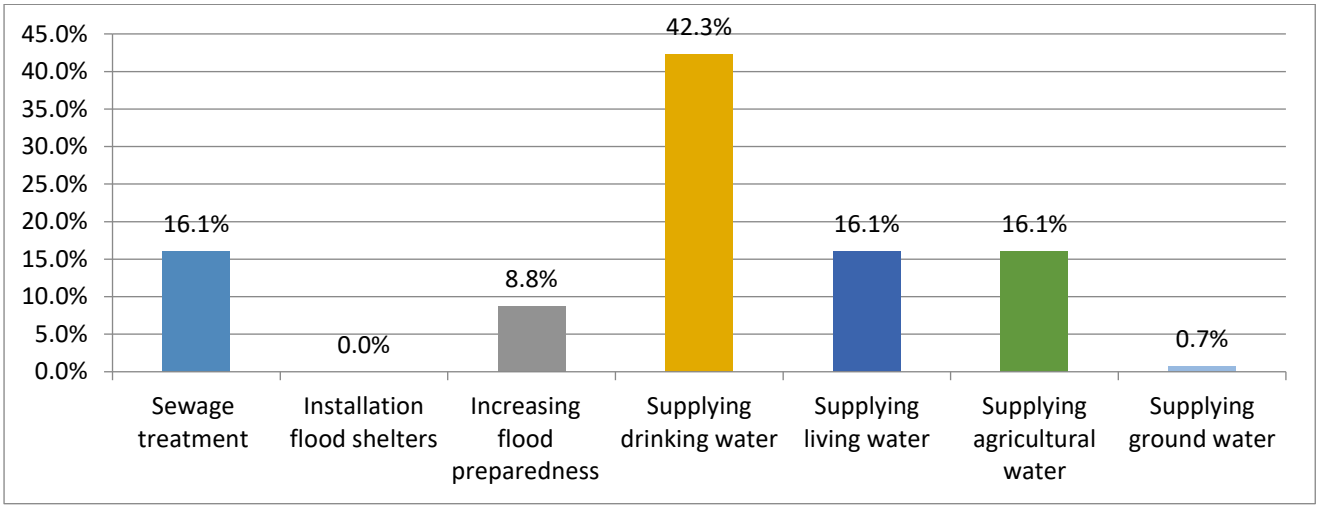
ii. Heat



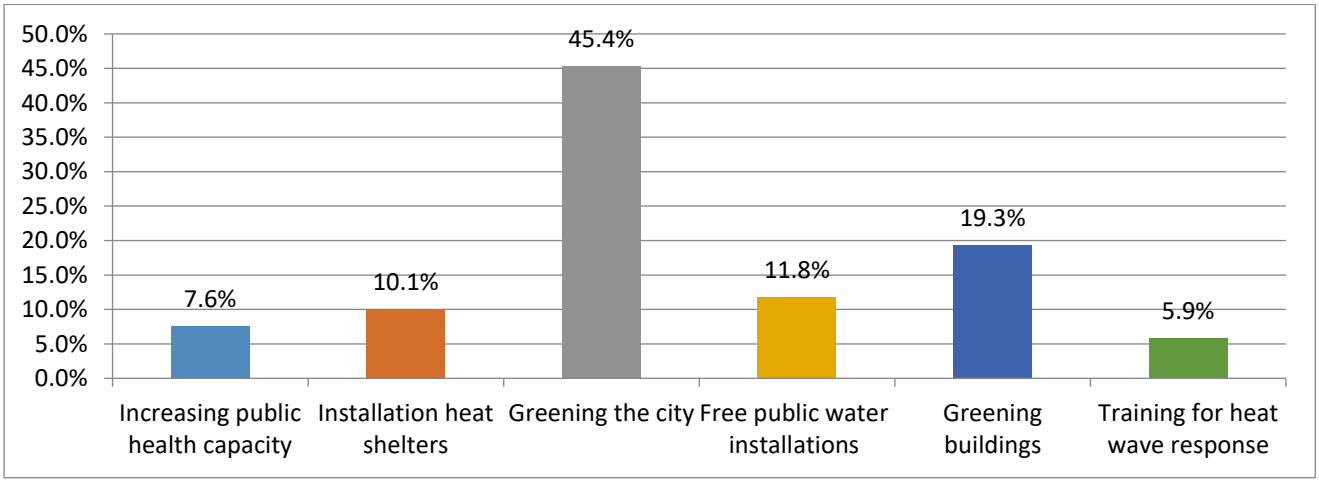
c. The most desirable climate change measures

	Index	Num of respondents	Percentage
Water	Sewage treatment	22	16.1%
	Installation flood shelters	0	0.0%
	Increasing flood preparedness	12	8.8%
	Supplying drinking water	58	42.3%
	Supplying living water	22	16.1%
	Supplying agricultural water	22	16.1%
	Supplying ground water	1	0.7%
Heat wave	Increasing public health capacity	9	7.6%
	Installation heat shelters	12	10.1%
	Greening the city	54	45.4%
	Free public water installations	14	11.8%
	Greening buildings	23	19.3%
	Training for heat wave response	7	5.9%

i. Water



ii. Heat

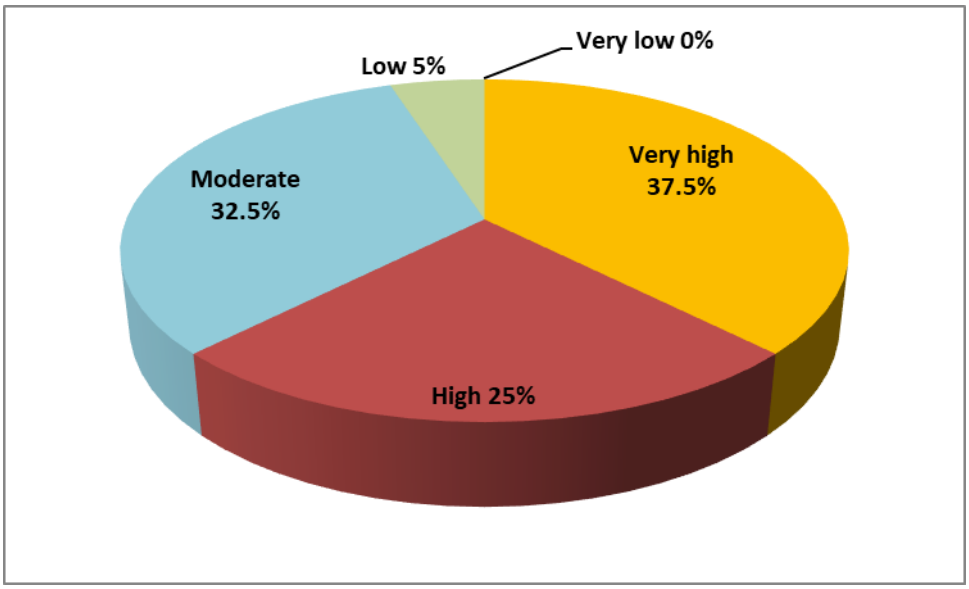


(2) Climate Change Awareness – Women

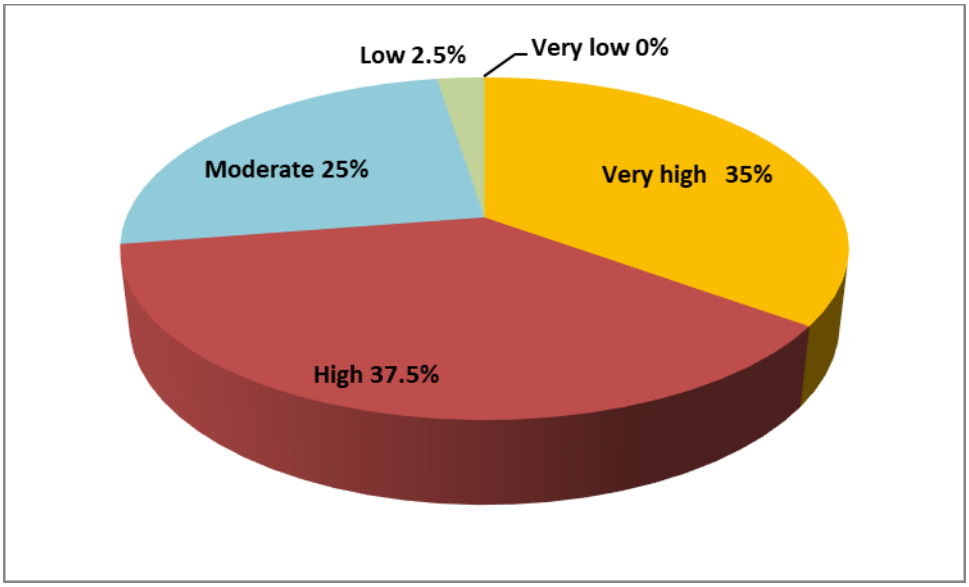
a. Respondent information

		Num of respondents	Percentage (%)
Gender	Female	40	100
	Total	40	**100**
Age	10's	7	17.5
	20's	5	12.5
	30's	8	20
	40's	8	20
	50's	9	22.5
	Over 60	3	7.5
	Total	**40**	**100**
Occupation	Government Official	6	15
	Office worker/ Technician	4	10
	Sales/Marketing	5	12.5
	Freelance	3	7.5
	Production/transportation	3	7.5
	Self employed	4	10
	House wife	4	10
	Student	7	17.5
	No job	4	10
	etc.	0	0
	Total	**40**	**100**

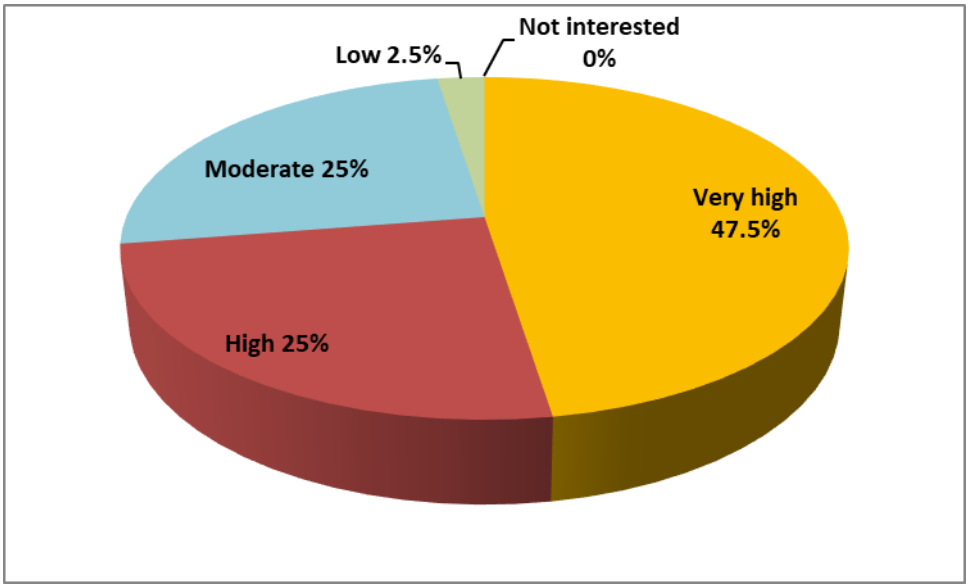
b. How much is climate change influencing the quality of your life?



c. How much do you think climate change will influence your life in the next 5 years?



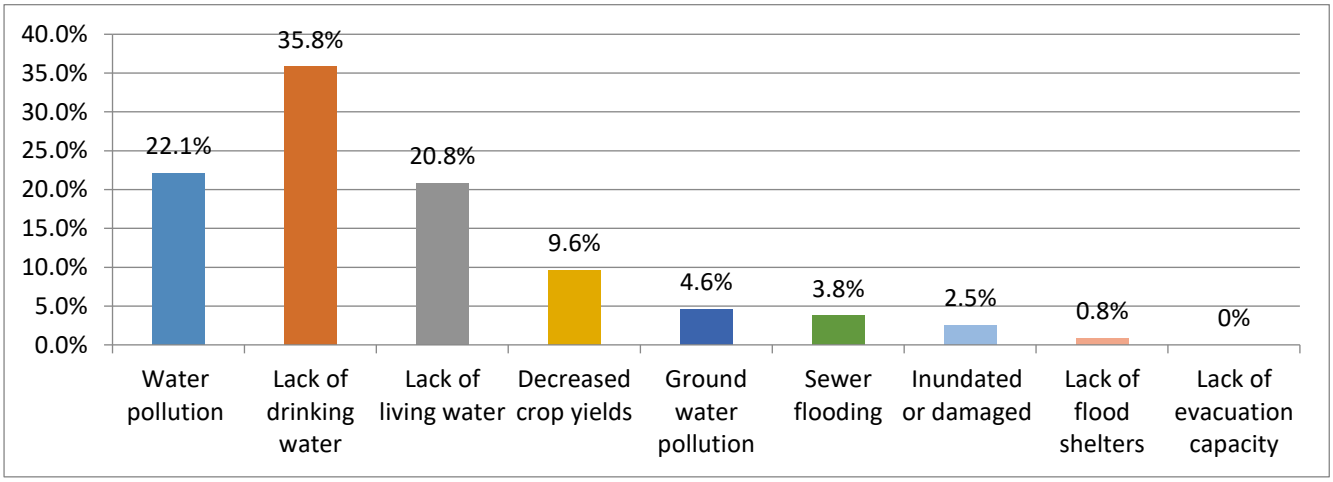
d. How severe do you think the climate change impacts are in Kurunegala?



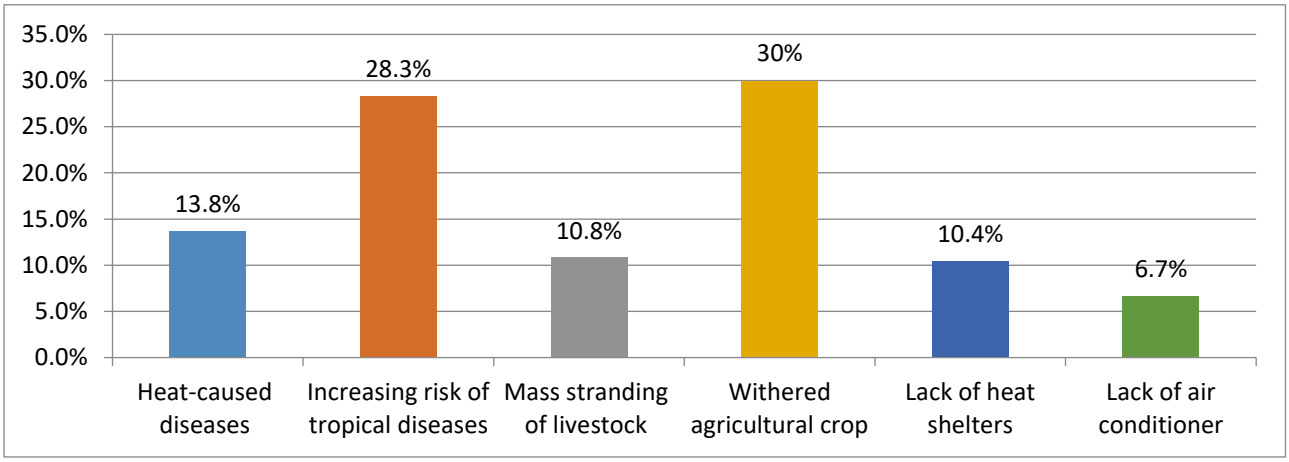
e. The most affected climate change risks

	Index	Num of respondents	Percentage
Water	Water pollution	53	22.1%
	Lack of drinking water	86	35.8%
	Lack of living water	50	20.8%
	Decreased crop yields	23	9.6%
	Ground water pollution	11	4.6%
	Sewer flooding	9	3.8%
	Inundated or damaged	6	2.5%
	Lack of flood shelters	2	0.8%
	Lack of evacuation capacity	0	0%
Heat wave	Heat-caused diseases	33	13.8%
	Increasing risk of tropical diseases	68	28.3%
	Mass stranding of livestock	26	10.8%
	Withered agricultural crop	72	30%
	Lack of heat shelters	25	10.4%
	Lack of air conditioner	16	6.7%

i. Water



ii. Heat



f. The most desirable climate change measures

	Index	Num of respondents	Percentage
Water	Sewage treatment	27	11.3%
	Installation flood shelters	15	6.3%
	Increasing flood preparedness	19	7.9%
	Supplying drinking water	81	33.8%
	Supplying living water	50	20.8%
	Supplying agricultural water	36	15%
	Supplying ground water	12	5%
Heat wave	Increasing public health capacity	33	13.8%
	Installation heat shelters	25	10.4%
	Greening the city	90	37.5%
	Free public water installations	43	17.9%
	Greening buildings	45	18.8%
	Training for heat wave response	4	1.7%

i. Water