Special Seminar

Prof. **Ranjana Udaya Kumara Piyadasa**

Title: Climate change, Vulnerability and its impacts to the coastal environment

Speaker: Dr. Ranjana. Udaya. Kumara. Piyadasa.

Professor, Head of Department of Environment Technology, University of Colombo, Sri Lanka

Date and Time: September 30, 2022, at 2:00 pm
Location: Theatre Lecture , 1F of Research & Project 1

Organized by
Department of Environmental Science & Technology, Saitama University
The Strategic Research Area for Sustainable Development in East Asia (SRASDEA)

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Faculty of Technology, University of Colombo

•https://www.youtube.com/watch?v=vC_ULmDBZE

Dialogue on Climate Change

•Climate change, Vulnerability and its impacts to the coastal environment

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•https://www.ft.lk/columns/Global-warming-and-climate-change/4-731011

Content

- Introduction
- What is climate change?
- The Triggering Factors
- Global Climate Change: Causes, impacts,
- Coastal valnerability
- Sea level rise
- Case study on cosatal environment
- Conclusions

- what evidence can you find of the occurrence of climate change?????

What have you heard and seen?

Global warming causing new evolutionary patterns

nzherald.co.nz

EXAGGERATED SCIENCE

How Global Warming Research is Creating a Climate of Fear

SPIEGEL ONLINE

Global warming could burn insurers
Activists call on industry to act

seattlepi.com

•Seattle mayors' meeting a cozy climate for business

The Seattle Times

In a Shift, White House Cites Global Warming as a Problem

The New York Times ON THE WEB

Research Links Global Warming to Wildfires

STT SCI-TECH TODAY Technology, Discovery & Innovation

Is Global Warming Fueling Katrina?

TIME

Rise in wild fires a result of climate change

CNN INTERNATIONAL .com

THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

'High Confidence' That Planet Is Warmest in 400 Years;

•Seattle reports milestone in cutting emissions

Jellyfish creature the answer to global warming?

www.Scienceblog.com

The Seattle Times

The Seattle Times

How one number touched off big climate-change fight at UW

What we can see today

- Grinnell glacier park- USA
- 1914

- 2000

- Pasterze glacier- Austria
- 1875

- 2004

- Portage glacier- Alaska, USA
- 1914

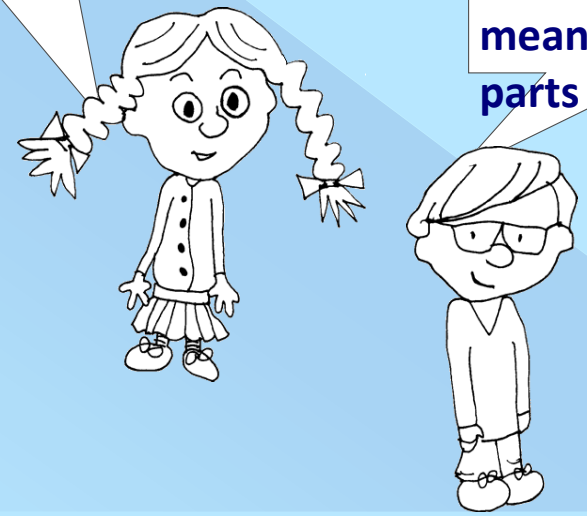
- 2004

•https://en.wikipedia.org/wiki

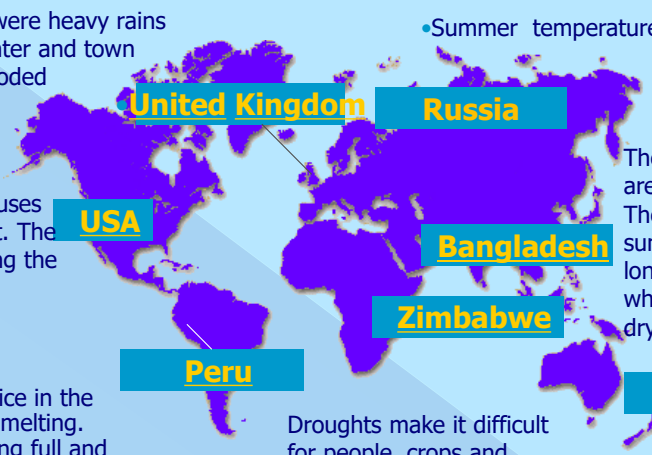
POSITIVE PROOF OF GLOBAL WARMING

What is climate change?

- What is climate change?
- It's something to do with the weather.
- Let's see what it means to different parts of the world.



- Different countries different stories



There were heavy rains last winter and town was flooded

- Summer temperature very high.

The monsoon rains are much worse. Then in the summer there are long droughts when everything is dry.

- Global warming causes the polar ice to melt. The extra water is making the sea levels rise.

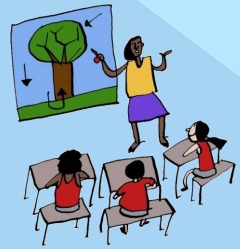
- The snow and ice in the mountains are melting. Lakes are getting full and there could be floods or landslides.

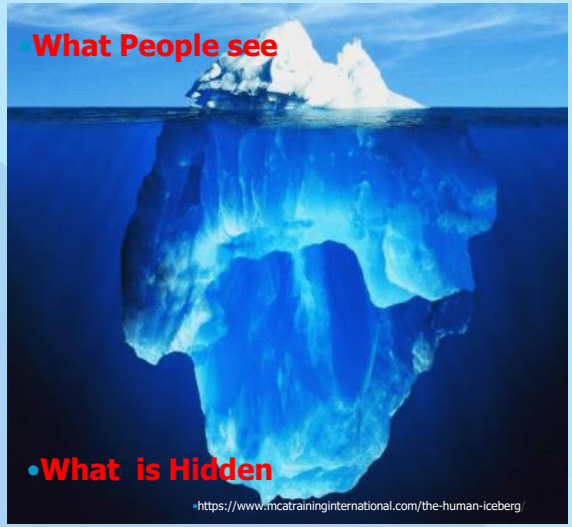
Droughts make it difficult for people, crops and animals to survive. The rains are not regular.

There were lot of flooding & wild fire

- So the world's weather is changing.
- There are floods in some places and droughts in others.
- People all over the world will be affected.

ITS LIKE ICEBERG



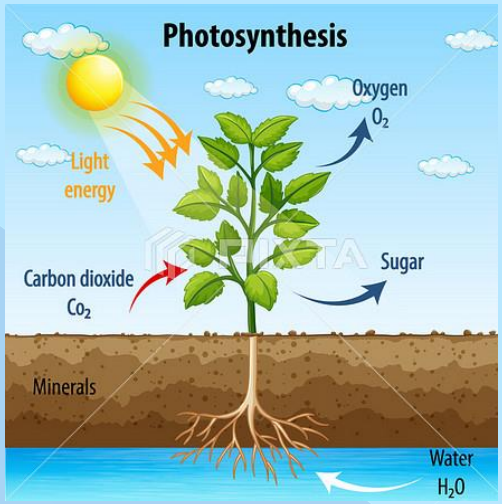


- Impacts of climate change bigger than what we can see

Climate predictions in 1970

- In 1970 the most of the climactic scientists predictions were totally wrong.

- Some reports state with the sea level rise and some of the Islands are lost and submerge.

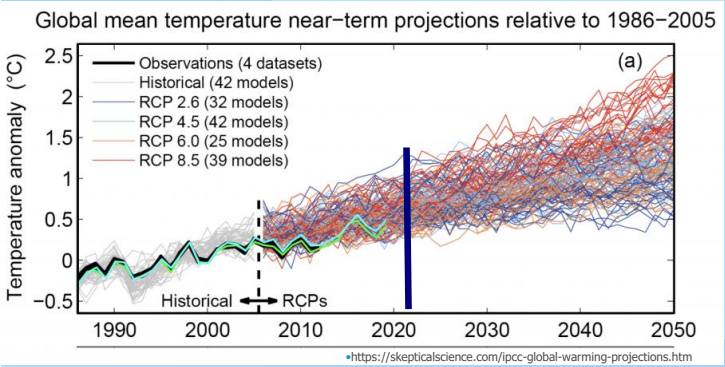


•https://pixta.jp/illustration/76968886

But all the projections are totally not correct

- **Intergovernmental Panel on Climate Change (IPCC)**

- The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change overview.



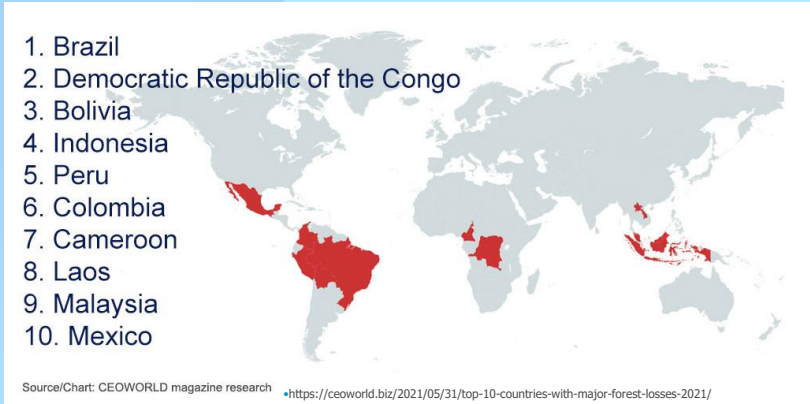
•https://skepticalscience.com/ipcc-global-warming-projections.htm

- 4 scenarios
- population
- economic growth
- energy consumption and sources
- Climate change

Representative Concentration Pathway (RCP) describe 4 different scenarios based on different assumptions about population, economic growth, energy consumption and sources and land use over this century on Climate change.

Top 10 countries with major forest losses, 2021

Since 1990, it is estimated that 420 million hectares of forest have been lost https://www.fao.org/state-of-forests/en/



•https://ceoworld.biz/2021/05/31/top-10-countries-with-major-forest-losses-2021/

- All the countries belongs to TROPICAL countries- Rain forests

Global Climate Change

- relation to Environment and Development

, Water and Biodiversity

•Global Climate Change

Global Climate Change

- **Causes**
- **Impacts**
- **Mitigation**
  - = All measures suitable to reduce, delay or avoid impacts
  - Reducing greenhouse gas emissions
  - Reducing other stress factors, e.g. water supply shortage
- **Adaptation**
  - = All measures suitable to counteract expected damage
  - Building dams along the coast, changing agric. crops, etc,
  - Selling ‚Carbon Certificates' within Kyoto Protocol

Is the Climate Changing?

- What are the indicators?
- Is the change slow or rapid?

indicators

- Natural – Changers of the earth orbit,
  Solar activity,
  Volcanic aerosol
- Anthropogenic (Man made)

Global Climate Change

Our global climate is changing dramatically.

The change is due to the anthropogenic emission of

- Carbon dioxide (CO_2)
- Methane (CH4)
- Nitrous oxide (NOx)
- Ozone (O_3) & water vapor (H2o)

- Without greenhouse gases, the average temperature of Earth's surface would be about −18 ° C

Due to climate change humankind faces some environmental and social challenges of an unprecedented scale.

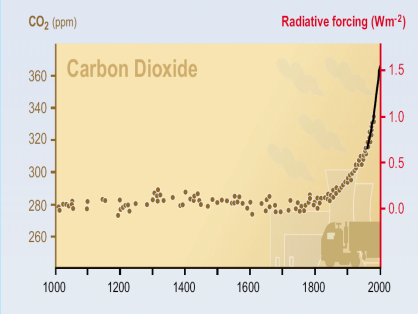
Its directly influence to Development of the Country

Indicators of Climate Change

- Concentration indicators
- Weather indicators
- Biological and physical indicators

Concentration Indicators – CO_2

- Atmospheric CO_2 concentration

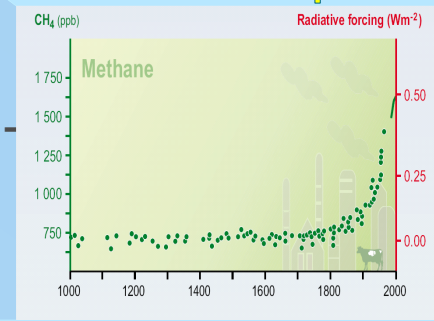


- Year 1000 to 1750 period 280ppm
- year 1970 its 325.68 ppm
- year 2005 its 379 ppm

- **Today 414.72 ppm**

Concentration Indicators – CH_4

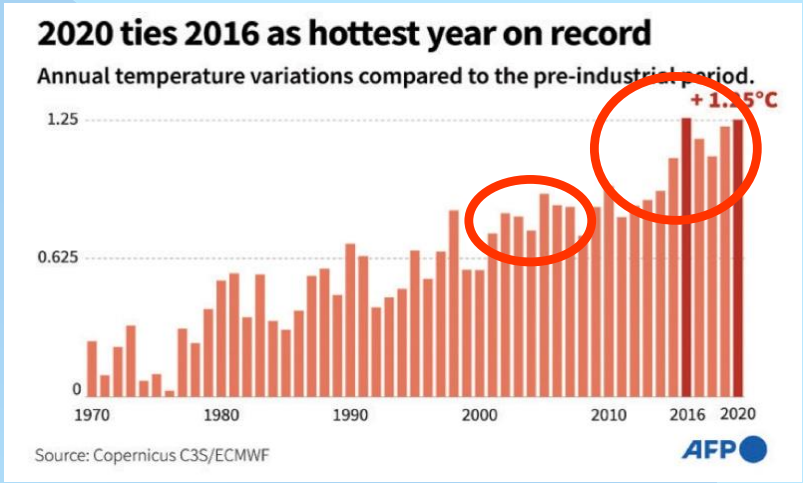
- Atmospheric CH_4 changes



- from 700 ppb for the period 1000 - 1750 but 1774 ppb in 2005

- **Today 1892.2 ppb**

Weather Indicators

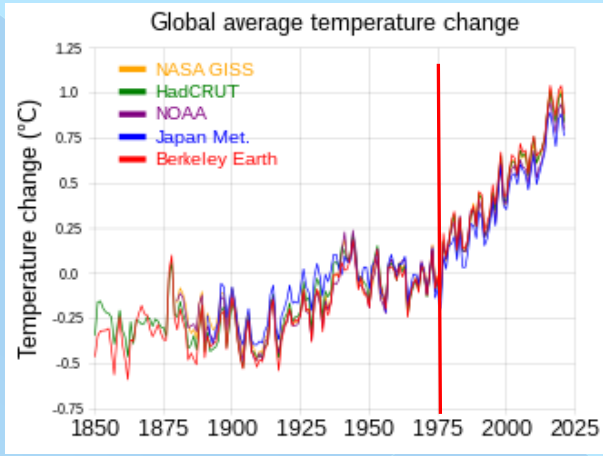


- **In the 21st century all years 2000-2005 were exceptionally warm. The year 2016 was the warmest year of all times after that 2021**

Weather Indicators

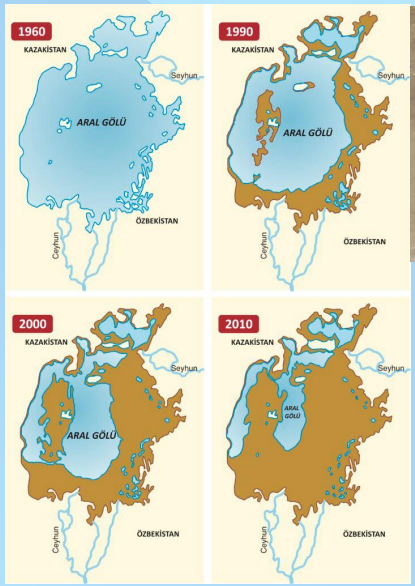
Global mean surface temperature has increased by 0.6 ± 0.2 ˚C over the Current and last centurise

- **Global average temperature datasets from NASA,**
- **NOAA, Berkeley Earth, and meteorological offices of the U.K. and Japan**



- https://en.wikipedia.org/wiki/Global_surface_temperature

Biological & Physical Indicators



- https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2019-10-11

Once the fourth largest lake in the world – Areal Sea in Central Asia

- **Lake shrinking due to climate change and human activity**

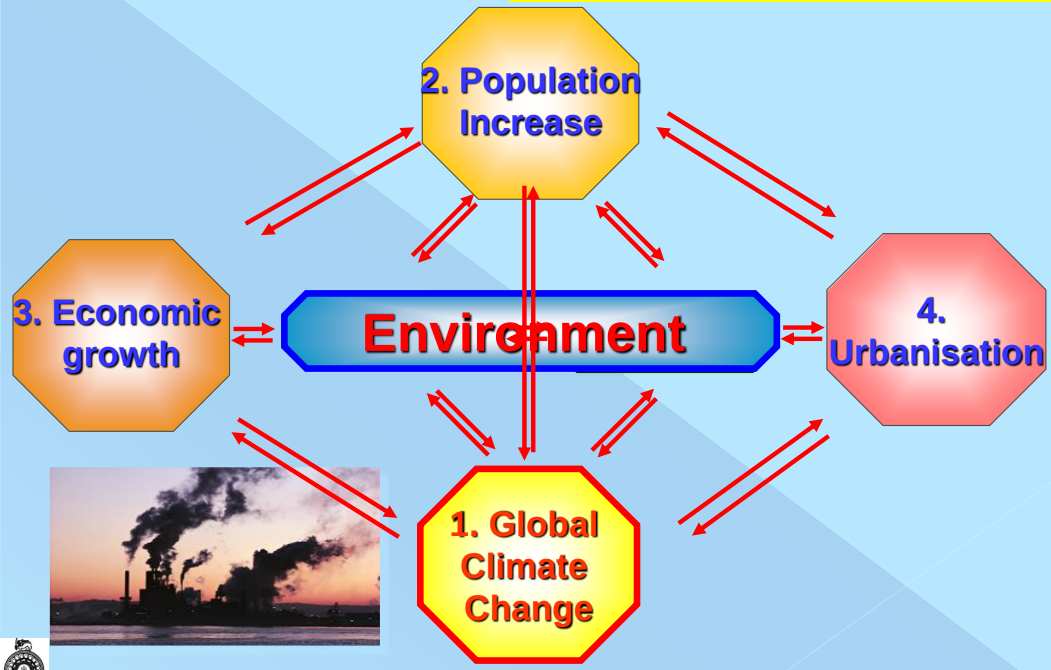
- https://www.theperspective.se/2022/04/22/article/blue-gold-turned-into-sand-will-the-waters-return-to-the-aral-sea/

Biological & Physical Indicators

- 1. Global mean sea level has increased at an average annual rate of 1 – 2 mm during 20th century
- Arctic sea-ice thickness has decreased by 40% in recent decades in late summer to early autumn and decreased in extent by 10-15%

Triggering Factors

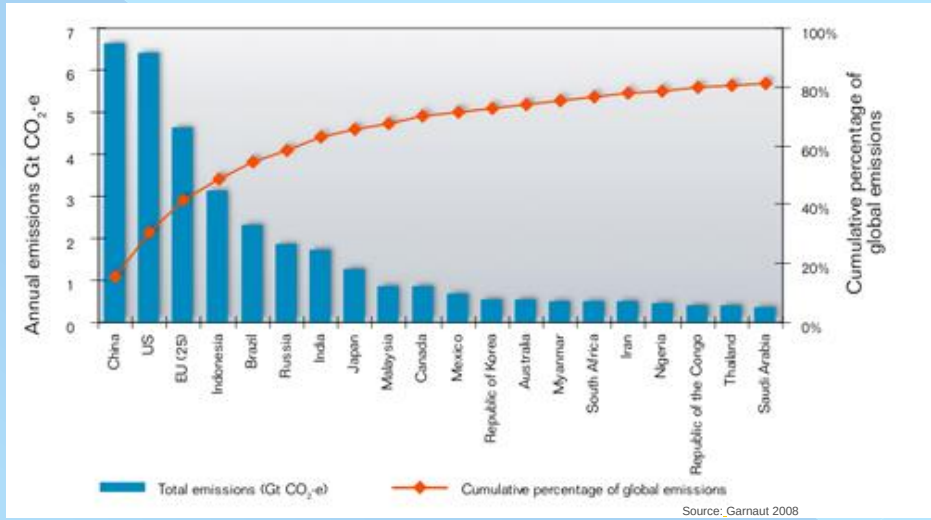
Triggering factors regarding future environmet



Triggering factors regarding future Environmennt on Climate change

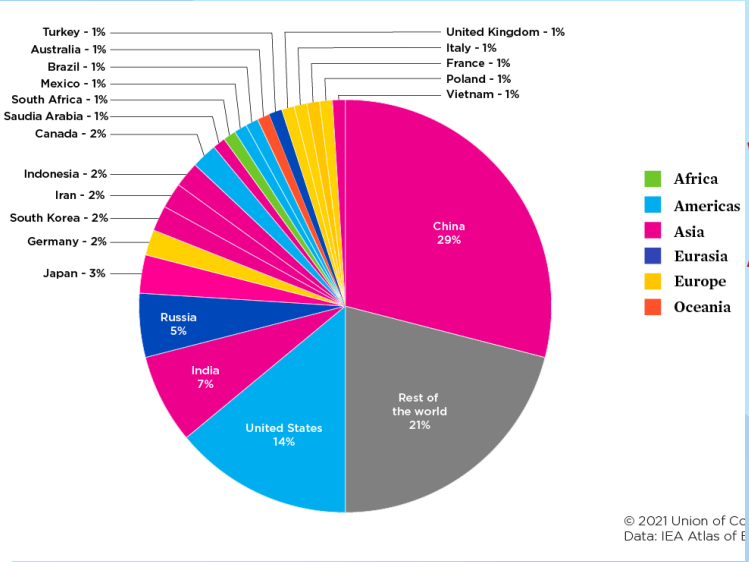
Triggering Factors

Factor 1: Global Greenhouse Gas Emissions



The 20 largest greenhouse gas emitters: total emissions and cumulative share (%) of global emissions; Year 2004

Top Annual CO_2 Emitting countries,
(from fossil fuels)

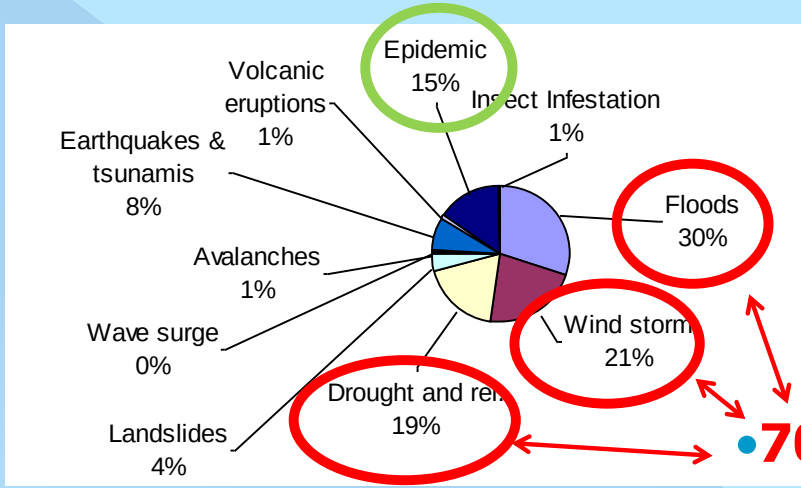


World Top Emitters- ASIA

46%

•https://www.ucsusa.org/resources/each-countrys-share-co2-emissions

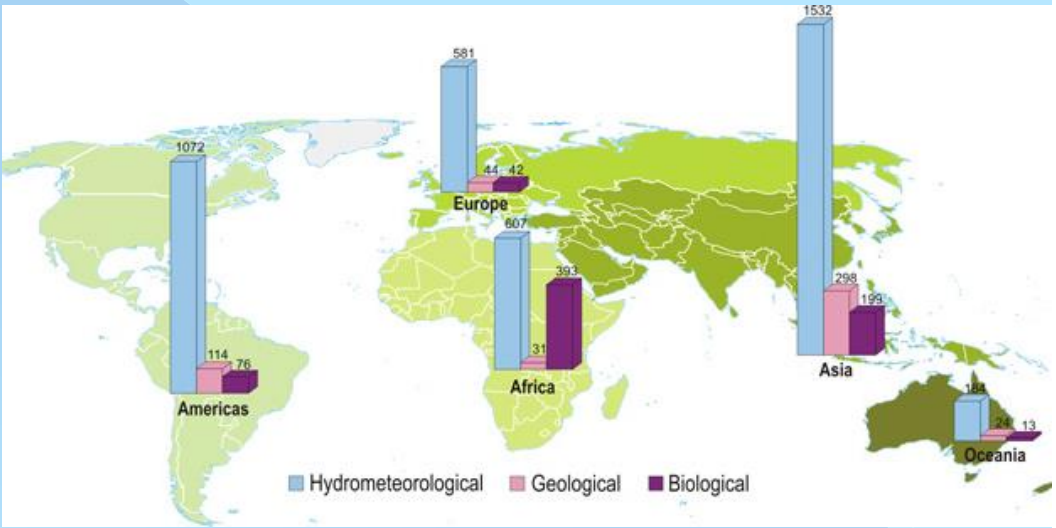
Global Distribution of Natural Disasters



•World Distribution of Disasters triggered by Natural Hazards *(1995-2004)*

•Source: http://www.unisdr.org/disaster-statistics

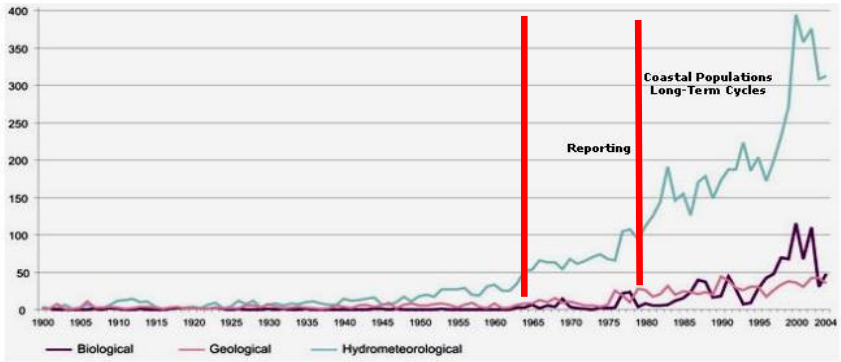
Global Occurrence of Natural Disasters



• Number of Natural Disasters by Origin

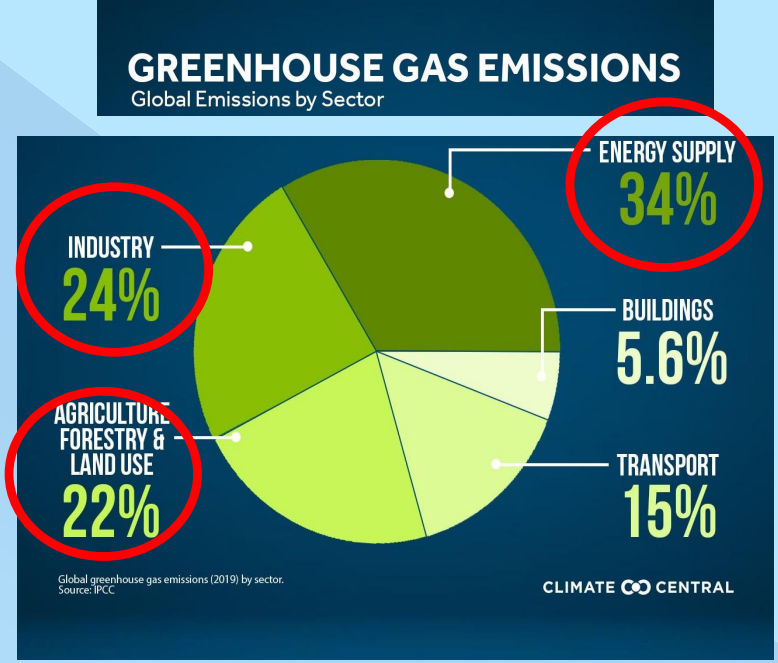
• Regional Distribution (1995 – 2004)
Source: http://www.unisdr.org/disaster-statistics

Global Occurrence of Natural Disasters



TOTAL NUMBER OF NATURAL DISASTERS REGISTERED IN EMDAT 1900 - 2004

UNISDR



- **80%** from Energy, Industry, Agriculture

- https://www.climatecentral.org/climate-matters/peak-co2-heat-trapping-emissions

The 20 largest greenhouse gas emitters:

Develop and Industrial countries total emissions 80%

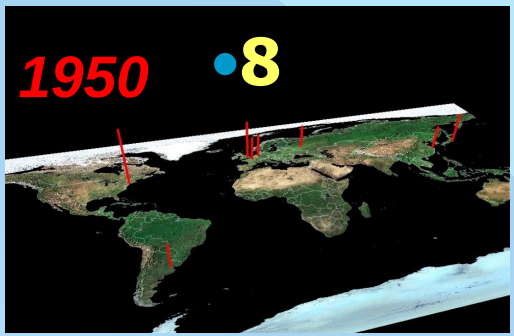
Rest of the world: Total emission 20%

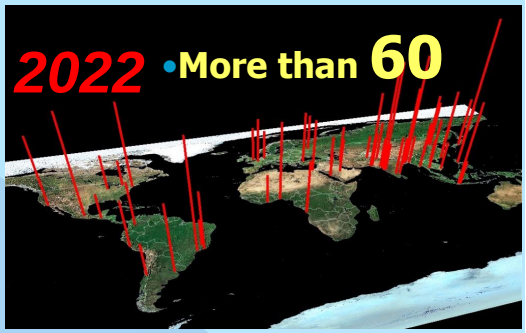
What we can understand ????

Triggering Factors

Factor 2: Population Development

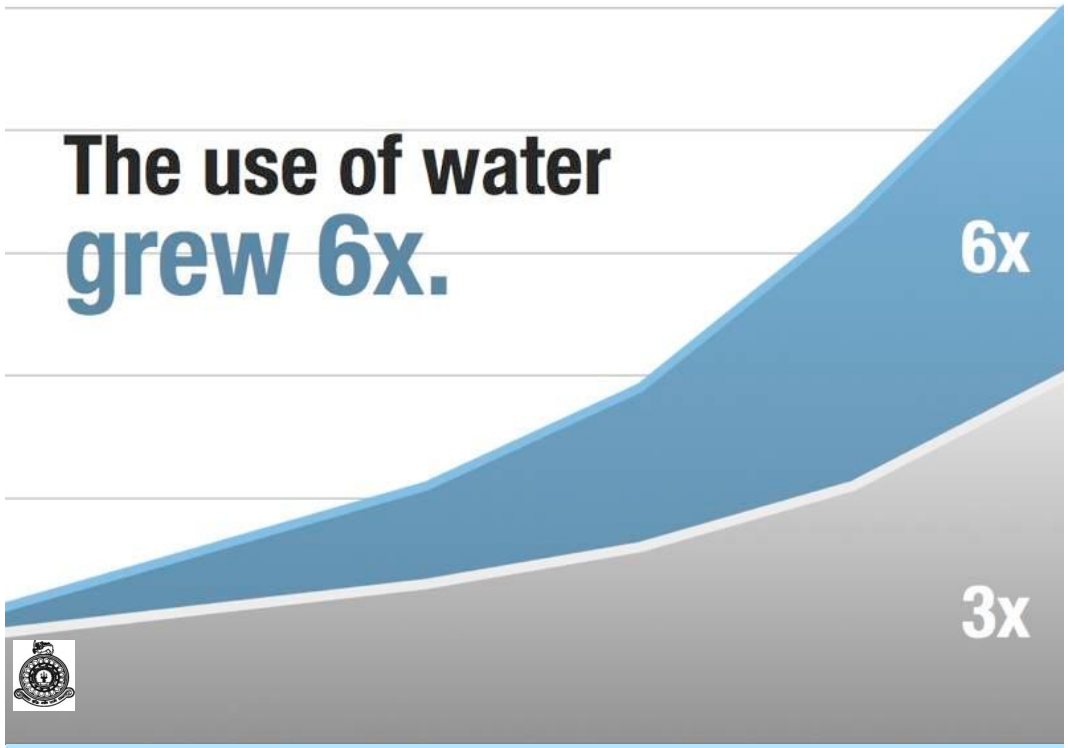
- World Cities exceeding 5 million residents

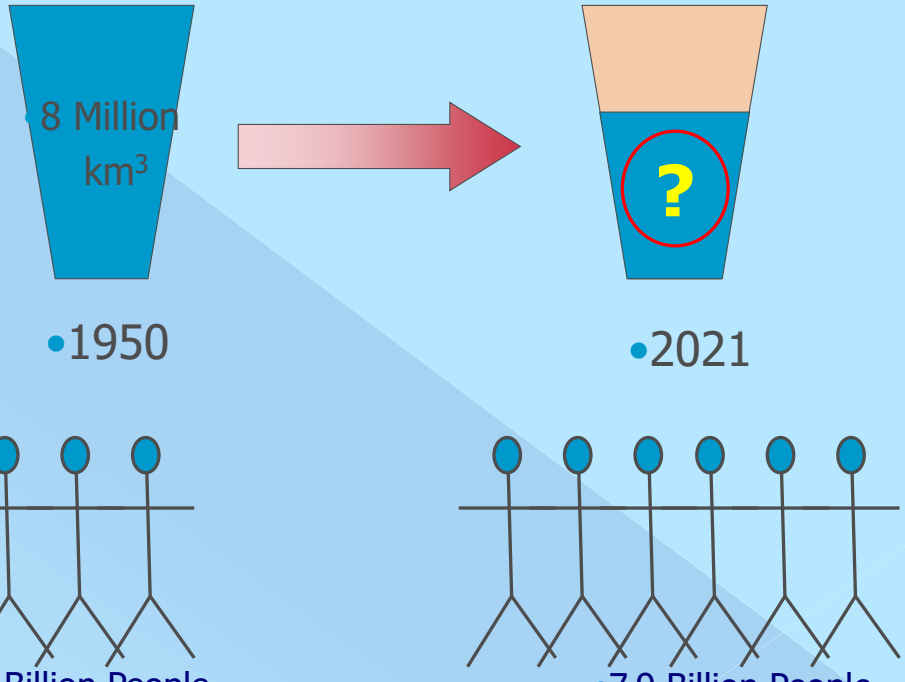


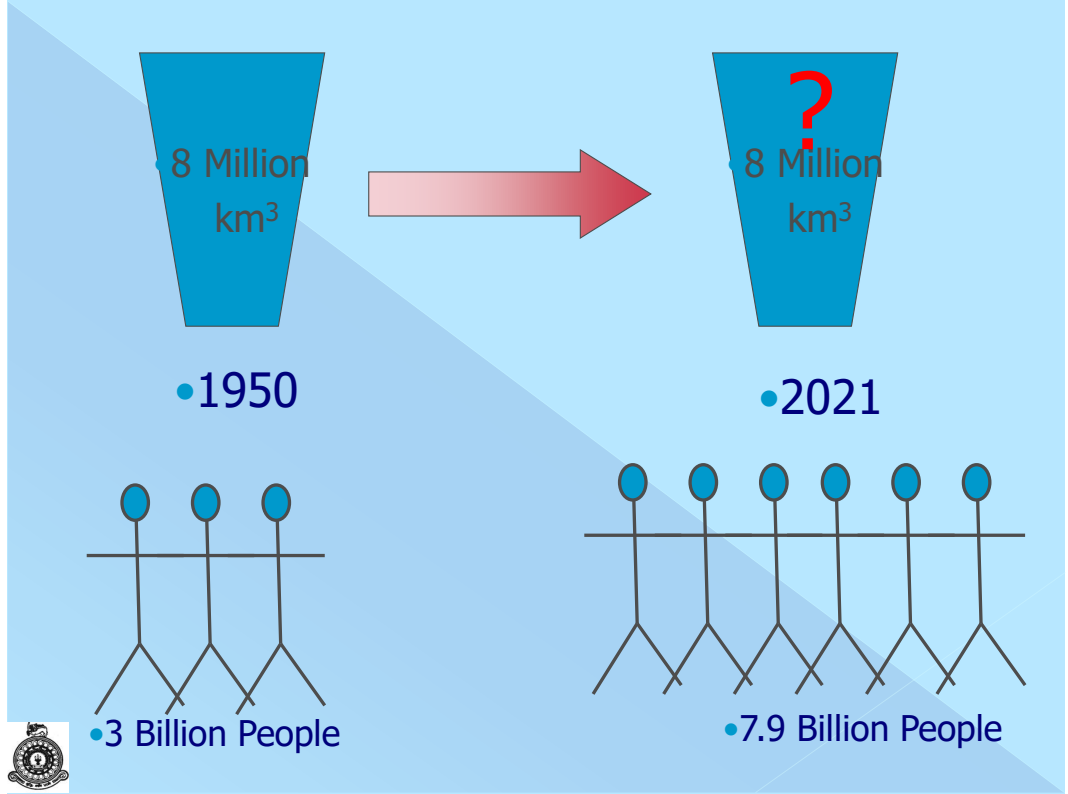


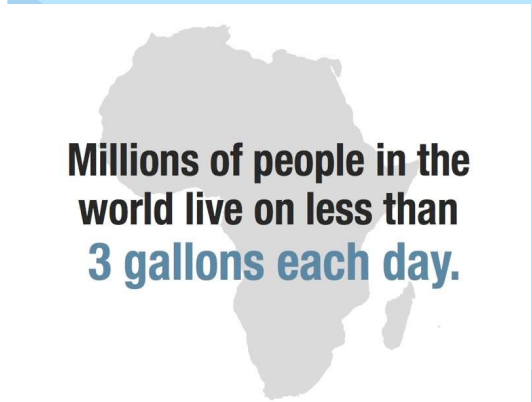
A doubling the water demand until 2050 is prognosed by World Bank.

The use of water grew 6x.

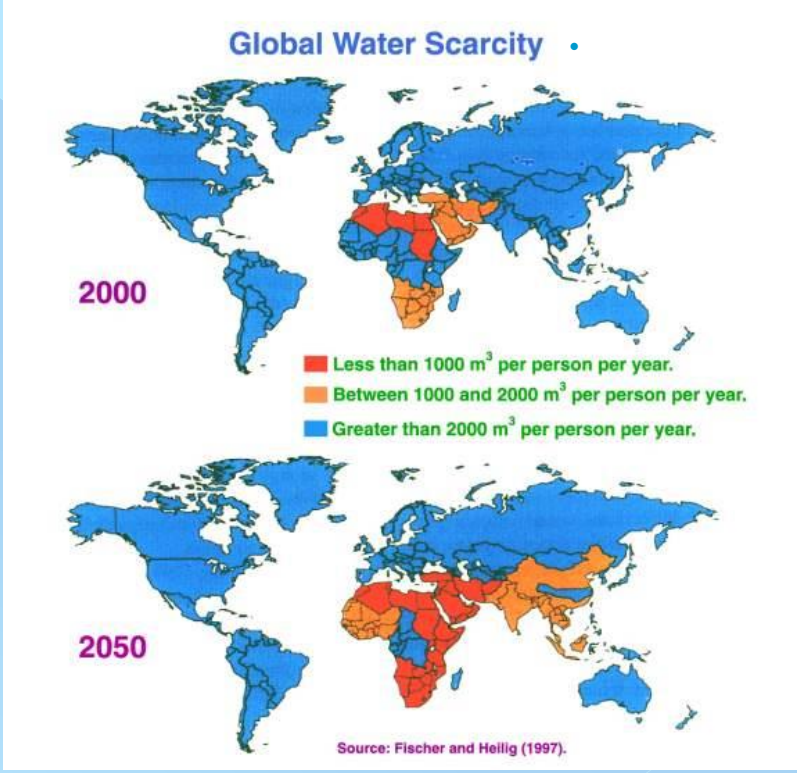








•https://public.wmo.int/en/media/press-release/wake-looming-water-crisis-report-warns

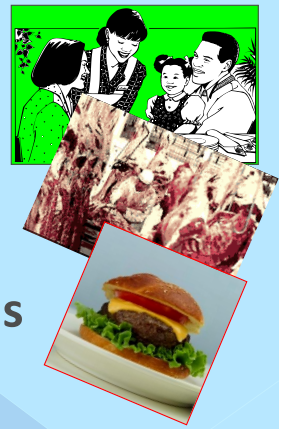


Triggering Factors

Economic Growth

The problems of water crisis will also be driven by rapid economic development..

As nations such as China and other countries grow economically more prosperous, with that , their citizens are switching to more protein-rich Western diets.



It takes some **15,500 litres of water** to produce a kilogram of industrial **beef**, ten times as much as is needed to produce **1 kilogram of wheat**..

Triggering Factors

Factor 3: Economic Growth

has shown a fast **economic growth** in the past:

- ►GDP increased by annually (Gross Domestic Product)
- ► Industrial output by annually increased

But about **1/3** of population lives **below the poverty line**

Economic growth is needed, but it is still linked with a high degree of

- ► **water use**
- ► **water pollution and**
- ► **the emission of greenhouse gases.**

Triggering Factors

Economic Growth

Agricultural Water Demand (Rain or Irrigation Water)

- **To produce**

1 ton of grain = = 1,000 m³ water are needed.

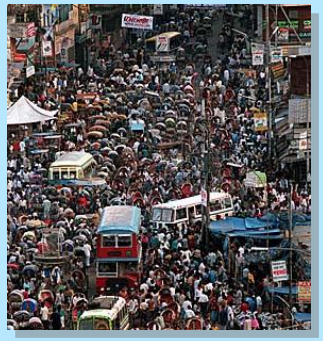
1 ton of **cotton = 15,000 m³ water**

1 ton of paper = 500 m³ water

Triggering Factors

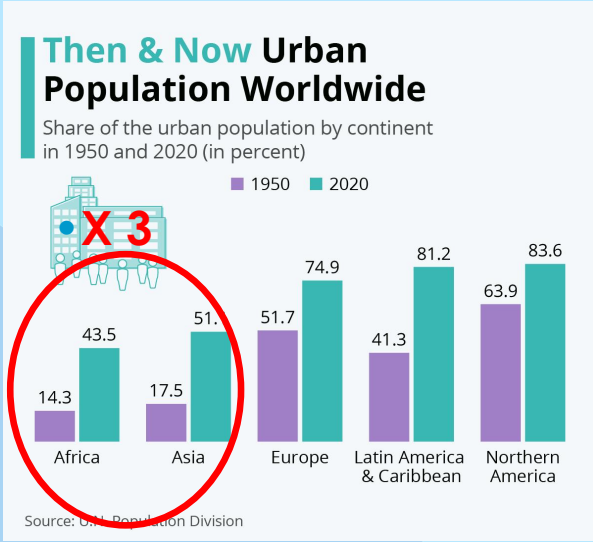
Factor 4: Urbanization

The urbanisation is high in the world: about 1/3 of the population lives in cities.

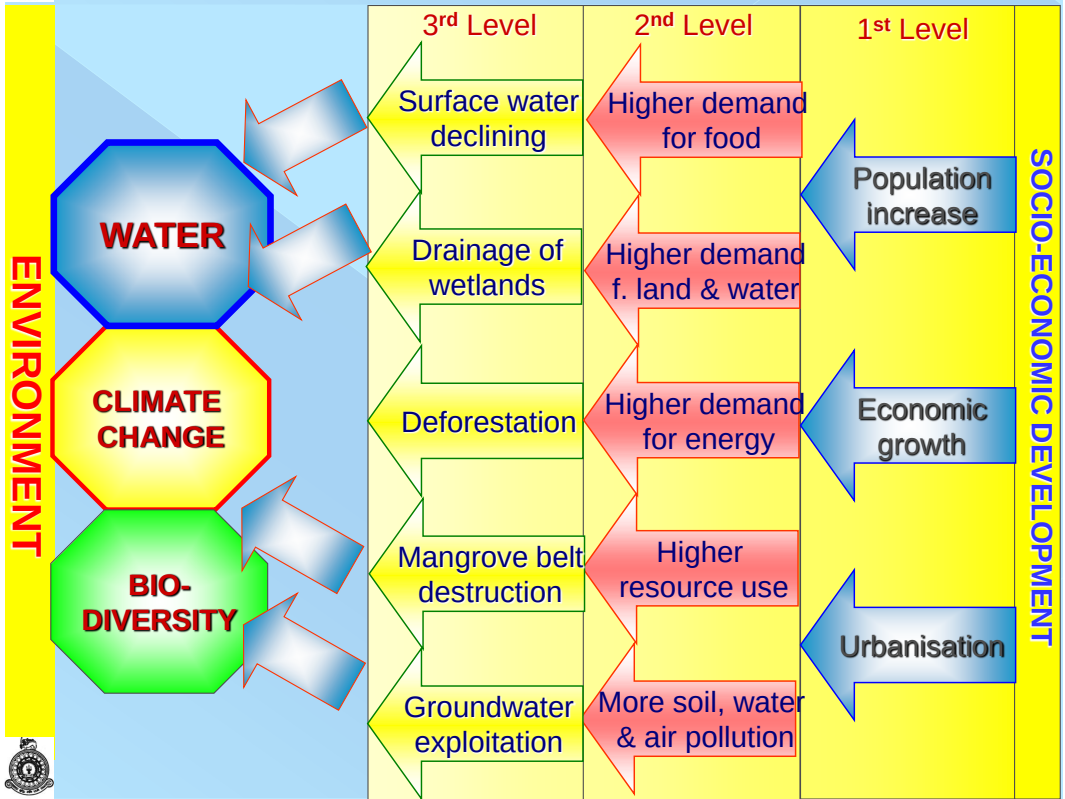


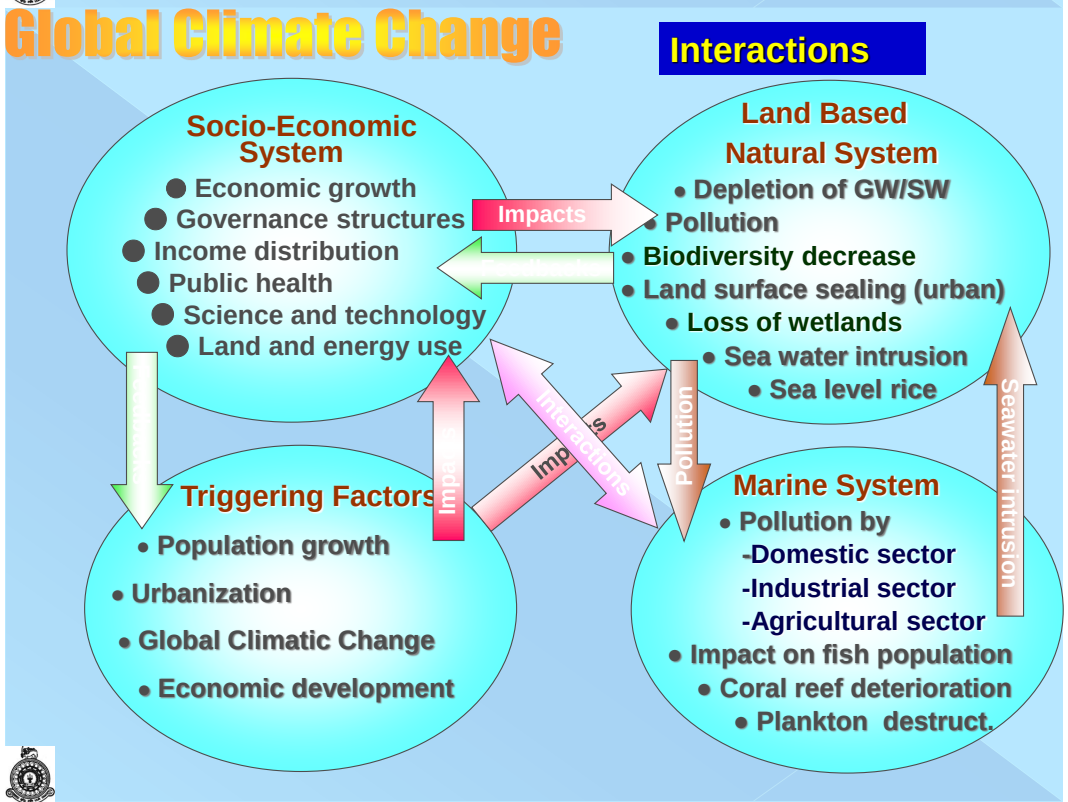
The water and energy demand per capita as well as the general resource use in cities is higher than rural areas.

- **Population changers in Urban areas**



- Resources usages are very high and its directly impacted to the environment

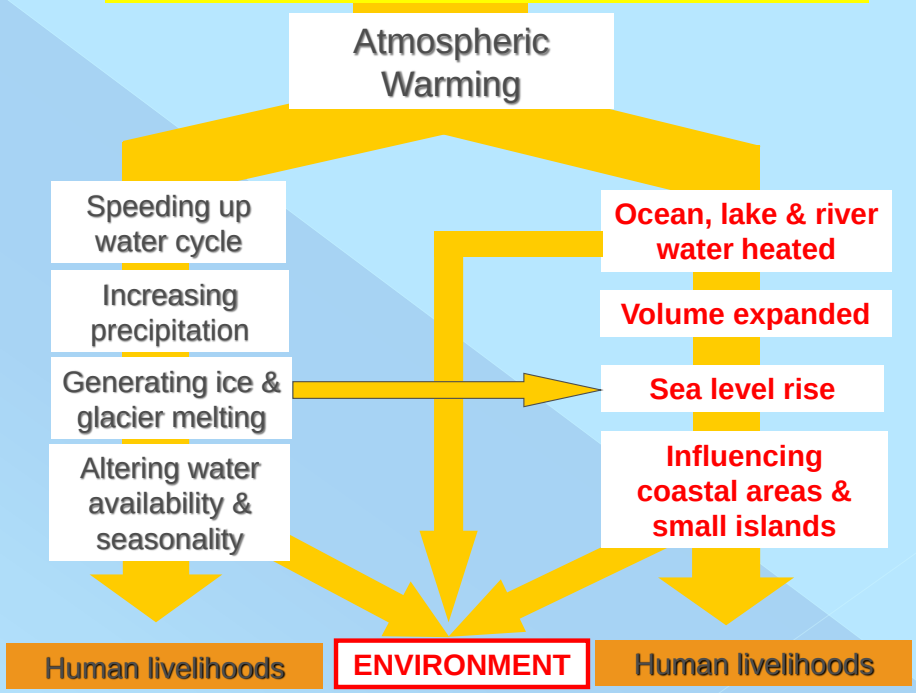




Global Climate Change

Impacts

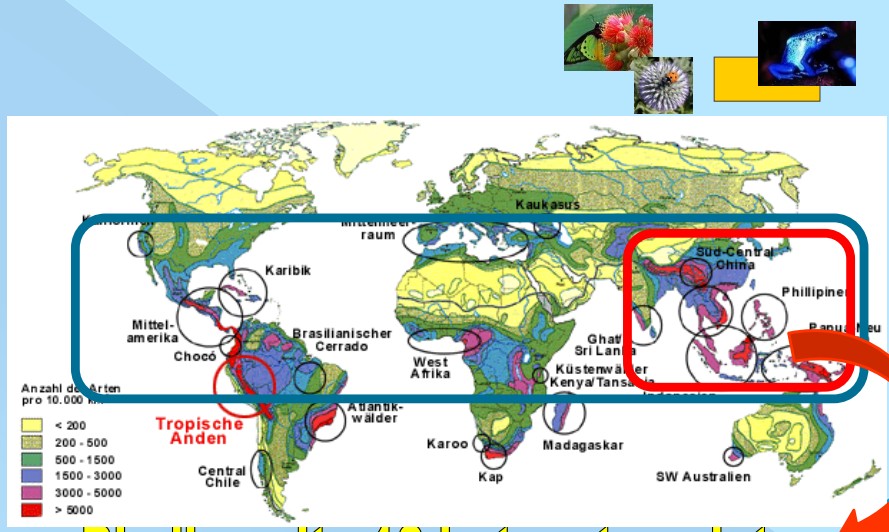
Impacts of Climate Change



Cities at Risk of Sea Level Rise

Cities most at risk from sealevel rise and storm surges

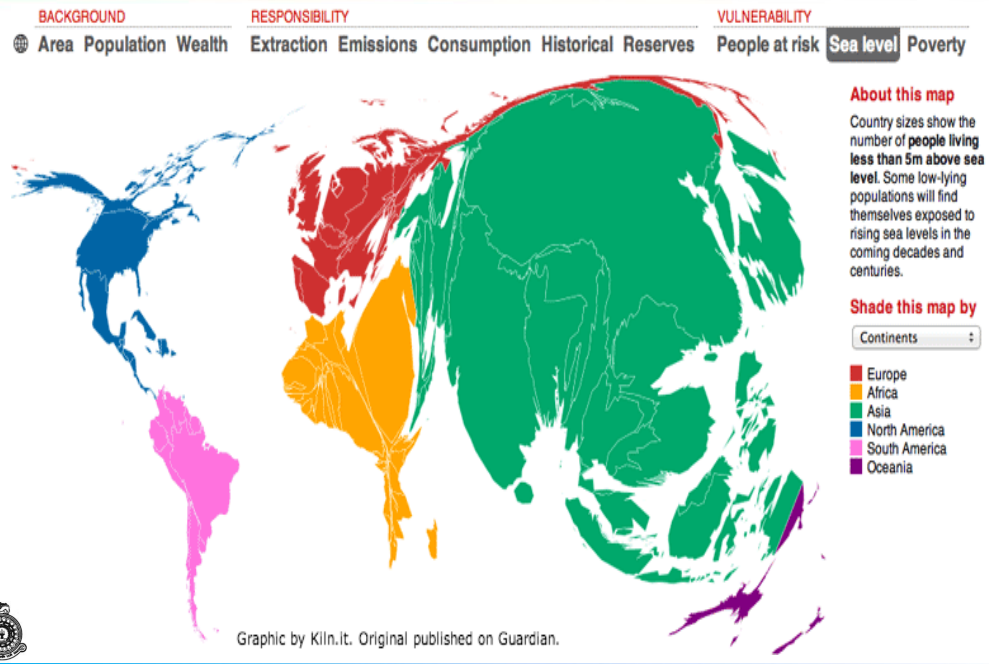
- 95% 0f Biodiversity Hotpots are marine Locations



Biodiversity 18 hotspots points

- With Sea Level rise all marine hotpots may destroy and disappear

Population within 5m of sea level



Major Impacts of Sea Level Rise

- Storms and Flooding
- Tides
- Changing Coastlines
- Saltwater Intrusion
- Subsidence

- The low-lying countries and Islands are most vulnerable to the effects of climate change such as rising sea levels and coral reef deterioration.

- **Meeting underwater with President**

- "We are not prepared to die. We are not going to become the first victims of the climate crisis"-
- "But we are the first victims if sea level rise"

Mohamed Nasheed-
President Maldives,
Climate conference 2015

Shoreline Erosion and Human Communities

- Coastal erosion is already a widespread problem
- vulnerable to long term sea-level rise
- any increase in the frequency of storm surges.

2006 May

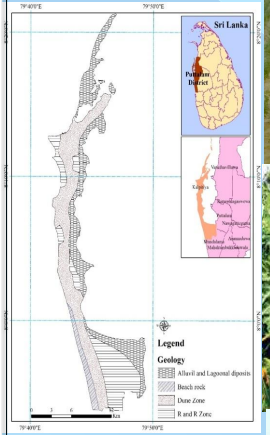
2007

- Monsoon rain activation and human activities as well as climate change directly or indirectly affected to coastal erosion

- 27 June 2007

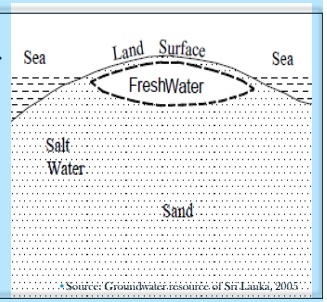
- Physical and Environmental Setting of the area

- Geological Map



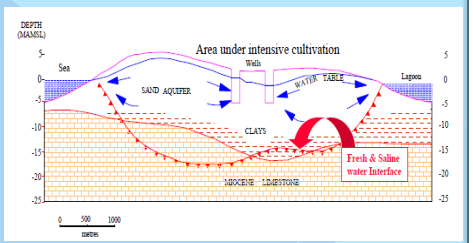
- Source: Coastal Atlas, IUCN, 2014; Modified by Author Using Geographical Information System, 201

Groundwater lens of Kalpitiya peninsula



- Source: Groundwater resource of Sri Lanka, 2005

Groundwater cross section of Kalpitiya peninsula



- Source: Groundwater conditions in the coastal regions of the Dry Zone of Sri Lanka, http://tsunami.obeysekera.net/Presentations/Lasantha.pdf, 2015

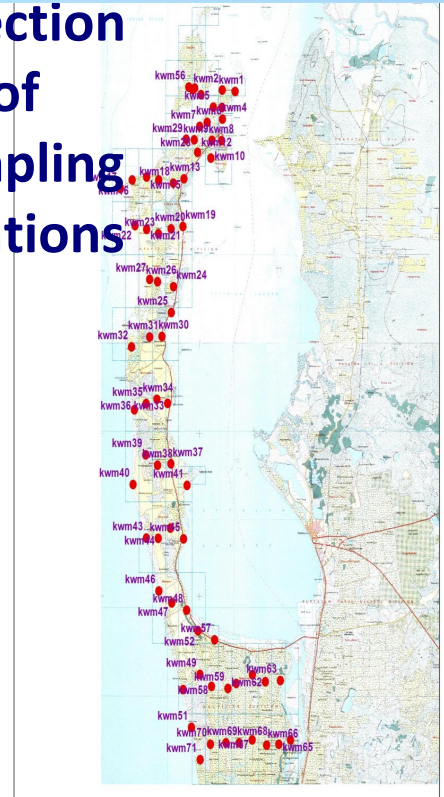
- Case study on climate change and sea level rise

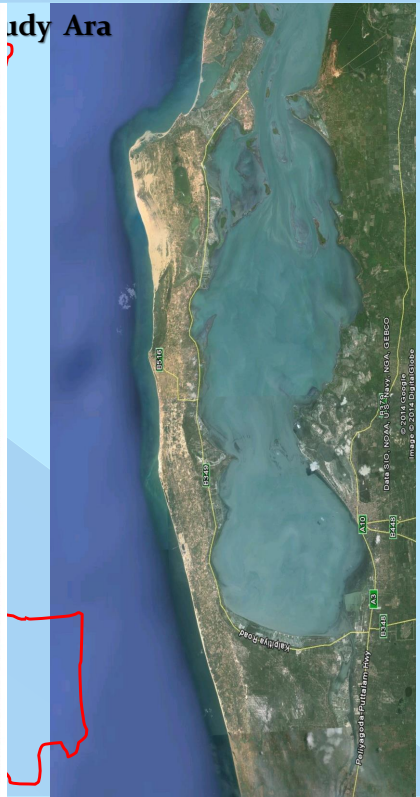
- Sri Lanka Island in the Indian Ocean, the adverse impacts of the Climate change will head on to Sri Lanka with more damages on the coastal region of the country.

- Most of the effects of Sea level rise will be on the livelihood options of coastal population in Sri Lanka.

- On this purpose, the effects of Sea Level rise in the perspectives of Island vulnerability needs to be assessed properly considering the aspects related to the phenomena with reference to the Sri Lankan coastal areas.

Selection of sampling locations





•Methodology of Data Collection and Analysis d..

•Navigate the locations

•Magellan exploits 620

Water quality monitoring

ulti parameter

Measurements of the Physical Parameters of the Wells

- Total Depth of well
- Ground water level
- Apron height

Bore Wells construction

•Navigate to location

•ANALYSIS & DISSCUSSION

•Mainly focuses on the analysis results and interpretations of the developed I under seven main segments,

1) Temporal and Spatial changes of Shoreline in Kalpitiya peninsula
2) Socio- economic vulnerability Index – analysis and interpretations
3) Bio-physical Vulnerability Index – Analysis and Interpretations
4) Integrated Bio-physical Vulnerability Index
5) Spatial Vulnerability Index - Analysis and Interpretations

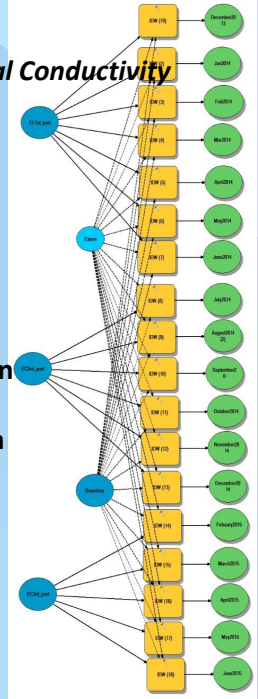
Methodology of Data Collection and Analysis contd..

Methodology of monthly data analysis

•*For Electrical Conductivity*

•Used Data Layers

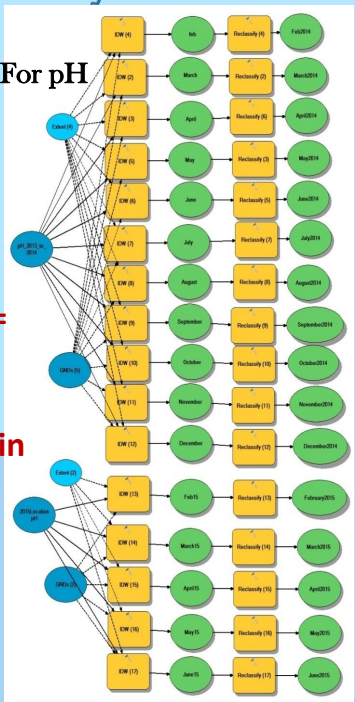
•Well Location and monthly collected data



•No of Months = 24

•Used Tool = Spatial Analysis in ArcGIS 10.1

•For pH



Temporal and Spatial changes of Shoreline in Kalpitiya peninsula

- According to the shoreline change investigations it was evident that both the highly eroding areas and sand depositing areas are forming in the Kalpitiya coasts over the past years.
- Primary and secondary data sources used for

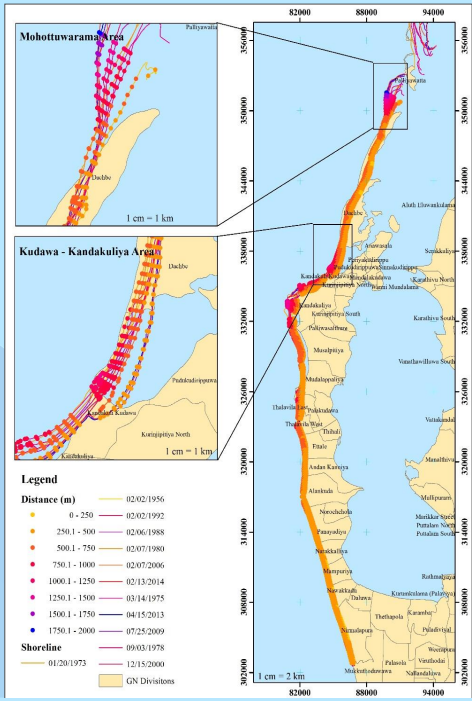
No.	Data source	Year
1	Arial photograph	1956
2	Landsat TM, ETM+ and Landsata8 image	1973, 1975, 1978, 1980, 1992, 2000
3	Geo Eye image (Google+ image)	2006, 2009, 2013, 2014
4	GPS Track	2015

Temporal and Spatial changes of Shoreline

Both positive and negative changes are evident and negatives shows considerable impacts on the coastal areas.

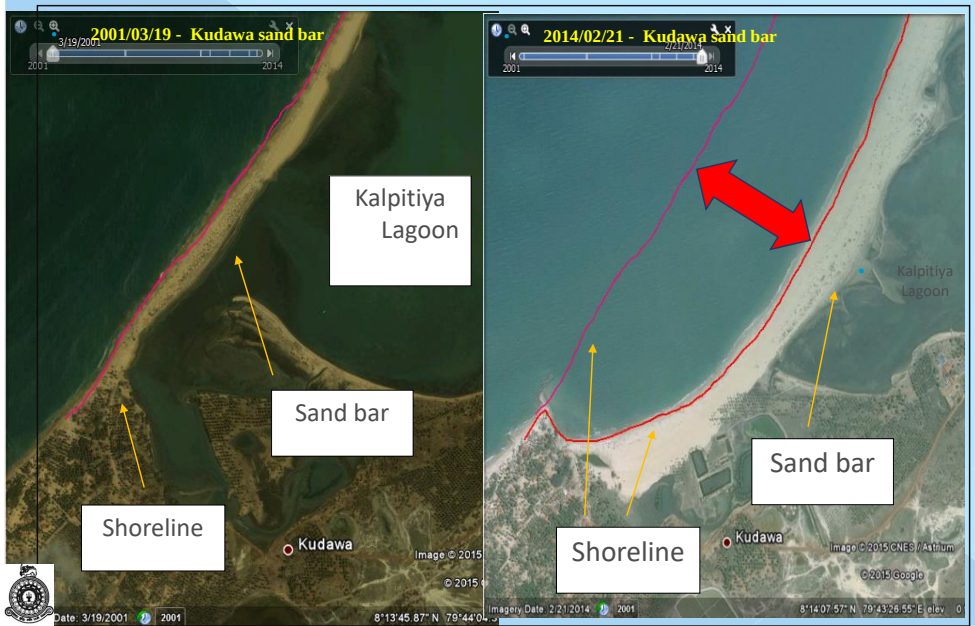
Northern areas of the pennisula are critically damages due to the negative effects of erosion as Box 'A'

Box 'B' , sand deposits areas can be identified in Kandakuliya beach area.

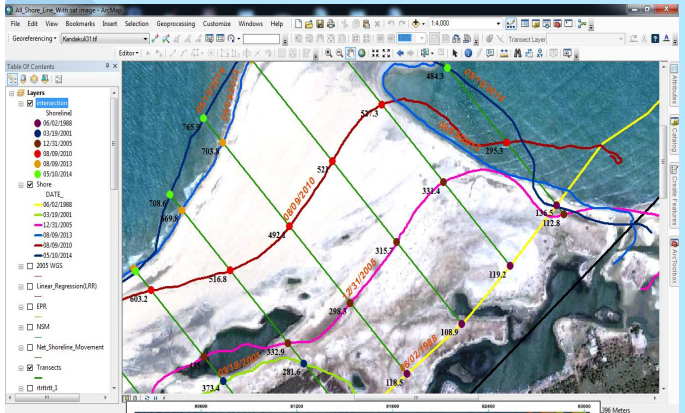


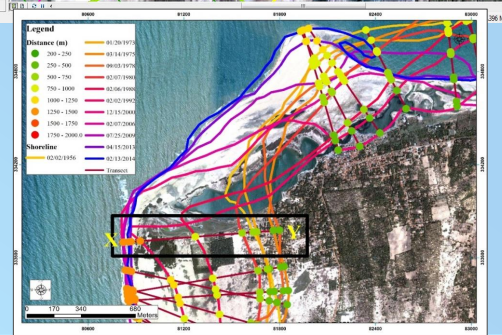
- Shore line changed moved to the landwards
- 29m within a year

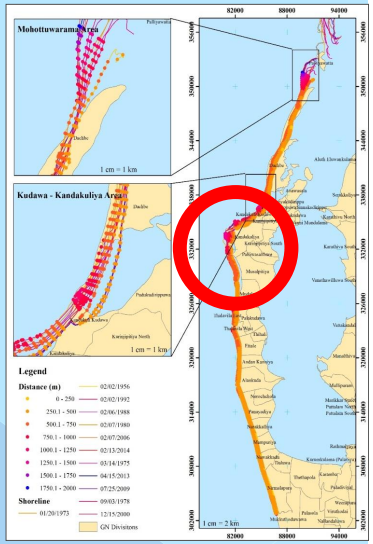
Kudawa coast area was located close to the Kalpitiya lagoon. These coast area was changed 32 m/yr from 1973 to 2014



- : Sand Accumulation of Kandakuliya







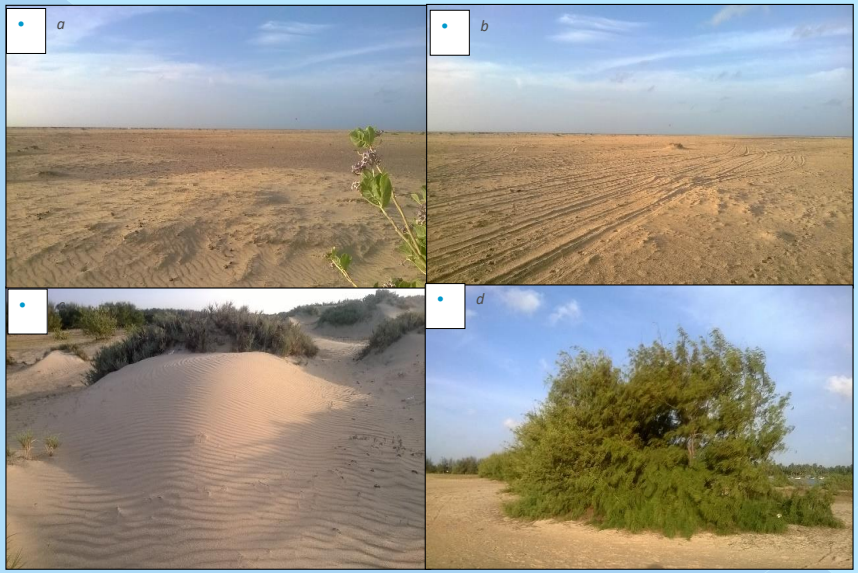
Sand Accumulation of Kandakuliya

	Period	No of Year	Max distance (m)	Average Rate (m/yr)
a	1956 - 1988	32	364.2	11.3
b	1988 - 2005	17	206.8	12.16
c	2005 - 2010	5	205.34	41.06
d	2010 - 2013	3	257.5	85.16
e	2013 - 2014	1	15.41	15.41

Evidences for Coastal Erosion and shore line changers

- a : 2014.05.23
- b : 2014.08.08
- c : 2014.11.08
- d : 2015.06.08
- e : 2015.11.25

Evidences for Coastal depositions



Water quality variation and Sea water intrusion

•Vulnerability by Water Quality Index

Equation 1

$$Wi = wi / \Sigma n\ wi$$

'Wi' is the relative weight and 'wi' is weight of each parameter, 'n' is number of parameters and ' **i** ' is the '**i** th' sample location.

Equation 2

$$Qi = (Ci / Si) \times 100$$

Equation 3

$$Qi = (Ci-Vi / Si-Vi) \times 100$$

Qi = quality rating, Ci = value of the water quality parameter, Si = value of the water quality parameter from recommended WHO, Vi = the ideal value which is considered as 7.0 for pH and 14.6 for DO

Equation 4

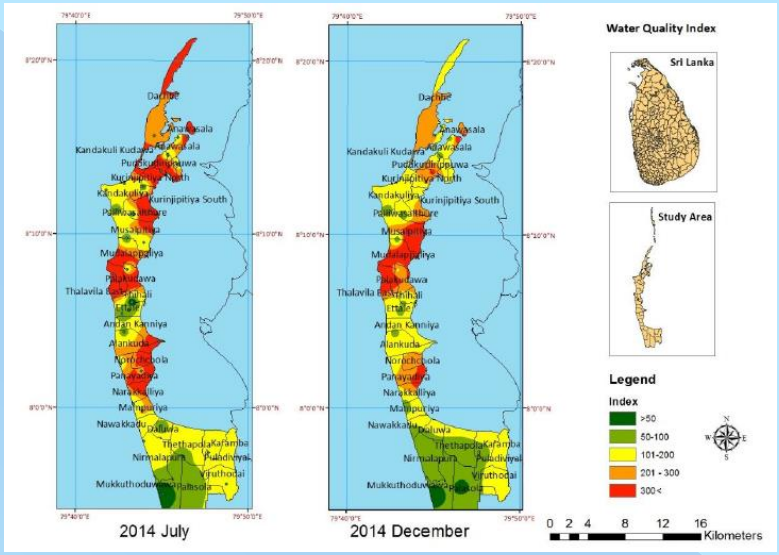
$$SIi = Wi\ Qi$$

Equation 5

$$WQI = \Sigma n\ SIi$$

- WQI values
- 1. <50 =Excellent
- 2. 50 - 100 = Good
- 3. 100 - 200 = Poor
- 4. 200 - 300= Very poor
- 5. >300 = Unsuitable

•Vulnerability by Water Quality Index



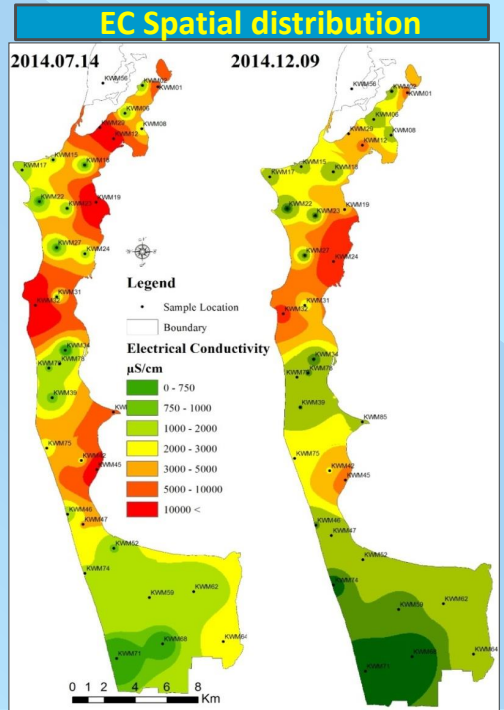
- **Water quality index revealed that urbanized and agricultural land areas unsuitable for drinking purpose in both dry and wet seasons**

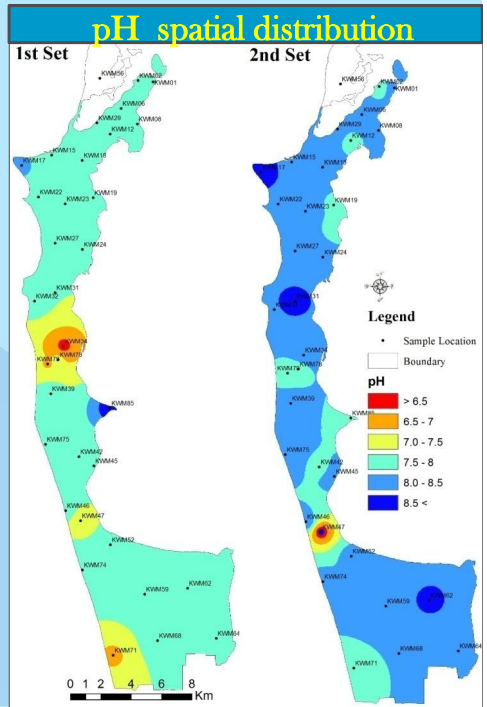
•Vulnerability by Water Quality Index

The parameters utilized in calculating the WQI

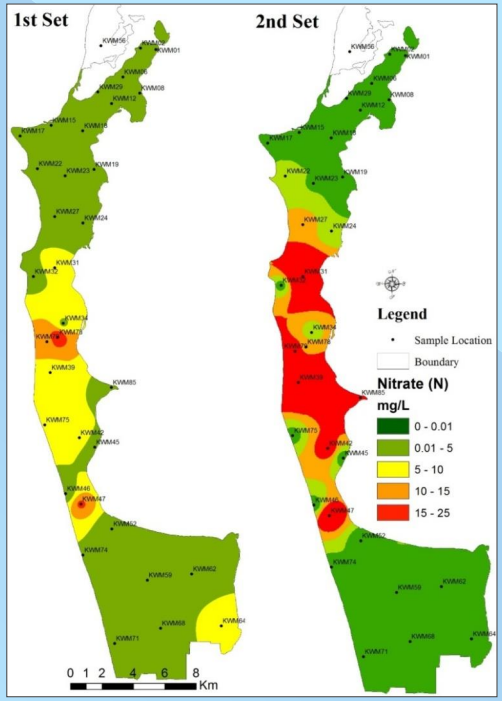
1. Electrical Conductivity (µs/cm)
2. Total Dissolved Solids (mg/L)
3. Chloride(mg/L)
4. PH
5. Total alkalinity (TA)
6. Total hardness (TH)
7. Calcium
- 8. Magnesium
- 9. Sulphate
- 10. Fluoride
- 11. Turbidity in NTU
- 12. Total Iron in mg/L (as Fe)
- 13. Nitrate in mg/L (as N)

•Ground water Vulnerability Assessment

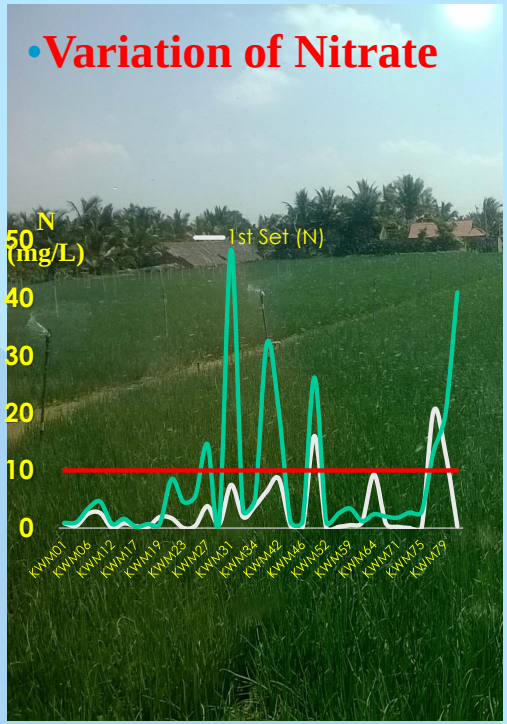




•Ground water Vulnerability Assessment



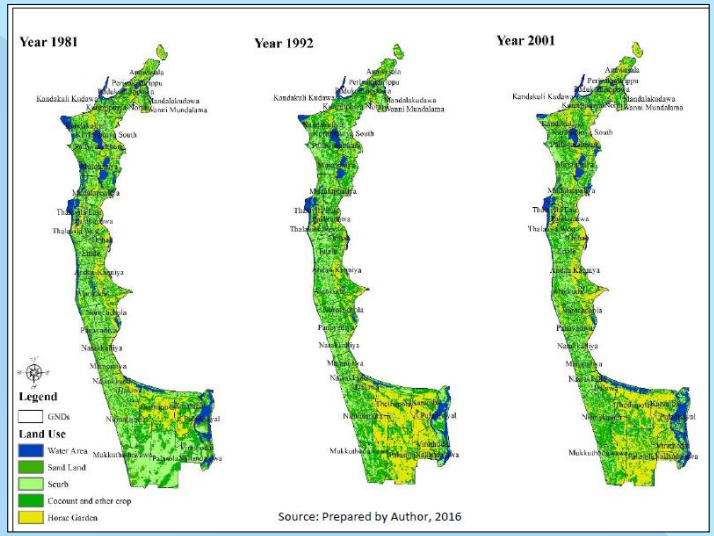
•Variation of Nitrate



CONCLUSIONS

- **There are no doubts that global climate change will**
  - **► change the hydrologic cycle, intensify rainfall and runoff**
  - **► increase air, soil and water temperatures**
  - **► result in more extreme weather events**
  - **► aggrevate the already existing water & land related problems.**
- **► Global warming will affect all parts of the world and all sectors of the economy. It is causing sea levels rise, inundating wetlands and productive coastal zones.**

• Land use pattern changes of in Kalpitiya peninsula



- **When compared with land use and quality of ground water in study area shows positive relationship**

◈ **Adaptation to climate change is necessary** to address impacts resulting from the warming which is already unavoidable due to past emissions

Beyond adaptation

◈ However:

- Adaptation alone cannot cope with all the projected impacts of climate change
- The costs of adaptation and impacts will increase as global temperatures increase

Making development more sustainable can enhance both mitigate and adaptive capacity, and reduce emissions and vulnerability to climate change

- Thank you very much for your Attention.

- Ranjana U K Piyadasa
- Professor in Hydrogeology
- University of Colombo, Sri Lanka

The New War?

The battles of yesterday were fight over the land….

Those of the present center on oil.

But those of the future — a future made hotter and drier by climate change in much of the world —

So……

New war seem likely to focus on water….

In Spain, Water Is a New Battleground, NY Times, June 3, 2008

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