IO3.2 Seaweeds and climate change

ERASMUS+ programme

Macroalgae Initium project

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Difference between weather and climate

- Weather and climate are not the same thing.
  - **Weather** is short term in a limited area and can change rapidly.
  - **Climate** is the average of many years of weather observation, is long term, on a wide area, has seasonal changes and measured over long spans of time.

Photo: Dreamstime

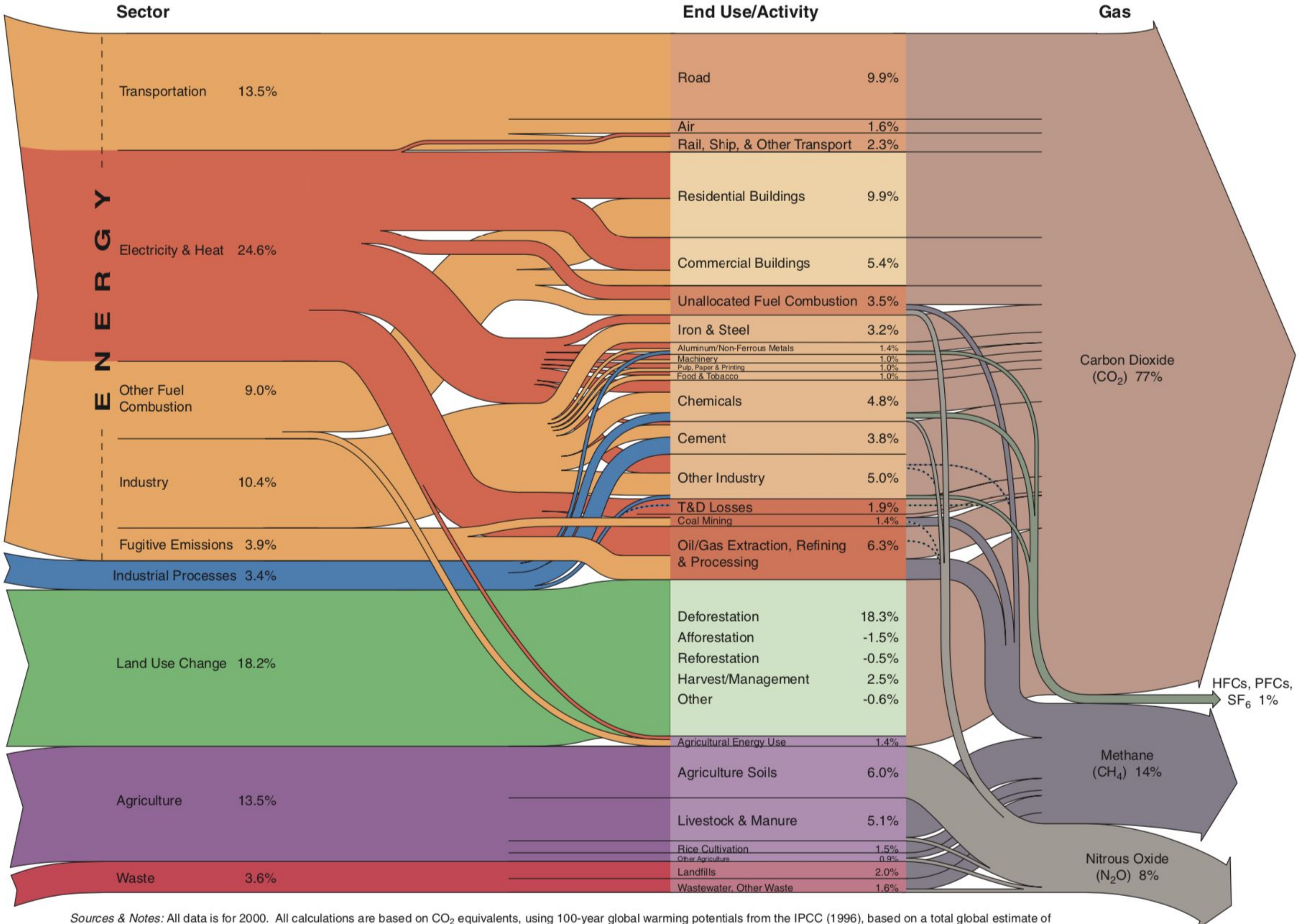
- Climate is affected by many factors:
  - Abiotic factors: Latitude, Altitude, Ocean currents, Topography, Solar radiation, Evaporation, Volcanic activity….
  - Biotic factors: Transpiration, Respiration, Photosynthesis, Decomposition, Digestion…..

Greenhouse gases

- Greenhouse gases are essential to our climate:
  - Solar radiation passes through the clear atmosphere. Some solar radiation is reflected by the Earth and the atmosphere. Most radiation is absorbed by the Earth’s surface and warms it. Some of the infrared radiation passes through the atmosphere, and some is absorbed and re-emitted in all directions by greenhouse gas molecules. **The effect of this is to warm the Earth’s surface and the lower atmosphere.**
  - Planets with very little greenhouse effect are either very cold (e.g Pluto) or they have huge temperature swings from day to night (e.g Mars). Planets with abundant greenhouse gases are very hot (e.g Venus)
  - A number of greenhouse gases occur naturally in the Earth’s atmosphere: Water vapor, Carbon dioxide, Methane, Nitrous Oxide.
  - The greenhouse gas content of the atmosphere is being altered by human activity. The result of this change is global warming.

- What created greenhouse gases? (diagram, next page)

World GHG Emissions Flow Chart



Sources & Notes: All data is for 2000. All calculations are based on CO_2 equivalents, using 100-year global warming potentials from the IPCC (1996), based on a total global estimate of 41,755 $MtCO_2$ equivalent. Land use change includes both emissions and absorptions; see Chapter 16. See Appendix 2 for detailed description of sector and end use/activity definitions, as well as data sources. Dotted lines represent flows of less than 0.1% percent of total GHG emissions.

Greenhouse gases

CARBON DIOXIDE CO_2: Carbon Dioxide in Earth’s atmosphere has risen by about 30% since the beginning of the industrial revolution. Most of the increase is due to the combustion of fossil fuels, which releases the long-stored CO_2 back into the atmosphere.

METHANE CH_4: Methane is released by coal mining, landfills, and by agriculture, particularly through the digestive processes of beef and milk cows.

NITROUS OXIDE N_2O: Nitrous oxide is produced by cars, by fossil fuels used for heat and electricity, and by agriculture

FLUORINATED GASES: Hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride are synthetic, powerful greenhouse gases that are emitted from a variety of household, commercial, and industrial applications and processes.Fluorinated gases are typically emitted in smaller quantities than other greenhouse gases, but they are potent greenhouse gases.

Gas's effect on climate change

Each gas's effect on climate change depends on three main factors:

a. How much is in the atmosphere?
b. How long do they stay in the atmosphere?
c. How strongly do they impact the atmosphere?

Climate change resulting from the enhanced greenhouse effect is expected to have widespread consequences;

- sea-level rise and possible flooding of the low lying areas,
- melting of glaciers and sea ice,
- changes in rainfall patterns with implications for floods and droughts, and
- changes in the incidence of climatic extremes, especially high temperature extremes. These effects of climate change have impacts on ecosystems, health, key economic sectors such as agriculture, and water resources.

Climate Change Indicators: Ocean Acidity

- Measurements made over the last few decades have demonstrated that ocean carbon dioxide levels have risen in response to increased carbon dioxide in the atmosphere, leading to an increase in acidity (that is, a decrease in pH)
- Although the ocean's ability to take up carbon dioxide prevents atmospheric levels from climbing even higher, rising levels of carbon dioxide dissolved in the ocean can have a negative effect on some marine life. Carbon dioxide reacts with seawater to produce carbonic acid. The resulting increase in acidity, changes the balance of minerals in the water.
- This makes it more difficult for corals, some types of plankton, and other creatures to produce a mineral called calcium carbonate, which is the main ingredient in their hard skeletons or shells
- Thus, declining pH can make it more difficult for these animals to thrive. This can lead to broader changes in the overall structure of ocean and coastal ecosystems, and can ultimately affect fish populations and the people who depend on them.

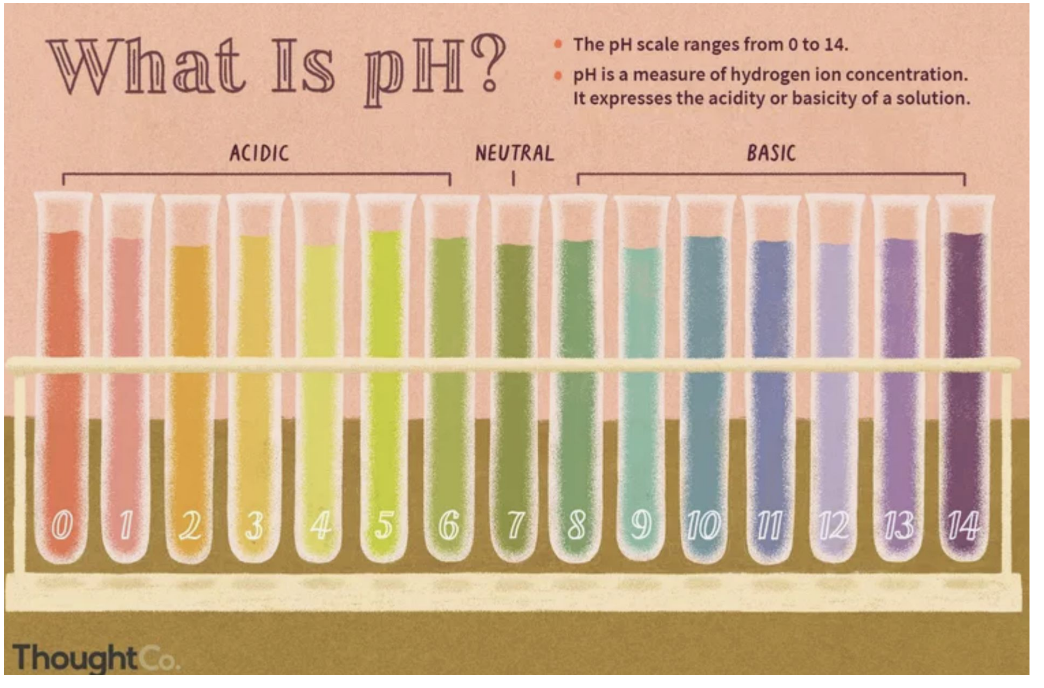
Understanding PH

pH is a measure of hydrogen ion concentration, a measure of the acidity or alkalinity of a solution. The pH scale usually ranges from 0 to 14.

Aqueous solutions at 25°C with a pH less than 7 are acidic, while those with a pH greater than 7 are basic or alkaline.

A pH level of 7.0 at 25°C is defined as "neutral" because the concentration of H_3O^+ equals the concentration of OH^- in pure water.

Very strong acids might have a negative pH, while very strong bases might have a pH greater than 14.



Practical:

RED CABBAGE PH INDICATOR

INTRODUCTION:

- Red cabbage contains a pigment molecule called flavin (an anthocyanin).
- This water-soluble pigment is also found in apple skins, plums, poppies, cornflowers, and grapes.
- Very acidic solutions will turn anthocyanin into a red color. Neutral solutions result in a purplish color. Basic solutions appear in greenish-yellow. Therefore, you can determine the pH of a solution based on the color that it turns the anthocyanin pigments in red cabbage juice.
- The color of the juice changes in response to changes in its hydrogen ion concentration; pH is the -log[H+]. Acids will donate hydrogen ions in an aqueous solution and have a low pH (pH 7).

MATERIALS*:

- Red cabbage-chopped
- Water
- Cups or containers
- Pipette
- Substances to test: baking soda, vinegar, lemon juice (and many more household products, milk, apple juice, soap…)

**List of materials included on a separate document*

EXPERIMENT:

- Chop up the red cabbage into small pieces. Place 2-3 cups in a saucepan and cover with water. Bring the solution to a boil and then turn off the heat. Let it sit for about 30 minutes to cool down.
- Sieve the water and cabbage into a jug. The dark purple liquid in the jar is the pH indicator liquid.
- Fill one cup with water (this is neutral, or the control), one with vinegar (this is acidic), and one with a teaspoon of baking soda mixed with water (this is basic).
- Use a pipette to drop about 20 ml of red cabbage indicator into each cup.
- Observe how the colours change

SAFETY: Please, wear safety goggles and gloves when using strong acids/bases

MAKING AN INDICATOR FROM RED CABBAGE

The compounds that give red cabbage its colour can be extracted and used as a pH indicator solution. Here we look at the method and the colours!

MAKING THE INDICATOR

1 ROUGHLY CHOP THE CABBAGE

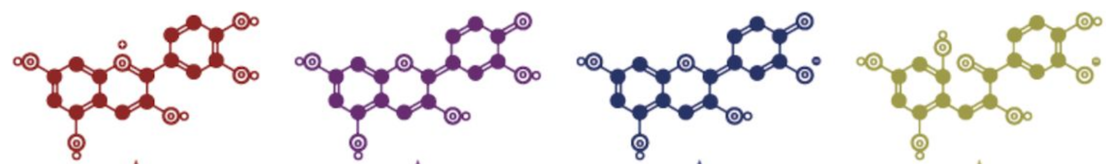
2 BOIL FOR A FEW MINUTES

3 STRAIN AND LET COOL

4 USE AS AN INDICATOR!

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

← ACIDIC — pH — ALKALINE →



Hydrogens on carbon atoms implied; each carbon has 4 bonds.

The red cabbage extract can be used to determine whether substances are acidic or alkaline. The structures of the anthocyanin pigments which give the red cabbage its colour are subtly changed at varying pH. These different structures give a range of colours.

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