Evaluation of water quality improvement in a large-scale watershed, Korea

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1. Introduction

The Nakdong River suffers from drought upstream and flooding downstream. During the dry season, Water quality becomes a serious social problem. A water quality improvement project is now being implemented, as one of the Four Major Rivers Restoration Project; the project includes expansion of sewage-waste water treatment facilities, control planning for non-point contaminating source, and installing buffer retention facilities. The objective of this study is to analyze the long-term water quality impact of the water quality management practices in the Nakdong River basin.

2. Method and Material

The Soil and Water Assessment Tool (SWAT) model was developed to quantify the impact of water quality management practices and the pollutant loading in the Nakdong River basin. The study area was divided into 67 sub-basins and their stream reaches. The model was fitted to the observed daily streamflow, SS, TN, and TP data from 67 points for an 8-year period (2002–2009), and applied to simulate practicable improvement measures by various BMPs on Nakdong River watershed (Arabi et al., 2007; Bracmort et al., 2006; Ouyang et al., 2008; Zhongwei, 2006). Each control measure is described in Table 1. Expansion and upgrading of sewage-waste water treatment facilities were applied to control point source pollution. A variety of retention facilities were applied to control diffuse pollution on many sites and buffer retention facilities were installed the facilities on nine sites in the critical areas for the preventing of pollution-related accidents

Tabl**e 1**. Water quality improvement measures.

Type of Scenario		Description
Scenario-2007		Current condition (2007)
Scenario-2012	Point source	Expansion and upgrading of sewage-waste water treatment facilities
	Non-point source	Rainwater retention facilities, ecological detention ponds (23), Agricultural pond and ecological wetlands (33)
	Other	Installing buffer retention facilities

3. Results and Discussion

The calibration and validation results showed that the SWAT model was able to simulate the daily streamflow well with % difference and Nash-Sutcliffe efficiency less than 25%, greater than 0.6, respectively. The simulation results call for about 13.3% decrease of Total nitrogen loading and about 9.5% decrease of Total-P loading in the Nakdong River basin through project implementation, and most of the loading

reductions are caused by large sewage treatment facilities in the lower basin (Geumho, Nakdong estuary, and Suyoung region).

Table 2. Control effects of improvement measures in upstream

Items	SS	BOD	TN	TP
Total reduction loads (kg/d)	112	91,489	1,357,662	11,651
Total reductionrate (%)	-0.06	-8.6	-16.1	-5.2
PS reduction loads (kg/d)	2	33,677	461,559	5,094
PS reductionrate (%)	0.04	-3.8	-11.0	-4.1
NPS reduction loads (kg/d)	182	8,359	217,453	1,080
NPS reduction rate (%)	-0.10	-4.8	-5.2	-1.1

Table 3. Control effects of improvement measures in downstream

Items	SS	BOD	TN	TP
Total reduction loads (kg/d)	116,285	691,925	2,103,716	75,347
Total reductionrate (%)	-24.7	-35.8	-10.4	-13.8
PS reduction loads (kg/d)	2,584	399,986	965,166	40,574
PS reductionrate (%)	-7.0	-26.7	-9.3	-11.0
NPS reduction loads (kg/d)	353,274	39,534	112,344	4,933
NPS reduction rate (%)	-81.4	-9.1	-1.2	-2.8

4. Conclusion

The 'Four Major Rivers Restoration Project' aims to improve water quality management plans by investing in environmental infrastructure. The SWAT model was developed to quantify the impact of land management practices and the pollutant loading in the Nakdong drainage basin. The model results demonstrated that the water quality improvement project is effectively reduces point-source loading, but more investment and changes in practice are need to control non-point source pollution.

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