Mitigating Climate Change / Drought Impacts in Tea and Readiness for El Nino 2024

(Outreach Activity 02/2024/LC/RPC)

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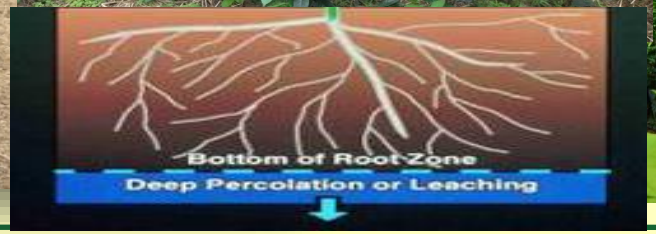
Tea Research Institute of Sri Lanka

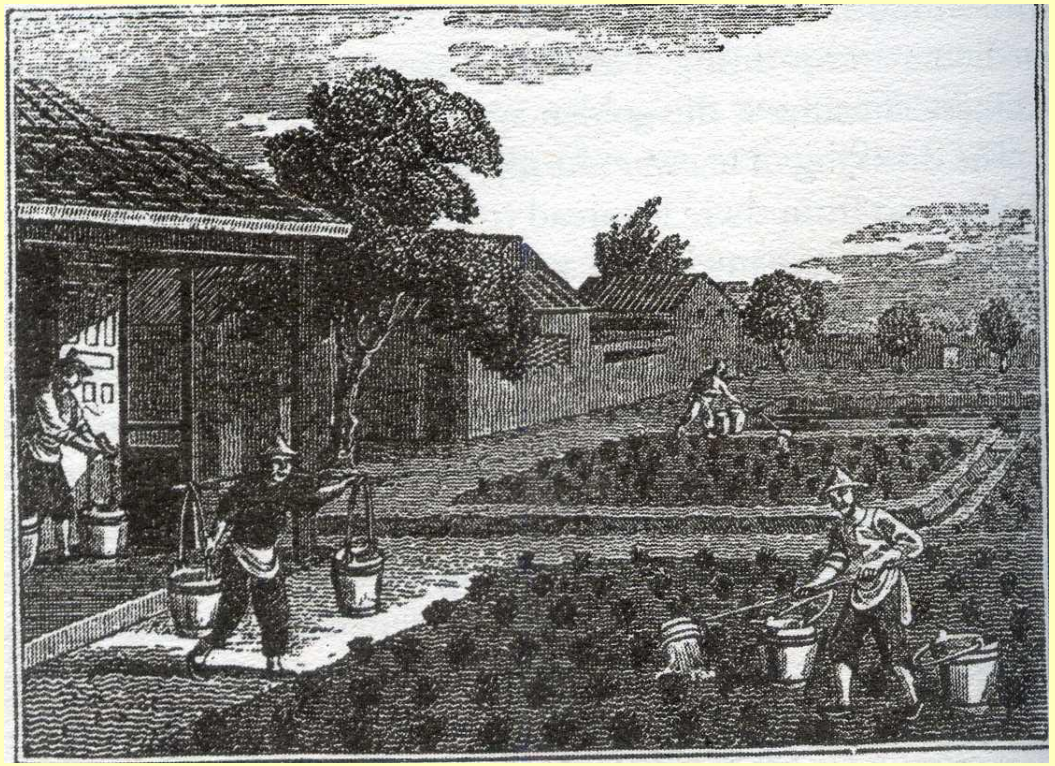
Regional Scientific Forum
Kandy
2024-02-20



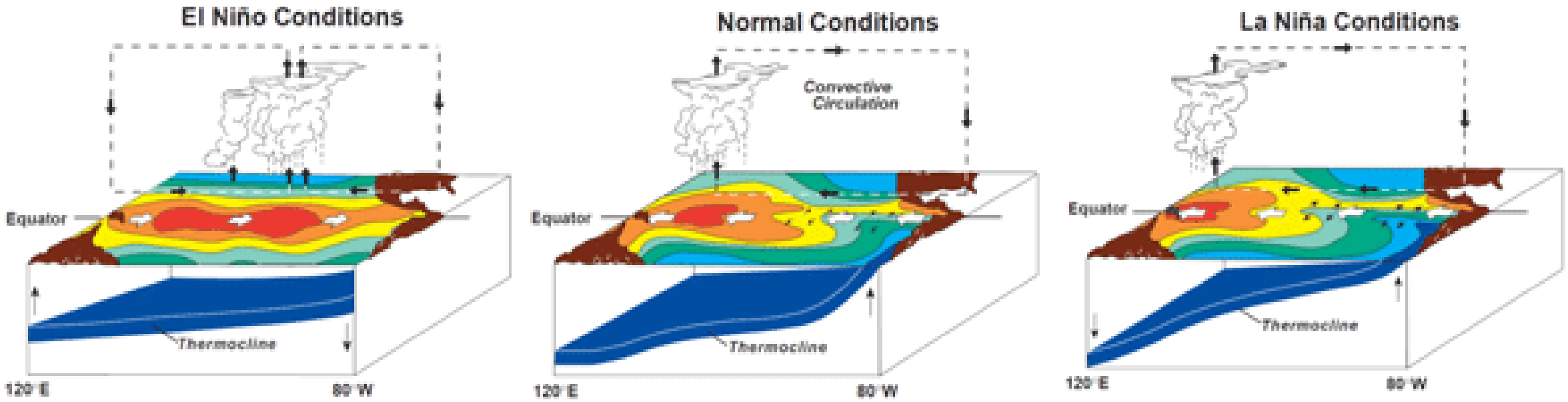
Introduction

- Industry with a heritage & background
- What is El nino and present situation
- Global climate change and it’s impact
- Agriculture drought in tea
- Present forecast for 2024
- Drought mitigation
- Irrigation
  - Conventional
  - Non-conventional
- Future directions



ENSO - El Niño/Southern Oscillation

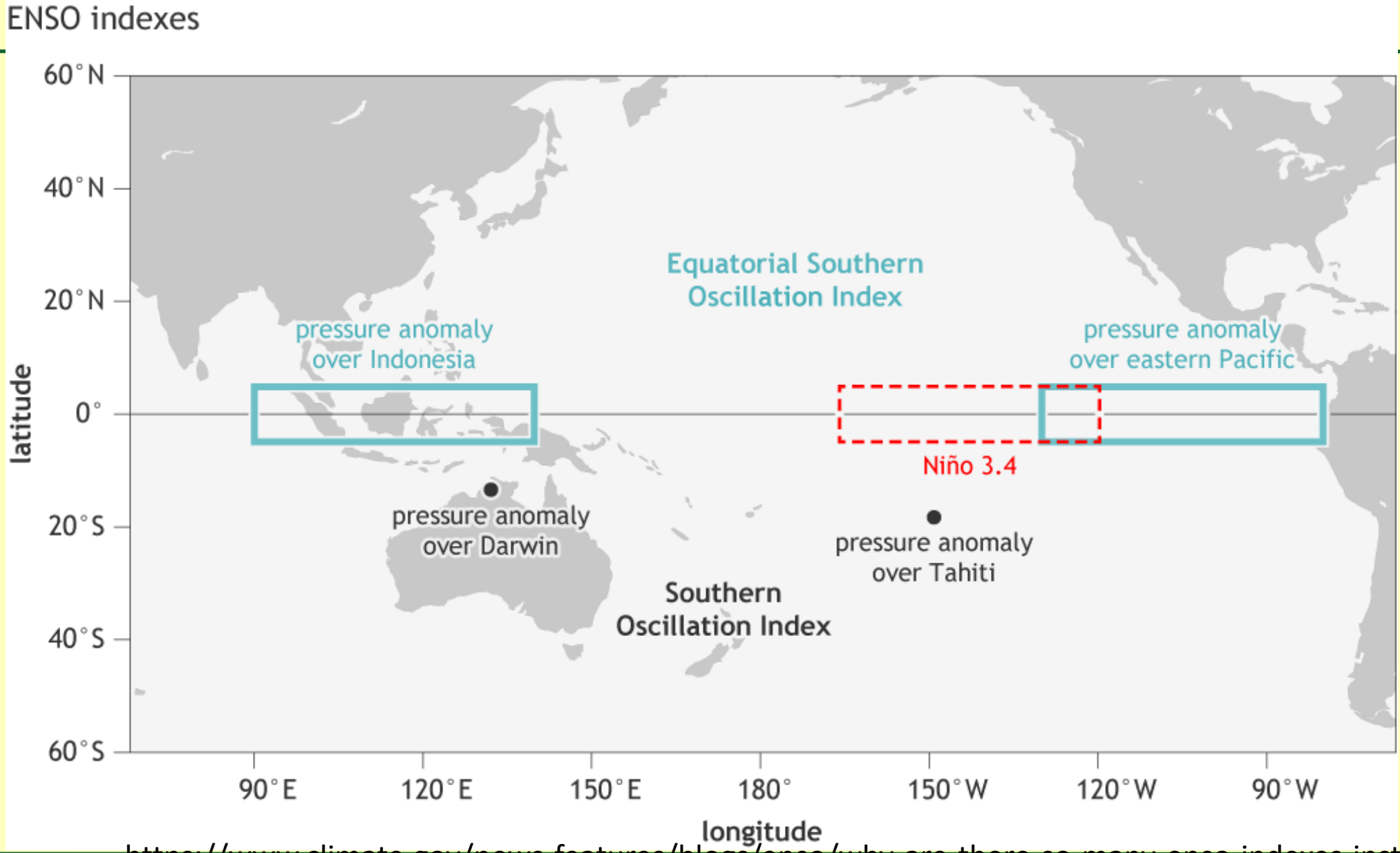
Irregular periodic variation in winds and sea surface temperatures over the tropical eastern Pacific Ocean, affecting the climate of much of the tropics and subtropics. The warming phase of the sea temperature is known as *El Niño* and the cooling phase as *La Niña*. The *Southern Oscillation* is the accompanying atmospheric component, coupled with the sea temperature change: *El Niño* is accompanied by high air surface pressure in the tropical western Pacific and *La Niña* with low air surface pressure there. The two periods last several months each and typically occur every few years with varying intensity per period.



This diagram shows a model of surface temperatures, winds, areas of rising air, and the thermocline (blue surface) in the tropical Pacific during El Niño, normal, and La Niña conditions. Click to enlarge. Source: NOAA/PMEL/TAO Project Office, Dr. Michael J. McPhaden, Director

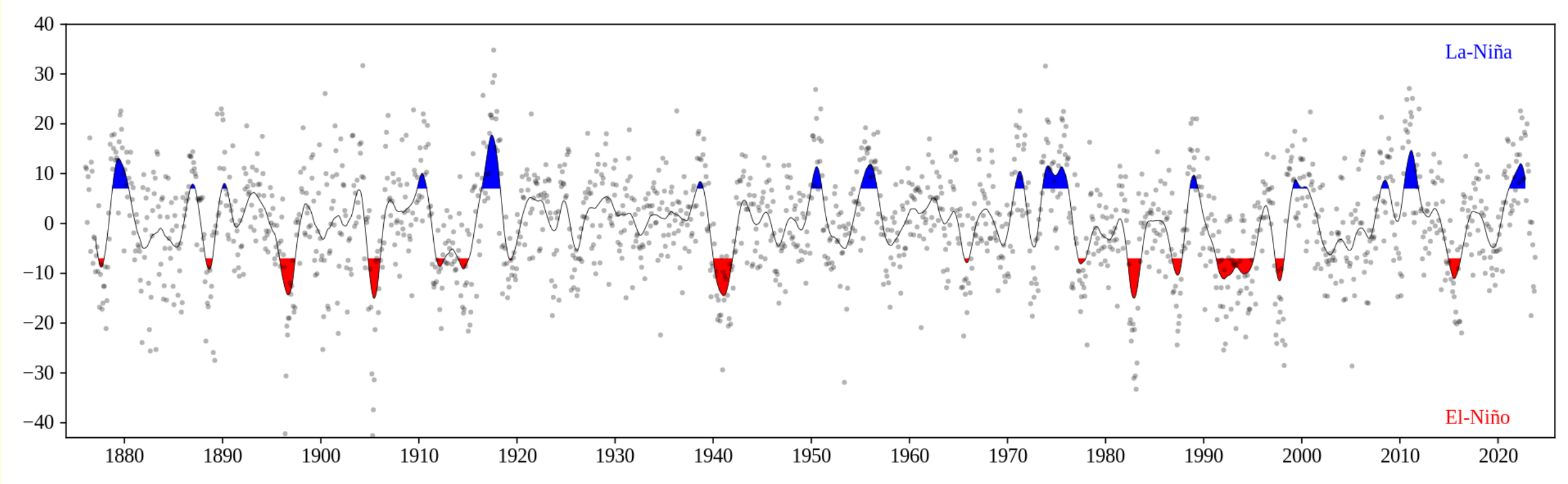
https://reefresilience.org/stressors/climate-and-ocean-change/el-nino-southern-oscillation/

The regions where the air pressure are measured and compared to generate the Southern Oscillation Index



https://www.climate.gov/news-features/blogs/enso/why-are-there-so-many-enso-indexes-instead-just-one

Southern Oscillation Index time series 1876–2023

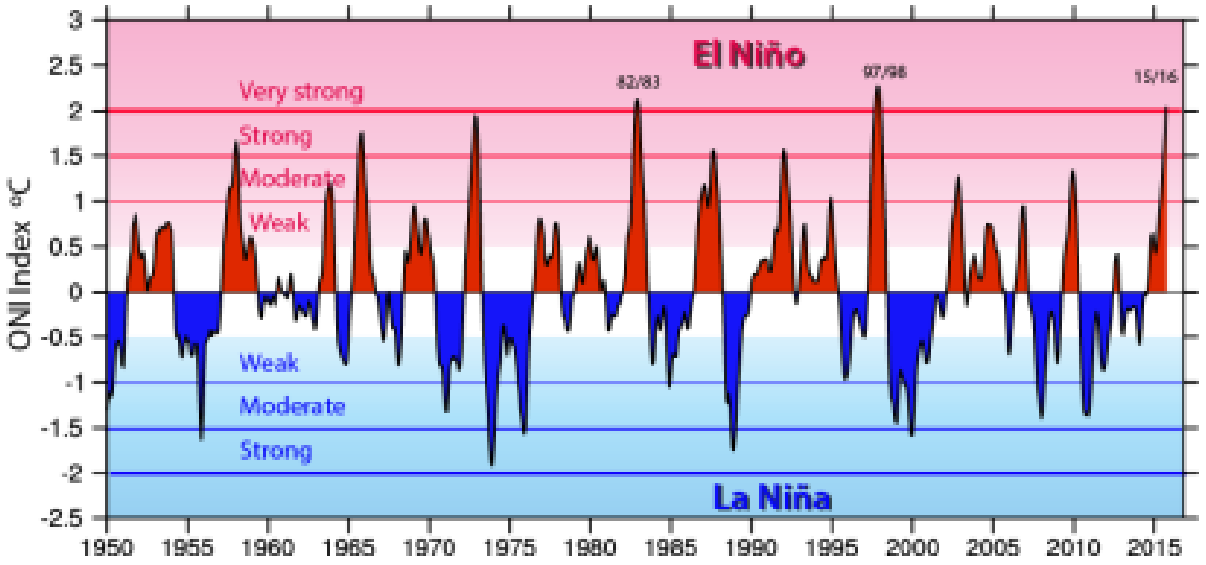


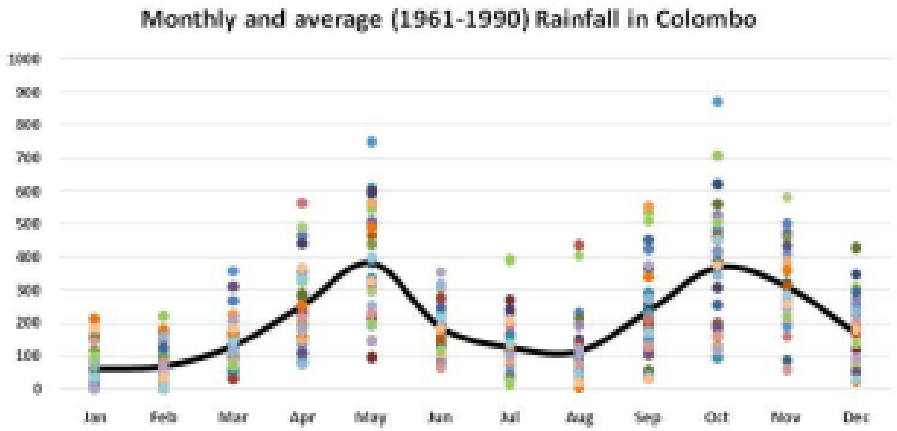
https://commons.wikimedia.org/wiki/File:SOI.svg#/media/File:SOI.svg

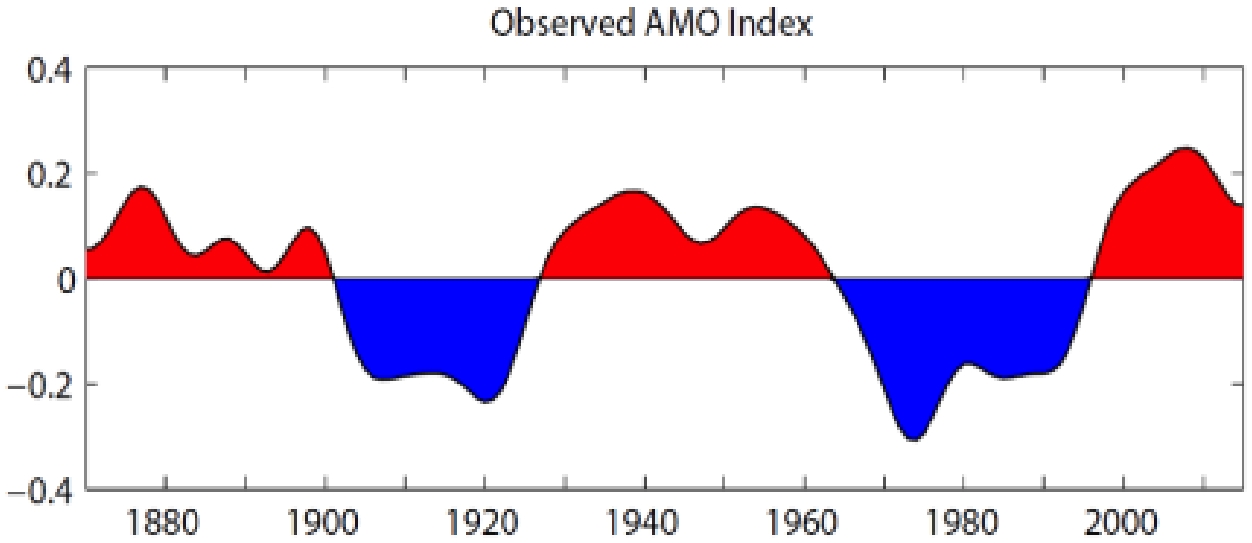
Types of Climate Variability

Interannual Variability: Fluctuations that occur from one year to the next, like El Niño and La Niña events.

- **Seasonal Variability:** Changes in climate patterns that occur within a single year, such as the monsoon season or variations in winter temperatures.
- **Decadal Variability:** Climate patterns that persist for a decade or longer, such as the Atlantic Multidecadal Oscillation (AMO) or the Pacific Decadal Oscillation (PDO).







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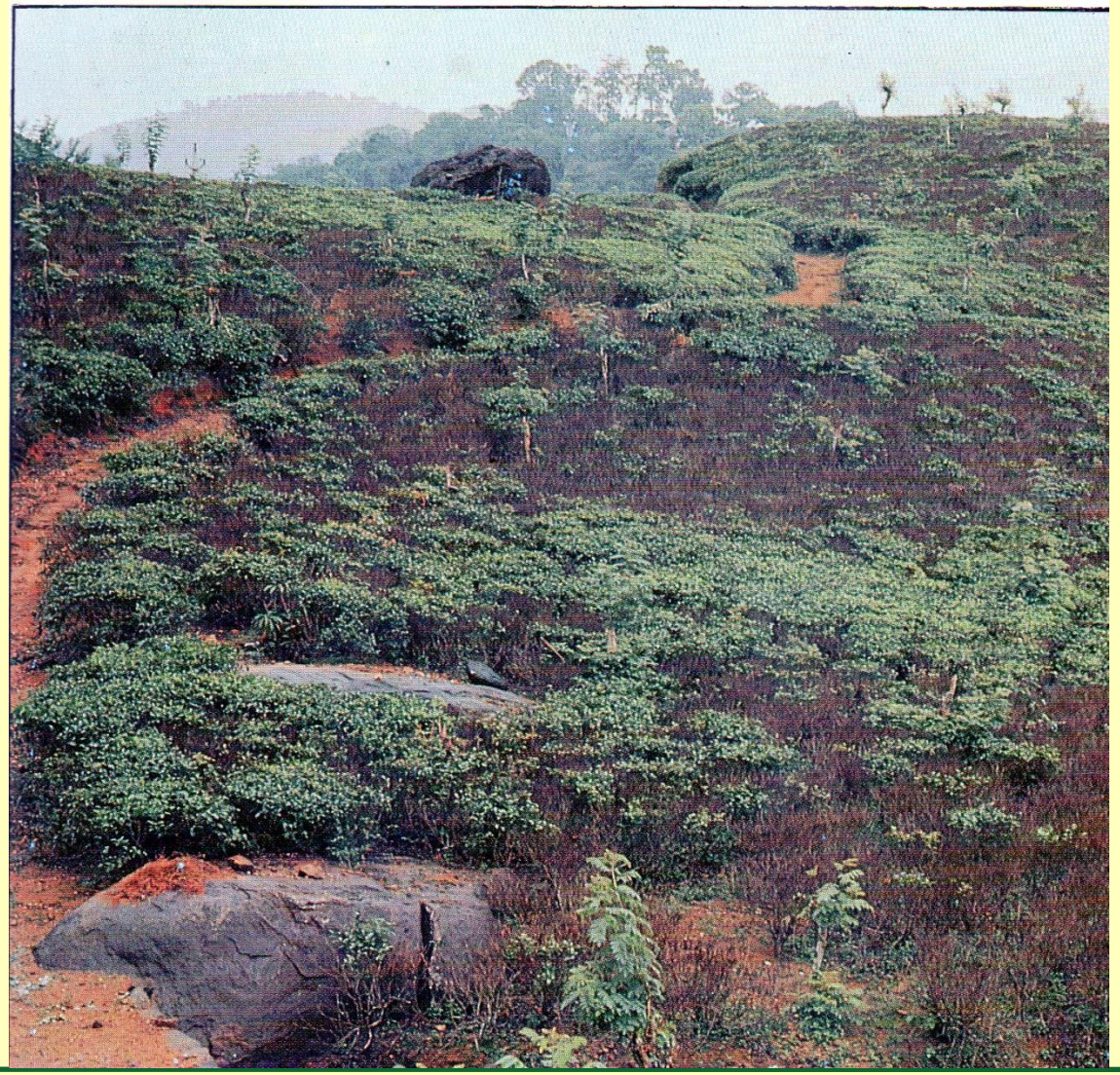
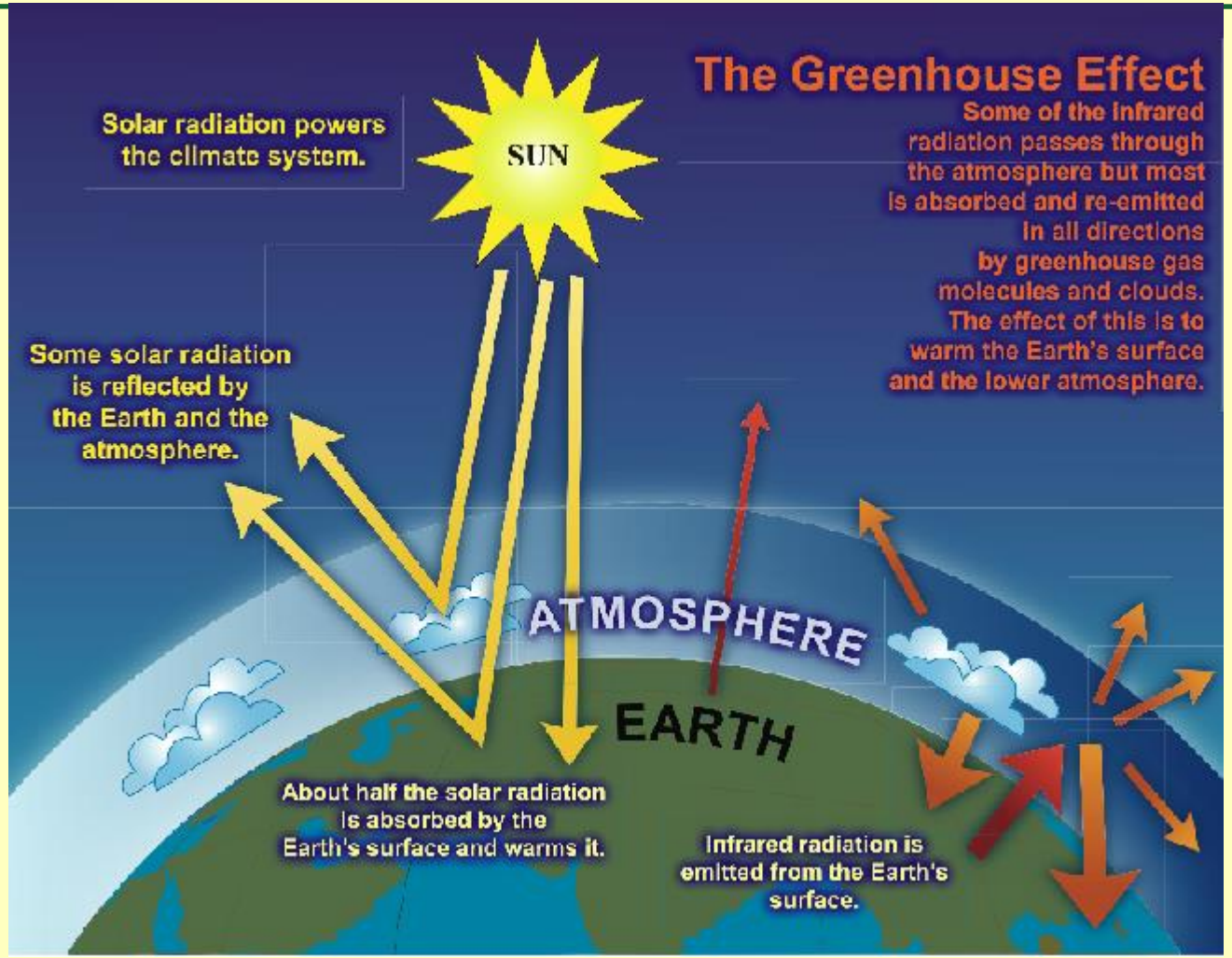
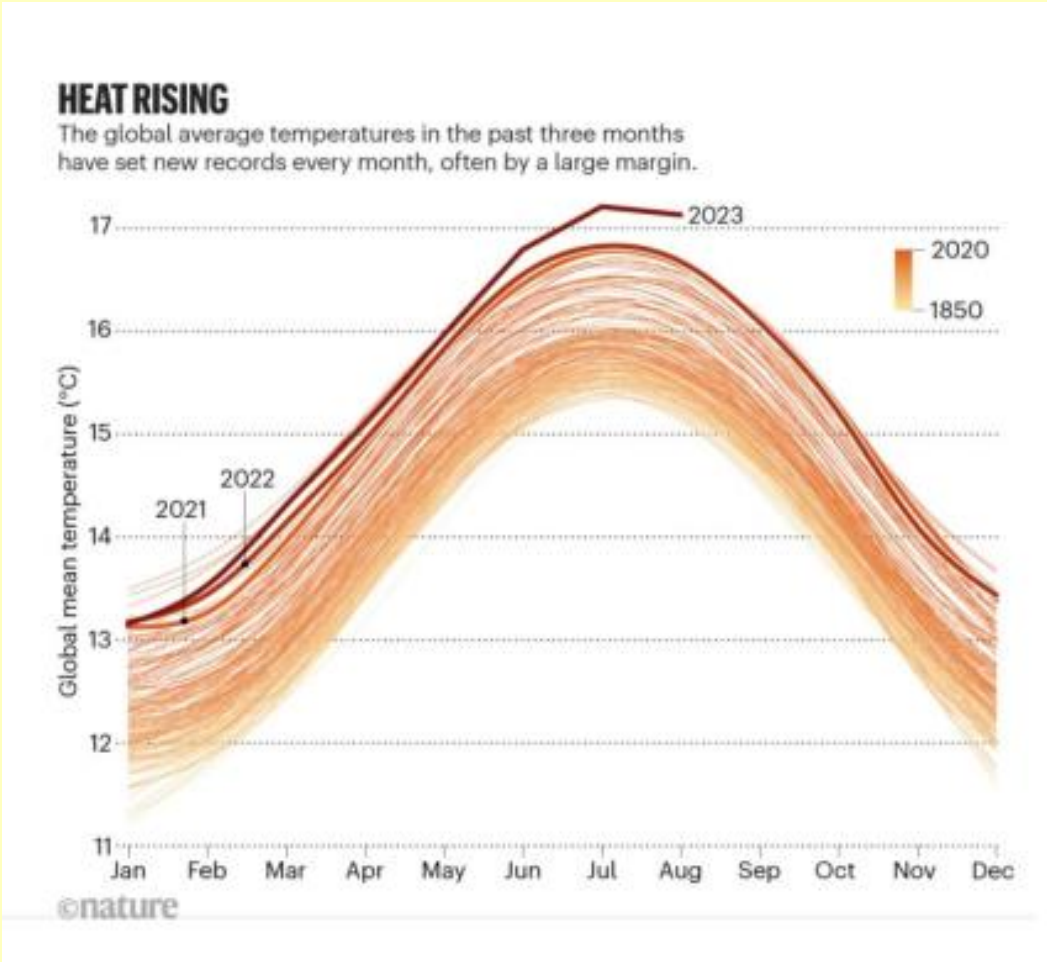
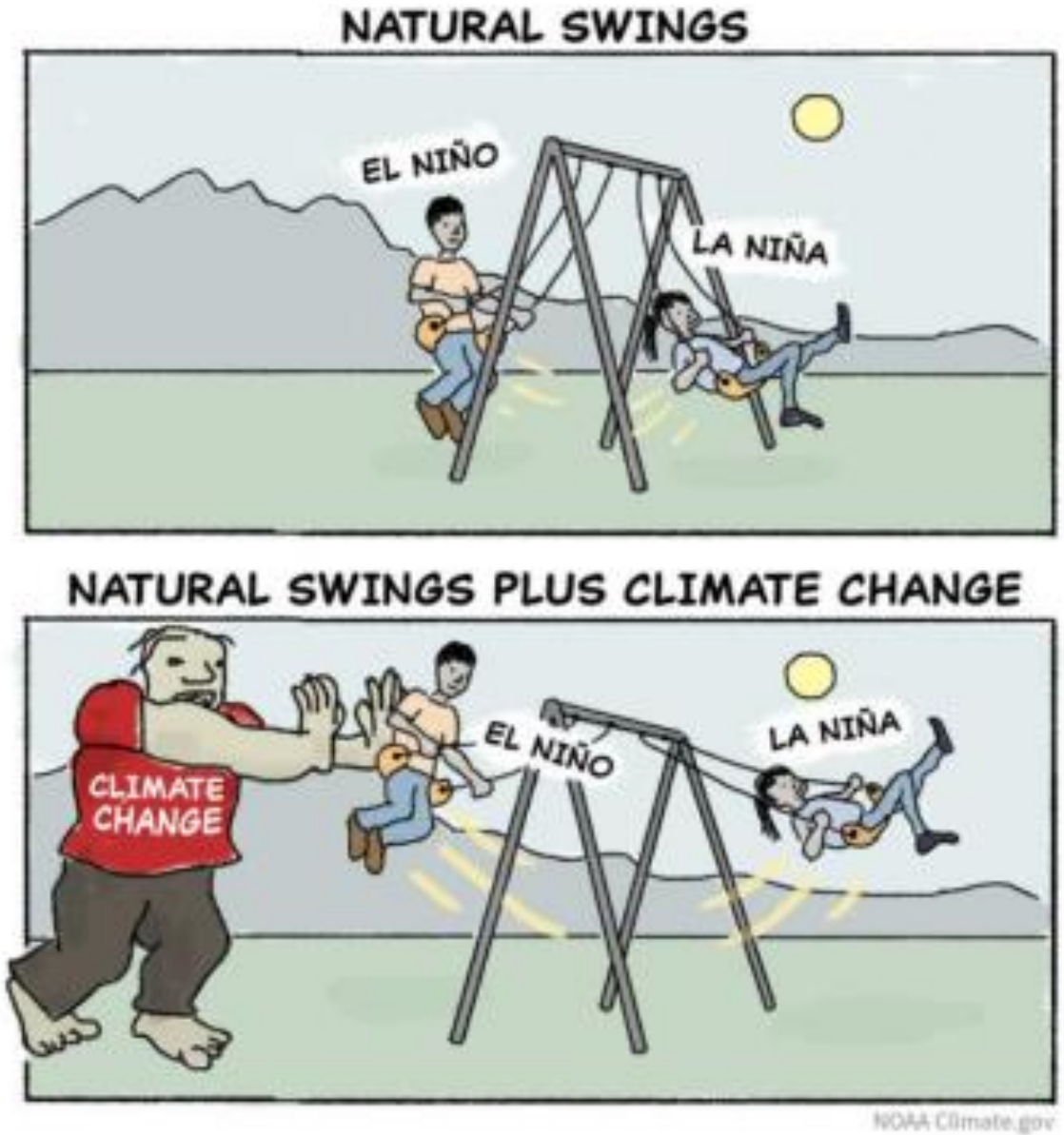


Global Climate Change







"Natural Swings," natural oscillation between the El Niño and La Niña climate phenomena.

"Climate Change" pushes the swing set, amplifying the effects of the oscillation, - intensification of weather patterns due to climate change. El Niño and La Niña are parts of the El Niño-Southern Oscillation (ENSO) climate pattern,

the added factor of climate change, these natural events can have even more extreme impacts on global weather patterns.

WORLD METEOROLOGICAL ORGANIZATION
Weather Climate Water

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El Niño expected to last at least until April 2024

PRESS RELEASE

08 November 2023

The ongoing El Niño event is expected to last at least until April 2024, influencing weather patterns and contributing to a further spike in temperatures both on land and in the ocean, according to a new Update from the World Meteorological Organization.

Key messages

- El Niño is expected to fuel further temperature increases
- Impacts will continue into 2024
- It will exacerbate extreme weather and climate-events, like heatwaves, floods and droughts
- Early Warnings for All save lives

https://wmo.int/news/media-centre/el-nino-expected-last-least-until-april-2024

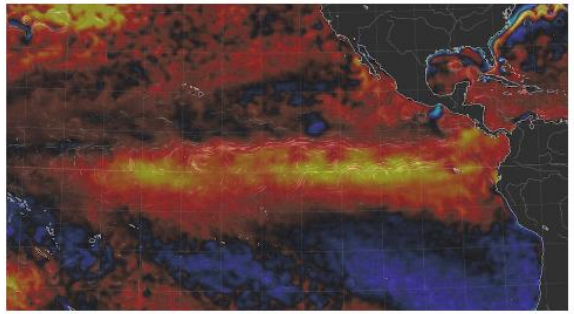
The Washington Post
Democracy Dies in Darkness

El Niño is nearing historic strength. What this means and when it will end.

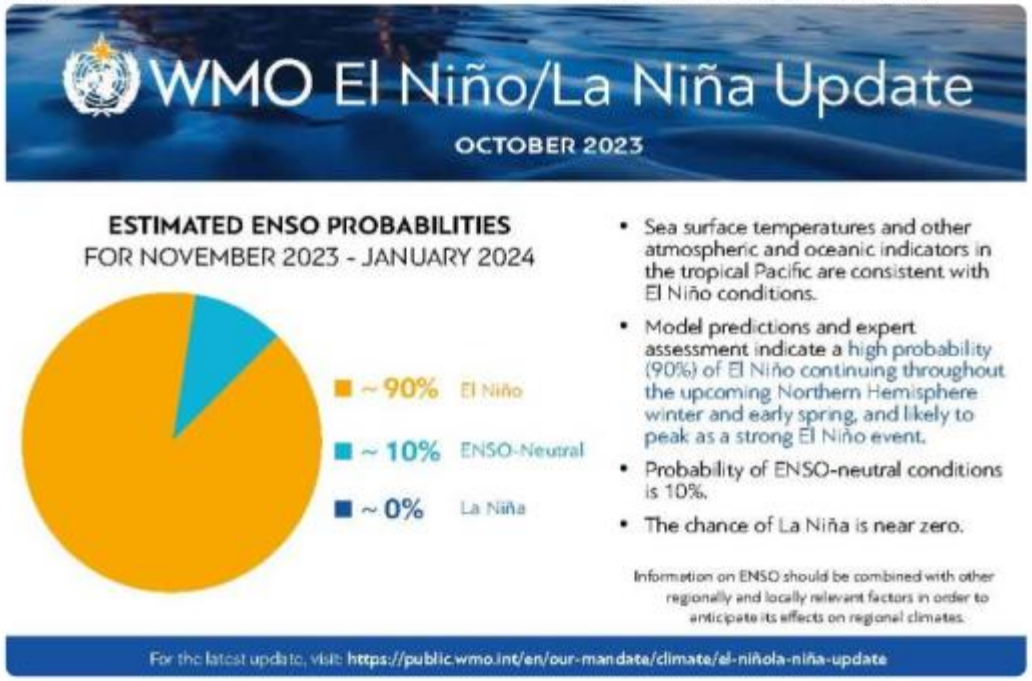
This could be one of the strongest El Niño events observed over the past 75 years, new data shows

By Scott Dance

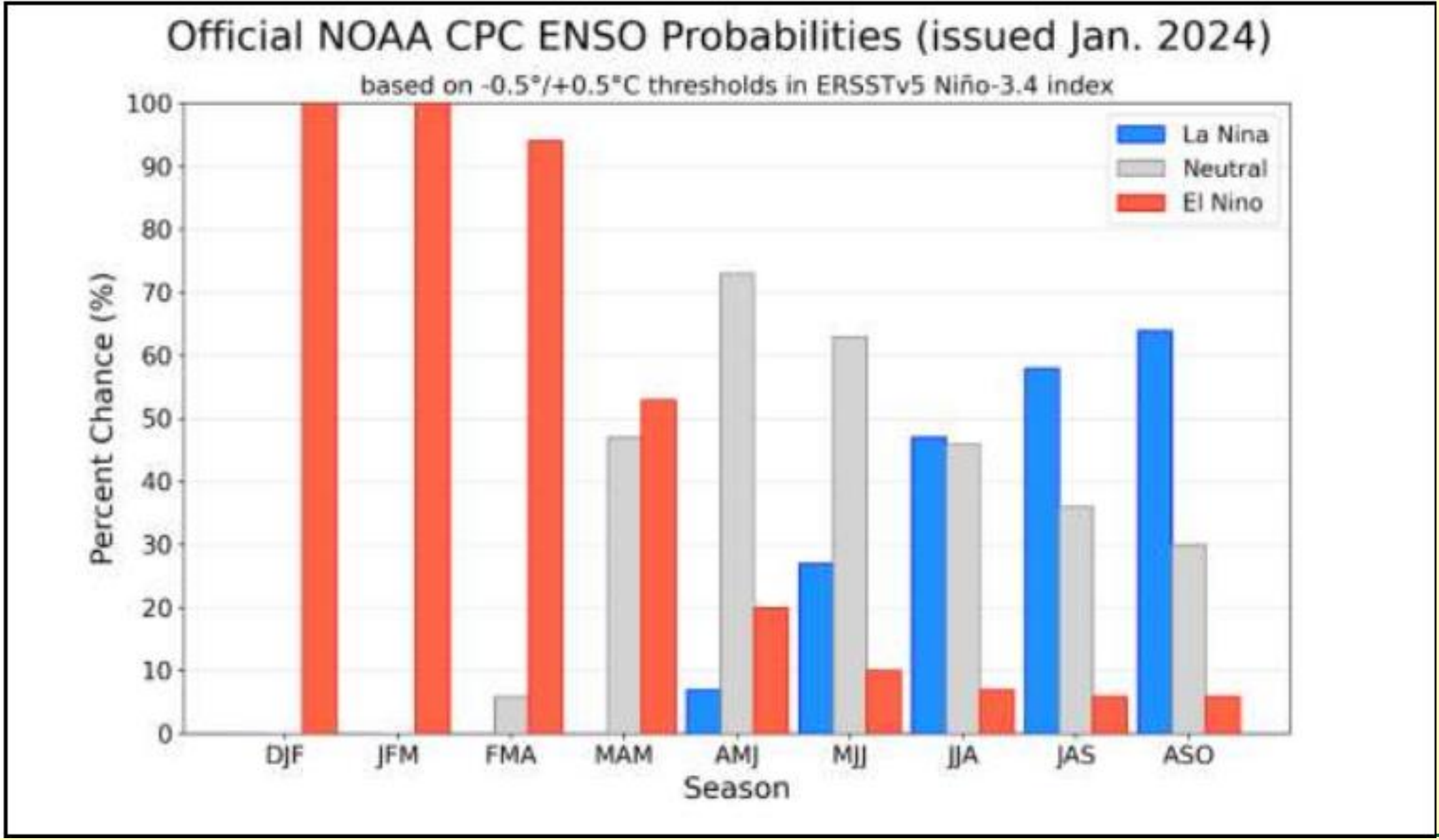
December 15, 2023 at 1:55 p.m. EST



Sea surface temperature differences from normal show abnormally warm waters over the eastern and central tropical Pacific Ocean, indicating strong El Niño conditions. (earth.nullschool.net)



WMO El Niño / La Niña Update - October 2023


Official NOAA CPC ENSO Probabilities (issued Jan. 2024)
based on -0.5°/+0.5°C thresholds in ERSSTv5 Niño-3.4 index
La Nina
Neutral
El Nino
Percent Chance (%)
100
90
80
70
60
50
40
30
20
10
0
DJF
JFM
FMA
MAM
AMJ
MJJ
JJA
JAS
ASO
Season

Impact of El Niño on Rainfall

Tropical Agriculturist, Vol.167 (1), 2019

Table 3. Comparison of mean cumulative rainfall (mm) during *El Niño, La Niña* and Neutral years in the selected locations of the WZ and IZ during FIM season

Station	AER	Neutral	*El Niño*	*La Niña*
Pussallawa (West Hall)	WU2b	422.5[a]	238.3[a]	444.2[a]
Pussallawa (New Peacock)	WU2b	300.9[a]	182.5[a]	393.4[a]
Sita-Eliya	WU3	237.7[a]	109.7[a]	244.4[a]
Hanthana	WM2b	293.9[a]	135.1[a]	292.3[a]
Peradeniya	WM2b	296.3[ab]	182.5[b]	393.4[a]
Rathnapura	WL1a	591.7[a]	374.1[b]	712.0[a]
Arandara (Atala)	WL1a	454.5[a]	486.2[a]	660.9[a]
Bombuwela	WL1b	428.2[a]	221.0[b]	565.6[a]
Labuduwa	WL2a	348.7[ab]	170.7[b]	574.0[a]
Gampaha-Henarathgoda	WL3	335.1[ab]	216.1[b]	522.6[a]
Bandarawela	IU3c	275.1[a]	145.1[b]	306.8[a]
Kundasale	IM3a	225.9[ab]	110.5[b]	311.0[a]
Lunuwila	IL1a	252.6[b]	203.3[b]	453.0[a]
Batalagoda	IL1a	320.8[a]	287.0[a]	309.8[a]
Girandurukotte	IL2	271.2[a]	162.4[a]	241.9[a]

The means with-in a row followed by the same letter are not significantly different at p=0.05

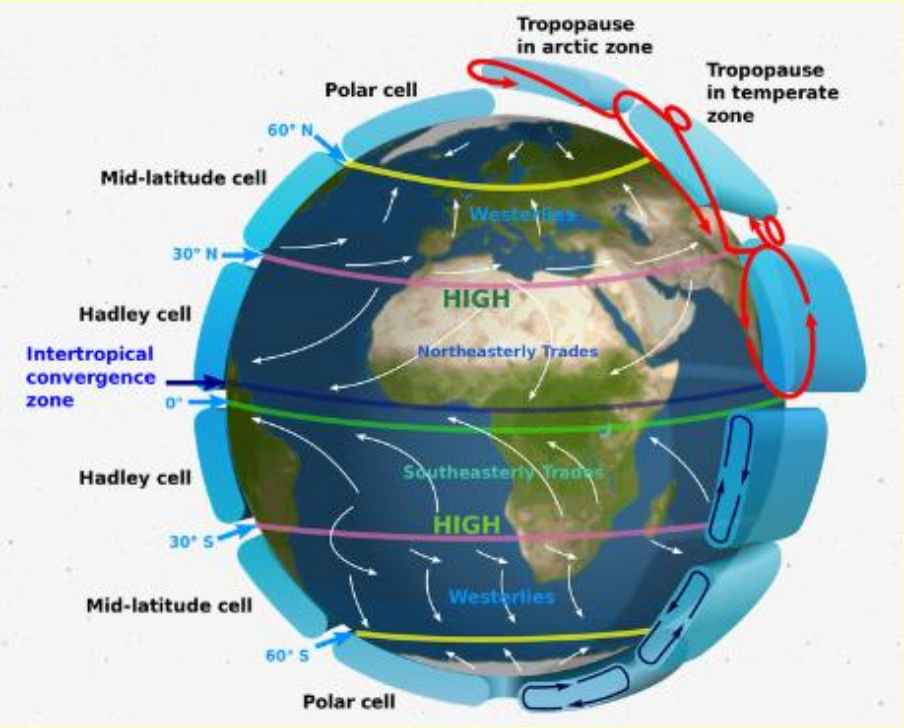
Table 6. Comparison of mean cumulative rainfall (mm) of *El Niño, La Niña* and Neutral years in the selected locations of the WZ and IZ during the NEM season

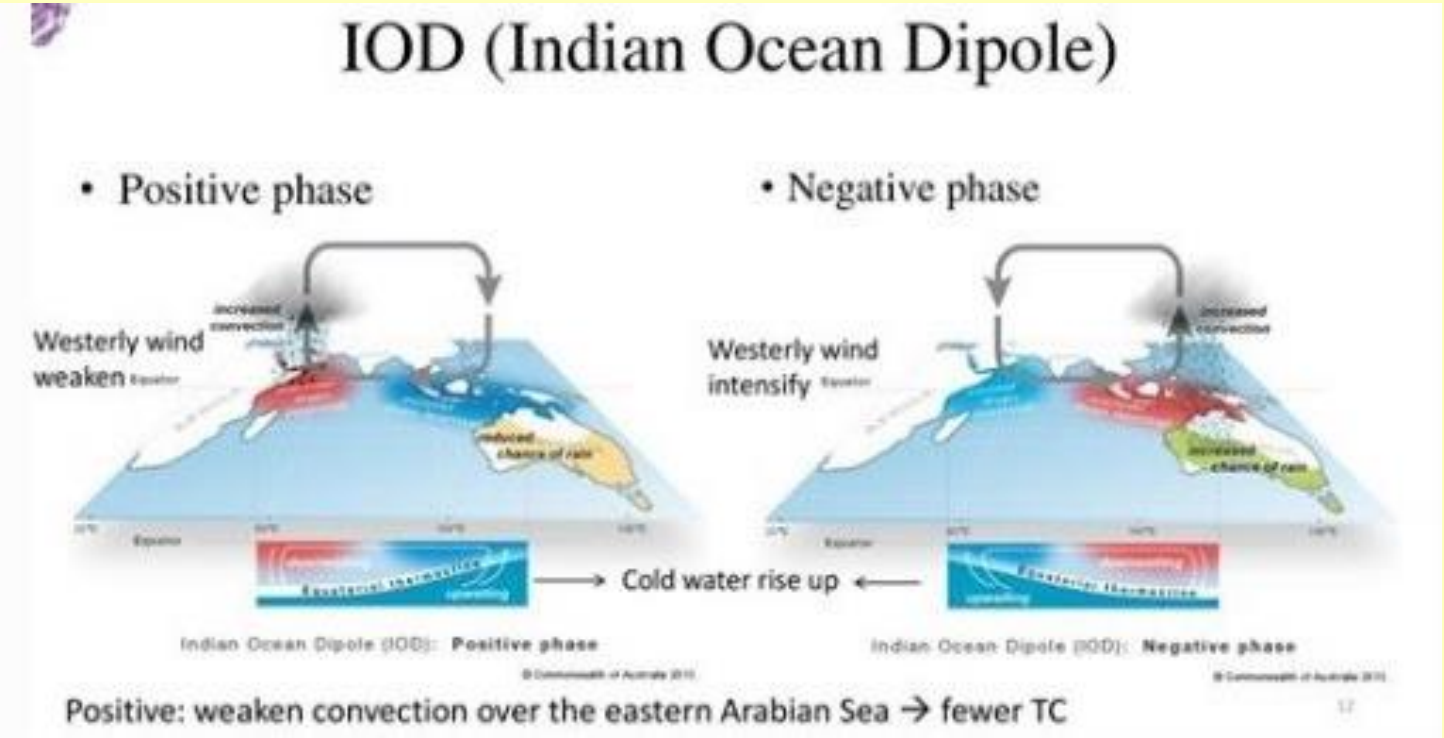
Station	AER	Neutral	*El Niño*	*La Niña*
Pussallawa (West Hall)	WU2b	323.9[a]	288.6[a]	557.9[a]
Pussallawa (New Peacock)	WU2b	331.9[a]	187.6[a]	432.2[a]
Sita-Eliya	WU3	431.8[a]	387.7[a]	633.0[a]
Hanthana	WM2b	301.7[a]	255.3[a]	565.9[a]
Peradeniya	WM2b	314.8[a]	187.6[a]	432.2[a]
Rathnapura	WL1a	502.7[a]	471.7[a]	571.0[a]
Arandara (Atala)	WL1a	332.8[a]	229.2[a]	556.2[a]
Bombuwela	WL1b	378.3[a]	378.2[a]	557.5[a]
Labuduwa	WL2a	376.0[a]	312.2[a]	545.9[a]
Gampaha-Henarathgoda	WL3	248.9[a]	193.8[a]	366.7[a]
Bandarawela	IU3c	378.2[a]	283.5[a]	487.0[a]
Kundasale	IM3a	278.7[b]	269.3[b]	607.0[a]
Lunuwila	IL1a	185.8[ab]	69.6[b]	290.1[a]
Batalagoda	IL1a	295.1[a]	257.1[a]	506.3[a]
Girandurukotte	IL2	851.3[a]	820.1[a]	1191.0[a]

The means within a row followed by the same letter are not significantly different at p=0.05

Abeysekara et al, 2019

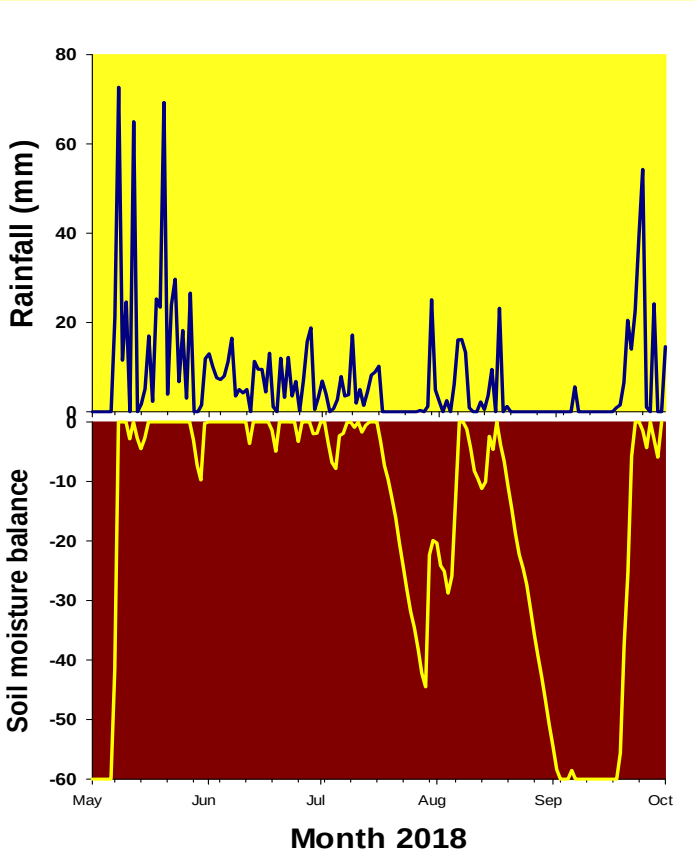
Other Factors…,

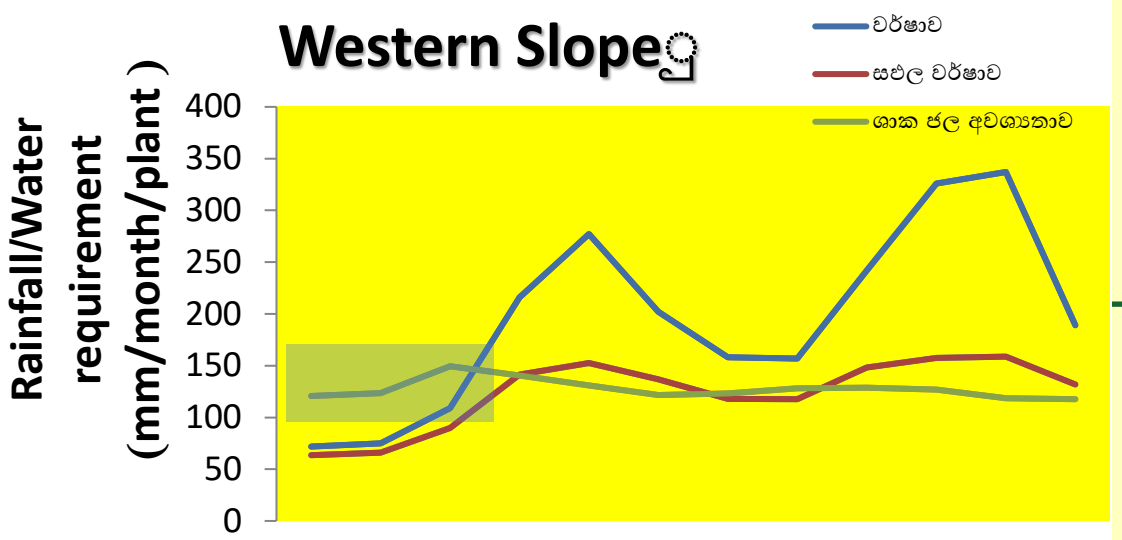


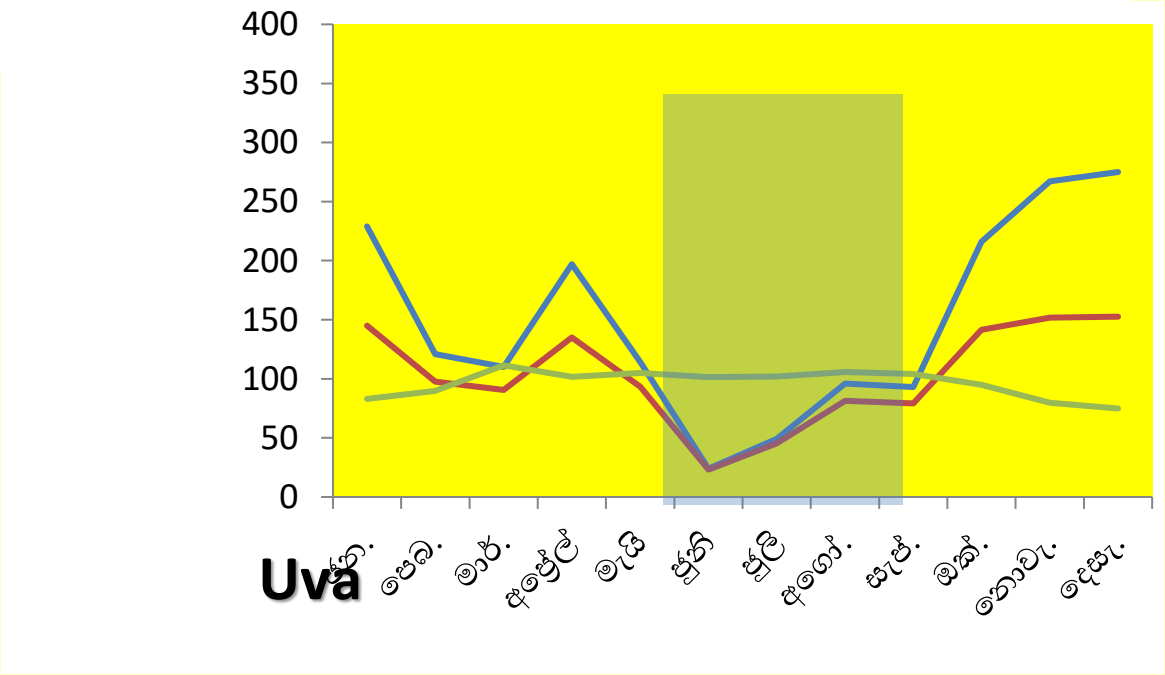


Indian Ocean Dipole (IOD) Phase	Impact on Monsoon	Example
Positive IOD	Enhances monsoon rainfall over the Indian subcontinent	In 1997, a positive IOD offset the impact of El Nino, resulting in above-normal monsoon rainfall.
Negative IOD	Weakens monsoon rainfall over the Indian subcontinent	In 2019, a negative IOD contributed to deficient monsoon rainfall, particularly during the first month of the monsoon season.
Neutral IOD	Minimal or neutral impact on the monsoon	A neutral IOD does not significantly influence the monsoon and allows other factors to play a more dominant role.

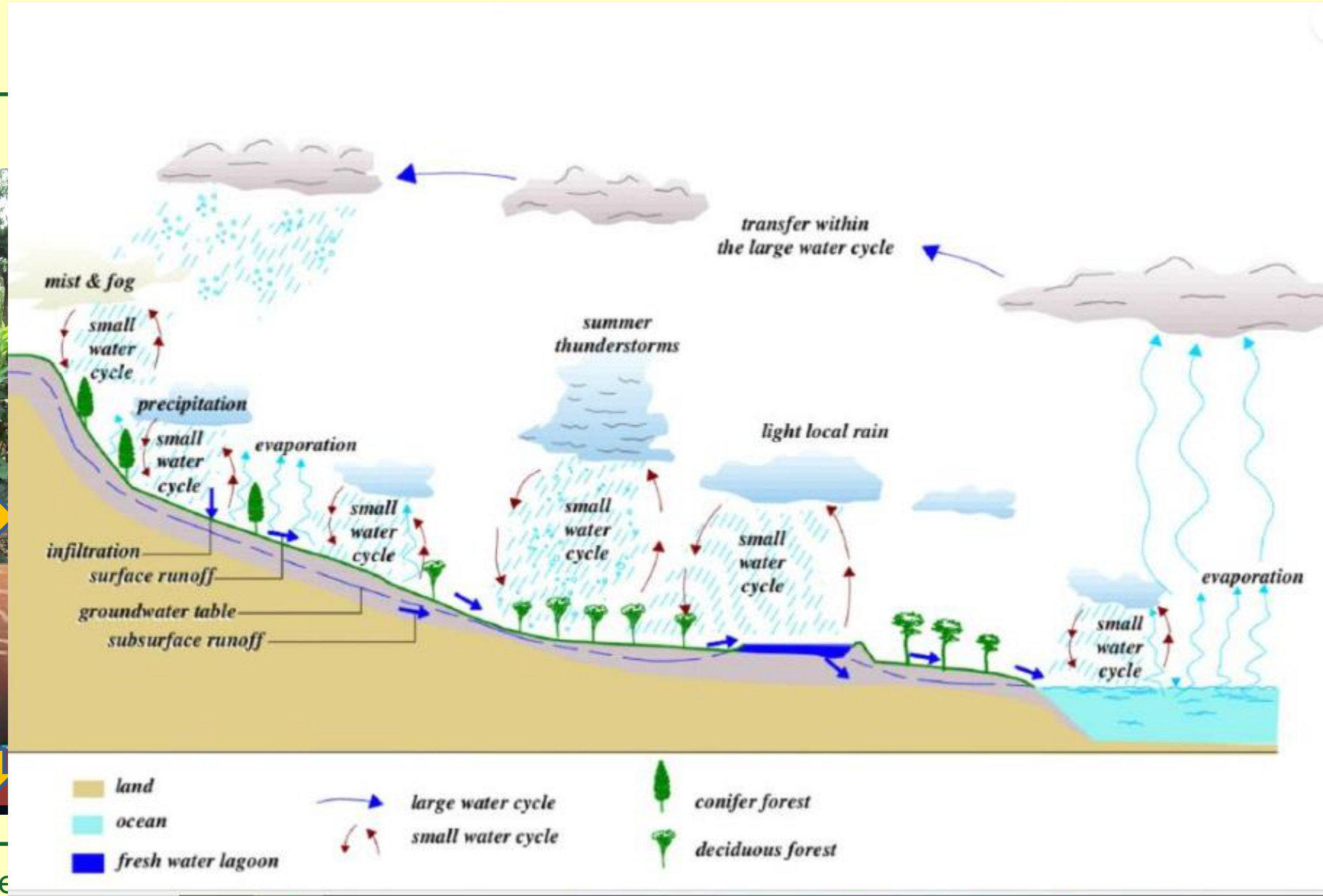
Drought periods..,

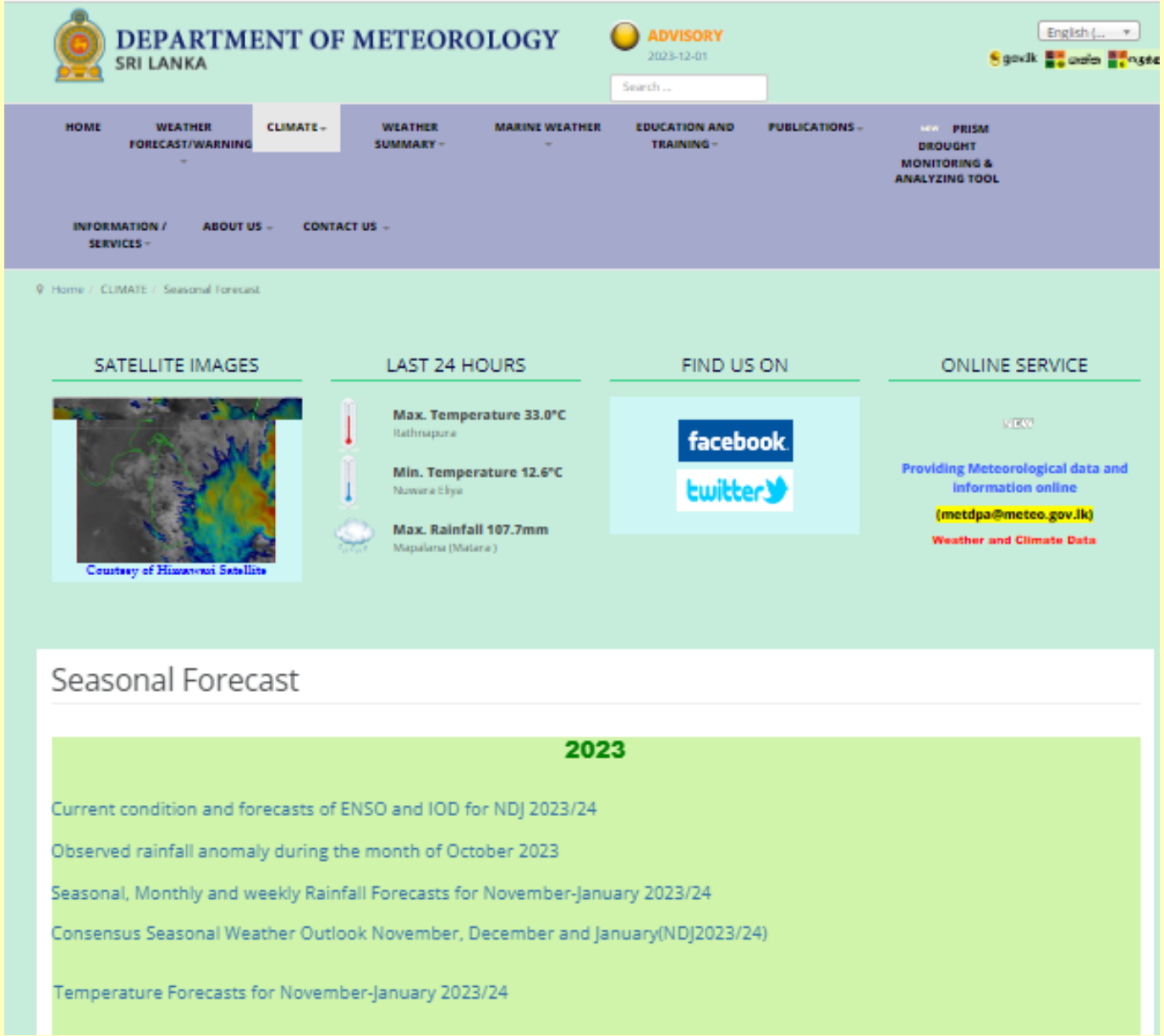






Behavior of Rainfall





https://www.meteo.gov.lk/index.php?option=com_content&view=article&id=78&Itemid=290&lang=en

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வளிமண்டலவியல் திணைக்களம்
DEPARTMENT OF METEOROLOGY
இ இலங்கை இலங்கை SRI LANKA

Consensus Seasonal Weather Outlook

February, March and April(FMA2024)

Seasonal Rainfall and Temperature for Sri Lanka

These forecasts are prepared using

- The prevailing global climate conditions.
- Forecasts from different climate models from around the world.
- Statistical downscaling of GCM output using CPT

Issued by Centre for Climate Change Studies (CCCS)

and

Research Division

Seasonal Forecast (meteo.gov.lk)

Weekly Rainfall forecasts for the month of February 2024

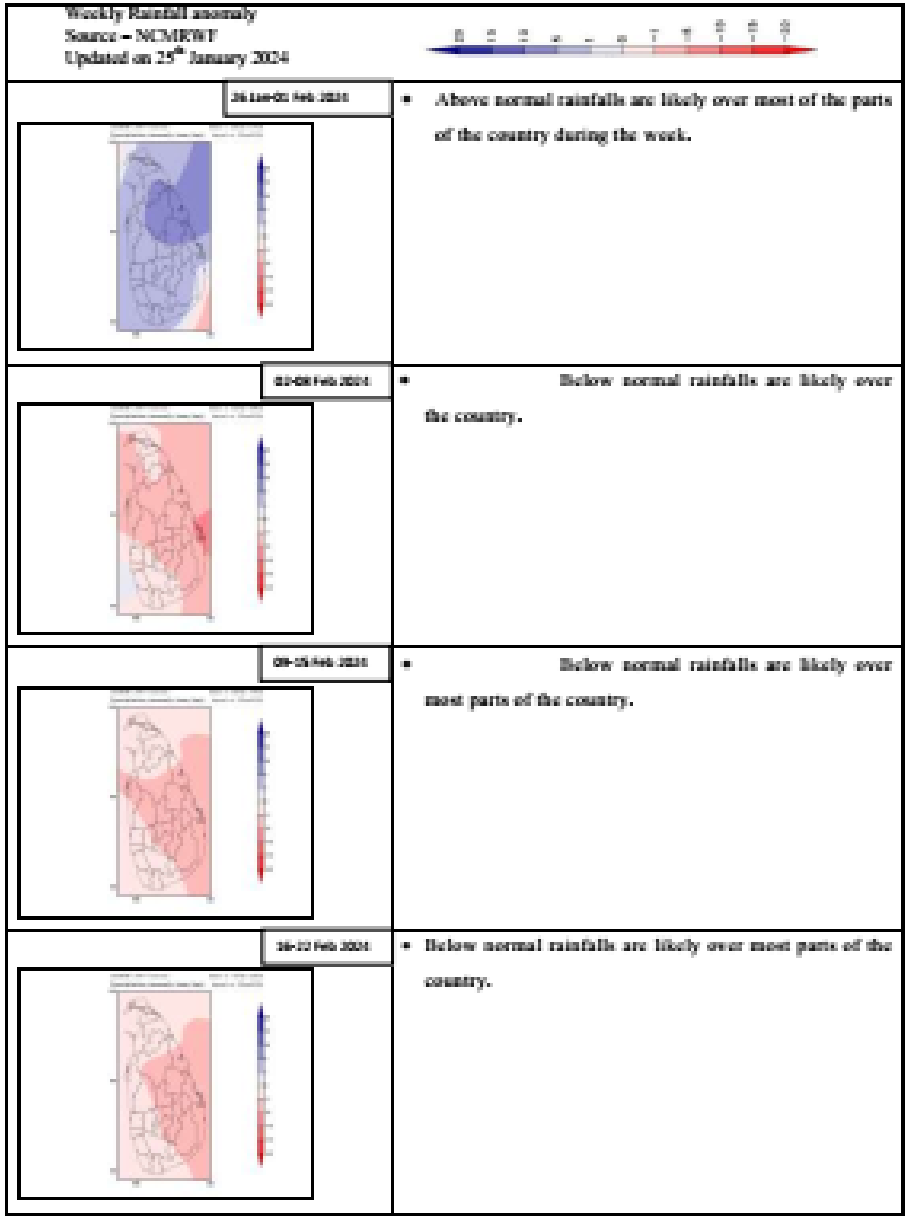


Fig 3.Weekly rainfall forecast for February 2024

1.1.1 Impacts of El-Niño on monthly rainfall anomaly during February, March and April

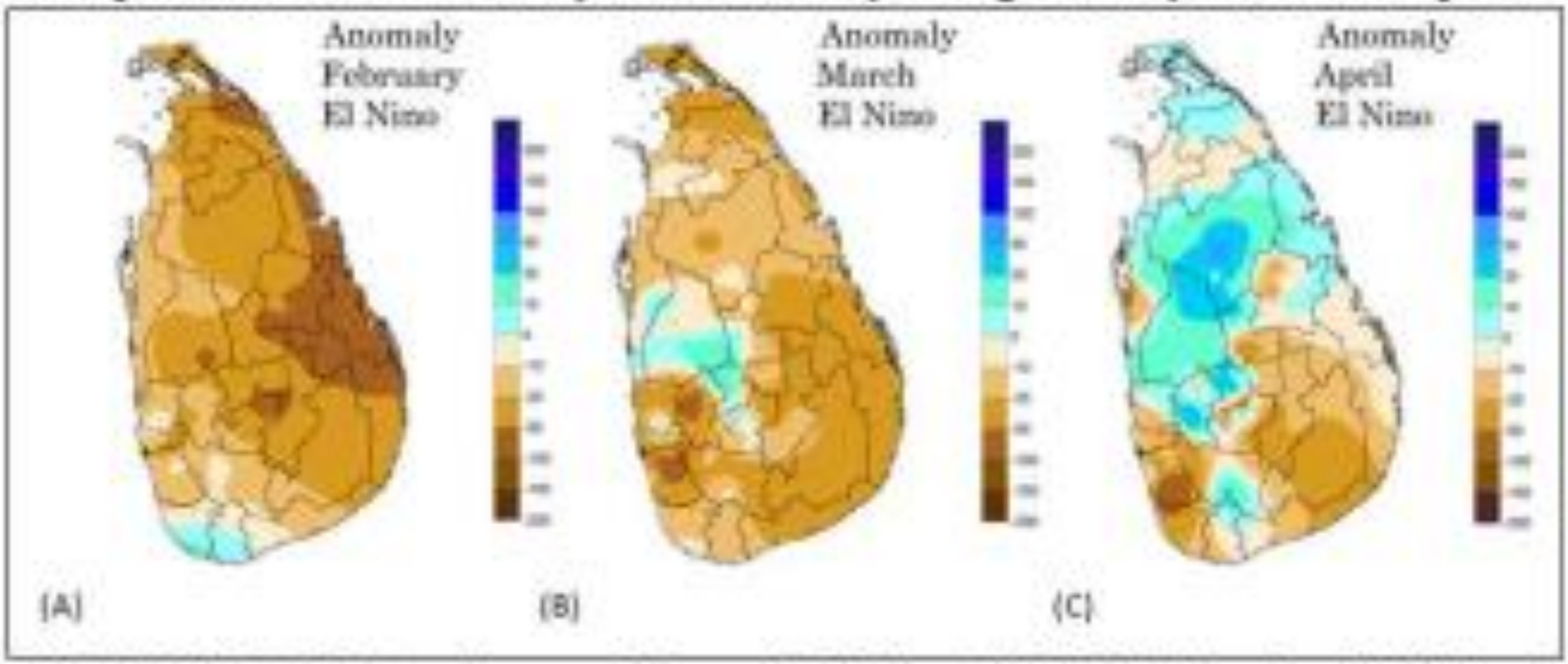


Fig 3b: Monthly Rainfall Anomaly maps of the months of February(A), March (B) and April (C) during El-Niño years (Hapuarachchi et al 2016)

District	Average Maximum Temperature (°C) – (FMA) (1981-2010)	Probability %		
		Below	Normal	Above
Anuradhapura	33.7	30	30	40
Badulla	28.5	40	30	30
Batticaloa	30.1	25	25	50
Colombo	31.6	25	25	50
Galle	30.4	30	25	45
Hambantota	30.8	35	30	35
Katugastota	30.8	25	25	50
Katunayake	32.5	25	25	50
Mannar	31.6	30	30	40
Mahailluppallama	33.0	30	30	40
NuwaraEliya	22.1	30	25	45
Potturvil	30.4	30	30	40
Puttalam	32.7	30	30	40
Ratnapura	33.8	25	25	50
Ratmalana	31.7	30	20	50
Trincomalee	30.9	20	25	55
Vavuniya	33.1	30	30	40
Kurunegala	33.7	25	25	50
Bandarawela	25.2	40	30	30

Table 3: probabilistic forecast for Maximum Temperature for FMA season 2024

5.2 Rainfall forecast for February 2024

There is a higher chance of having below normal rainfall over most parts of the country during the month of February 2024. But there is some possibility for developing wave type disturbances over and vicinity of Sri Lanka which could be enhanced the rainfall over Sri Lanka. Further there is some possibility for ground frost during early morning hours in Nuwara Eliya district during the month of February.

5.3 Rainfall forecasts for March 2024

There is a chance of having below normal rainfall over most parts of the country during the month of March 2024.

5.4 Rainfall forecasts for April 2024

There is a possibility of having near normal rainfall over western, Southern, Central and Sabaragamuwa provinces and there no signal for remaining areas of the country where having equal probability for below or near or above or during the month of April 2024.

District	Average rainfall (mm) – FMA (1981-2010)	Probability%		
		Below	Normal	Above
Colombo	495.4	60	20	20
Kalutara	626.7	60	20	20
Galle	567.2	60	20	20
Matara	487.2	25	35	40
Hambantota	237.5	15	30	55
Ampara	271.7	20	35	45
Batticaloa	244.0	30	35	35
Trincomalee	191.4	30	35	35
Mullaithivu	169.2	35	35	30
Jaffna	105.0	40	30	30
Killinochchi	145.2	40	35	25
Mannar	208.5	50	30	20
Puttalam	257.3	55	25	20
Gampaha	420.8	60	25	15
Kegalle	592.7	55	25	20
Ratnapura	648.4	35	35	30
Monaragala	334.3	20	30	50
Badulla	432.7	35	35	30
Pollonnaruwa	268.0	35	35	30
Vavuniya	195.6	35	35	30
Anuradapura	245.7	45	30	25
Kurunegala	337.3	60	25	15
Matale	380.3	50	30	20
Kandy	393.7	30	30	40
Nuwaraeliya	430.5	20	30	50

Table 1: Probabilistic Rainfall Forecast for FMA season 2024 using CPT

Weekly Rainfall forecasts for the month of February 2024

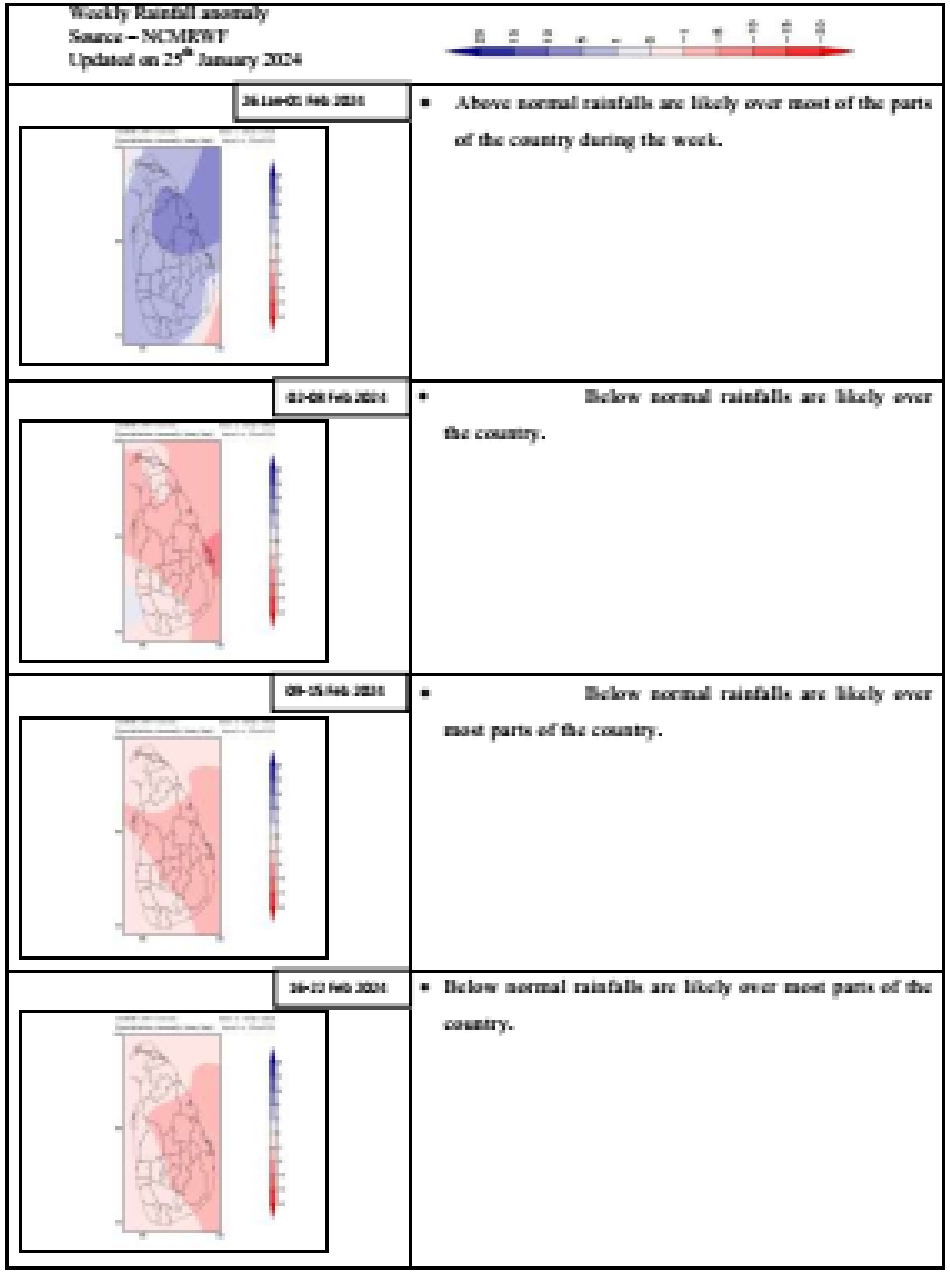
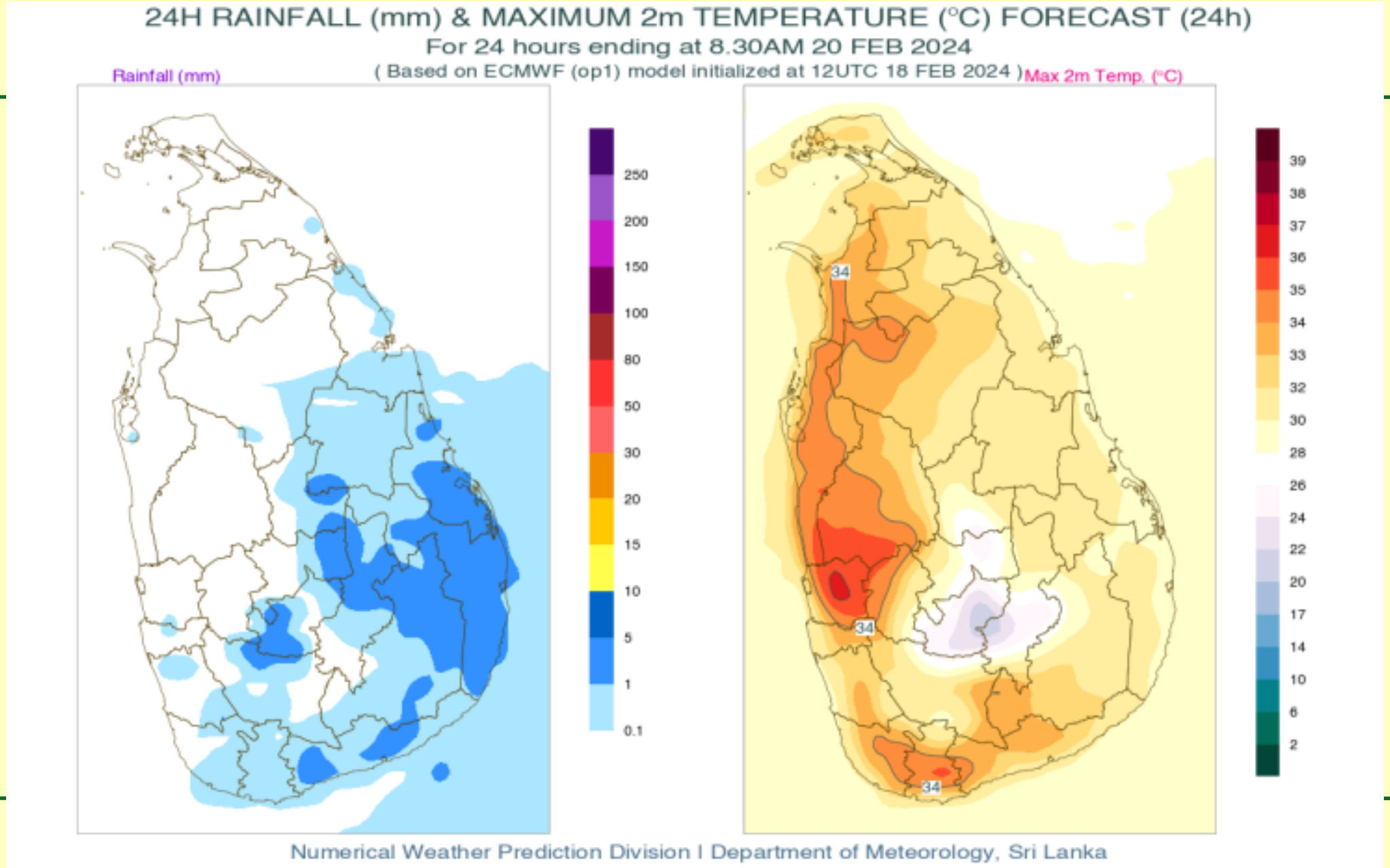


Fig 3.Weekly rainfall forecast for February 2024

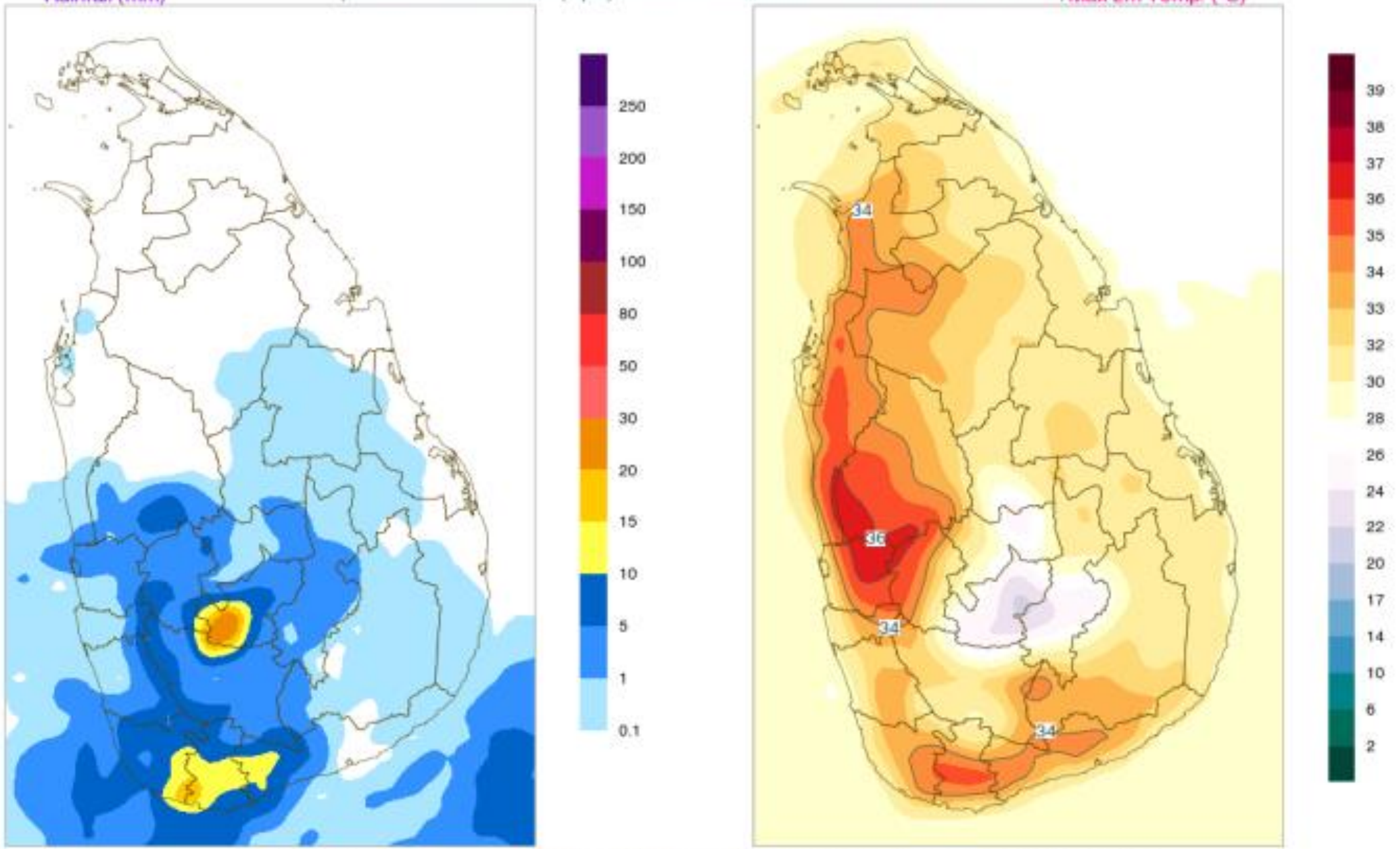
10D Forecast – (http://222.165.186.51/public/emfc10d.html)



24H RAINFALL (mm) & MAXIMUM 2m TEMPERATURE (°C) FORECAST (24h)

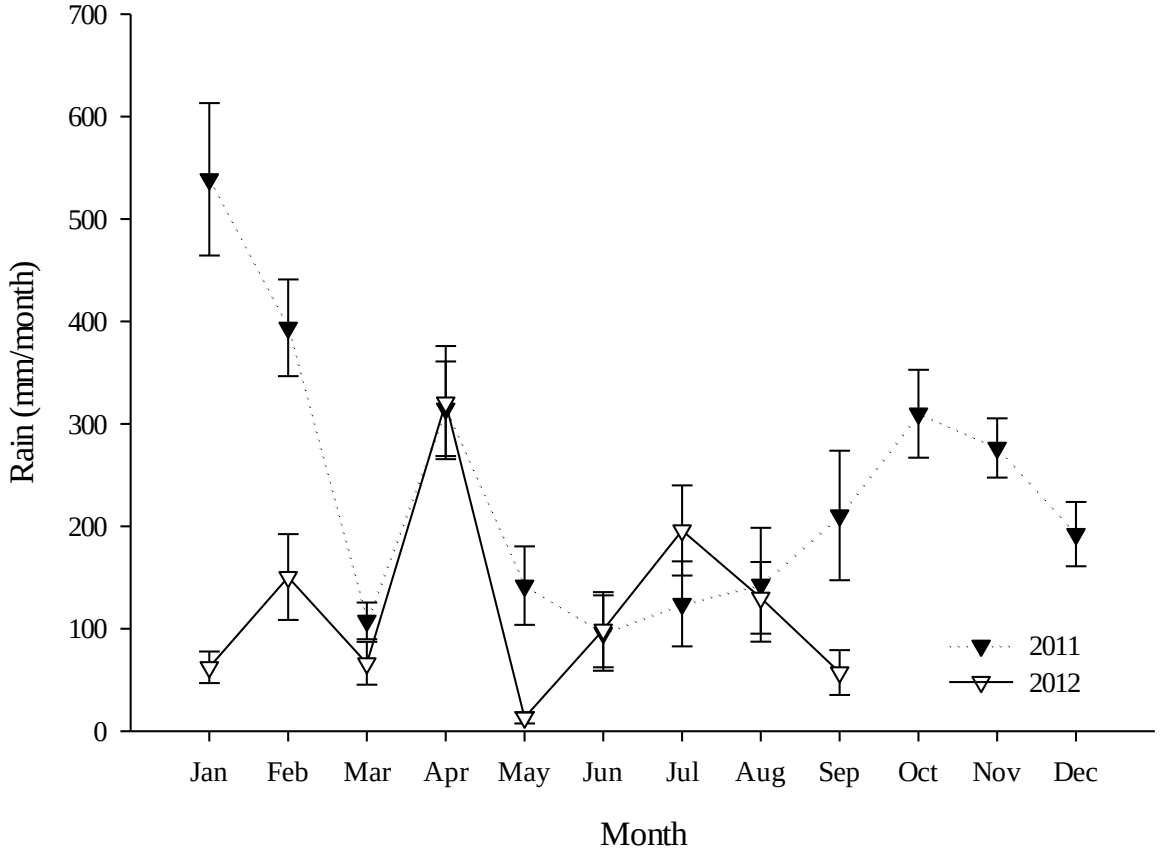
For 24 hours ending at 8.30AM 21 FEB 2024

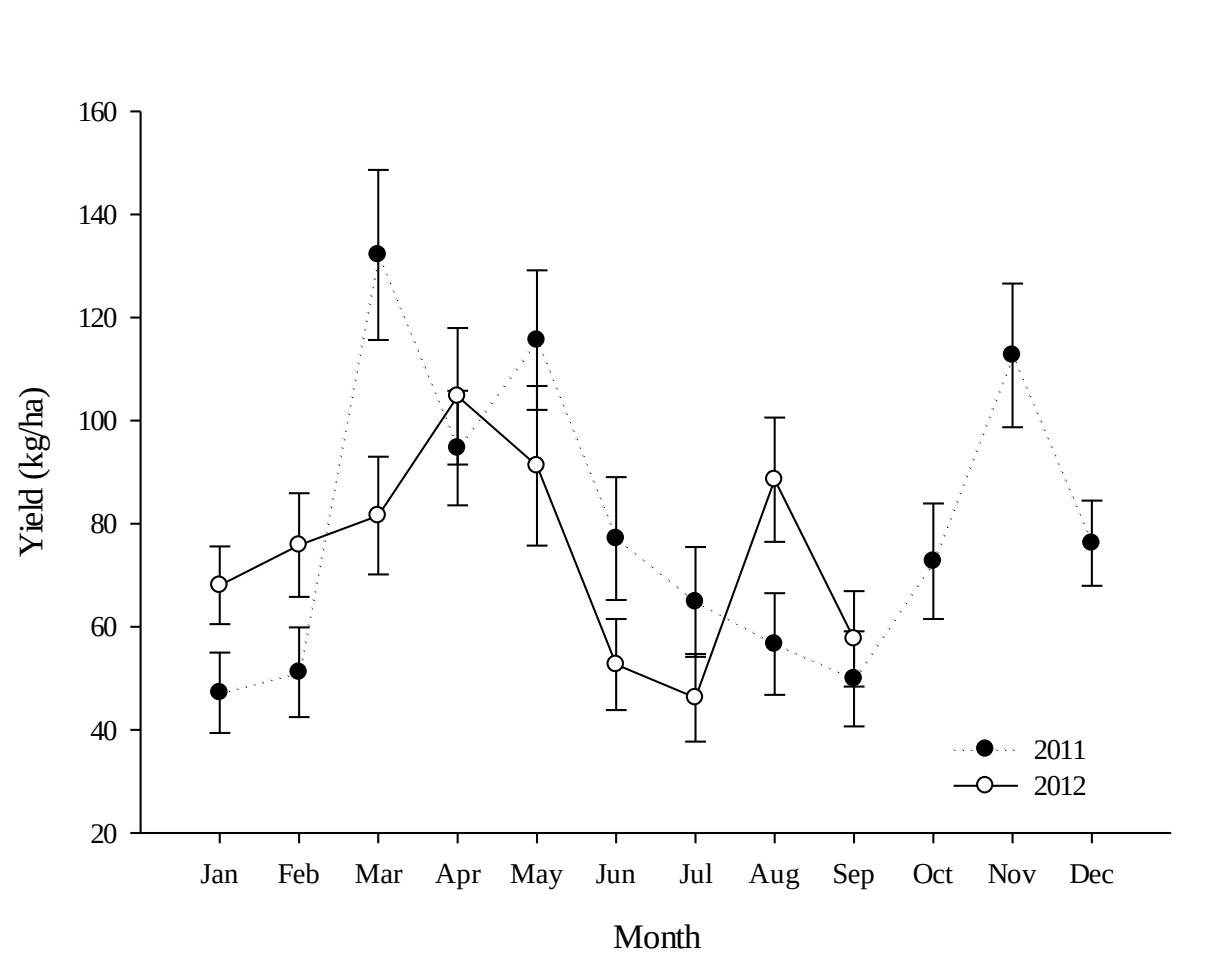
(Based on ECMWF (op1) model initialized at 12UTC 18 FEB 2024)



Numerical Weather Prediction Division I Department of Meteorology, Sri Lanka

2012 Drought





2012 Drought Impact

Estate	VP% <2yrs	VP% 2-5Yrs	VP% >5Yrs	Seedling	Pest Incidence
1	0	0	50%	30%	Mild
2	0	0	0	0	No
3	0	0	2%	0	No
4	5%	0	0	40%	Mild
5	0	0	0	0	Severe
6	0	0	5%	5%	Mild
7	0	0	0	0	No
8	0	0	0	0	No
9	40%	0	0	0	Mild
10	0	0	0	0	Mild
11	0	0	0	0	Severe
12	0	0	10%	10%	Mild
13	60%	5%	0	0%	Mild
14	0	0	0	2%	Mild
15	0	0	0	0%	Mild

Estate	May	June	July	SE Monsoon
1	19.2	59.4	49.9	21.7
2	58.9	59.5	35.4	18.7
3	35.6	69.1	63.1	13.3
4	15.2	21.5	26.5	9.6
5	27.0	25.5	19.1	16.3
6	19.5	53.6	35.4	15.6
7	14.8	54.6	26.5	5.5
8	3.8	42.3	26.9	-11.8
9	28.8	27.3	15.3	13.9
10	-6.3	40.5	27.9	14.5
	21.7(±5.6)	45.3(±5.2)	32.6(±4.5)	11.7(±3.0)

Minimizing Drought Impact (Advisory Circular PA – 2)

T.R.I. ADVISORY CIRCULAR **No. PA 2**

Issued in: January 2011 Serial No. 02/11

DROUGHT MITIGATION IN TEA PLANTATIONS

(This circular cancels the circular No. PA 2 serial No. 2/01 issued in January 2001)

Drought is a serious environmental hazard. Its damage to cultivated crops has become frequent in the recent past and tea is no exception. Most of the tea growing regions in Sri Lanka receive rains from both north-east and south-west monsoons. However, tea plantations are adversely affected by moisture stress conditions due to uneven distribution of rainfall within the year. The main dry period in most of the tea growing regions extends from early January to about late March. However, those areas which receive mainly the north-east monsoon rains, *viz.* Uva and some parts of the Low and Mid country, have the main dry period generally extending from late June to about early September.

During these dry months, considerable damage can be caused to both young and mature tea, with extensive casualties being observed in young clonal tea during their first and the second year after planting. In order to minimize such damage and ensure early recovery, the following precautionary measures need to be adopted prior to, and following, a drought. The drought effects differ with the growth stage of tea that is whether it is young tea (before first pruning) or mature tea (after first pruning). Hence drought mitigation measures also should vary according to the stage of growth of the tea.

1. New clearings - tea before the first proper prune

New Clearings – Prior to 1st Prune

Pre Drought & During the Drought..

1. **Mulching :**
   - Mana / Gautemala grass - 37.5ton/ha
   - Partially decomposed saw dust / paddy husk / refuse tea – 15-20ton/ha
     - 6-8” from base of plant, 1-2” thickness
     - For saw dust / paddy husk – mix or spray with 2-3kg of Urea per 100kg of material
2. **Weed control :**
   - Free from weeds / No weedicide application during drought
3. **Spraying Sulphate of Potash (SOP) / Muriate of Potash (MOP) :**
   - 2% SOP / MOP solution
     - 2kg/100L /ha – 1st Year
     - 4kg/100L/ha – 2nd Year
     - 8kg/ha/ha – 3rd Year
     - 2 – 4 week interval
     - Mixing urea 2kg/ha enhance K absorption
   - Kaolin 5-10kg/100L of water to reduce transpiration

New Clearings – Prior to 1st Prune….,

4. **Skiffing :**
   - If drought continues, skiff removing topmost 2-3” of foliage
5. **Fertilizer application :**
   - No fertilizer application during drought
6. **Green Manure Crops and Cover Crops :**
   - Should be lopped
7. **Pest Control :**
   - Mites, tea totrix and nettle grub are major dry weather pests
   - Refer control measures

During drought periods, applying **potassium sulfate (K_2SO_4)** to plant leaves can have several beneficial effects. Let's explore these reasons:

Improved Photosynthetic Characteristics and Water Relations:

Foliar application of potassium sulfate can enhance photosynthesis rates and maintain water relations in plants. It helps maintain cell osmotic potential and turgidity, which is crucial during water scarcity.

By providing potassium, plants can better cope with drought stress, leading to improved growth and seedling development [1].

Root Growth and Drought Resistance:

Potassium plays a role in root growth and development. During drought, maintaining root health is essential for water uptake.

Potassium helps maintain turgor pressure in plant cells, reducing water loss and wilting. This contributes to drought resistance [2].

Aids in Photosynthesis and Food Formation:

Potassium is a vital nutrient for photosynthesis. It participates in the process of converting light energy into chemical energy (glucose).

Adequate potassium levels support efficient photosynthesis, even under drought conditions [2].

Reduces Respiration and Prevents Energy Losses:

Potassium helps regulate respiration in plants. By reducing respiration rates, it prevents unnecessary energy losses during drought stress [2].

Remember that foliar application of potassium sulfate directly to leaves can be an effective way to provide fast-acting potassium during drought. However, it's essential to follow recommended doses to avoid leaf burn [3].

For more detailed information, you can refer to the following research articles:

Allah Wasaya et al. (2021): "Foliar Potassium Sulfate Application Improved Photosynthetic Characteristics, Water Relations, and Seedling Growth of Drought-Stressed Maize" [1].

Additional studies on potassium's effects during drought stress are available in scientific literature.

Keep in mind that potassium sulfate should be used judiciously, considering the specific crop, soil conditions, and environmental factors.

Issued in: January 2011 Serial No. 02/11

Drought Mitigation in Tea Plantations

(This circular cancels the circular No. PA 2 serial No. 2/01 issued in January 2001)

Drought is a serious environmental hazard. Its damage to cultivated crops has become frequent in the recent past and tea is no exception. Most of the tea growing regions in Sri Lanka receive rains from both north-east and south-west monsoons. However, tea plantations are adversely affected by moisture stress conditions due to uneven distribution of rainfall within the year. The main dry period in most of the tea growing regions extends from early January to about late March. However, those areas which receive mainly the north-east monsoon rains, viz. Uva and some parts of the Low and Mid country, have the main dry period generally extending from late June to about early September.

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1. New clearings - tea before the first proper prune

1.1 Measures to be adopted before and during drought

1.1.1 Mulching

The inter-rows of new clearings should be thatched with Guatemala or Mana grass well before the monsoon sets off. For this purpose, about 37.5 metric tons per hectare (15 tons per acre) fresh material would be required. This could be obtained from a single lopping from one hectare of well-tended grass clearing. Partially decomposed waste materials such as sawdust, paddy husk and refuse tea can be used (at the rate of 15 - 20 tons/ ha) for mulching. They can be applied as a layer 1" - 2" thick, leaving about 6" - 8" from the base of the tea plants. If paddy husk or saw dust are used, they should be mixed or sprayed with urea at the rate of 2 - 3 kg per 100 kg of material. Mulching should be repeated 2 - 3 times a year depending on the rate of decomposition of the material used.

1.1.2 Weed control

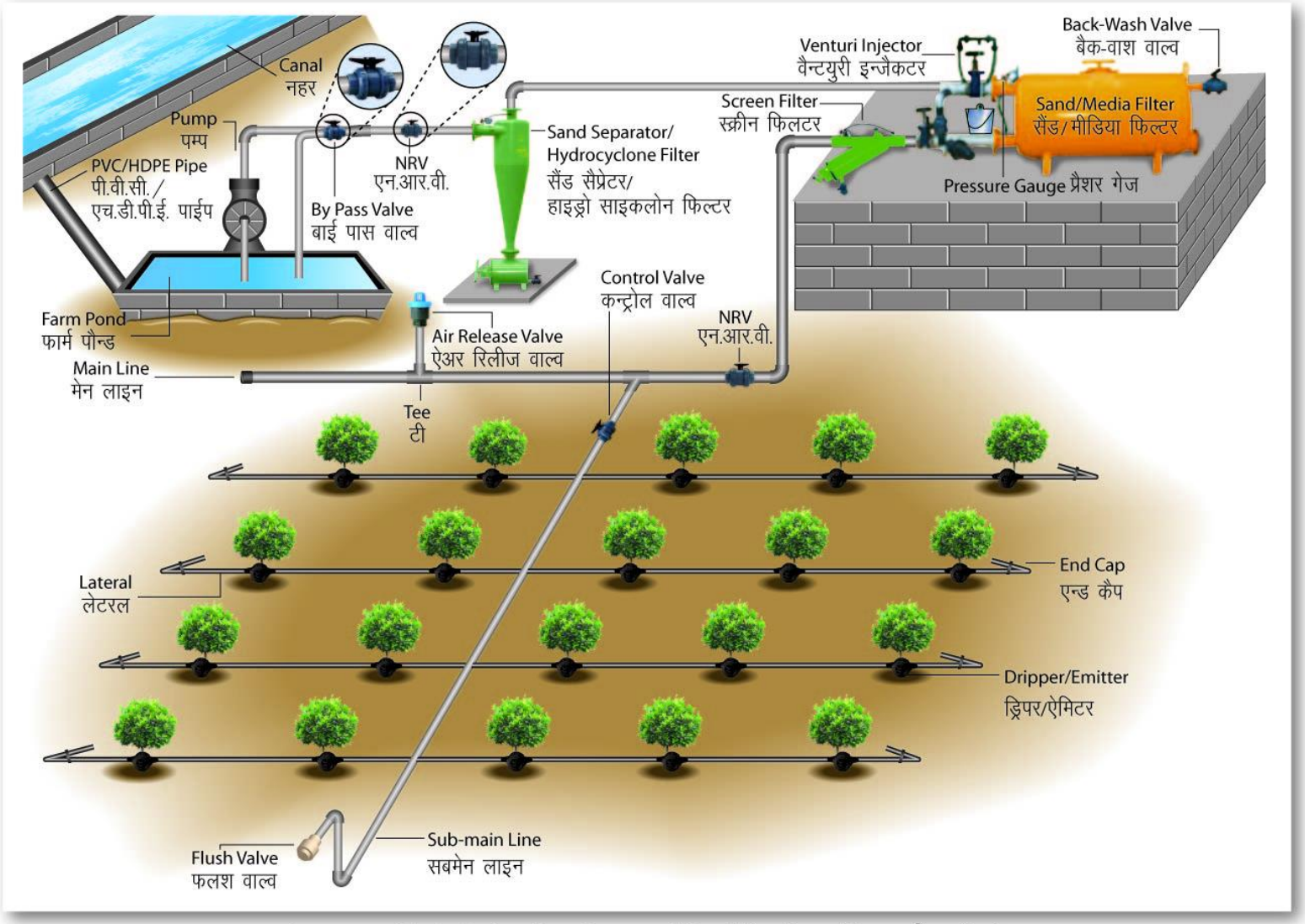
New clearings should be kept free of weeds during drought. Hence, weeding program should be completed before the onset of the drought. If weeds are present during the drought, they can be slashed down to minimize competition for soil moisture. As plants are under moisture stress, spraying of any herbicide during drought is not recommended.

1.1.3 Spraying of Sulphate of potash (SOP) or Muriate of potash (MOP) and Kaolin

In order to reduce transpiration by the leaves, 2% SOP or 2% MOP can be sprayed (at the rate of 2 kg/ ha in 100 L of water during 1st year, 4 kg/ ha 200 L of water during 2nd year and 8 kg/ ha in 400 L of water during 3rd year) using a knapsack sprayer. Spraying should commence at least a month prior to the onset of drought and continue at 2 - 4 week intervals depending on the severity of drought. Urea can also be mixed (2 kg/ ha) with SOP or MOP to enhance K

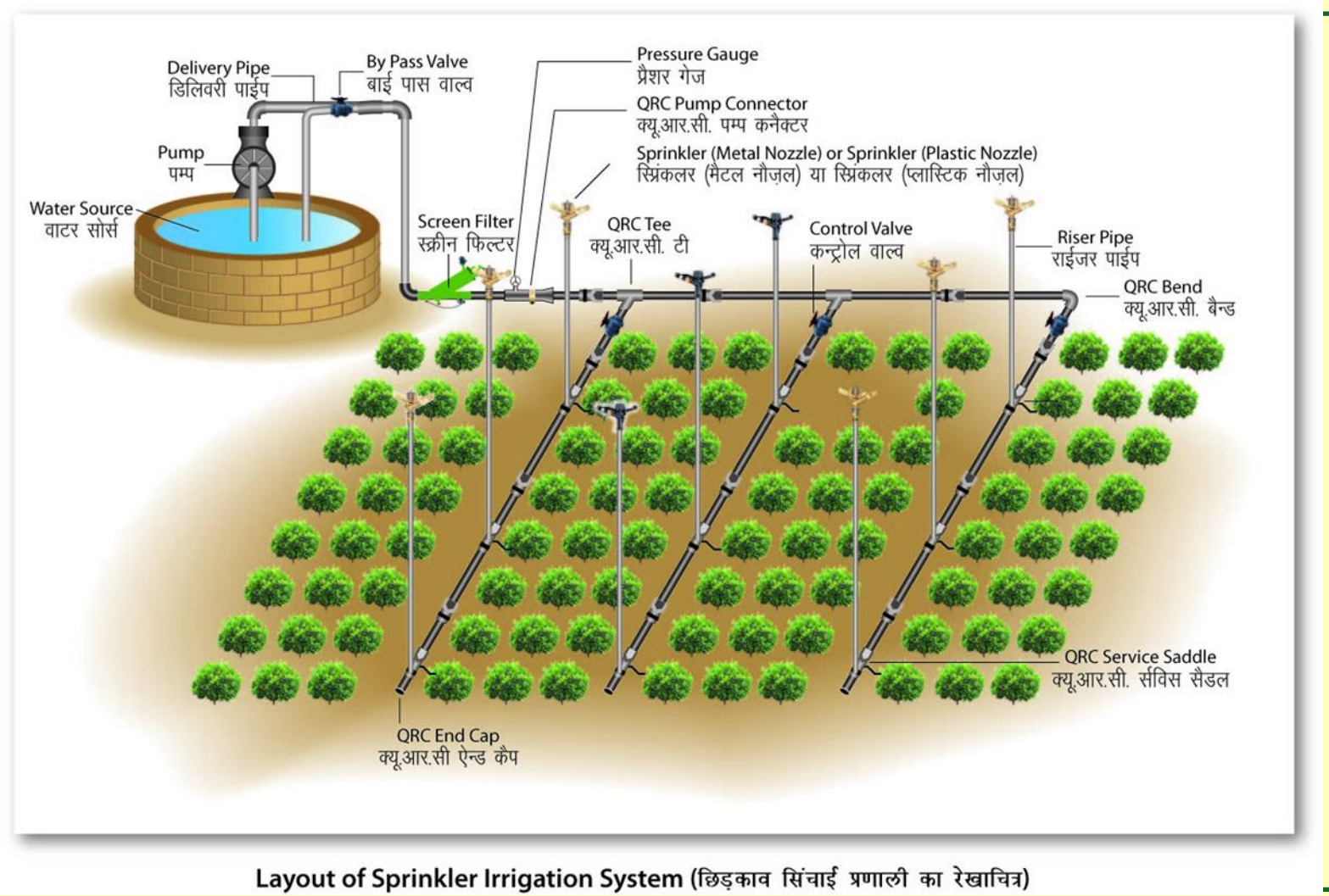
Farmer adopted techniques

Drip Irrigation



Layout of Drip Irrigation System (ड्रिप सिंचाई पद्धति का रेखाचित्र)

Sprinkler Irrigation



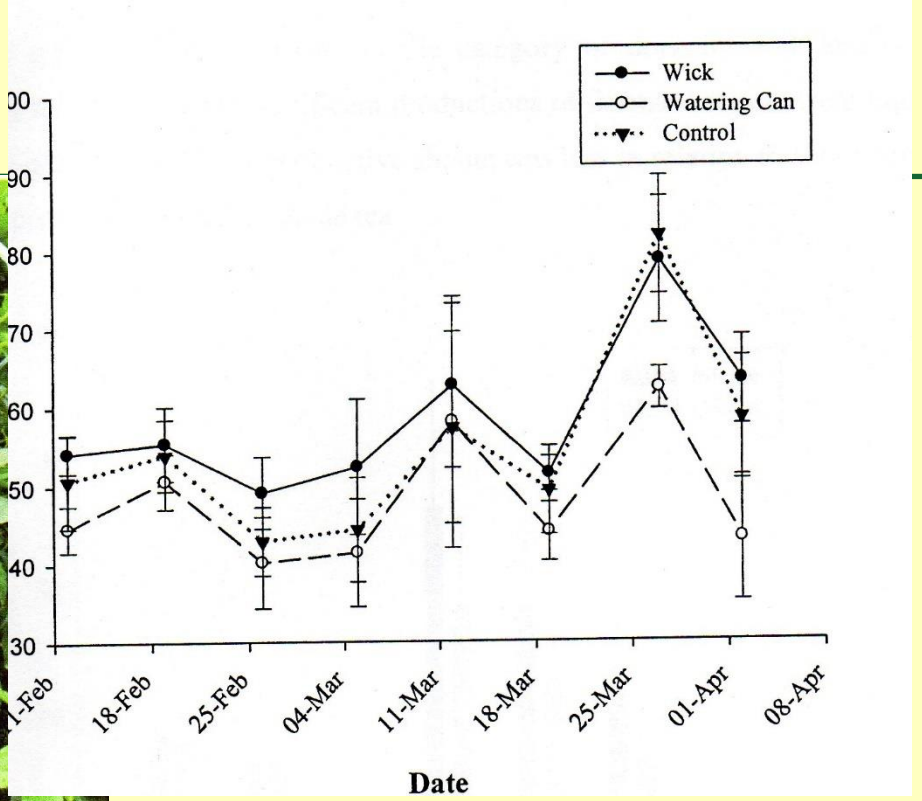
Layout of Sprinkler Irrigation System (छिड़काव सिंचाई प्रणाली का रेखाचित्र)

Mobile Irrigator

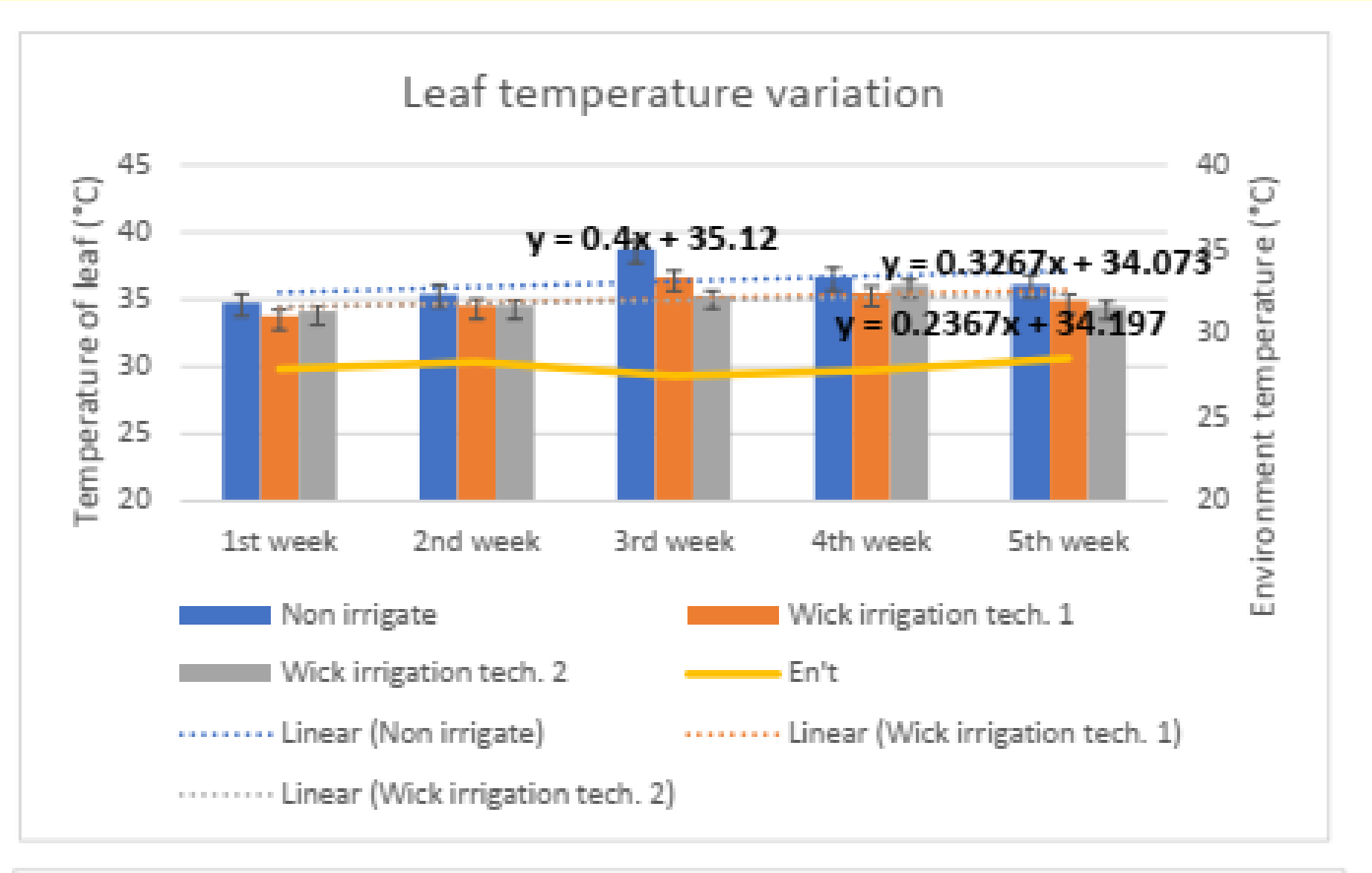
විශාල විහිදුම් වපසරියක් සහිත විසිරි ජල සම්පාදකයක් යොදා ගැනීම මගින්, වඩා කාර්යක්ෂමව අඩු වියදමකින් ජල සම්පාදනය සිදු කර ගත හැකි වේ. මෙය කුඩා පල නියඟයෙන් මියයාම වලක්වා ගැනීම සඳහා ඉතා වැදගත්වේ (ශාන්ත ජෝකිම් වත්ත, 2010)

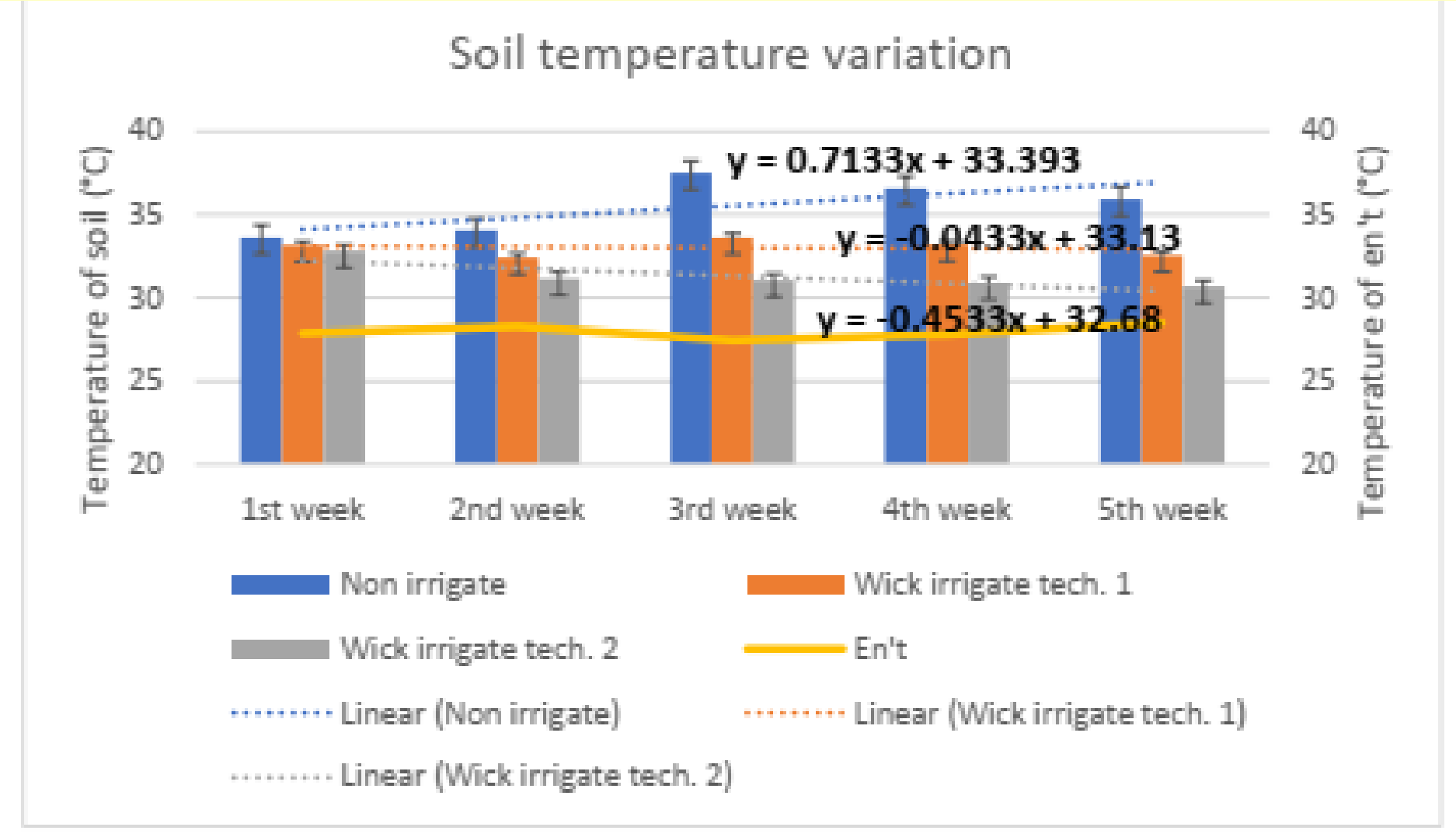
බ්‍රසීලයේ කොපි වතු ආශ්‍රිතව මෙවැනි විශාල විසිරි ජල සම්පාදකයන් යොදා ගනී (Titus & Pereira, 2008)

Wick Irrigation

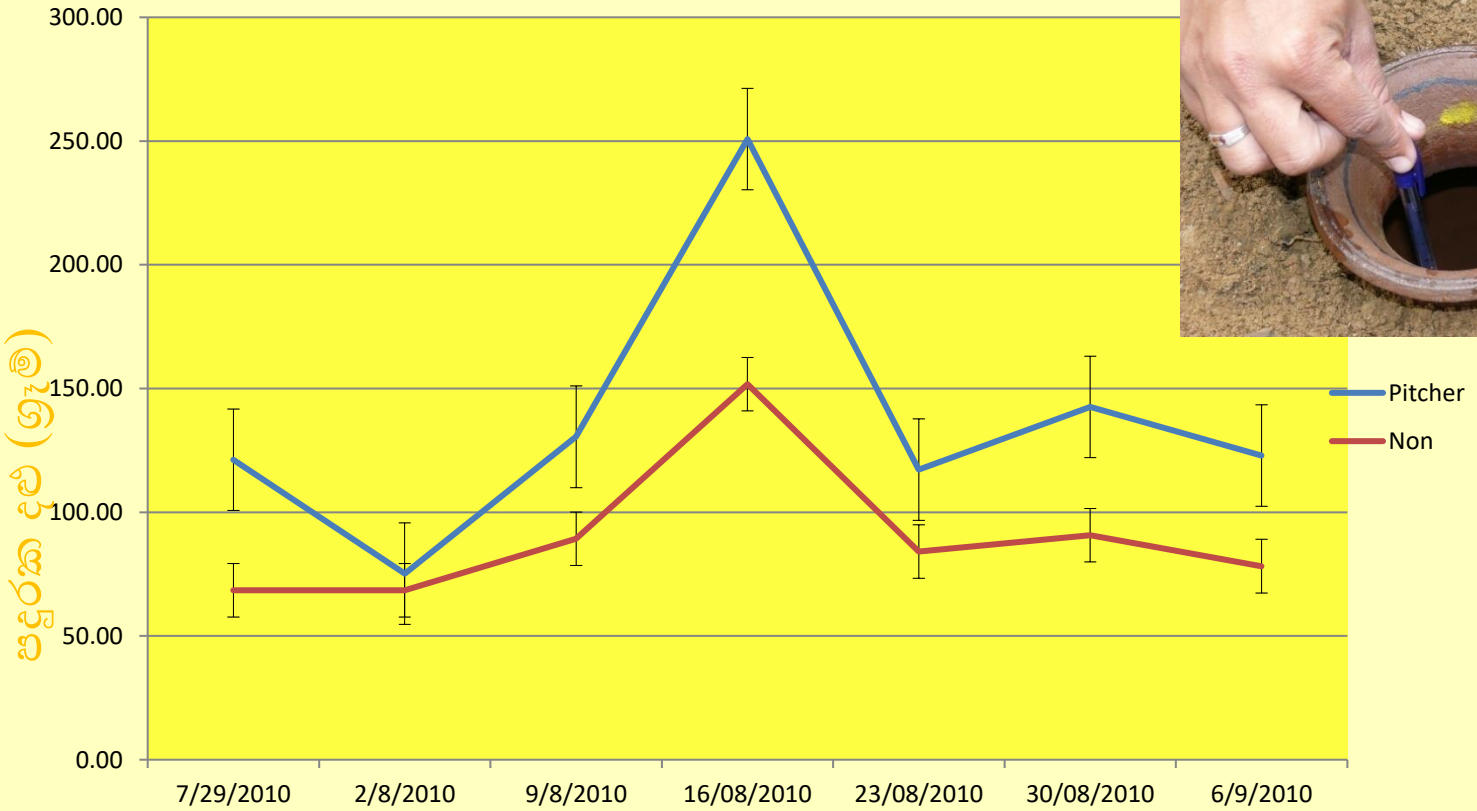


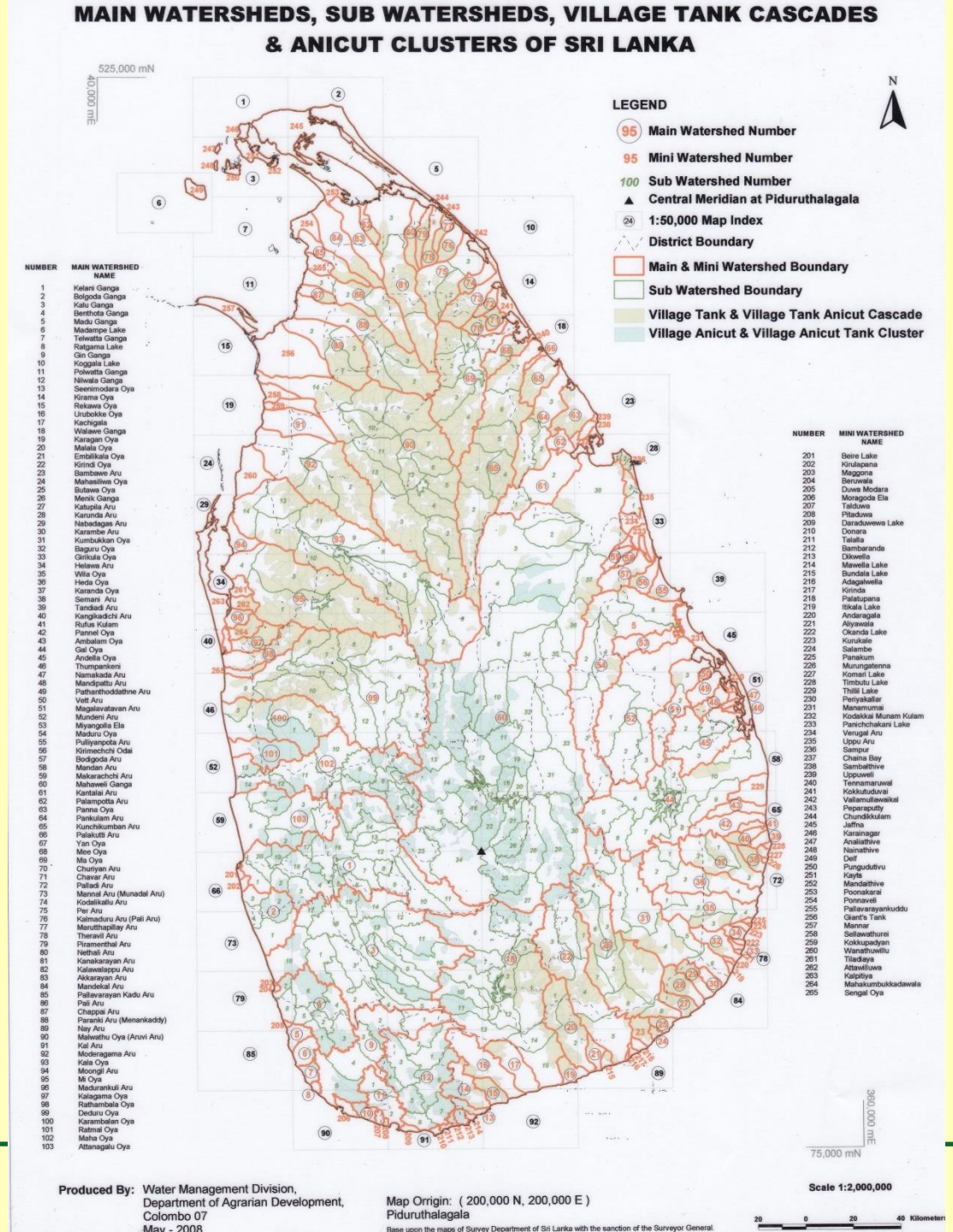
ප්‍රතිකර්මය	අස්වැන්න අමු දළු (කි.ග්‍රෑම්/සතියට/අක්කරයට)
Wick irrigation (තිර මගින්)	109.4(±6.4)
Watering can (අතින් යෙදීම)	90.0(±8.1)
පාලිතය	102.8(±5.4)
CV	11.89
LSD	15.4


Leaf temperature variation
Temperature of leaf (°C)
Environment temperature (°C)
45
40
35
30
25
20
40
35
30
25
20
y = 0.4x + 35.12
y = 0.3267x + 34.073
y = 0.2367x + 34.197
1st week
2nd week
3rd week
4th week
5th week
Non irrigate
Wick irrigation tech. 1
Wick irrigation tech. 2
En't
Linear (Non irrigate)
Linear (Wick irrigation tech. 1)
Linear (Wick irrigation tech. 2)

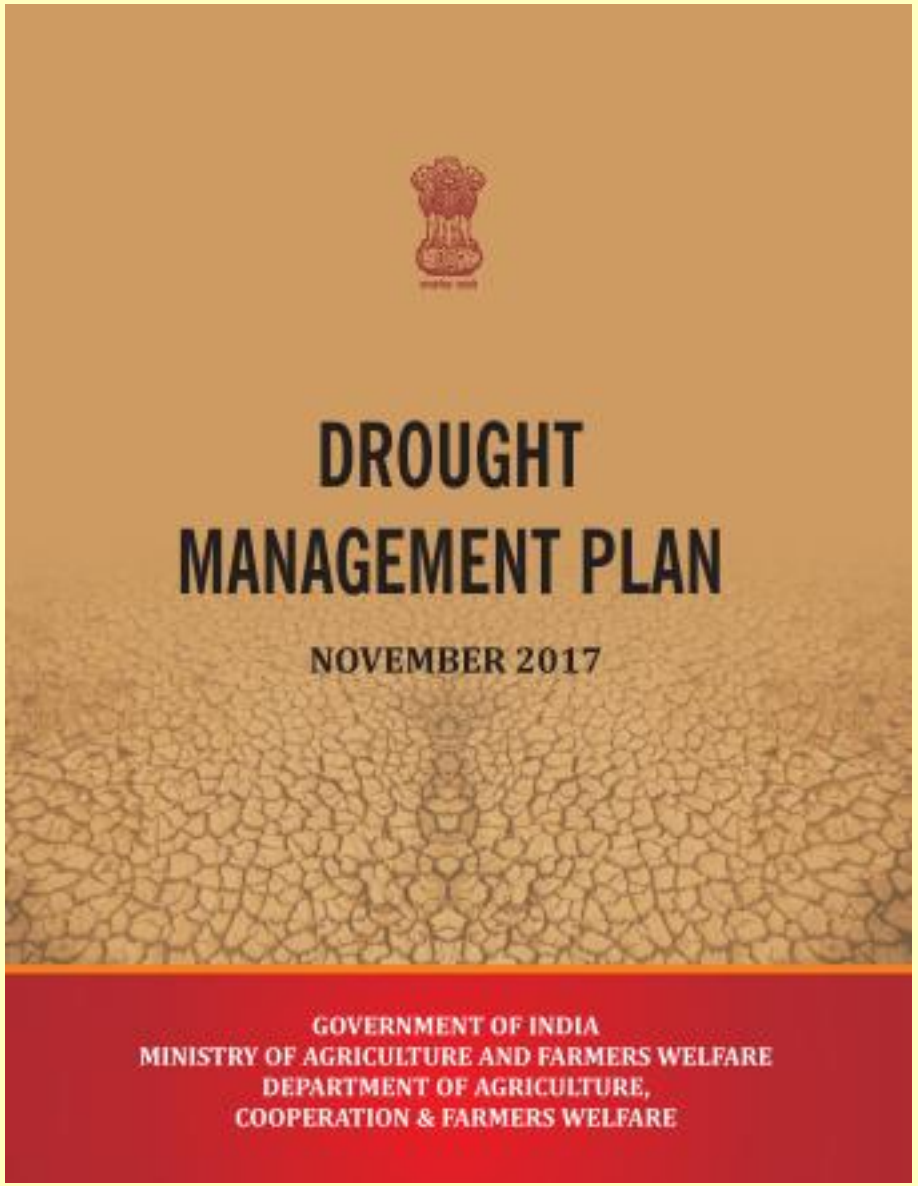

Soil temperature variation
Temperature of soil (°C)
Temperature of en't (°C)
40
35
30
25
20
y = 0.7133x + 33.393
y = -0.0433x + 33.13
y = -0.4533x + 32.68
1st week
2nd week
3rd week
4th week
5th week
Non irrigate
Wick irrigate tech. 1
Wick irrigate tech. 2
En't
Linear (Non irrigate)
Linear (Wick irrigate tech. 1)
Linear (Wick irrigate tech. 2)

Alternative Irrigation :





Small reservoir at Theppukulama, Lellopitiya



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