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Impact of Land-Use and Land-Cover Change on urban air quality in representative cities of China

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ABSTRACT

The atmospheric particulate pollution in China is getting worse. Land-Use and Land-Cover Change (LUCC) is a key factor that affects atmospheric particulate pollution. Understanding the response of particulate pollution to LUCC is necessary for environmental protection. Eight representative cities in China, Qingdao, Jinan, Zhengzhou, Xi'an, Lanzhou, Zhangye, Jiuquan, and Urumqi were selected to analyze the relationship between particulate pollution and LUCC. The MODIS (MODerate-resolution Imaging Spectroradiometer) aerosol product (MOD04) was used to estimate atmospheric particulate pollution for nearly 10 years, from 2001 to 2010. Six land-use types, water, woodland, grassland, cultivated land, urban, and unused land, were obtained from the MODIS land cover product (MOD12), where the LUCC of each category was estimated. The response of particulate pollution to LUCC was analyzed from the above mentioned two types of data. Moreover, the impacts of time-lag and urban type changes on particulate pollution were also considered. Analysis results showed that due to natural factors, or human activities such as urban sprawl or deforestation, etc., the response of particulate pollution to LUCC shows obvious differences in different areas. The correlation between particulate pollution and LUCC is lower in coastal areas but higher in inland areas. The dominant factor affecting urban air quality in LUCC changes from ocean, to woodland, to urban land, and eventually into grassland or unused land when moving from the coast to inland China.

1. Introduction

Atmospheric particulate matter comprises colloids of solid particles or liquid droplets suspended in the atmosphere; the diameters of these particles or droplets range from 0.001 to 20 μm. With the rapid development of China's economy, atmospheric particulate pollution is escalating, which significantly affects economic development and people's lives (Brunekreef and Holgate, 2002). In particular, PM_{10} and $PM_{2.5}$, having particulate aerodynamic diameters of less than 10 and 2.5 μm, can easily enter the lungs, and being enriched with organic pollutants and viruses, can cause serious harm to human health (Colvile et al., 2001; Brunekreef and Holgate, 2002; Xu, 2002; Espinosa et al., 2002; Marcazzan et al., 2003; Kocifaj et al., 2006; Huang et al., 2012). Atmospheric particulate matter can also lead to a poor atmospheric visibility by absorbing and scattering light (Wang et al., 2009; Chen et al., 2010; Han et al., 2011).

Research on Land-Use and Land-Cover Change (LUCC) using remote sensing technology has a long history and has made progress (Singh, 1989; Jensen, 1996; Coppin et al., 2004; Lu et al., 2004; Liu et al., 2008; Dewan and Yamaguchi, 2009a, 2009b; Dewan et al., 2012; Wei et al., 2015). LUCC is an important indicator in understanding the interactions between human activities and the environment (Dewan et al., 2012). In recent years, land cover has changed rapidly in developing nations, particularly in China (Wu et al., 2008; Zeng et al., 2014; Liu et al., 2014; Güneralp et al., 2015). The rapid changes of land cover are often characterized by urban sprawl (Mundia and Aniya 2006; Jat et al. 2008; Dewan and Yamaguchi 2009b; Dewan et al., 2012; Dewan, 2012; Byomkesh et al., 2012; Liu et al., 2014), farmland displacement (Ali, 2006; Du et al., 2013), and deforestation (Zhang and Song, 2006), leading to the loss of arable land (Lopez et al., 2001), habitat destruction (Alphan, 2003), and the decline of the natural greenery areas (Swanwick et al. 2003; Kong and Nakagoshi 2006). These losses have a substantial impact on urban environmental conditions such as biodiversity, climate change, and atmosphere particulate pollution at local and/or global scales (Nagendra et al., 2004; Phan and Nakagoshi, 2007).

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Researchers have conducted numerous studies on atmospheric particulate pollution. Related studies on atmospheric particulate pollution have mainly focused on its spatial and temporal distribution (Li et al., 2003, 2005; Fan et al., 2011; Chen et al., 2013; Sun et al., 2016), health effects (Samet et al., 2000; Brunekreef and Holgate, 2002; Nemmar et al., 2003; Dominici et al., 2006; Zhang et al., 2006;

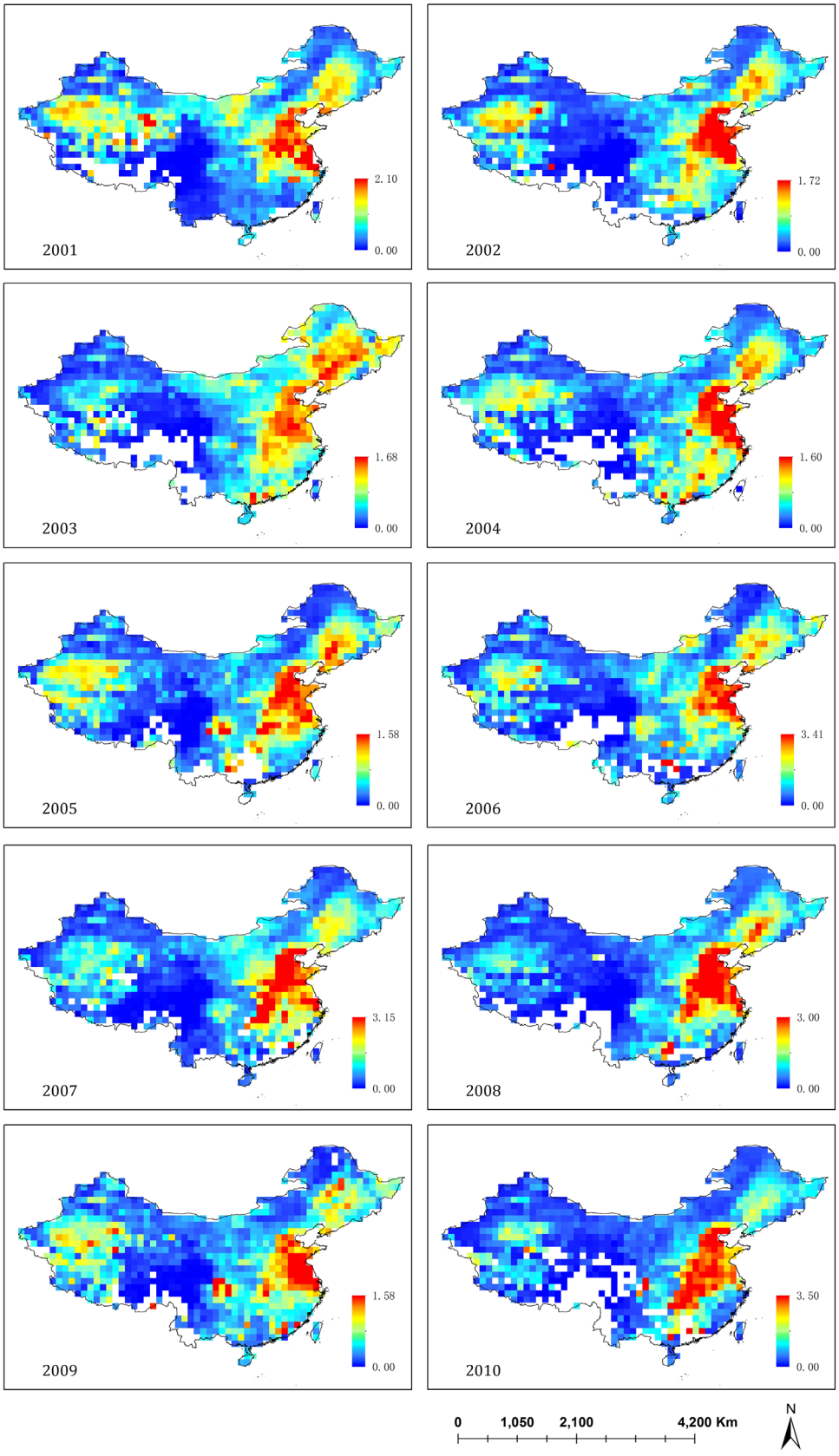

Fig. 1. Aerosol optical depth (AOD) spatial distribution of China in June from 2001 to 2010.