Global scenarios for biodiversity need to better integrate climate and land use change

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Global scenarios for biodiversity need to better integrate climate and land use change

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It is now widely recognized that climate and land use changes are among the most important threats to biodiversity and ecosystem services (Maxwell, Fuller, Brooks, & Watson, 2016; Scheffers et al., 2016). Biodiversity models and scenarios are developed to explore the possible future impacts of these threats (Thuiller et al., 2013; Urban et al., 2016). Such approaches are needed to inform decision-makers on conservation or management options that anticipate the response of biodiversity to future climate and land use change.

From the 1990s to the early 2000s, biodiversity models and scenarios based on climate change simulations accumulated in the scientific literature at a rate similar to that of scenarios assessing the future impacts of land use change on biodiversity. Since the early 2000s, the number of scenarios based on climate change simulations has shot up while those addressing the effects of land use change have increased only slightly (Titeux et al., 2016). The research focus on the future impacts of climate change on biodiversity is now stronger than ever before (Figure 1).

The steep increase in the consideration of climate change in biodiversity models and scenarios coincides with the release of the special report on emission scenarios (SRES) by the Intergovernmental Panel on Climate Change (IPCC) in 2000 (Nakicenovic et al., 2000) and its use in the Third Assessment Report in 2001 (Figure 1). The IPCC has played a key role in assessing the scientific information available from research co-ordinated at the global level. The SRES provided an overarching framework for the development of climate change simulations that are used as a reference and made widely accessible through dedicated data distribution centres. Through its endeavour to provide decision-makers with scientifically credible information on climate change and its effects on the environment and the society, the IPCC has also raised public awareness and impacted policy (Zhao, 2017).

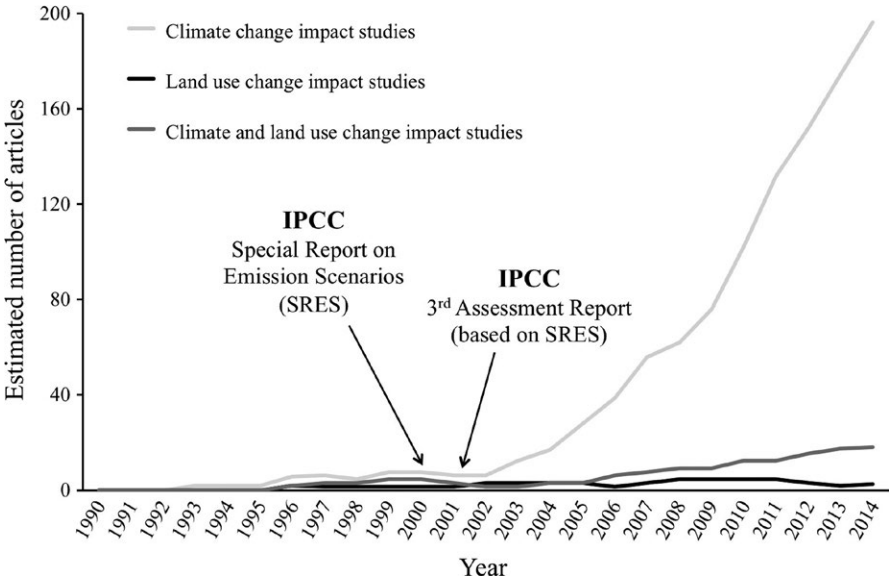

FIGURE 1 Effect of the activities of the Intergovernmental Panel on Climate Change (IPCC) on the ecological research agenda. The estimated yearly number of scientific studies reflects the trend in the research effort to address the future impacts of climate and/or land use changes on biodiversity over the period 1990-2014—see Titeux et al. (2016) for details on the extensive review of the scientific literature. The amount of climate change impact studies has increased abruptly since 2002 after some of the most important milestones of the IPCC. Studies examining the effects of land use change on biodiversity are lagging behind

Climate change has become part of a large number of research programmes and funding instruments within, but also beyond, the scope of climate research. The whole scientific community has been increasingly stimulated to examine the impacts of climate change as an issue of societal concern.

The focus on climate change in biodiversity scenarios has not been matched by similar attention to the consequences of land use change (Sirami et al., 2017; Titeux et al., 2016), despite the publication of an IPCC special report on this issue at the same time as the SRES (Watson et al., 2000). Underrepresenting land use change in scenarios that explore possible futures for biodiversity is not a credible approach because the direct destruction and modification of habitats will remain a significant conservation threat in the near future (Maxwell et al., 2016; Pereira, Navarro, & Martins, 2012; Tingley, Estes, & Wilcove, 2013). This imbalanced research agenda now imposes critical constraints when it comes to guiding anticipative conservation actions and to weighing the future outcomes of different policy or management options (Titeux, Henle, Mihoub, & Brotons, 2016).

Most of the few studies that project the combined impacts of multiple threats such as climate and land use change on biodiversity are based on integrated assessment models developed for the climate change community and adopted by the IPCC. These models simulate future changes in the main types of vegetation and their impacts on climate (Verburg, van Asselen, van der Zanden, & Stehfest, 2012), but they only capture a part of the key aspects of land use that impact biodiversity (Harfoot et al., 2014; Martin, Van Dyck, Dendoncker, & Titeux, 2013). For instance, changing land management and the intensity of land use will cause unprecedented habitat modifications in the future but are largely ignored in current integrated assessment models, or they are represented in a highly aggregated and simplistic manner (van Asselen & Verburg, 2013). These models are therefore insufficient to properly predict the full range of responses of biodiversity to future land use change (Harfoot et al., 2014; Titeux et al., 2016).

Efforts are underway to achieve a more detailed representation of future land use trajectories based on a more realistic representation of (variations in) human decision-making than in current integrated assessment models. Recently developed models simulate the interactions between global forces and the diversity of local factors that determine changes in the way humans will exploit the land surface (Rounsevell et al., 2012; Sleeter et al., 2012; Verburg et al., 2016). These models offer promising perspectives to increase our ability to predict how the local impacts of land use change will scale up and interplay with the effects of climate change to determine the future of biodiversity at the global level.

Co-ordinated work at the international level is needed to compare a wide range of models that simulate future land use change beyond the current integrated assessment approaches. Previous intercomparison studies have shown that a diverse set of models is needed to capture the high degree of uncertainty associated with future land use change, but these comparisons mainly focused on the types of vegetation (e.g., cropland, pastures, forests) that impact the climate system (Alexander et al., 2017; Prestele et al., 2016; Schmitz et al., 2014). Similar studies with a strong and explicit focus on biodiversity should now evaluate the relative potential of different models for adequately representing the ways in which human activities will impact those land use and landscape characteristics that are critical to biodiversity at varying scales. Only if the different ways that people manage and impact ecosystems are represented in the models, it will be possible to use their outcomes in a manner that allows anticipating the positive or negative impacts of human activities on biodiversity. Identifying the aspects of land management and policies that are still poorly captured in the range of currently available models will also be needed to propose further data acquisition and modelling efforts. We believe this is a first critical step for the development of a roadmap to integrate climate and land use change at multiple scales into models and scenarios that explore possible futures for biodiversity.

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established to help implement effective policies for conserving biodiversity based on a strengthened dialogue between the scientific community, governments and other stakeholders (Díaz et al., 2015; Vohland & Nadim, 2015). This platform is in the process of establishing a long-term research agenda for the development of a new generation of models and scenarios that could contribute more significantly to policy support for biodiversity conservation (IPBES, 2016). For moving towards novel management strategies and policies that could address the future and cross-scale impacts of climate and land use change on biodiversity, we invite the expert group on models and scenarios of the IPBES to facilitate and encourage new model intercomparison approaches targeted to the specific needs of the biodiversity community. The success of the IPCC has shown that the effective implementation of an ambitious research agenda does not solely depend on research efforts—it also requires a sufficient level of societal acceptance to effect political change. As it focuses on reinforcing the **science–policy** interface for biodiversity and on improving the connection between nature and people, the IPBES is offering a suitable context and should play a central role in pushing the research needs that we highlight here up in the programme of international and interdisciplinary research funding instruments. We encourage all those who are engaging in the IPBES to build on the experience and success of the IPCC in mobilizing the scientific and non-scientific communities.

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BIOSKETCH

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