Annual highlights 2023

The relevancy and indeed need for ECONOVO's research agenda has been strongly visible in 2023, coming up in media and public discussions again and again. Earth's average land and ocean surface temperature in 2023 was the highest global temperature in the >150 years since consistent instrumental recording started. 2023 saw a series of extreme weather conditions across the globe. This included unprecedented heatwaves, significant droughts, and intense hurricane and cyclone seasons in a wide variety of areas. Linked to warming, but also other global-change dynamics, 2023 saw intense wildfire activity as well, e.g., in Canada and Hawaii. On top of this, other dynamics towards ecological novelty also continued to ferment heated discussions and concerns worldwide, e.g., alien species and losses of keystone species due to pressures such as poaching. Importantly, the scientific, political, and public discussions on these issues are very often hampered by poor understanding of the ecological mechanisms, consequences and dynamics involved. This leads to high uncertainty as regards future expectations and the most appropriate responses. As a result, there was strong scientific and public attention to our work, e.g., with many interviews and other media features, both nationally and internationally.

Figure 1. Several studies lead by ECONOVO researchers concerned the impacts of prehistoric humans on ecosystems and biodiversity, showing that ecosystem conditions today and across the last 5-10,000 years can be considered novel relative to the deeper time scales on which current biodiversity evolved. This includes studies showing that the severe extinctions among large-bodied mammals (megafauna) across the last 50,000 years are strongly linked to the expansion of humans, that most surviving megafauna species have experienced severe parallel, human-linked declines in population size, that vegetation consumption in natural areas as a consequence must have been severely reduced, and that, vice versa, pre-extinction vegetation exhibited structural characteristics suggesting high levels of chronic disturbance – as depicted here on the left (reconstructions by Brennan Stokkermans for the study) – in contrast to classic theory and the situation in most natural areas today.

Testifying to the pervasive, ongoing human influence on ecosystems worldwide, ECONOVO-led research using satellite data showed that human activities are a widespread, important driver of forest structure even within protected areas and so-called intact forest landscapes. Our research has also pointed to natural solutions to the dominance by alien plants, a widespread, rising concern. Based on data from natural areas in India, we showed that otherwise widely dominating invasive plants are kept in check in areas where very large herbivores (such as elephants, gaur, and water buffalos) are abundant, promoting native plant species richness. Looking directly to the future, ECONOVO-led research showed that areas of unique importance to global tree diversity are likely to become exposed to particularly high levels of rainfall change. ECONOVO also contributed to research showing that even moderate future climate change scenarios would expose more than 2 billion people to extreme heat towards the end of the century, with this number reaching more than 4 billion people under the more extreme scenarios. These highly worrying findings suggest a strong need to avoid such high-warming scenarios, and, at the same time, also point to a need to develop resilient strategies to deal with the high level of change that must be expected even in the best case, for people, but also for biodiversity and ecosystems. Reflecting its importance and quality, much of ECONOVO's research was published in highly respected journals, namely *Nature, Nature Communications, Nature Ecology & Evolution, Nature Climate Change, Nature Sustainability, PNAS,* and *Science Advances*.

Figure 2. A number of events also highlighted the recognition given to the ECONOVO team and its research agenda. In 2023 Center Director Jens-Christian Svenning received the prestigious Carlsberg Foundation Research Prize, with this motivation given in the press release: "Professor Jens-Christian Svenning from Aarhus University has been awarded the prize for his internationally acclaimed basic research spanning from macroecological processes to the development of methods and ideas for rewilding to benefit both the planet's climate and its ecosystems. He is also a tireless pioneer in his field when it comes to developing solutions to major global social challenges resulting from climate change." (Photo by Martin Juul/Carlsberg Foundation).