FRONTIERS REPORT 2022 – KEY MESSAGES

Top-Level Narrative

Each edition of the *Frontiers report* introduces selected emerging environmental issues that present distinct challenges and require tailored solutions. These issues have profound effects on our society, economy and ecosystems. *Frontiers 2022: Noise, Blazes and Mismatches* identifies three issues:

Listening to Cities: From Noisy Environments to Positive Soundscapes
Wildfires Under Climate Change: A Burning Issue
Phenology: Climate Change Is Shifting the Rhythm of Nature

Listening to Cities: From Noisy Environments to Positive Soundscapes

- Long-term exposure to noise pollution is a major, growing environmental issue that affects the mental and physical health of all age groups. Not only does it cause sleep disturbance, annoyance and headaches, but it is also increasingly understood as a risk factor that can contribute to the development of hypertension, coronary heart disease, diabetes and irreversible hearing damage.
- In Europe alone, long-term exposure to noise contributes to 12,000 premature deaths and 48,000 new cases of ischemic heart disease.
- Residents of cities around the world such as Barcelona, Cairo and New York are exposed to high levels of noise.
- In New York, 90 per cent of mass transit users are exposed to noise levels exceeding the recommended 70 dB limit.
- In Ho Chi Minh City, cyclists are exposed to noise levels above 78 dB, which can cause irreversible hearing loss.
- High noise levels also disrupt the acoustic communication that urban animals such as birds, frogs and insects rely on for survival.

Several solutions can tackle this issue:

- Vegetation in urban environments absorbs acoustic energy and diffuses noise. Tree belts, shrubs, green walls and green roofs help amplify natural sounds by attracting wildlife, and they improve the visual streetscape as well.
- Trees, in particular, can help reduce urban noise pollution. For example, customized placement of trees in rows behind traditional highway noise barriers can reduce noise levels by 12 dB.
- Green spaces, courtyards and quiet urban parks offer relief from noisy places and benefit our mental well-being.

- Indirect measures such as reducing available driving space by increasing the number of cycle lanes can reduce road traffic noise. Also, low-emission zones encourage electric mobility, which reduces noise and improves air quality.
- Visual surroundings affect our perception of soundscapes and vice versa. Urban greens offer a pleasant visual effect that contributes to the development of positive soundscapes.

Ultimately, city planners need to consider the public and personal health benefits of positive soundscapes when designing cities. Green spaces offer a nature-based solution for peaceful soundscapes.

Wildfires Under Climate Change: A Burning Issue

Wildfires are the most visible emerging environmental issue in this year's Frontiers Report, and they are predicted to worsen in the coming years and decades.

- Wildfires are a natural part of earth's systems, but they are becoming much more large, dangerous and likely to occur as a result of climate change and human influence. This can have destructive consequences for homes and property, human health, and the environment.
- Human alterations of landscapes through land clearing, deforestation, agricultural expansion, introduction of invasive species, urban and rural development, and inappropriate fire management have interfered with natural fire regimes.
- As a result of deforestation and forest fragmentation, wildfires now burn through areas such as humid tropical forests, where they seldom spread in the past.
- Extreme weather events such as hotter temperatures and more droughts lead to longer fire seasons and increase the likelihood of fire weather conditions.
- The frequency of lightning strikes is projected to increase with a changing climate.
- Fire-generated thunderstorms have become more frequently reported in Australia, Europe and North America in recent decades. These thunderstorms contribute to more dangerous conditions for fires on the ground.
- Wildfires emit substantial amounts of pollutants, such as black carbon, particulate matter and greenhouse gases.
- Wildfires also lead to water pollution, erosion, ocean fertilization and significant biodiversity loss.

There are three main types of wildfires, each with its own challenges:

- Ground fires: These burn decomposed organic subsurface soil layers and usually do not produce visible flames. Difficult to entirely suppress, they can smoulder over winter and may re-emerge in spring.
- Surface fires: These burn through leaf litter, dead material and vegetation on the ground and are most common in woodlands and savannahs.
- Crown fires: These ascend from ground to tree crown and can spread through the forest canopy. The most intense and dangerous form of wildfire, they are common in Mediterranean-climate woodlands and boreal forests.

Natural wildfires occur when three elements combine:

- **Ignition:** heat from the sun or a lightning strike to ignite a fire
- **Fuel:** sufficient combustible material to feed the flames

- **Weather:** conditions of temperature, wind or low relative humidity that enable spread

Solutions that support wildfire prevention, response and management build resilience in ecosystems and communities as they face changing fire weather:

- Improved planning, policies, and practices, increased fire-fighting capabilities, and community resilience-building programmes;
- Greater long-term cooperation among different regions and countries to share resources;
- Involvement of vulnerable groups in all stages of preparedness and response;
- More appreciation and uptake of indigenous fire management techniques such as prescribed burning; and
- Modern tools such as long-range weather forecasting, remote-sensing capabilities – satellites, ground-based radar, lightning detection – and data handling that improve the monitoring and management of wildfires.

Adaptive management approaches include building resilience to wildfires in ecosystems before they occur and ensuring a proactive mindset becomes the norm in vulnerable communities rather than a reactive one.

Phenology: Climate Change Is Shifting the Rhythm of Nature

Phenology refers to periodic events in biological life cycles. Timing is critical: birds must have their nestlings in the nest when there is ample food to nurture them, pollinators must be active when their host plants flower and snow hares must change their white coat colour to brown when the snow disappears.

What is happening?

- Decades of global warming cause shifts in the timing of life stages of interacting species, sometimes resulting in ecosystem-disrupting phenological mismatches. For example, some birds now have their nestlings in the nest when food supply is already waning, so late-breeding pairs have lower success than early-breeding ones.

- Phenological shifts due to anthropogenic climate change have been detected in many life cycle events from reproduction to migration, or from leafing, flowering to fruiting. Phenological mismatches are becoming more common.

Where is this happening?

- This is a truly global problem, affecting plant and animal species **from mountains to oceans and from polar to equatorial regions**.
- Because temperature is a strong influence on phenological cues, phenological shifts are more pronounced at **higher latitudes** as temperature rises.
- Over 1,200 years of observations track the blooming date of **cherry blossom in Japan** as the beginning of spring, usually within April. Since 1900, the blooming has advanced progressively to earlier dates in late March.
- **The great tit population in the Netherlands** has advanced its egg-laying in response to warming trends, but the shift is not enough to match the peak of the caterpillar population. Caterpillars' phenology is expected to continue advancing faster than birds' in the coming decades, further increasing the mismatch.

- An analysis of the spring arrival times of **117 European migratory bird species** over five decades suggests increasing levels of phenological mismatches to spring events that contribute to population declines in some migrants, particularly those wintering in sub-Saharan Africa.
- **Eastern South Pacific humpback whales** have advanced their arrival to **Colombia**'s Gorgona National Natural Park by up to one month earlier over the last three decades. This is likely due to changes in krill availability in Antarctic feeding grounds.
- Shortened day length and lower temperature in autumn usually prompt the **eastern monarch butterfly** of North America to fly south. An analysis of migration over 29 years shows that they have delayed migration by six days per decade due to warmer than normal temperatures. Late-season migrants appear less likely to reach overwintering sites than those migrating earlier in the season, possibly from encountering mismatches in food availability along the way.

What will be the result of these shifts?

- Climate change propels phenological shifts in terrestrial, aquatic and marine ecosystems. If too rapid, these shifts can lead to phenological mismatches with significant consequences for individuals and potentially for populations, communities and whole ecosystems.
- The current rate of anthropogenic climate change is accelerating too quickly for many plant and animal species to adapt through their phenological capacity to shift the timing of life cycle stages.
- Phenological shifts in crops in response to seasonal variations will be challenging for food production in the face of climate change. Shifts in the phenology of commercially important marine species and their prey have significant consequences for fisheries productivity.

What can be done to tackle this?

- Existing conservation measures serve as immediate interventions. Restoring habitats, conserving biodiversity, building corridors to enhance ecological connectivity and genetic diversity and adjusting protected-area boundaries as species' ranges shift help strengthen their adaptive capacity.
- Conservation and ecosystem management measures must be taken to encourage micro-evolution, where species evolve and adapt to new conditions. A critical example of this is promoting genetic diversity within populations, as this is the crucial prerequisite for micro-evolution and eventual natural selection.
- The more genetic diversity a species has, the greater the chance it can successfully adapt to the changing climate. The maintenance of ecological integrity and habitat connectivity is vital to species' survival.

However, there are limited solutions to this problem aside from keeping the warming of our planet within limits. While habitat protection and biodiversity conservation can delay the worse outcomes, the only way to effectively reduce damages from mismatched phenological shifts worldwide is to rapidly reduce CO_2 emissions.