Study Guide

2022-2023

NOVA SCOTIA

Nova Scotia Envirothon

Last Revised March 2023

Learning Outcomes: Aquatic Ecology

Abiotic

Identify the processes and phases of the water cycle.

Understand the concept of watersheds. Know the features of a healthy and unhealthy watershed.

Biotic

Identify aquatic species common to Nova Scotia and understand their dependence on one another. Know which aquatic species are considered 'at risk' and what their status is. Know how to use a dichotomous key to identify micro- and macro-invertebrates. Habitat: Understand habitat needs of aquatic species.

Understand the concept of migratory fish and give local examples.

Understand the impact invasive and introduced species can have on an ecosystem and give local examples.

Aquatic Environments

Know what classifies a wetland from other ecosystems. Understand the functions and values of wetlands.

Watercourse Protection & Conservation

Understand ways the Province manages, conserves and protects aquatic resources. Give examples of local regulations which are in place to protect aquatic resources. How can you protect aquatic resources?

Know various methods of conserving water and why they are important. How can you conserve water?

Understand water quality testing and monitoring and why these tests are used to assess and manage aquatic environments. Understand point and non-point source pollution and ways to reduce them. Explain how water quality can be improved.

Learning Outcomes: Forestry (1/2)

Tree Physiology & Identification

Identify common tree species without a key, know how to use a key for unusual & less common species in the Acadian Forest Region.

Know the characteristics (shade tolerance, longevity, site, common uses) of the tree species native to Nova Scotia.

Know the parts and tissues of a tree and be able to explain the growth processes as they relate to the life cycle, including photosynthesis and respiration.

Forest Ecology

Understand the structure of a forest (canopy, understory, ground layer and crown classes).

Understand forest ecology concepts and abiotic and biotic factors affecting them including the relationship between soil and forest types, tree communities, forest succession and biodiversity.

Sustainably Managed Forests

Understand what silviculture is and the various treatments used, both in even-aged and uneven-aged management (thinning, clear cutting, shelter wood, selection cutting, pre-commercial thinning, site preparation and planting).

Know how to use forestry tools and equipment in order to measure tree diameter, height and basal area. Be able to examine growth rings to determine tree age and tree history (periods of drought, growth, scarring from fire).

Be able to interpret macro-features from an aerial photograph.

Understand how social, economic and environmental factors influence forest management decisions and be able to address current forestry issues from different perspectives (ie. Clear cutting vs old growth, prescribed burns in protected areas), and know the provincial regulations pertaining to wildlife habitat and watercourse protection.

LEARNING OUTCOMES: FORESTRY (2/2)

Value of the Forests

Understand the importance and value of trees in an urban and community setting and what factors affect their health and survival.

Understand the economic value of forests and their importance to society including biodiversity, biomass, carbon sequestration, economic benefits, non-timber forests products, and why trees and forests are important to human health, recreation, wildlife and watershed quality.

Understand the economic importance of the forest industry to the provincial, national and international economies, and identify the main types of forest Products produced in the Maritimes.

Learning Outcomes: Soils and Land Use

Soil Conservation and Land Use Management

Understand why soils are a vital (and essentially non-renewable) natural resource that must be managed properly in order to sustain human society.

Compare different land uses and conservation practices and their impacts on soils, with particular emphasis on agriculture and food production.

Understand how soil management is integral to maintaining clean water and a healthy aquatic environment.

Chemical Properties of Soil and Soil Fertility

Understand how soil fertility reflects the overall chemical, physical, and biological conditions within a given soil.

Understand the concept of micronutrients and macronutrients as they relate to soils and plant nutrition.

Identify roles and benefits of organic matter in soils.

Physical Properties of Soil and Soil Formation

Understand basic soil forming processes and the factors affecting them.

Understand the concept of soil parent material and how different parent materials can affect soil properties.

Be able to identify common soil horizons and soil features and use this information to interpret soil properties and limitations for land use (e.g., texture, structure, colour, organic matter content, stoniness, drainage class).

Be able to use soil survey maps and related information to make interpretations about soil limitations, opportunities, and appropriate land use.

LEARNING OUTCOMES: WILDLIFE (1/2)

Birds, Mammals, Amphibians and Reptiles

Identify wildlife species common to Nova Scotia and the Maritimes using field guides, mounted specimens, skins/pelts, skulls, silhouettes, decoys, wings, scats, tracks, sounds or other common signs.

Define habitat and know the habitat requirements for wildlife and the factors that affect wildlife sustainability. Explain major causes of habitat loss in Nova Scotia.

Wildlife Ecology

Identify basic needs required by common wildlife species.

Describe wildlife adaptations and their significance (hibernation, migration, colouration, etc.). Identify general food habits (herbivore, omnivore, carnivore), habitats (terrestrial, aquatic) and habits (diurnal, nocturnal) using skull morphology and/or teeth. Identify and explain the advantages of physiological and/or behavioural adaptation of wildlife to their environment.

Know the difference between an ecosystem, community and population. Understand population dynamics such as birth, mortality, age-structure, sex ratio and mating systems. Understand the impact of limiting and decimating factors of common wildlife species on wildlife management. Understand the relationship between predator and prey.

Define succession and explain how a change in climate, topography or land use might modify the process of succession.

Define biodiversity and terminology (limited factor, territory, home range, forest fragmentation, etc.). Explain why biodiversity is important to people and wildlife. Understand the importance of the three levels of biodiversity (genetic, species and ecosystem/community) and the implications of loss at each level. Explain the major causes of biodiversity loss in NS.

Describe food chains, food webs and trophic levels with examples from NS.

LEARNING OUTCOMES: WILDLIFE (2/2)

Conservation and Wildlife Management

Understand the concept of carrying capacity and why it is the main factor affecting population size. Relate the concept of carrying capacity to a wildlife species native to NS. Understand the difference between biological carrying capacity and cultural carrying capacity.

Explain common wildlife management practices and methods that are being used to manage and improve wildlife habitat in NS. Understand the role hunters and trappers play in wildlife management. How can you help in the protection, conservation, management and enhancing of NS wildlife populations?

Issues Involving Wildlife and Society

Understand how non-native, invasive species threaten our environment and the biodiversity of many wildlife species. Understand the impact that non-native, invasive plants can have on wildlife habitat and native wildlife species. Be familiar with species that are non-native and/or invasive species to Nova Scotia.

Understand the impact that land-use decisions can have on wildlife populations. Understand that wildlife resources are under constant pressure caused by human population growth, environmental degradation and habitat reduction.

Understand the various status of 'at risk' species (vulnerable, threatened, endangered, extirpated, extinct) and the factors that are affecting these species. Understand species reintroduction. Explain common causes that lead to depleted populations and describe measures being taken to help their recovery. Know the organization and agencies responsible for listing species as 'at risk' on global, national and provincial levels.

Understand the impacts, both positive and negative, of people on biodiversity. Negative impacts could be fragmentation of habitat due to development (roads, buildings, etc.), disturbance of wildlife nesting seasons, destruction of habitat due to vehicles, motor vehicle collisions, trash interfering with wildlife health (food intake), pesticides in the environment. Positive impacts could be enhancement of wildlife habitat in order to attract wildlife viewing, increased knowledge through visiting wildlife and natural areas, funding for wildlife management.

Describe white nose syndrome and how is it affecting bats. What measures are being taken to discover outbreaks and prevent spread? Describe brainworm and how is it affecting the mainland moose population.

LEARNING OUTCOMES:
ADAPTING TO A CHANGING CLIMATE

Factors Contributing to a Changing Climate

1. Describe climate change and the process through which it occurs.
2. Outline the factors, both anthropogenic and natural, which influence climate and climate change.
3. Describe the major economic sectors that contribute to greenhouse gas (GHG) emissions.
4. Describe major energy sources and explain how each contributes to climate change.
5. Outline indicators of climate change

Measuring & Monitoring a Changing Climate

1. Describe the history of international collaboration on climate change and analyze the successes and shortcomings.
2. Describe the various sources of scientific data which are used as evidence of climate change and explain how we know this data to be reliable.
3. Evaluate climate data and draw conclusions based on that data.
4. Explain the use of modelling in forecasting climate and the sources of uncertainty in climate projections.

Risks & Impacts to Natural Resources & Society from a Changing Climate

1. Explain the consequences of climate changes on aquatic, forest, wildlife and soil ecosystems.
2. Describe the social and economic impacts of climate change.

Policies & Programs for Adapting to a Changing Climate

1. Explain how various levels of government, non-governmental organizations, and individuals are involved in mitigating and adapting to climate change at the local, national, and international levels.
2. Describe innovative technologies and programs designed to combat climate change.
3. Explain the importance of primary resource sectors (forestry, agriculture, fisheries) to the economy of Nova Scotia.
4. Describe the unique challenges faced by regions largely dependent on primary resources, and how climate change influences these challenges.
5. Explain how to best apply climate change risk assessment and adaptation measures in regions with primary resource dependent economies.

Source: Envirothon New Brunswick Current Environmental Issue Learning Outcomes, 2023

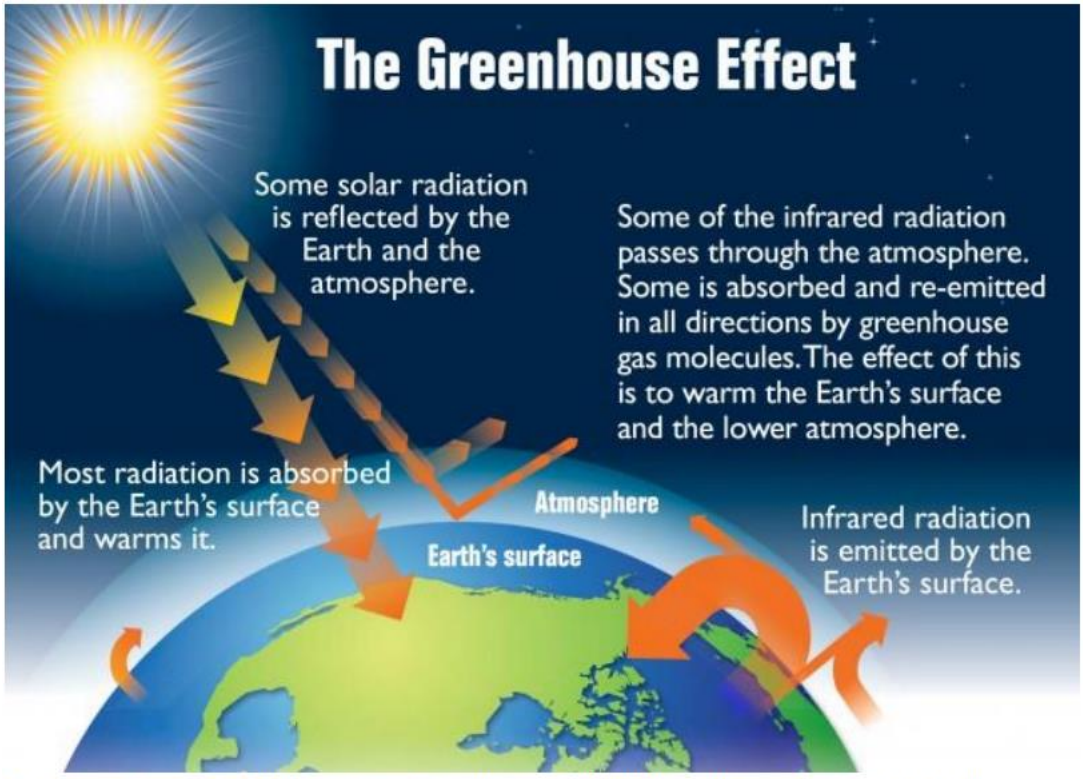
ADAPTING TO A CHANGING CLIMATE: KEY CONCEPTS

Key Topic 1: Factors Contributing to a Changing Climate

Key Concepts

The Greenhouse Effect | Key Greenhouse Gases | Other Greenhouse Gases | Aerosols | Climate Feedback

1. The Greenhouse Effect



The greenhouse effect helps trap heat from the sun, which keeps the temperature on earth comfortable. But people's activities are increasing the amount of heat-trapping greenhouse gases in the atmosphere, causing the earth to warm up.

1. The Greenhouse Effect

- Earth's temperature depends on balance between energy entering and leaving the planet's system
- Sunlight can be either reflected or absorbed by earth's surface
- Absorbed energy warms the planet; some of this energy is reflected back into atmosphere as heat (infrared radiation)
- Certain gases (greenhouse gases) in the atmosphere act like a blanket around the earth, keeping the earth warmer than it should be

2. Key Greenhouse Gases

- Carbon Dioxide
- Methane
- Nitrous Oxide
- F-Gases

The Carbon Cycle

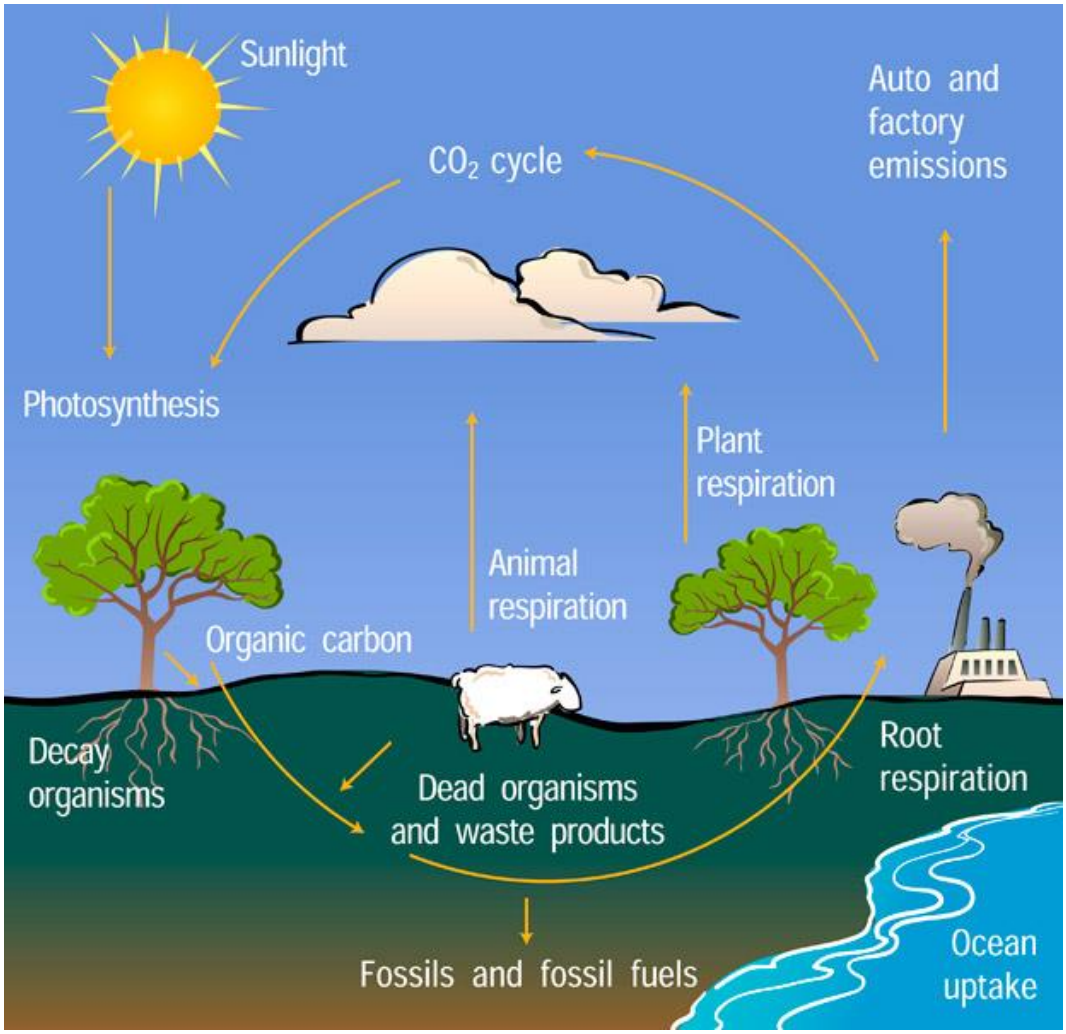


Image Source: UCAR Centre for Science Education, 2023

3. Other Greenhouse Gases

- Ground-Level Ozone
- Water Vapour

4. Aerosols

- Aerosols are microscopic (solid or liquid) particles
- These particles stay suspended in the air for days to weeks
- Human activities like burning fossil fuels and biomass contribute to emissions of aerosols, but they also occur from natural sources like volcanoes and marine plankton
- Depending on the aerosol, they can either have a cooling or a warming effect
- Aerosols can also interact with clouds, changing their ability to form and dissipate

5. Climate Feedbacks

Climate feedbacks are natural processes that respond to global warming by setting or further increasing change in the climate system. Two types of climate feedbacks: positive and negative.

Positive Feedbacks: Feedbacks that amplify changes

- Example: water vapour and the melting of Arctic sea ice
    - As the earth warms, rate of evaporation and amount of water vapour increase
    - Because water vapour is a greenhouse gas= warms the planet

Negative Feedbacks: Feedbacks that set the change in climate

- Example: Clouds
    - Clouds can have both cooling and warming effects on the climate
    - Clouds reflect sunlight= cooling the planet
    - Clouds slow the escape of heat into the atmosphere= warming the planet

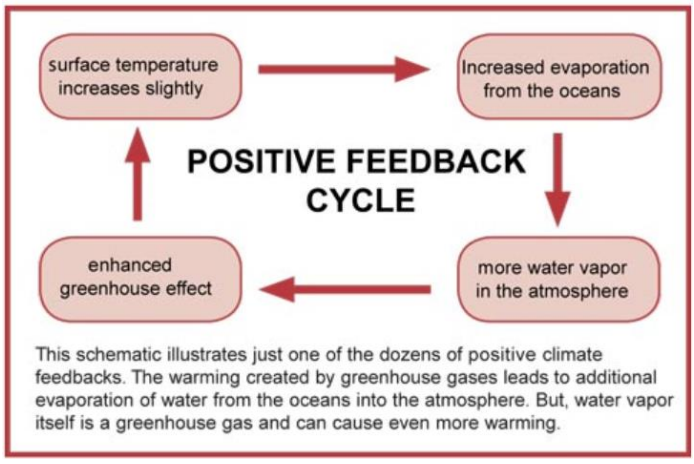
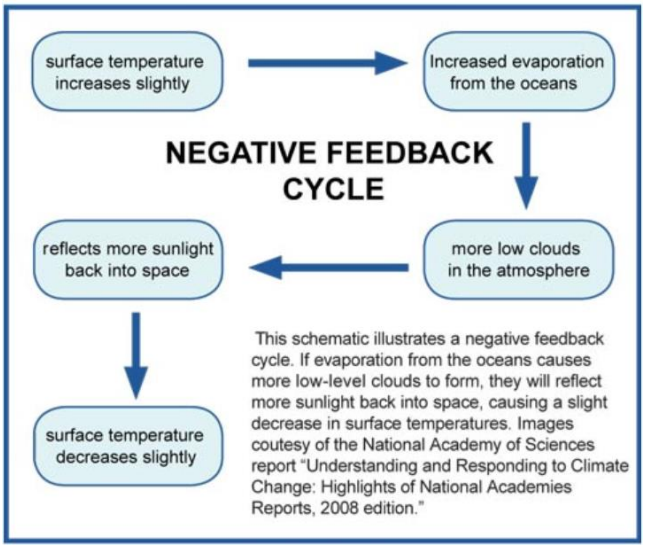
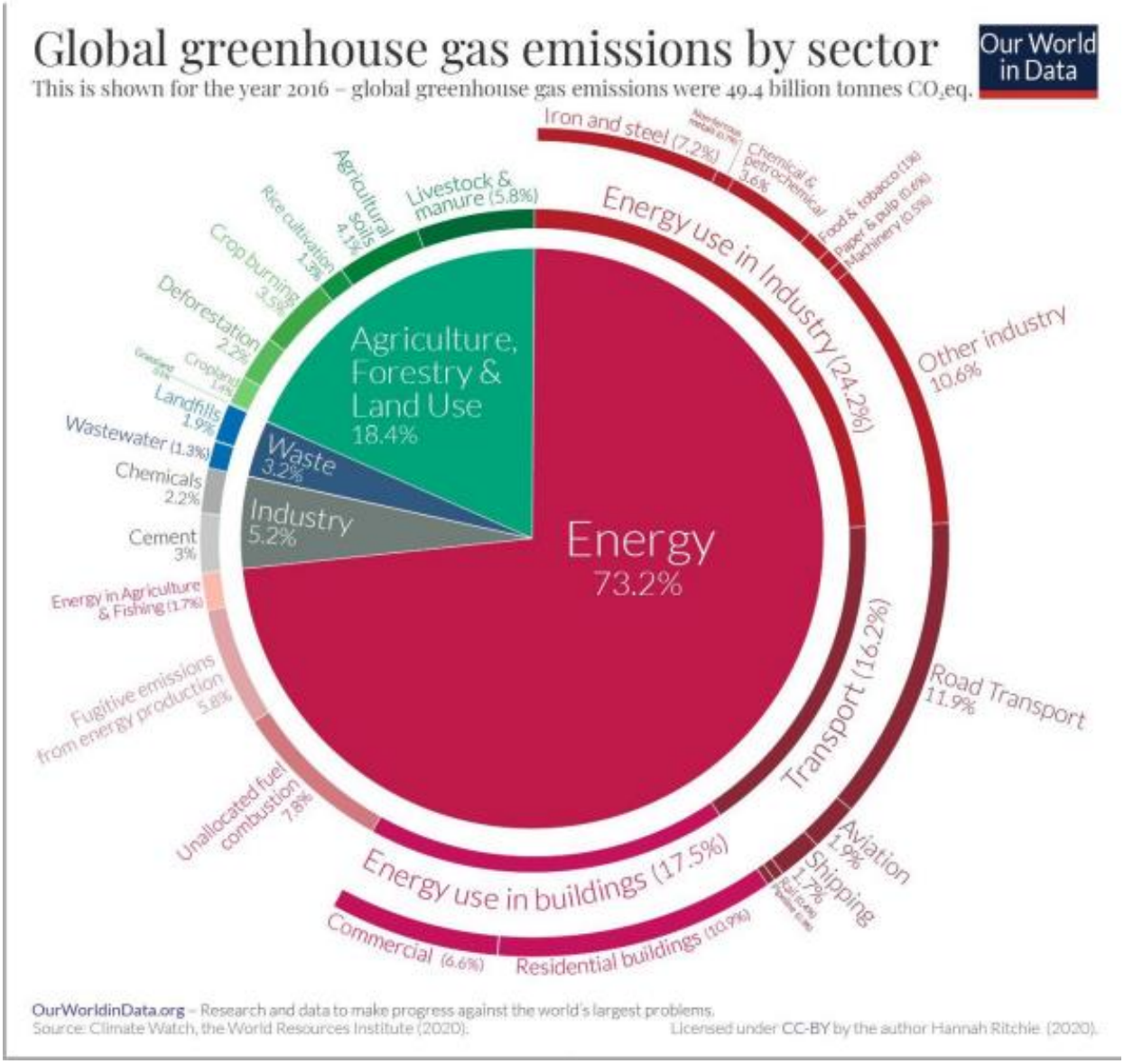


Image Source: Southwest Climate Change Network, 2019



Global Greenhouse Emissions by Sector

Globally, we emit around 50 billion tonnes of greenhouse gases each year. Where do these greenhouse gases come from?



Compare & Contrast Different Forms of Energy

Main forms of energy to understand & identify advantages and disadvantages:

- Natural gas
- Biofuels
- Biomass
- Landfill gas or biogas
- Waste-to-energy plants
- Nuclear energy

- Geothermal energy
- Hydropower
- Solar energy
- Wind energy

Key Topic 2: Measuring and Monitoring a Changing Climate

Key Historical Policies, Political Leaders, & International Collaborations on Climate Change

- Margaret Thatcher (1989 speech to the UN)
- Intergovernmental Panel on Climate Change (IPCC)
- Rio Earth Summit (1992)
- UN Sustainable Development Goals
- United Nations Framework Convention on Climate Change (1994)
- The Kyoto Protocol
- Conference of the Parties (COP)
- The Copenhagen Accord
- REDD+
- IPCC Special Report on Global Warming of 1.5°C (2018)
- Extinction Rebellion
- Greta Thunberg

Climate Models & How They Work

Climate models, also known as general circulation models or GCMs, use mathematical equations to characterize how energy and matter interact in different parts of the ocean, atmosphere, and land. Building a climate model requires identifying and quantifying Earth system processes and representing them with mathematical equations. Climate Models are tested using a process called “hind-casting”. This process tests the model by running it backwards in time, comparing the results with observed climate and weather conditions to see how well they match.

To project the future, climate scenarios- possible stories about how quickly human population will grow, how land will be used, how economies will evolve etc.- are programmed into the model, allowing the model to calculate the atmospheric conditions that would result for each scenario.

Understand the Representative Concentration Pathways

- Each RCP based on different scenarios with the amount of greenhouse gases in the atmosphere in 2100
- Each pathway based on different scenarios:
    - RCP 2.6= a stringent mitigation scenario
    - RCP 4.5 & RCP 6.0= two intermediate scenarios
    - RCP 8.5= a scenario with very high greenhouse gas emissions

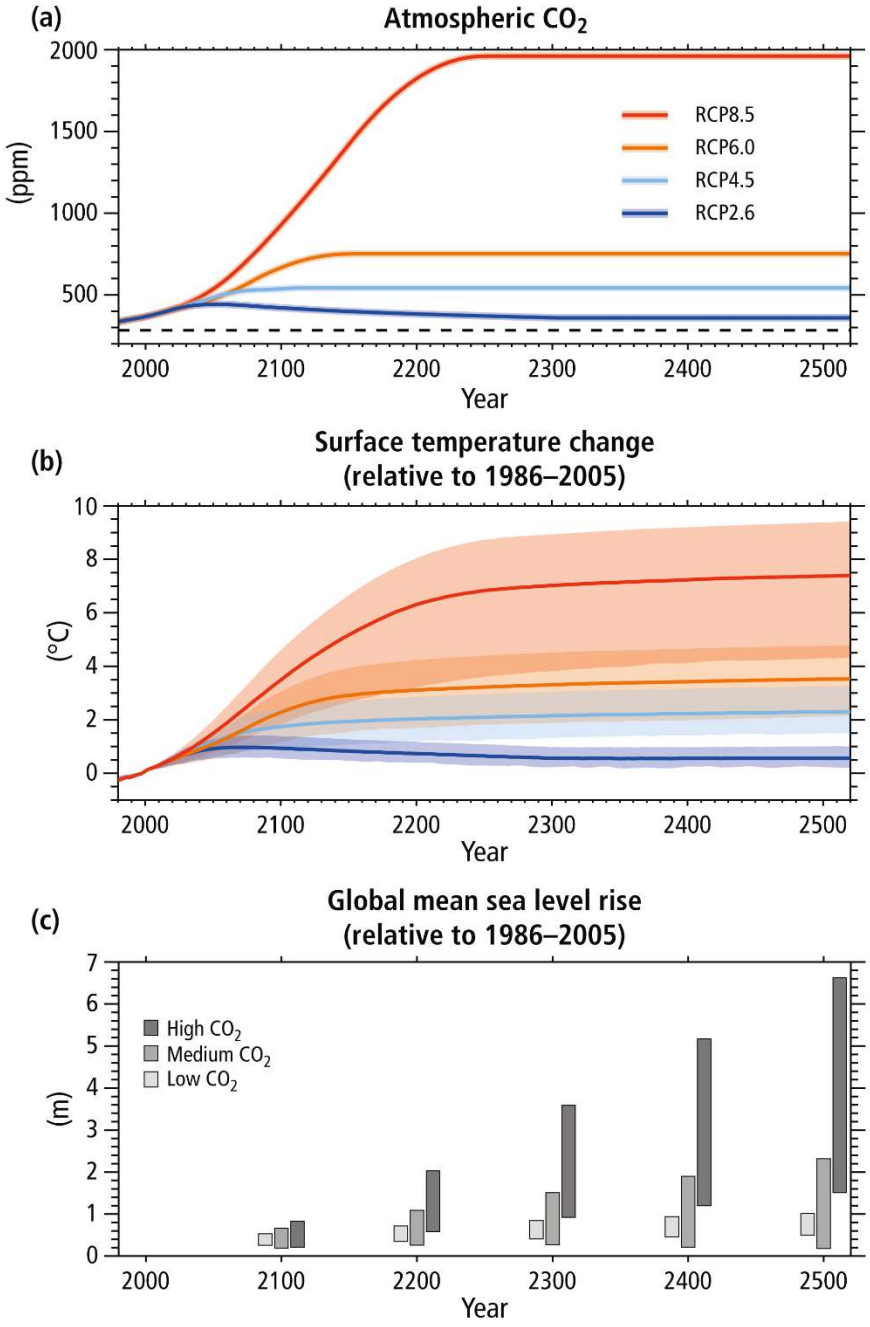


Image Source: IPCC Report on Climate Change, 2014

Understand how a Climate Model differs from a Weather Prediction Model

- Climate models are probabilistic
- Based on global patterns in the ocean and atmosphere

Learn more about Climate Models with The Very Simple Climate Model Activity: https://scied.ucar.edu/interactive/simple-climate-model

Key Topic 3: Risks and Impacts to Natural Resources and Society from a Changing Climate

Key Points

- Climate change can alter where species live, how they interact, and the timing of biological events, which could fundamentally transform current ecosystems and food webs
- Climate change can overwhelm the capacity of ecosystems to mitigate extreme events and disturbances, such as wildfires, floods, and drought
- Mountain and arctic ecosystems and species are particularly sensitive to climate change
- Projected warming could greatly increase the rate of species extinctions, especially in sensitive regions

Understand the following impacts of a changing climate:

- Changes in the Timing of Seasonal Life Cycle Events
- Range Shifts
- Food Web Disruptions
- Buffer and Threshold Effects
- Pathogens, Parasites, and Disease
- Extinction Risks

Schematic Representation of the Canadian Arctic Marine Food Web

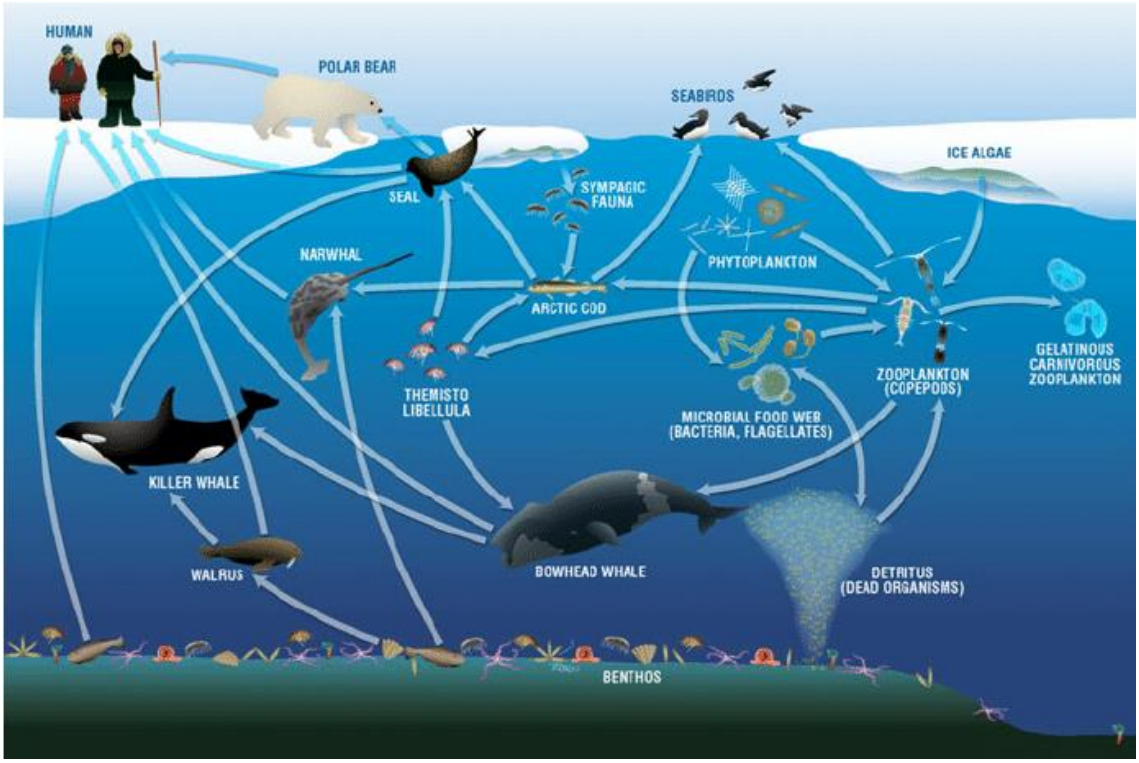


Image Source: Darnis et al., 2012

Impacts to Canadian Agriculture from Climate Change

Understand and explain the opportunities and challenges for Canadian agriculture based on the following impacts of climate change:

- Increased temperatures
- Longer growing seasons
- Shifting precipitation patterns
- Increase in frequency and intensity of extreme weather events
- Increase in pest and disease pressures
- Impact of multiple stressors on soil health

Understand and explain the impacts of climate change for agriculture based on the five distinct regions in Canada:

1. Pacific Region
2. Prairie Region
3. Central Canada
4. Atlantic Canada
5. Northern Canada

Explore the agricultural maps on Climate Atlas for each region in Canada:
https://climateatlas.ca/climate-change-maps-agriculture

Impacts on Ecosystems & Fisheries

Understand how marine ecosystems are impacted by climate change:

- Biological impacts
- Ocean acidification
- Biodiversity loss
- Shifting distributions of marine species
- Range increases or decreases
- Invasive species
- Impact on Arctic mammals
    - Sea ice melt
    - Air temperatures in the Arctic increasing 3x faster than the global average

Impacts on Forests

Understand how forests are impacted by climate change:

- Tree migration
- Increased frequency of forest fires
- Severe droughts
- Pests and pathogens
- Carbon competition
    - Carbon offset reforestation projects
    - Carbon credit programs

Impacts on the Economy

Understand how the economy is impacted by climate change:

- The cost of climate disasters
- Property and critical infrastructure damage
- Human health and productivity
- Increased energy demand
- Trade and supply chain disruptions
- Negative impacts to the agriculture, forestry, fishery, and tourism sectors
- New business opportunities due to climate change
    - Ex. Electric vehicle production, renewable energy
- Government resilience initiatives
    - Ex. The Green New Deal

Global Impacts to GDP

	Temperature rise scenario, by mid-century			
	Well-below 2°C increase	2.0°C increase	2.6°C increase	3.2°C increase
	Paris target	*The likely range of global temperature gains*		*Severe case*
Simulating for economic loss impacts from rising temperatures in % GDP, relative to a world without climate change (0°C)				
World	−4.2%	−11.0%	−13.9%	−18.1%
OECD	−3.1%	−7.6%	−8.1%	−10.6%
North America	−3.1%	−6.9%	−7.4%	−9.5%
South America	−4.1%	−10.8%	−13.0%	−17.0%
Europe	−2.8%	−7.7%	−8.0%	−10.5%
Middle East & Africa	−4.7%	−14.0%	−21.5%	−27.6%
Asia	−5.5%	−14.9%	−20.4%	−26.5%
Advanced Asia	−3.3%	−9.5%	−11.7%	−15.4%
ASEAN	−4.2%	−17.0%	−29.0%	−37.4%
Oceania	−4.3%	−11.2%	−12.3%	−16.3%

Image Source: Swiss Re Institute: The economics of climate change, 2021

Social Impacts of Climate Change

Understand the social impacts of climate change:

- Disproportionate impacts from the following:
    - Extreme weather events
    - Health effects
    - Food security
    - Livelihood scarcity
    - Water security
    - Cultural identity
- Vulnerable social groups will bear the greatest burdens of climate change
    - Women
    - Children
    - Persons with disabilities

    - Indigenous peoples
    - Ethnic minorities
    - Landless tenants
    - Migrant workers
    - Displaced persons
    - Sexual and gender minorities
    - Older people
    - Other socially marginalized groups
- Disproportional impacts to vulnerable populations from measures to address climate change
    - Lack of well designed and inclusive policies
    - Inequitable access to information
    - Social inequalities
    - Communities need to be engaged as partners in climate solutions, not as beneficiaries

Disproportionate Impacts of Climate Change on Indigenous Communities

Understand how climate change impacts Indigenous communities:

- Loss of ancestral land
- Restricted access to traditional gathering areas for food and medicine
- Forced displacement or relocation
- Forced adaption of traditional lifeways
- Using Traditional Ecological Knowledge (TEK) for climate adaptation

Disproportionate Impacts of Climate Change in Southeast Asia

Understand how Southeast Asia is particularly vulnerable to climate change:

- Rising sea levels
- Heat waves
- Droughts
- More intense and frequent rain events
- Increase in tropical cyclones
- Increased heat and humidity
- Lack of carbon reduction strategies
    - Developing nations lack financial capacity to address climate change

Disproportionate Impacts of Climate Change in Africa

Understand how Africa is particularly vulnerable to climate change:

- Sea level rise
- Melting of continental glaciers
- Food insecurity
- Extreme climate events
    - Droughts
    - Floods
    - Landslides
- Lack of early detection systems
    - Weather, water, and climate observing systems
- Severe poverty reduces capacity to adapt to climate change

Key Topic 4: Policies and Programs for Adapting to a Changing Climate

The United Nations Sustainable Development Goals

Understand how the UN Sustainable Development Goals can guide global climate action strategies

- Visit the UN SDG website to learn more about each of the 14 SDG's: https://sdgs.un.org/goals

UN Sustainable Development Goals

Image Source: United Nations Department of Global Communications

The Federal Adaption Policy Framework for Climate Change

The Federal Adaptation Policy Framework guides domestic action by the Government of Canada to address Adaption to the impacts of climate variability and change. It sets a vision of climate adaptation in Canada, provides objectives, roles of the federal government, and provides criteria for achieving Canada's climate objectives. This framework focused on medium-term strategies, while recognizing that adapting to climate change requires a long-term vision.

The Government of Canada has the following vision: Canada is resilient to a changing climate by successfully adapting to the challenges and opportunities, and ensuring the health, safety, and security of Canadians and Canada's environmental, social, and economic wealth in a long term and sustainable manner.

The Federal Adaptation Policy Framework has the following objectives:

- Canadians understand the relevance of climate change and the associated impacts on their quality of life
- Canadians have the necessary tools to adapt to climate change effectively
- The federal government, as an institution, is resilient to a changing climate

Understand how the federal government can effectively integrate climate change considerations into its programs, policies, and operations:

- Generating and sharing knowledge
- Building adaptive capacity to respond and helping Canadian take action
- Integrating adaptation into federal policy and planning

Understand the criteria for identifying federal priorities:

- Nature of impacts and vulnerability
- Appropriateness of federal action
- Mainstreaming ability
- Collaboration potential
    - Ex. The Memorandum of Cooperation between the Government of Canada and the Government of the State of California of the United States of America concerning Climate Action and Nature Protection (2022)

The Role of Technology in Combatting Climate Change

Understand how technology can help countries set and reach climate targets:

- Technology can help countries and companies quantify, reduce, and monitor their emissions
- Technology can simplify the process of quantifying and monitoring emissions
    - Technology can make this process more efficient, transparent, and effective

Examples of how technology can assist in monitoring carbon emissions:

- Measuring and reporting carbon footprint
- Abatement planning and management
    - Identifying key sources of emissions and implementing measures to reduce them
- Carbon offsetting

Carbon Sequestration

Carbon sequestration secures carbon to prevent it from entering the Earth's atmosphere. Carbon sequestration aims to stabilize carbon in solid and dissolved forms so that it does not cause the atmosphere to warm. There are two main types of carbon sequestration: biological and geological.

Biological carbon sequestration: the storage of carbon dioxide in vegetation such as grasslands or forests, as well as in soils and oceans.

Carbon Sequestration in Oceans

- Oceans absorb roughly 25% of carbon dioxide emitted from human activities annually
- Colder and nutrient rich parts of the ocean are able to absorb more carbon dioxide than warmer parts
- Carbon is both released and absorbed from the ocean, creating both a positive and negative atmospheric flux

Carbon Sequestration in Soil

- Carbon sequestered in soil by plants through photosynthesis
- Carbon stored in the soil as soil organic carbon (SOC)
- Carbon also stored in soil as carbonates
    - Carbonates created over thousands of years when carbon dioxide dissolved in water, combines with calcium and magnesium minerals
    - Carbonates have the ability to store carbon for more than 70,000 years
- Agriculture can degrade and deplete carbon stored in soil

Carbon Sequestration in Forests

- 25% of global carbon emissions stored in forests, grasslands, and rangelands
- When plants and trees die, stored carbon is released into the atmosphere
- Deforestation and wildfires decrease forests' ability to act as a carbon sink

Carbon Sequestration Capacity per Forest Type

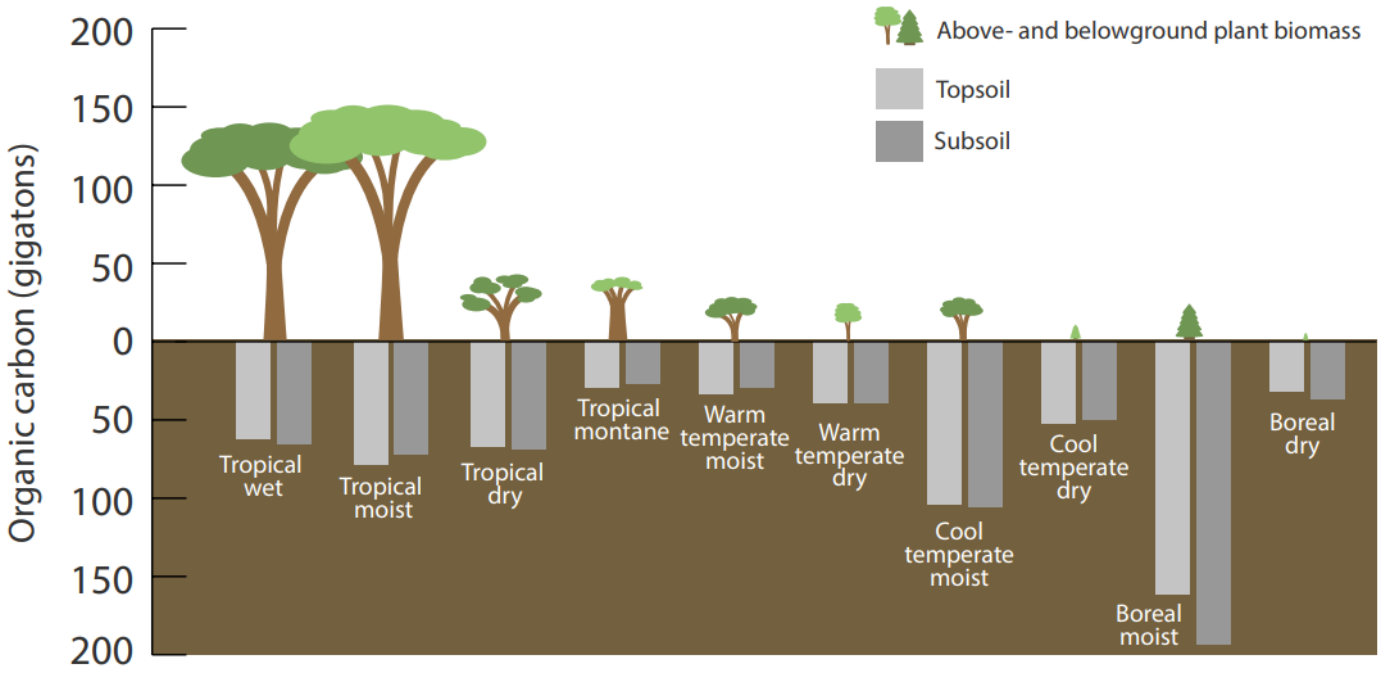


Image Source: Kayler, Janowiak, & Swanston, 2017

Carbon Sequestration in Grasslands

- Grasslands becoming more reliable carbon sinks as forests are increasingly impacted by wildfires
- Grasslands sequester carbon underground
    - Carbon stays fixed in the roots and soil rather than in the leaves and woody biomass
    - Grasslands are more resilient in unstable conditions than forests in terms of their carbon sequestration

Carbon Sequestration Diagram

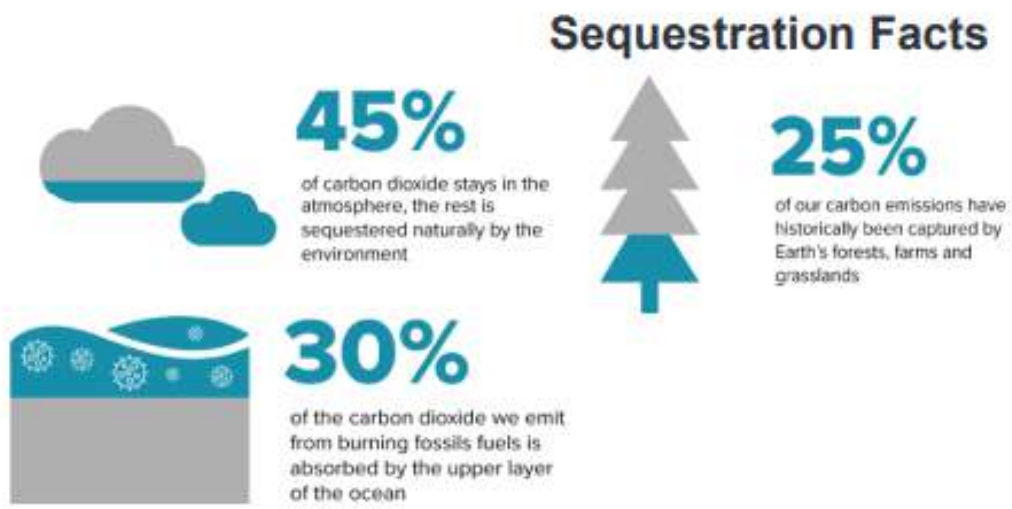


Image Source: New Brunswick Current Environmental Issue, 2023

Geological Carbon Sequestration: the process of storing carbon dioxide in underground geological formations, or rocks. Typically, carbon dioxide is captured from an industrial source (i.e. a power plant) and injected into porous rocks for long-term storage.

Scientists are exploring new ways to remove and store carbon from the atmosphere using new technology. Researchers are also looking at how carbon dioxide can be used as a resource, rather than trying to remove it.

Examples of carbon capturing technology:

- Graphene production
- Direct air capture
- Engineered molecules

Global Carbon Storage

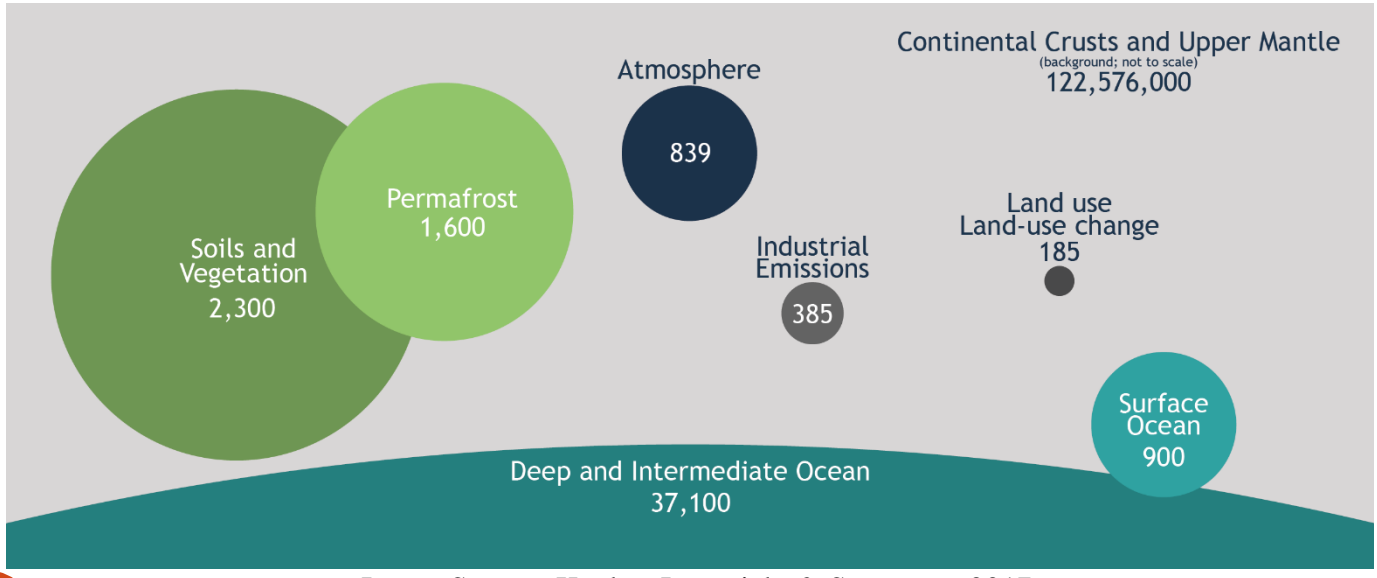


Image Source: Kayler, Janowiak, & Swanston, 2017