Text S1. Estimation on change in shrub and grassland biomass

The change in shrub and grassland biomass over East Asia during 1990-2009 was estimated using an empirical approach developed by Piao et al. (2007) and Piao et al. (2009). In this approach, we extrapolated relationships between Normalized Difference Vegetation Index (NDVI) and observed aboveground biomass carbon density of shrublands (Eq. 1) and grasslands (Eq. 2) to all shrubland and grassland area over East Asia, respectively, resulting in the spatial-temporal change in shrubland and grassland biomass during 1990-2009.

$$BCD_s = 3114.2 \times NDVI_s^{2.3705} \qquad \text{(Eq. 1)}$$

Where BCD_s is the biomass carbon density of shrublands (g C m^{-2}) and $NDVI_s$ is the mean growing season (April - October) NDVI of shrublands.

$$BCD_g = 291.64 \times NDVI_g^{1.5842} \qquad \text{(Eq. 2)}$$

Where BCD_g is the biomass carbon density of grasslands (g C m^{-2}) and $NDVI_g$ is the mean growing season (April - October) NDVI of grasslands.

Table S1. Change in forest area and forest biomass carbon stock during 1990-2009 for each country in East Asia. Data are provided by FAO (2010).

Country	Forest Area Change (km^2 per year)	Biomass Carbon Stock Change (Pg C yr^{-1})
China	24860	0.09
Japan	15	0.02
Mongolia	-819	-0.004
North Korea	-1268	-0.003
South Korea	-74	0.008
Overall	22714	0.11

Table S2. Carbon balance of different components of terrestrial territory in East Asia estimated using different approaches.

Method	Component		Carbon balance ($Pg\ C\ yr^{-1}$)	Reference
Inventory and satellite based estimation	Vegetation	Forest	-0.11 ± 0.006	FAO, 2010
		Shrub	-0.024 ± 0.011	This study
		Grassland	0.001 ± 0.001	This study
	Soil	Forest	-0.014 ± 0.009	This study
		Shrub	-0.022 ± 0.028	This study
		Grassland	0.003 ± 0.004	This study
		Cropland	-0.022 ± 0.004	Huang et al., 2006
	Dead wood		-0.032	Pan et al., 2011
	DOC & POC		-0.019	Mayorga et al., 2010
	DIC		-0.029	Hartmann et al., 2009
	Litter		-0.012	Pan et al., 2011
	Wood products		-0.013 ± 0.002	This study
	Total		-0.293 ± 0.033	
Process model based estimation	CO_2 fertilization & Climate Change		-0.289 ± 0.135	This study

Table S2. Continued

Method	Component	Carbon balance ($Pg\ C\ yr^{-1}$)	Reference
	Nitrogen deposition	-0.107 ± 0.025	Tian et al., 2011; Mao et al., 2012
	Land use change	-0.013 ± 0.029	This study
	Troposphere O_3	0.02	Tian et al., 2011
	Agriculture management	-0.022 ± 0.004	Huang et al., 2010
	Wildfire	0.018 ± 0.010	Van der Werf et al., 2010
	Chemical weathering	0.020	Hartmann et al. 2009
	Biofuel	0.189 ± 0.010	Wang et al., 2012
	Total (including biofuel emission)	-0.224 ± 0.141	
	Total (excluding biofuel emission)	-0.413 ± 0.141	
Atmospheric inversion based estimation	Net CO_2 exchange	-0.380 ± 0.507	This study
	Food & wood trade	-0.04	This study
	Non-CO_2 emission	0.15	Folberth et al., 2005
	Total	-0.270 ± 0.507	

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