Tellus (2007), 59B, 587–601
Printed in Singapore. All rights reserved

TELLUS

An overview of regional land-use and land-cover impacts on rainfall

By R. A. PIELKE Sr.[1]*, J. ADEGOKE[2], A. BELTRÁN-PRZEKURAT[5], C. A. HIEMSTRA[1], J. LIN[6], U. S. NAIR[3], D. NIYOGI[4] and T. E. NOBIS[1], [1]*CIRES, University of Colorado, Boulder, CO 80309, USA;* [2]*Laboratory for Climate Analysis & Modeling (LCAM), Department of Geosciences, 420K Robert H. Flarsheim Hall, 5100 Rockhill Road, University of Missouri-Kansas City, Kansas City, Miissouri 64110-2499, USA;* [3]*Earth System Science Center, University of Alabama in Huntsville, 320 Sparkman Dr, Huntsville, Alabama 35805, USA;* [4]*Purdue University, Department of Agronomy, and Department of Earth and Atmospheric Sciences, West Lafayette, Indiana 47907-2054, USA;* [5]*CIRA, Colorado State University, Fort Collins, CO 80523, USA;* [6]*Department of Earth Sciences, University of Waterloo, Waterloo, ON, Canada, N2L 3G1*

(Manuscript received 22 February 2006; in final form 26 October 2006)

ABSTRACT

This paper documents the diverse role of land-use/land-cover change on precipitation. Since land conversion continues at a rapid pace, this type of human disturbance of the climate system will continue and become even more significant in the coming decades.

1. Introduction

The role of landscape change in altering convective rainfall has been well documented (e.g. Pielke, 2001; Pitman, 2003). This paper summarizes the subject by landscape conversion type with a particular focus on how regional change results in changes in rainfall, in the same area. The teleconnection effect, where regions remote from the landscape conversion have altered rainfall (e.g. as discussed in Chase et al., 2000 and Avissar and Werth, 2005) is not the focus of this paper, as this is discussed elsewhere (e.g. Pielke et al., 2002; Marland et al., 2003).

Cotton and Pielke (2007; Table 6.2) list papers on the issue as to how regional weather patterns are affected by land-use and land-cover change. Warm season rainfall should be expected to change whenever deep cumulus convection is common in a region, since the surface fluxes of moisture, sensible, and latent heat change. This is the fuel for thunderstorms both in terms of moisture and in altering the convective available potential energy (Stull, 1988). The effect on cold season rain and snowfall, if any, is much less clear, and is not discussed in this paper.

The structure of the paper is to present examples of the role of human land-cover/land-use change for several landscape types. The main goals are to update earlier review papers as well as to further demonstrate the important role of landscape change as a first-order climate forcing. Land-use/land-cover change, while highlighted as a major climate forcing in National Research Council (2005), is still not generally recognized in international climate assessments as having a role on precipitation that is at least as large as caused by the radiative effect of the human addition of added well-mixed greenhouse gases.

We categorize the human landscape conversions with respect to several biome classes. We chose the specific categorization framework in Sections 2 to 9 since the different responses can be more effectively presented. While not inclusive of all landscapes, the examples that we present clearly document the important (and diverse) role of land-use/land-cover changes on climate.

2. Short-grass conversion to dryland agriculture and irrigated agriculture

Prior to agricultural settlement in the mid-19th-Century, grasslands comprised 300 million hectares of central North America, 21% of which (61.5 million ha) was short-grass steppe (Küchler, 1964; Sims and Risser, 2000). Short-grass steppe occupies a region that stretches from Western Nebraska to Western Texas, adjacent to the eastern front of the Rocky Mountains. It is dominated by low stature (5–30 cm), drought-tolerant, warm-season grasses such as *Bouteloua gracilis* and *Buchloë dactyloides* (Archibold, 1995; Sims and Risser, 2000).

*Corresponding author.
e-mail: pielke@atmos.colostate.edu
DOI: 10.1111/j.1600-0889.2007.00251.x