Supplementary Information for

Economic development and coastal ecosystem change in China

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Supplementary Methods

Human impacts. For fishing, we considered two impact drivers - China's fish catch in exclusive economic zones and globally. Global fish catch (and oceangoing freight; see below) were included in the analysis to more inclusively examine the marine impacts of China's booming economy, and their inclusion (or omission) does not change the overall results of our research. Data of specific species groups generally had the same trends, and were not included as individual impacts nor further analyzed to reduce interdependence.

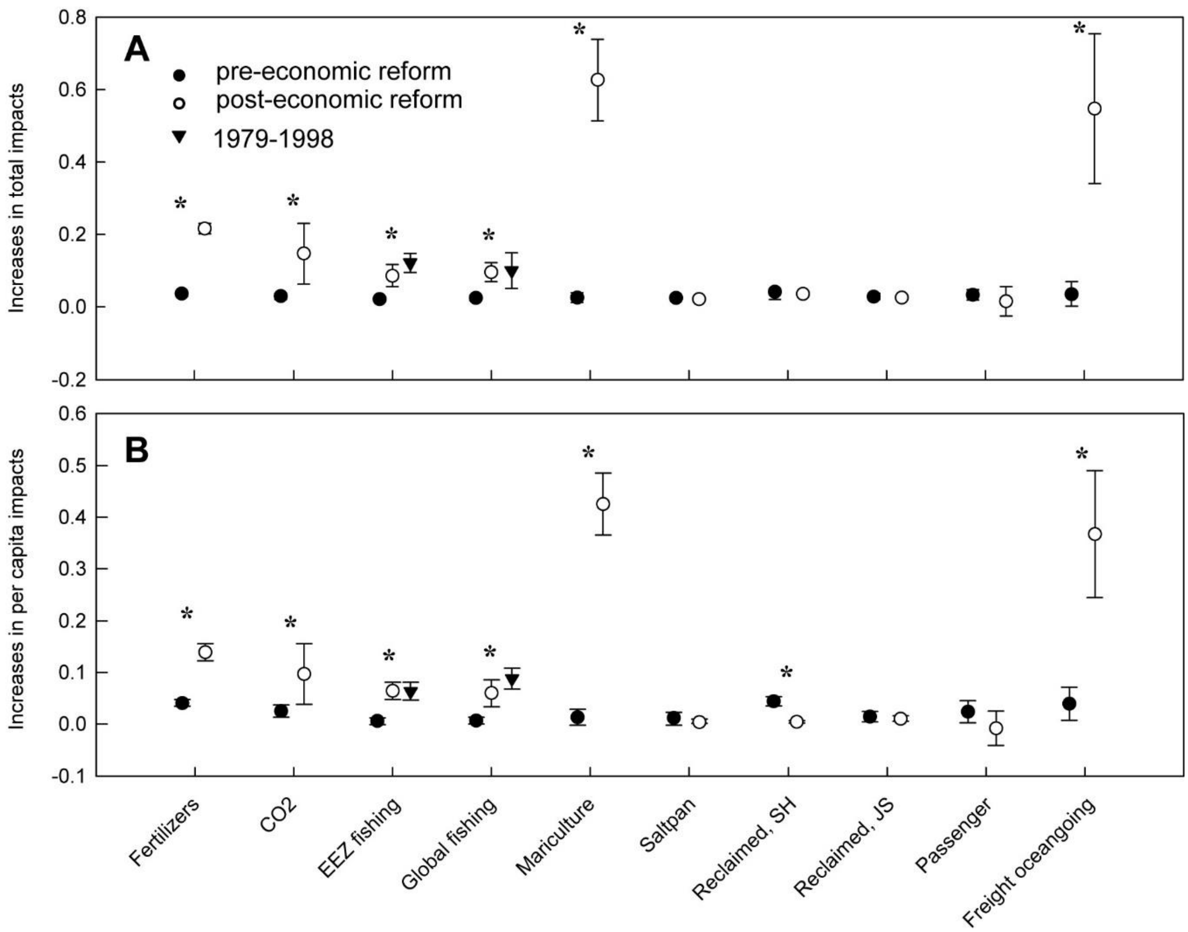
For waste emissions, we considered three sources of land-based pollutant discharge (excess watershed fertilizers, watershed industrial water pollution, and coastal sewage) and two sources of ocean-based pollutant discharge (offshore waste dumping and oilfield production wastewater). We also collected data on CO_2 emissions. Long-term data of the exact amount of each chemical constituent were lacking. Our estimates may not reflect the exact amount of pollutants that deposited into the ocean. Excess watershed fertilizers were estimated as the total amount of fertilizer consumption in China's watershed minus that of plant uptake (see Supplementary Table S6). Watershed BOD was estimated proportional to the industrial GDP and area of the watershed (see Supplementary Table S1). Coastal sewage was estimated as the sum of the coastal provinces'.

For habitat transformations, we considered four impact factors: human uses of coasts and seas for salt production pans and mariculture, and coastal reclamation activities in Shanghai and Jiangsu. Data of long-term coastal reclamations at the scale of China were unavailable.

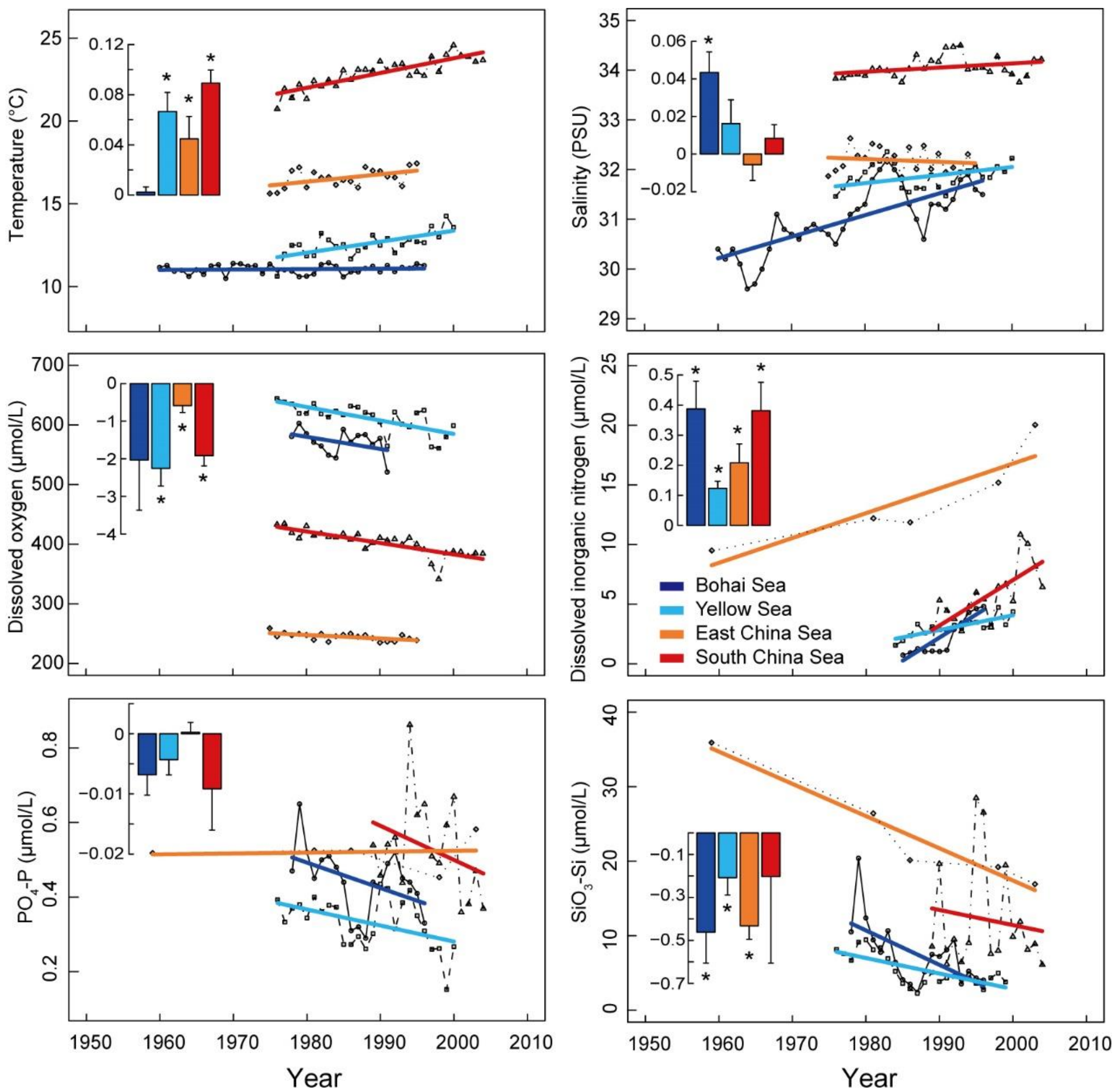
For transportation disturbance, as maritime transportation has been considered a good proxy for marine species invasions[1,2], our transportation data should indicate the trajectory of species invasions in coastal China. Long-term, consecutive data of species invasions in coastal China did not exist.

Note: (*i*) although tourism is a substantial component of China's coastal marine products, we did not include tourism that has been mainly considered an ecosystem service[3-5]; (*ii*) direct human effects[1] can also be increasing and associated with economic growth (due to attractiveness of better developed regions). Since we analyzed coastal population trends above and found no difference in population growth between pre- and post-reform periods, we did not further analyze direct human effects.

Quantifying historical trends in coastal degradation. For sea physical environment, we used long-term observational data of water column temperature, salinity, dissolved oxygen, dissolved nitrogen, PO_4-P and SiO_3-Si at permanent sites or along permanent transects in each of the four China's coastal seas[6-9], often starting from the late 1970s. For depletion of fishery resources, we used change of trophic level index (the trophic level of primary producers set as 1) and maximum body length data between 1950 and 2006 developed by Sea Around Us Project. Long-term changes in fishery resources in China's seas remained largely unquantified in the primary literature, and a few long-term studies[10,11] in the Bohai and Yellow Seas showed consistent patterns with the estimates of Sea Around Us Project. For algal blooms, we extracted number of red tide occurrences from three sources: (*i*) Bulletin of Marine Disasters in China (www.soa.gov.cn), (*ii*) Bulletin of Marine Environmental Status of China (www.soa.gov.cn), and (*iii*) Chinese scientific literature. The highest number of red tide occurrences in each year reported among these sources was used. Due to a lack of long-term data, we did not quantify the trends in other types of algal blooms. Red tides are the major component of coastal algal blooms in China. For degradation of corals, coral cover at three sites with long-term studies were collected. We extracted coral cover data from each study and computed their means by year at each site. Where available, maximum and minimum coral covers were also extracted and shown. We accounted for methodological variation among these data (see Supplementary Table S3). For loss of coastal wetlands, we used the area data of total coastal wetlands and each of the following major types extracted from a previous study interpreting available satellite images between 1978 and 2008[12]: non-vegetated mud/beach, vegetated marshes/mangroves, estuarine waters, estuarine delta and lagoon. Such data before 1978 were not available. To specifically examine change in mangroves that were not reported in the above study, we extracted mangrove area data from published literature. Relative wetland/mangrove area at each time point was computed assuming their area in ~ 1978 as 1.



Supplementary Figure S1 Yearly average increases in various human impacts on China's coastal ecosystems in pre- and post-economic reform periods. (**A**) Total impacts. (**B**) Per capita impacts. Data estimates are based on relative values (1978 = 1) and shown as means and 95% confidence intervals. Differences between pre- and post-reform periods are considered if there is no overlap in their 95% CIs (shown with a *). For fishing, estimates were also done excluding data since 1999 when fishery catches were mandated as constant. SH and JS indicate Shanghai and Jiangsu, respectively.



Supplementary Figure S2 Changing water environments in China's coastal seas: Bohai, Yellow, East China and South China Seas. Insets are plots of the annual rate of change (+ SE). Significant changes ($P < 0.05$) are indicated with * above error bars. Data were extracted from long-term observations along permanent transects in each sea (see Methods).

Supplementary Table S1 Summary of the time-series data of human impacts and data sources.

Category	Impact factor	Explanation	Time periods	Source
Fishing	EEZ fishing	China's total fish catch in its exclusive economic zones	1950-2006	Sea Around Us Project[a], www.seaaroundus.org
	Global fishing	China's total fish catch globally	1950-2006	Sea Around Us Project[a], www.seaaroundus.org
Waste emissions	Excess watershed fertilizers	Total amount of fertilizer consumption in a year in China's watershed minus that of plant uptake; for calculations, see note **b**	1952, 1957, 1961-2010	FAOSTATS, http://faostat.fao.org China Statistical Yearbooks[13]
	Watershed BOD	Total emissions of organic water pollutant in China's watershed; for calculations, see note **c**	1980-2001, 2003-2007	World Resource Institute, http://earthtrends.wri.org World Bank, http://data.worldbank.org/
	Coastal sewage	Total volume of sewage discharged in China's coastal provinces	1985-1989, 1991-1995, 1998-2010	China Statistical Yearbooks[13]
	Offshore waste dumping	Total volume of offshore waste dumping	1997-2010	China Marine Statistical Yearbooks[14]
	Offshore oilfield wastewater	Total volume of oiled wastewater produced from offshore oil production	1999-2010	China Marine Statistical Yearbooks[14]
	CO_2	China's fossil-fuel CO_2 emissions data (including emissions from cement production and excludes emissions from bunker fuels)	1950-2010	The Global Carbon Project, www.globalcarbonproject.org
Habitat transformations	Saltpans	Area data of the total human use of coasts and seas for salt production pans	1952, 1957, 1962, 1965, 1970, 1975, 1978-1992, 1996-2010	China Marine Statistical Yearbooks[14]
	Mariculture	Area data of the total human use of coasts and seas for mariculture	1957, 1962, 1965, 1970, 1975, 1978-1992,	China Marine Statistical Yearbooks[14]

			1994-2010	
	Reclamation, Shanghai	Area data of total reclaimed coasts and seas in Shanghai	1951-1995, 2000, 2009	Refs. 15,16 Yearbooks of China Water Resources[17]
	Reclamation, Jiangsu	Area data of total reclaimed coasts and seas in Shanghai	1951-2008	Ref. 18
Transportation	Marine passenger	Total turnover volume of marine passenger transportation (passengerkilometer, pkm)	1952, 1957, 1962, 1965, 1970, 1975, 1978, 1981-1992, 1994-2010	China Marine Statistical Yearbooks[14, d]
	Coastal freight	Total turnover volume of coastal freight transportation (ton-kilometer, tkm)	1978-2010	China Marine Statistical Yearbooks[14]
	Oceangoing freight	Total turnover volume of oceangoing freight transportation (tkm)	1951-2010	China Statistical Yearbooks[13]

Notes: **a**, Bias-corrected the fishery data reported by Food and Agriculture Organization of the United Nations (FAO);

b, Excess watershed fertilizers in each year was estimated as

$$EWF_t = \begin{cases} \sum_{i=1}^{n} \frac{DA_i}{LA_i} \bullet NPK_{i,t} \bullet (1 - r_{i,t}) & t = 1981, 1982, ..., 2010 \\ NPK_{total,t} \bullet (1 - r_t) \bullet \sum_{i=1}^{n} \frac{DA_i}{LA_i} \bullet \frac{AA_{i,t}}{AA_{total,t}} & t = 1952, 1957, 1961, ..., 1980 \end{cases}$$

where *EWF* is the excess watershed fertilizer, *t* is the time (year), *i* is a province of China, *total* indicate the total of China, *DA, LA, AA* and *NPK* are the drainage area, total land area, agricultural area and fertilizer consumption, respectively, and *r* is the coefficient of plant utilization. *r* varied with per sown acre fertilization rate (kg/hm^2) and also geographically. In our study, we used the average *r* of different geographical region * fertilization rate combinations determined in previous studies (Supplementary Table S6)[19,20]. The fertilizer consumption data for each province before 1980 was unavailable, so we used the agricultural area (i.e. *AA*) of each province to estimate fertilizer consumption in each province, and *r* based on the national average fertilizer consumption per sown acre. The *NPK* data between 1981 and 2010 and in 1952 and 1957 were extracted from China Statistical Yearbooks, while those between 1961 and 1980 (not consecutively presented in China Statistical Yearbooks) were extracted from FAOSTATS. The data of these two sources were generally consistent (FAO rely on the statistics provided by member countries), though FAO did not provide China's province-level data of fertilizer consumption. Additional analysis using data from either source did not compromise our results. *DA* and *LA* were computed on ArcGIS 9.3 using China's administrative boundaries data (http://ngcc.sbsm.gov.cn/) and China's drainage basin map previously developed by Huang *et al.*[21]. For coastal provinces, *DA* was set to be equal to *LA*. Due to a lack of data, AA_i/AA_{total} before 1978 was assumed to be the same as in 1978. The allocation pattern of China's agriculture between 1952 and 1978 should not change much over years with the planned economy policy during that period;

c, Watershed BOD in each year was estimated as

$$WBOD_t = x_t \bullet \frac{BOD_{wri,t}}{GDP_{ind,t}} \bullet \sum_{i=1}^{n} \frac{GDPind_{i,t}}{LA_i} \bullet DA_i$$

where *WBOD* is the total amount of the watershed BOD discharge, BOD_{wri} is the total amount of national daily average BOD emissions estimated by World Resource Institute, GDP_{ind} and $GDPind_i$ are the total amount of gross industrial product of China and province *i*, respectively, and *x* is the number of days. GDP_{ind} and $GDPind_i$ were extracted from China's National Database of Statistics; and

d, For the pre-economic reform period, passenger transportation data of China's total and China's Ministry of Communications' were both available in 1952, 1957, 1962 and 1965, and China's total in 1970, 1975 and 1978 were estimated by dividing those of China's Ministry of Communications' in the same year by their average percentage of China's total in 1952, 1957, 1962 and 1965 (85%, ranging from 81-88%).

Supplementary Table S2 Summary of the data for the cross-sectional and panel analyses. Due to lack of consistent data or historical boundary changes, some provinces were excluded or combined with others. For the panel analysis, the start of the time period was generally selected in consideration of the availability of consecutive, consistent data.

Analysis	Impacts	Time period	Provinces included	Sources of raw data
Cross-sectional	Excess fertilizers	2001-2010	All except Heilongjiang and Xinjiang	Ref. 13
	CO_2	2001-2007	All except Xizang; Chongqing and Sichuan were combined	Ref. 22
	Coastal sewage	2001-2010	All 11 coastal	Ref. 14
	Fishery catch	2001-2010	All 11 coastal	Ref. 14
	Mariculture	2001-2010	All 11 coastal	Ref. 14
	Saltpan	2001-2010	All 11 coastal except Shanghai	Ref. 14
	Passenger	2001-2010	All 11 coastal except Heibei, Tianjin and Jiangsu	Ref. 14
	Freight coastal	2001-2010	All 11 coastal	Ref. 14
	Freight oceangoing	2001-2010	All 11 coastal	Ref. 14
Panel	Excess fertilizers	1981-2010	All except Heilongjiang and Xinjiang; The following were combined: (*i*) Chongqing and Sichuan; (*ii*) Guangdong and Hainan	Ref. 13
	CO_2	1995-2007	All except Xizang; Chongqing and Sichuan were combined	Ref. 22
	Coastal sewage	1998-2010	All 11 coastal	Ref. 14
	Fishery catch	1978-2010	All 11 coastal; Guangdong and Hainan were combined	Ref. 14
	Mariculture	1978-2010	All 11 coastal; Guangdong and Hainan were combined	Ref. 14
	Saltpan	1978-2010 (no 1993-1995)	All 11 coastal except Shanghai; Guangdong and Hainan were combined	Ref. 14
	Passengers	1999-2010	All 11 coastal except Heibei, Tianjin and Jiangsu	Ref. 14

Freight coastal	1999-2010	All 11 coastal	Ref. 14
Freight oceangoing	1999-2010	All 11 coastal	Ref. 14

Supplementary Table S3 Summary of searches and selecting criteria of primary literature on coastal degradations in China

Coastal response	**Literature source**	**Search item**	**Criteria for selecting studies and data**	**Resulting studies**
Red tides	CNKI	SU = red tide AND SU = China + our country AND SU = change + problem + disaster (translated from Chinese)	The study reported the change in number of red tide occurrence over at least 10 years	Refs. 23-31
Corals	CNKI	SU = coral AND SU = change (translated from Chinese)	The study reported coral cover at at least one of the following three sites: Daya Bay in Guangdong, Lutuitou of Sanya in Hainan and Woody Island in South China Sea.	Refs. 32-43
	Web of Science	TS = coral AND TS = (diversity OR richness OR abundance OR cover) AND TS = (South China Sea OR Daya OR Hainan OR Guangdong OR Fujian OR Xiamen)	We used data reported for consistent locations across studies within each site. For the Woody Island, we used coral covers in its northern part that were more often reported, while a few reports of coral cover in other parts were excluded. For similar considerations, coral covers at the four Daya Bay sites Dalajia, Xiaolajia, Bashazhou and Mabianzhou were used while others excluded. Furthermore, we used coral cover estimated with similar methods whenever possible (done by the same research group using the same methods).	
Mangroves	CNKI	SU = mangrove AND SU = change + dynamic AND SU = area (translated from Chinese)	The study (*i*) determined change in mangrove area over several time points across at least one decade and (*ii*) included a time point around 1978 (1976-1980)	Refs. 44-50

Supplementary Table S4 Summary of the results of tests of the EKC relationship between GDP per capita (x_t) and various human impacts (y_t). NA, not apply or not exist.

Analysis	$\ln(y_t)$	Unit	$\ln x_t$	$(\ln x_t)^2$	$(\ln x_t)^3$	C	AR(1)	MA(1)	Adjusted R^2	EKC shape [a]	Turning points (USD) [b]
Time-series											
Total impacts	Excess watershed fertilizer	10^4 t	4.29 (0.00)	-0.28 (0.00)	NA	-8.36 (0.01)	0.80 (0.00)	NA	0.99 (0.00)	Inversed U-shaped	2251
	CO_2	10^3 t C	2.25 (0.00)	-0.12 (0.01)	NA	4.28 (0.01)	0.79 (0.00)	0.59 (0.00)	0.99 (0.00)	Inversed U-shaped	11202
	EEZ catch	t	-9.46 (0.01)	1.64 (0.00)	-0.09 (0.01)	31.83 (0.00)	0.69 (0.00)	NA	0.97 (0.00)	Inversed N-shaped	(98); 2391
	EEZ catch (1950-1998)	t	-1.70 (0.01)	0.19 (0.00)	NA	18.15 (0.00)	0.70 (0.00)	NA	0.96 (0.00)	U-shaped	(81)
	Global catch	t	-12.08 (0.00)	2.10 (0.00)	-0.11 (0.00)	37.02 (0.00)	0.77 (0.00)	NA	0.99 (0.00)	Inversed N-shaped	(104); 1983
	Global catch (1950-1998)	t	-1.76 (0.00)	0.19 (0.00)	NA	18.86 (0.00)	0.87 (0.00)	NA	0.98 (0.00)	U-shaped	(96)
	Mariculture	km^2	4.20 (0.00)	-0.24 (0.00)	NA	-8.60 (0.00)	0.45 (0.02)	NA	0.99 (0.00)	Inversed U-shaped	6869
	Saltpan	km^2	1.41 (0.00)	-0.09 (0.00)	NA	3.01 (0.00)	NA	NA	0.89 (0.00)	Inversed U-shaped	2122
	Passenger	10^8 pkm	13.43 (0.00)	-1.79 (0.01)	0.08 (0.02)	-29.48 (0.00)	NA	NA	0.86 (0.00)	N-shaped	841; 4892
	Freight coastal	10^8 tkm	40.56 (0.02)	-5.95 (0.02)	0.29 (0.02)	-85.37 (0.02)	0.48 (0.01)	NA	0.96 (0.00)	N-shaped	NA
	Freight oceangoing	10^8 tkm	NA	NA	NA	13.35	0.98	NA	0.99	NA	NA

						(0.00)	(0.00)		(0.00)		
Per capita	Excess watershed	kg	4.03	-0.27	NA	-11.82	0.76	NA	0.99	Inversed	1931
impacts	fertilizer		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)	U-shaped	
	CO_2	kg C	11.67	-1.80	0.10	-19.49	0.70	0.60	0.99	N-shaped	NA
			(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)		
	EEZ catch	kg	-8.58	1.44	-0.08	18.08	0.57	NA	0.94	Inversed	(125); 2337
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	N-shaped	
	EEZ catch	kg	5.39	-1.08	0.07	-7.41	NA	NA	0.93	N-shaped	NA
	(1950-1998)		(0.03)	(0.02)	(0.01)	(0.10)			(0.00)		
	Global catch	kg	-10.87	1.86	-0.10	22.40	0.70	NA	0.98	Inversed	(119); 1818
			(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	N-shaped	
	Global catch	kg	-1.63	0.17	NA	5.78	0.74	NA	0.96	U-shaped	(107)
	(1950-1998)		(0.00)	(0.00)		(0.00)	(0.00)		(0.00)		
	Mariculture	m^2	4.00	-0.23	NA	-13.67	0.47	NA	0.99	Inversed	5516
			(0.00)	(0.00)		(0.00)	(0.01)		(0.00)	U-shaped	
	Saltpan	m^2	0.79	-0.06	NA	-0.66	NA	NA	0.60	Inversed	1166
			(0.00)	(0.00)		(0.20)			(0.00)	U-shaped	
	Passenger	10^{-6} pkm	-0.17	NA	NA	7.88	0.61	NA	0.66	Linear decrease	NA
			(0.02)			(0.00)	(0.00)		(0.00)		
	Freight coastal	tkm	38.13	-5.61	0.28	-80.91	0.48	NA	0.95	N-shaped	NA
			(0.02)	(0.02)	(0.02)	(0.03)	(0.01)		(0.00)		
	Freight oceangoing	tkm	NA	NA	NA	11.64	0.98	NA	0.99	NA	NA
						(0.00)	(0.00)		(0.00)		
Cross-sectional	Excess watershed	t/km^2 land	1.09	NA	NA	-6.41	NA	NA	0.10	Linear increase	NA
	fertilizer	area	(0.05)			(0.12)			(0.05)		
	CO_2	t C/km^2 land	1.68	NA	NA	-5.29	NA	NA	0.44	Linear increase	NA
		area	(0.01)			(0.05)			(0.00)		

	Coastal sewage	10^4 t/km	1.26	NA	NA	-4.53	NA	NA	0.22	Linear increase	NA
		coastline	(0.08)			(0.39)			(0.08)		
	Fishery catch	t/km	NA	NA	NA	NA	NA	NA	NA	NA	NA
		coastline									
	Mariculture	km^2/km	60.47	-3.99	NA	-228.94	NA	NA	0.60	Inversed	1959
		coastline	(0.01)	(0.01)		(0.01)			(0.01)	U-shaped	
	Saltpan	km^2/km	NA	NA	NA	NA	NA	NA	NA	NA	NA
		coastline									
	Passenger	10^4 pkm/km	2.02	NA	NA	-12.50	NA	NA	0.52	Linear increase	NA
		coastline	(0.03)			(0.06)			(0.03)		
	Freight coastal	10^4 tkm/km	-34.88	2.41	NA	133.34	NA	NA	0.79	U-shaped	1376
		coastline	(0.02)	(0.01)		(0.02)			(0.00)		
	Freight oceangoing	10^4 tkm/km	4.63	NA	NA	-26.97	NA	NA	0.68	Linear increase	NA
		coastline	(0.00)			(0.01)			(0.00)		
Panel	Excess watershed	t/km^2	6.71	-0.72	0.03	-19.05	NA	NA	0.98	N-shaped	NA
	fertilizer	landarea	(0.00)	(0.00)	(0.01)	(0.00)			(0.00)		
	CO_2	t C/km^2	-11.93	1.80	-0.08	30.74	NA	NA	0.99	Inversed	(187); 8528
		landarea	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)	N-shaped	
	Coastal sewage	10^4 t/km	1.95	-0.10	NA	-4.11	NA	NA	0.99	Inversed	27865
		coastline	(0.00)	(0.00)		(0.01)			(0.00)	U-shaped	
	Fishery catch	t/km	-3.12	0.80	-0.05	6.75	NA	NA	0.90	Inversed	(14); 2341
		coastline	(0.05)	(0.00)	(0.00)	(0.05)			(0.00)	N-shaped	
	Fishery catch	t/km	-11.62	2.17	-0.12	24.15	NA	NA	0.89	Inversed	(66); 1633
	(1978-1998)	coastline	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)	N-shaped	
	Mariculture+0.001 [c]	km^2/km	-16.32	3.00	-0.17	24.17	NA	NA	0.85	Inversed	(67); 2113
		coastline	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)	N-shaped	
	Saltpan+0.013 [c]	km^2/km	3.83	-0.28	NA	-14.45	NA	NA	0.73	Inversed	968

	coastline	(0.00)	(0.00)		(0.00)			(0.00)	U-shaped	
Passenger	10^4 pkm/km	0.35	NA	NA	0.25	NA	NA	0.86	Linear increase	NA
	coastline	(0.05)			(0.86)			(0.00)		
Freight coastal	10^4 tkm/km	107.72	-13.51	0.58	-282.50	NA	NA	0.95	N-shaped	NA
	coastline	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)		
Freight	10^4 tkm/km	0.62	NA	NA	3.81	NA	NA	0.83	Linear increase	NA
oceangoing+22 [c]	coastline	(0.04)			(0.09)			(0.00)		

a, The EKC curve shape is defined according to the signs of the estimated coefficients of ln(x), ln(x)^2 and ln(x)^3 (see refs. 51, 52);

b, the turning points with parentheses are those small ones omitted to define the EKC shape in Table 1 of the main text; and

c, the value (the minimum in the original data, except zero) was added for log-transformation considerations.

Supplementary Table S5 Summary of the results of tests of the EKC relationship between GDP per capita (x_t) and various human impacts (y_t), with trade openness (o_t), population density (p_t) and time trend (t_t) included as explanatory variables. NA, not apply or not exist.

$\ln(y_t)$	Unit	$\ln x_t$	$(\ln x_t)^2$	$(\ln x_t)^3$	$\ln o_t$	$\ln p_t$	t_t	C	AR(1)	MA(1)	Adjusted R^2	EKC shape	Turning points (USD)
Excess watershed fertilizer	10^4 t	3.29	-0.25	NA	-0.02	0.71	0.05	-9.24	0.66	NA	0.99	Inversed U-shaped	662
		(0.00)	(0.00)		(0.89)	(0.79)	(0.40)	(0.46)	(0.00)		(0.00)		
CO_2	10^3 t C	1.21	NA	NA	0.01	1.67	-0.06	-0.39	0.85	0.50	0.99	N-shaped	NA
		(0.00)			(0.89)	(0.19)	(0.02)	(0.94)	(0.00)	(0.00)	(0.00)		
EEZ catch	t	-10.50	1.79	-0.09	-0.09	2.13	-0.02	22.83	0.53	NA	0.97	Inversed N-shaped	(102); 3197
		(0.00)	(0.00)	(0.00)	(0.27)	(0.20)	(0.46)	(0.00)	(0.00)		(0.00)		
EEZ catch (1950-1998)	t	10.35	-2.04	0.13	0.16	1.13	0.00	-9.47	NA	NA	0.98	N-shaped	(90); 329
		(0.00)	(0.00)	(0.00)	(0.02)	(0.26)	(0.83)	(0.13)			(0.00)		
Global catch	t	-12.49	2.16	-0.12	-0.05	1.40	-0.01	30.42	0.68	NA	0.99	Inversed N-shaped	(109); 1974
		(0.00)	(0.00)	(0.00)	(0.51)	(0.25)	(0.53)	(0.00)	(0.00)		(0.00)		
Global catch (1950-1998)	t	-1.63	0.17	NA	0.04	0.88	0.00	13.50	0.73	NA	0.98	U-shaped	(110)
		(0.01)	(0.00)		(0.62)	(0.52)	(0.96)	(0.04)	(0.00)		(0.00)		
Mariculture	km^2	4.16	-0.24	NA	-0.07	0.26	0.01	-9.77	0.44	NA	0.99	Inversed U-shaped	5791
		(0.00)	(0.00)		(0.68)	(0.92)	(0.94)	(0.53)	(0.06)		(0.00)		
Saltpan	km^2	NA	NA	NA	-0.10	1.39	0.00	0.37	0.71	NA	0.88	NA	NA
					(0.36)	(0.34)	(0.96)	(0.96)	(0.00)		(0.00)		
Passenger	10^8 pkm	30.50	-4.11	0.19	0.16	9.71	-0.28	-120.32	-0.57	NA	0.84	N-shaped	NA
		(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)		(0.00)		
Freight coastal	10^8 tkm	21.32	-2.89	0.15	0.49	16.18	-0.38	-130.95	NA	NA	0.98	N-shaped	NA
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			(0.00)		
Freight oceangoing	10^8 tkm	11.60	-1.89	0.10	0.34	1.60	0.13	-28.52	0.55	NA	1.00	N-shaped	(124); 4389
		(0.01)	(0.01)	(0.01)	(0.01)	(0.49)	(0.00)	(0.01)	(0.00)		(0.00)		

Supplementary Table S6 Coefficients of plant utilization of agricultural fertilizers in different province * fertilization amount combinations in China, based on the median in ref. 20. The coefficients of plant utilization were only determined in six typical provinces in ref. 19, and those in the adjacent provinces were assumed to be the same. NA, not apply.

Geographical regions	Fertilization rates (kg/hm^2)			
	0-100	100-200	200-300	300-500
Northern coastal: Shandong, Hebei, Beijing, Tianjin, Liaoning, Jilin, Jiangsu	0.44	0.37	0.30	0.20
Southern coastal: Guangdong, Guangxi, Shanghai, Fujian, Zhejiang	NA	0.38	0.29	0.20
Northern central: Henan, Anhui	0.38	0.27	0.21	0.16
Southern central: Hunan, Hubei, Jiangxi	0.51	0.39	0.29	0.18
Northern west: Shanxi (East), Shanxi (West), Gansu, Qinghai, Ningxia, Inner Mongolia	0.42	0.31	0.23	0.15
Southern west: Guizhou, Chongqing, Sichuan, Yunnan, Xizang	0.51	0.32	0.21	0.10

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