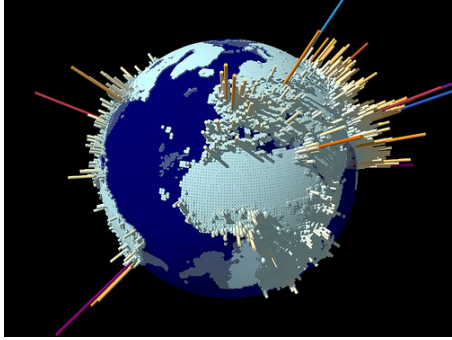
"Modern Tendency in Agriculture Development towards Water Security under Changing and Variable Climate

Buddhi Marambe

Professor & Director/Agriculture Education Unit

Faculty of Agriculture, University of Peradeniya

Food Security – The Equation



- World population

  ↑ 9.3 billion (2050)

  7 billion (2012)

- Population in

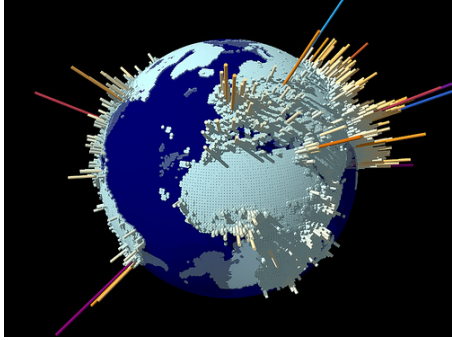
  China peaks at 1.4 billion (2030)

  ↑ India peaks at 1.7 billion (2060)

  Sri Lanka peaks at 23 million (2030)

- About 90 % of the population growth will be observed in developing countries

Food Security – The Equation



- 9.3 billion people by 2050—require 60% to 100% increase in food
- But only about additional 10% of current arable, non-protected land will be available (445 Mha)

  (Lambin, 2011)
- The competition will be stiff
- Water availability and access are key constraints to poverty reduction and food security

Increasing Demand for Food, Limited Land and Water Reserves

Global food security index 2012

An assessment of food affordability, availability and quality

A report from the Economist Intelligence Unit

- Sri Lanka is ranked 62nd from among 105 countries (ahead of India – 66, Pakistan – 75, Nepal – 79, and Bangladesh – 81)

Water – a precious resource

- Water availability (m^3 per sq km)

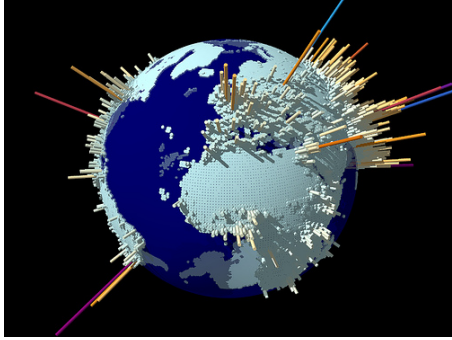
South-East Asia	> 150,000
Pacific sub-region	< 30,000

- Per capita water availability (m^3 per person)

Pacific sub-region	> 50,000
South-East Asia	< 2500

(Sri Lanka 2400)

Food Security – The role of water

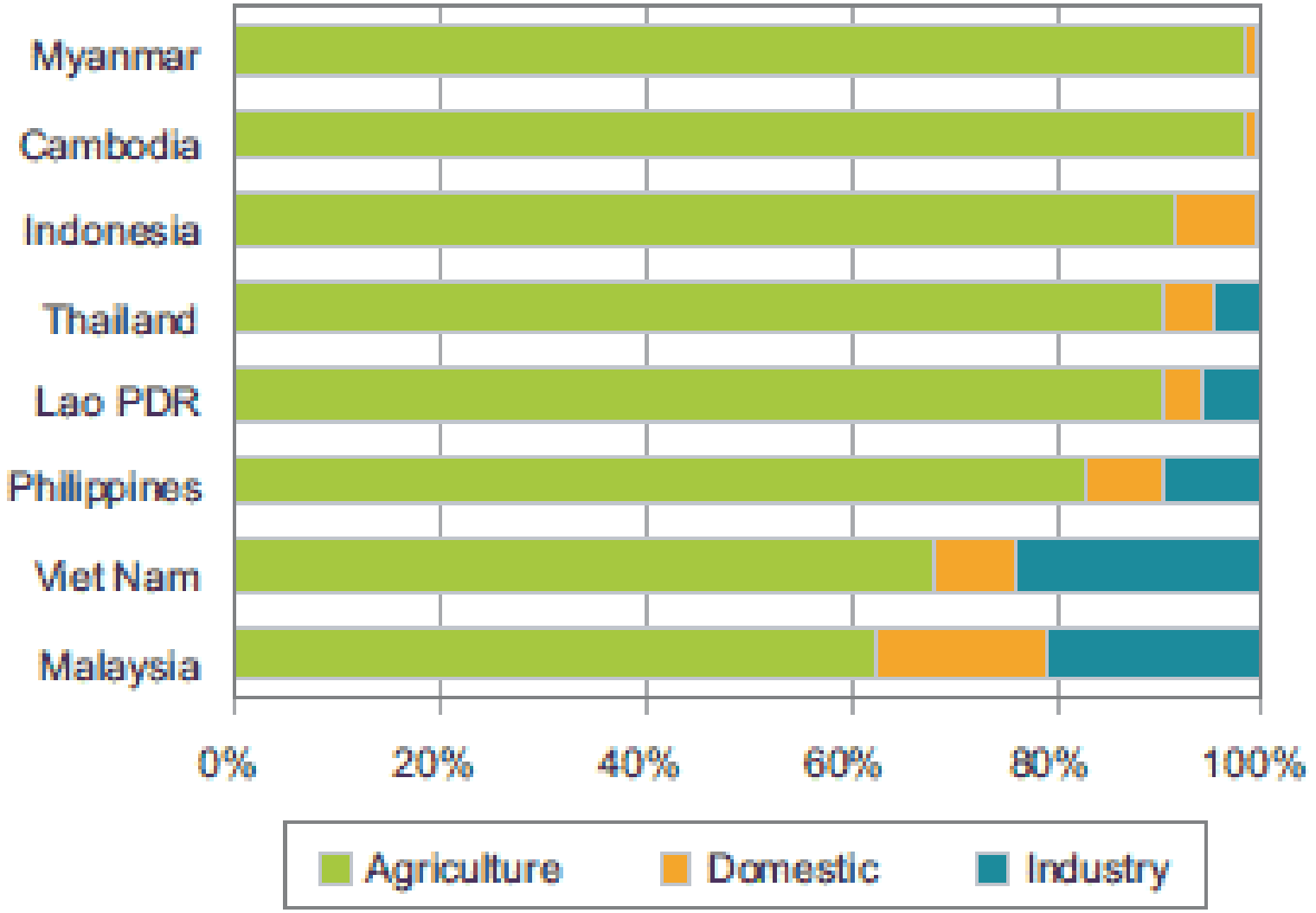


- Roughly 30% of the food produced worldwide (1.3 billion tons) - is lost or wasted every year
- The water used to produce it is also wasted.

  Producing 1 kg rice - 3,500 L of water,

  Producing 1 kg of beef - 15,000 L of water
- Dietary shift is the greatest to impact on water consumption over the past 30 years.
- The way that water is managed in agriculture has caused wide-scale changes in ecosystems and ecosystem services (in USA - estimated cost is US$ 9–20 billion per year).

Proportional use of water withdrawals by sector, South-East Asia and North and Central Asia



(ESCAP, 2002)

Water Security – The Situation

- By 2030

  one third of the world population will be based along river basins and scarcity of water for agriculture will have a tremendous impact on their livelihoods.

  Overall, the world's water demand will grow from 4500 billion m^3 to 6900 billion m^3 (a 40% increase from the current water supply).

- The developed world is already facing water scarcity for agriculture.
- Approx. 70% of the water in the world is used for agricultural purposes and of that, much is utilized by developing countries.
- Sri Lanka - Irrigation water requirement for paddy will increase by 13-23% by 2050 compared to that of 1961-1990

(De Silva et al. 2007)

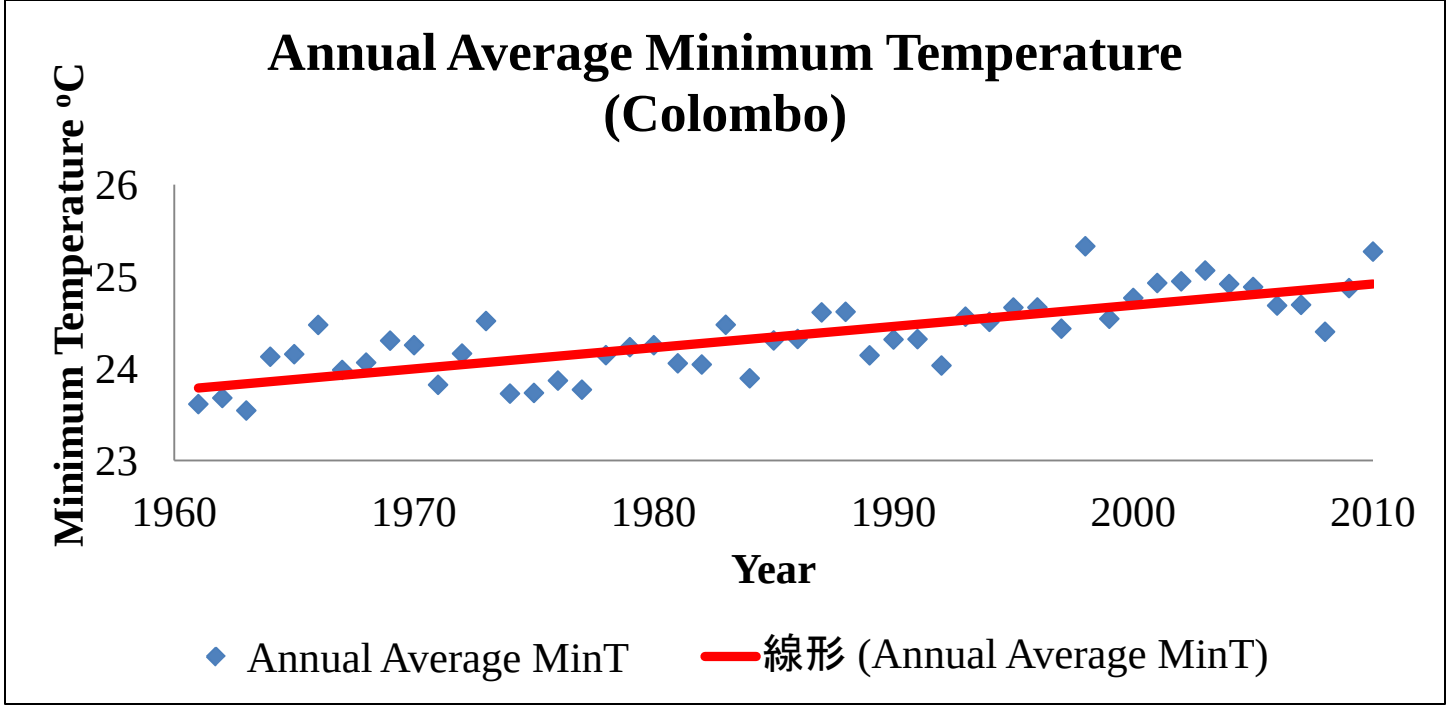
Issues

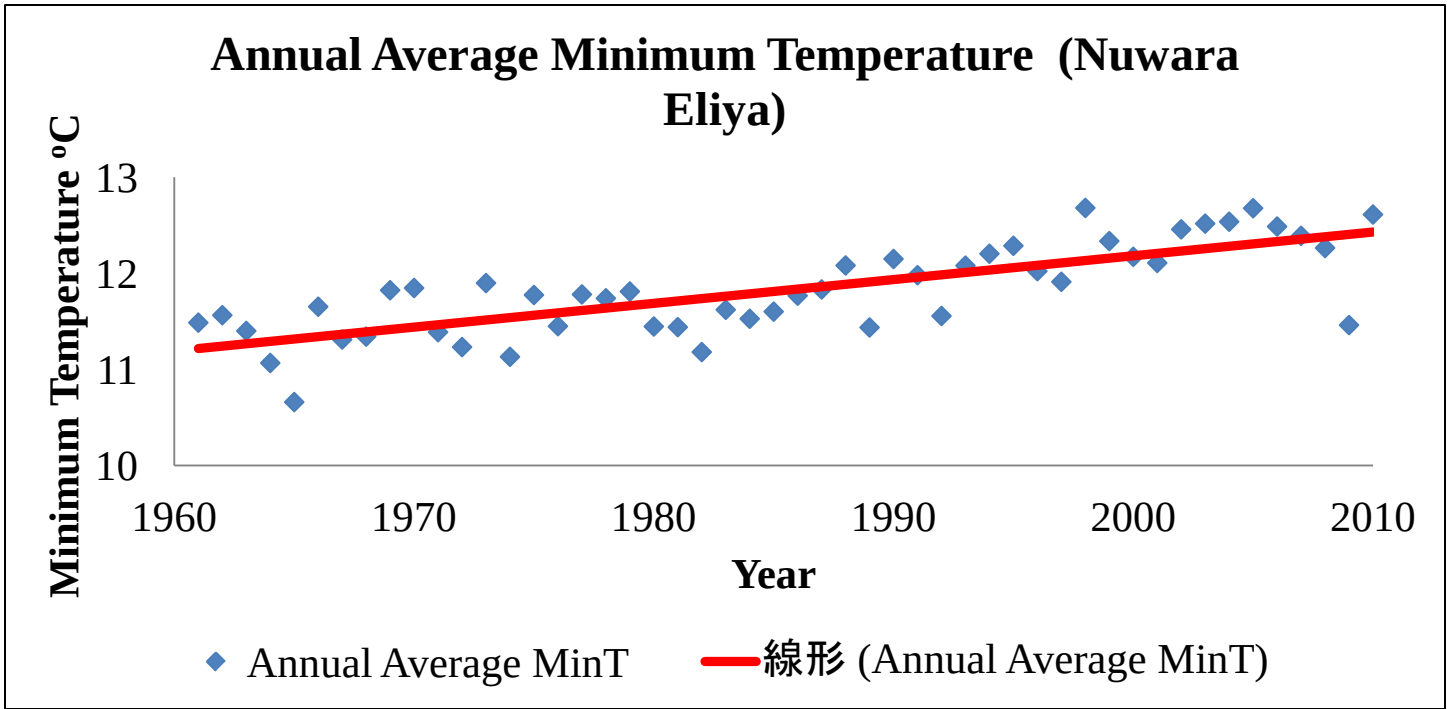
- Poverty
- **climate change**
- decreasing arable agricultural land
- increasing population pressure
- **weak trends in technology generation and adoption in agriculture** – lack of quality seeds and breeds heavy post-harvest losses, water saving techniques
- global economic recession
- Increasing food prices, and
- poor accessibility of nutritious food

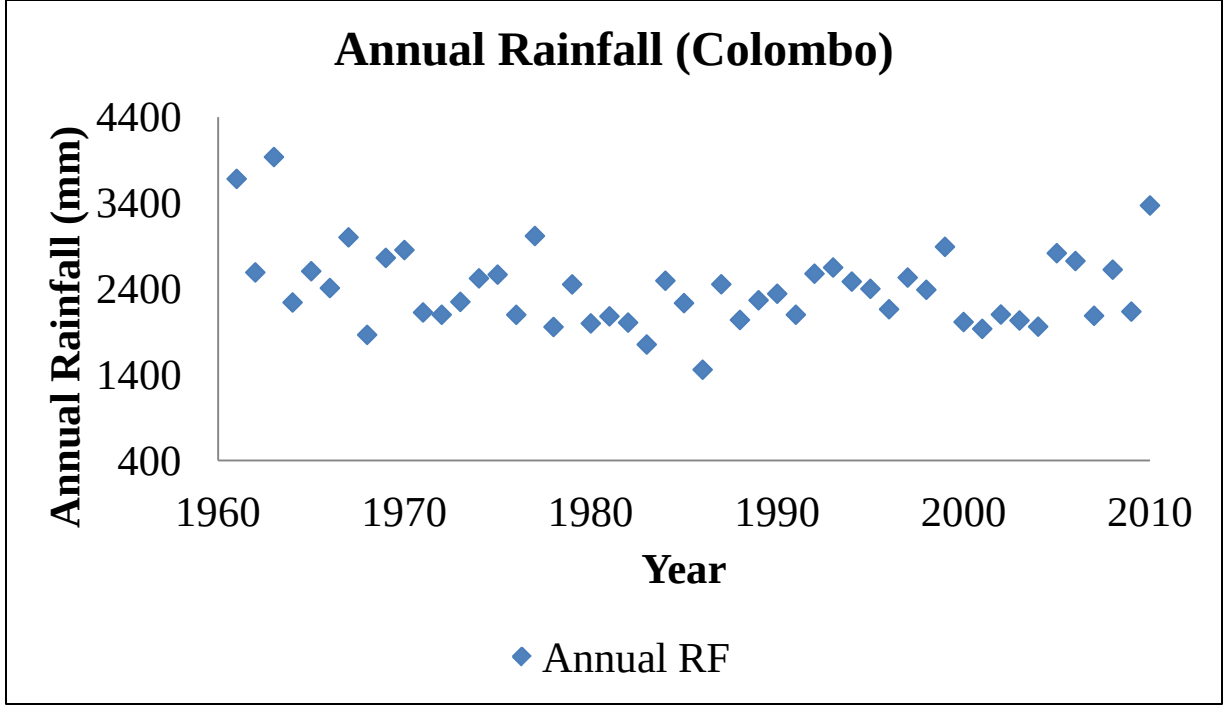
Climate change in Sri Lanka

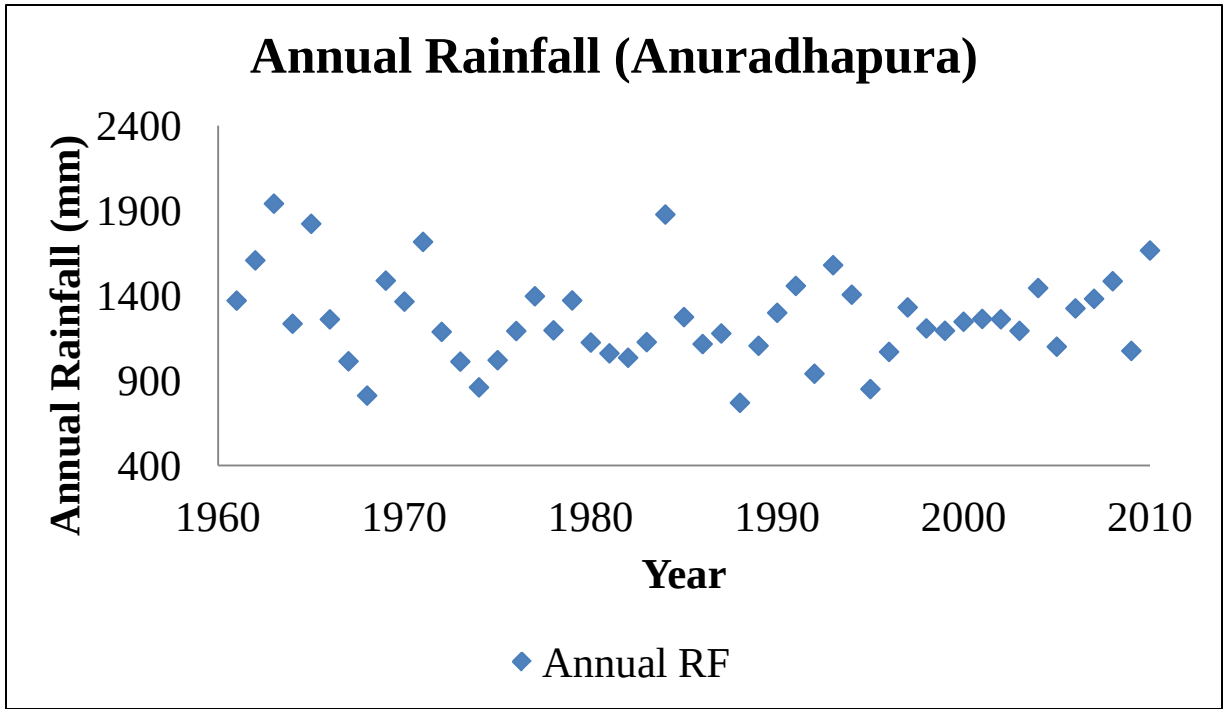
- Slow & continuous rise of ambient temperature
  (0.01 – 0.03 °C per year)
- Frequent occurrence of extreme weather events
  - Droughts & floods have increased
  - High intensity rains – Land slides have increased
  - Tornado type winds have increased
  - Intense lightning strikes have increased
  - Total number of dry days have increased
  - Number of cold nights/comfort nights have decreased
  - Warm days have increased



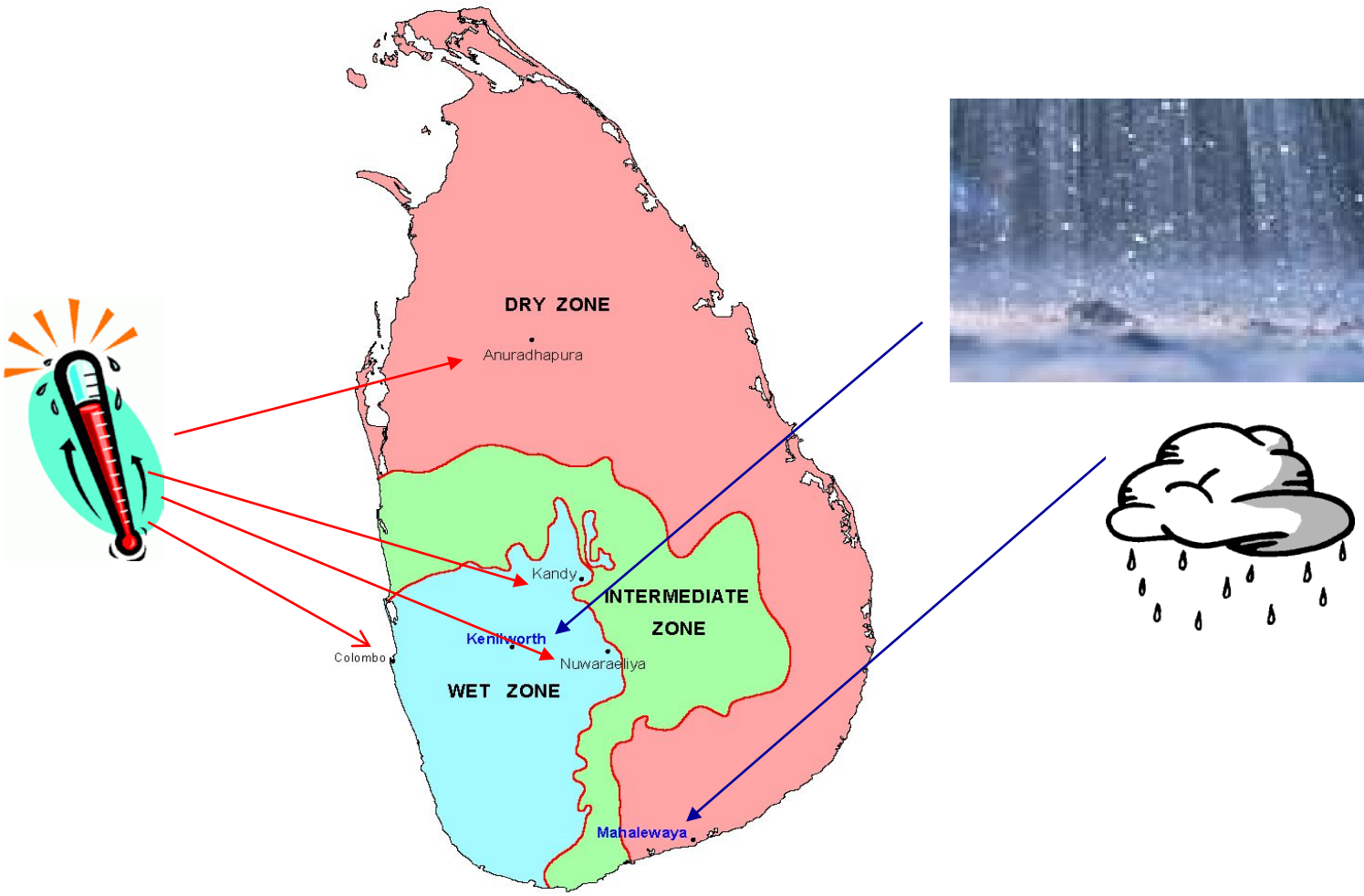

Annual Average Minimum Temperature (Colombo)
Minimum Temperature ºC
26
25
24
23
1960
1970
1980
1990
2000
2010
Year
Annual Average MinT
線形 (Annual Average MinT)

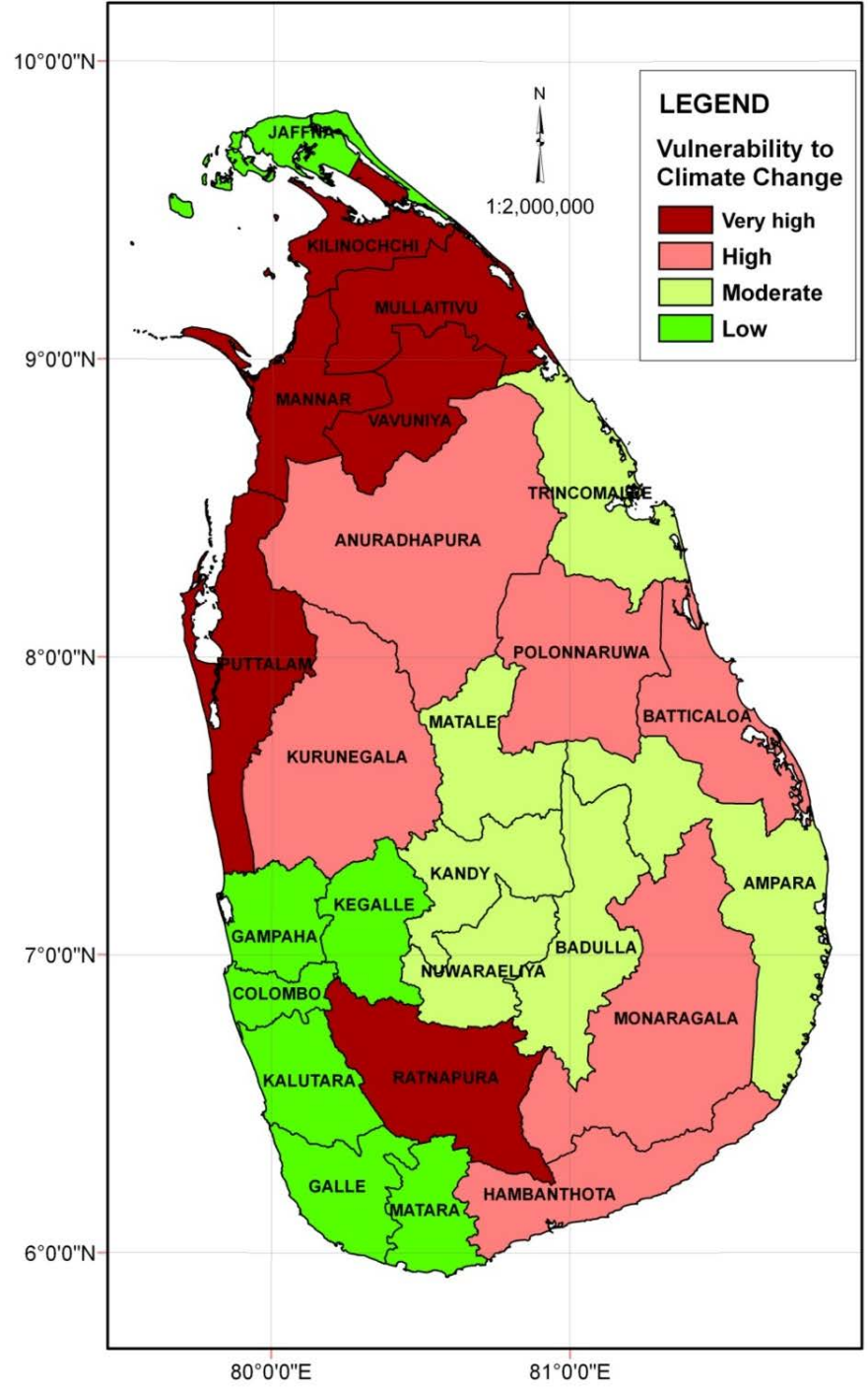

Annual Average Minimum Temperature (Nuwara Eliya)
Minimum Temperature ºC
13
12
11
10
1960
1970
1980
1990
2000
2010
Year
Annual Average MinT
線形 (Annual Average MinT)


Annual Rainfall (Colombo)
Annual Rainfall (mm)
4400
3400
2400
1400
400
1960
1970
1980
1990
2000
2010
Year
Annual RF


Annual Rainfall (Anuradhapura)
Annual Rainfall (mm)
2400
1900
1400
900
400
1960
1970
1980
1990
2000
2010
Year
Annual RF

Very Recent Findings on Climate Change





Climate Change Vulnerability Map

Punyawardena et al., 2012

Rainfall Variability

- Phenomenon that was well established
- Rainfall –

  Low intensity ⟶ high Variability

  Sahara desert ⟶ high RF variability

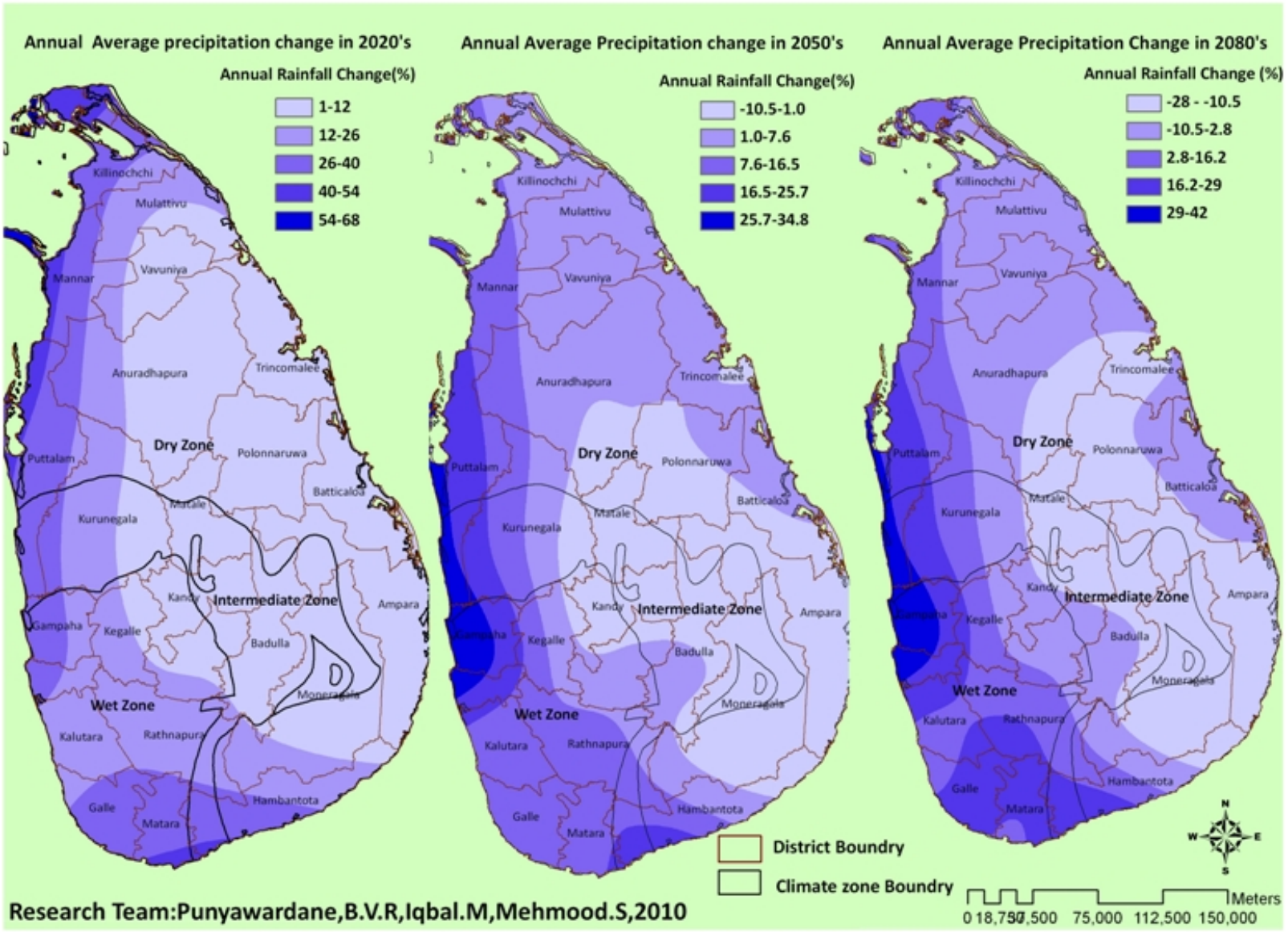
- In Sri Lanka

  dry zone ⟶ high RF variability

Variability of seasonal rainfall in Sri Lanka

Season	1931-1960	1961-1990
FIM (March-April)	23%	27%
SWM (May-Sept)	21%	16%
SIM (Oct-Nov)	22%	23%
NEM (Dec-Feb)	31%	42%
Annual	11%	14%

Projected Precipitation Changes over Sri Lanka by PRECIS RCM in combination with ECHAM4 GCM for B2 Scenario

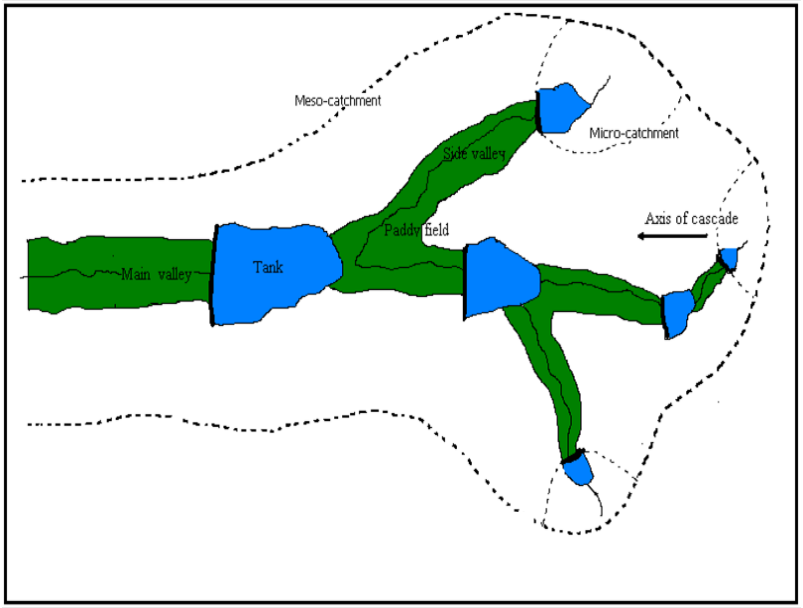


Research Team:Punyawardane,B.V.R,Iqbal.M,Mehmood.S,2010

Hydrological civilization in Sri Lanka

Reservoirs (Cascade Systems) ⟶ reduce impacts of RF variability

Building resilience



Anthropogenic activities

Climate Change - Impact

- Global warming
- Extreme weather events
- Wetter rainy seasons and drier dry seasons
- Serious implications for food production
- South Asian Agriculture – mostly affected with a large number of small farmers of which majority live under poverty.
- Sri Lanka, India and Bangladesh - highly exposed and highly sensitive to climate change (ADB, 2009)

Impacts of Climate Change on Agriculture

- Agriculture – weather dependent

- Climate of the country has undergone a drastic change

  No rains when it is needed (drought)

  More rains when it is not needed (floods)

- Increasing temperature – direct and indirect impacts

Impacts due to changes in rainfall regime

- Low and high soil moisture – affects agriculture
- For most of the soil groups used in agriculture -

  decrease in ground water replenishment by several fold even with slightly lower rainfall

  affect agriculture in areas with lift irrigation (e.g. Kalpitiya and Jaffna)

- Heavy rainfall will cause severe damages to irrigation infrastructure and thus limits water availability for agriculture

- Fruit bearing trees such as rambutan, require 3-4 weeks of dry spell in February, in order to bear flowers in March

Sudden rainfall in February will deprive this pre-requisite for flower primordial initiation

South and South–East Asia

- Home to more than 50 % of the world's poor and malnourished
- Nearly 50 % of the population is dependent on agriculture
- Climate change in the region is expected to reduce agriculture productivity by 10-50 % in the next three decades (APAARI 2012)

The solutions depend on …..

- Demographic changes
  - population
  - urbanization
- Economic growth
- Structural changes in agriculture
- Consumption patterns
- Technologies adopted
- Water security

Policy perspectives

- Agriculture policies while being the cornerstone for achieving food and water security and improving livelihoods.
- Agriculture policies will boost green growth once combined with the climate change policies protect the environment and contribute to the eradication of poverty.

- National Agriculture Policy 2007
- National Climate Change Policy 2011

The new paradigm

- Productive and resilient agriculture needs good management and wise use of natural resources such as land, water, soil and genetic resources.

- A transformation of agriculture is required and being promoted by worldwide.

Issues

- Climate change will bring more uncertainties
- Maintaining Water, Food, Energy and Environment Security will remain a significant challenge – finding a balance – maintain ecosystems that underpin food and livelihood security
- Agricultural water use will be a key – water storage and water productivity is important

(H. Manthrithilake, 2013)

Act fast, get it right and make it work

Food security can't wait, neither can action on climate change

Adaptation

- "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities“

  (IPCC, 2007)

- Adjustment to new or changing environment by following appropriate actions

- Technological, managerial, behaviroral, policy

Climate-Smart Agriculture

Agriculture that sustainably:

1. increases productivity
2. resilience (adaptation)
3. reduces GHG (mitigation)

and

enhances achievement of national food security and development goals (FAO, 2010)

Climate change mitigation will never be the main goal for agriculture.

WWW.FAO.ORG/CLIMATECHANGE/CLIMATESMART/EN

Climate Smart Agriculture

Proven Technologies

EXAMPLES

Climate Smart Water Management

- Produce more nutritious food with less water:

  Innovative technologies are required to ensure a greener and more sustainable food production.

  (1) improve crop yields

  (2) implement efficient irrigation strategies

  (3) reuse of drainage water and use of water resources of marginal quality produce smarter ways to use fertilizer and water

  (3) improve crop protection

  (4) reduce post-harvest losses

  (5) create more sustainable livestock and fisheries production.

Climate Smart Water Management

- Focus on human capacities and institutional framework: new institutional arrangements to centralize the responsibility for water regulation, yet decentralize water management responsibility and increase user ownership and participation.

Climate Smart Water Management

- Improve the value chain: From production, post-harvest handling, processing, retailing, consumption to distribution and trade, efficient water and food recycling strategies can be addressed.
- Help secure the environmental water requirements when reuse of treated water is not culturally acceptable for other uses.

Water Conserving Agricultural Techniques

- Breeding and use of new varieties (drought & flood tolerant)
- Effective water management strategies (Sprinkler & drip irrigation technologies)
- Rainwater harvesting
- Altering the timing of planting dates to adapt to changing growing conditions
- Aerobic rice culture/*Kekulan* system/SRI method
- Crop Diversification
- *Bethma* system

Water Conserving Agricultural Techniques

- Improved management practices (*e.g.* Shade trees in Tea, Organic matter integration)
- Integrated pest management techniques
- Integrated nutrient management
- Improving water storage
- Retaining soil moisture
- SALT
- Utilizing residual moisture
- Seasonal Climate Forecasting (SCF)
- Integrated water resource management




Thank you