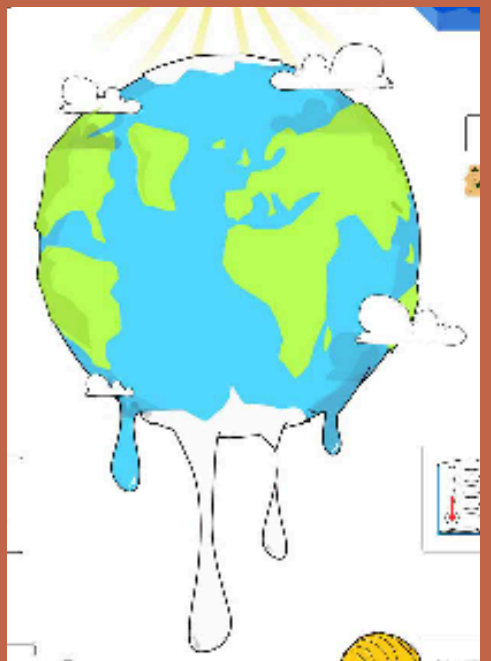
MODULE 3Adaptation and mitigation strategies



Green Engineering

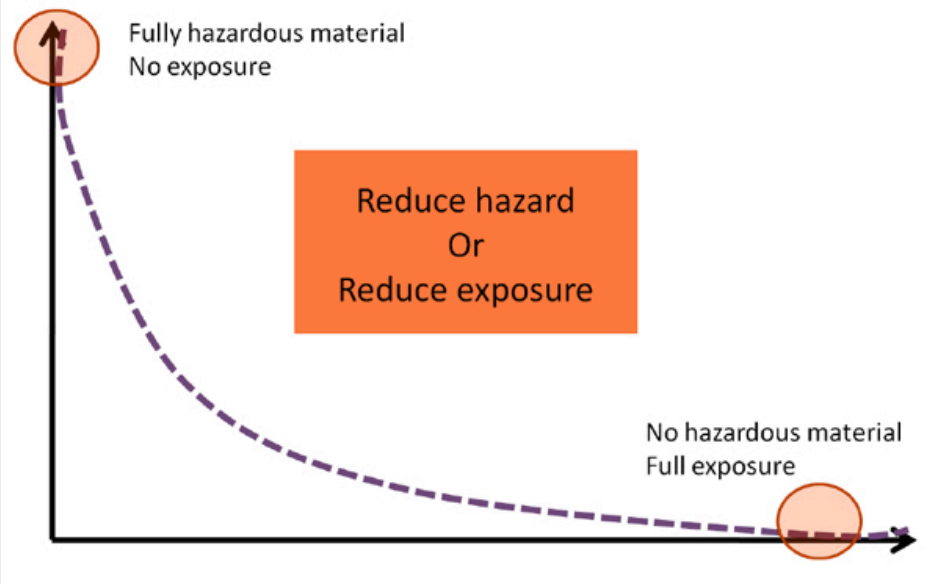
- Green Engineering is the development and commercialization of industrial processes that are economically feasible and reduce the risk to human health and the environment.

Green Engineering is the design, commercialization, and use of processes and products to reduce pollution, promote sustainability, and minimize risk to human health and the environment without sacrificing economic viability and efficiency.

Principles of Green Engineering

1. Inherent Rather Than Circumstantial

- Designers need to strive to ensure that all materials and energy inputs and outputs are as inherently nonhazardous as possible.



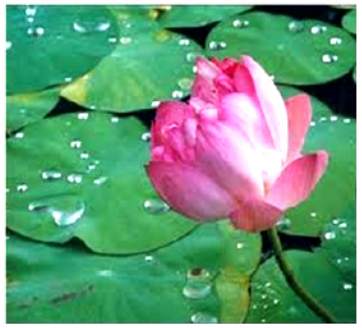
Principles of Green Engineering

2. Prevention Instead of Treatment

- It is better to prevent waste than to treat or clean up waste after it is formed.

3. Design for Separation

- Separation and purification operations should be designed to minimize energy consumption and materials use.



NeroShield™ CT100 - Concrete Care

Principles of Green Engineering

4. Maximize Efficiency

- Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.
  - Mass Efficiency is defined as the ratio between the Actual Component Mass to that of the Raw Material required to produce the same component.
  - Energy Efficiency is defined as the ratio between the minimum energy required to produce a component to that of the actual energy consumed to produce the same component

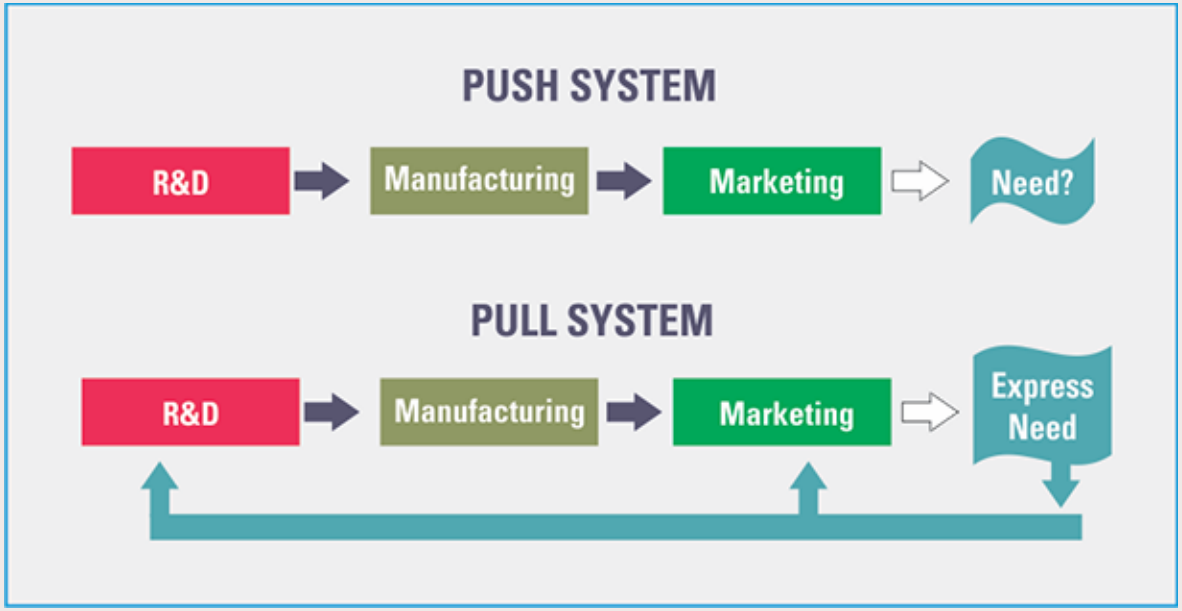
Principles of Green Engineering

5. Output-Pulled Versus Input-Pushed

- Products, processes, and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.
- In pull type marketing, the customer wants/needs the product and in push type marketing, the products are pushed to the customers
- When a product is pushed to the customer, it is creating an artif icial demand and hence this practice may use more energy and material than required. Therefore, it is not supporting sustainability.

Principles of Green Engineering

5. Output-Pulled Versus Input-Pushed



Principles of Green Engineering

6. Conserve Complexity

- Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.
- A complex system contains many constituents and they interact nonlinearly and they are interdependent. It also possesses structure spanning several scales and the system is capable of adapting to the new environment.
- It is appropriate to consider the complexity of the system before deciding whether to reuse, recycle, or discard.
- If a simpler system can achieve the same function as a complex system, from a sustainability point of view, the simpler system is better

Principles of Green Engineering

7. Durability Rather Than Immortality

- Targeted durability, not immortality, should be a design goal.
- During the design stage, designing a robust system that lasts forever has been one of the best practices. Such practices result in overdesign (i.e., less mass, energy, and temporal efficiency).
- Products that last well beyond their useful life often cause environmental issues.
- Technological obsolescence is another issue when a product is designed to outlast its technological life cycle.
- If a component within a system has a longer life than the system, then the design should accommodate for easy removal and reuse or recycle of the component.

Principles of Green Engineering

8. Meet Need, Minimize Excess

- Design for unnecessary capacity or capability (e.g., “one size fits all”) solutions should be considered a design flaw.
- Unnecessary capacity and designing with unnecessary capability will consume additional resources during all life cycle stages.

Principles of Green Engineering

9. Minimize Material Diversity

- Material diversity in multicomponent products should be minimized to promote disassembly and value retention.
- Material diversification causes many sustainability issues.
- For example, at the interface of the two materials, there can be chemical corrosion resulting in loss of strength and also cause environmental issues during disposal.
- Also, if the design does not accommodate ease of separation at the end of life, the land fill will either have to spend enormous resources to separate them to either reuse or recycle them or leave them as it resulting in contamination of the landfill.

Principles of Green Engineering

10. Integrate Material and Energy Flows

- Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.
- A manufacturing plant has many processes and many products manufactured simultaneously. Some of the processes may produce excess heat that can be used elsewhere in another process. Similarly, one area may be producing excess material that can be shared with another area as raw material.

Principles of Green Engineering

11. Design for Commercial “Afterlife”

- Products, processes, and systems should be designed for performance in a commercial “afterlife.”
- If a component or sub-system within a system reaches "end-of-life" prior to the system's end-of-life, then the design of such system should accommodate the component or sub-system to be upgraded or substituted.

Principles of Green Engineering

12. Renewable Rather Than Depleting

- Material and energy inputs should be renewable rather than depleting.
- Using a renewable form of energy such as solar, wind etc. or waste from this product becomes a feedstock for another product.

Design for Engineering, Green technologies

What is green technology

- It is a technology which is environmentally friendly, developed and used in such a way so that it doesn't disturb our environment and conserves natural resources.
- It is also known as environmental technology and clean technology

WHAT IS GREEN TECHNOLOGY

"Green Technology" is a system that uses innovative methods to create an environmental friendly products

It uses renewable natural resources that never depletes, so future generation can also benefit from it.

It can effectively change waste pattern and production in a way that it won't harm the planet.

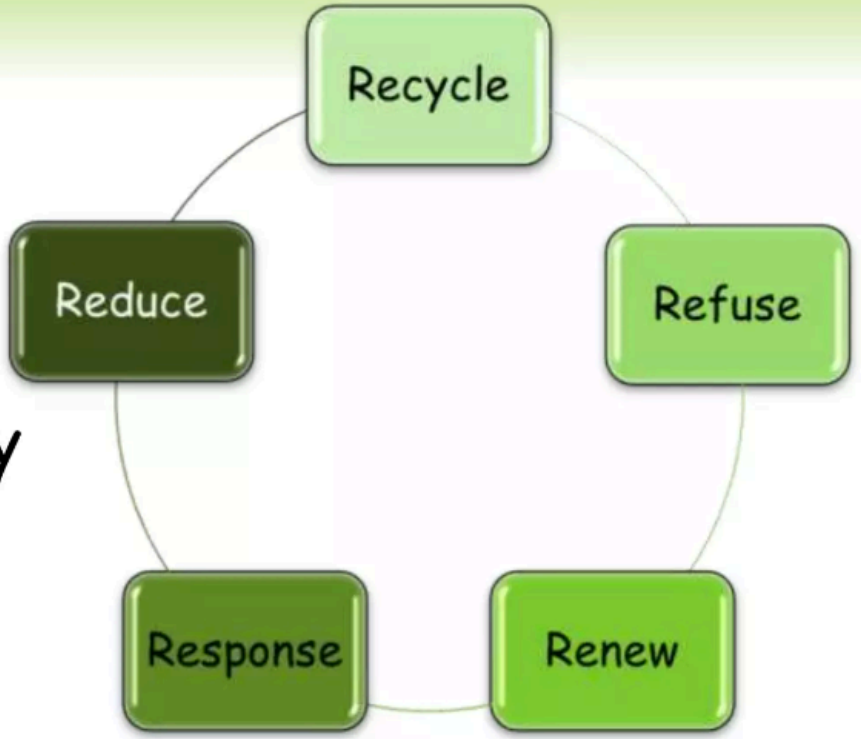
Design for Engineering, Green technologies

- Green engineering technologies help to create sustainable, eco-friendly designs and solutions with the aid of updated tools, methods, designs, and innovations.

- These technologies play a significant role in optimizing sustainability in various areas of energy, agriculture, waste management, and bioremediation.

Goals of green technology

- Reduce
- Recycle
- Refuse
- Renew
- Responsibility

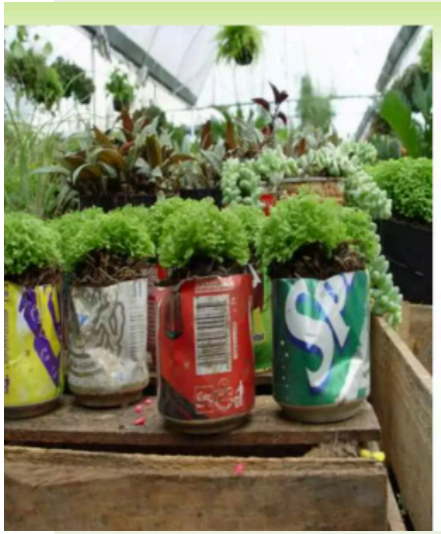


Goals of green technology
1. Reduce

- Fuels
- Waste
- Energy consumption
- Wastage of clean water

Goals of green technology
2. Recycling

- Paper
- Plastic
- Cans
- Batteries
- Clothing



Goals of green technology
3. Renewing

- Renewing Energy:

1. Wind power
2. Water power
3. Solar Energy
4. Bio-fuel

- Waste water

GOALS OF GREEN TECHNOLOGY

4.REFUSE

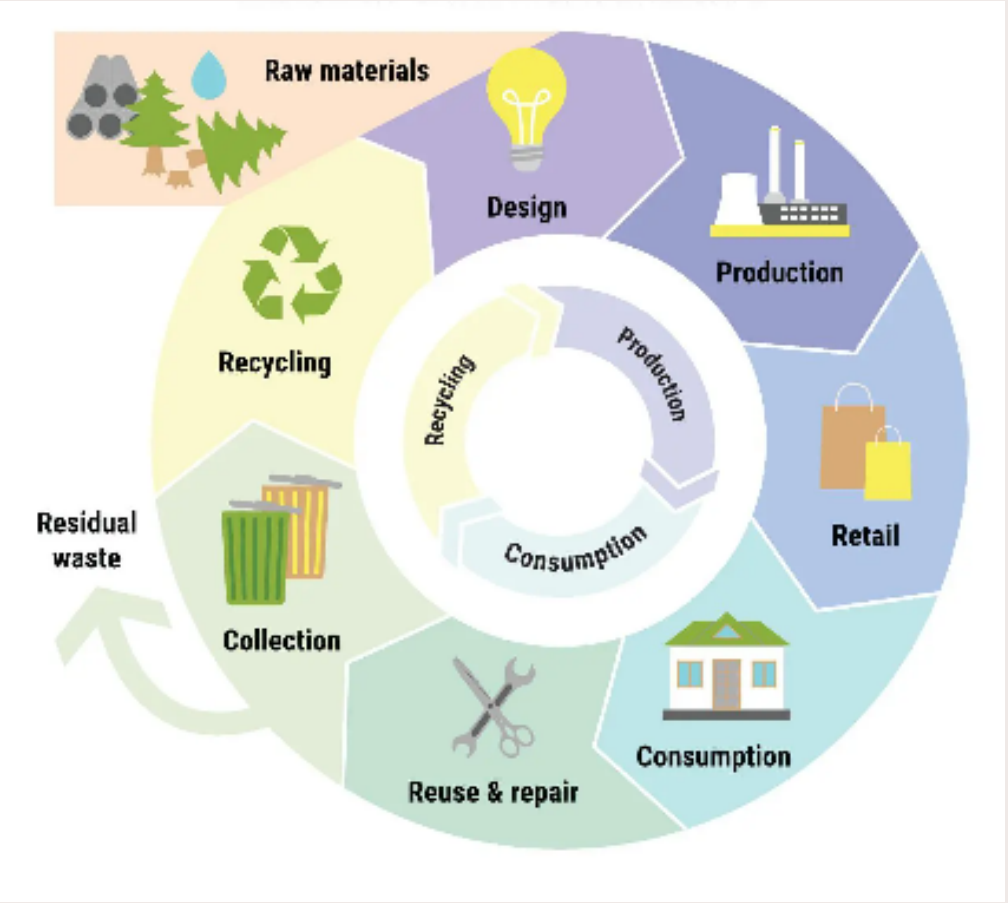
Refuse the use of plastic bags

Goals of green technology
5. Responsibility

- Don't waste electricity – Switch off electrical equipment when not required.
- Don't waste water – Never leave taps open while brushing or washing dishes.
- Don't waste fuel
- Don't waste food – Don't cook extra food and throw, always keep in mind that there are million in the world starving without food

Branches Of Green Technology

- Green Chemistry
- Green Energy
- Green IT
- Green Building
- Green Nanotechnology

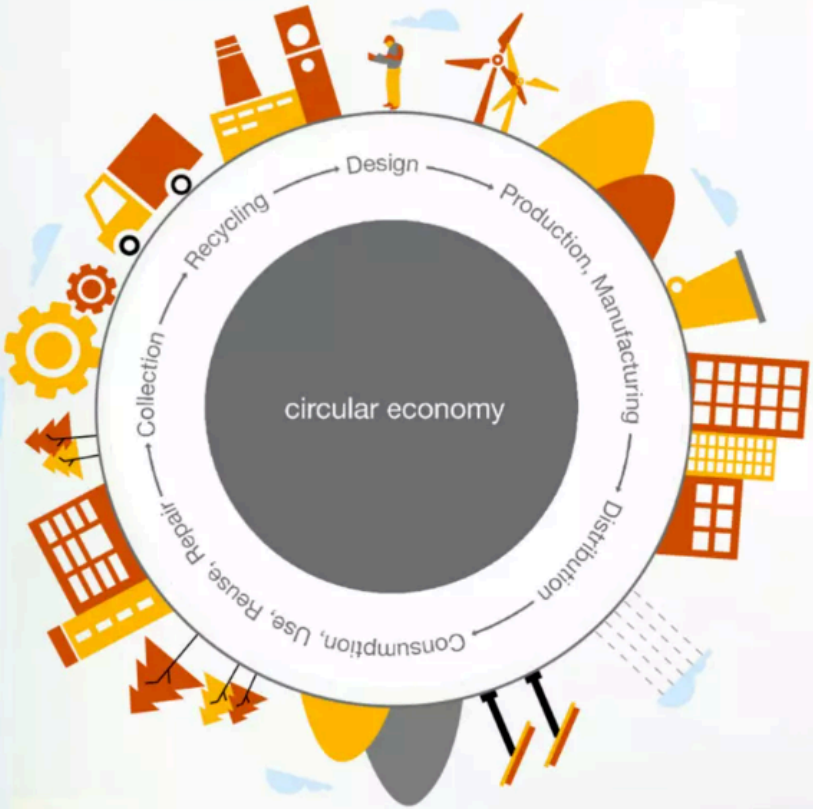


Circular economy

- A circular economy entails markets that give incentives to reusing products, rather than scrapping them and then extracting new resources.

- In such an economy, all forms of waste, such as clothes, scrap metal and obsolete electronics, are returned to the economy or used more efficiently.

DEFINING CIRCULAR ECONOMY



Credit: PwC

Defined as a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials & products for as long as possible.

Ideally, circular economy aims to increase the life cycle of products.

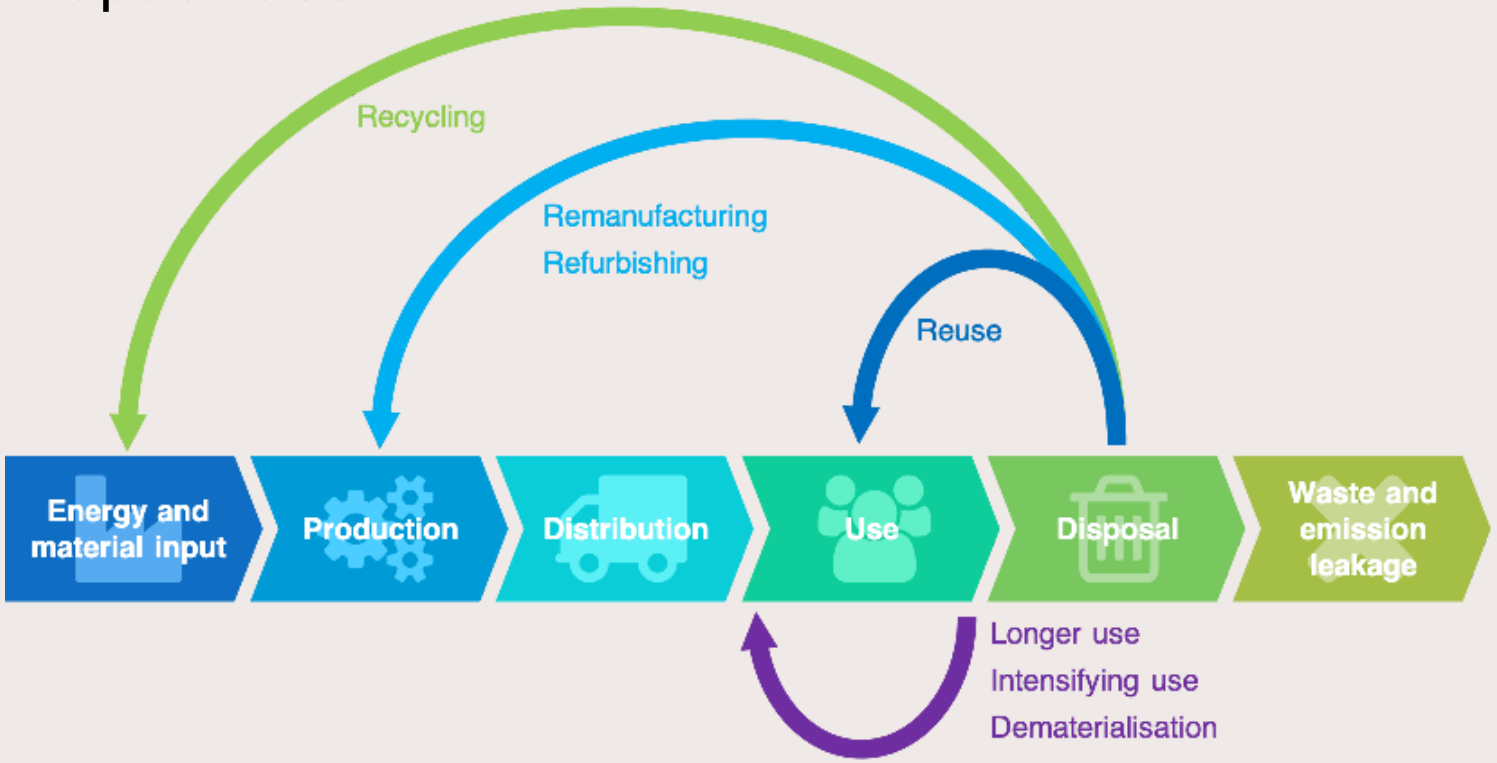
Source: https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits

Circular economy

- In practice, it implies reducing waste to a minimum.
- When a product reaches the end of its life, its materials are kept within the economy wherever possible.
- These can be productively used again and again, thereby creating further value.

Circular economy

- This can provide a way to not only protect the environment but use natural resources more wisely, develop new sectors, create jobs, and develop new capabilities.



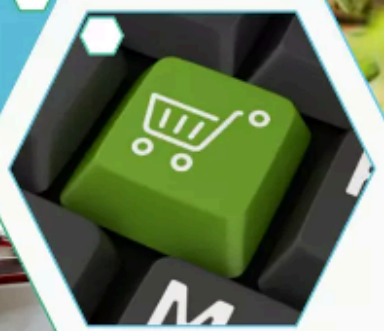
Circular economy

BENEFITS OF CIRCULAR ECONOMY

Towards Zero Waste

Benefits Consumers (long-lasting products)

New Opportunities (jobs)



Reduce Carbon Emissions

Renewable Resources (instead of finite)

LINEAR VS RECYCLE VS CIRCULAR ECONOMY

LINEAR ECONOMY

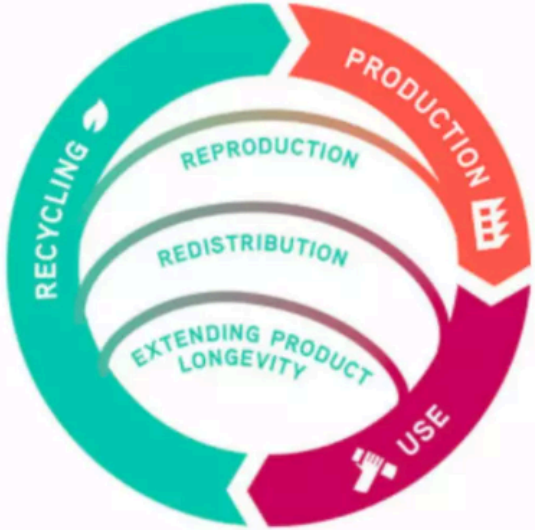
Harvesting of finite materials & resources, manufacture and simply dispose after use. Accumulates waste.

RECYCLING ECONOMY

Economy with feedback loops that recycles & reuse materials in an effort to minimize waste and increase sustainability.

CIRCULAR ECONOMY

Continuous use of renewable energy, materials & resources within a circular loop aimed at keeping wastes to a minimum.



THE NEED FOR CIRCULAR ECONOMY

45% of CO_2 Emissions due to Production

Manufacturing & production of everyday materials.

22.2b tons of Biomass Annually

Amount of biomass harvested to feed the global population annually.

87% of CO_2 Emissions from Fossil Fuels

Burning of coal, natural gas & oil.

2/3 Materials Harvested Lost

- **In 2015, more than 67 billion tons of harvested material are irretrievably lost**
- **1/3 of food rotted and disposed**
- **Only 9.3 billion tons (9%) of plastic are captured & recycled**

- ***National Geographic***

THREE PRINCIPLES OF CIRCULAR ECONOMY

ELIMINATE POLLUTION

Harness new materials & process technologies to ensure waste & pollution are not created in the first place.

CIRCULATE PRODUCTS & MATERIALS

Redesign products to be reused, repaired or re-manufactured so that they last longer and kept in circulation.

REGENERATE NATURE

Return nutrients to the forest, replant trees, remove plastic waste from the ocean, working with nature for benefit of all.

Planning of cities as climate resilient

- Climate resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate.
- Climate resilience refers to how well something withstands, and how quickly it recovers from, natural hazards made worse by climate change.

Planning of cities as climate resilient

- Climate resilience is often associated with acute events – like heat waves, heavy downpours, hurricanes, or wildf res – that will become more frequent or intense as the climate changes.
- Good resilience planning also accounts for chronic events, like rising sea levels, worsening air quality, and population migration

Planning of cities as climate resilient

- Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks.

- Cities and local communities are responding by investing in infrastructure updates and climate-smart planning to mitigate the impacts of acute and chronic events.

Planning of cities as climate resilient

The necessity of Climate Resilient Cities:

- Climate change will have impacts on many sectors:

✔ Temperature and precipitation variability will impact agriculture and subsequently food security, and livelihoods, which will increase the extent and severity of vector-borne diseases as the incidence of floods and waterlogging increases

✔ Flooding will cause loss and damage to infrastructure and property in affected areas

Planning of cities as climate resilient

The necessity of Climate Resilient Cities: (cont..)

- Climate change will have impacts on many sectors: (cont..)

✔ Sea level rise will cause damage to coastal ecosystems, increase damages from storm surges and will make coastal freshwater aquifers saline.

✔ Climate-induced disasters will have serious economic and social consequences like loss to property, infrastructure, health, forced migration etc.,

Planning of cities as climate resilient

- Addressing climate change and creating climate resilience in cities includes:
  - ❖ building resiliency in city water supply,
  - ❖ reducing the risk of f boding from cloudbursts or storm surges with nature-based solutions
  - ❖ ensuring wastewater infrastructure that can withstand the increasing pressure that climate change puts on sewers and treatment plants

Pla limate


Understand local climate
Identify vulnerabilities, risks and impact
Formulate adaptation options
Assess and prioritise options
Implement measures
Monitor and evaluate effectiveness
Review strategies
Resilience Framework

Planning of cities as climate resilient

Author: R. Tiffer Sotomayor. 2022

Planning of cities as climate resilient

Benefits of Climate-Resilient Cities:

- They have the capability to reduce and manage the negative impacts of climate change because they have planned and factored these changes in their development goals and planning by:

✔Utilizing climate information (past and future) to identify climate stressors typical to their cities/region

✔Preparing and implementing strategies to reduce the vulnerability of population and city systems.

✔ Adapting to change, preparing and responding to disasters, mitigating GHG emissions

Planning of cities as climate resilient: Examples

Stormwater solutions with multiple purposes, Roskilde, Denmark

- The storage tank serves a double purpose as a recreational facility for skaters
- Skate bowl is a lake that can hold rainwater in a flooding situation.

Planning of cities as climate resilient: Examples

Kampung Admiralty, Singapore

- Aim is to integrate housing for the elderly, and hence Singapore's flagship vertical village.
- The design of the Hydrological system allows for over a million gallons of tap water to be conserved each year as storm water runoff is stored in the rainwater harvesting tank and reused for irrigation.

Climate change and infrastructure planning

Climate resilient infrastructure

Climate resilient infrastructure

- Climate change adaptation measures that can be adopted to help make infrastructure more climate-resilient include:

o the rehabilitation of water supply and sanitation systems to reduce leakages

oadoption of measures to reduce demand, thus easing water scarcity, and pressure on existing water sources

Climate resilient infrastructure

- Climate change adaptation measures that can be adopted to help make infrastructure more climate-resilient include: (cont..)

- making energy efficiency investments through solar power and solar water heating
- conducting community information campaigns on the benefits of climate-resilient and energy-efficient basic infrastructure
- exploring design alternatives that mitigate climate-related risks

Climate resilient infrastructure

There are three main aspects of climate resilience:

- Preparation
- adaptation, and
- recovery.

Climate resilient infrastructure

Preparation

- It includes building structures to withstand signif icant stresses, like high winds and powerful tremors while sustaining minimal damage.
- Some buildings need only small changes to become climate-resilient, like applying storm shutters or fastening shelves.
- Others will need fundamental changes, like elevating the structure off the ground, bracing structural elements, or switching to fireproof materials.
- some communities will need new construction, like concrete seawalls and levees to protect from stronger hurricanes.

Climate resilient infrastructure

Preparation (cont..)

- Preparation also means communicating hazard risks to residents, so they know how to shelter or evacuate when disasters strike.
- Communications can include hazard maps, text alerts, or evacuation routes.
- In a diverse country, these messages must be communicated in many languages.

Climate resilient infrastructure

❑ Adaptation

- It recognizes that hazard risks change—especially on a warming planet—and that we need flexible responses.
- Zoning laws and building codes need to be continuously updated to reflect climate projections.
- Older homes must also be retrofitted to ensure they meet the highest construction standards.

Climate resilient infrastructure

Recovery

- Communities must make plans and reserve resources for recovery. To be effective, recovery must be both complete and rapid.
- For homeowners, this means quickly assessing damage, communicating it to insurance companies, and commissioning repairs.
- And governments at all levels must prepare to facilitate this work. For instance, if roads are not cleared of debris after a storm, they can thwart repairs and distribution of aid.
- The return of business activity and public services after a disaster is also vital to recovery.

Nature based solutions in disaster management

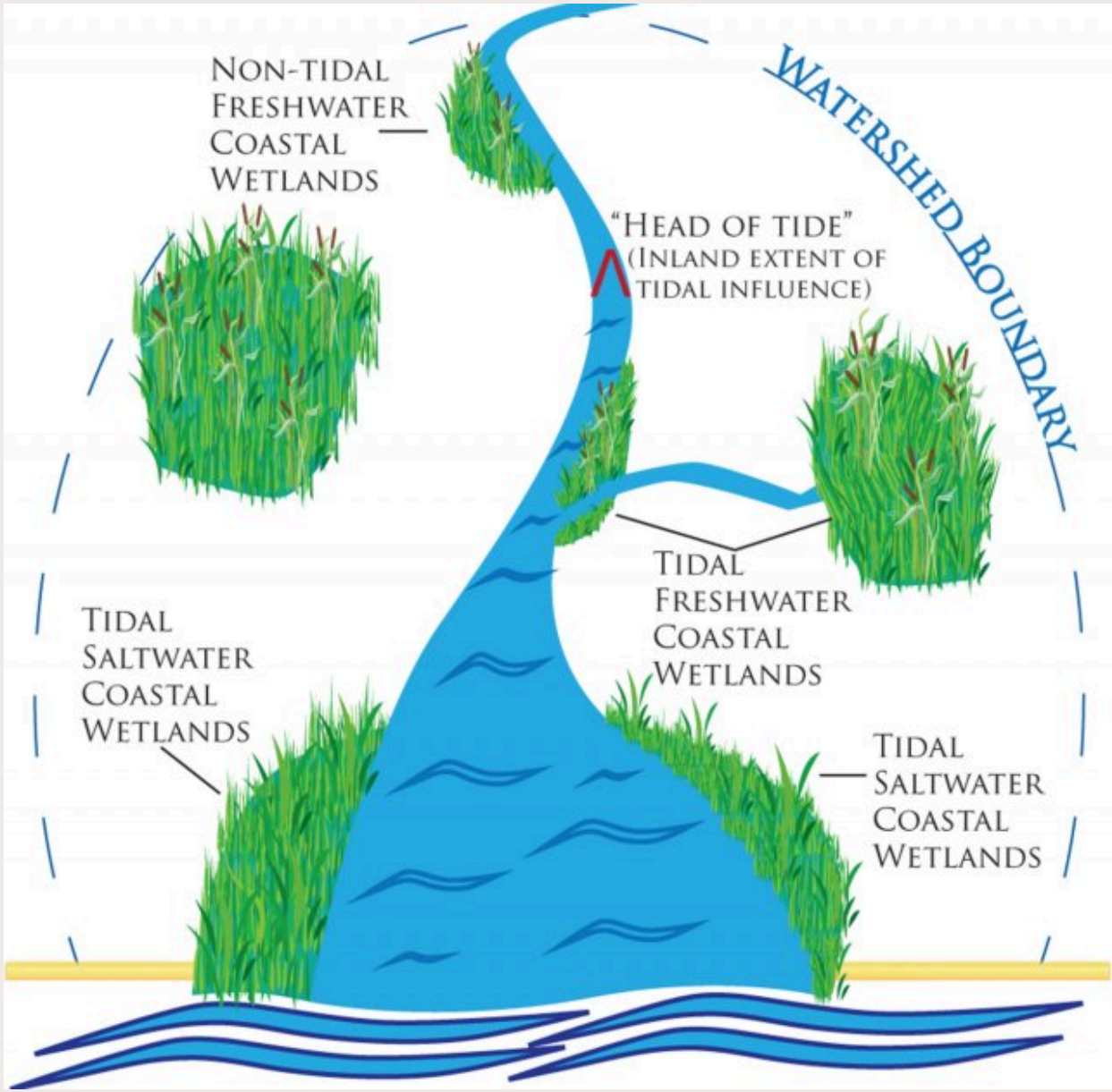
Nature based solutions in disaster management

- Climate change is increasing the frequency, intensity and magnitude of disasters, leading to a higher number of deaths, injuries and increased economic losses.
- Nature can be a cost-effective and no-regret solution to reducing risks from disasters, complementing conventional engineering measures such as sea walls and storm channels.

Nature based solutions in disaster management

- Nature-based solutions (NbS), such as conserving forests, wetlands and coral reefs, can help communities prepare for, cope with, and recover from disasters, including slow-onset events such as drought.


Urban wetlands
make cities liveable
Filter and improve water quality
Spaces for recreation and education
Provide livelihood opportunities
Buffer impact of floods and storm surges
Biodiversity habitats
Improve air quality and abate heat islands
Replenish groundwater
Urban wetlands
make cities vibrant


NON-TIDAL
FRESHWATER
COASTAL
WETLANDS
WATERSHED BOUNDARY
"HEAD OF TIDE"
(INLAND EXTENT OF
TIDAL INFLUENCE)
TIDAL
FRESHWATER
COASTAL
WETLANDS
TIDAL
SALTWATER
COASTAL
WETLANDS
TIDAL
SALTWATER
COASTAL
WETLANDS

Nature based solutions in disaster management

- Forests and other vegetation help stabilise slopes and therefore reduce the risk of landslides.
- Wetlands can help regulate floods.
- Coastal vegetation and natural features such as sand dunes and mangroves can provide protection from storm surges, strong winds and cyclones.
- Healthy coral reefs can reduce wave energy during coastal storms.

Nature based solutions in disaster management

- *In 2013, when Typhoon Haiyan hit the Philippine province of Leyte, 5,500 people died from storm surges along exposed coastlines.*
- *However, several communities in the same area remained relatively unaffected and credited the presence of mangroves with saving their lives and properties.*

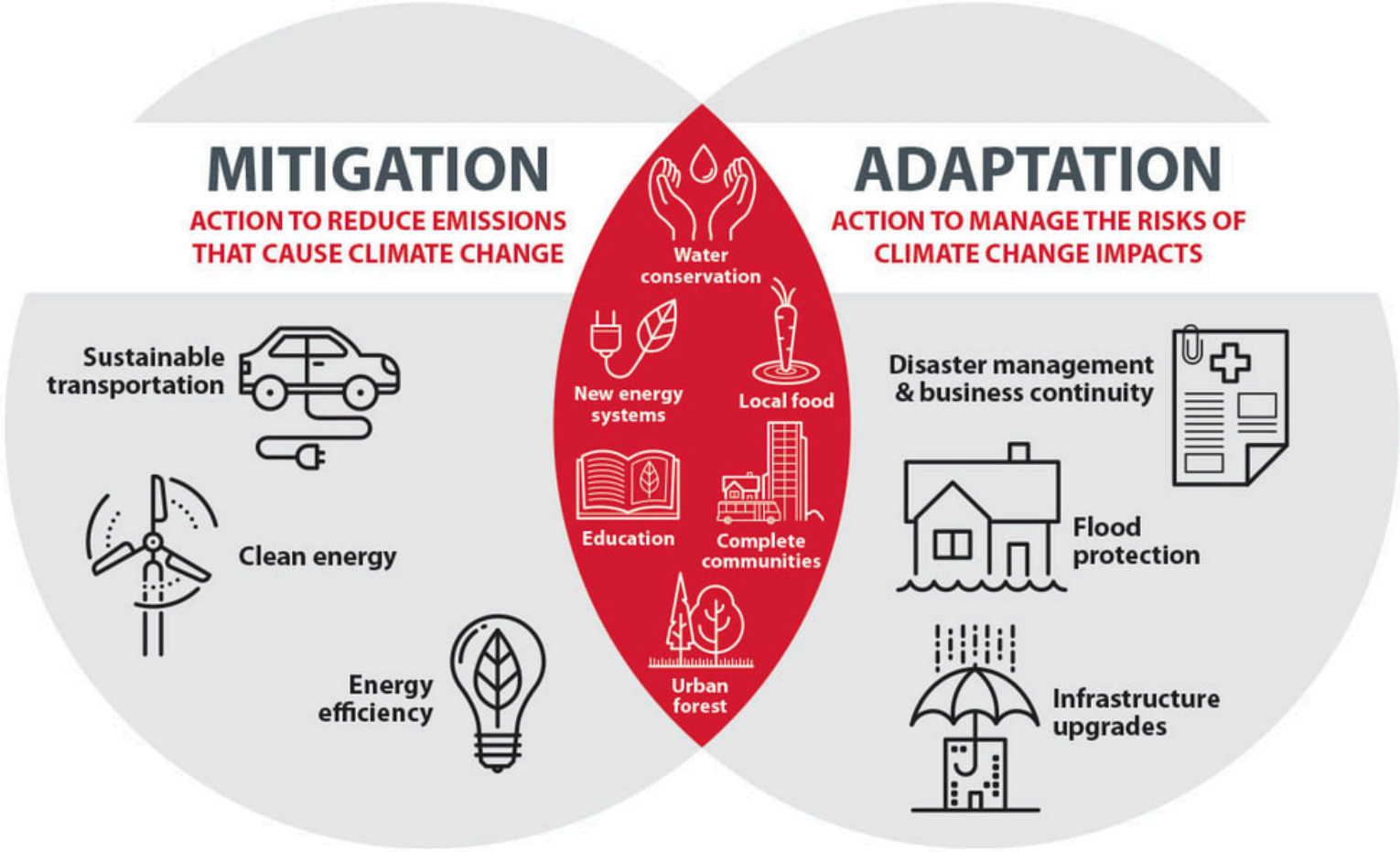
adaptation strategies for combating climate change

6 actions preventing climate change

Sustainability for all www.activesustainability.com

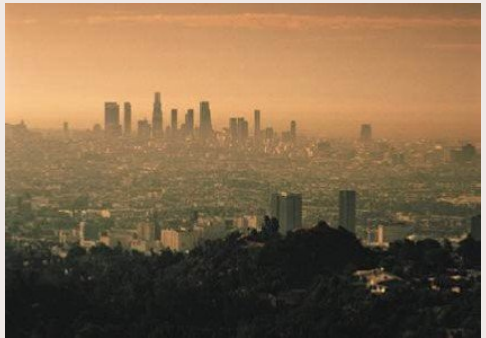
acciona

Building Climate Resilience



adaptation strategies for combating climate change-OUTDOOR AIR

- Climate changes can make it more difficult for communities to maintain air quality that protect human health and the environment.
- Increases in ground level ozone (tropospheric ozone) pollution levels due to climate change may make it more difficult to attain or maintain ozone standards.
- Climate change may also increase particulate matter (PM) levels through changes in the frequency or intensity of wildfires



adaptation strategies for combating climate change-OUTDOOR AIR

Voluntary Transportation Tips

- Reduce vehicle emissions by encouraging smart growth development.
- Choose a cleaner commute — car pool, use public transportation, bike or walk when possible.
- Combine errands to reduce "cold starts" of your car and avoid extended idling.
- Be sure your tires are properly inflated.
- Keep car, boat and other engines properly tuned, and avoid engines that smoke.
- Follow gasoline refueling instructions for efficient vapor recovery. Be careful not to spill fuel and always tighten your gas cap securely.

adaptation strategies for combating climate change-OUTDOOR AIR

Household Tips

- Use environmentally safe paints and cleaning products whenever possible.
- Some products that you use at your home or office are made with smog-forming chemicals that can evaporate into the air when you use them. Follow manufacturers' recommendations for use and properly seal cleaners, paints, and other chemicals to prevent evaporation into the air.
- Conserve electricity. Consider setting your thermostat a little higher in the summer and lower in winter. Participate in local energy conservation programs. Look for the ENERGY STAR label when buying home or office equipment.
- Consider using gas logs instead of wood. If you use a wood-burning stove or fireplace insert, make sure it meets EPA design specifications. Burn only dry, seasoned wood.

adaptation strategies for combating climate change-OUTDOOR AIR

Days when ozone is expected to be high:

- Conserve electricity and set your air conditioner at a higher temperature.
- Choose a cleaner commute — car pool, or use public transportation.
- Refuel cars and trucks after dusk.
- Combine errands and reduce trips.
- Limit engine idling.
- Use household, workshop, and garden chemicals in ways that keep evaporation to a minimum, or try to delay using them during poor air quality days.

Days when particle pollution is expected to be high:

- Reduce or eliminate fireplace and wood stove use.
- Avoid using gas-powered lawn and garden equipment.
- Avoid burning leaves, trash and other materials.

adaptation strategies for combating climate change-INDOOR AIR

- **Proper ventilation** is essential for moisture control and to dilute pollutants generated indoors.
- Weatherization or retrofitting may include:

oinstalling storm windows

oweather stripping

ocaulking

oinsulating your home

- It should also include an assessment of the ventilation required, and adjustment to the ventilation if needed, to accommodate weatherization changes in the home.

adaptation strategies for combating climate change-WaTER

- Climate change can make it more difficult for communities to provide drinking water and wastewater services, protect water quality, and maintain healthy aquatic environments

- Construct New infrastructure
- Increase System Efficiency
- Model Climate Risk
- Modify Land Use
- Modify Water Demand
- Monitor Operational Capabilities
- Plan for Climate Change
- Repair and Retrofit Facilities

adaptation strategies for combating climate change-

WASTE

- Climate change can make it more difficult to properly manage hazardous and non-hazardous wastes.

PUBLIC HEALTH

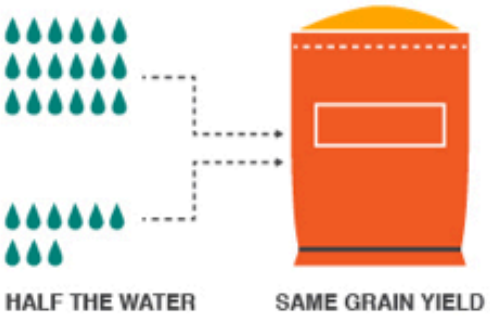
- Climate change can make it more difficult for communities to maintain public health.

Adaptation Strategies *for the* Developing World

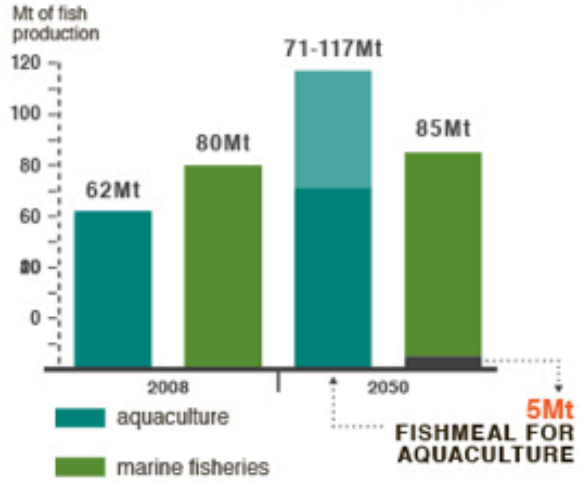
THERE ARE MANY FACTORS that affect crops, livestock, and marine life. These factors are often climate-related and out of the farmer's control. However, there are several adaptation strategies that can help mitigate risk, and provide the same amount of yield with limited resources.

Simple strategies like changing planting dates and using different seed varieties could offset potential yield decreases due to climate change.

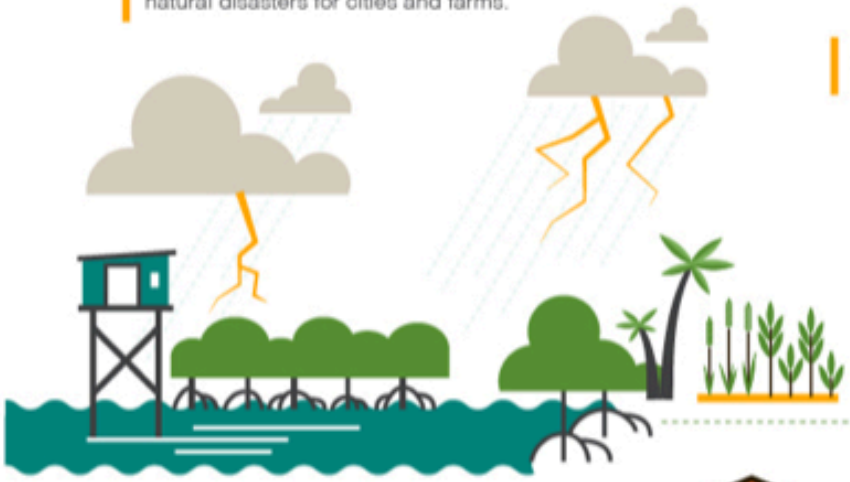
By using better agricultural techniques, farmers could use less water yet get the same yields.



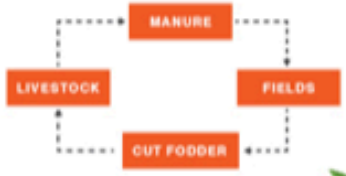
Aquaculture has a huge potential to meet future protein needs, but **CURRENTLY** relies on fishmeal, **A LIMTED RESOURCE.**



Mangroves provide protection from natural disasters for cities and farms.



Diversified farms incorporating both livestock + crops can ensure food security and mitigation benefits.



Agroforestry (trees on farms) can increase environmental benefits, helping farmers deal with increased climate variability

Wild relatives of current crops are a critical source of diversity for adapting to climate change, as they make plants resitent to harsher climates.

10% OF VIETNAMESE RICE FARMERS are already using sustainable intensification of rice.