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Assessing the impact of Holocene land cover change on the Asian monsoon climate

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The Asian monsoon system is the strongest monsoon system worldwide. Including large parts of China and India, it influences the life of nearly two thirds of the present-day global population. But the Asian monsoon region comprises also the homelands of some of the oldest human civilisations. The linkage between the development or collapse of these cultures and the monsoon variability is still a matter of discussion. The role early human societies could have played with respect to the Holocene climate and environmental change are of special interest in the context of recent global warming. They might have influenced the climate via land use change.

Monsoon circulations are primarily driven by the thermal contrast between continents and oceans. Therefore, land cover changes and their accompanied effect on the energy- and water balance may have a direct influence on the monsoon dynamics.
Pollen-based vegetation reconstructions suggest that large parts of the Asian monsoon region were much more covered by forests during the mid-Holocene (e.g. Ren, 2007, Zhao et al., 2009). However, a complete picture of the mid-Holocene land cover and its change during the following millennia cannot be derived yet.

In this study, we therefore chose an idealised approach, using the general circulation model ECHAM5-JSBACH: By prescribing idealised vegetation distributions, we analyse the impact of large-scale land cover change on the Asian monsoon climate under different orbital forcings. Based on these results, we assess the role of land cover change for the Holocene climate change and address possible consequences for the neolithic cultures living in the Asian monsoon domain.

In most parts of the Asian monsoon region, the influence of the prescribed land cover change on climate is small compared to the orbitally induced signal. However, our results show that large-scale forest decline in East and South Asia can lead to a strong decrease in regional precipitation. Thus, climate- and/or human-induced land cover changes might have strongly contributed to the mid- to late-Holocene climate change. Furthermore, one can not exclude that land-cover change might have forced the decline of major neolithic Asian cultures by further weakening the orbitally induced decreasing summer monsoon known from reconstructions (e.g. Wang et al., 2005).

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