

The Biogeophysical Climatic Impacts of Anthropogenic Land Use Change during the Holocene

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The first agricultural societies were established around 10ka BP and had spread across much of Europe and southern Asia by 5.5ka BP with resultant anthropogenic deforestation for crop and pasture land. Various studies have attempted to assess the biogeochemical implications for Holocene climate in terms of increased carbon dioxide and methane emissions. However, less work has been done to examine the biogeophysical impacts of this early land use change. In this study, global climate model simulations with HadCM3 were used to examine the biogeophysical effects of Holocene land cover change on climate, both globally and regionally, from the early Holocene (8 ka BP) to the early industrial era (1850 CE).

Two experiments were performed with alternative descriptions of past vegetation: (i) potential natural vegetation simulated by TRIFFID but no land-use changes, and (ii) where the anthropogenic land use model, KK10 (Kaplan et al., 2009, 2011*) has been used to set the HadCM3 crop regions. Snapshot simulations have been run at 1,000 year intervals to examine when the first signature of anthropogenic climate change can be detected both regionally, in the areas of land use change, and globally. Results indicate that in regions of early land disturbance such as Europe and S.E. Asia detectable temperature changes, outside the normal range of variability, are encountered in the model as early as 7ka BP in the June/July/August (JJA) season and throughout the entire annual cycle by 2-3ka BP. Areas outside the regions of land disturbance are also affected, with virtually the whole globe experiencing significant temperature changes (predominantly cooling) by the early industrial period. Large-scale precipitation features such as the Indian monsoon, the intertropical convergence zone (ITCZ), and the North Atlantic storm track are also impacted by local land use and remote teleconnections. We investigated how advection by surface winds, mean sea level pressure (MSLP) anomalies, and tropospheric stationary wave train disturbances in the mid- to high-latitudes winds led to remote teleconnections.

*Kaplan, Jed O., Kristen M. Krumhardt, and Niklaus Zimmermann. "The prehistoric and preindustrial deforestation of Europe." *Quaternary Science Reviews* 28.27 (2009): 3016-3034.

Kaplan, J. O., K. M. Krumhardt, E. C. Ellis, W. F. Ruddiman, C. Lemmen, and K. K. Goldewijk (2011), Holocene carbon emissions as a result of anthropogenic land cover change, *The Holocene*, 21(5), 775-791