Climate change study reveals unappreciated impacts on biodiversity

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Shrinking ice sheets and melting ice caps are well known consequences of climate change. But a new study reveals that impacts on biodiversity will be just as severe in other regions of the world. When multiple dimensions of climate change are analyzed, different regions emerge as threatened by different aspects of climate change. The tropics, for example, will be highly affected by local changes in temperature and precipitation, leading to novel climates with no current analogues in the planet. These results, recently published in *Science*, expose the complexities of climate change effects on biodiversity and the challenges in predicting and preserving natural ecosystems in a changing Earth.

"Polar regions have gained substantial attention because they are experiencing a very high temperature increase. Polar climates will shrink in area, providing reduced habitat for arctic and subarctic species, but climate change is more than melting ice. Warming in the tropics will create entirely novel climatic conditions, currently not experienced by species anywhere else on Earth. Whether species will be able to adapt to these novel climates is an open question. There is a risk of neglecting such vital information because the temperature increase in the polar regions is easier to grasp in comparison", says senior author Miguel Araújo, Chair in Integrative Biogeography at Imperial College London, senior researcher of the Spanish National Research Council (CSIC) at the National Museum of Natural Sciences in Madrid, and visiting Full Professor at University of Copenhagen.

Some species face extreme events, others a long move

The study, which is the outcome of an international collaboration led by the CSIC National Museum of Natural Sciences in Madrid and the University of Copenhagen in collaboration with the Universities of Évora, Helsinki and the Imperial College London, is the first to provide a detailed global overview of the threats and opportunities for biodiversity arising from different measurements of climate change.

Using 15 climate change models used by the IPCC (International Panel for Climate Change), the authors examined how different aspects of change in temperature and precipitation could affect species persistence around the world. They reviewed most climate change metrics available, applied them into the 21st century, and related the emerging climate change patterns to expected threats and opportunities for biodiversity.

Raquel Garcia researcher from the CSIC National Museum of Natural Sciences in Madrid and Center for Macroecology, Evolution and Climate at University of Copenhagen:

"Climate change can be measured in many more ways than is traditionally done in studies of climate change impacts on biodiversity. For example, we can measure whether extreme events will become more or less extreme, whether given climatic conditions will become more or less available, and how far climatic conditions will move from their current locations. When we compare this variety of measurements into the future, it becomes apparent that biodiversity will experience different climatic challenges in different regions. Extreme warming and drying events, for example, are projected to mainly affect the tropics, causing a severe threat for sensitive species. When we consider how far the current climatic conditions will move, the distance is greatest in some regions of cold and polar climates. Species in such regions will thus face greater difficulties in tracking the types of climates they have

adapted to."

One cure does not fit all

Carsten Rahbek, co-author of the paper, Director of Center for Macroecology, Evolution and Climate at University of Copenhagen and professor at Imperial College London:

"These results provide us with a much more nuanced picture of the implications of climate change for biodiversity. Although climate change is a global phenomenon, it is expressed in many different ways, varying from region to region and thus there is no single cure to apply to all areas. We need to consider the consequences according to the main regional effects. The good news is that the better we understand the implications of climate change, the better we can design management actions to preserve biodiversity and ecosystems."

Conservation scientist Mar Cabeza, co-author from University of Helsinki says:

"Improving habitat quality in areas shrinking climatically to help species adapt locally, or promoting landscape connectivity for species that need to move to track suitable climates through time, are sound conservation strategies. Yet, combinations of novel climates and extreme events, such as expected for the tropics, imply that great uncertainties exist regarding species needs in a changing climate. In such cases, climate change mitigation remains a critical conservation option."

The complexity of nature

"Scientists are far from being able to accurately predict the impacts of global environmental changes on biodiversity and ecosystems worldwide.

The actual effects of climate change on biodiversity are extremely difficult to predict. To put it plainly, the level of complexity we have to deal with when trying to predict the future effects of climate changes on species and ecosystems, is unprecedented in natural sciences, and this is why we have to work with simplifications that uncover the major trends of change that are happening in the natural world", says Miguel Araújo.

"While climate change metrics implemented in this study do not account for detailed responses of individual species to climate change, they are likely to remain an important tool in the toolbox for biodiversity impact assessments", concludes Raquel Garcia and continues:

"The sheer number of underdescribed and undiscovered species means that assessments relying on available species data represent a very small proportion of the existing biodiversity. For example, global inventories account for less than 20% of all existing insects, a group with considerable influence on ecosystem functioning and services. When carefully implemented and linked to threats and opportunities, measurements of climate change, such as those examined in our study, yield first-order assessments of the potential effects on the biota as a whole."

More information: "Multiple Dimensions of Climate Change and Their Implications for Biodiversity," by R.A. Garcia et al. *Science*, 2014.

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