THE ATMOSPHERE

Conditions in the atmosphere such as **weather** and **climate** influence the abiotic features of the Great Southern Reef. Air temperatures influence the critical water temperature kelp requires for optimum growth (around 20 degrees C) and contribute to marine heatwaves that cause kelp forests loss. Atmospheric change is increasing stresses on the kelp forest ecosystems on the Great Southern Reef and globally. The ocean absorbs most of the excess heat from greenhouse gas emissions, leading to rising ocean temperatures.

Essential role in ecosystem functioning

In addition to determining the abiotic conditions in which kelp thrives, the atmosphere plays an essential role in ecosystem functioning through nutrient cycling and energy flows. Without sunlight, kelp would not grow. Kelp absorbs carbon dioxide and releases oxygen, playing a critical role in climate stabilisation.

- **Sunlight** is essential for **photosynthesis** by which kelp uses solar energy to produce food (primary biomass). Kelp maximises access to sunlight through adaptations such as gas chambers, 'floaties', and wide spreading blades. Kelp is the **primary biomass** and the foundation trophic level of the GSR ecosystem. See the Fact Sheet
- **Weather and climate** influence water temperature and therefore the spatial distribution of kelp forests within Australia's **temperate** climate zone. Global wind circulations (trade winds) drive the ocean currents that determine water temperatures along the GSR.

Atmosphere, hydrosphere, and biosphere interactions

- **Biochemical cycles** essential to ecosystem functioning are the carbon cycle, oxygen cycle and water cycle. Kelp absorbs carbon dioxide and releases oxygen. Kelp ecosystems are identified as 'carbon sinks' permanently removing carbon from the atmosphere and sequestering it into the deep sea or coastal sediments. It is estimated that 11% of global macroalgae is permanently sequestered in the ocean with about 90% of that in the deep sea.
- **Oxygenation**. Waves, currents and kelp oxygenate ocean water. Oxygen is used by consumer organisms at higher trophic levels.
- **Acidification** occurs when carbon dioxide in the atmosphere dissolves into the ocean, lowering the pH and making it more acidic, a process accelerated by warming waters. This affects shelled organisms
- **Upwelling**, a natural process bringing cold, nutrient-rich water to the surface, is caused by wind and earth's rotation. Coastal upwelling supports some of the world's most fertile ecosystems. **Figure 9**.
- **Natural stresses** impacting the hydrosphere such as high energy waves and floods are linked to atmospheric weather conditions.
- **La Nina and El Nino events** alter normal trade winds and subsequent ocean current conditions including the EAC, Leeuwin Current and upwelling currents.

Atmosphere – Hydrosphere – Biosphere interactions

Quotes from 'Marine heatwaves threaten the future of underwater forests'

- In 2011, strong La Niña conditions increased the southward flow of the Leeuwin Current, which pushed warm water from the tropics into cooler temperate latitudes.
- At the same time, winds were calmer than normal resulting in unusually high transfer of heat from the air into the upper layers of the ocean. The outcome was an unprecedented marine heatwave which affected more than 2,000 km of the west Australian coastline from north of Ningaloo Reef to Cape Leeuwin on the southwestern corner of the continent. Water temperatures soared past anything recorded for at least 140 years.
- Many of the species found along the coastline of southwestern Australia have evolved to live in cooler temperate waters. When peak summer sea temperatures soar, as they did in early 2011, many species overheat and become physiologically stressed or even die.
- One forest-forming seaweed was eradicated from over 100 km of coastline in just a few months as a result of the marine heat wave.

Source: The Conversation – selected statements. https://theconversation.com/marine-heatwaves-threaten-the-future-of-underwater-forests-37154