

# **Groundwater Management Issues in Sri Lanka**



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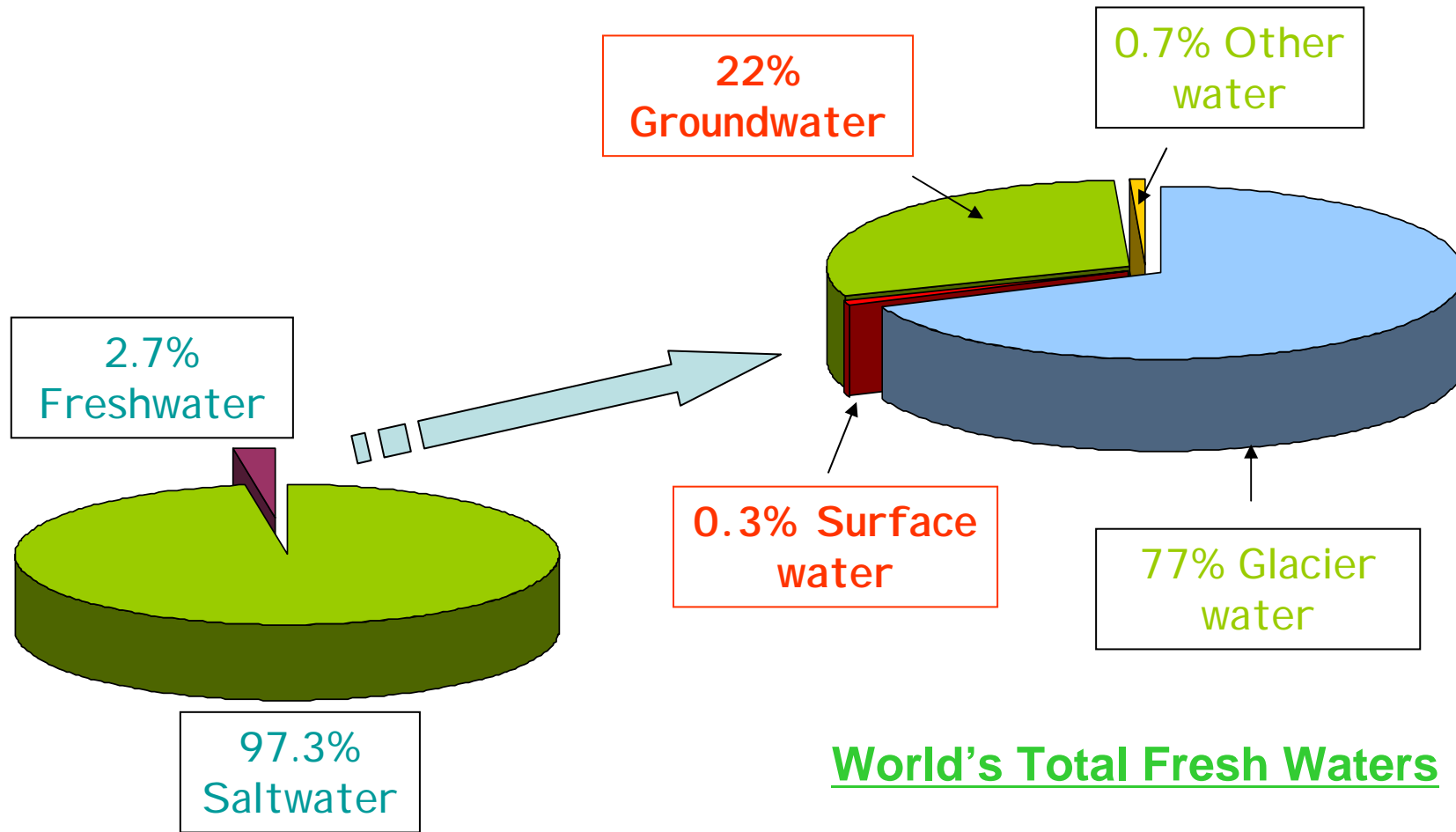
# Presentation Outline

- Introduction
- Groundwater Management
- Alternatives to Groundwater



# Introduction

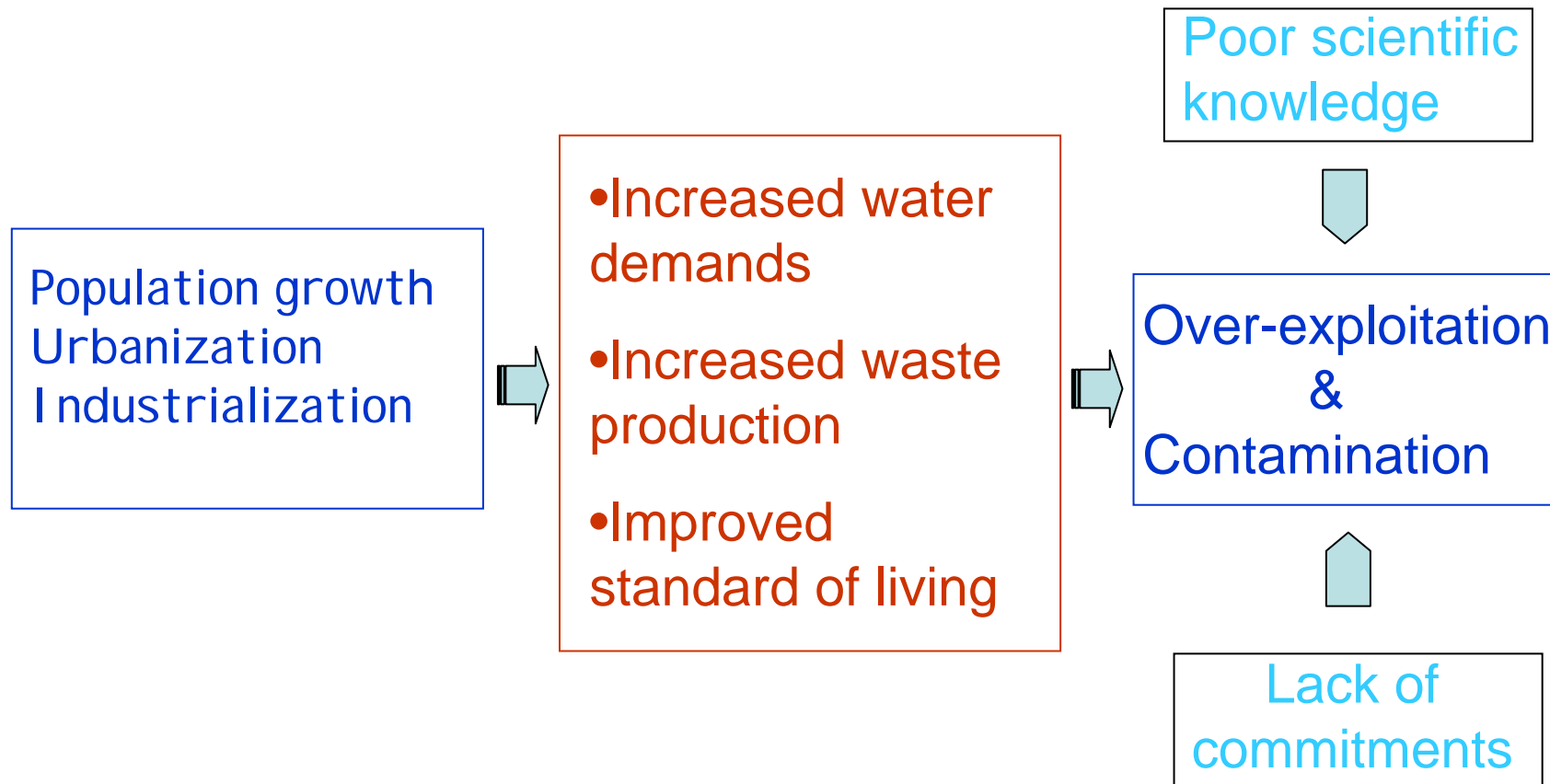
# World Fresh Water Resource



World's Total Water Resource

World's Total Fresh Waters

# Challenges for a Sustainable Water Resource



# In Sri Lanka;

Competition and water shortages are increasing because of;

- Rapid economic growth
- High variability in rainfall
- Pollution

As a result;

- Shortage in surface water sources
- Lack of piped water supply (by 2005 only 26.9% had access to pipe water supply)
- Groundwater is being extracted more
  - By end 2005, nearly 70% population relied on groundwater
  - Over 25% of piped water supply is from groundwater
  - Groundwater is becoming a popular source for Agricultural use



# Study Areas

## Main focus

### Water Supply;

Groundwater source management in two urban centers

**1. Colombo** (1,610.6 km<sup>2</sup>, 4.3 mil. )

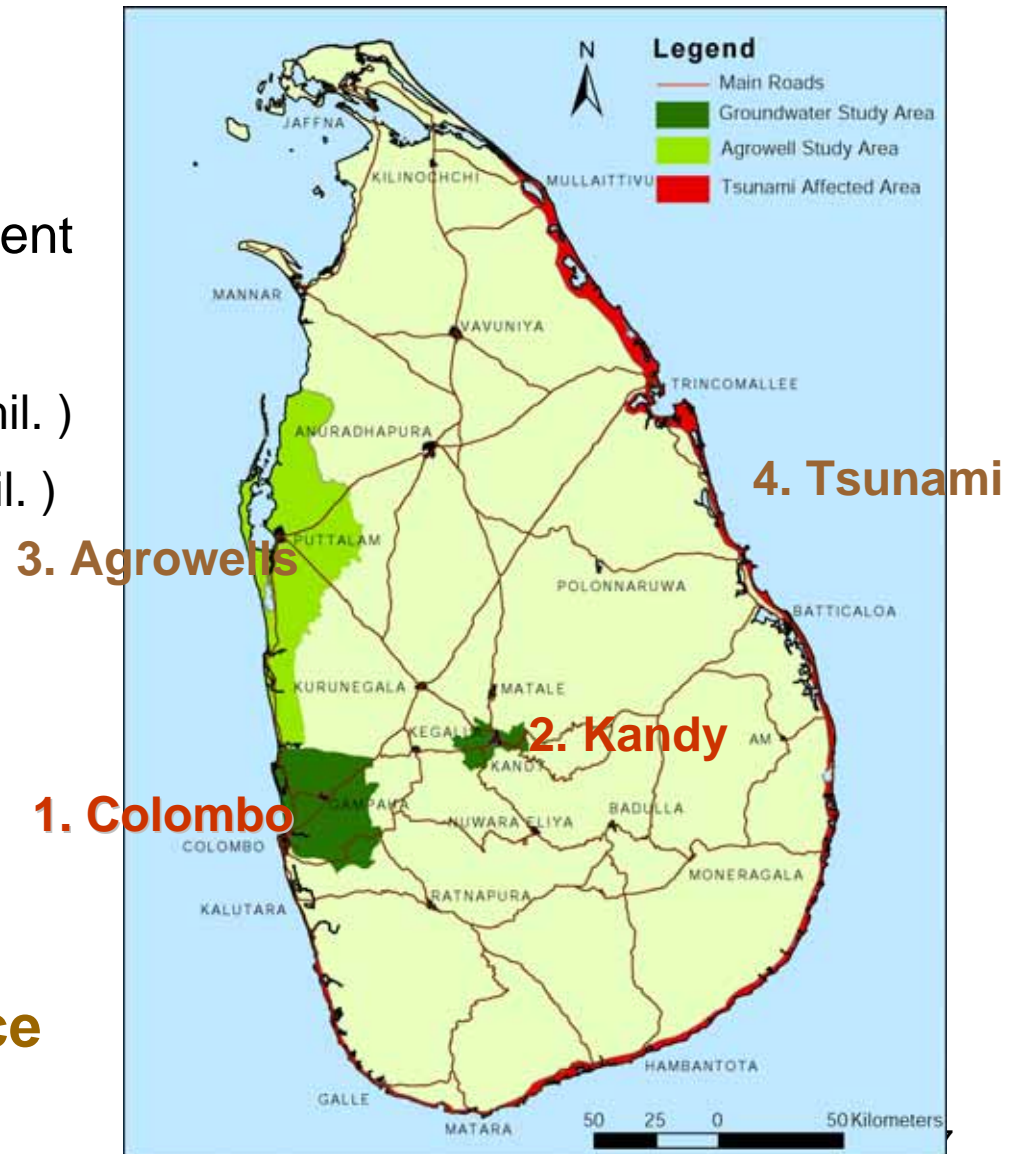
**2. Kandy** (321.8 km<sup>2</sup>, 0.81 mil. )

### Agriculture;

**3. Agrowell use in irrigation** **1. Colombo**

### Tsunami;

**4. Groundwater resource after the Tsunami event**



# Urban Area Details

## Colombo

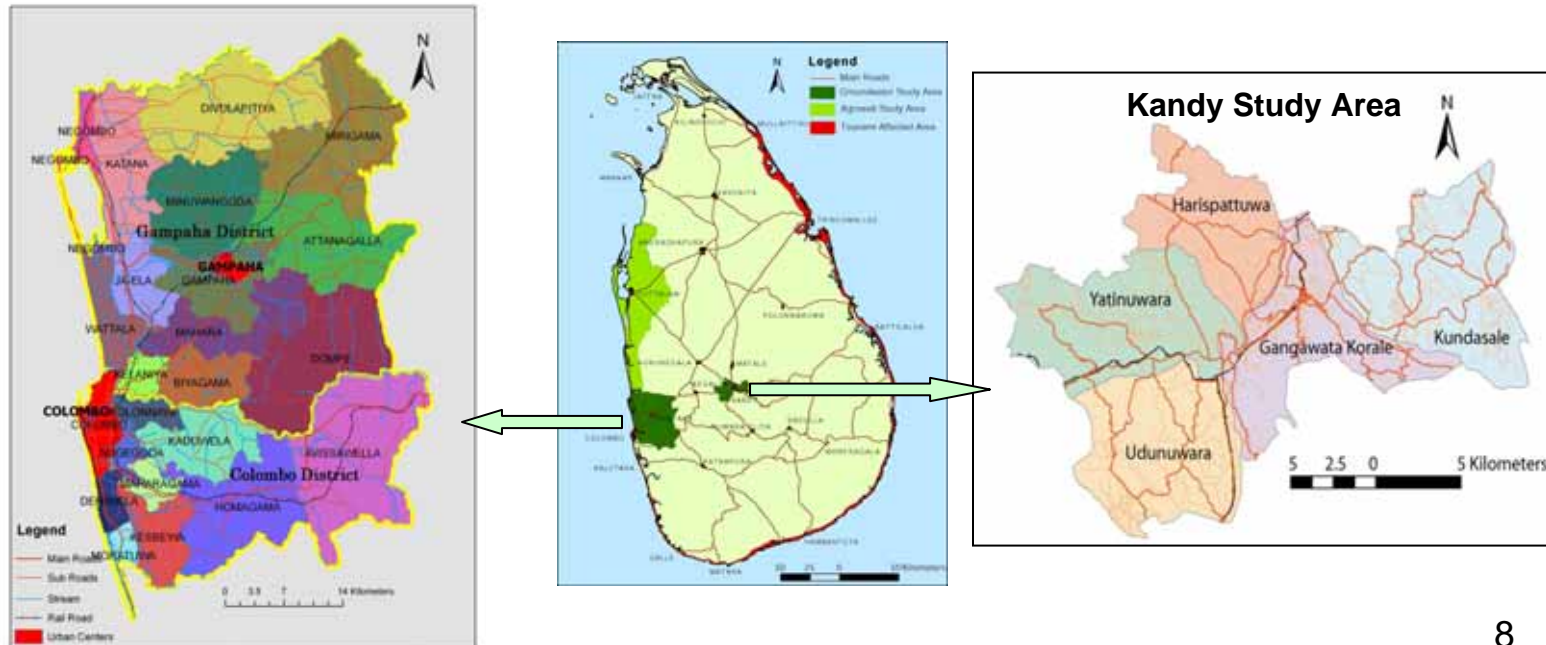
Study area:

- Colombo city and the suburbs
- Land area: 1,610.6 km<sup>2</sup>
- Population 4.3 million (2001)
- Population growth rate 1.7%
- GDP contribution **48.1%** (2002)

## Kandy

Study area:

- Kandy city and the suburbs
- Land area: 321.8 km<sup>2</sup>
- Population 0.81 million (2001)
- Population growth rate 1.2%
- GDP contribution **9.4%** (2002)





# Geomorphology and Topography

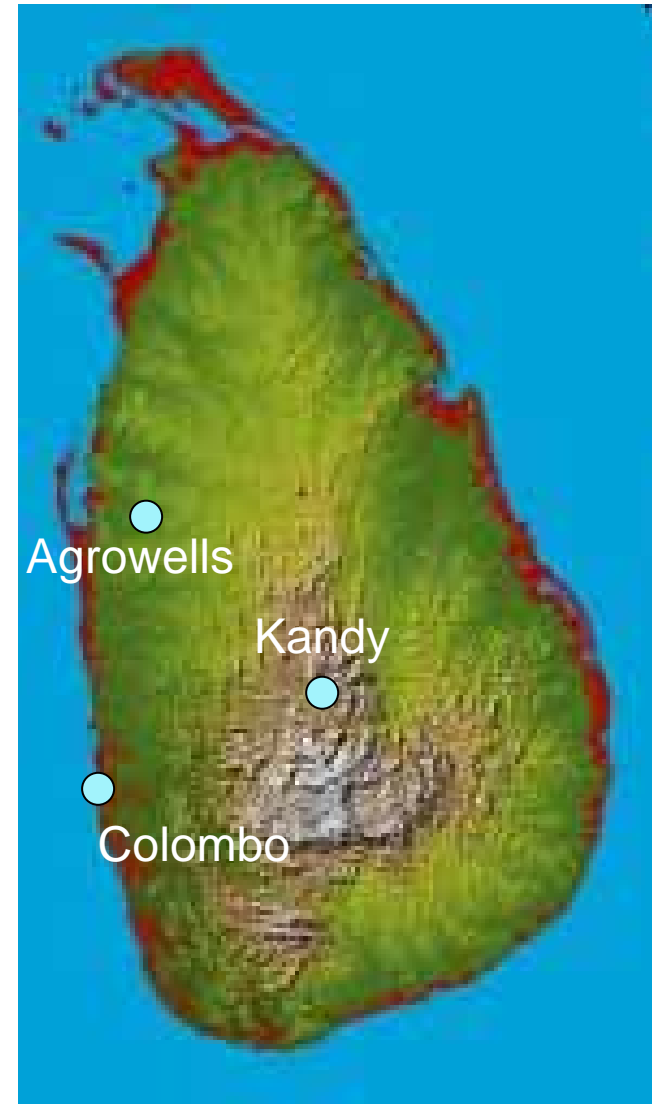
Topography of Sri Lanka is of three plateaus;

2300m, 500m and 0-300m

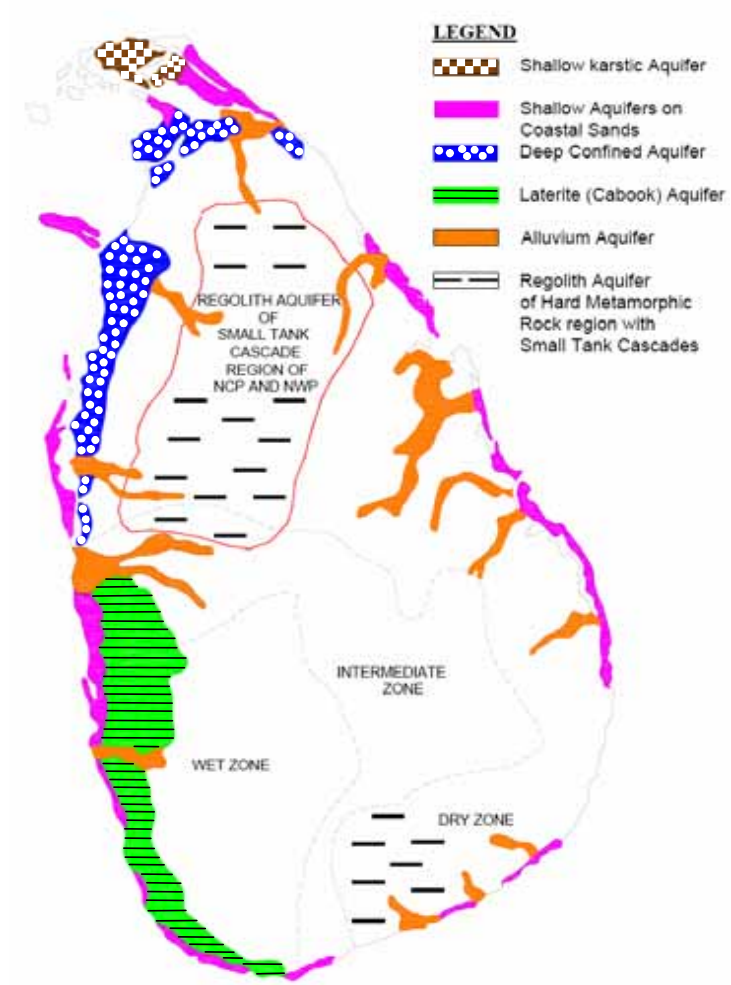
Kandy - located in the middle plateau at around 500 to 1200m elevation.

Colombo - located in the coastal plains of the western region (wet zone)

Agrowells – mostly located in the northwestern plains (dry zone)



# Groundwater Resource in Sri Lanka



**IMPORTANT**  
**In most areas GW only within the hard-rock**

**Distribution of the Major Aquifer Types in Sri Lanka**

(Modified from Panabokke and Perera 2005)

# Hydrogeology in study cities



## Colombo:

- Base metamorphic rock 5 to 15 m deep
- Significant section of the study area is formed on river deltas

### Groundwater

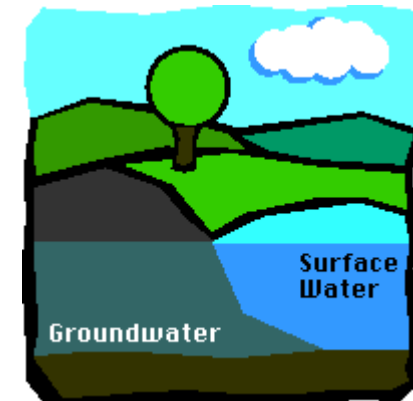
1. Semi-confined hard rock aquifers
2. GW in laterite deposits (honey-comb type weathered rock)
3. River alluvial aquifers in unconfined deposits

## Kandy:

- Base metamorphic rock 0 to 10 m deep

### Groundwater

1. Semi-confined hard rock aquifers
2. River alluvial aquifers in unconfined deposits

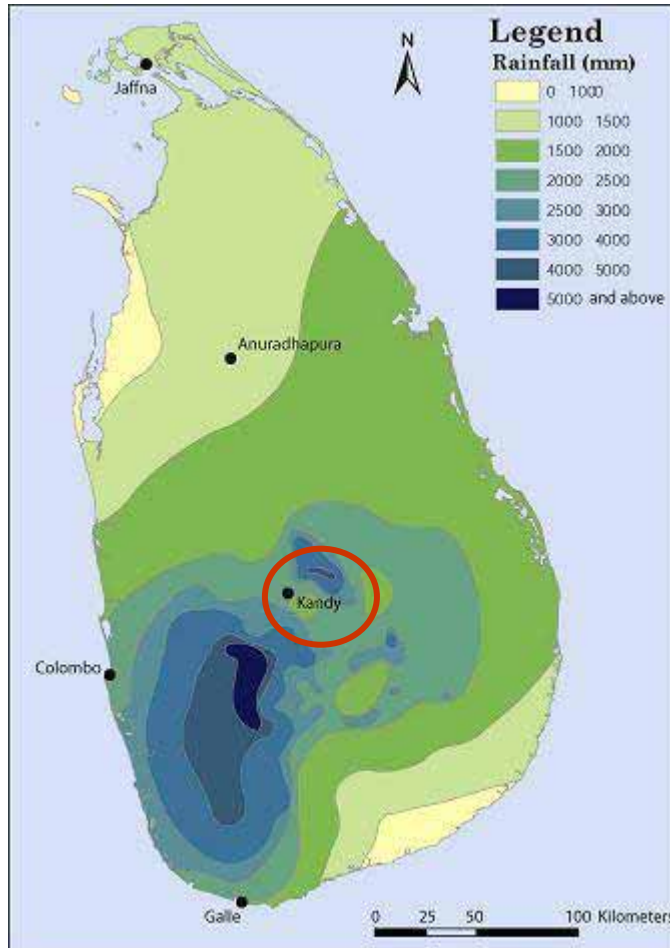


# Climate

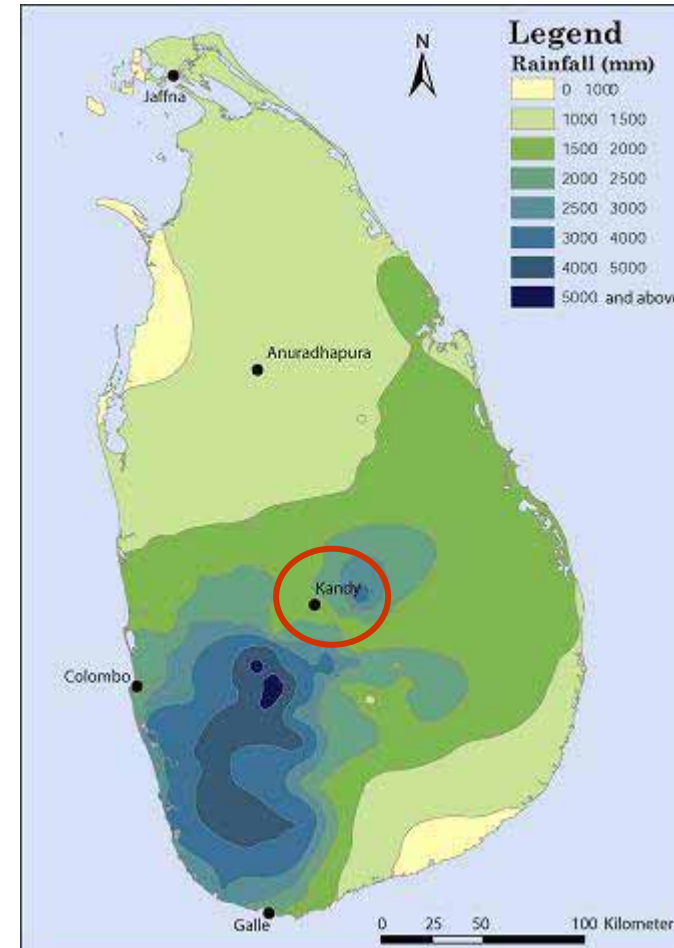
- Sri Lanka divided into three different climatic zones based on amount and pattern of rainfall received.
  - Wet zone (more than 1900 mm rainfall/year)
  - Intermediate zone
  - Dry zone (usually less than 1500mm rainfall/year)
- Colombo
  - 2000-2500 mm/year (average 2376 mm/year, monthly maximum and minimum 360mm in May and 78mm in February)
- Kandy
  - 1500-2000 mm/year (average 1841 mm/year, monthly maximum and minimum 278mm in November and 68mm in February)
- Agrowell Area
  - 1000-1500 mm/year



# Observed Rainfall Variations



**1911-1961**



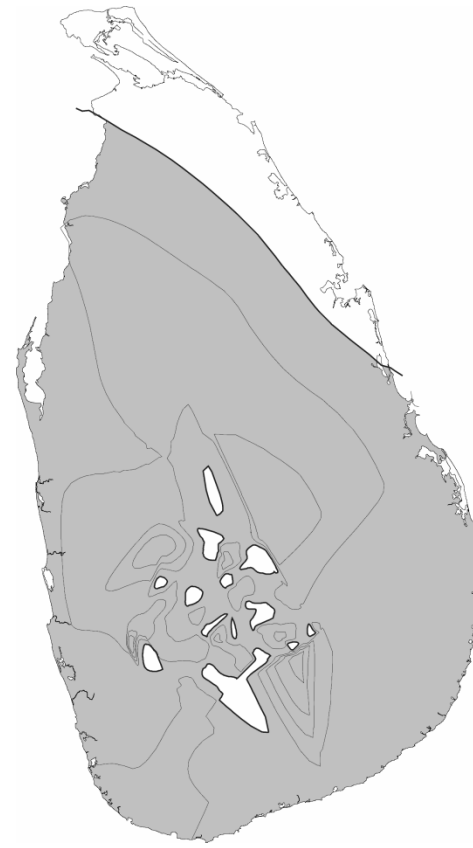
**1961-1990**

# Changes in Wet/Dry spells

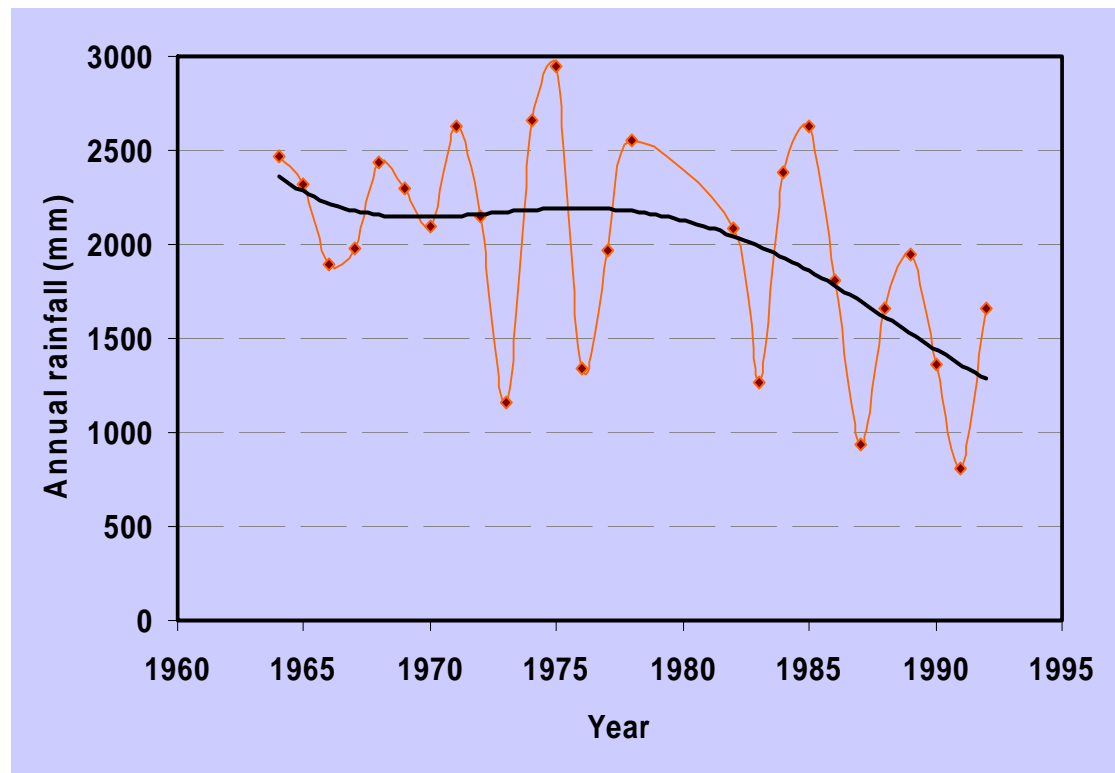
Increasing wet spells



Increasing dry spells



# Rainfall Changes in Kandy



# WATER AVAILABILITY

Country Averages;

- Groundwater : 420 m<sup>3</sup>/per person (2001)
- Surface water : 2,400 m<sup>3</sup>/per person (2001)
- Rainwater runoff : 1,850 m<sup>3</sup>/per person (2001)

However, one considers the total aggregate water availability, shows a **reasonable water resource** but, the variations over space and time demand a proper management strategy

Within study areas

Study area	Ground Water	Surface Water	Rainfall
Colombo - average	815	5,300	3,745
Kandy - average	176	2,049	592

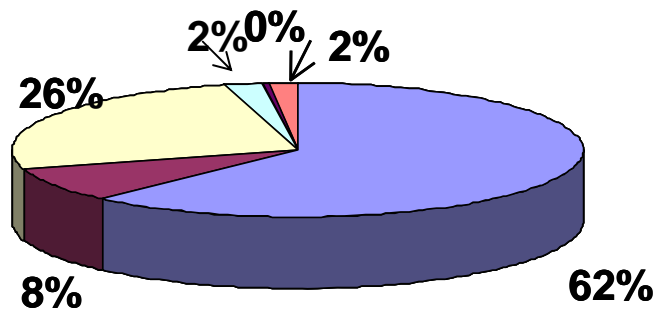
() per-capita water availability, \* Kelani Ganga basin detailed basin assessment



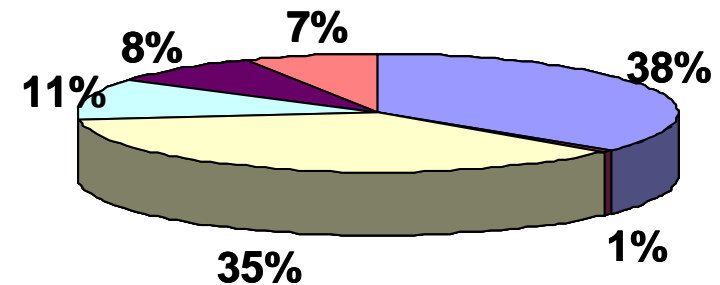
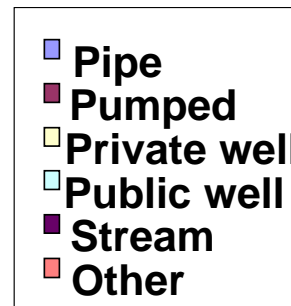
# Present Water Use

	Surface water		Groundwater		NRW
	Domestic	Industrial	Deep Domestic	Shallow Domestic	
Colombo (2001)	380,248	158,445	11,151	6,970	234,000
Kandy (2000)	36,679	5,972	5,546	804	41,000

## Sources for Drinking Water (Source – NWS&DB)



Colombo study area



Kandy Study area

**Groundwater use: Colombo over 36%, Kandy over 47%**

**Both groundwater & surface water will be extracted more in future**

# Groundwater Management Issues



# Low Yield and Lower Success Rates

## Success rates;

- Success rate at well construction = 80%  
(limit; production well 20 l/min and hand operated well 4 l/min – NWD&DB sources)
- After about 5 to 6 years of operation success rate = 65%\*
- Wells maintain by local authorities = 50-55%\*
- Our study in Kandy = 50%
- Lowering success rate with time attributed to poor maintenance and over extractions.

## Yields;

Not promising for large scale use since average yield in Kandy area is 90 l/s



# 1. Problems with Groundwater Exploitation

## Some examples

### Coastal Aquifers;

- Over extractions during dry season causing saline water intrusions

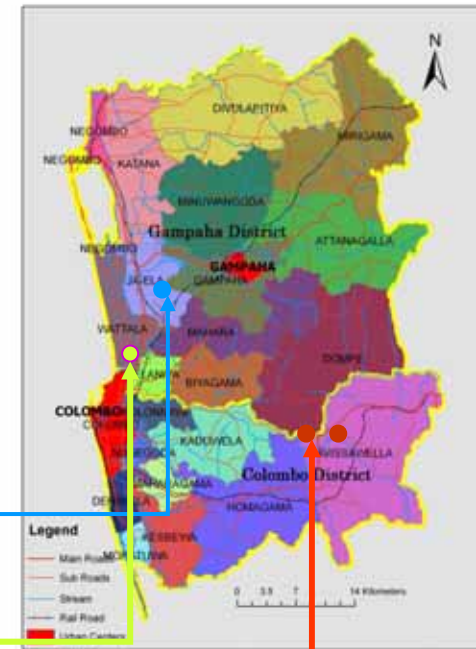
Eg. Coastal belt– Specially by Hotel Sector

### Laterite Aquifers;

- Shallow well water draw-down as a result of deep well over-pumping

Eg. Ekala industrial zone groundwater for industry

Ragama groundwater for water supply



### Semi Confined Hard-rock Aquifers

- Rapid water level draw-downs (over 40 m)

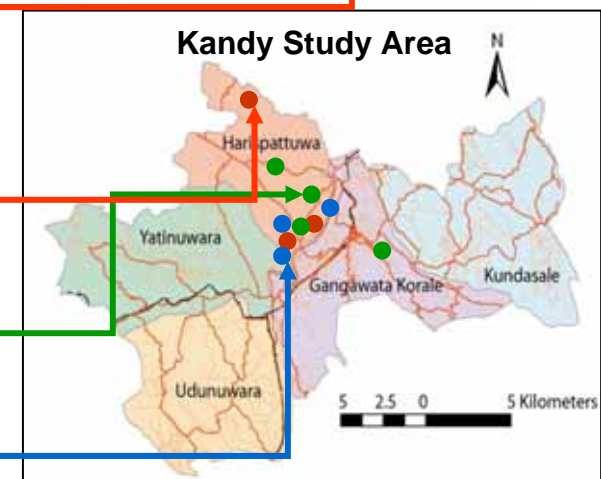
Eg. Bandaragama, Katugastota, Gohagoda, Galhinna

- Decreasing yields

Eg. Rajapihilla, Ampitiya, Bokkawala, Katugastota

- Many Abandoned Schemes

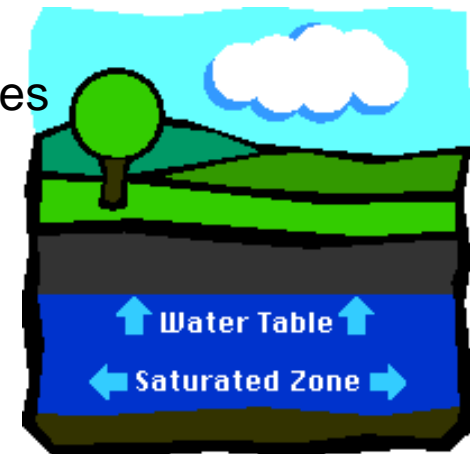
Eg. Kulugammana, Yatihalagala, Kondadeniya



# Possible Causes for Failures

## Note; Hard-rock aquifers

- a. Poor yield estimations
- b. Clogging the fracture zone/path of borehole wells, thus failure to recover even after flushing
- c. Limitations in storage capacity – higher yield in newly constructed borehole wells and over-exploitation cause water level depletion
- d. Slow recharging potential in hard-rock/crevice aquifers
- e. Failures in the siphon action within a fracture zone of a borehole well specially during high rate pumping
- f. Lack of information to take timely and adequate measures



# Management

Few Years back;

Shift the intake to a new borehole location and abandoned the existing boreholes

In many cases;

Shifting to new locations too were failures,  
Supply became expensive

With new studies;

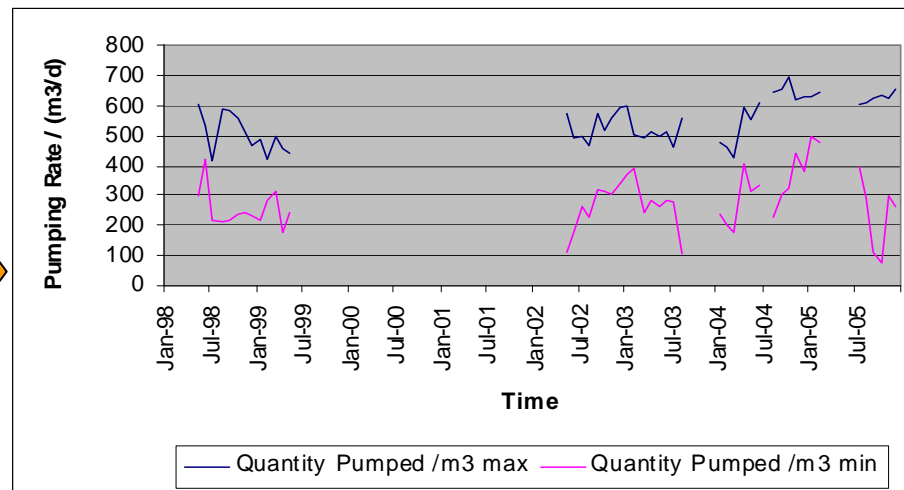
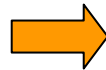
Determining the exact yield difficult

Phasing out the use of deep groundwater from fairly large extractions

## 2. No Reliable Information on groundwater

- Groundwater related data very little; **Three main institutions exploiting groundwater**
- In most instances, **available data is limited to the initial drill log only**, after construction little monitoring done.
- No continuous Data. No reliable data.
- Some data collected, during foreign funded projects, is **lost or misplaced**
- No centralized GW information system.
- Few Research projects

Eg. data available at;  
**Kandy-Owissa GW pumping station used for a water supply scheme**

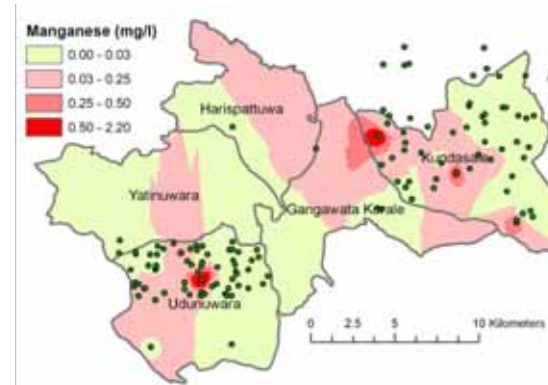
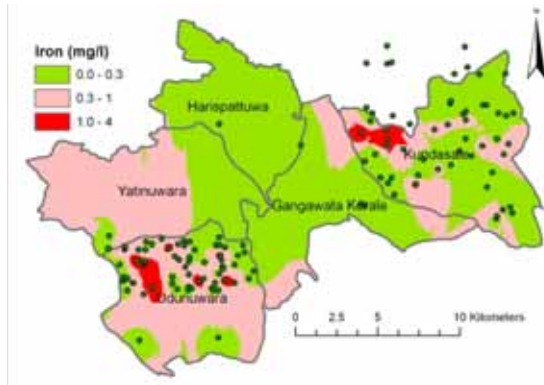


# 3. Groundwater Quality Problems

## Deep Groundwater

No major widespread quality concerns in two study areas expect for;

- ▶ Nitrates (128 mg/l Kandy –East),
- ▶ Iron/Manganese and
- ▶ Hardness (1,100 mg/l Kandy East and South)



Kandy iron and manganese



# Groundwater Quality Problems contd.

## Shallow Groundwater;

contamination from;

- ✦ From fertilizer,
- ✦ Bacteriological (Fecal) contamination from domestic waste
- ✦ Untreated industrial discharge (Colombo)



Eg. Shallow GW total coliform (pfu per 100ml)

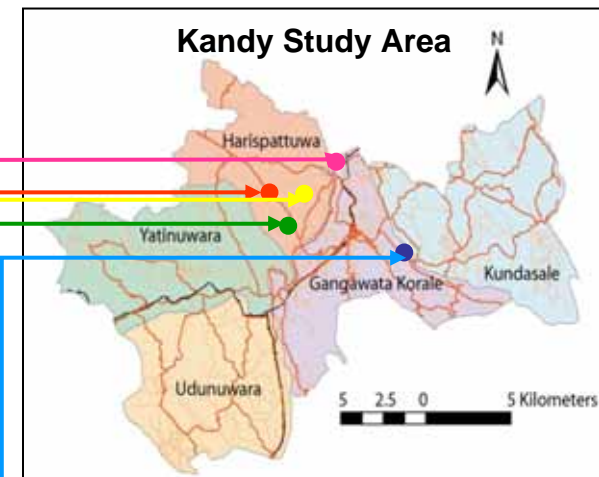
Polgolla 2-44

Hedeniya 150-300

Akurana 24-144

Kulugammana 0-56

Ampitiya 24-84



# Management issues

1. Pollution control very poor
2. Intension of relevant the authorities is to increase present 60 % access to safe water to 99% by year 2025

However;

Need a clear definition and proper guidelines for categorizing a safe drinking source;

Currently; any piped water supply or so called protected well (a lined well) is considered a safe sources but no quality level/assurance required

Most individual sources even, in some instances piped water supplies do not comply to drinking water standards

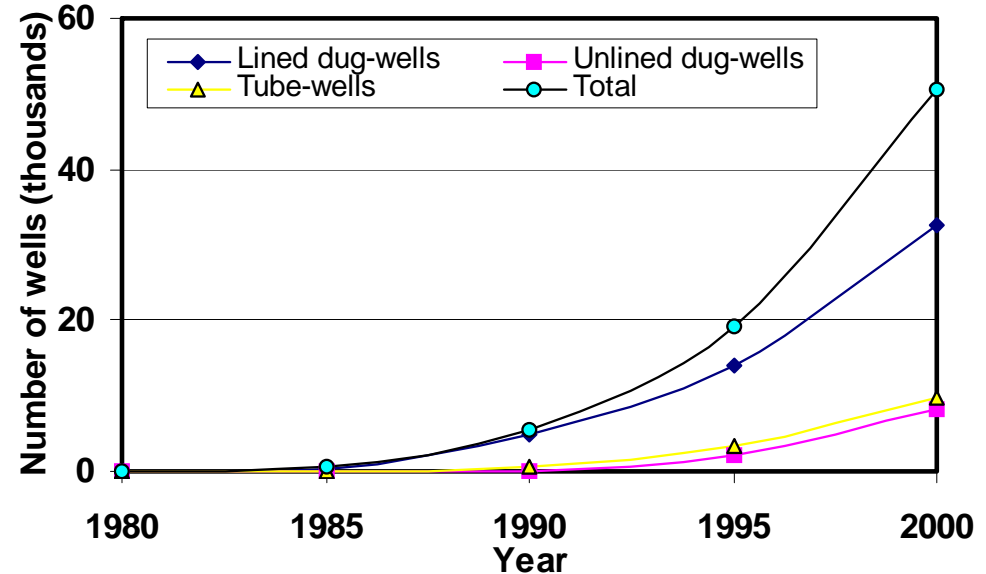
# Agrowell Program

- Widely used in the dry zone (annual rainfall less than 1500mm) of Sri Lanka
- Initially intended to irrigate during dry season using groundwater and only for off-season cash crops
- Program was funded by both the state and by the NGOs
- Now even used to supply water to paddy cultivation
- Resulted in rapid increase of agrowells specially in the northwest

As a result;

Localized water level depletion

Nutrient Pollution



Agrowell growth

# **Affects from Tsunami**

# Destruction caused - to groundwater sources





# Well Monitoring and Cleaning



# Impacts to water sector

- Damage to water supply distribution systems
- Damage to the onsite toilet waste pits (over 60,000)
- Tsunami wave intrusion made most wells in the area become saline and also contaminated with fecal matter (Well water COD 128 mg/l, total and fecal coliform levels 30 and 7, conductivity 1169  $\mu\text{S/cm}$ )
- Over 12,000 wells damaged
- Over pumping for cleaning purposes resulted further damage because of advancement of the salt water wedge

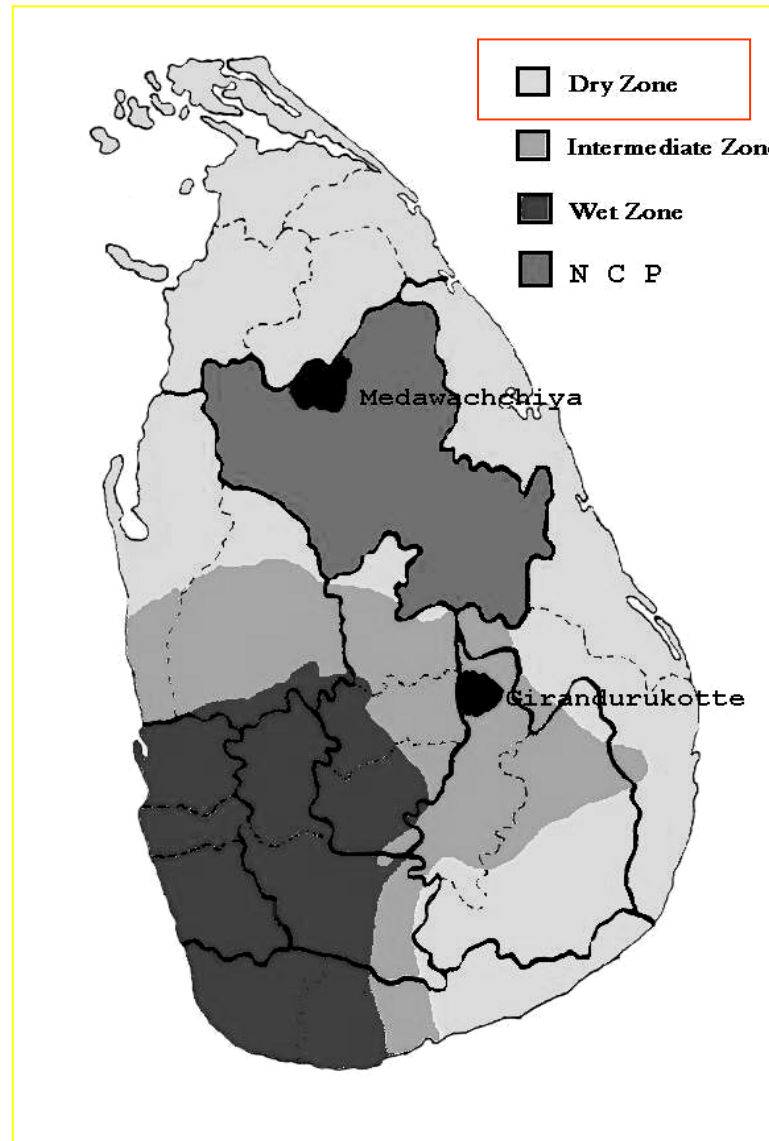
## **Highlight:**

**For such cases Collaborative research is very important**

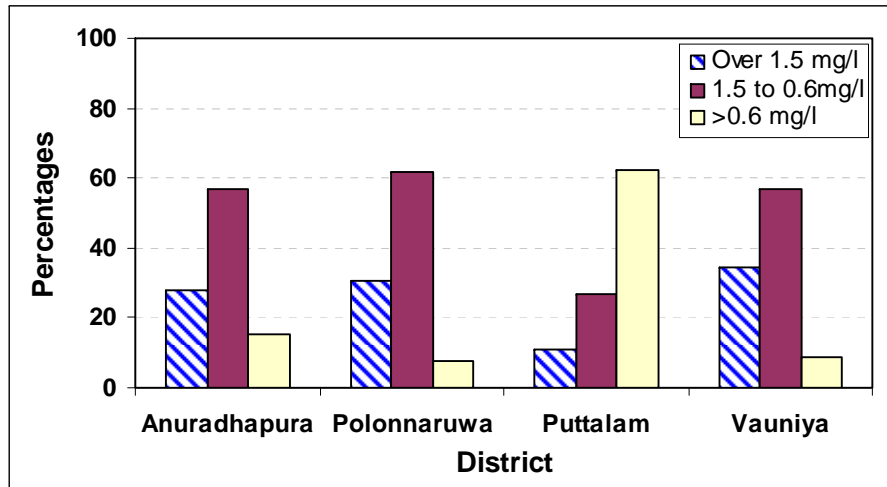
**Special case:  
Fluoride Contamination in the  
Dry Zone**



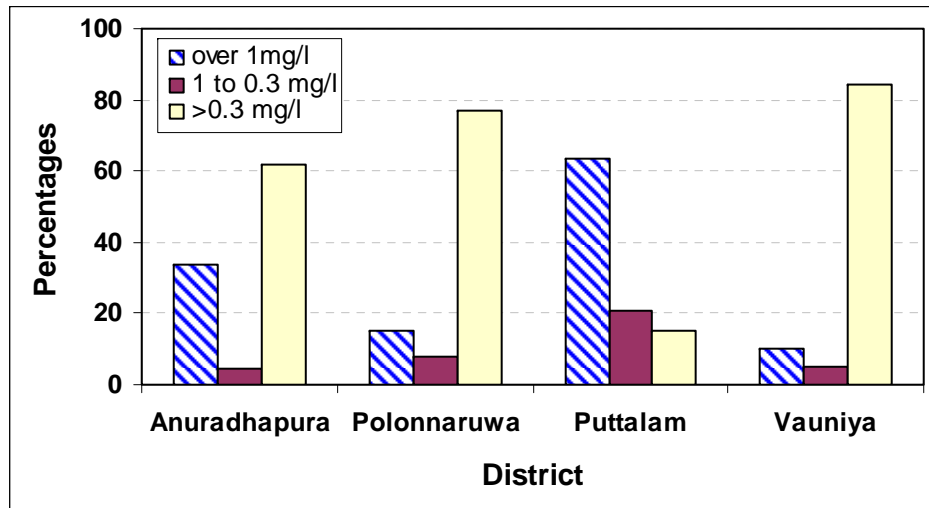
# Dry Zone of Sri Lanka



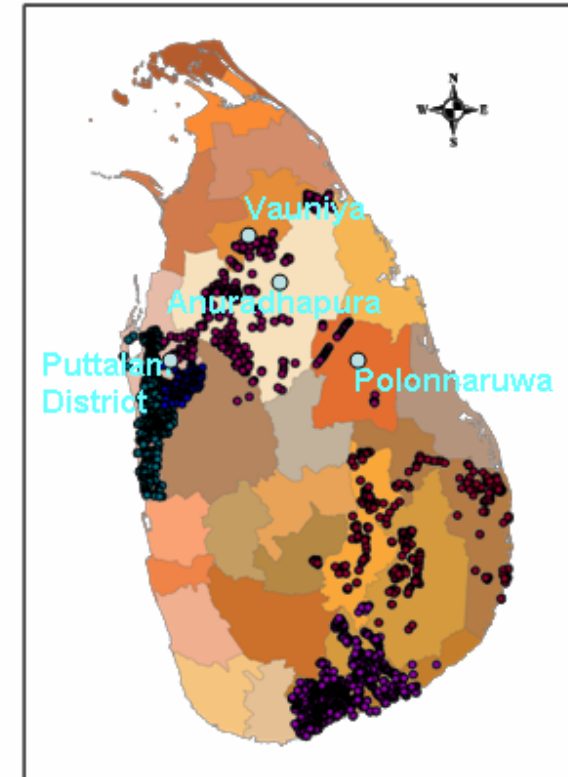
# Fluoride and Iron Levels



**Fluoride Level**



**Total Iron Level**



Wells having quality details

# Health issues from Fluoride

## 1. Dental and Skeletal Fluorosis;

Many Thousands sufferers



## 2. Renal Failure

More and more groundwater uses in dry zone areas affected by renal failures

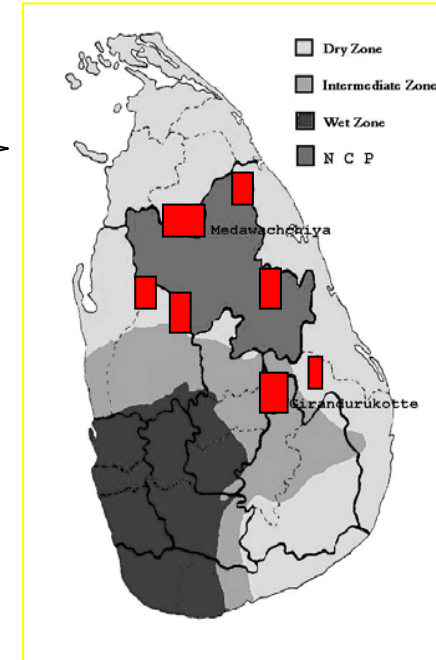
Clear regions identified



Actual cause still unknown

Is it due to groundwater contaminated with;

- Fluoride?? (number 1 suspect)
- Pesticide??
- Poor Quality fertilizer??
- Poor quality aluminum cooking utensils??



**Highlight:**

**For such cases Collaborative research is very important**



# **Alternatives to Groundwater**

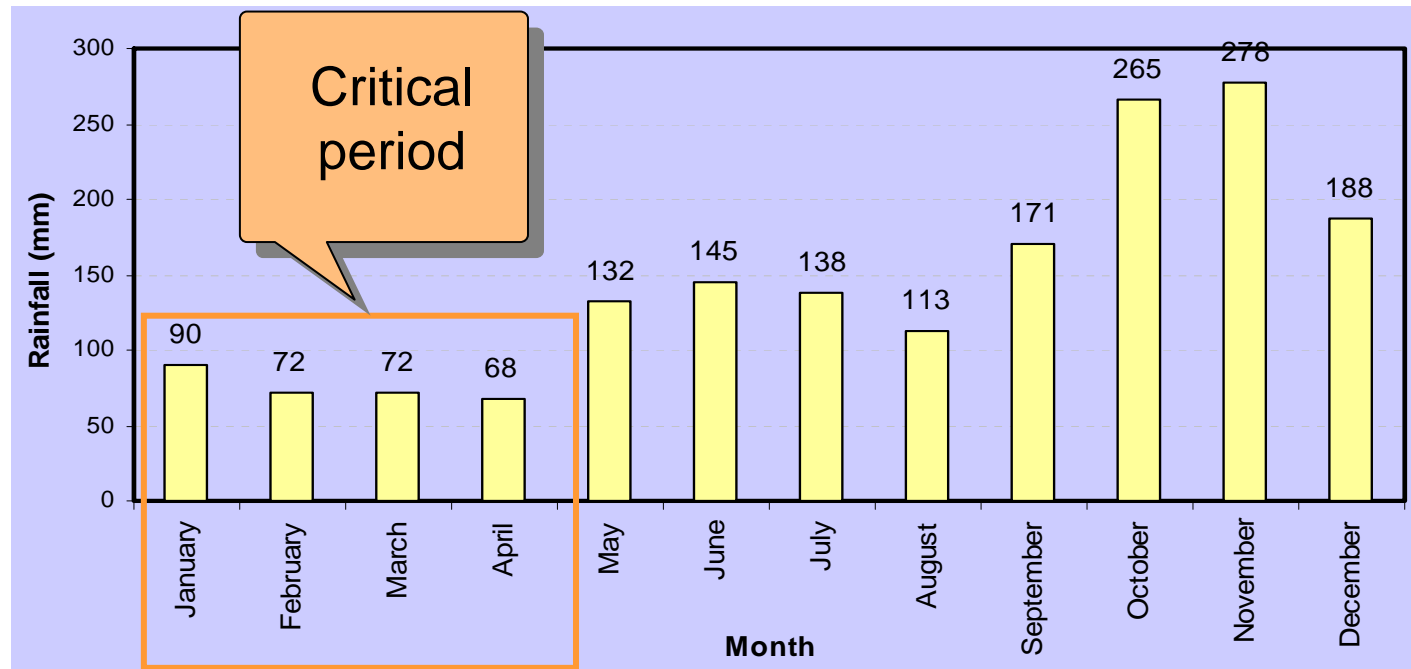
# Surface Water

1. Reliability is low during dry periods (from February to April)
2. Quality deterioration due to;
  - ◆ Industrial discharges
  - ◆ Domestic discharges
  - ◆ Salinity intrusion
3. Conflicting water allocation priorities between
  - ◆ hydropower generation and water supply
  - ◆ Irrigation and water supply
4. No proper implementation of effluent standards

# Rainwater Harvesting

# Potential for Rain-Water Harvesting

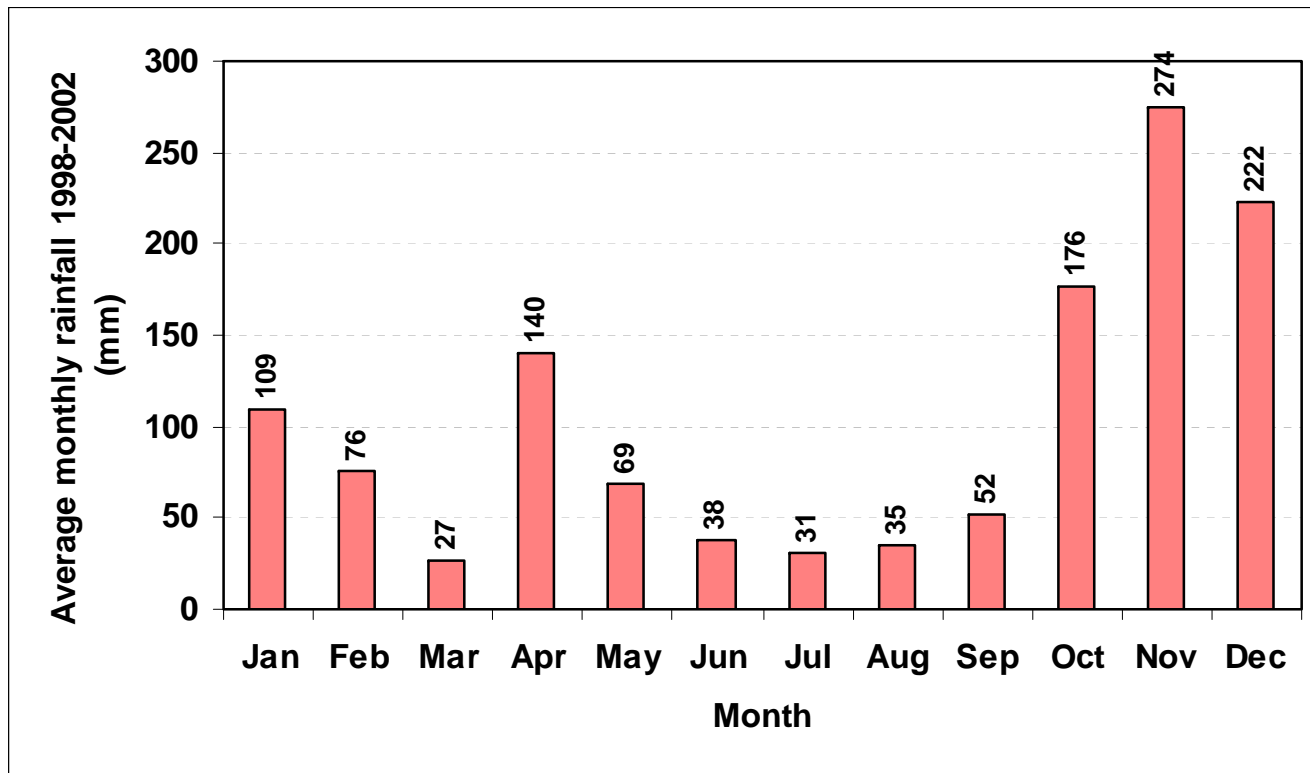
Rainfall availability along with the recently introduced RWH policy, Potential for HWR as an alternative source for potable water is very good



Average rainfall in Kandy – **Wet Zone**



# In Dry Zone



## Rainfall variation

Rainwater Harvesting used in a number of places, but need further work as;

- In urban areas, very few prefer to harvest rainwater
- However, most in peri-urban and rural areas keen to harvest rainwater
- Of them most prefer rainwater for secondary purposes (washing gardening etc.)
- knowledge and awareness on RWH is very poor

Need alternatives and better techniques for;

- New harvesting techniques
- Cheap storage facilities
- Better storage for longer duration use

**Highlight:**

**For such cases Collaborative research is very important**

# **IGES Study**

## **Sustainable Water Management Policy (SWMP) study**

was initiated by the Freshwater Project of the Institute for Global Environmental Strategies (IGES),

### **AIM:**

To develop integrated policy options for sustainable water management in Asia

### **Project Period:**

2004-2007 (three years)

Main Focus was on Groundwater issues

# IGES Case study Cities



# Highlight

Subsequent to a decision taken during a stakeholder meeting through the IGES study, the **National Academy of Science of Sri Lanka** jointly with the Department of Civil Engineering, University of Peradeniya organized a groundwater workshop last month and after this workshop, the Academy took a decision to push for a Groundwater Policy for the Country



Thank you

A Typical Agrowell