Unit 3

S1: climate change impacts on different sectors

sectors affected by climate change

- Agriculture
- Forestry
- Ecosystem
- Water resources
- Human health
- Industry
- Settlement/Infrastructure
- Society

Intro

- **Economy** is heavily dependent on climate sensitive sectors such as agriculture, fisheries, tourism, forest sector, etc..
- Some of the expected impacts are: Agriculture: Based on a 20-year baseline climate observation, it is projected that yields of maize and other cereal crop will reduce by 7% by 2050.

We are already seeing the economic impacts of the changing climate. According to Morgan Stanley, climate disasters have cost North America $415 billion in the last three years, much of that due to wildfires and hurricanes.

Flooding in Southeast Texas from Hurricane

high tide flooding in coastal area

Agriculture

- Climate change and climate variability are projected to have a substantial effect on **agricultural** production both in terms of crop yields and the location where different crops can be grown.
- Increases in temperature and carbon dioxide (CO_2) can alter crop yield
- Warmer temperatures may make many crops grow more quickly, but warmer temperatures could also reduce yields.

- More extreme temperature and precipitation can prevent crops from growing.
- Many weeds, pests and fungi thrive under warmer temperatures, wetter climates, and increased CO2 levels.
- Changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers.
- Overall, climate change could make it more difficult to grow crops, raise animals, and catch fish in the same ways and same places as we have done in the past.
- Affects nutrition and food security of countries affected by climate change.

Forestry

- Effects on **forestry** due to climate change include increased risk of **droughts, storms and fires (abiotic**) and **pests and diseases** (biotic) – all leading to disturbances to forest health.
- Climate influences the structure and function of forest ecosystems and plays an essential role in forest health.

- Climate changes directly and indirectly affect the growth and productivity of forests: directly due to changes in atmospheric carbon dioxide and climate and indirectly through complex interactions in forest ecosystems.
- Warming temperatures could increase the length of the growing season. However, warming could also shift the geographic RANGES of some tree species.

https://www.youtube.com/watch?v=G4H1N_yXBiA

Fishery

- There is strong global evidence for these effects. Rising ocean temperatures and ocean acidification are radically altering marine aquatic ecosystems, while freshwater ecosystems are being impacted by changes in water temperature, water flow, and fish habitat loss.
- Climate change is modifying fish distribution and the productivity of marine and freshwater species.

- while changing rainfall patterns and water use impact on inland **freshwater fisheries** and aquaculture.
- The rising ocean acidity makes it more difficult for marine organisms such as shrimp, oysters, or corals to form their shells – a process known as calcification.
- Many important animals, such as zooplankton, that forms the base of the marine food chain have calcium shells. Thus the entire marine food web is being altered – there are 'cracks in the food chain'.
- As a result, the distribution, productivity, and species composition of global fish production is changing.

- Fisheries and aquaculture contribute significantly to food security and livelihoods.
- Low-lying countries such as the Maldives are particularly vulnerable and entire fishing communities may become the first climate refugees.
- The impacts of climate change can be addressed through adaptation and mitigation. The costs and benefits of adaptation are essentially local or national, while the costs of mitigation are essentially national whereas the benefits are global.

- Nobel Prize-winning economist Joseph Stiglitz, a professor at Columbia University, wrote :

"We will pay for climate breakdown one way or another, so it makes sense to spend the money now to reduce emissions rather than wait until later to pay a lot more for the consequences…

It's a cliché, but it's true: An ounce of prevention is worth a pound of cure."

https://www.youtube.com/watch?v=390Ar_KtlW0

Unit 3

Climate change impact in various sector

S3 & S4

-SMK

Unit 3 - Climate change impact in various sector

S3

- Socio economic impact – tourism
- Industries and business

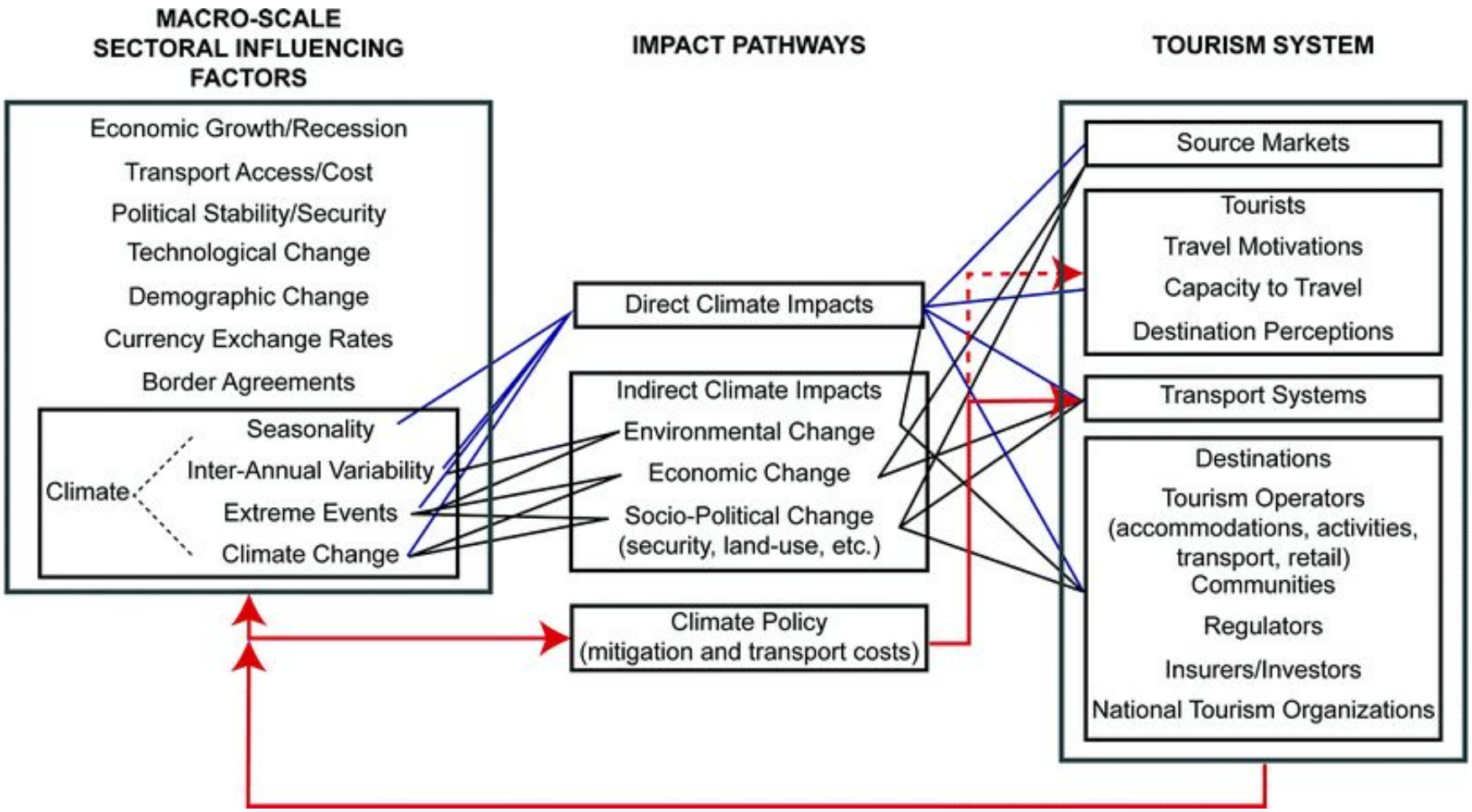
S4

- Acid rain and human health impact
- Sea surface temperature increases and aquatic organisms impact

Unit 3 Climate change impact in various sector – S3.1

SOCIO ECONOMIC IMPACT – TOURISM

Socio economic impact – tourism



Impact of Climate Change on Tourism

- The tourism sector depends heavily on a **natural and cultural heritage.**
- The tourism sector is highly **climate sensitive** as climate defines the length and quality of tourism seasons, affects tourism operations, and influences environmental conditions that both attract and deter visitors.
- Tourists will quickly switch their choice of destination when the results of climate change impact on their enjoyment.
- Generating more than USD 6 trillion in revenue each year and providing livelihoods to more than 255 million people, the tourism sector is particularly important for some of the world's poorest countries.

Impact of Climate Change on Tourism Subsectors at risk include:

- Mountain and Snow tourism
- Forest and Lake tourism
- Biodiversity and Agricultural tourism
- Cities and Urban Centre tourism
- Beach and Coastal tourism
- Ocean and Sea Life tourism

Impact of Climate Change on Tourism Operational level impacts will include:

- Reduced water availability could lead to disputes with local industry and communities
- Extreme weather events will increase operational uncertainty, particularly in poorer countries
- Expensive or unavailable insurance in areas exposed to extreme weather or sea-level rise
- Efforts to cut emissions may add costs to the industry, particularly from transport emissions

Some impacts of climate change in

http://www.theatlantic.com/infocus/2011/10/bangkok-underwater/100178/#img10

http://daily.bangkokbiznews.com/gallery/20111011

http://61.19.55.253/mcrd/?p=83

Destroyed infrastructure and beaches in Thailand

Flooding beaches in Chennai

Coral reef

Impact on Society

- As a society, we have structured our day-today lives around historical and current climate conditions.
- We are accustomed to a normal RANGE of conditions and may be sensitive to extremes that fall outside of this range.

- Climate change could affect our society through impacts on a number of different social, cultural, and NATURAL RESOURCES.
- For example, climate change could affect human health, infrastructure, and transportation systems, as well as energy, food, and water supplies.

impact on society

- Some groups of people will likely face greater challenges than others.
- Climate change may especially impact people who live in areas that are vulnerable to COASTAL storms, drought, and sea LEVEL rise or people who are poor.
- Some types of professions and industries may face considerable challenges from climate change.
- Professions that are closely linked to weather and climate, such as outdoor tourism and agriculture, will likely be especially affected.

- Projected climate change will affect certain groups of people more than others, depending on where they live and their ability to cope with different climate hazards.
- In some cases, the impacts of climate change would worsen EXISTING vulnerabilities.
- People who live in poverty may have a difficult time coping with changes.
- These people have limited financial resources to cope with heat, relocate or evacuate or respond to increases in the cost of food.

- Climate change may make it harder and more expensive for many people to Insure their homes, businesses, or other valuable assets in risk-prone areas.
- Insurance is one of the primary mechanisms used to PROTECT people against weather-related disasters
- Climate change will also likely affect tourism and recreational ACTIVITIES.

Unit 3 Climate change impact in various sector – S3.2

INDUSTRIES AND BUSINESS

INDUSTRIES AND BUSINESS

- Climate change will have an impact on both industrial raw material supplies and processes.
- Although the greatest effect will most likely be via global MARKET development, climate change can have notable impacts to those industrial sectors in India whose raw materials are heavily dependent on weather and other changes in the natural environment.

- As discussed earlier most of the supplies coming from forests, agriculture and livestock would be heavily hampered due to climate change.
- This could in turn affect industries and pose a problem in procurement of raw materials.

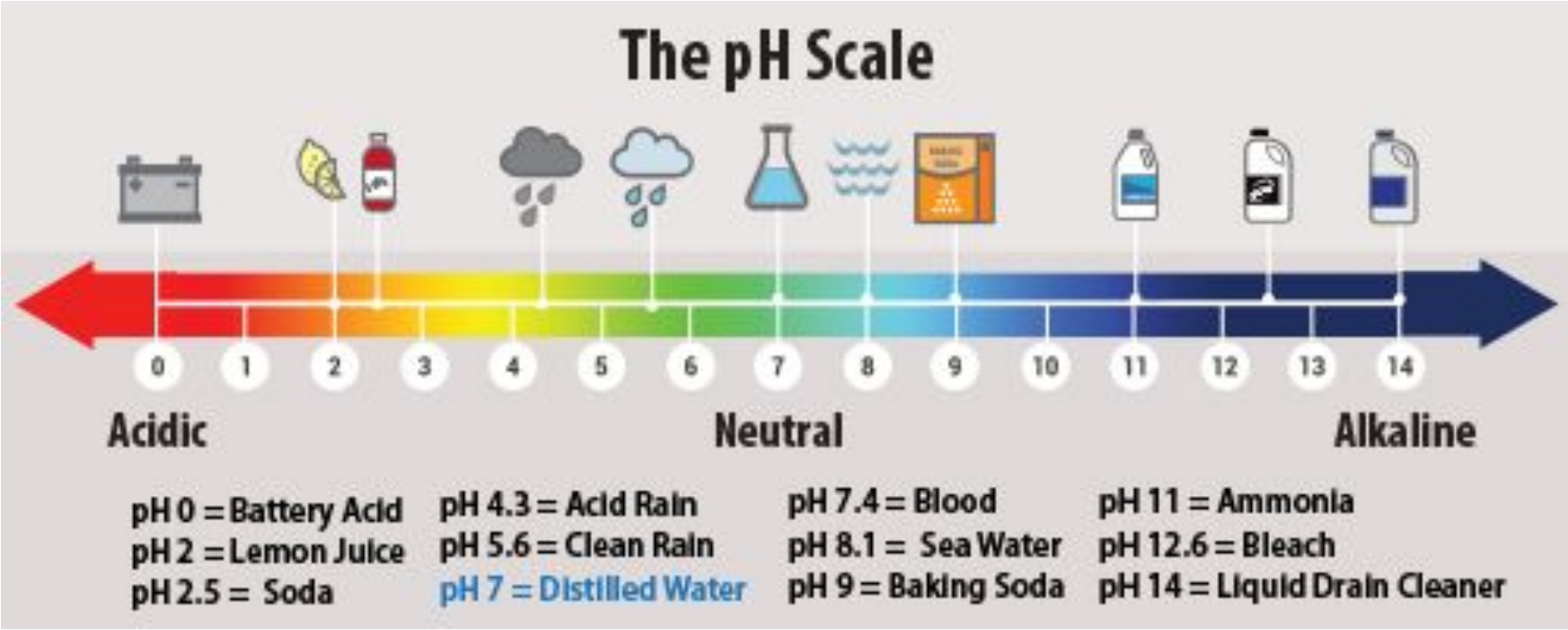
- Climate change can produce new challenges to the CONSTRUCTION industry when changing weather conditions demand the implementation of new type of construction materials and plants.
- For example, the changing damp conditions, frequency of storms and thawing of ground frost require attention.
- Basic work during the winter may become easier due to warmer weather, although rainy weather increases the risk of damage to the structures and increases drying costs.

- Climate change would severely affect the infrastructure and transportation systems hereby compromising with the logistics and supply chain of the industry.
- Changes in temperature, precipitation, sea level, and the frequency and severity of extreme events will likely affect how much energy is produced, delivered, and consumed

- Water impacts due to climate change can drastically affect the industry.
- Power plants can require large amounts of water for cooling.
- It will also increase the electricity consumption.
- Growing crops for biomass and biofuel energy could stress water resources in certain regions, depending on the type of crop, where it is grown, agricultural production in the region, and current water and nutrient management practices.

- Rising temperatures, increased evaporation, and drought may increase the need for energy-intensive methods of providing drinking and irrigation water.
- For example, desalinization plants can convert salt water into freshwater, but consume a lot of energy.

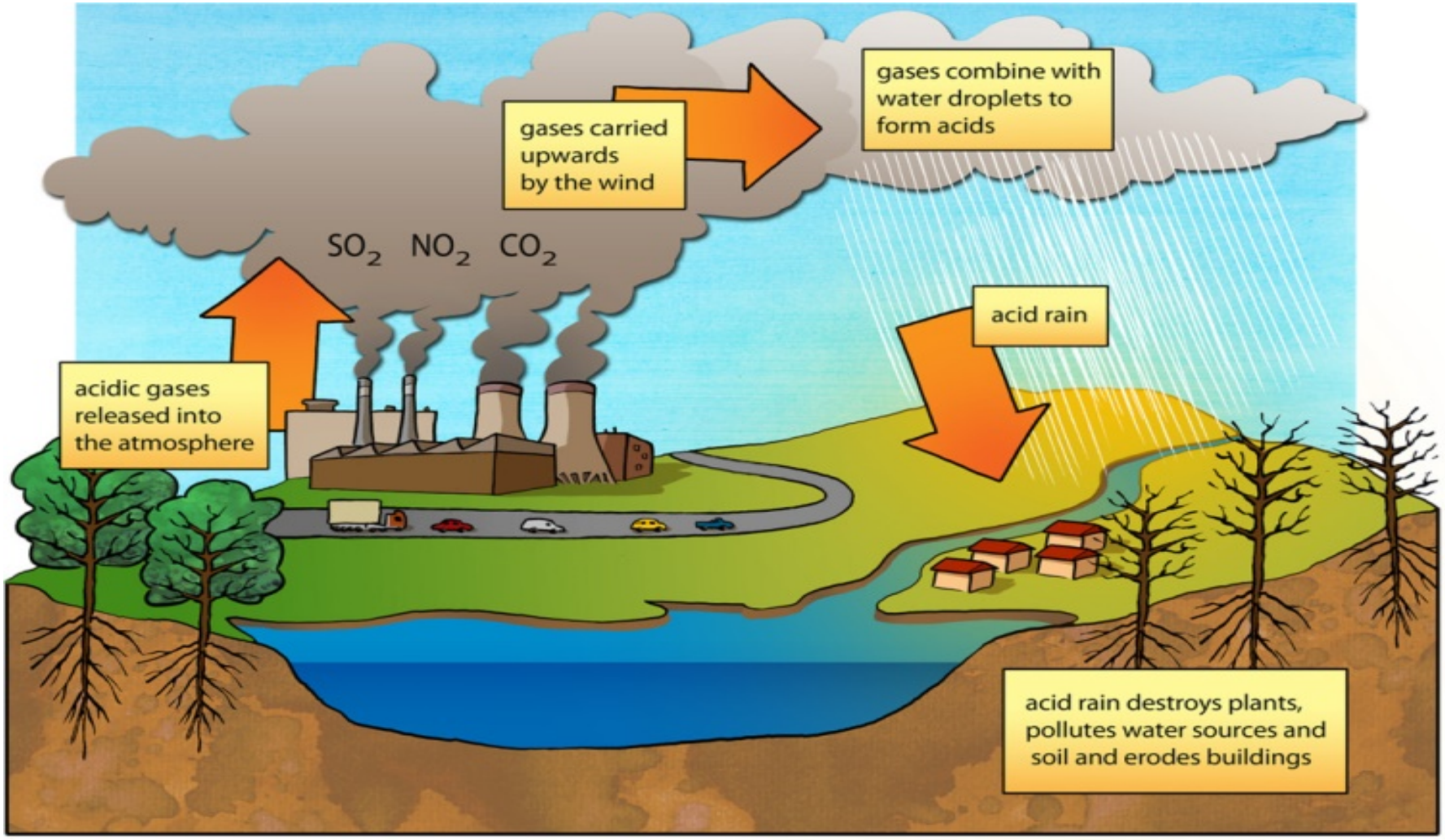
- Flooding and intense storms can damage power lines and electricity distribution equipment.
- These events may also delay repair and maintenance work.
- Electricity outages can have serious impacts on other energy systems as well.
- Climate change could impact wind and solar power, but there is little research in this area.
- Impacts will depend on how wind and cloud cover patterns change, which are very difficult to project using current climate models.



Unit 3 Climate change impact in various sector – S4.1

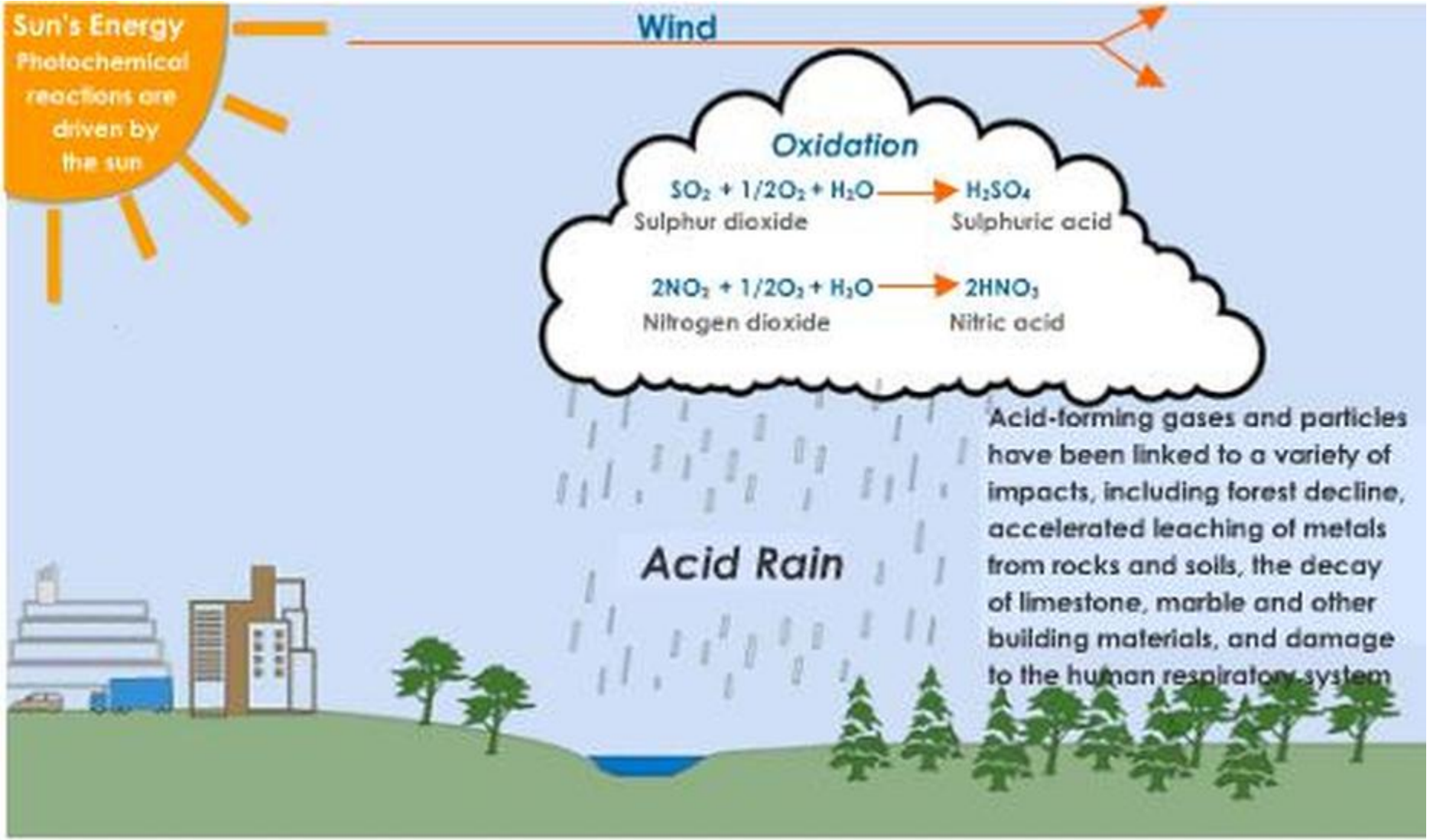
ACID RAIN AND HUMAN HEALTH IMPACT

Acid rain


gases carried upwards by the wind
gases combine with water droplets to form acids
SO_2 NO_2 CO_2
acid rain
acidic gases released into the atmosphere
acid rain destroys plants, pollutes water sources and soil and erodes buildings

Acid rain

- Climate change and acid rain are closely associated, so much so that acid rain's impacts need to be part of climate change studies.
- Acid rain really has left a legacy in terms of how it has changed our systems.
- Acid rain is caused by air pollutants, mostly **nitrogen oxides and sulfur dioxide**, which are produced by power plants and gasoline-powered vehicles.
- Most rain is slightly acidic, but these pollutants can make rain much more acidic (to a pH of 4 -- neutral pH is 7).
- Acid rain has many ecological effects, especially on lakes, streams, wetlands, and other aquatic environments.
- Acid rain makes such waters more acidic, which results in more aluminum absorption from soil, which is carried into lakes and streams. ... Trees' leaves and needles are also harmed by acids.


Sun's Energy
Photochemical reactions are driven by the sun
Wind
Oxidation
$SO_2 + 1/2O_2 + H_2O \rightarrow H_2SO_4$
Sulphur dioxide
Sulphuric acid
$2NO_2 + 1/2O_2 + H_2O \rightarrow 2HNO_3$
Nitrogen dioxide
Nitric acid
Acid Rain
Acid-forming gases and particles have been linked to a variety of impacts, including forest decline, accelerated leaching of metals from rocks and soils, the decay of limestone, marble and other building materials, and damage to the human respiratory system

What Causes Acid Rain?

- Acid rain results when **sulfur dioxide (SO_2) and nitrogen oxides (NO_X)** are emitted into the atmosphere and transported by wind and air currents. The SO_2 and NO_X react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before falling to the ground.
- While a small portion of the SO_2 and NO_X that cause acid rain is from natural sources such as volcanoes, most of it comes from the burning of fossil fuels. The major sources of SO_2 and NO_X in the atmosphere are:
  - Burning of fossil fuels to generate electricity. Two thirds of SO_2 and one fourth of NO_X in the atmosphere come from electric power generators.
  - Vehicles and heavy equipment.
  - Manufacturing, oil refineries and other industries.
- Winds can blow SO_2 and NO_X over long distances and across borders making acid rain a problem for everyone and not just those who live close to these sources.

Acid Rain

Causes

- Natural Causes
- Electricity generation
- Vehicles
- Agriculture
- Industrial processes and consumption levels

Effects

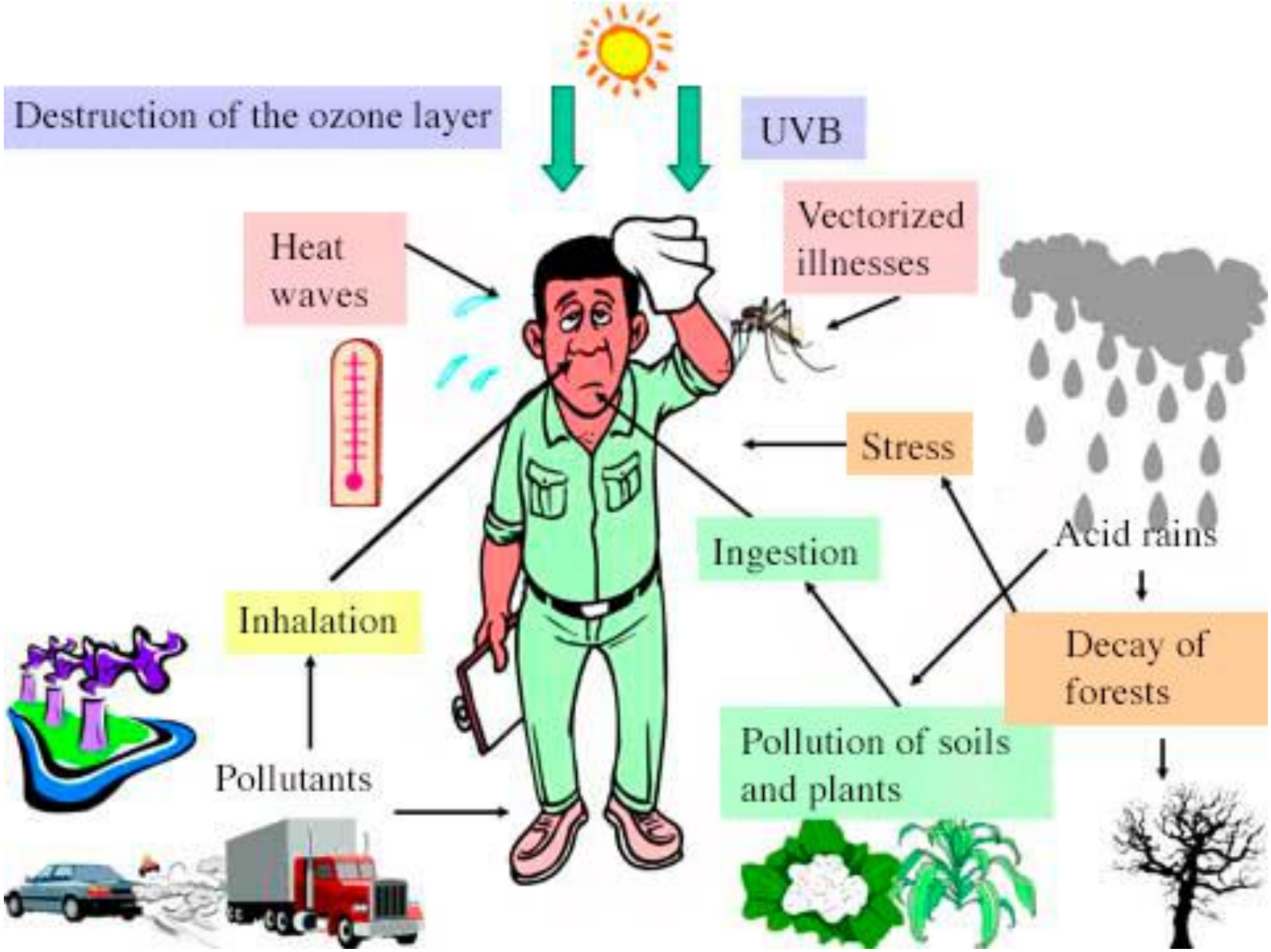
- Effects on aquatic environments
- Effects on animals and plants
- Effects on forests
- Effects on global warming
- Effects on soil
- Effects on vegetation cover
- Effects on buildings
- Effects on health

Solutions

- Optimize fossil energy processes
- Transition to renewable energies
- Confine the use of fertilizers and pesticides
- Restoring environments
- Save energy
- Reduce consumption levels
- Convince others
- Education
- Government regulations

Human health impact

- Weather and climate play a significant role in people's health. Changes in climate affect the average weather conditions that we are accustomed to.
- Warmer average temperatures will likely lead to hotter days and more frequent and longer heat waves which could increase the number of heat related illness and deaths



HUMAN HEALTH IMPACT

- Increases in the frequency or severity of extreme weather events such as storms could increase the risk of dangerous flooding, high winds, and other direct threats to people and property.
- Warmer temperatures could increase the concentrations of unhealthy air and water pollutants.

- Heat waves can lead to heat stroke and dehydration, and are the most common cause of weather-related deaths. Young children, older adults, people with medical conditions, and the poor are more vulnerable than others to heat-related illness.

- Climate change could lead to extreme weather events which would reduce the availability of fresh food and water;
- Interrupt communication, utility, and health care services;
- Contribute to carbon monoxide poisoning from portable electric generators used during and after storms;
- Increase stomach and intestinal illness among evacuees & Contribute to mental health impacts such as depression and post-traumatic stress disorder (PTSD).
- Climate change could lead to reduced air quality caused due to increases in Ozone, changes in Fine Particulate Matter and changes in allergen.

- Changes in temperature, precipitation patterns, and extreme events could enhance the spread of some diseases.
- These include food borne diseases
  - caused due to rapid growth of bacteria in warm environments and contamination of crops due to overflow
- water-borne diseases
  - caused due to increase in water-borne parasites like Giardia caused due to flooding and storm water runoff
- Animal borne diseases
  - caused due to changes in air temperatures

Every year foodborne diseases cause:

almost **1 in 10** people to fall ill

33 million healthy life years lost

Foodborne diseases can be deadly, especially in children <5

420 000 deaths

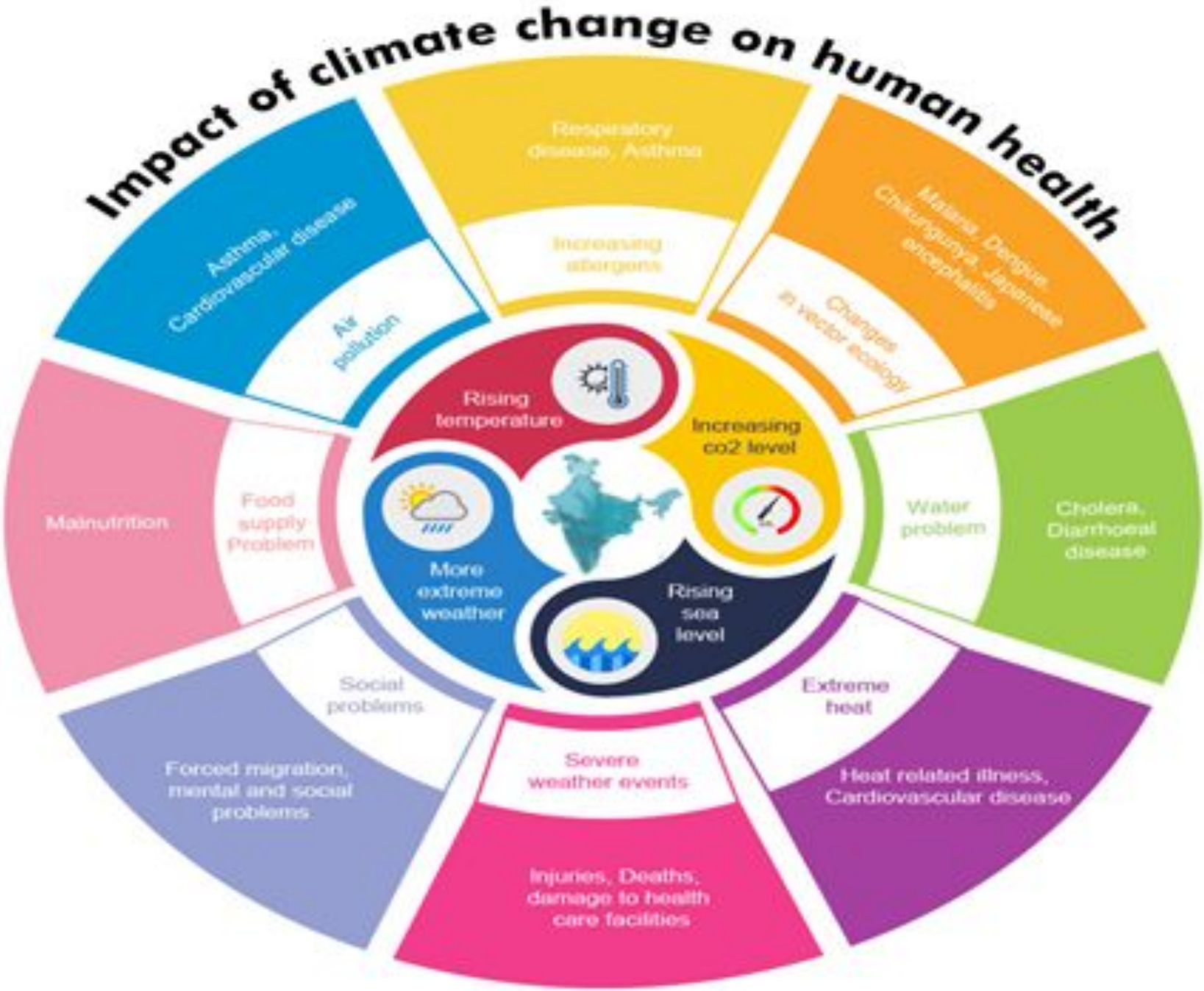
Children account for almost **1/3** **of deaths from foodborne diseases**

For more information: **www.who.int/foodsafety**

#SafeFood

Source: WHO Estimates of the Global Burden of Foodborne Diseases. 2015.

World Health Organization


Impact of climate change on human health
Respiratory disease, Asthma
Increasing allergens
Asthma, Cardiovascular disease
Air pollution
Malaria, Dengue, Chikungunya, Japanese encephalitis
Changes in vector ecology
Rising temperature
Increasing co2 level
Malnutrition
Food supply Problem
More extreme weather
Rising sea level
Water problem
Cholera, Diarrhoeal disease
Social problems
Forced migration, mental and social problems
Severe weather events
Injuries, Deaths, damage to health care facilities
Extreme heat
Heat related illness, Cardiovascular disease

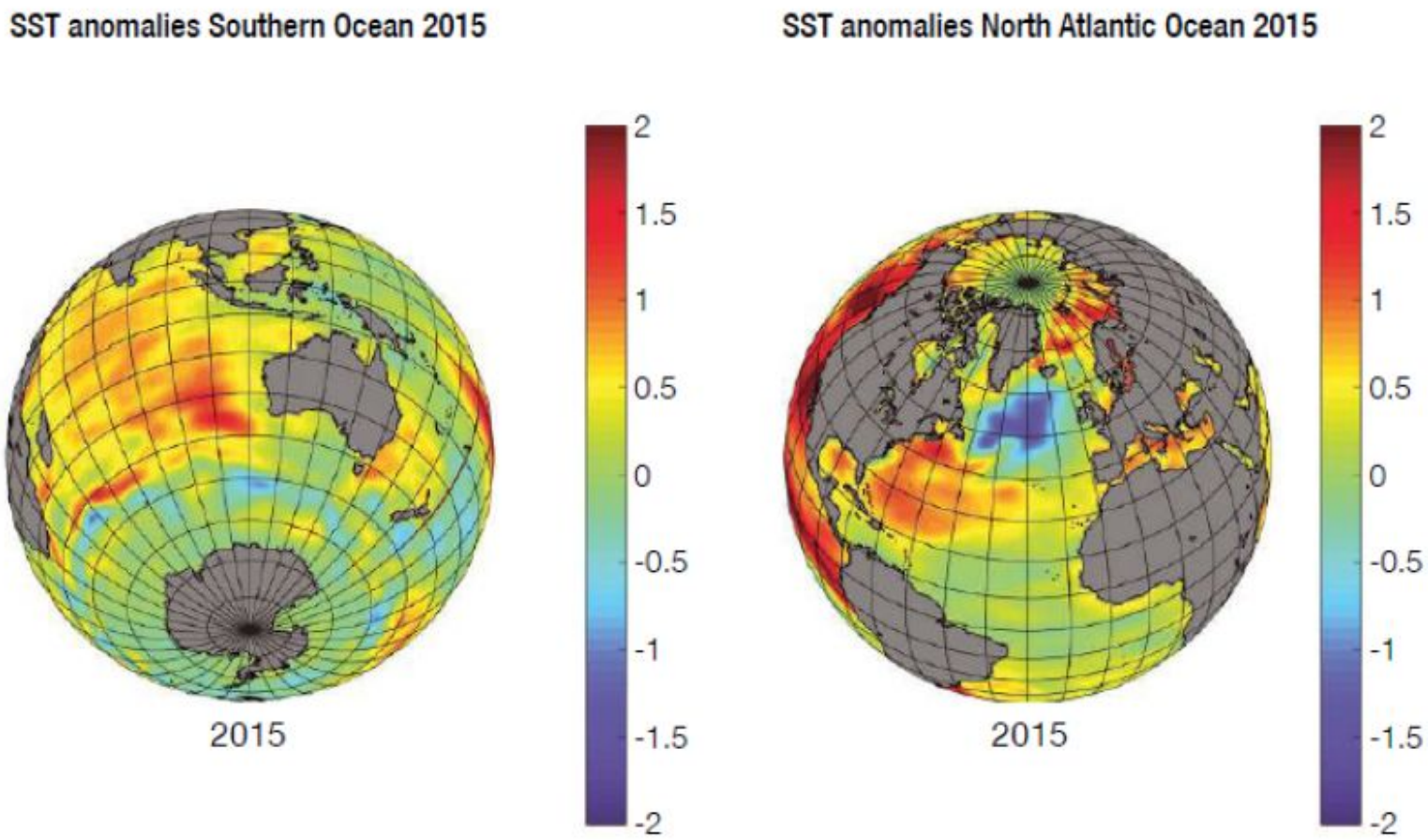
Farm to Table

The Potential Interactions of Rising CO_2 and Climate Change on Food Quality and Safety

Unit 3 Climate change impact in various sector – S4.2

SEA SURFACE TEMPERATURE INCREASES AND AQUATIC ORGANISMS IMPACT

- The ocean absorbs vast quantities of heat as a result of increased concentrations of greenhouse gases in the atmosphere, mainly from fossil fuel consumption.
- The Fifth Assessment Report published by the Intergovernmental Panel on Climate Change (IPCC) in 2013 revealed that the ocean had absorbed more than 93% of the excess heat from greenhouse gas emissions since the 1970s. This is causing ocean temperatures to rise.

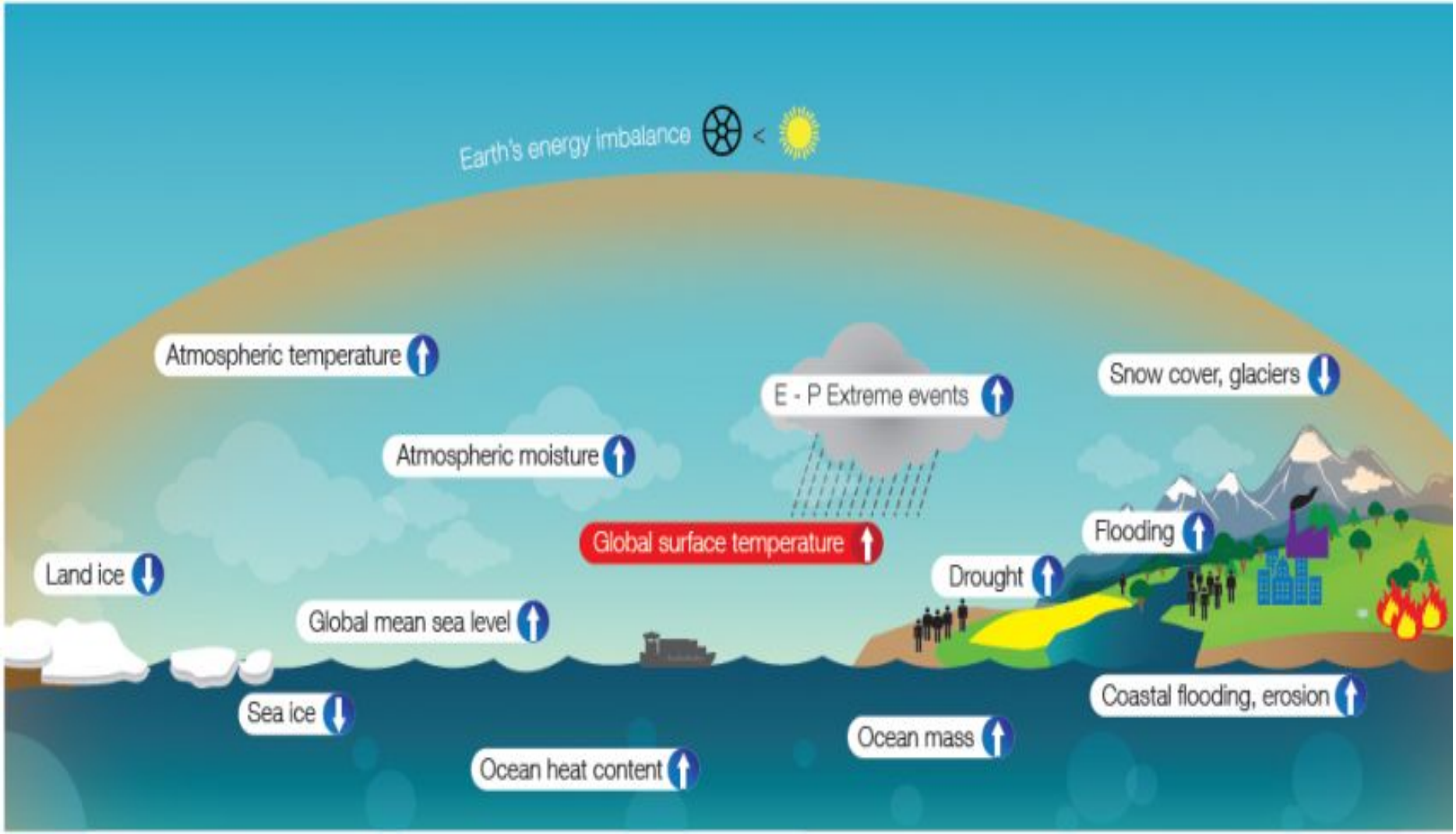


The distribution of excess heat in the ocean is not uniform, with the greatest ocean warming occurring in the Southern Hemisphere and contributing to the subsurface melting of Antarctic ice shelves.

- The ocean's ability to absorb excess heat has shielded humans from even more rapid changes in climate. Without this oceanic buffer, global temperatures would have risen much more than they have done to date.
- IPCC's Fourth Assessment Report published in 2007 estimated that the Earth had experienced a warming of 0.55°C since the 1970s.
- According to an analysis by the Grantham Institute, if the same amount of heat that has gone into the top 2,000 m of the ocean between 1955 and 2010 had gone into the lower 10 km of the atmosphere, the Earth would have seen a warming of 36°C.

Why is it important ?

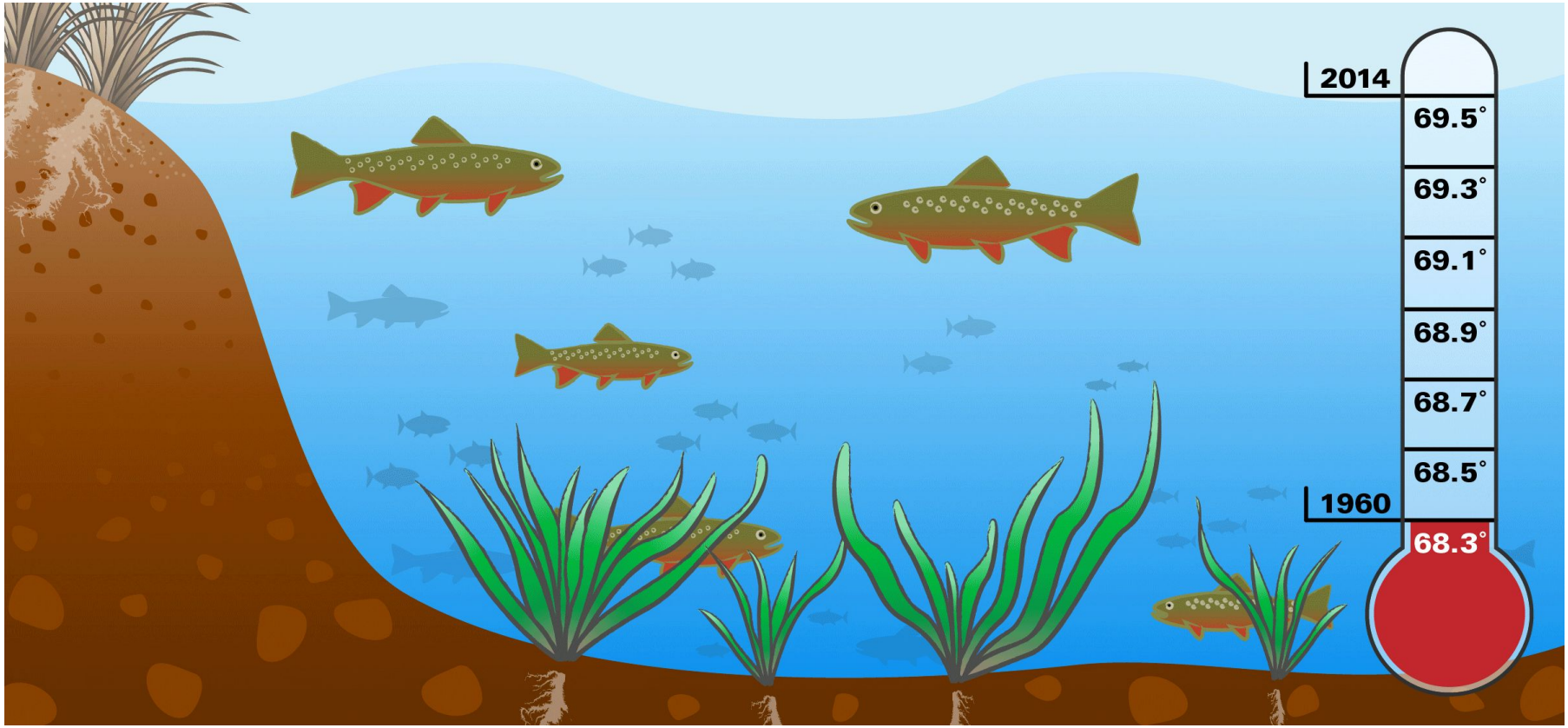
- Ocean warming leads to de-oxygenation – a reduction in the amount of oxygen dissolved in the ocean – and sea-level rise – resulting from the thermal expansion of sea water and continental ice melting.
- The rising temperatures,
  - coupled with ocean acidification (the decrease in pH of the ocean due to its uptake of CO_2)
  - affect marine species and ecosystems and, consequently
  - the fundamental benefits humans derive from the ocean.

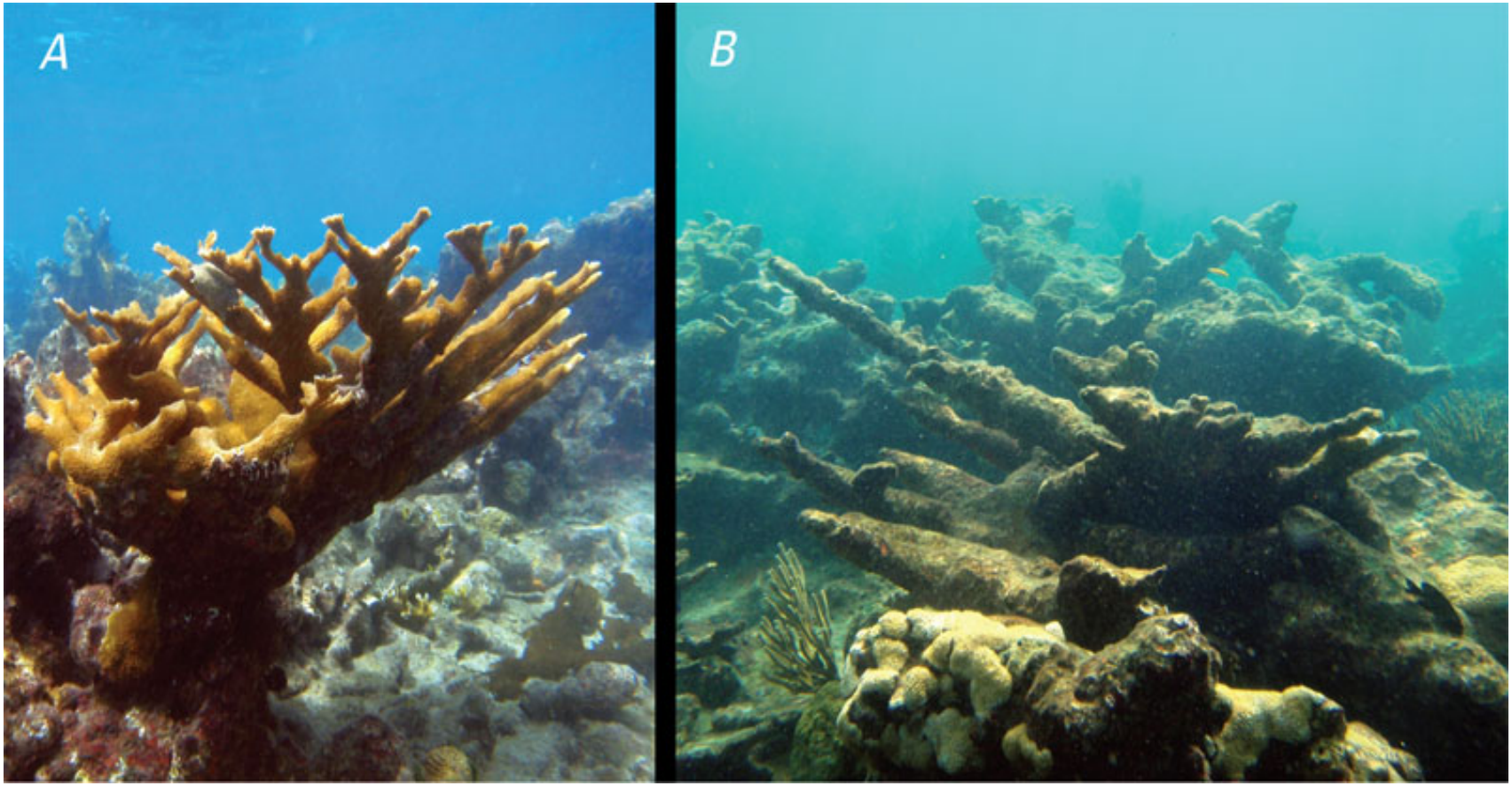

Earth's energy imbalance <
Atmospheric temperature
Atmospheric moisture
E - P Extreme events
Snow cover, glaciers
Global surface temperature
Flooding
Land ice
Drought
Global mean sea level
Sea ice
Coastal flooding, erosion
Ocean mass
Ocean heat content

Impact on marine species and ecosystems

- Marine fishes, seabirds and marine mammals all face very high risks from increasing temperatures, including high levels of mortalities, loss of breeding grounds and mass movements as species search for favorable environmental conditions.
- Coral reefs are also affected by increasing temperatures which cause coral bleaching and increase their risk of mortality.

Impact on marine species and ecosystems




A
B

Impact on humans

- A 2012 report by the Food and Agriculture Organization of the United Nations estimates that marine and freshwater capture fisheries and aquaculture provide 4.3 billion people with about 15% of their animal protein.
- Fisheries and aquaculture are also a source of income for millions of people worldwide. By altering distributions of fish stocks and increasing the vulnerability of fish species to diseases, ocean warming is a serious risk to food security and people's livelihoods globally.
- Economic losses related to ocean warming are likely to run from tens to hundreds of millions of dollars.
- Rising temperatures also affect vegetation and reef-building species such as corals and mangroves, which protect coastlines from erosion and sea-level rise.
- Rising sea levels and erosion will particularly affect low-lying island countries in the Pacific Ocean, destroying housing and infrastructure and forcing people to relocate.

- The rise in sea surface temperatures is causing more severe hurricanes and the intensification of El Niño events bringing droughts and floods. This can have significant socio-economic and health effects in some regions of the world.
- Warming ocean temperatures are linked to the increase and spread of diseases in marine species.
- Humans risk direct transmission of these diseases when consuming marine species, or from infections of wounds exposed in marine environments.

What can be done?

Limiting greenhouse gas emissions

There is an urgent need to achieve the mitigation targets set by the Paris Agreement on climate change and hold the increase in the global average temperature to well below 2°C above pre-industrial levels. This will help prevent the massive and irreversible impacts of growing temperatures on ocean ecosystems and their services.

Protecting marine and coastal ecosystems

Well-managed protected areas can help conserve and protect ecologically and biologically significant marine habitats. This will regulate human activities in these habitats and prevent environmental degradation.

Restoring marine and coastal ecosystems

Elements of ecosystems that have already experienced damage can be restored. This can include building artificial structures such as rock pools that act as surrogate habitats for organisms, or boosting the resilience of species to warmer temperatures through assisted breeding techniques.

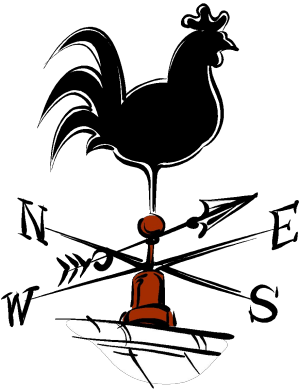
Improving human adaptation

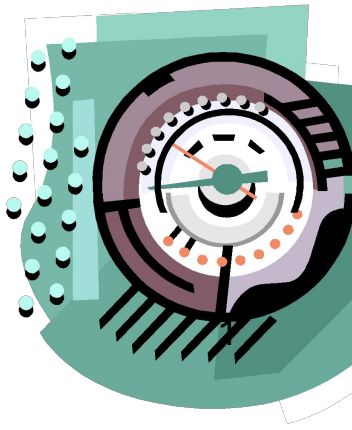
Governments can introduce policies to keep fisheries production within sustainable limits, for example by setting precautionary catch limits and eliminating subsidies to prevent overfishing. Coastal setback zones which prohibit all or certain types of development along the shoreline can minimise the damage from coastal flooding and erosion. New monitoring tools can be developed to forecast and control marine disease outbreaks.

Strengthening scientific research

Governments can increase investments in scientific research to measure and monitor ocean warming and its effects. This will provide more precise data on the scale, nature and impacts of ocean warming, making it possible to design and implement adequate and appropriate mitigation and adaptation strategies.

UNIT-3
WEATHER AND CLIMATE PARAMETERS MEASURING DEVICES
(S6&S7)





Weather Instruments

Essential Questions:

What are weather instruments and how are they used?

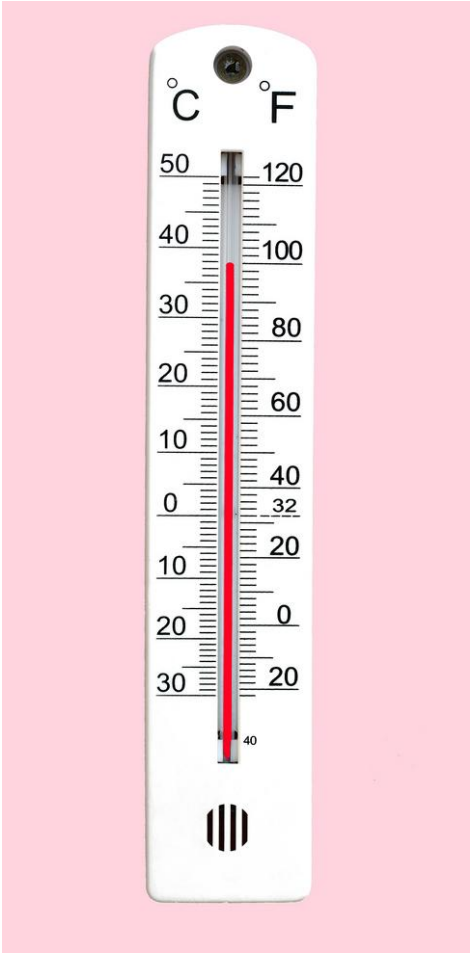
Weather Instruments

Meteorologist use different tools to measure weather. Here are some of the instruments they use:

- Thermometer
- Barometer
- Anemometer
- Hygrometer
- Rain gauge
- Wind Vane
- Weather balloon
- Satellite

Thermometer

A thermometer measures heat and cold. Meteorologist use it to measure air temperature. Liquids **expand** (get bigger) when heated and **contract** (get smaller) when cooled. That means their **volume** (occupied space) changes with their temperature.



Thermometer

The liquid inside older thermometers is mercury. It was used because of its resistance to heat and cold. Unlike water, mercury freezes at minus 39 degrees Celsius (-39°C) and boils at three hundred fifty seven degrees Celsius (357°C).

Thermometer Units of Measure

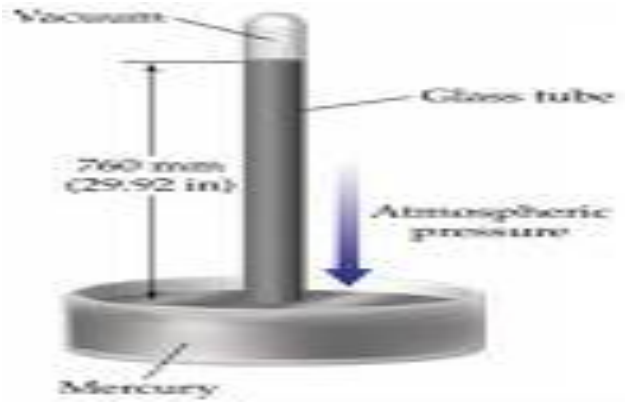
The two (2) measurement units used with a thermometer are degrees ***Fahrenheit*** and degrees ***Celsius***.

The Fahrenheit scale sets the freezing point of water at 32 degrees (32°F) and the boiling point at 212 degrees (212°F).

The Celsius scale sets the freezing point of water at 0 degrees (0° C) and the boiling point at 100 degrees (100°C).

Barometer

A barometer measures ***air pressure*** or ***barometric pressure***. The barometer dial is marked in two scales. The outer scale shows the units of inches of mercury. The inner scale shows air pressure in ***millibars***.



Air Pressure

Air pressure is a function of the quantity of air and the amount of space in which the air is contained. Air pressure is also the function of temperature.

Air Pressure and Weather

Changing air pressure indicates changing weather.

Rising air pressure usually means that cooler, drier air is coming, so there will be ***fair weather***.

Falling air pressure usually means that warmer, moister air is coming, so there will be ***wet weather***.

Anemometer

An anemometer measures the speed or strength of wind.
The most common types of anemometer have a mechanism that rotates as it catches the wind.

Wind Speed and Weather

Wind speed is related directly to wind strength. Wind strength is commonly reported on the ***Beaufort scale.*** The Beaufort scale rates the strength of wind on a scale of 0 – 12.

A Beaufort number of 0 indicates total calm.

A Beaufort number of 12 indicates hurricane strength winds (exceeding 74 mph).

Hygrometer

A hygrometer measures relative humidity. Humidity is the amount of water vapor in the air.

A reading of 100 percent relative humidity means that the air is totally saturated with water vapor and cannot hold any more, creating the possibility of rain.

Weather Instruments

- Hygrometers are instruments used for measuring humidity.
- Psychrometer
  - A simple form of a hygrometer
  - consists of two thermometers, one of which includes a dry bulb and the other of which includes a bulb that is kept wet to measure wet-bulb temperature.
  - Evaporation from the wet bulb lowers the temperature, so that the wet-bulb thermometer usually shows a lower temperature than that of the dry-bulb thermometer, which measures dry-bulb temperature.
  - Relative humidity is computed from the ambient temperature as shown by the dry-bulb thermometer and the difference in temperatures as shown by the wet-bulb and dry-bulb thermometers.

People and Humidity

The process of ***sweating*** is the human body's attempt to keep cool and maintain its current temperature. If the air is at 100-percent relative humidity, sweat will not ***evaporate*** into the air. As a result, we feel much hotter than the actual temperature when the relative humidity is high. If the relative humidity is low, we can feel much cooler than the actual temperature because our sweat evaporates easily, cooling us off.

Rain Gauge

- A **rain gauge** is an instrument used to gather and measure the amount of liquid ***precipitation*** over a set period of time.
- Most standard rain gauges have a wide funnel leading into a cylinder that is marked in inches or centimeters.
- They are calibrated (set up) so that one-tenth of an inch of rain measures one inch when it collects inside. In other words, each inch in the funnel counts as one-tenth of an inch of rain.

Types of Rain gauges

Rain gauges can be broadly classified into two categories as

i) **Recording / Automatic type rain gauge**

- **Weighing bucket,**
- **Tipping bucket,**
- **Floating type**

ii) **Non- recording / Non- automatic type rain gauge :**

- **Symon's Raingauge**

Non- recording / Non- automatic type rain gauge : Symon's Raingauge

- The non-recording gauge extensively used by **Meteorological Department of Government of India is the Symons' gauge .**
- The rain gauge is set up in a concrete block **60 cm x 60 cm x 60 cm.**
- A cylindrical graduated measuring glass is furnished with each instrument, which reads to 0.2 mm. The rainfall should be estimated to the nearest

  0.1 mm.
- A receiving bottle of rain gauge has a capacity of about **75 to 100 mm of rainfall**, the rain should be measured 3 or 4 times in a day, in case of heavy rainfall. The rainfall is measured every day at **08.30 hours IST.**

- Usually, rainfall measurements are made at 08.30 hr IST and sometimes at 17.30 hr IST also.
- Thus the non-recording or the Symon's rain gauge gives only the total depth of rainfall for the previous 24 hours (*i.e.,* daily rainfall) and does not give the intensity and duration of rainfall during different time intervals of the day.

The following important points to be kept in mind, while selecting the site for a rain gauge station.

1. The site where a rain-gauge is set up should be an open place.
2. The distance between the rain-gauge and the nearest object should be atleast twice the height of the object. In no case should it be nearer to the obstruction than 30 metres.
3. The rain-gauge should never be situated on the side or top of a hill if a suitable site on a level ground can be found.
4. In the hills, where it is difficult to find level space, the site for the gauge should be chosen where it is best shielded from high winds, and where the wind does not cause eddies.
5. A fence, if erected to protect the gauge from cattle etc. should be so located that distance of the fence is not less than twice its height.

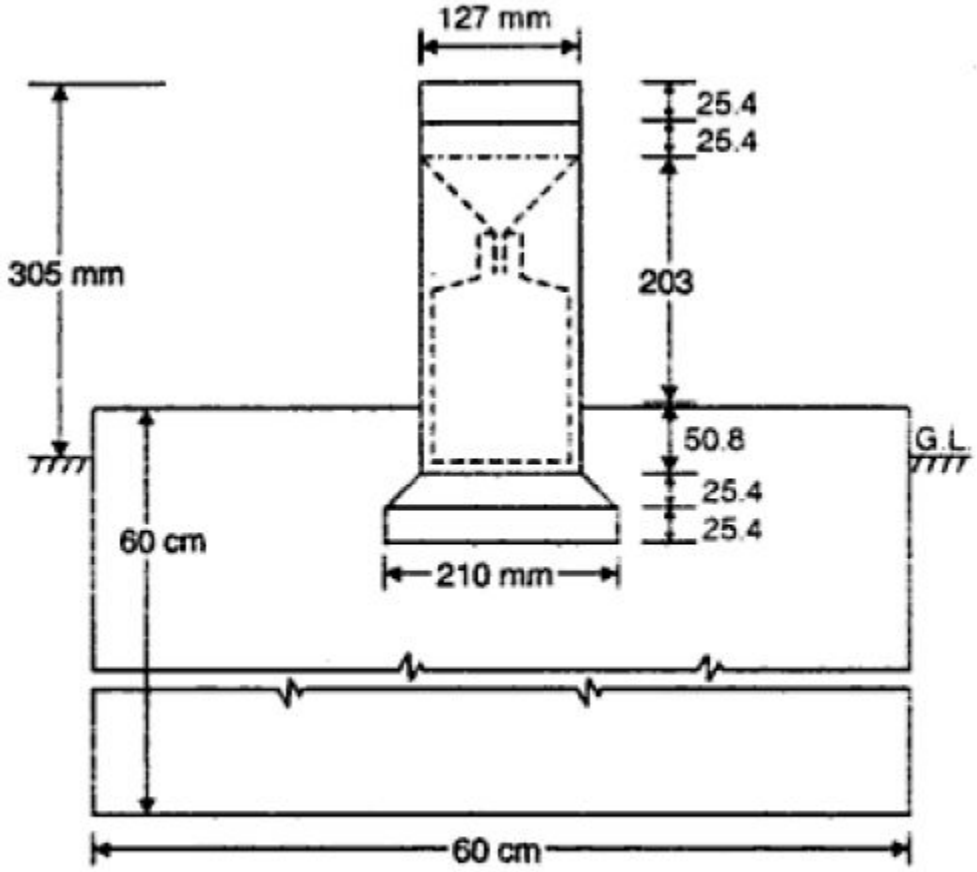


FIG. SYMON'S RAIN-GAUGE (ADOPTEDBY METEOROLOGICAL DEPT. OF GOVT. OF INDIA)

Recording / Automatic type rain gauge

1. Weighing bucket,
2. Tipping bucket,
3. Floating type

Weighing bucket type rain gauge

- Self recording rain gauges are used to determine rates of rainfall over short period of time.
- The most common type of Self recording rain gauge is weighing bucket type. It consists of receiver bucket supported by spring or any other weighing mechanism.
- The movement of the bucket due its increasing weight is transmitted to a pen which traces the record on a clock driven chart.
- The rotation of the drum sets the time scale while the vertical motion of the pen records the cumulative precipitation

- This type of gauge normally has no provision for emptying itself.
- The bucket is been emptied and the pen has been set to zero, whenever the rainfall chart is changed.

Merits.

- The main usefulness of this type of gauge is that, it can record snow, hail, mixture of rain and snow.
- All forms of precipitation are weighed and recorded automatically.

Demerits.

- Effect of temperature and friction on weighing mechanism.
- Shrinkage and expansion of chart paper caused by changes in humidity may distort the time and scale of rainfall.

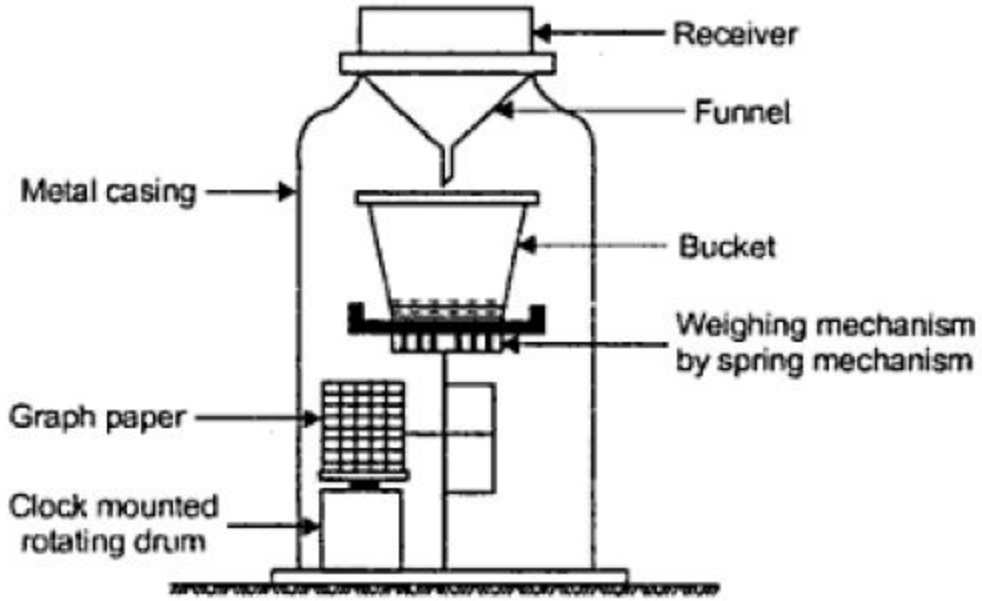


FIG. WEIGHING BUCKET TYPE RAIN-GAUGE.

Tipping bucket type [Tilting bucket]

- A Steven's tipping bucket type rain gauge consists of **300 mm diameter,** sharp edge receiver. At the end of the receiver is provided with a funnel.
- Just below the funnel a pair of tipping buckets is pivoted such that when one of the bucket receives a rainfall of 0.25 mm it tips and empties into a tank below, while the other bucket takes its position and the process is repeated.
- The tipping of the bucket actuates on electric circuit which causes a pen to move on a chart wrapped round a drum which revolves by a clock mechanism. **This type cannot record snow.**

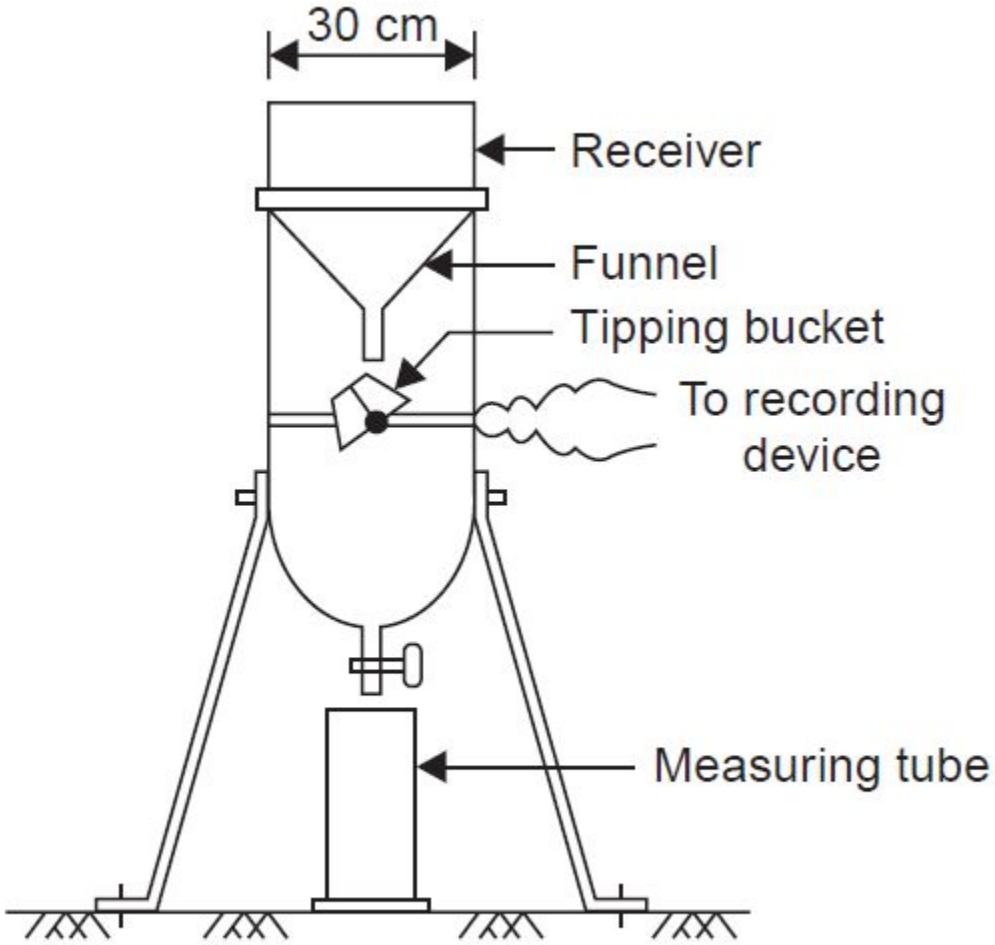


Fig. Tipping bucket gauge

- The water from the tipped bucket is collected in a storage can.
- The water collected in the storage can is measured at regular intervals to provide the total rainfall and also serve as a check.
- It may be noted that the record from the **tipping bucket gives data on the intensity of rainfall.**
- Further, the instrument is ideally suited for digitalising of the output signal.

Merits

- It is the only recording rain gauge, which can be used in **remote places** by installing the recorder at a convenient and easily accessible location.

Demerits

- The instrument is not satisfactory for use in light drizzle of very light rain.
- The time of beginning and end of rainfall cannot be determined accurately.
- This type of gauge is not suitable for measuring snow without heating the collector.

Floating type rain gauge [Natural syphon type]

- This type of rain gauge is also known as **syphon type rain gauge**, as it uses the **syphon mechanism** to empty the rainwater collected in the float chamber.
- This is adopted by **I.M.D**
- The working of float type or syphon type raingauge is **similar to the weighing bucket type rain gauge.**
- In this type, as the rain is collected in a float chamber, the float moves up which makes a pen to move on a chart wrapped round a clock driven drum
- When the float chamber fills up, the water siphons out automatically through a siphon tube kept in an interconnected siphon chamber.

- **The clockwork revolves the drum once in 24 hours.**
- The clock mechanism needs rewinding once in a week when the chart wrapped round the drum is also replaced.
- The vertical lines in the pen-trace correspond to the sudden emptying of the float chamber by syphon action **which resets the pen to zero level.**
- It is obvious that the natural syphon-type recording rain gauge gives a plot of the **mass curve of rainfall.**

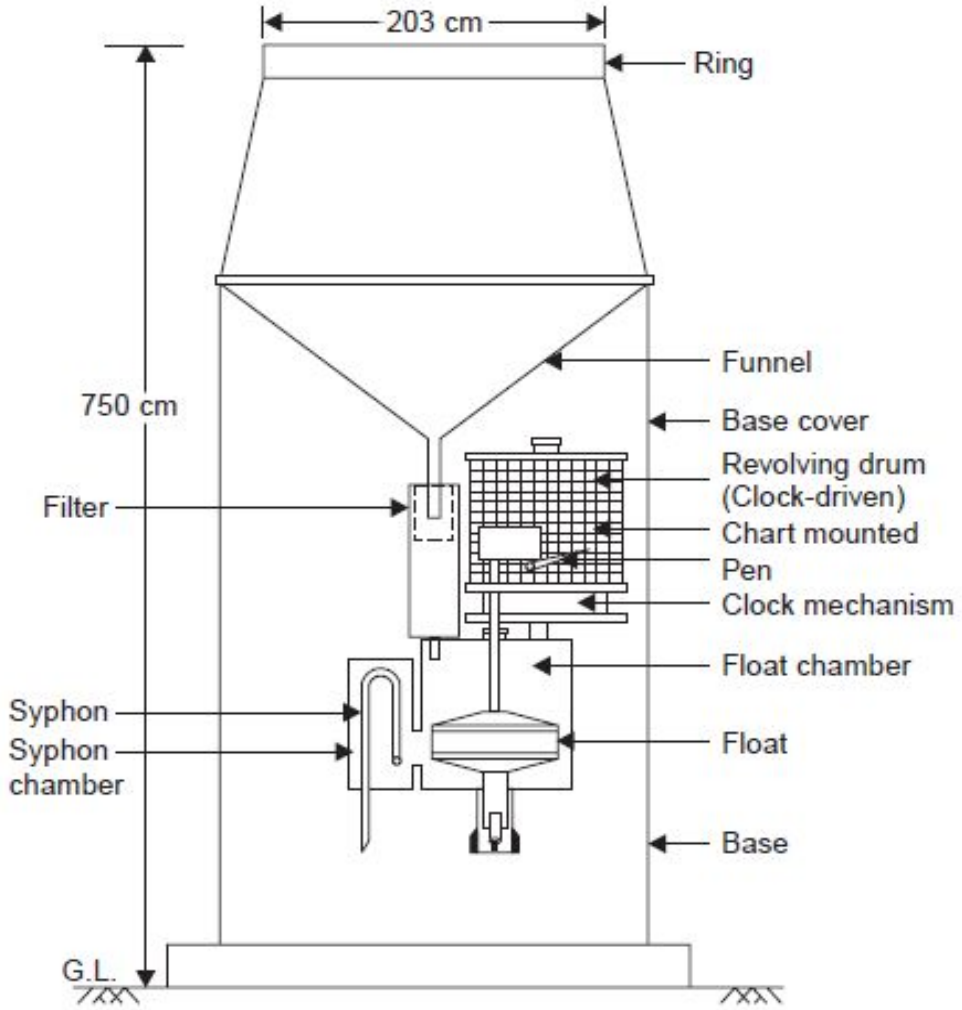
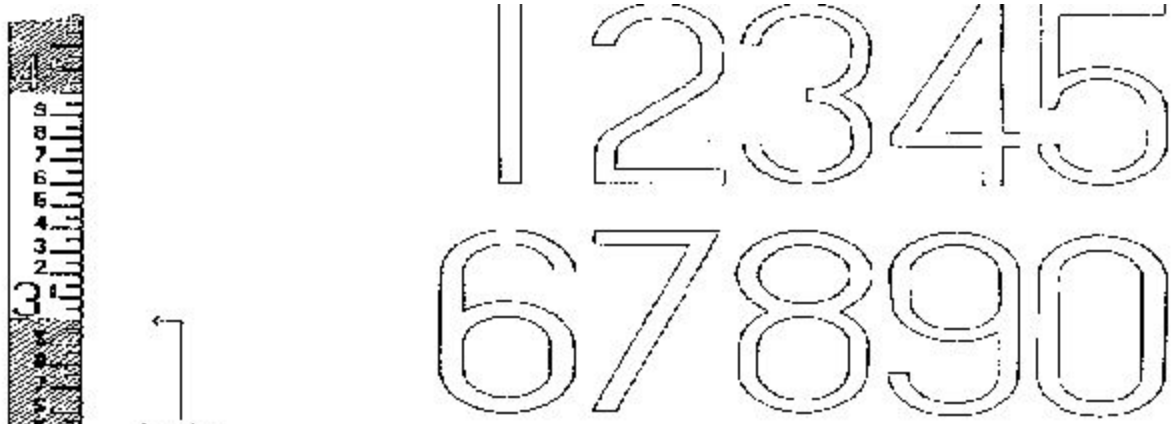


Fig. Float type rain gauge

Tide Pole (or Tide Staff) Gauges

TIDE GAUGES



SPECIMEN FIGURES

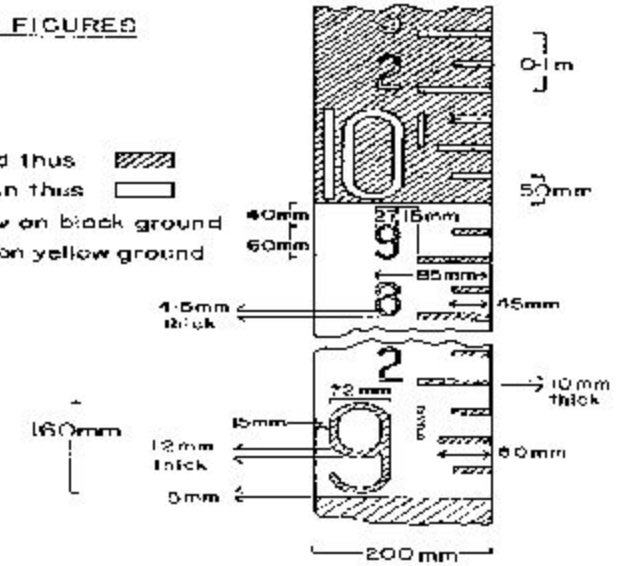
COLOUR KEY

Black shown shaded thus

Traffic yellow shown thus

Even numbers yellow on black ground

Odd numbers black on yellow ground



MARKING OF VISUAL TIDE SCALE

Committee on Tide Gauges

January 1970

9
8
7
6
5
4
3
2
7
9
8
7
6
5
4
3
2

Tide pole gauges

- The simplest possible system, and lowest cost
- Very educational
- Important common sense ‘reality check’ alongside modern black box digital tide gauge systems

Of course, tide poles have not for many years been a primary source of sea level data. However, it is always worth having a simple tide pole at every gauge site as a check.

Although they are simple, there is a need for datum control, just as there is for more expensive and complicated gauges

Float Gauges

Classical
Float
Gauge

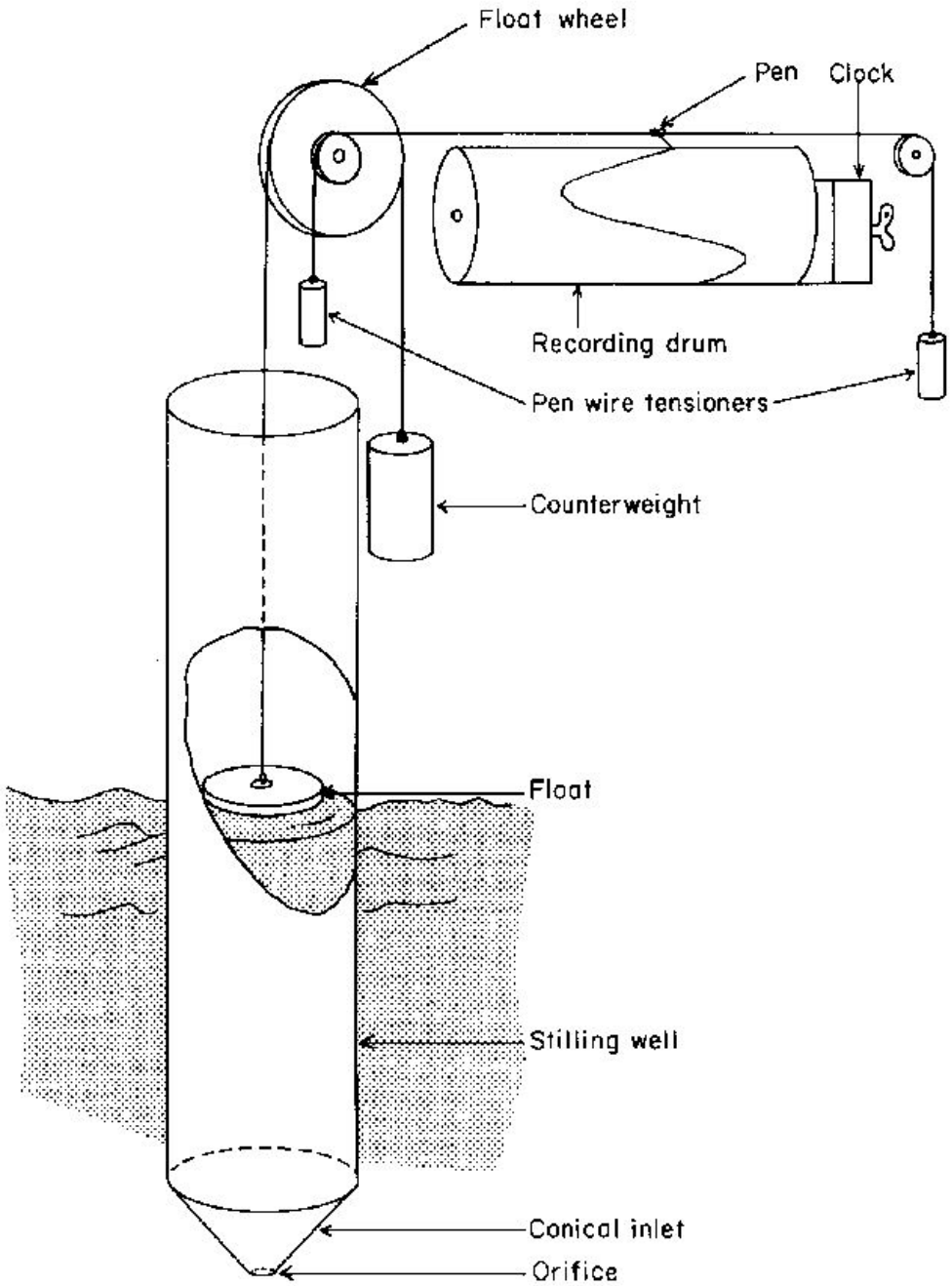
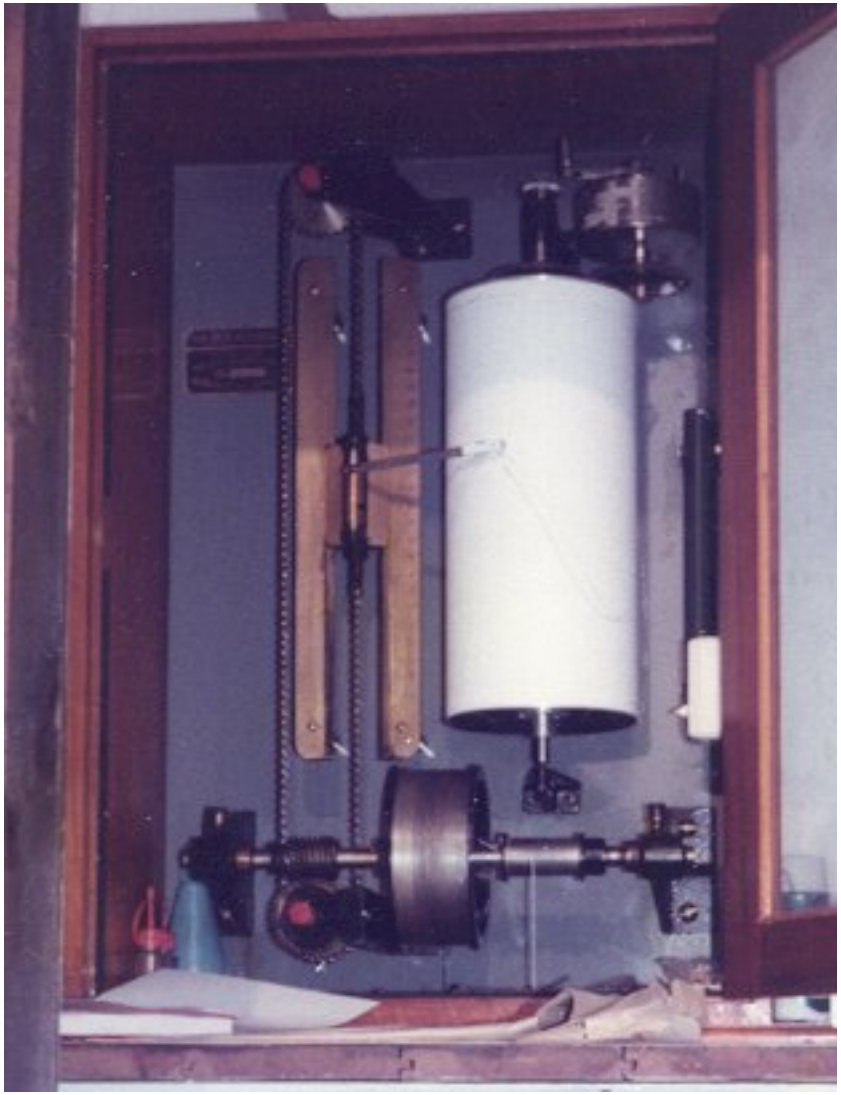


Figure 3.1



Lea chart recorder for a float gauge (photo taken in 1983)

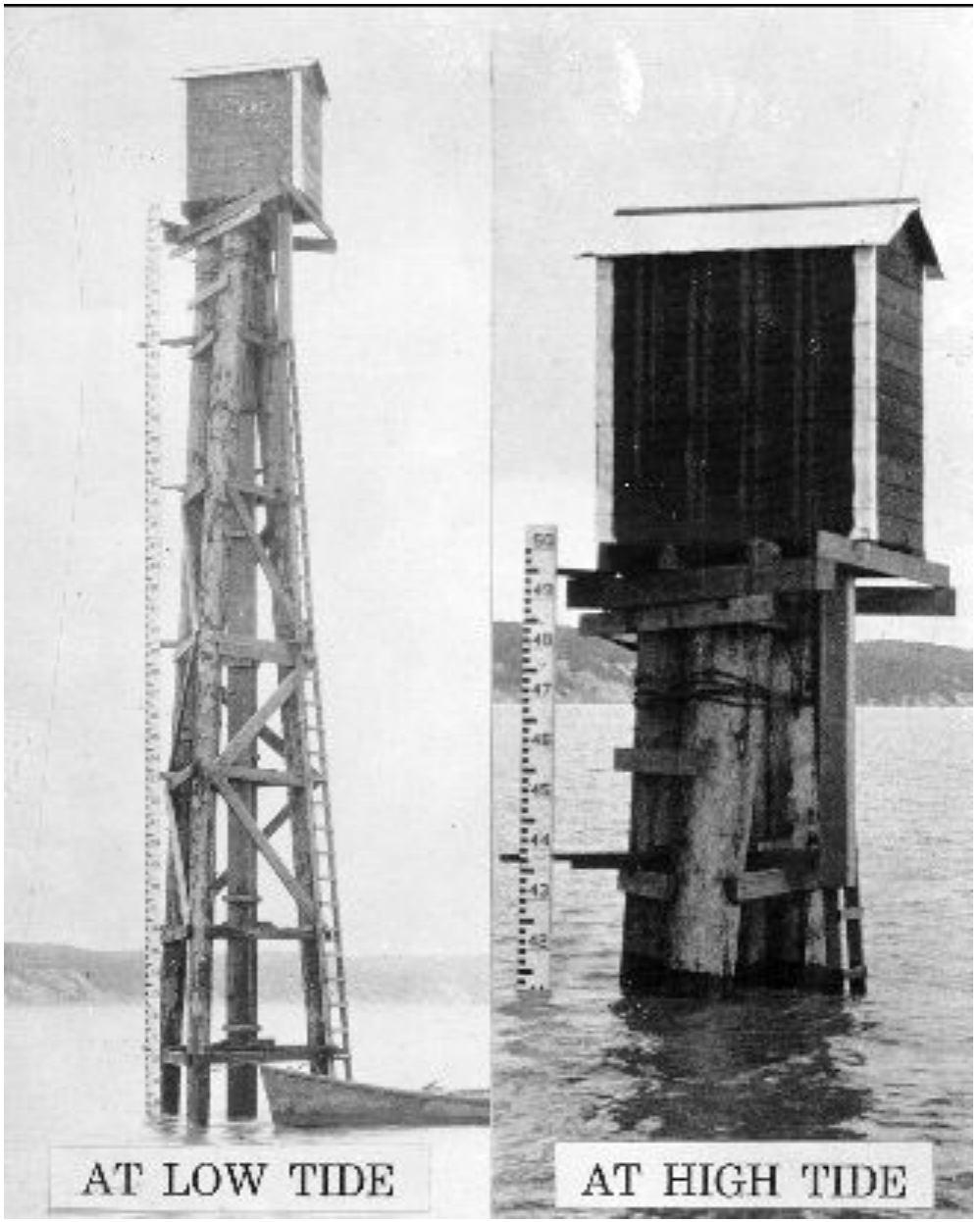
Importance of Float Gauges

- They still form a large part of the global network
- No need for paper charts now. They can be made digital with the use of shaft encoders
- Even if they are now being replaced with acoustic, pressure and radar systems, they were the source of most of the historical record

UK Float Gauge
at Holyhead

Float gauges
are still important
components of GLOSS
and can be made
into digital gauges
with the use of
encoders

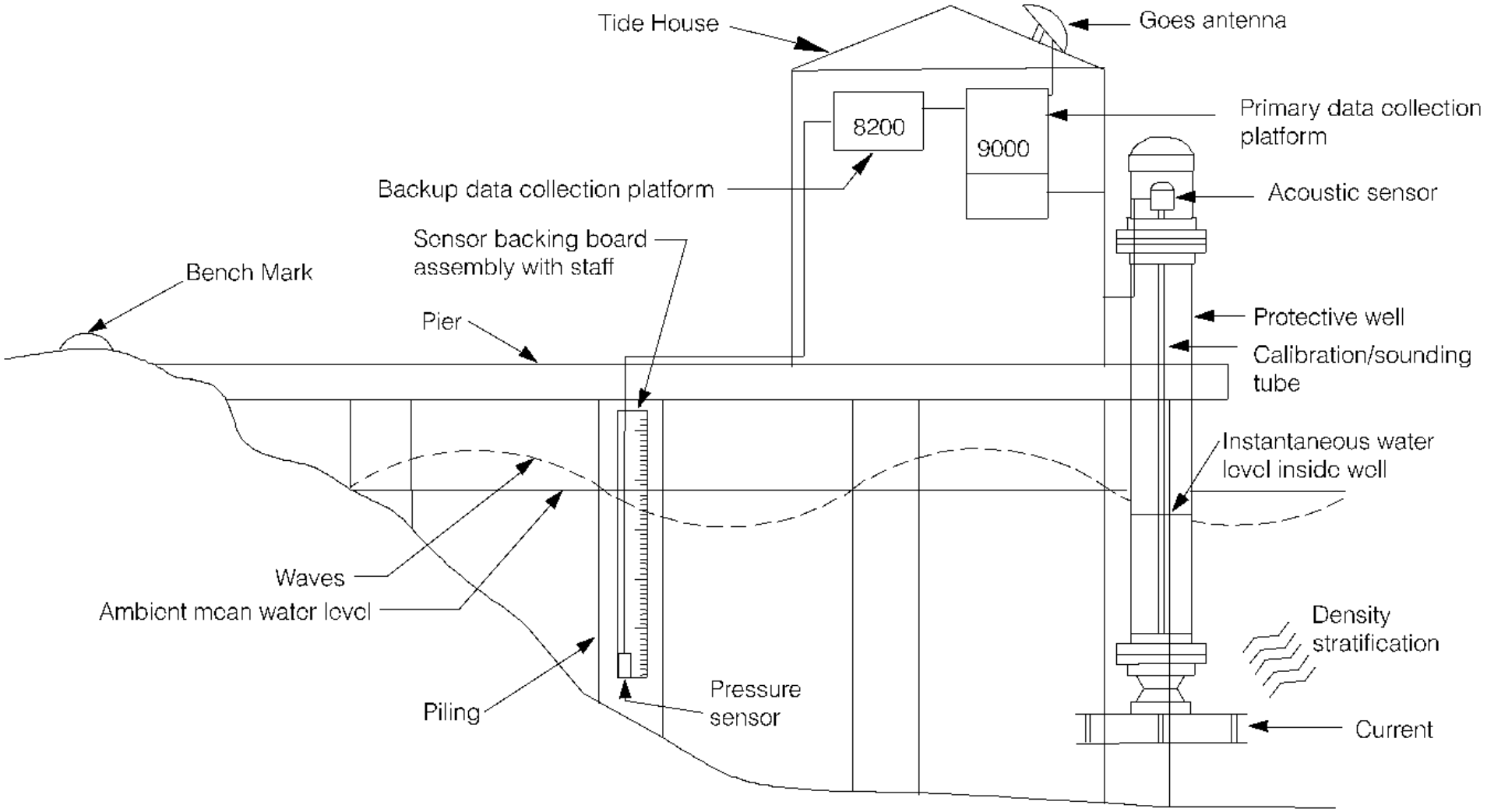
Classical stilling well float gauge from the US east coast high tidal range area



Acoustic Gauges

Acoustic gauges

- Acoustic systems in tube with Aquatrak transducer (NGWLMS or SEAFRAME) with various data loggers. These are now something of a GLOSS standard in many areas
- Acoustic systems in open air or inside the stilling wells of float gauges. Cheap but several groups have not been successful in operating them to good standards

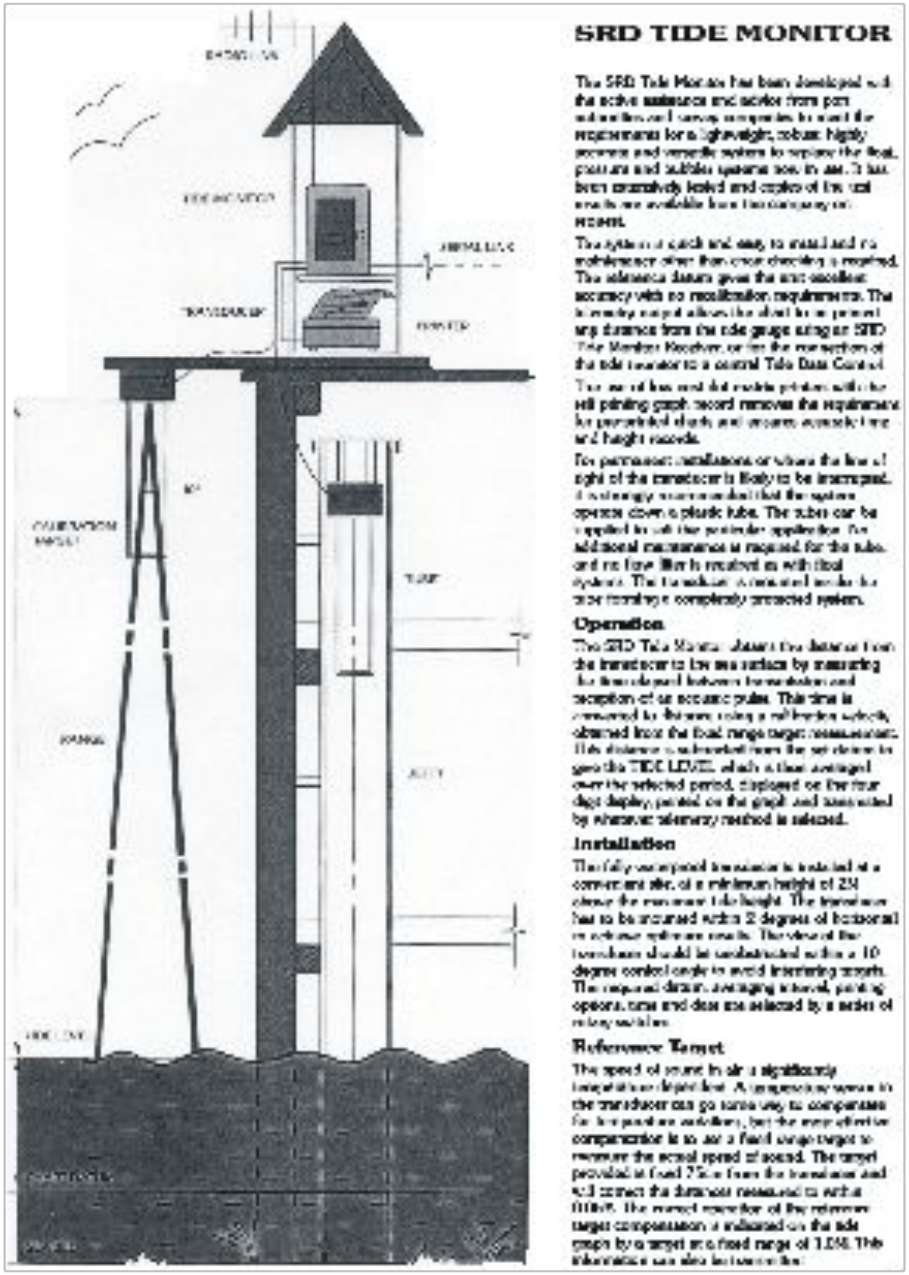


Schematic of the NGWLMS/SEAFRAME system

Acoustic SEAFRAME Gauge in Australia

SRD Tide Monitor in a well or in open air – Spain and South Africa have used these not very successfully.

Similar systems are manufactured by other companies e.g. MORS



SRD TIDE MONITOR

The SRD Tide Monitor has been developed with the active assistance and advice from port authorities and survey companies to meet the requirements for a lightweight, robust, highly accurate and versatile system to replace the float, pressure and bubbler systems now in use. It has been extensively tested and copies of the test results are available from the company on request.

The system is quick and easy to install and no maintenance other than visual checking is required. The reference datum gives the most excellent accuracy with no recalibration requirements. The telemetry output allows the client to be present any distance from the tide gauge using an SRD Tide Monitor Receiver, or for the transmission of the tide information to a central Tide Data Control.

The use of low cost dot matrix printers with the well proven graph record removes the requirement for pre-printed charts and ensures accurate time and height records.

For permanent installations or where the line of sight of the transducer is likely to be interrupted, it is strongly recommended that the system operates down a plastic tube. The tubes can be supplied to suit the particular application. No additional maintenance is required for the tube, and no false alarms received as with float systems. The transducer is mounted inside the tube making a completely protected system.

Operation

The SRD Tide Monitor obtains the distance from the transducer to the sea surface by measuring the time elapsed between transmission and reception of an acoustic pulse. This time is converted to distance using a calibration velocity obtained from the fixed range target transducer. This distance is subtracted from the set distance to give the TIDE LEVEL which is then averaged over the selected period, displayed on the real time display, printed on the graph and transmitted by whatever telemetry method is selected.

Installation

The fully encapsulated transducer is mounted at a convenient site, at a minimum height of 2M above the maximum tide height. The transducer has to be mounted within 2 degrees of horizontal to achieve optimum results. The face of the transducer should be manufactured within a 10 degree conical angle to avoid interfering signals. The required datum, averaging interval, printing options, time and date are selected by a series of rotary switches.

Reference Target

The speed of sound in air is significantly temperature dependent. A temperature sensor in the transducer can give some way to compensate for this problem, but the most effective compensation is to use a fixed range target to measure the actual speed of sound. The target provided is fixed 2M from the transducer and will correct the distance measured to within 0.01%. The correct operation of the reference target compensation is indicated on the tide graph by a target at a fixed range of 1.8M. This information can also be transmitted

Pressure Gauges

Pressure gauges

- Bubbler gauges
- Transducer in the sea gauges
- ‘B’ (or ‘triple’) pressure systems

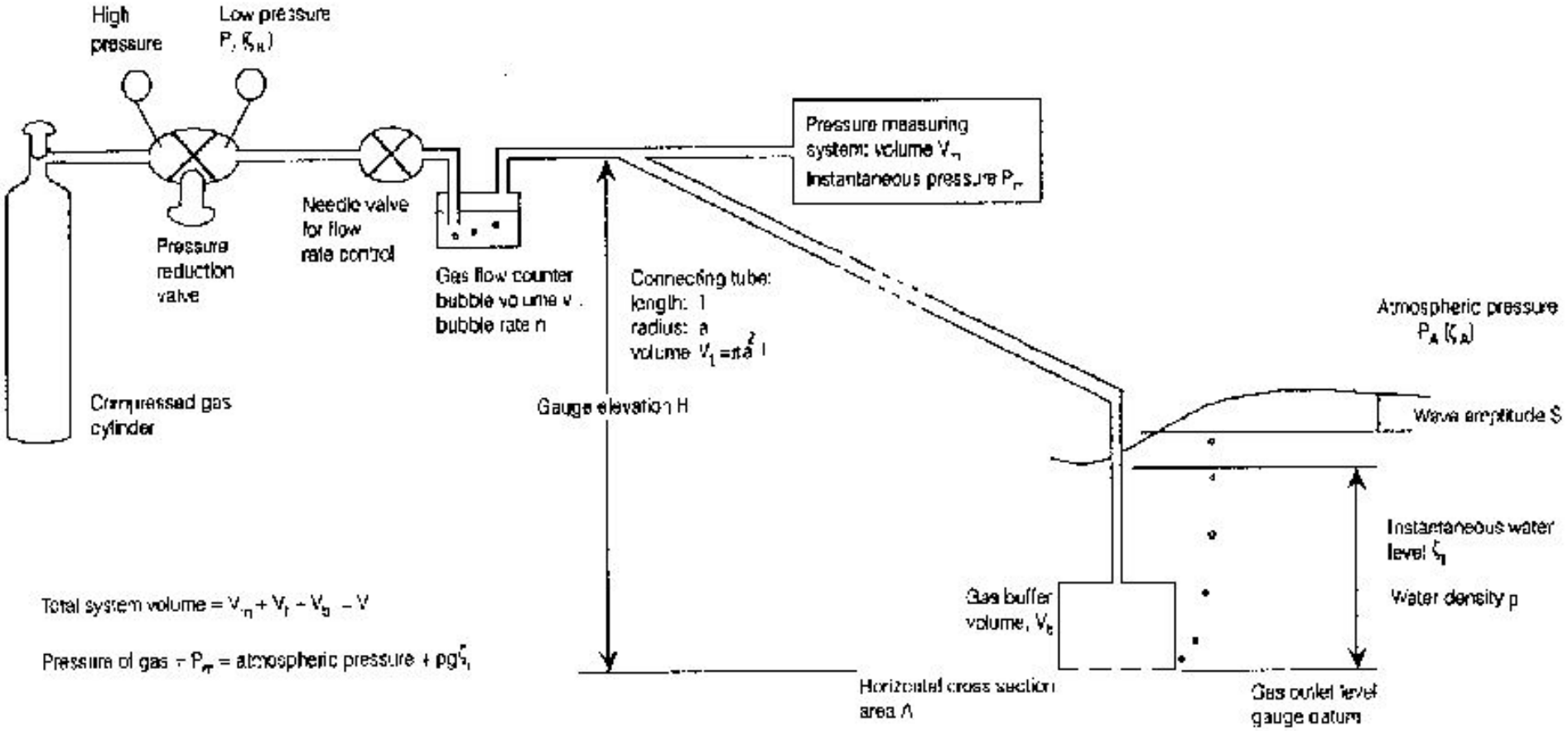
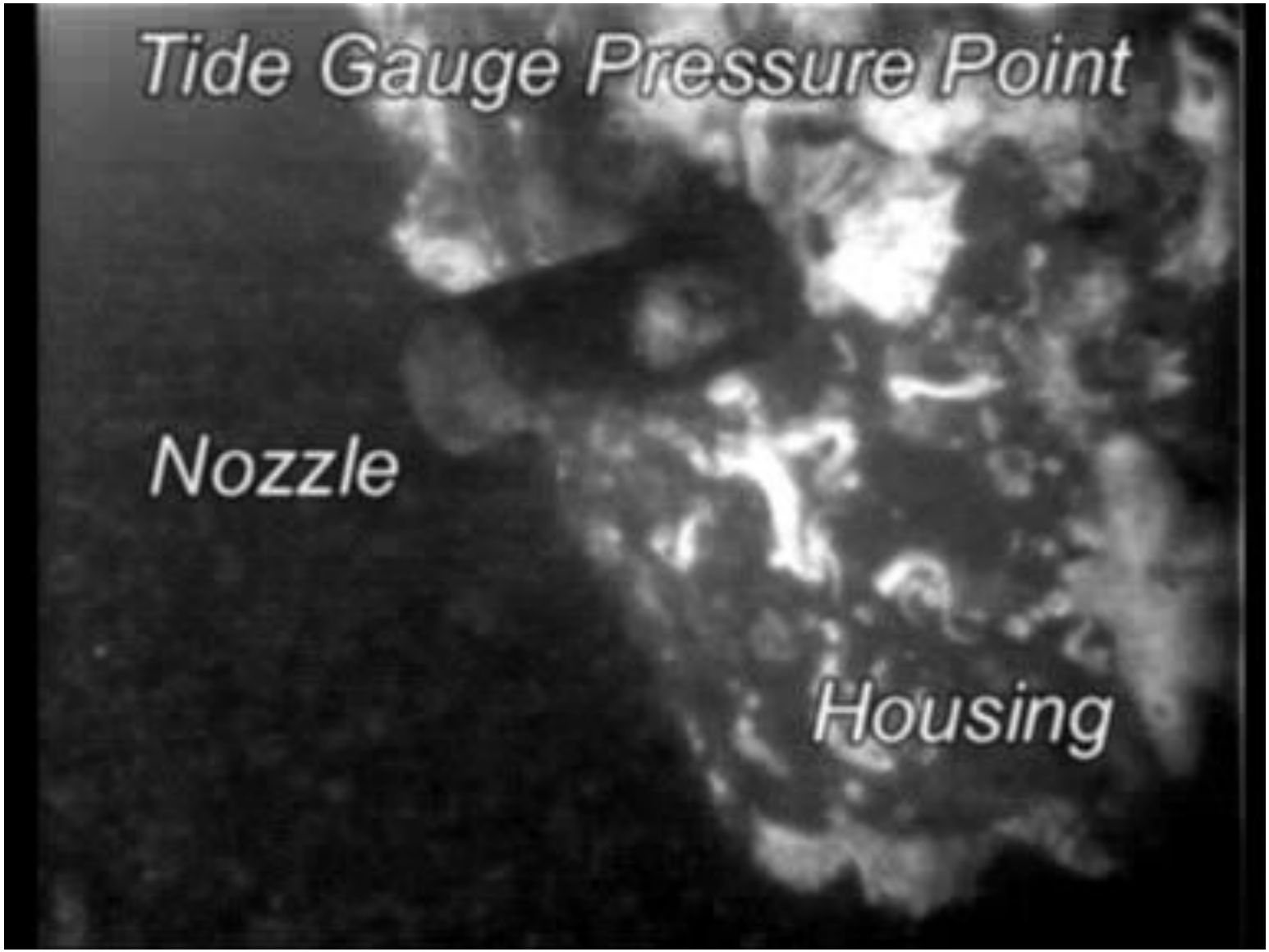
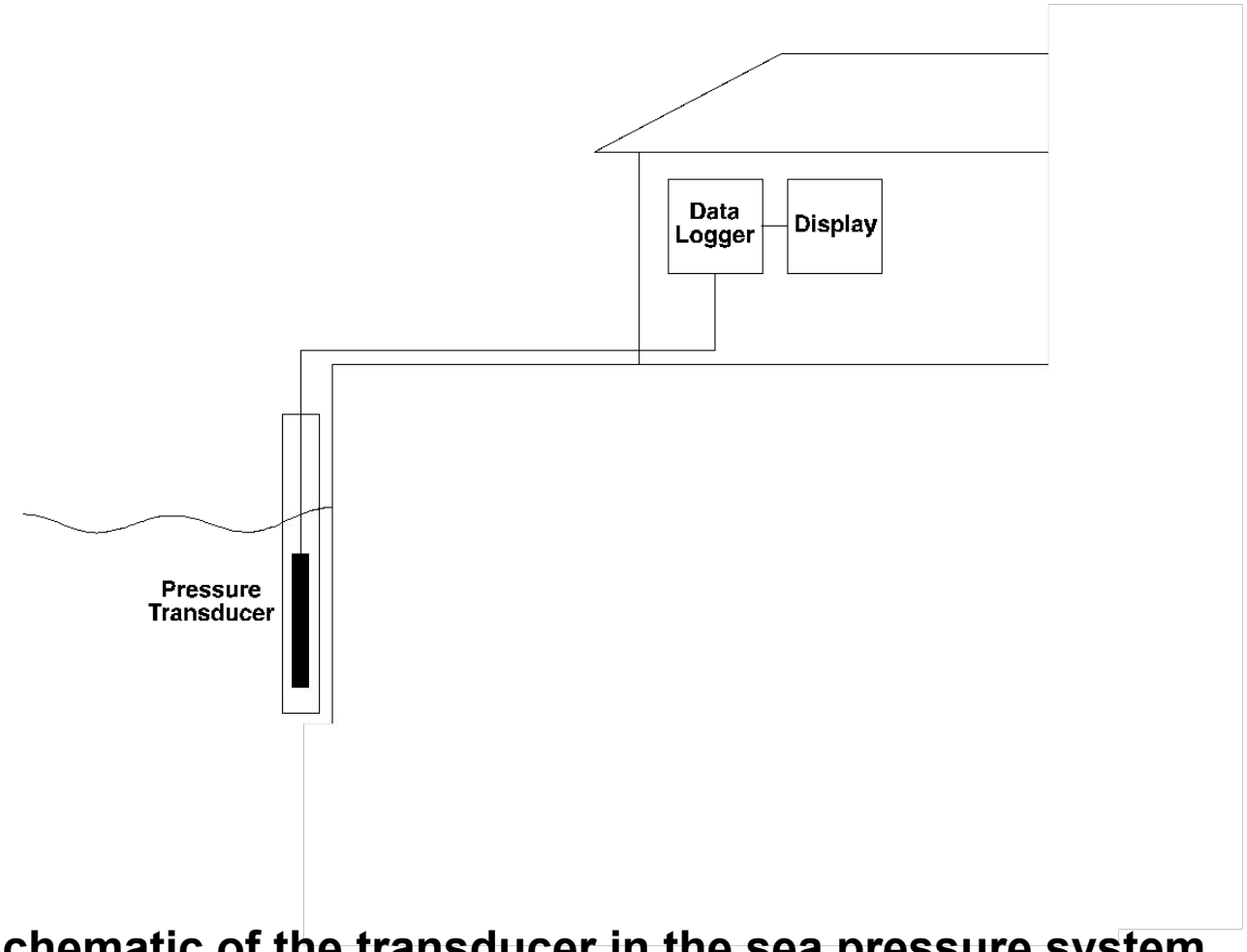


Figure 2.2

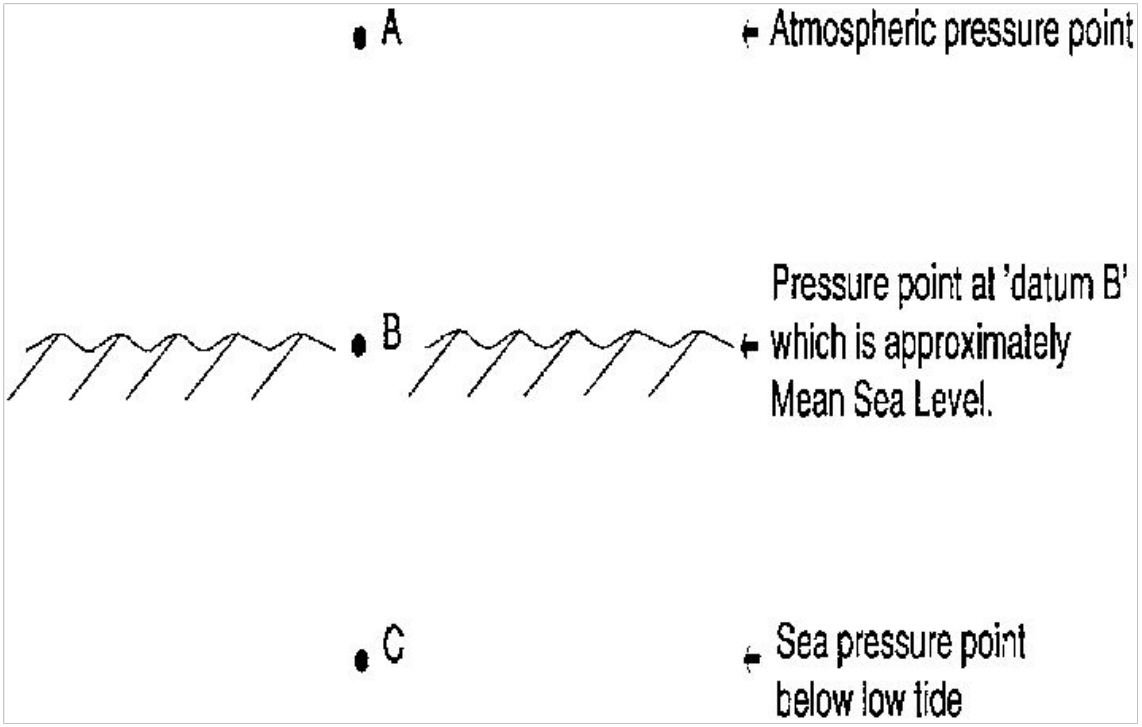
Schematic diagram of the pneumatic tide gauge and its principal system parameters


Tide Gauge Pressure Point
Nozzle
Housing



Schematic of the transducer in the sea pressure system

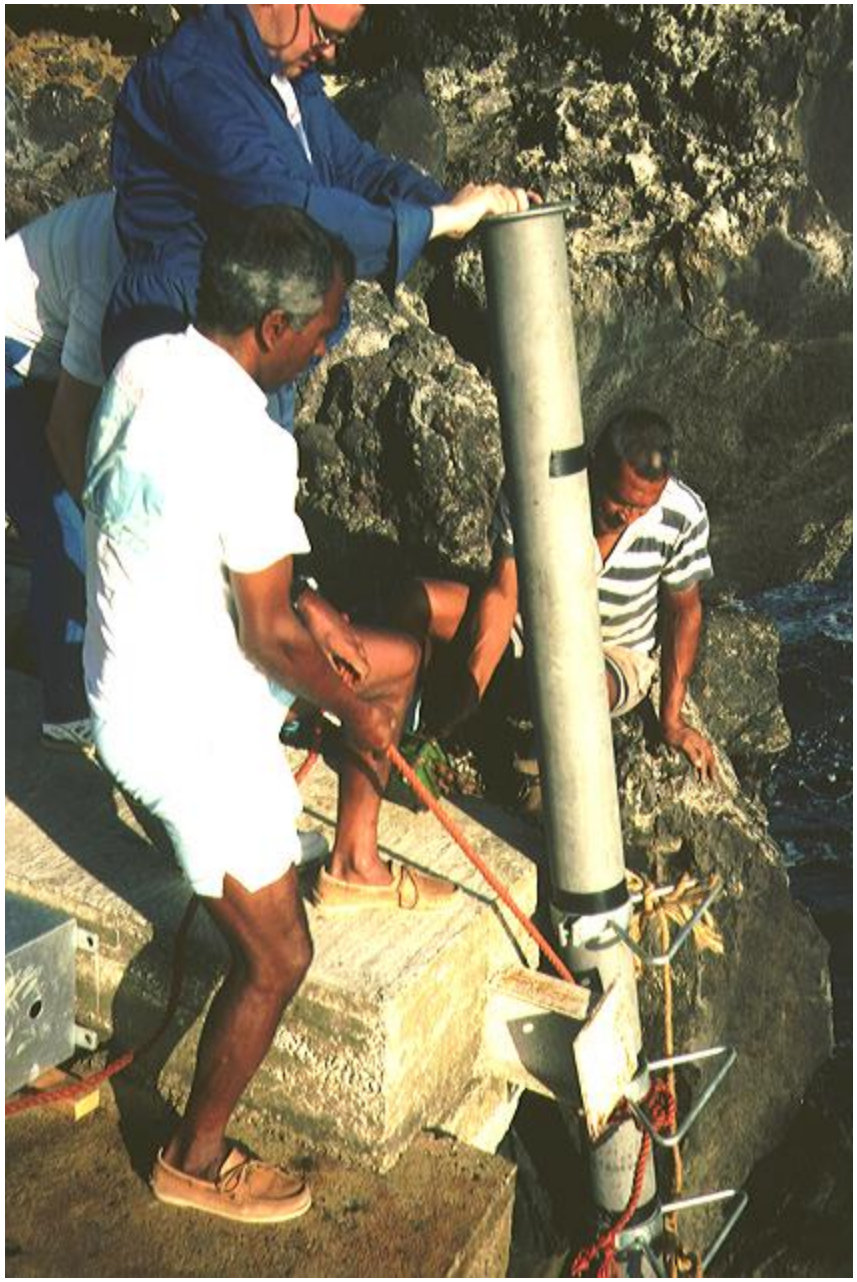
Most Appropriate for Tsunami Monitoring



Schematic illustration of a Triple (or 'B') pressure gauge setup containing three pressure transducers

-This can provide ongoing datum control to the 'C' data but can be very expensive

Installation of a ‘B’ gauge – See IOC Manual 4 for more details



Radar Gauges

Merits of Radar Gauges

- Relatively cheap
- Easily installed (no need for divers or stilling wells etc.)
- Digital so can be ‘real time’
- New technology, but experience so far generally favourable
- Several manufacturers
- But that means not all can be rigorously tested

Liverpool - UK

South Africa


29 7:52 AM

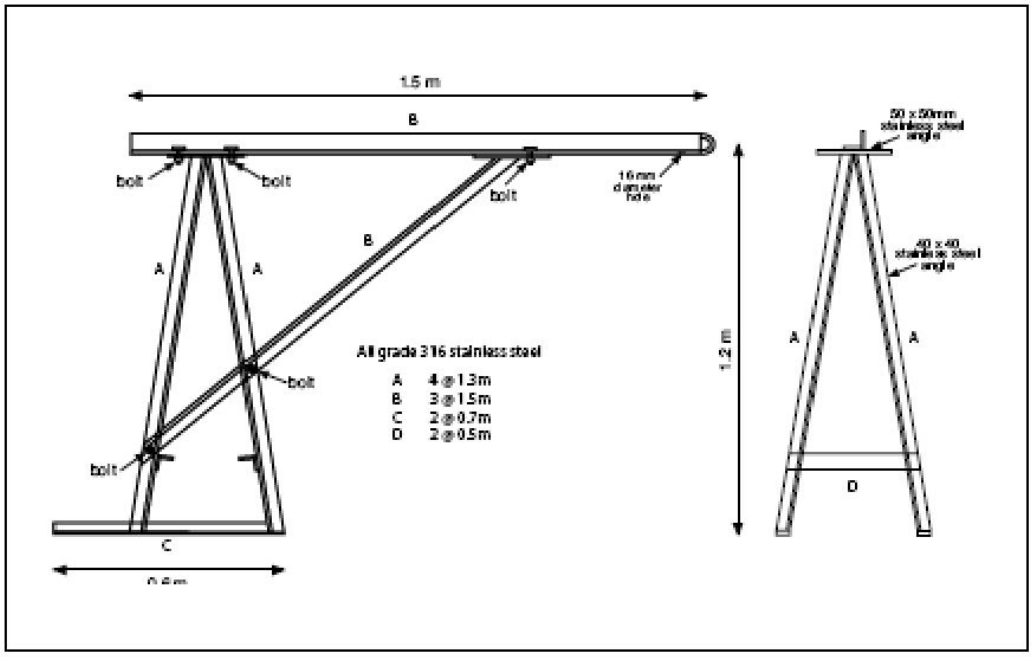

MHF1

Kirinda – Sri Lanka

Infrastructure needed

- An arm for the radar gauge
- Mountings for the pressure sensors (one below low tide and one at approximately MSL)
- A simple stilling well for calibration checks

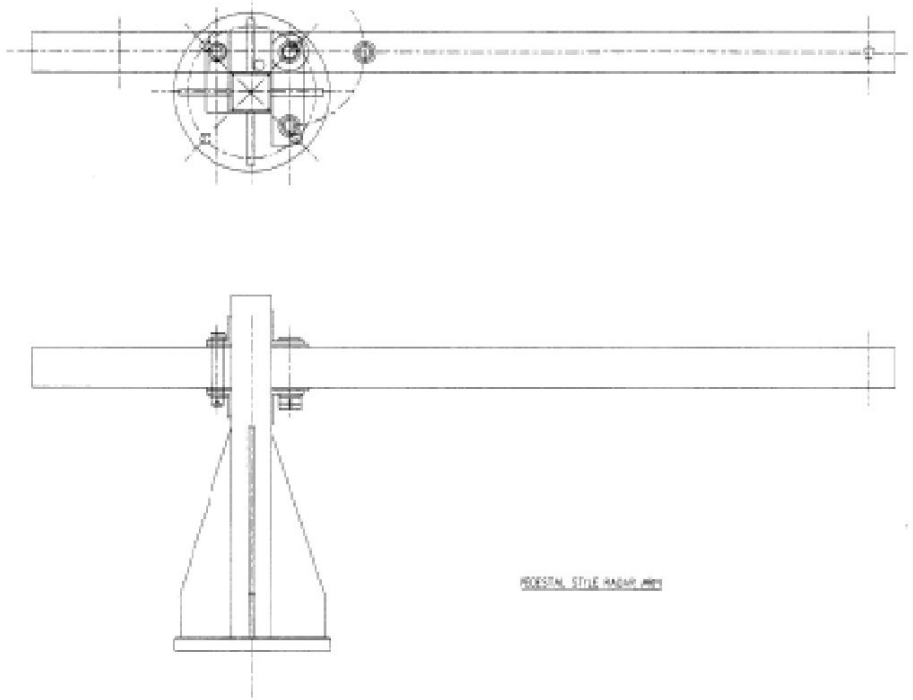
- Also power etc.
- Note that technical details will be discussed by Peter Foden and Ruth Farre later in the week



◄ Assembled davit

Stainless steel self-tapping anchor bolt ►

As used at Pemba

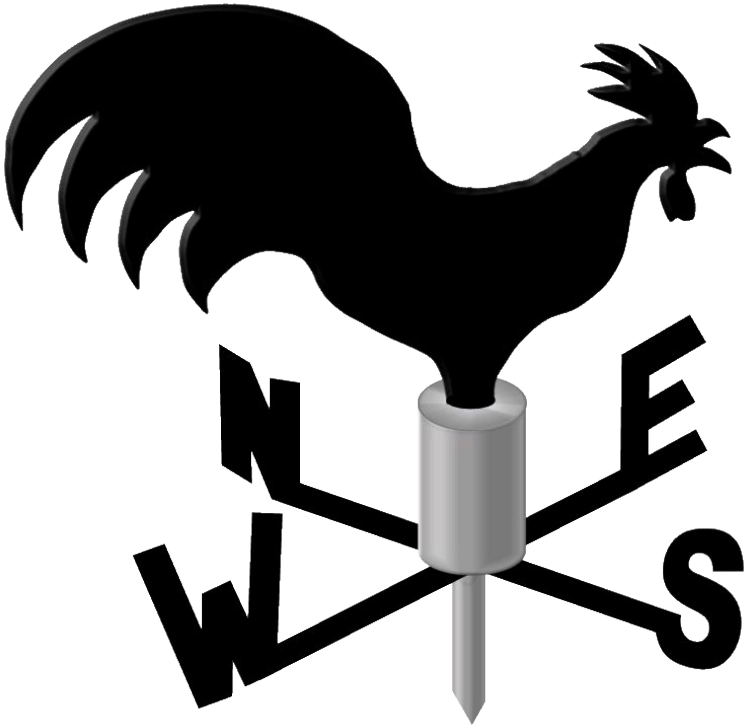


As used at Liverpool

Other Instruments

Wind Vane

A wind vane indicates in what direction the wind is traveling.

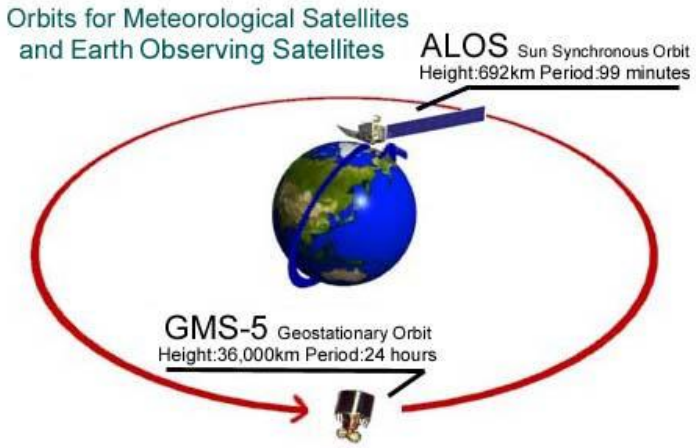


Weather Balloon

- A Weather balloon is a mobile weather station sent up to measure atmospheric pressures, temperature, wind speeds and humidity.

Satellite

- Weather satellites are used for viewing large weather systems on Earth such as hurricanes and other cloud formations.



Unit 3

S7-S9

- S7 :SLO1- Ice probes and sediment cover

  SLO2- Climate feed back
- S8 :SLO1- water vapour feedback

  SLO 2- Ice Albedo feedback

S9: SLO1- Vulnerability assessment

SLO2- case study on Vulnerability assessment- flood, drought and heat waves

Ice core

- They contain layer upon layer of snow that fell, never melted, and compacted into glacial ice. Within this ice are clues to past climate known as proxies. For example, gas bubbles trapped in the ice contain chemical clues that reveal past temperature.

Ice core Data

- The amount of dust in each annual layer provides information about airborne continental dust and biological material, volcanic ash, sea salts, cosmic particles, and isotopes produced by cosmic radiation that were in the atmosphere at the time the dust was deposited in the ice.

Sediment cores

- These cores are long cylinders of the earth's crust, drilled up from beneath the seafloor. The cores are arranged end-to-end, they show a glimpse of the Earth's past geology and climate.
- Scientists collect long sediment cores and examine the materials trapped within, to reconstruct past ocean conditions. The varieties and concentration of certain microorganisms record past changes in ocean temperature and composition.

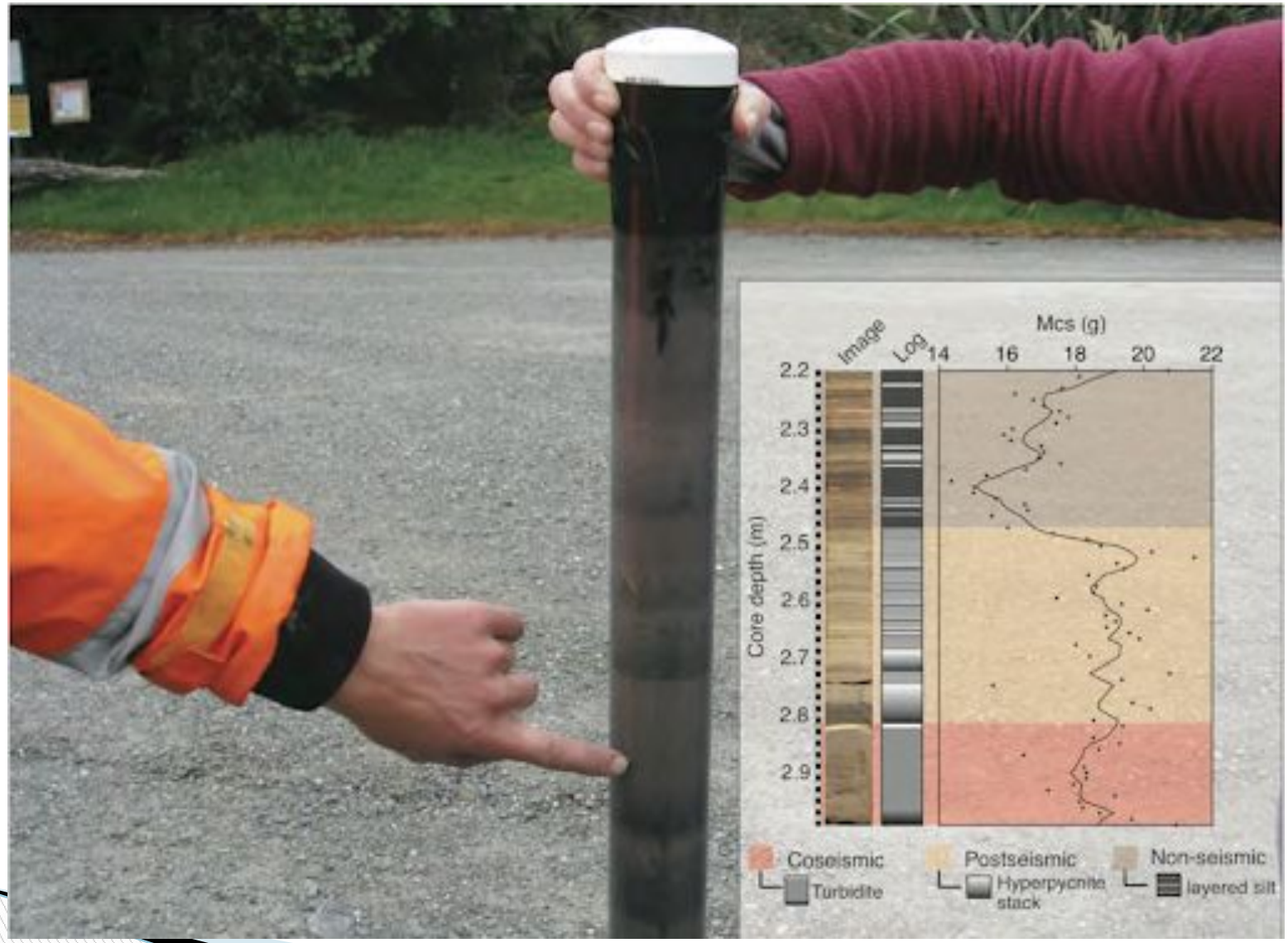


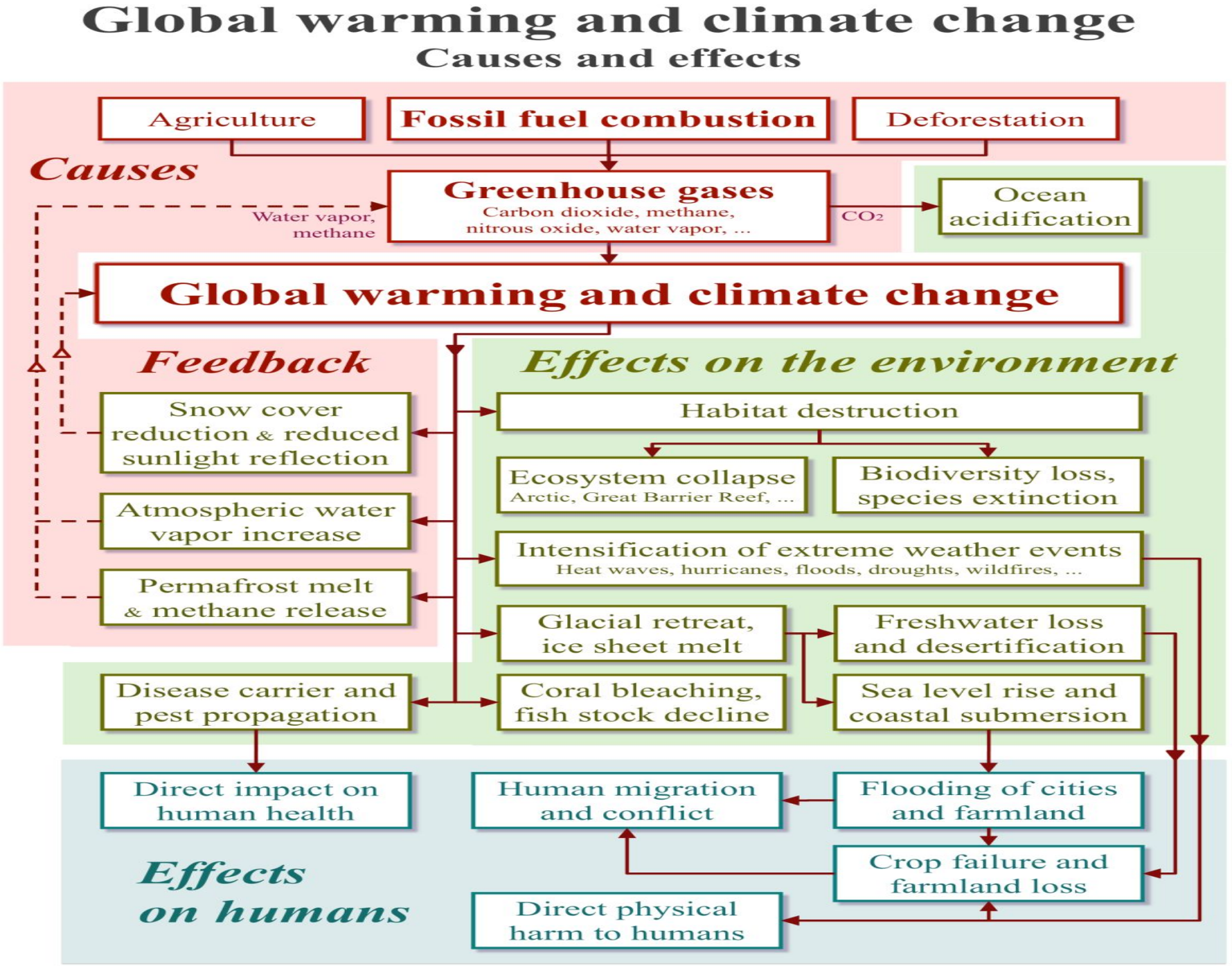
Image
Log
Mcs (g)
14
16
18
20
22
Core depth (m)
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
Coseismic
Turbidite
Postseismic
Hyperpycnite stack
Non-seismic
layered silt

- Sediment cores are collected by hammering 1-m sections of 3 inch (7.6 cm) aluminum pipe into the subsurface, capping the pipe, and extracting it using ropes and a farm jack.
- Sediment samples were wet sieved through 250 μm and 64 μm sieves to separate course from fine fractions.

Climate feedback

- Climate feedback is important in the understanding of global warming because feedback processes may amplify or diminish the effect of each climate forcing.
- The term "forcing" means a change which may "push" the climate system in the direction of warming or cooling.
- An example of a climate forcing is increased atmospheric concentrations of greenhouse gases. By definition, forcings are external to the climate system while feedbacks are internal; in essence, feedbacks represent the internal processes of the system.

https://www.youtube.com/watch?v=363HhzYzJlA


Global warming and climate change
Causes and effects
Agriculture
Fossil fuel combustion
Deforestation
Causes
Greenhouse gases
Carbon dioxide, methane, nitrous oxide, water vapor, ...
Water vapor, methane
CO_2
Ocean acidification
Global warming and climate change
Feedback
Effects on the environment
Snow cover reduction & reduced sunlight reflection
Atmospheric water vapor increase
Permafrost melt & methane release
Habitat destruction
Ecosystem collapse
Arctic, Great Barrier Reef, ...
Biodiversity loss, species extinction
Intensification of extreme weather events
Heat waves, hurricanes, floods, droughts, wildfires, ...
Glacial retreat, ice sheet melt
Freshwater loss and desertification
Disease carrier and pest propagation
Coral bleaching, fish stock decline
Sea level rise and coastal submersion
Direct impact on human health
Human migration and conflict
Flooding of cities and farmland
Crop failure and farmland loss
Direct physical harm to humans
Effects on humans

- Feedback occurs when outputs of a system are routed back as inputs as part of
  a chain of cause-and-effect that forms a circuit or loop. The system can then be said to feed back into itself.
- Feedback in general is the process in which changing one quantity changes a second quantity, and the change in the second quantity in turn changes the first.

Water vapor feedback

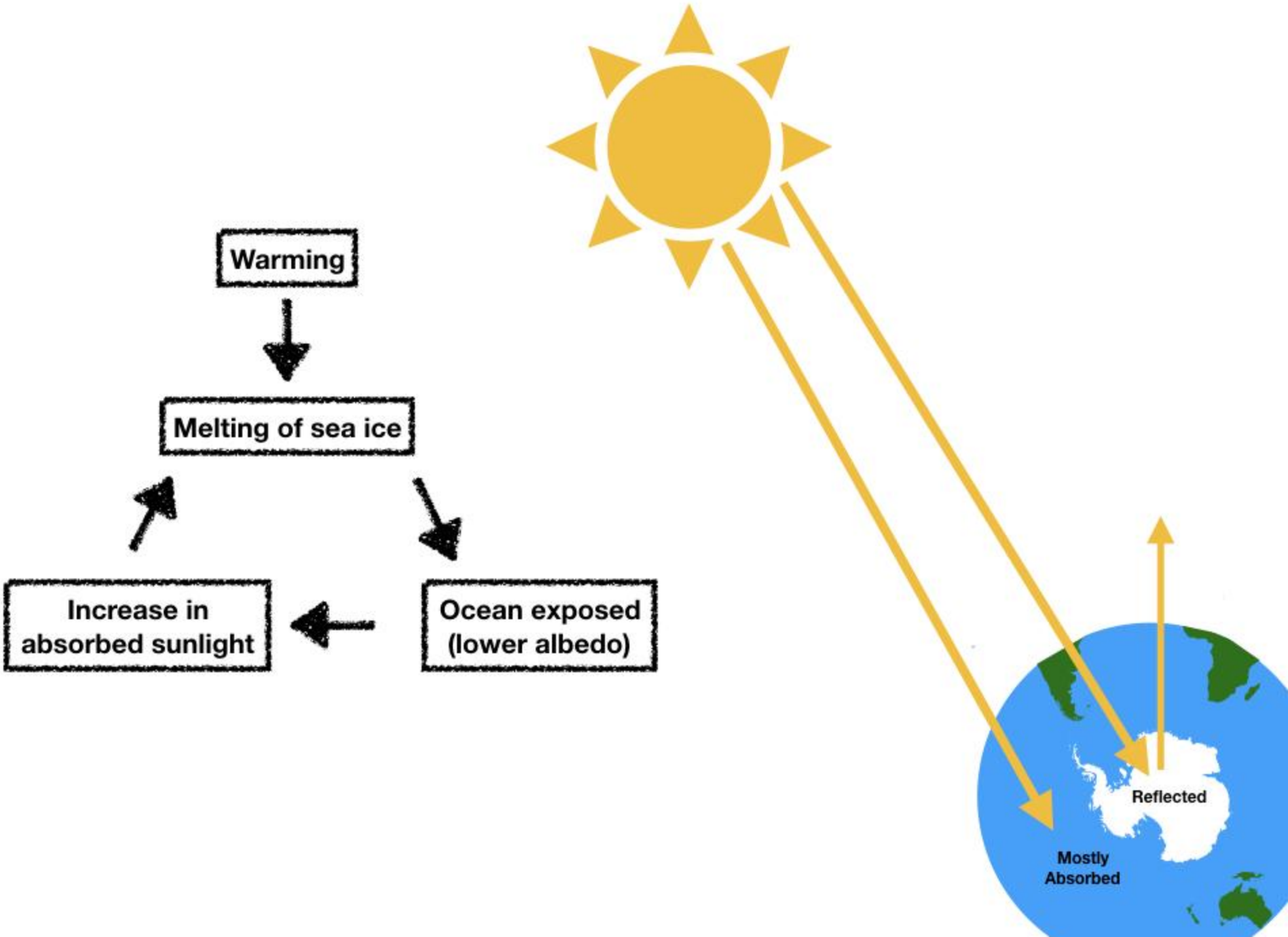
- If the atmospheres are warmed, the saturation vapor pressure increases, and the amount of water vapor in the atmosphere will tend to increase.
- Since water vapor is a greenhouse gas, the increase in water vapor content makes the atmosphere warm further; this warming causes the atmosphere to hold still more water vapor (a positive feedback).
- The result is a much larger greenhouse effect than that due to CO_2 alone.

Contd.

- When ice melts, land or open water takes its place.
- Both land and open water are on average less reflective than ice and thus absorb more solar radiation.
- This causes more warming, which in turn causes more melting, and this cycle continues.
- During times of global cooling, additional ice increases the reflectivity which reduces the absorption of solar radiation which results in more cooling in a continuing cycle.

Ice–albedo feedback

- Ice–albedo feedback is a positive feedback climate process where a change in the area of ice caps, glaciers, and sea ice alters the albedo and surface temperature of a planet. Ice is very reflective, therefore some of the solar energy is reflected back to space.
- Ice–albedo feedback plays an important role in global climate change.


Warming
Melting of sea ice
Ocean exposed (lower albedo)
Increase in absorbed sunlight
Reflected
Mostly Absorbed

Vulnerability assessment

- Methods of vulnerability assessment have been developed over the past several decades in natural hazards, food security, poverty analysis, sustainable livelihoods and related fields. These approaches—each with their own nuances—provide a core set of best practices for use in studies of climate change vulnerability and adaptation

- Climate change vulnerability assessments help establish understanding of the extent to which changing climate will affect the system in question (e.g. basin, water use sector, country, city, etc.).
- Three key components of vulnerability – exposure, sensitivity and adaptive capacity.

- Thus vulnerability assessments eg : in temperature and rainfall (exposure), assessing the characteristics of the system itself and how it may respond to such hazards is (sensitivity), as well its ability to deal with the anticipated impacts is (adaptive capacity).

- In the context of water resource management, vulnerability assessments may focus system vulnerability to reduced water availability, increased seasonal variability, changes in water quality, vulnerability to increased seasonal water variability, but also vulnerability to extreme events such as floods and droughts, amongst other things

- **Vulnerability Assessments can support adaptation planning in several ways:**
- Identify areas most likely to be impacted by projected changes in climate;
- Build an understanding of why these areas are vulnerable, including the interaction between climate change, non-climatic stressors, and cumulative impacts;
- Assess the effectiveness of previous coping strategies in the context of historic and current changes in climate; and
- Identify and target adaptation measures to systems with the greatest vulnerability.