BRIDGE

CLIMATE CRISIS AND BIODIVERSITY

The effects of the climate crisis

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“The meteorite of the sixth mass extinction is **us**.”

– Telmo Pievani

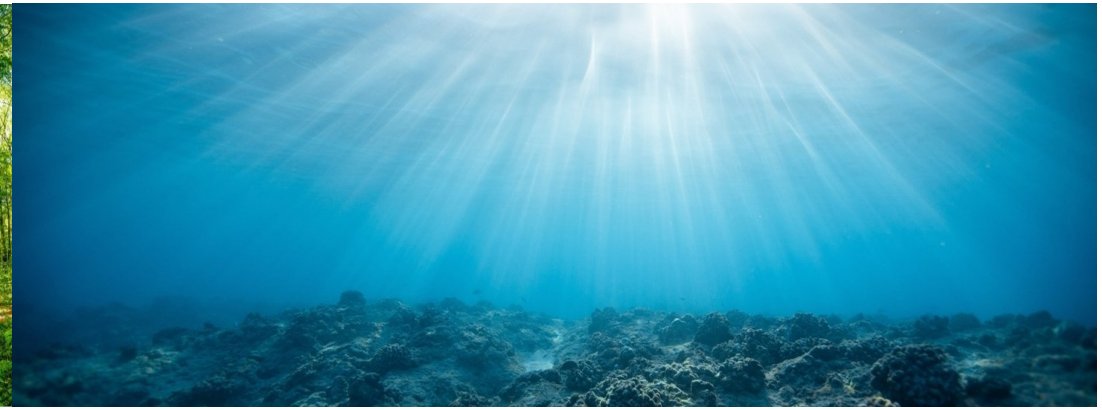
Philosopher of biology, evolutionist, essayist

Why does climate change cause biodiversity loss?

Mankind began to change the balance of nature when it started using fossil fuels and cutting down trees in large forests.

We have built factories, trains, cars, cities, with great consumption of coal, oil and gas, and we have cut down trees, replacing them with more and more fields to grow our food. The chemical reaction by which we obtain energy from fossil fuels emits carbon dioxide CO2, which increases the natural greenhouse effect that would guarantee us an average temperature on Earth of 15°C.

Forests, but also the oceans with their photosynthetic algae, have always been a natural producer of oxygen and a storehouse for CO2: through chlorophyll photosynthesis they capture carbon dioxide from the atmosphere and return oxygen. But deforestation, pollution and altered climatic conditions are limiting their ability to perform these functions.



Why does climate change cause biodiversity loss?

Among the threats to biodiversity of anthropogenic origin, global warming accounts for approximately 7% of the causes of its loss: climate change in fact fuels a 'domino effect' that can trigger increasingly extreme phenomena.

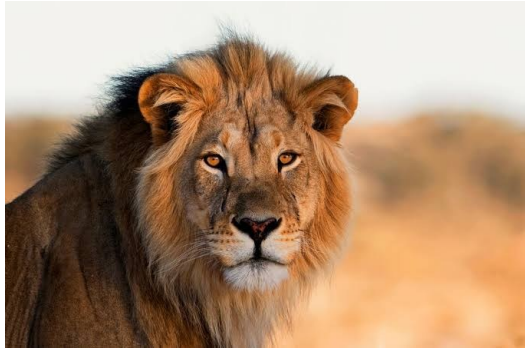
Although temperature is the most widely used climatic parameter for this type of study, changes in rainfall patterns, relative humidity, solar radiation, evapotranspiration and sea acidification linked to increased CO2 in the atmosphere can influence biodiversity much more significantly.

An interesting approach to the study of biological and ecological changes caused by climate change is that of the phenology of species: the timing of flowering, migration, hibernation, spawning and the different phases of the life cycles of numerous species provide us with valuable information on the changes that are taking place in response to climate change. In fact, phenology provides us with additional data for the study of climate change.

Such changes are not always definitive, but can theoretically be considered reversible.

In some cases, they also affect only certain individuals and not an entire population or species (e.g. physiological and behavioural variations).

What we have lost and what we will lose



Lion *(Panthera leo)*

According to calculations by the Stanford Biology Department research team, human impacts on animal biodiversity have now become a form of global environmental change that will soon affect our health.

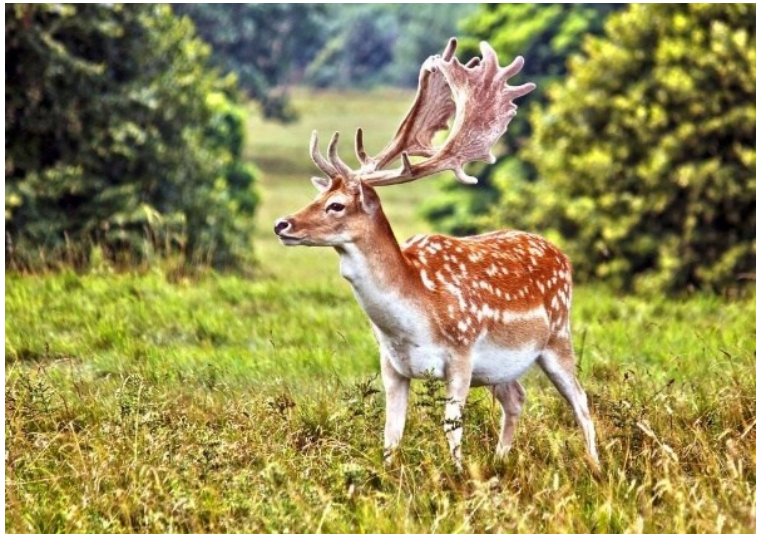
Defaunation of the Anthropocene

Among terrestrial vertebrates, 322 species have become extinct since 1500, and populations of species on Earth show an average decline in abundance of 25%. The patterns for invertebrates are equally dire: 67% of monitored populations show an average decline in abundance of 45%. These losses have consequences for the functioning of ecosystems and human well-being. Much, however, remains unknown about what has been called the ‘defaunation of the Anthropocene’.

Knowledge gaps hamper our ability to predict and limit impacts, but what is clear is that defaunation is a pervasive component of the **planet's sixth mass extinction**, as well as a major driver of global ecological change.

In the pictures, some of the exctincted animals in Lebanon

Cheetah *(Acinonyx jubatus)*



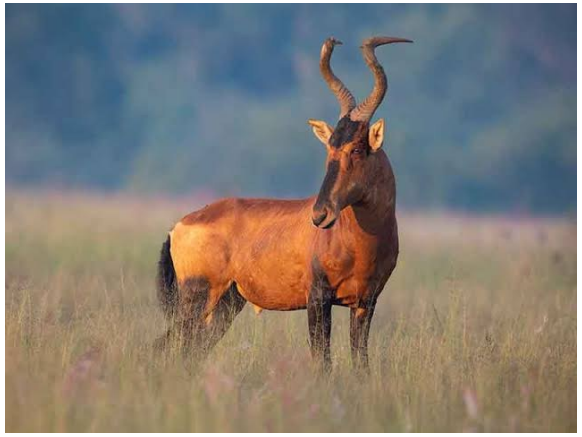
Persian fallow deer (Dama mesopotamica)

Forecasting the Impacts of Climate Change

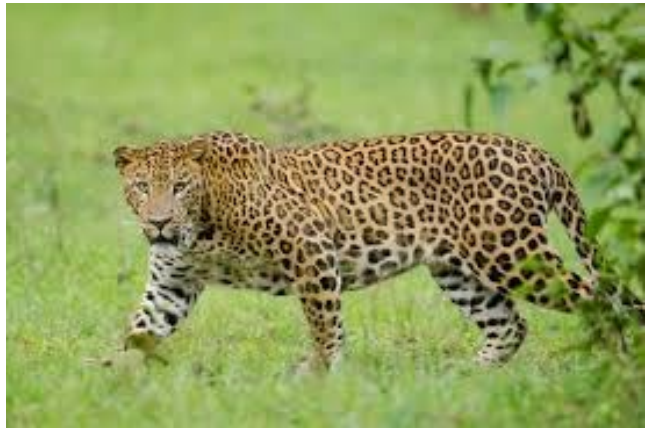
According to a study published in Nature in 2020, about 2% of communities and 20% of their constituent species will disappear. Within this 2% would be some of the world's most important and biodiversity-rich ecosystems, such as coral reefs. Unprecedented temperature regimes will begin before 2030 in the tropical oceans, and recent events of mass coral bleaching in the Australian Great Barrier Reef are already a clear indication of what will happen.

In Africa, on the other hand, the loss of biodiversity will be more sudden and, according to studies, could start in 2040.

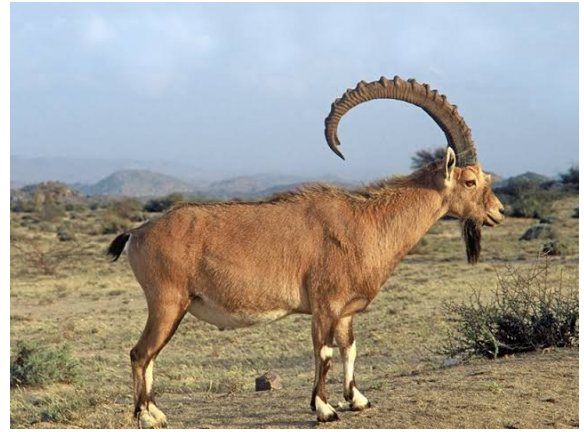
What we have lost and what we will lose



Hartebeest *(Alcelaphus buselaphus)*



Leopard *(Panthera pardus)*



Nubian ibex *(Capra nubiana) reintrioduced in the Shouf Biosphere Rserve in 2017*

What we have lost and what we will lose

The results highlight the imminent risk of sudden and severe biodiversity losses due to climate change and provide a framework for predicting both when and where these events might occur.

Projected climate change impacts by 2100

A paper published in Nature in 2020, considers temperature and precipitation tolerance ranges for over 30,000 marine and terrestrial species on annual projections (1850 to 2100), to estimate their ability to withstand extreme climatic conditions.

Assuming that the limit of tolerance to these climatic conditions is reached simultaneously by all the species considered, two scenarios are assumed:

HIGH EMISSIONS SCENARIO (+4°C)

extinction

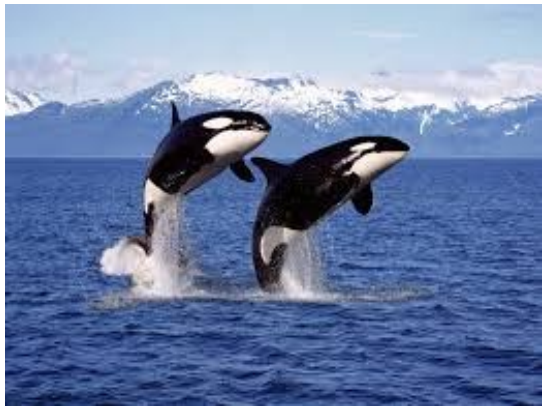
~15% OF COMMUNITIES PLANTS AND ANIMALS

LOW EMISSION SCENARIO (+2°C)

extinction

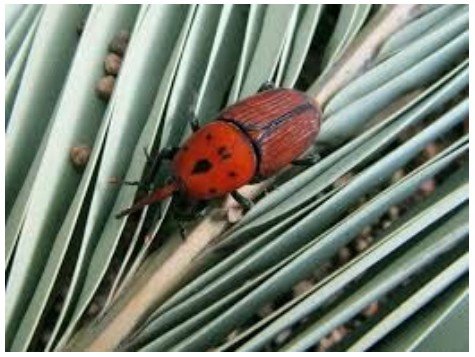
~2% OF COMMUNITIES PLANTS AND ANIMALS

The most impactful consequences on biodiversity

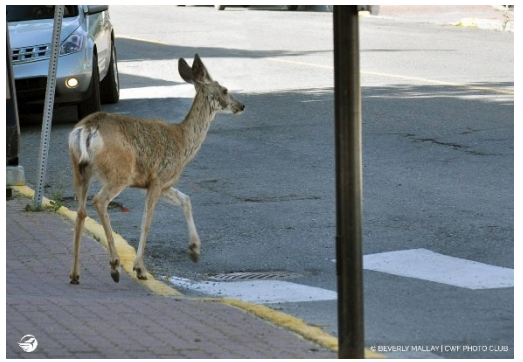


The increase in extreme phenomena can have serious consequences not only for human safety, but also for the state of biodiversity. For example, in the boreal forests, global warming has increased the incidence of natural fires, with a direct impact on their biodiversity.

- Each species responds differently to environmental changes. This means that important spatial and temporal connections between different species, which have evolved over millions of years of life (such as the relationships between pollinating insects and blooms or between predators and prey), could alter, leading to real upheavals in trophic chains, processes and ecosystem functions. This is the case, for example, of **killer whales** and **belugas** in Arctic waters: rising ocean temperatures cause the ranges of the two cetaceans to overlap, allowing killer whales to frequent cold waters previously populated by belugas, which are thus exposed to attacks by a new predator.
- The reduction of extreme winter climates is causing the spread of **mosquitoes**, carriers of diseases such as **dengue**, **yellow fever** and **malaria**, expected to increase even in latitudes where they have never been present. A spread of ticks, vectors of pathogens leading to diseases such as Lyme disease, can also be expected.
- Some tree pests are on the rise: some beetles, including *Dendroctonus ponderosae*, which feeds on pine trees in North America or the **red weevil** *Rhynchophorus ferrugineus*, responsible for the death of palm trees in all Mediterranean sites, as well as other insects, such as the Chinese wasp *Dryocosmus kuriphilus*, the disease carrier for many chestnut trees.
- The change produced on the environment by our activities worsens the natural ability of many species to adapt to climate change. Several habitats where species could take refuge have also been compromised and may therefore no longer be available or accessible due to man-made barriers (urban infrastructure, roads, railways, etc.).



Red weevil



The most impactful consequences on biodiversity

Effects on mountain and alpine environments

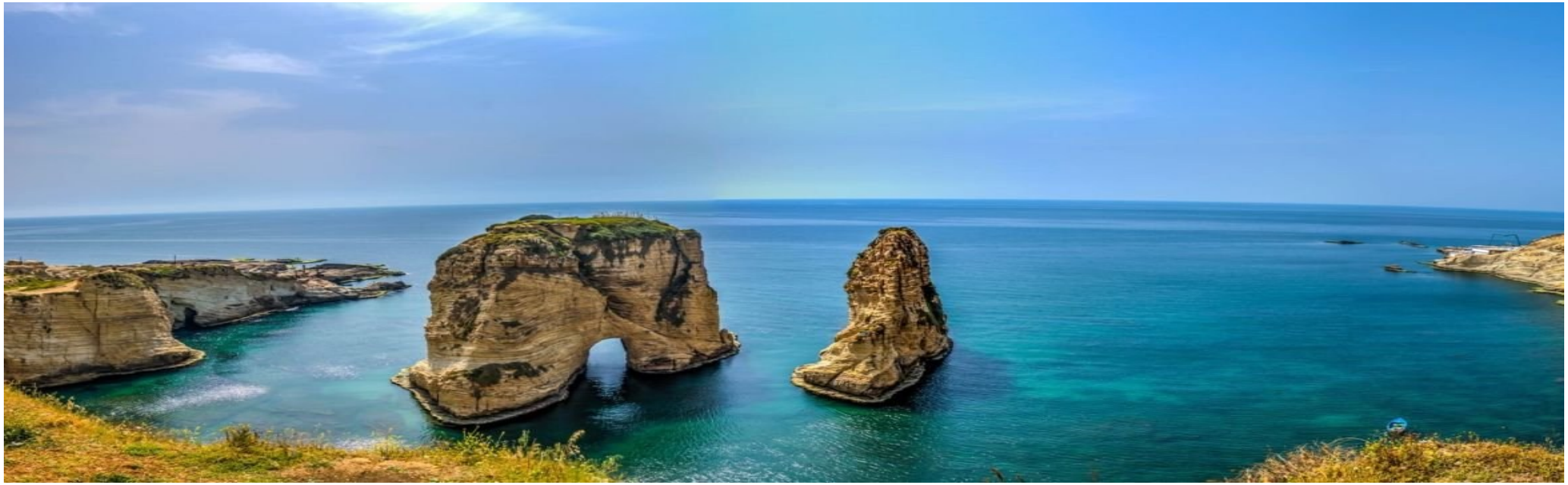
Globally, natural systems characterised by perennial ice or snow have already undergone significant influences, ranging from the enlargement and increase in the number of glacial lakes, increased soil instability in regions with permafrost, avalanches and landslides in mountainous regions, to changes in some Arctic and Antarctic ecosystems, such as sea-ice biomes. In **Lebanon**, there could be a general increase in the altitudinal distribution limits of many mountain species like the **Cedar tree**, with a shift to higher altitudes, as far as there is 'altitudinal space' available.

Alpine glaciers are in severe retreat: 60 per cent of the glacier area in the Alps has been lost in the last century. Studies on potential future development (until 2100) indicate that only parts of the glaciers at higher altitudes will 'survive'. Similar is the trend of glaciers all over the world, from Tibet to the Andes.

The most impactful consequences on biodiversity

Effects on Mediterranean environments

There has been a warming of more than 2°C in the Mediterranean area since the end of the 19th century, and it is assumed that there could be a further temperature increase of 1.5°C in 2050. Theoretically, in response to an increase in temperature on a regional scale, favourable conditions could be created for a significant expansion of the distribution range of Mediterranean species: a progressive 'Mediterraneanisation' of the inland areas of the peninsula. However, this process would be severely hindered by the environmental diversity and the level of fragmentation present, and therefore the living communities would show difficulties, also geographical (not only ecological), in following and supporting the gradients of transformation taking place. In Mediterranean environments, change would flank and worsen what have already been identified as the most serious threats currently present: tourism, pollution, fish overfishing, fires, desertification, and the depletion of water resources



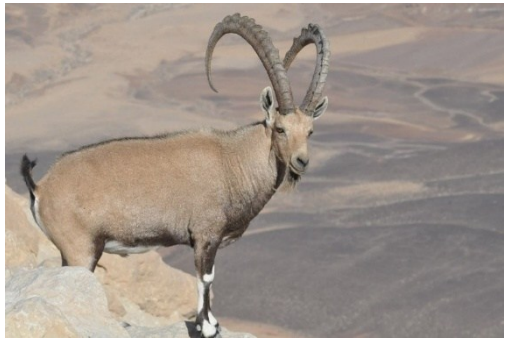
The most impactful consequences on biodiversity

Effects on marine environments

In the sea, the most evident changes concern temperature distribution and, consequently, the circulation of currents, sea level rise and the repetition of exceptional weather events. These changes trigger profound reactions in marine ecosystems and profoundly affect productivity and biodiversity, factors that are in turn linked to social, economic and cultural aspects. Among these changes, scientists have recently identified **deoxygenation**: since the 1960s, the oceans have lost an average of 2% of their oxygen! If man were to continue emitting CO2 at the current rate, the loss would rise to 3 or even 4% by the end of this century. One third of the CO2 that is released into the atmosphere by human activities is absorbed by the oceans: in a balanced system, thanks to chlorophyll photosynthesis, it is transformed into oxygen by phytoplankton and marine plants. Conversely, when it becomes too much, CO2 turns into **carbonic acid**, **acidifying the waters of the oceans** with very serious consequences for many organisms at the base of the food chain.

The most impactful consequences on biodiversity

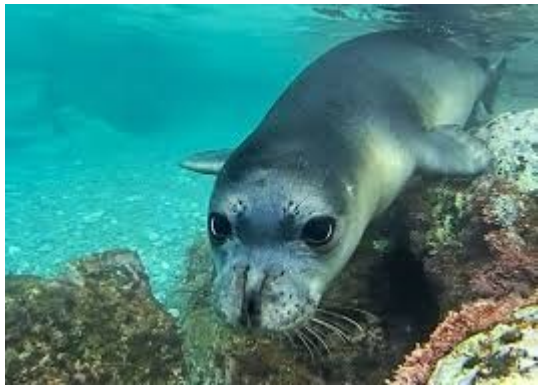
Lebanon's cedar tree *(Cedrus libani)*



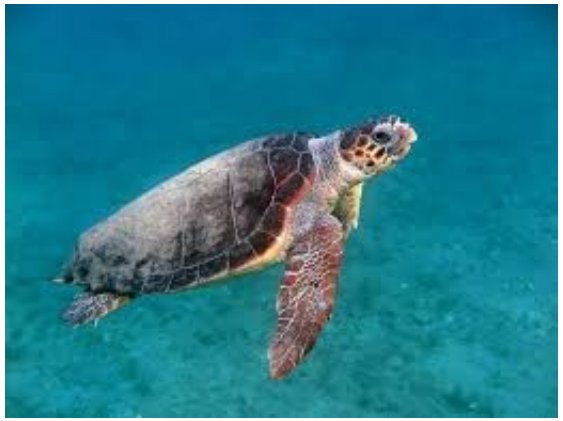
Nubian ibex *(Capra nubiana)*

Species for which there is already evidence of impacts from climate change in Lebanon:

- Lebanon's cedar tree *(Cedrus libani)*
- Loggerhead sea turtle (*Caretta caretta*)
- Mediterranean monk seal *(Monachus monachus)*
- Bonelli's eagle *(Aquila fasciata)*
- Lebanon lizard *(Phoenicolacerta laevis)*
- Levant freshwater crab *(Potamon potamios)*
- Black-striped pipefish *(Syngnathus abaster)*
- African wildcat *(Felis lybica lybica)*
- Nubian ibex *(Capra nubiana)*
- Red coral *(Corallium rubrum)*



Mediterranean monk seal *(Monachus monachus)*



Loggerhead sea turtle (*Caretta caretta*)

The most impactful consequences on biodiversity

The species most affected by climate change in the world:

- Polar Bear (*Ursus maritimus*)
- Adelia Penguin (*Pygoscelis adeliae*)
- Royal penguin (*Aptenodytes patagonicus*)
- Walrus (*Odobenus rosmarus*)
- Antarctic krill (*Euphasia superba*)
- Giant panda (*Ailuropoda melanoleuca*)
- Snow leopard (*Panthera uncia*)
- Wading birds (*Phalaropus sp.*)
- Sulphurised toucan (*Ramphastos sulfuratus*)
- Alpine flowers in general
- *Iberian imperial eagle (Aquila adalberti)*
- *Salmonidae (different genera and species)*
- Marine plankton in general
- Sea turtles (different genera and species)
- North-Atlantic right whale (*Eubalaena glacialis*)
- Orangutans (*Pongo sp.*)
- Andean cat (*Leopardus jacobita*)
- Andean flamingos (*Phoenicoparrus andinus* e *Phoenicopterus jamesi*)
- Cheetah (*Acinonyx jubatus*)
- Amphibians in general