Modeling and prediction of pollutant load outflow from the Yangtze River Basin

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Along with the increase in industrial and domestic wastewater and use of chemical fertilizers due to rapid economic development, the pollutant load of the Yangtze River basin gradually increases from upstream to downstream, and simultaneously, the amount of the pollutant load transporting to the sea has been increasing annually. This research aims to model the pollutant load outflow from the Yangtze River basin. For that purpose, we have developed an evaluation model for the circulation of water and materials in the river basin by incorporating the mass balance model in the SWAT (Soil and Water Assessment Tool) model (Arnold et al., 1998). The model allowed us to predict the influences of land use, river basin renovation activities, and management projects on the circulation of water and materials in the catchment basin, taking into account various soils, land use practices, and land management systems. A geographic information systems (GIS) database consisting of landforms, land uses, soil types, and soil characteristics was required for data input into the assessment model. Climate dataset consisted of daily maximum, minimum, and average temperatures, humidity, rainfall, wind velocity, and the amount of solar radiation. For validation of the model, we used observation data for water quality from 2004 to 2010 collected at the major hydrological stations along the main stream of the Yangtze River, including Pingshan, Zhutuo, Yichang, Shashi, Hukou, and Datong hydrological station about 550 km from the estuary.
The model was calibrated by the observation data during 2004-2006 and validated by the data during 2008-2010. The validation showed that the monthly flow variations were modeled accurately, although the correlations were lower for the downstream area than for the upstream area, and the modeling ability for phosphorous load was lower than that for nitrogen load. We used the validated model to estimate the distribution dynamics of the pollutant load of both nitrogen and phosphorus outflow, such as the total nitrogen (T-N), nitrate nitrogen (NO3-N), nitrite nitrogen (NO2-N), ammonium nitrogen (NH3-N), total phosphorous (T-P) and dissolved phosphorus (DIP) from the the Yangtze River. The simulation results showed that in the decade from 2001 to 2010, the amount of NO_3-N increased by 2.9 times, NO_2-N increased 3.2 times, and NH_3 N increased 3 times compared to values from the 1980s (Duan et al., 2000). In order to verify these estimated results further, we also measured the water quality at the Datong hydrological station from 2011 to 2014 (Table 1), and found that the average annual amount of transported NO_3-N, NO_2-N, and NH_3-N still keep on the high level condition, and increased by 2.2 times, 3.2 times, and 3.5 times respectively compared to values from the 1980s (Duan et al., 2000). Therefore, we conclude that the pollutant load outflow had remained at a high level during 2000-2014.

Acknowledgement:
This study is supported by the project "Analyses of the impact of the anthropogenic pollution on the ecosystem of the East China Sea and the sea around Japan" (2011-2015), funded by National Institute for Environmental Studies, Japan.

Keywords: Pollutant load, Nitrogen, Phosphorus, Yangtze river basin

Table 1: Average annual concentration (mg/L) and total outflow (10^4 t) of total nitrogen (T-N), total phosphorous (T-P), nitrate nitrogen (NO_3-N), nitrite nitrogen (NO_2-N), ammonium nitrogen (NH_3-N), and dissolved phosphorus (DIP) observed at the Datong hydrological station,

	T-N	**T-P**	**NO_2-N**	**NO_3-N**	**NH_3-N**	**DIP**
	Average annual concentration (mg/L)					
2011	2.43	0.15	0.04	1.71	0.45	0.11
2012	2.35	0.13	0.03	1.62	0.49	0.09
2013	2.47	0.15	0.02	1.65	0.61	0.11
2014	2.70	0.13	0.04	1.85	0.46	0.11
Average	2.49	0.14	0.03	1.71	0.50	0.11
	Annual total outflow(10^4 t)					
2011	162.17	9.81	2.42	114.05	30.20	7.64
2012	235.01	12.57	2.92	162.08	49.19	8.79
2013	194.88	11.45	1.55	130.19	48.13	9.00
2014	238.70	11.60	3.10	163.50	40.90	9.50
Average	207.69	11.36	2.50	142.45	42.11	8.73

