

ASSESSMENT OF THE TEMPERATURE REGIME IN AGRO ECOLOGICAL REGIONS OF SRI LANKA

A.B. ABEYSEKERA¹, B.V.R. PUNYAWARDENA¹, A.K. HETTIARACHCHI¹,
E.V.G. NIMAL JAYARATHNA BANDA¹ AND K.H.M.S. PREMALAL²

¹ *Natural Resources Management Centre, Department of Agriculture, Peradeniya,
Sri Lanka,* ² *Department of Meteorology, Colombo, Sri Lanka*

ABSTRACT

Sri Lanka exemplifies a variety of climatic conditions depending on the geographical settings of respective locations. Considering the high heterogeneity of climatic factors, different soil types, terrain, vegetation and land use of the island, Sri Lanka has been delineated in to 46 Agro Ecological Regions (AERs). In the absence of adequate spatial coverage of temperature data to assess the temperature regime of different geographical settings of the country in delineating aforesaid AERs, elevation differences have been taken in to account to capture the spatial variation of temperature as a proxy parameter to identify different AERs. However, it has been observed that there are significant differences exist in temperature regime among different AERs of the country which have not quantified yet due to lack of meteorological observatories representing each AER. It has led to limit the use of the AER map, especially in recommending crops where temperature regime should also be taken in to account. Thus, a study was undertaken to assess the temperature regime of all 46 AERs of Sri Lanka using available daily minimum and maximum temperature data covering 23 AERs. Using spatial interpolation technique of Geographic Information System (GIS), the maximum and minimum temperature values were interpolated for the rest of AERs. There is an apparent increasing trend of all temperature parameters from Wet zone to Dry zone while decreasing trend with increasing altitude as expected. However, there was hardly any discernible trend in temperature parameters with respect to expected quantum of rainfall in each AER. These values can be used for

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agricultural and other weather related decision making and research purposes with a least margin of error in the absence of point data of temperature for each AER.

KeyWords: Agro Ecological Regions, Temperature regime, Maximum temperature, Minimum temperature

INTRODUCTION

Despite the relatively small aerial extent, Sri Lanka demonstrates a variety of climatic conditions depending on the geographical settings of respective locations. It covers a total area of 65,610 km² of land area including 2,905 km² of inland water bodies. Maximum width east-to-west is 225 km and length in north-to-south direction is 435 km. (C&SD, 2016). It is located between 5°55' to 9°50' North latitudes and 79°42' to 81°53' East longitudes (National Atlas, 2007). Extensive faulting and erosion over time have produced a wide range of topographic features with three distinguishable elevation zones within the island; the Central Highlands, the plains, and the coastal belt. In the south-central part of Sri Lanka, the rugged Central Highlands spans around 65 km in north-south direction with peak elevation at 2,524 m (Punyawardena *et al*, 2013).

The climate of Sri Lanka is considered as tropical monsoonal with a marked seasonal variation of rainfall. There are four important geographical and topographical features in Sri Lanka which considerably influence the climate over the island, in particular the rainfall and temperature regimes. The first is the fact that Sri Lanka is a small island situated in the warm tropical Indian Ocean, proximate to the equator. The second is its propinquity to the Bay of Bengal which is frequently subjected to the climatic variations. The next is the existence of large mass of hills at the centre of island which is perpendicular to two approaching moisture laden monsoon wind streams. The other factor is the presence of vast land mass of the Indian sub-continent to the immediate north and northwest of Sri Lanka (Punyawardena, 2008). These four factors, directly or indirectly influence the rainfall and temperature regimes of the island.

The spatial variation of temperature regime in the island occurs mainly due to altitude; there is no temperature variation due to latitude. In general, with increasing altitude, the atmospheric temperature decreases and this phenomenon is known as the

Atmospheric Lapse Rate. In addition, the mean monthly temperatures differ slightly depending on the seasonal movement of the sun, with some modifying influence caused by rainfall. In the lowlands, the mean annual temperature is 27.5°C and the mean daily range is 6°C. In the Central highland with altitudes up to 2,400 m a cooler climate is experienced. At Nuwara Eliya, altitude 1,800 m, the mean annual temperature is 15.9°C and the mean daily range is 10°C (National Atlas, 2007). However, during the period of January to March the diurnal variation around Nuwara Eliya is so large and ground frost is observed on average about four to five days early in the mornings or nights when the temperature near the ground falls below freezing point. During the period from May to September, if the westerly winds are strong, the leeward area east of the central highland, and the relatively flat terrain extending to the east coast experience warm and dry winds. Such Föhn like local wind is known as the *Kachchan* or *Yal-hulang* (Punyawardena, 2010). The coldest month with respect to mean monthly temperature is January and the warmest months are April and August.

Considering the high heterogeneity, Sri Lanka has been delineated in to 46 Agro Ecological Regions (AERs). The delineation of AER boundaries of Sri Lanka has been based on the monthly rainfall regime at 75% probability level, terrain characteristics, predominant soil type, land use and vegetation so that each AER represents an uniform agro-climate, soils and terrain conditions and as such would support a particular farming system where certain range of crops and farming practices find their best expression (Punyawardena, 2007). In the absence of adequate spatial coverage of temperature data to assess the temperature regime of different geographical settings of the country due to lack of meteorological observatories, in delineating aforesaid AERs, elevation differences have been taken in to the account to capture the spatial variation of temperature as a proxy parameter. However, it has been observed that there are considerable differences exist in temperature regime among different AERs of the country which have not quantified yet. It has limited the use of the AER map especially in recommending crops for each AER where temperature regime should also be taken in to account. However, Geographic Information System (GIS) provides a better solution for this constraint by interpolating available point data over the space.

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This study was undertaken to assess the temperature regime of all 46 AERs using available minimum and maximum temperature data and by means of GIS technique, so that agricultural and other weather related decisions and research can be accomplished without limitations arising from unavailability of temperature data of each AER.

METHODOLOGY

Daily maximum and minimum temperature data were collected from 38 meteorological observation stations which are maintained by the Department of Meteorology, Department of Agriculture, Tea Research Institute and Rubber Research Institute. The study period of 30 years was considered from 1986-2015. Due to the presence of large number of missing data and/or being only a short time series, it was unable to consider the entire study period for all locations. The locations of the meteorological observation stations used in the study, their latitude, longitude, altitude and the study period taken into consideration are shown in Table 1 and the location map is illustrated in Figure 1.

From available daily minimum and maximum temperature data, monthly average temperature values, monthly average maximum temperature and monthly average minimum temperature values were calculated. Thirty year averages were calculated for resulted average temperature, maximum temperature and minimum temperature values. With the available temperature data, maximum and minimum temperature ranges could be calculated only for 23 AERs which are shown in the Table 1. To calculate the maximum and minimum temperature ranges for rest of the AERs, a surface interpolation method known as Krigging was selected using Arc-GIS (version 9.2) software.

In general, all interpolation algorithms in GIS environment including Krigging, estimate the value at a given location as a weighted sum of data values of surrounding locations. The weight is a function of distance to the surrounding data points where weight increases with decreasing separation distance (Isaaks and Srivastava, 1989).

Geographic locations of the meteorological stations considered for the study were geo-referenced to the geographical coordinate system before being used in the study. The average maximum and minimum temperature value for the twelve months

of the year were linked to the each point location. Considering the Natural breaks as the default classification method, marked point location surfaces were overlaid on the Agro-ecological map of Sri Lanka (Punyawardena *et al*, 2003). Then, the values for remaining AERs were calculated.

Table 1. Geographical details and study period of meteorological observation stations used in the study.

Station	AER	Latitude (N)	Longitude (E)	Altitude (m)	Study period
Thalawakele	WU 2a	6° 93'	80° 67'	1500.0	1989 - 2015
Nuwara Eliya	WU 3	6° 97'	80° 77'	1894.6	1986 -2015
Sita Eliya	WU 3	6° 58'	80° 46'	1860.0	1988 - 2014
Deniyaya	WM 1a	6° 33'	80° 55'	250.0	1989 - 2007 / 2013 - 2015
Peradeniya	WM 2b	7° 25'	80° 60'	487.6	1986 - 2015
Katugastota	WM 3b	7° 33'	80° 63'	477.0	1986 - 2015
Matale	WM 3b	7° 47'	80° 62'	357.0	1986 - 2015
Agalawatta	WL 1a	6° 53'	80° 15'	65.5	1986 - 2015
Ratnapura	WL 1a	6° 68'	80° 40'	34.4	1986 - 2015
Bombuwela	WL 1b	6° 57'	80° 02'	3.0	1986 - 2015
Galle	WL 2a	6° 03'	80° 22'	12.5	1986 - 2015
Colombo	WL 3	6° 90'	79° 87'	7.3	1986 - 2015
Katunayake	WL 3	7° 17'	79° 88'	8.5	1986 - 2015
Bandarawela	IU 3c	6° 83'	80° 98'	1219.0	1986 - 2015
Passara	IU 3c	6° 92'	81° 13'	1120.0	1990 - 2015
Badulla	IM 1a	6° 98'	81° 05'	669.6	1986 - 2015
Kundasale	IM 3a	7° 27'	80° 68'	492.0	1994 - 2015
Batalagoda	IL 1a	7° 52'	80° 45'	100.0	1986 - 2015
Kurunegala	IL 1a	7° 47'	80° 37'	116.1	1986 - 2015
Makandura	IL 1a	7° 32'	79° 97'	25.0	1986 - 2015
Moneragala	IL 1c	6° 87'	81° 35'	146.0	1986 - 1988 / 1994 - 2015
Girandurukotte	IL 2	7° 40'	81° 08'	292.0	1977 - 2004
Maho	IL 3	7° 82'	80° 28'	100.0	1986 - 2015

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Table 1. cont.

Angunakolapelessa	DL 1b	6° 17'	80° 88'	23.0	1986 - 2015
Anuradhapura	DL 1b	8° 35'	80° 38'	92.5	1986 - 2015
Maha Illuppallama	DL 1b	8° 12'	80° 47'	137.8	1986 - 2015
Vavuniya	DL 1b	8° 75'	80° 50'	97.5	1986 - 2015
Maduru oya	DL 1c	7° 64'	81° 22'	16.0	1999 - 2015
Polonnaruwa	DL 1c	7° 52'	81° 03'	43.0	2011 - 2015
Pottuvil	DL 2a	6° 52'	81° 50'	3.6	1986 - 2015
Aralaganwila	DL 2b	7° 68'	81° 18'	230.0	1986 - 2015
Batticaloa	DL 2b	7° 72'	81° 70'	2.7	1986 - 2015
Trincomalee	DL 2b	8° 58'	81° 25'	79.0	1986 - 2015
Jaffna	DL 3	9° 68'	80° 03'	3.0	1969 - 1983 / 2001 - 2015
Puttalam	DL 3	8° 03'	79° 83'	2.1	1986 - 2015
Mannar	DL 4	8° 59'	79° 55'	3.6	1986 - 1990 / 1998 - 2015
Hambantota	DL 5	6° 12'	81° 13'	15.5	1986 - 2015
Weerawila	DL 5	6° 18'	81° 23'	30.0	2001 - 2013

The temperature data collected from the stations Sita Eliya, Kurunegala and Maha- Illuppallama representing Wet, Intermediate and Dry zone, respectively, were not included in the interpolation process. Those data points served as a sub-set of total data set to validate the interpolation or estimation method of GIS software.

RESULTS AND DISCUSSION

There is an apparent increasing trend of all temperature parameters from Wet zone to Dry zone while decreasing trend with increasing altitude as expected. However, there was hardly any discernible trend in temperature parameters with respect to expected quantum of rainfall in each AER confirming that it is only a function of altitude, movement of the sun and climatic zone. Table 2 shows the monthly maximum temperature ranges for each AER.

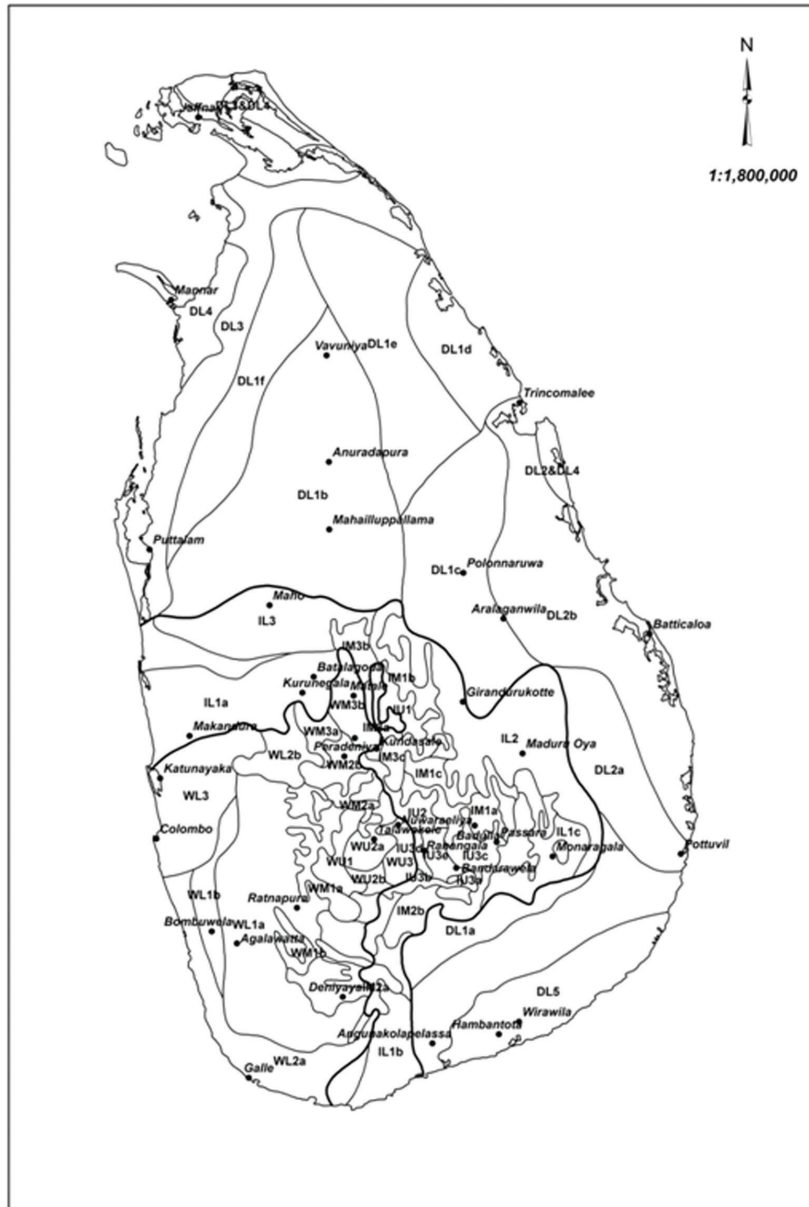


Figure 1. Locations of meteorological observation stations used in the study overlaid on the Agro-ecological map of Sri Lanka.

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Table 2. Monthly maximum temperature (°C) ranges for 46 AERs of Sri Lanka

CZ		AER	Jan			Feb			Mar			Apr		
Wet Zone	Up Country	WU 1	24.3	–	25.4	25.6	–	26.7	26.1	–	27.2	26.1	–	27.2
		WU 2a	20.3	–	27.1	21.7	–	28.3	22.6	–	29.2	22.2	–	28.6
		WU 2b	23.2	–	24.3	25.6	–	26.7	27.2	–	28.2	26.1	–	27.2
		WU 3	16.3	–	22.5	17.5	–	23.4	18.9	–	24.3	19.5	–	24.5
	Mid Country	WM 1a	27.4	–	32.9	29.6	–	33.7	30.1	–	34.4	29.6	–	33.9
		WM 1b	25.4	–	26.4	25.6	–	26.7	28.2	–	29.3	27.2	–	28.3
		WM 2a	25.4	–	26.4	27.7	–	28.8	28.2	–	29.3	27.2	–	28.3
		WM 2b	25.0	–	32.9	27.3	–	32.8	28.8	–	34.3	27.8	–	33.4
		WM 3a	28.6	–	29.7	30.9	–	32.0	31.4	–	32.5	30.6	–	31.7
		WM 3b	25.8	–	31.9	27.8	–	33.4	29.9	–	35.2	29.4	–	34.5
	Low Country	WL 1a	27.5	–	35.0	29.4	–	36.0	30.9	–	36.3	29.6	–	35.4
		WL 1b	28.7	–	32.7	29.4	–	32.8	30.3	–	33.0	29.7	–	33.2
		WL 2a	27.4	–	32.4	28.8	–	33.1	29.4	–	34.0	28.6	–	33.2
		WL 2b	29.7	–	30.7	30.9	–	32.0	32.5	–	33.5	31.7	–	32.8
		WL 3	28.2	–	33.7	29.6	–	34.2	30.3	–	33.9	29.3	–	33.2
Intermediate Zone	Up Country	IU 1	24.3	–	25.4	29.8	–	30.9	32.5	–	33.5	31.7	–	32.8
		IU 2	28.6	–	29.7	28.8	–	29.8	30.3	–	31.4	30.6	–	31.7
		IU 3a	23.2	–	24.3	24.6	–	25.6	26.1	–	27.2	26.1	–	27.2
		IU 3b	23.2	–	24.3	23.5	–	24.6	25.0	–	26.1	25.0	–	26.1
		IU 3c	18.9	–	25.1	20.8	–	26.7	23.2	–	28.2	23.3	–	28.3
		IU 3d	19.0	–	25.0	20.2	–	26.6	22.0	–	27.7	21.1	–	28.1
		IU 3e	23.2	–	24.3	23.5	–	24.6	26.1	–	27.2	26.1	–	27.2
	Mid Country	IM 1a	21.8	–	28.0	23.6	–	30.1	26.5	–	32.3	27.2	–	32.7
		IM 1b	28.6	–	29.7	29.8	–	30.9	32.5	–	33.5	31.7	–	32.8
		IM 1c	24.3	–	25.4	24.6	–	25.6	29.3	–	30.3	28.3	–	29.5
		IM 2a	26.4	–	27.5	24.6	–	25.6	29.3	–	30.3	27.2	–	28.3
		IM 2b	25.4	–	26.4	25.6	–	26.7	28.2	–	29.3	27.2	–	28.3
		IM 3a	24.1	–	31.1	26.1	–	32.4	28.7	–	34.3	29.0	–	33.8
		IM 3b	29.7	–	30.7	30.9	–	32.0	32.5	–	33.5	31.7	–	32.8
		IM 3c	28.6	–	29.7	29.8	–	30.9	28.2	–	29.3	31.7	–	32.8

TABLE 2. CONTINUED.

Intermediate Zone	Low Country	IL 1a	25.7	–	31.5	27.3	–	33.7	30.9	–	35.6	30.4	–	35.1
		IL 1b	30.7	–	31.8	32.0	–	33.0	33.5	–	34.6	32.8	–	33.9
		IL 1c	25.9	–	32.6	28.3	–	33.7	30.6	–	36.2	30.6	–	36.4
		IL 2	25.8	–	32.3	27.5	–	33.8	29.7	–	36.1	30.8	–	37.2
		IL 3	27.9	–	33.4	29.7	–	35.5	32.7	–	37.4	31.5	–	36.7
Dry Zone	Low Country	DL 1a	26.4	–	27.5	30.9	–	32.0	32.5	–	33.5	29.5	–	30.6
		DL 1b	26.3	–	32.8	29.1	–	34.8	31.5	–	37.0	31.1	–	36.8
		DL 1c	25.9	–	31.6	25.7	–	33.0	29.6	–	35.6	32.0	–	36.6
		DL 1d	28.6	–	29.7	30.9	–	32.0	33.5	–	34.6	33.9	–	35.0
		DL 1e	28.6	–	29.7	30.9	–	32.0	33.5	–	34.6	33.9	–	35.0
		DL 1f	29.7	–	30.7	30.9	–	32.0	33.5	–	34.6	33.9	–	35.0
		DL 2a	25.8	–	31.3	27.6	–	31.9	29.2	–	33.4	30.3	–	34.9
		DL 2b	26.2	–	29.7	27.1	–	30.9	28.4	–	32.4	29.8	–	34.0
		DL 3	27.0	–	30.6	28.4	–	32.4	30.2	–	34.3	30.8	–	34.8
		DL 4	26.9	–	31.0	28.7	–	32.8	30.5	–	34.2	31.1	–	34.7
		DL 5	26.9	–	32.5	28.4	–	32.9	29.4	–	33.4	29.2	–	33.4
Wet Zone	Up Country	WU 1	26.1	–	27.3	23.2	–	24.5	23.0	–	24.3	23.1	–	24.5
		WU 2a	21.0	–	27.7	18.8	–	25.7	18.3	–	25.7	18.1	–	26.2
		WU 2b	26.1	–	27.3	23.2	–	24.5	23.0	–	24.3	23.1	–	24.5
		WU 3	17.9	–	24.9	16.1	–	22.8	15.7	–	22.5	15.9	–	22.7
	Mid Country	WM 1a	28.3	–	31.1	27.6	–	31.9	27.5	–	31.3	27.3	–	31.7
		WM 1b	27.3	–	28.4	25.9	–	27.2	25.7	–	27.0	25.9	–	27.3
		WM 2a	26.1	–	27.3	27.2	–	28.6	25.7	–	27.0	27.3	–	28.7
		WM 2b	26.5	–	32.6	26.2	–	31.2	25.6	–	31.3	25.4	–	31.5
		WM 3a	30.8	–	32.0	28.6	–	29.9	28.4	–	29.8	28.7	–	30.1
		WM 3b	28.8	–	33.6	27.5	–	32.3	27.1	–	32.4	27.2	–	32.7
	Low Country	WL 1a	27.4	–	34.5	26.9	–	33.1	26.9	–	32.7	27.0	–	32.9
		WL 1b	28.8	–	32.5	28.6	–	31.6	28.3	–	31.1	28.3	–	30.9
		WL 2a	27.8	–	31.9	27.8	–	30.5	27.5	–	30.1	27.4	–	30.0
		WL 2b	30.8	–	32.0	28.6	–	29.9	28.4	–	29.8	28.7	–	30.1
		WL 3	28.5	–	32.8	28.5	–	31.7	28.3	–	31.4	28.2	–	31.4

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TABLE 2. CONTINUED.

CZ		AER	May			Jun			Jul			Aug		
Intermediate Zone	Up Country	IU 1	32.0	–	33.1	29.9	–	31.3	29.8	–	31.1	30.1	–	31.4
		IU 2	32.0	–	33.1	31.3	–	32.6	31.1	–	32.5	30.1	–	31.4
		IU 3a	28.4	–	29.6	27.2	–	28.6	27.0	–	28.4	27.3	–	28.7
		IU 3b	26.1	–	27.3	24.5	–	25.9	25.7	–	27.0	24.5	–	25.9
		IU 3c	23.6	–	29.5	23.3	–	28.8	23.2	–	28.7	22.9	–	28.9
		IU 3d	21.9	–	29.2	21.3	–	28.1	21.6	–	28.7	21.5	–	28.2
		IU 3e	27.3	–	28.4	25.9	–	27.2	25.7	–	27.0	25.9	–	27.3
	Mid Country	IM 1a	27.8	–	33.2	28.0	–	33.3	27.6	–	33.4	27.5	–	33.6
		IM 1b	32.0	–	33.1	29.9	–	31.3	29.8	–	31.1	27.3	–	28.7
		IM 1c	27.3	–	28.4	27.2	–	28.6	27.0	–	28.4	27.3	–	28.7
		IM 2a	27.3	–	28.4	25.9	–	27.2	27.0	–	28.4	27.3	–	28.7
		IM 2b	29.6	–	30.8	27.2	–	28.6	27.0	–	28.4	25.9	–	27.3
		IM 3a	27.7	–	33.1	27.1	–	32.3	26.2	–	31.8	30.1	–	31.4
		IM 3b	32.0	–	33.1	29.9	–	31.3	29.8	–	31.1	30.1	–	31.4
		IM 3c	30.8	–	32.0	28.6	–	29.9	29.8	–	31.1	27.3	–	28.7
	Low Country	IL 1a	29.1	–	34.0	28.2	–	32.4	27.1	–	32.0	27.8	–	32.8
		IL 1b	32.0	–	33.1	31.3	–	32.6	31.1	–	32.5	31.4	–	32.8
		IL 1c	30.4	–	36.8	31.5	–	37.3	31.5	–	37.8	31.9	–	37.5
		IL 2	30.3	–	37.9	31.5	–	38.1	31.8	–	38.0	32.0	–	38.3
		IL 3	30.5	–	35.3	29.8	–	34.4	30.3	–	36.1	30.7	–	35.9
Dry Zone	Low Country	DL 1a	29.6	–	30.8	29.9	–	31.3	29.8	–	31.1	30.1	–	31.4
		DL 1b	30.3	–	35.6	30.3	–	35.2	30.9	–	36.2	30.8	–	36.3
		DL 1c	32.2	–	37.0	32.5	–	36.9	33.3	–	37.3	33.1	–	37.7
		DL 1d	33.1	–	34.3	32.6	–	34.0	33.8	–	35.2	32.8	–	34.2
		DL 1e	33.1	–	34.3	32.6	–	34.0	33.8	–	35.2	32.8	–	34.2
		DL 1f	33.1	–	34.3	32.6	–	34.0	33.8	–	35.2	32.8	–	34.2
		DL 2a	31.2	–	37.2	32.0	–	37.2	31.7	–	37.0	30.0	–	36.9
		DL 2b	30.6	–	36.1	31.5	–	37.2	31.5	–	37.2	31.0	–	37.0
		DL 3	30.0	–	33.8	30.1	–	33.5	29.5	–	33.8	29.1	–	33.7
		DL 4	30.6	–	33.7	30.3	–	32.7	29.0	–	31.6	29.5	–	32.6
		DL 5	28.4	–	33.8	28.2	–	34.2	28.2	–	34.5	28.0	–	34.2

TABLE 2. CONTINUED.

CZ		AER	Sep		Oct		Nov		Dec	
Wet Zone	Up Country	WU 1	23.6	– 24.9	24.3	– 25.5	23.6	– 24.6	24.0	– 25.0
		WU 2a	19.3	– 26.4	19.5	– 26.5	19.4	– 26.7	19.7	– 26.6
		WU 2b	23.6	– 24.9	24.3	– 25.5	23.6	– 24.6	24.0	– 25.0
		WU 3	16.6	– 22.6	16.2	– 22.7	16.6	– 22.2	15.9	– 22.2
	Mid Country	WM 1a	27.2	– 32.1	27.4	– 32.3	27.5	– 32.6	27.9	– 32.3
		WM 1b	26.2	– 27.5	25.5	– 26.6	25.6	– 26.5	25.0	– 26.1
		WM 2a	27.5	– 28.9	26.6	– 27.8	25.6	– 26.5	24.0	– 25.0
		WM 2b	25.7	– 31.7	25.7	– 31.9	25.4	– 31.5	24.7	– 30.8
		WM 3a	28.9	– 30.2	29.0	– 30.2	29.4	– 30.4	28.2	– 29.3
		WM 3b	27.2	– 32.9	27.4	– 32.7	27.3	– 32.2	25.9	– 31.8
	Low Country	WL 1a	26.9	– 33.5	27.1	– 33.7	27.0	– 33.8	27.2	– 33.9
		WL 1b	28.2	– 31.1	28.2	– 31.5	28.1	– 32.3	28.4	– 32.5
		WL 2a	27.4	– 30.3	27.3	– 31.1	27.5	– 32.0	27.4	– 32.4
		WL 2b	30.2	– 31.5	30.2	– 31.3	29.4	– 30.4	28.2	– 29.3
		WL 3	28.0	– 31.6	27.7	– 31.7	27.7	– 32.6	28.1	– 33.1
Intermediate Zone	Up Country	IU 1	30.2	– 31.5	30.2	– 31.3	29.4	– 30.4	28.2	– 29.3
		IU 2	31.5	– 32.8	30.2	– 31.3	28.5	– 29.4	27.2	– 28.2
		IU 3a	27.5	– 28.9	26.6	– 27.8	25.6	– 26.5	22.9	– 24.0
		IU 3b	26.2	– 27.5	25.5	– 26.6	24.6	– 25.6	21.9	– 22.9
		IU 3c	22.8	– 28.7	22.1	– 27.3	20.5	– 25.8	18.9	– 25.2
		IU 3d	22.5	– 28.2	21.3	– 26.8	20.7	– 25.6	18.9	– 24.8
		IU 3e	26.2	– 27.5	25.5	– 26.6	24.6	– 25.6	22.9	– 24.0
	Mid Country	IM 1a	27.2	– 33.4	25.8	– 32.1	23.3	– 30.4	21.6	– 28.6
		IM 1b	30.2	– 31.5	30.2	– 31.3	29.4	– 30.4	27.2	– 28.2
		IM 1c	28.9	– 30.2	27.8	– 29.0	26.5	– 27.5	25.0	– 26.1
		IM 2a	27.5	– 28.9	26.6	– 27.8	25.6	– 26.5	22.9	– 24.0
		IM 2b	27.5	– 28.9	27.8	– 29.0	26.5	– 27.5	24.0	– 25.0
		IM 3a	26.6	– 32.4	26.0	– 32.2	25.1	– 31.5	24.2	– 31.1
		IM 3b	30.2	– 31.5	30.2	– 31.3	29.4	– 30.4	29.3	– 30.3
		IM 3c	28.9	– 30.2	29.0	– 30.2	28.5	– 29.4	28.2	– 29.3
	Low Country	IL 1a	27.7	– 33.5	27.6	– 33.2	27.1	– 32.5	25.2	– 32.0
		IL 1b	31.5	– 32.8	31.3	– 32.5	30.4	– 31.4	30.3	– 31.4
		IL 1c	31.2	– 37.4	29.2	– 36.0	27.7	– 33.6	26.5	– 33.0
		IL 2	30.9	– 38.1	28.9	– 36.4	25.9	– 34.6	25.3	– 32.5
		IL 3	30.6	– 36.5	28.8	– 35.8	28.4	– 34.6	26.9	– 34.0

ASSESSMENT OF TEMPERATURE REGIME

TABLE 2. CONTINUED.

CZ		AER		Sep		Oct		Nov		Dec			
Dry Zone	Low Country	DL 1a	28.9	–	30.2	27.8	29.0	28.5	–	29.4	25.0	–	26.1
		DL 1b	30.9	–	36.5	28.3	35.4	26.8	–	33.2	25.8	–	32.4
		DL 1c	32.5	–	38.1	27.8	37.2	25.9	–	33.4	25.1	–	32.5
		DL 1d	32.8	–	34.2	31.3	32.5	30.4	–	31.4	29.3	–	30.3
		DL 1e	32.8	–	34.2	31.3	32.5	30.4	–	31.4	29.3	–	30.3
		DL 1f	32.8	–	34.2	31.3	32.5	30.4	–	31.4	29.3	–	30.3
		DL 2a	30.8	–	36.8	28.3	35.3	26.1	–	33.0	26.1	–	32.0
		DL 2b	30.5	–	36.3	28.7	34.7	26.7	–	31.7	25.8	–	30.4
		DL 3	29.1	–	33.2	27.2	32.9	26.3	–	31.5	25.7	–	30.3
		DL 4	29.7	–	32.5	28.6	32.8	27.2	–	31.9	26.4	–	30.9
		DL 5	28.1	–	33.2	28.3	33.1	27.6	–	32.6	26.6	–	32.3

During the First Inter Monsoon (FIM) period, the maximum temperature values in the Wet Zone lies between 18.9 °C to 36.3 °C. In the Intermediate Zone and Dry Zone the values gradually increase as 21.1 °C to 36.8 °C and 28.4 °C to 37.0 °C, respectively. During FIM in all AERs, the highest values are recorded during the month of April due to sun's overhead position. May to September, the period of South West Monsoon (SWM), the maximum temperature values ranges from 15.7 °C to 33.6 °C, 21.3 °C to 38.3 °C and 28.0 °C to 38.0 °C in AERs of Wet, Intermediate and Dry Zone, respectively. During this period the highest maximum values are recorded in AERs of the Dry zone due to adiabatic warming of south west monsoonal wind stream after crossing the Central highlands while blowing over the Dry zone. During the period of Second Inter-Monsoon (SIM), when the island receives considerable amount of well distributed rainfall, the maximum temperature values of Wet Zone ranges between 16.2°C to 33.7°C. The temperature range of the Intermediate Zone is slightly higher giving a range of 20.5 °C to 36.4°C. The highest values of during season recorded in the AERs of the Dry Zone ranging from 25.9°C to 37.2°C. During the North East Monsoon (NEM) season, maximum temperature values in AERs of the Wet zone range from 15.9 °C to 36.0 °C. Compared to the other rainfall seasons, during this period the maximum temperature values of the Intermediate and Dry zones are slightly less with a range of 18.9 °C to

35.5°C and 25.0°C to 34.8°C, respectively. This is mainly attributed to the thick cloud cover of NEM over these regions which cut-off high solar irradiance and northerly and north-easterly wind blowing from High pressure area of the northern Indian land mass which is cool and dry.

Monthly minimum temperature ranges for each AER is shown in the Table 3. During the FIM period, the minimum temperature ranges of the Wet Zone, Intermediate Zone and Dry Zone are 5.6°C to 27.7°C, 9.1°C to 26.4°C and 18.6°C to 34.7°C respectively. The minimum temperature of the Wet Zone ranges from 10.3°C to 28.5°C during the Southwest Monsoon season. It increases from 13.4°C to 26.8°C within the Intermediate Zone and further increases from 19.0°C to 33.7°C within the Dry Zone. The range of minimum temperature is 8.0°C to 26.7°C in the Wet Zone within the Second inter-monsoon period and 12.1°C to 24.9°C in the Intermediate Zone. It increases from 18.7°C to 32.6°C within the Dry Zone. During the Northeast Monsoon period, the minimum temperature range of Wet Zone lies between 5.0°C to 25.3°C and 9.0°C to 24.3°C in the Intermediate Zone. Dry Zone indicates relatively higher values giving the range of 17.5°C to 32.8°C.

However, lowest minimum temperature values of all AERs of the Dry zone are recorded during the month of January, a common phenomenon to experience across all AERs of the country due to moisture bereft and cold north east monsoonal wind coming from cold northern Asian land mass and enhanced radiation cooling at night in the absence of clouds.

In common, the DL 4 agro-ecological region depicts comparatively higher minimum temperature values throughout the year compared to the other AERs.

ASSESSMENT OF TEMPERATURE REGIME

Table 3. Monthly minimum temperature (°C) ranges for 46 AERs of Sri Lanka

CZ		AER	Jan			Feb			Mar			Apr		
Wet Zone	Up Country	WU 1	13.8	–	15.0	13.8	–	15.1	14.1	–	15.6	15.9	–	17.4
		WU 2a	5.7	–	16.4	5.0	–	17.1	5.6	–	15.6	8.9	–	17.1
		WU 2b	13.8	–	15.0	13.8	–	15.1	14.1	–	15.6	15.9	–	17.4
		WU 3	5.5	–	13.4	5.3	–	14.1	6.5	–	14.5	8.8	–	14.7
	Mid Country	WM 1a	17.8	–	22.8	17.1	–	22.5	17.4	–	22.9	19.6	–	23.5
		WM 1b	15.0	–	16.3	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
		WM 2a	15.0	–	16.3	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
		WM 2b	13.5	–	22.1	13.3	–	22.3	15.3	–	22.6	18.4	–	22.9
		WM 3a	18.8	–	20.0	19.2	–	20.6	20.1	–	21.6	18.9	–	20.3
		WM 3b	15.5	–	22.1	15.2	–	21.9	16.6	–	22.8	19.2	–	23.7
	Low Country	WL 1a	19.4	–	23.9	19.6	–	23.9	20.7	–	24.4	21.8	–	25.0
		WL 1b	19.0	–	23.8	19.5	–	24.1	20.7	–	24.6	21.8	–	25.6
		WL 2a	21.7	–	24.7	22.0	–	25.3	22.6	–	26.2	22.9	–	27.8
		WL 2b	20.0	–	21.2	19.2	–	20.6	20.1	–	21.6	21.8	–	23.3
		WL 3	20.5	–	24.8	20.9	–	25.3	22.4	–	26.5	22.8	–	27.7
Intermediate Zone	Up Country	IU 1	18.8	–	20.0	19.2	–	20.6	20.1	–	21.6	21.8	–	23.3
		IU 2	17.5	–	18.8	17.9	–	19.2	18.6	–	20.1	20.3	–	21.8
		IU 3a	15.0	–	16.3	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
		IU 3b	13.8	–	15.0	13.8	–	15.1	14.1	–	15.6	15.9	–	17.4
		IU 3c	10.7	–	17.5	10.8	–	17.4	12.4	–	17.7	14.7	–	18.4
		IU 3d	9.8	–	18.3	9.0	–	18.7	9.1	–	18.5	12.7	–	18.9
		IU 3e	12.5	–	13.8	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
	Mid Country	IM 1a	13.7	–	20.4	12.9	–	20.4	13.8	–	20.8	16.7	–	21.2
		IM 1b	18.8	–	20.0	19.2	–	20.6	20.1	–	21.6	21.8	–	23.3
		IM 1c	16.3	–	17.5	16.5	–	17.9	17.1	–	18.6	18.9	–	20.3
		IM 2a	15.0	–	16.3	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
		IM 2b	16.3	–	17.5	15.1	–	16.5	15.6	–	17.1	17.4	–	18.9
		IM 3a	13.8	–	22.4	13.7	–	22.0	14.0	–	22.4	18.9	–	22.9
		IM 3b	20.0	–	21.2	19.2	–	20.6	20.1	–	21.6	21.8	–	23.3
		IM 3c	18.8	–	20.0	17.9	–	19.2	18.6	–	20.1	20.3	–	21.8
	Low Country	IL 1a	17.9	–	24.2	16.1	–	24.0	19.0	–	24.8	21.8	–	26.1
		IL 1b	21.2	–	22.5	20.6	–	21.9	21.6	–	23.1	23.3	–	24.8
		IL 1c	16.2	–	22.7	16.2	–	22.4	16.1	–	22.2	18.8	–	23.2
		IL 2	18.3	–	23.6	17.6	–	23.8	18.7	–	24.7	21.2	–	25.2
		IL 3	17.2	–	23.3	16.9	–	23.3	18.6	–	24.0	20.8	–	26.4

TABLE 3. CONTINUED.

CZ		AER	Jan			Feb			Mar			Apr		
Dry Zone	Low Country	DL 1a	17.5	–	18.8	17.9	–	19.2	18.6	–	20.1	18.9	–	20.3
		DL 1b	18.8	–	23.9	19.0	–	24.2	20.7	–	25.1	22.6	–	26.3
		DL 1c	18.0	–	23.5	18.8	–	23.3	19.2	–	23.9	21.2	–	25.4
		DL 1d	18.8	–	20.0	21.9	–	23.3	23.1	–	24.6	23.3	–	24.8
		DL 1e	18.8	–	20.0	23.3	–	24.6	23.1	–	24.6	23.3	–	24.8
		DL 1f	22.5	–	23.7	23.3	–	24.6	23.1	–	24.6	26.3	–	27.8
		DL 2a	19.1	–	24.2	20.2	–	24.7	20.8	–	25.0	22.6	–	26.0
		DL 2b	21.1	–	26.0	21.3	–	26.2	22.1	–	26.6	23.8	–	26.9
		DL 3	18.9	–	24.7	19.6	–	25.0	21.2	–	27.1	24.0	–	28.8
		DL 4	26.9	–	31.0	28.7	–	32.8	30.5	–	34.2	31.1	–	34.7
		DL 5	20.8	–	24.8	21.2	–	25.1	22.2	–	25.9	22.6	–	26.8
Wet Zone	Up Country	WU 1	17.1	–	18.5	17.5	–	18.8	17.1	–	18.3	16.9	–	18.2
		WU 2a	11.6	–	18.0	11.7	–	17.6	11.4	–	17.0	10.8	–	17.5
		WU 2b	17.1	–	18.5	17.5	–	18.8	17.1	–	18.3	16.9	–	18.2
		WU 3	10.6	–	15.4	11.5	–	15.0	11.2	–	14.6	10.6	–	14.5
	Mid Country	WM 1a	20.3	–	24.9	20.5	–	24.8	20.3	–	24.6	20.4	–	24.5
		WM 1b	18.5	–	19.9	18.8	–	20.1	18.3	–	19.6	19.5	–	20.7
		WM 2a	18.5	–	19.9	20.1	–	21.4	19.6	–	20.8	19.5	–	20.7
		WM 2b	19.0	–	23.5	19.4	–	23.4	19.4	–	23.1	18.0	–	23.1
		WM 3a	21.3	–	22.7	21.4	–	22.6	22.1	–	23.3	22.0	–	23.3
	Low Country	WM 3b	20.1	–	24.2	20.5	–	24.1	20.2	–	23.9	20.1	–	23.5
		WL 1a	22.4	–	25.7	22.2	–	25.7	22.0	–	25.4	22.0	–	24.9
		WL 1b	21.9	–	26.6	22.0	–	26.3	22.0	–	26.0	22.0	–	25.7
		WL 2a	22.7	–	28.1	22.9	–	27.4	23.0	–	27.0	22.9	–	26.8
		WL 2b	21.3	–	22.7	22.6	–	23.9	22.1	–	23.3	22.0	–	23.3
		WL 3	23.4	–	28.5	23.4	–	27.8	23.4	–	27.3	23.5	–	27.1
Intermediate Zone	Up Country	IU 1	21.3	–	22.7	21.4	–	22.6	22.1	–	23.3	22.0	–	23.3
		IU 2	19.9	–	21.3	20.1	–	21.4	20.8	–	22.1	19.5	–	20.7
		IU 3a	17.1	–	18.5	17.5	–	18.8	17.1	–	18.3	16.9	–	18.2
		IU 3b	15.7	–	17.1	16.2	–	17.5	17.1	–	18.3	16.9	–	18.2
		IU 3c	15.9	–	19.5	15.3	–	20.0	15.5	–	19.7	15.3	–	19.5
		IU 3d	14.0	–	20.2	14.0	–	20.9	12.4	–	20.8	12.9	–	20.2
		IU 3e	17.1	–	18.5	17.5	–	18.8	17.1	–	18.3	16.9	–	18.2

ASSESSMENT OF TEMPERATURE REGIME

TABLE 3. CONTINUED.

Intermediate Zone	Mid Country	IM 1a	17.6	–	21.7	16.6	–	21.6	16.5	–	21.5	16.0	–	21.1
		IM 1b	21.3	–	22.7	21.4	–	22.6	22.1	–	23.3	22.0	–	23.3
Intermediate Zone	Low Country	IM 1c	18.5	–	19.9	18.8	–	20.1	18.3	–	19.6	18.2	–	19.5
		IM 2a	17.1	–	18.5	17.5	–	18.8	17.1	–	18.3	16.9	–	18.2
		IM 2b	19.9	–	21.3	18.8	–	20.1	18.3	–	19.6	18.2	–	19.5
		IM 3a	19.7	–	24.1	19.1	–	24.3	19.1	–	23.8	19.1	–	23.8
		IM 3b	22.7	–	24.1	22.6	–	23.9	22.1	–	23.3	22.0	–	23.3
		IM 3c	21.3	–	22.7	21.4	–	22.6	20.8	–	22.1	20.7	–	22.0
		IL 1a	22.2	–	26.8	22.7	–	26.4	22.5	–	25.9	22.0	–	25.5
		IL 1b	24.1	–	25.5	23.9	–	25.2	24.6	–	25.8	23.3	–	24.6
		IL 1c	19.0	–	24.1	18.3	–	24.1	17.9	–	23.4	18.0	–	23.2
		IL 2	22.0	–	25.8	21.3	–	26.6	20.8	–	25.9	21.0	–	26.1
		IL 3	21.3	–	25.4	21.9	–	25.3	21.4	–	25.3	21.9	–	25.4
Dry Zone	Low Country	DL 1a	21.3	–	22.7	20.1	–	21.4	19.6	–	20.8	19.5	–	20.7
		DL 1b	23.1	–	26.6	23.8	–	26.5	23.6	–	26.2	23.4	–	26.0
		DL 1c	21.8	–	27.7	23.4	–	28.0	22.8	–	27.6	22.7	–	27.4
		DL 1d	24.1	–	25.5	25.2	–	26.5	24.6	–	25.8	24.6	–	25.8
		DL 1e	24.1	–	25.5	25.2	–	26.5	24.6	–	25.8	24.6	–	25.8
		DL 1f	26.9	–	28.2	26.5	–	27.8	25.8	–	27.1	25.8	–	27.1
		DL 2a	22.5	–	25.6	23.5	–	26.5	23.6	–	26.2	23.3	–	26.5
		DL 2b	23.9	–	27.3	24.0	–	27.3	23.6	–	27.0	23.6	–	26.8
		DL 3	23.8	–	29.2	24.7	–	28.4	24.7	–	28.0	24.1	–	27.5
		DL 4	30.6	–	33.7	30.3	–	32.7	29.0	–	31.6	29.5	–	32.6
		DL 5	23.9	–	27.2	23.5	–	26.7	23.4	–	26.1	23.2	–	25.9
Wet Zone	Up Country	WU 1	16.4	–	17.7	16.2	–	17.4	15.8	–	17.0	15.2	–	16.4
		WU 2a	10.3	–	17.4	10.0	–	17.5	9.2	–	16.9	7.2	–	17.8
		WU 2b	16.4	–	17.7	16.2	–	17.4	15.8	–	17.0	15.2	–	16.4
		WU 3	10.4	–	14.5	9.9	–	14.6	8.0	–	14.5	6.1	–	14.6
	Mid Country	WM 1a	20.2	–	24.1	19.5	–	23.3	19.2	–	23.7	18.2	–	22.7
		WM 1b	17.7	–	19.0	17.4	–	18.7	17.0	–	18.1	16.4	–	17.5
		WM 2a	19.0	–	20.4	18.7	–	20.0	17.0	–	18.1	16.4	–	17.5
		WM 2b	17.3	–	22.7	17.6	–	22.6	17.0	–	22.3	15.1	–	22.3
		WM 3a	20.4	–	21.7	21.2	–	22.5	20.4	–	21.6	16.4	–	17.5
		WM 3b	19.3	–	23.3	18.9	–	23.3	18.2	–	23.0	16.6	–	22.4
	Low Country	WL 1a	21.7	–	24.6	21.6	–	24.3	21.1	–	24.2	19.9	–	23.9
		WL 1b	21.8	–	25.3	21.5	–	25.1	20.9	–	24.4	19.6	–	23.7
		WL 2a	22.9	–	26.9	22.7	–	26.7	21.9	–	25.7	19.6	–	25.1
		WL 2b	21.7	–	23.1	21.2	–	22.5	20.4	–	21.6	19.8	–	21.0
		WL 3	23.1	–	27.2	22.7	–	26.6	22.1	–	25.5	21.2	–	25.0

TABLE 3. CONTINUED.

CZ		AER	Sep			Oct			Nov			Dec		
Intermediate Zone	Up Country	IU 1	20.4	–	21.7	21.2	–	22.5	20.4	–	21.6	19.8	–	21.0
		IU 2	19.0	–	20.4	20.0	–	21.2	19.3	–	20.4	18.7	–	19.8
		IU 3a	16.4	–	17.7	18.7	–	20.0	17.0	–	18.1	16.4	–	17.5
		IU 3b	15.0	–	16.4	17.4	–	18.7	15.8	–	17.0	15.2	–	16.4
		IU 3c	15.2	–	19.0	15.0	–	18.5	13.6	–	18.2	11.8	–	17.8
		IU 3d	13.4	–	19.2	14.0	–	19.1	12.1	–	19.5	11.5	–	18.6
	Mid Country	IU 3e	16.4	–	17.7	17.4	–	18.7	17.0	–	18.1	16.4	–	17.5
		IM 1a	16.1	–	21.1	16.0	–	21.1	16.0	–	20.9	14.9	–	20.7
		IM 1b	21.7	–	23.1	21.2	–	22.5	20.4	–	21.6	19.8	–	21.0
		IM 1c	17.7	–	19.0	17.4	–	18.7	17.0	–	18.1	16.4	–	17.5
		IM 2a	16.4	–	17.7	17.4	–	18.7	17.0	–	18.1	16.4	–	17.5
		IM 2b	17.7	–	19.0	20.0	–	21.2	17.0	–	18.1	16.4	–	17.5
	Low Country	IM 3a	18.8	–	23.7	18.1	–	22.9	16.6	–	22.5	14.9	–	22.1
		IM 3b	21.7	–	23.1	21.2	–	22.5	21.6	–	22.7	21.0	–	22.1
		IM 3c	20.4	–	21.7	20.0	–	21.2	20.4	–	21.6	18.7	–	19.8
		IL 1a	21.7	–	25.6	20.6	–	24.9	20.6	–	24.6	19.1	–	24.3
		IL 1b	23.1	–	24.4	22.5	–	23.7	21.6	–	22.7	21.0	–	22.1
		IL 1c	18.1	–	23.7	18.5	–	22.0	18.6	–	22.6	16.8	–	22.5
Dry Zone	Low Country	IL 2	20.7	–	25.3	20.5	–	24.9	20.4	–	24.3	18.9	–	24.1
		IL 3	21.3	–	25.0	20.6	–	24.7	19.9	–	23.9	18.2	–	23.9
		DL 1a	19.0	–	20.4	18.7	–	20.0	19.3	–	20.4	18.7	–	19.8
		DL 1b	23.1	–	25.0	22.2	–	25.3	21.2	–	24.5	19.8	–	24.2
		DL 1c	22.0	–	27.4	21.5	–	25.8	20.0	–	24.0	19.8	–	24.1
		DL 1d	24.4	–	25.7	23.7	–	25.0	22.7	–	23.9	22.1	–	23.2
		DL 1e	25.7	–	27.1	23.7	–	25.0	22.7	–	23.9	22.1	–	23.2
		DL 1f	25.7	–	27.1	25.0	–	26.3	23.9	–	25.0	23.2	–	24.4
		DL 2a	23.3	–	26.1	22.4	–	25.7	21.3	–	25.0	20.1	–	24.7
		DL 2b	23.4	–	26.6	22.9	–	26.1	22.4	–	25.9	21.6	–	26.0
		DL 3	23.5	–	27.6	22.6	–	27.3	21.6	–	25.8	20.2	–	25.3
		DL 4	29.7	–	32.5	28.3	–	32.6	27.0	–	31.6	26.2	–	30.6
		DL 5	23.1	–	25.9	22.9	–	25.8	22.5	–	25.3	21.6	–	25.1

ASSESSMENT OF TEMPERATURE REGIME

Table 4 shows r^2 and p -values for plotted graphs for observed maximum and minimum temperature data verses interpolated maximum and minimum temperature data points for the selected locations of Wet, Intermediate and Dry Zones. Since the r^2 and p -values are within the acceptable range (except for minimum temperature data at Maha-Illuppallama) the interpolated temperature values can be used with a reasonable accuracy in the AERs where point observations are absent.

Table 4. Significance of GIS interpolated maximum temperature (T-Max) and minimum temperature (T-Min) data points

Station	Climatic Zone (CZ)	T-Max	T-Min
		r^2 (p-value)	r^2 (p-value)
Sita Eliya	Wet zone	0.80 (0.000)	0.88 (0.000)
Kurunegala	Intermediate zone	0.86 (0.000)	0.85 (0.000)
Maha-Illuppallama	Dry zone	0.80 (0.006)	0.78 (0.483)

Although these interpolated values can be used for the agriculture and weather related decision making in different AERs without wide margin of errors where there are no observed climatic data available, it is very important to establish new meteorological stations in those regions to capture the actual picture of thermal regime. Meanwhile, it was revealed in this study that some available data points for a particular AER do not represent the entire AER over the space. For example, although Girandurukotte lies in the IL2 region, it is located on the boarder of IL2 and DL1c where temperature regime can be a mixture of both. Therefore, when establishing new meteorological stations for AERs in future, it is very important to select a place, which represents the whole AER.

CONCLUSIONS

Temperature is a very important climatic parameter which directly influences agriculture and weather related decision making. Although there were some temperature assessments done on district basis or meteorological stations basis, those values cannot directly taken as reference values for decision making especially when decisions are being made on AER basis. In agreement with the general climatology of Sri Lanka temperature values assigned for each AER through this study will be useful in agriculture and weather related decision making and research purposes with considerable amount of high accuracy.

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