Biospheric Productivity of China Deserts

Climate alarmists are continually warning about the potentially-catastrophic negative consequences of CO$_2$-induced global warming, which they contend will wreak havoc with Earth's natural and agro-ecosystems. In this summary we thus review how deserts have fared throughout China in response to rising air temperatures and atmospheric CO$_2$ concentrations, which climate alarmists characterize as unprecedented over thousands of years (in the case of temperature) to millions of years (in the case of CO$_2$ concentration).

We begin with the work of Brogaard et al. (2005), who studied the dry northern and northwestern regions of the country - including the Inner Mongolia Autonomous Region (IMAR) - which had been thought to have experienced declining vegetative productivity over the past few decades due to "increasing livestock numbers, expansion of cultivated land on erosive soils and the gathering of fuel wood and herb digging," which practices were believed to have been driven by rising living standards that in combination with a growing population were assumed to have increased the pressure on these marginal lands. In the case of increasing grazing, for example, Brogaard et al. note that the total number of livestock in the IMAR increased from approximately 46 million head in 1980 to about 71 million in 1997.

To better assess the seriousness of this supposedly "ongoing land degradation process," as they describe it, the researchers adapted a satellite-driven parametric model, originally developed for Sahelian conditions, to the central Asian steppe region of the IMAR by including "additional stress factors and growth efficiency computations." The applied model, in their words, "uses satellite sensor-acquired reflectance in combination with climate data to generate monthly estimates of gross primary production." And to their great surprise, this work revealed that "despite a rapid increase in grazing animals on the steppes of the IMAR for the 1982-1999 period," their model estimates did "not indicate declining biological production [italics added]."

Clearly, some strong positive influence compensated for the increased human and animal pressures on the lands of the IMAR over the period of Brogaard et al.'s study. In this regard, they mention the possibility of increasing productivity on the agricultural lands of the IMAR, but they note that crops are grown on "only a small proportion of the total land area." Other potential contributing factors they mention are "an increase in precipitation, as well as afforestation projects." Two things that are not mentioned are the aerial fertilization effect and the transpiration-reducing effect of the increase in the air's CO$_2$ concentration that was experienced over the study period. Applied together, the sum of these several positive influences (and possibly others that remain unknown) was demonstrably sufficient to keep plant productivity from declining in the face of greatly increasing animal and human pressures on the lands of the IMAR from 1982 to 1999.

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Working in the semi-arid Loess Plateau of northwestern Shanxi, China, Yang et al. (2011) studied characteristics of Caragana microphylla plantations that had been established there five, ten, twenty, thirty and forty years previously, in efforts to combat desertification, which in the 1960s had claimed 48.5% of the region's surface area. These perennial leguminous and sand-binding shrubs were chosen for the task because they have well-developed stems with many clustered branches and large root systems capable of adapting to poor nutrient conditions; and they were thus positioned in groups to act as sand barriers and windbreaks. So what did Yang et al. learn by scrutinizing the different-aged plants' environments?

The establishment and development of the C. microphylla shrubs, in the words of the five Chinese scientists, "improved soil texture, enhanced soil organic matter (SOM), total nitrogen (TN), and cation exchange capacity (CEC)." In addition, they report that "SOM, TN, and CEC were significantly higher at the center than at the outside of the shrub canopies and were higher at the 0-5 cm depth than at the 5-10 cm depth." Moreover, they state that "the differences in SOM, TN, and CEC from the center to the outside of shrub canopies were greater under 30- and 40-year-old shrubs than under 10- and 5-year-old shrubs." And they even discovered that the spatiotemporal heterogeneity of the soil properties "facilitated the development of herbaceous species diversity and the restoration of the [region's] natural ecosystem," which had previously been lost to desertification.

In a somewhat different study, Peng et al. (2010) used snow-depth measurements collected at 279 meteorological stations scattered across China, plus co-located satellite-derived Normalized Difference Vegetation Index (NDVI) data, to investigate spatio-temporal changes in snow depth over the period 1980-2006 and the effects of those changes on vegetative growth the following spring and summer. In doing so, the five researchers learned that "over the past three decades, winter snow depth overall increased in northern China, particularly in the most

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2 http://www.co2science.org/articles/V14/N21/EDIT.php.
In discussing the implications of their findings, Peng et al. write that the "increase in vegetation coverage in arid and semiarid regions of China, possibly driven by winter snow, will likely restore soil and enhance its anti-wind-erosion ability, reducing the possibility of released dust and mitigating sand-dust storms," while noting that the frequency of sand-dust storms has indeed "declined in China since the early 1980s (Qian et al., 2002; Zhao et al., 2004)." Thus, as the world has warmed over the past three decades, there has been another concomitant climatic change across China above 40°N latitude (an increase in winter snow depth) that has prompted a biological change (increased vegetative growth in desert areas and grasslands) that has prompted yet another climatic change (a reduction in sand-dust storms), all of which changes would be recognized by most people as positive developments.

In another study, Piao et al. (2005a) used a time series of NDVI data from 1982 to 1999, together with precipitation and temperature data, to investigate variations of desert area in China by "identifying the climatic boundaries of arid area and semiarid area, and changes in NDVI in these areas." In doing so, they discovered that "average rainy season NDVI in arid and semiarid regions both increased significantly during the period 1982-1999." Specifically, they found that the NDVI increased for 72.3% of total arid regions and for 88.2% of total semiarid regions, such that the area of arid regions decreased by 6.9% and the area of semiarid regions decreased by 7.9%. They also report that by analyzing Thematic Mapper satellite images, "Zhang et al. (2003) documented that the process of desertification in the Yulin area, Shanxi Province showed a decreased trend between 1987 and 1999," and that "according to the national monitoring data on desertification in western China (Shi, 2003), the annual desertification rate decreased from 1.2% in the 1950s to -0.2% at present."

Further noting that "variations in the vegetation coverage of these regions partly affect the frequency of sand-dust storm occurrence (Zou and Zhai, 2004)," Piao et al. concluded that "increased vegetation coverage in these areas will likely fix soil, enhance its anti-wind-erosion ability, reduce the possibility of released dust, and consequently cause a mitigation of sand-dust storms." Interestingly, in this regard, they report that "recent studies have suggested that the frequencies of strong and extremely strong sand-dust storms in northern China have significantly declined from the early 1980s to the end of the 1990s (Qian et al., 2002; Zhao et al., 2004)." It would thus appear that the dreaded climatic change claimed to have been experienced by the globe over the latter part of the 20th century was either (1) not so dreaded after all or (2) totally dwarfed by opposing phenomena that significantly benefited China, as its lands grew ever greener during this period and its increased vegetative cover helped to stabilize its soils and throw feared desertification into reverse.

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Writing as background for their work, Zhao et al. (2011)\(^5\) note that "many studies based on analyses of satellite images have detected a greening trend at global (Myneni et al., 1997; Nemani et al., 2003; Potter et al., 2007; Zhou et al., 2001) and regional scales (Donohue et al., 2009; Fang et al., 2004; Herrmann et al., 2005)." However, they say that "the response of vegetation to climatic changes widely differed by biome (Fang et al., 2005; Piao et al., 2006) and bioregion (Verbyla, 2008)."

Against this backdrop and focusing on the grassland-oasis-desert complex of northwest China, the four Chinese researchers "investigated spatio-temporal changes in vegetation growth and their responses to a changing climate by biome and bioregion, using satellite-sensed Normalized Difference Vegetation Index (NDVI) data from 1982 to 2003, along with corresponding climate data."

As a result of their efforts, the researchers found that over the 22 years of their study, when annual mean temperature increased by 0.06°C/year, "about 30% of the total vegetated area showed an annual increase of 0.7% in growing season NDVI," which trend "occurred in all biomes and all bioregions except Sawuer, a sub-region of the study area with no significant climate change." And breaking this result into three sub-periods, they report that the NDVI increase was remarkable during 1982-1988, then tended to be slight, and finally actually declined a bit from 1998 to 2003, which pattern largely resembles the concomitant pattern of global air temperature change, which could have been responsible for the shifts in regional precipitation that appeared to be driving the observed shifts in NDVI. And in further support of this connection, Zhao et al. note that "previous analyses of satellite-measured vegetation growth suggested a greening trend of vegetation in the central United States (Wang et al., 2001, 2003) and the Sahel (Anyamba and Tucker, 2005; Herrmann et al., 2005) due to the effects of increasing precipitation at seasonal or annual scales."

Given the findings presented above, it would appear that in response to the supposedly most dramatic global warming of the past two millennia - which is claimed to have been driven by the even more unprecedented concomitant increase in atmospheric CO\(_2\) concentration - the vegetation in China's deserts appears to have fared remarkably well.

REFERENCES


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