Export of phosphorus and nitrogen from agricultural river basins in Korea

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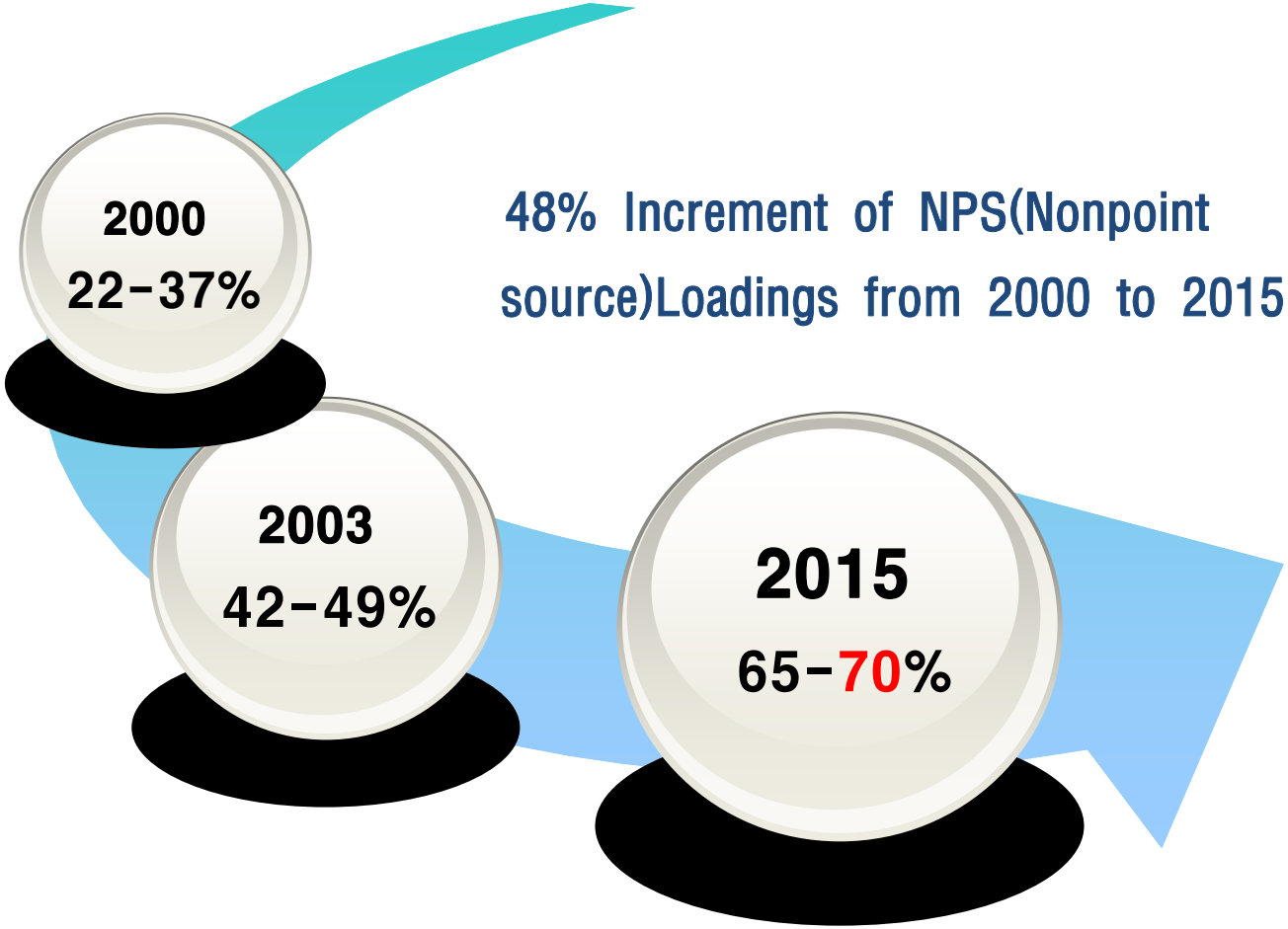
Background

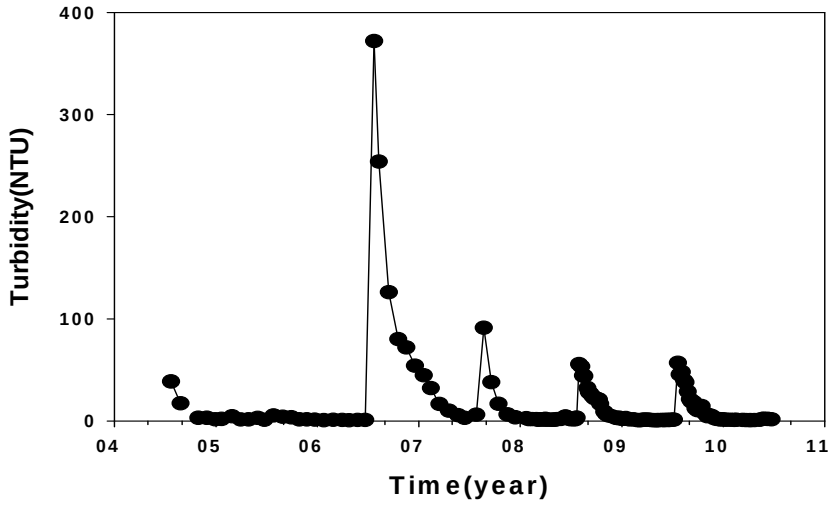
Establishment & announcement of master plan to manage water quality for Han River by ME(Ministry of Environment, 2006)

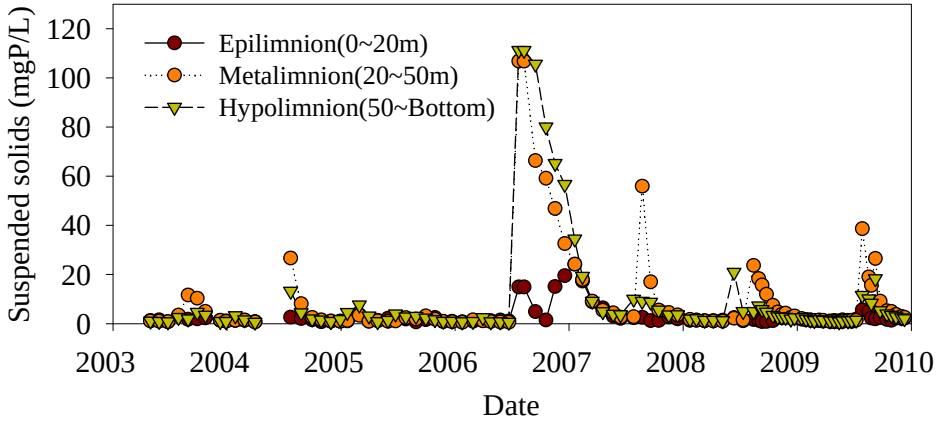


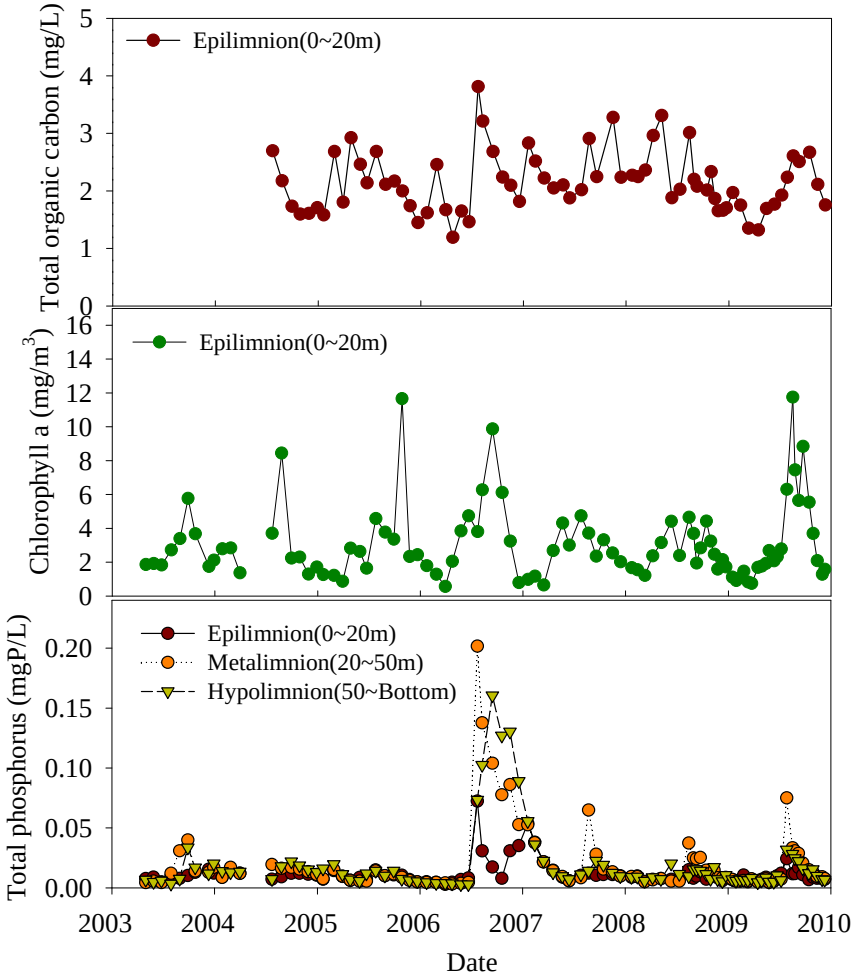
Background

Observation of High Turbidity(327 NTU) in outlet of Lake Soyang.

TOC, Chl-a have been increased after monsoon in every year.



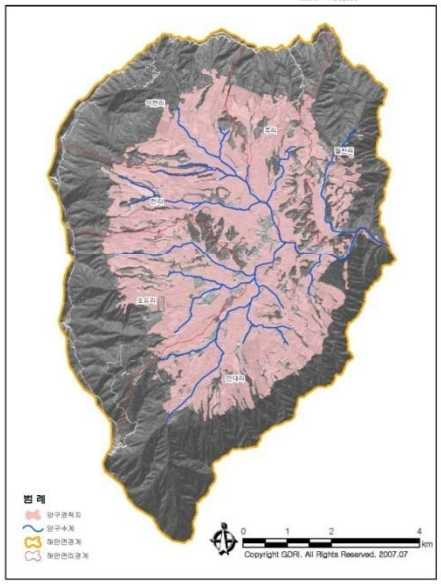


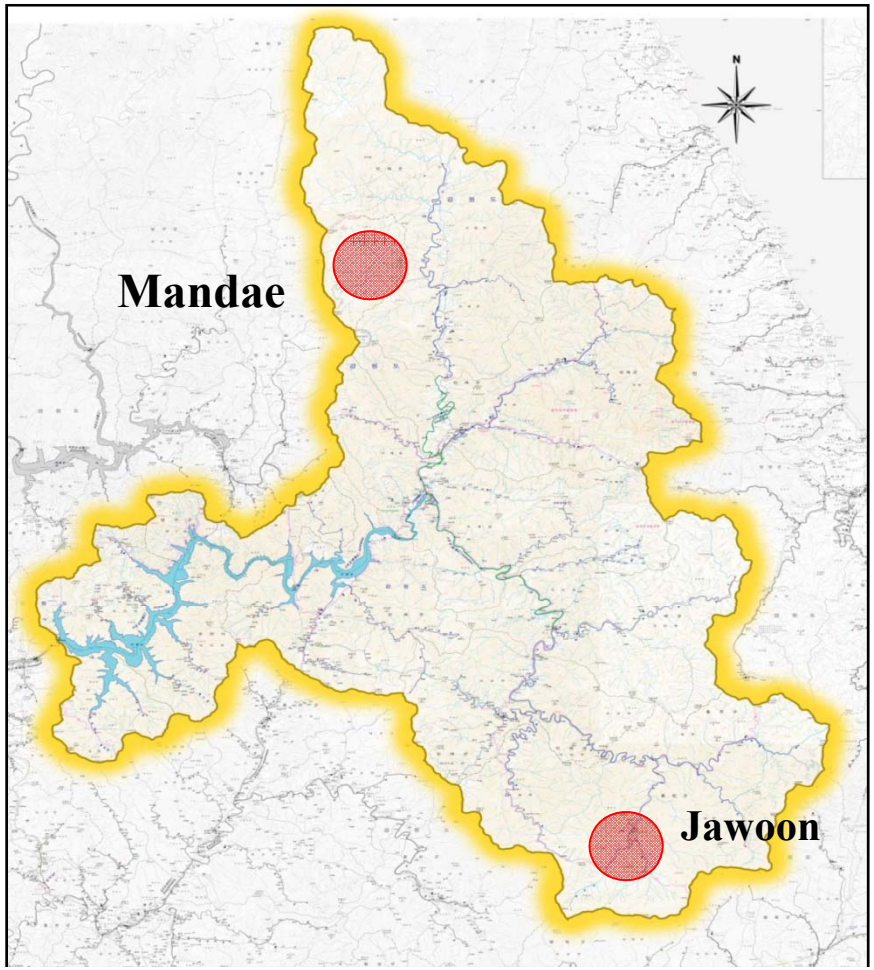


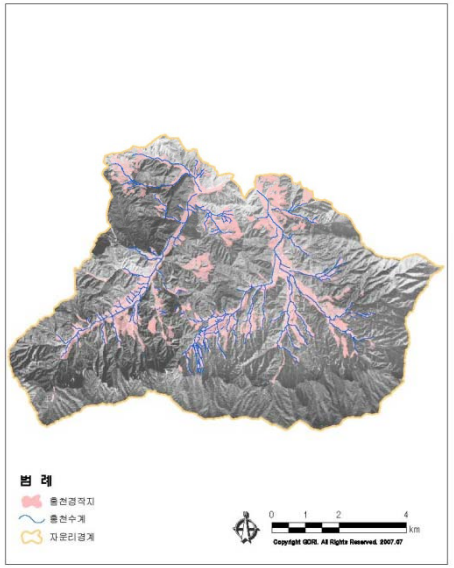
Background

Soyang watershed was designated as a special measures area by ME.

The government constructed non-point source control facilities.







Objectives

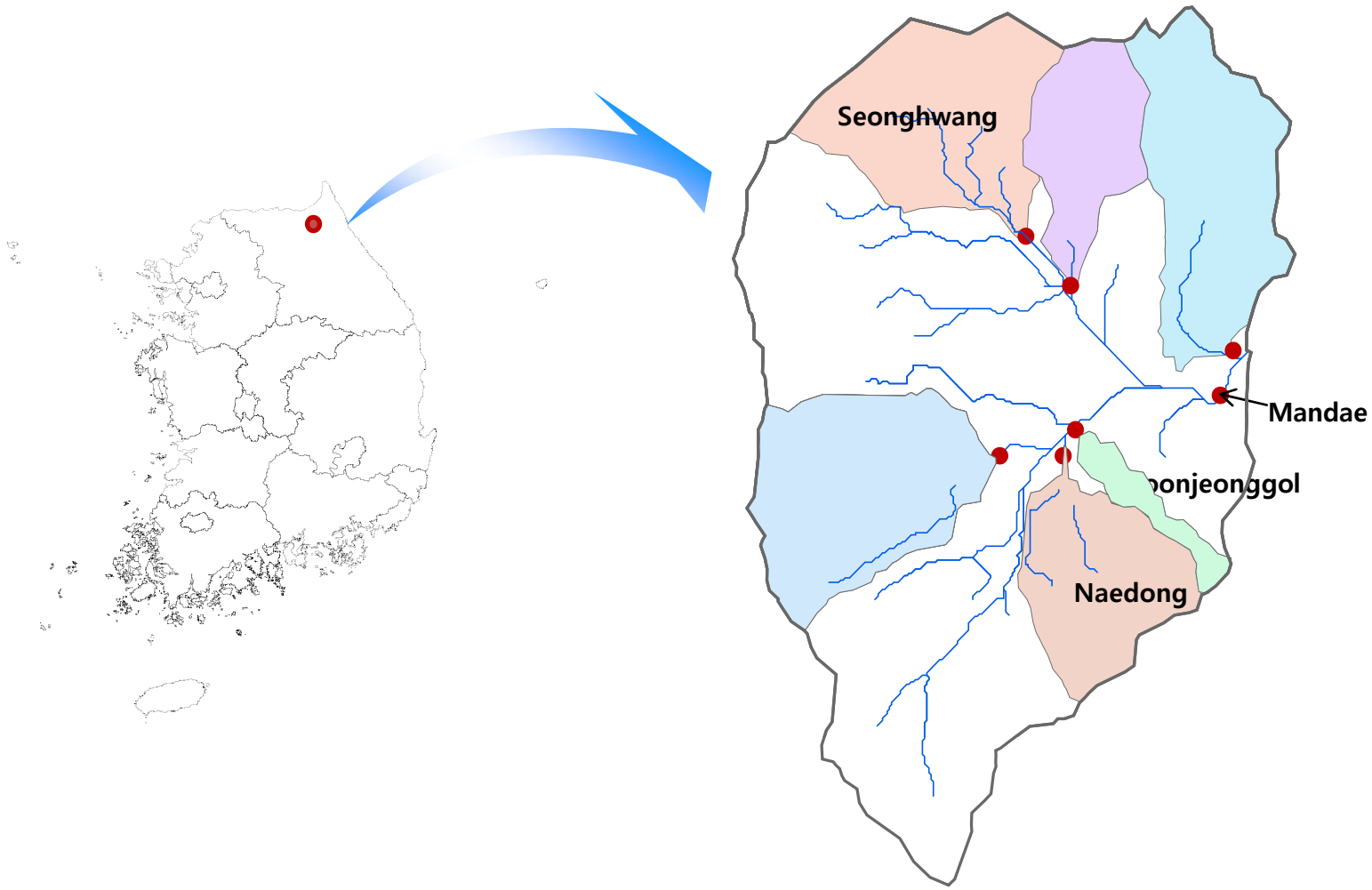
To design and mange those NPS control facilities, it is essential to understand runoff characteristics of pollutants(SS, T-N, T-P).

Objective of this study is to quantify the nitrogen and phosphorus loadings from agricultural basin river and to provide basic data to validate a watershed ecosystem model.

Study sites

Water quality and discharge were measured at 7 subwatersheds in Haean.

Mandae is outlet of Haean catchment

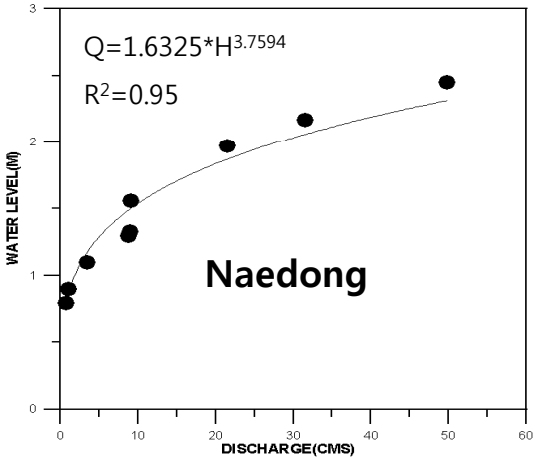


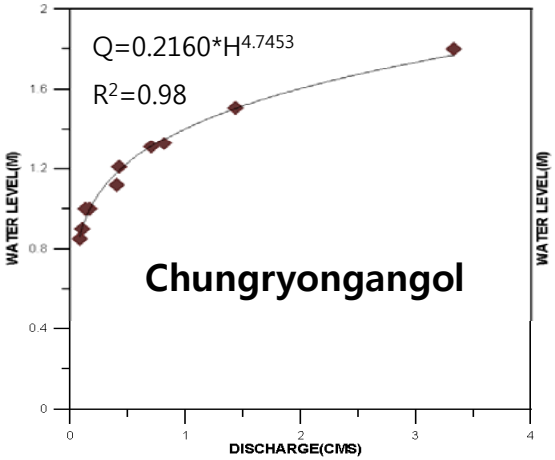
Measurement of discharge

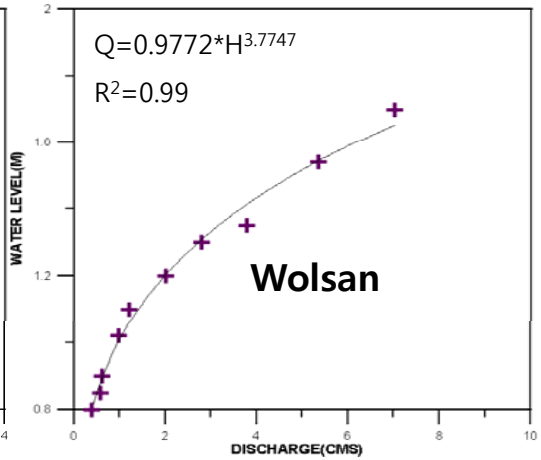
Stream discharge was quantified in DJ, ND, WO, KJ, SH, CH by measuring current velocity and water depth at set intervals across each stream channel with a magnetic current velocimeter.

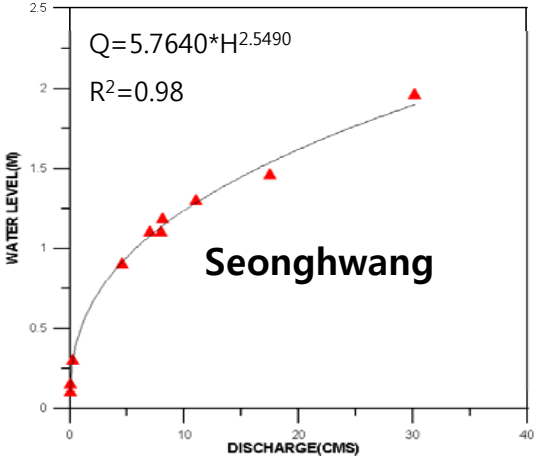
Doonjeong	Naedong	Wolsan
		
Kunjigol	**Seonghwang**	**Chungryongangol**
		

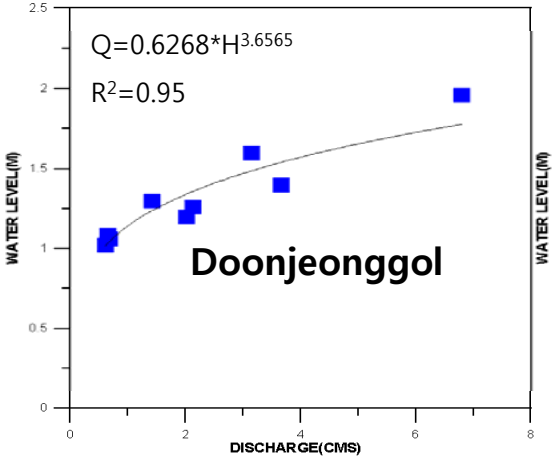
Measurement of discharge

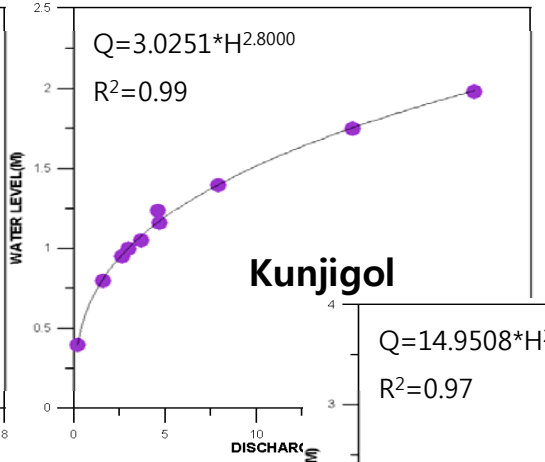


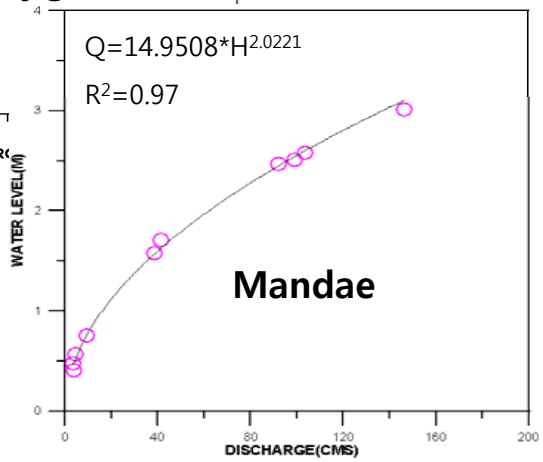












Analysis of water quality

Water quality parameter(14)

- Temperature, pH, DO, Turbidity, Electronic conductivity, Suspended solids, Biochemical oxygen demand, Chemical oxygen demand, Total phosphorus, Dissolved phosphorus, Total nitrogen, Ammonia, Dissolved organic carbon

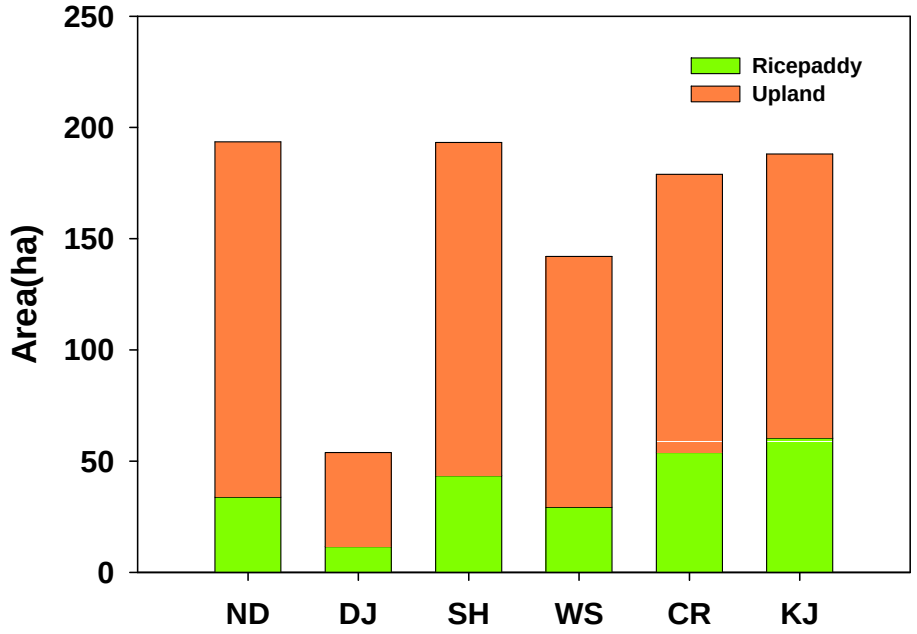
Methods

-Standard methods of Korea

-Standard methods of APHA 1998

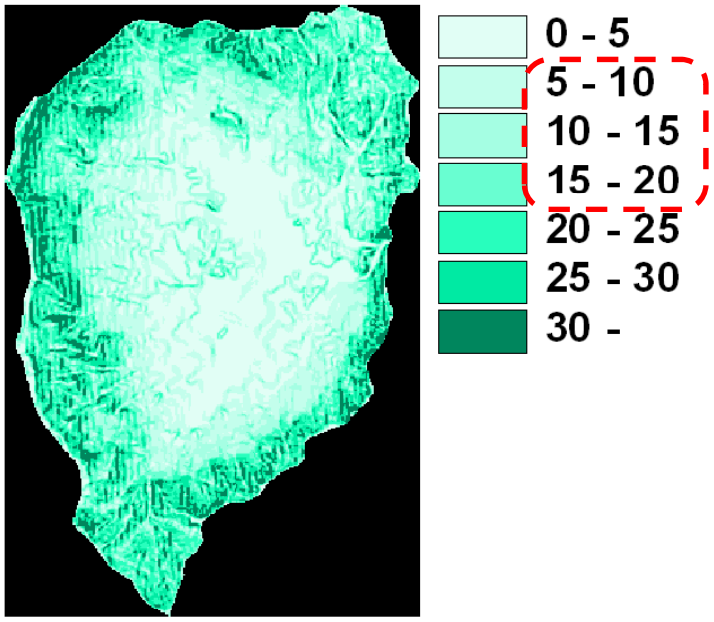
-Instrumental manual

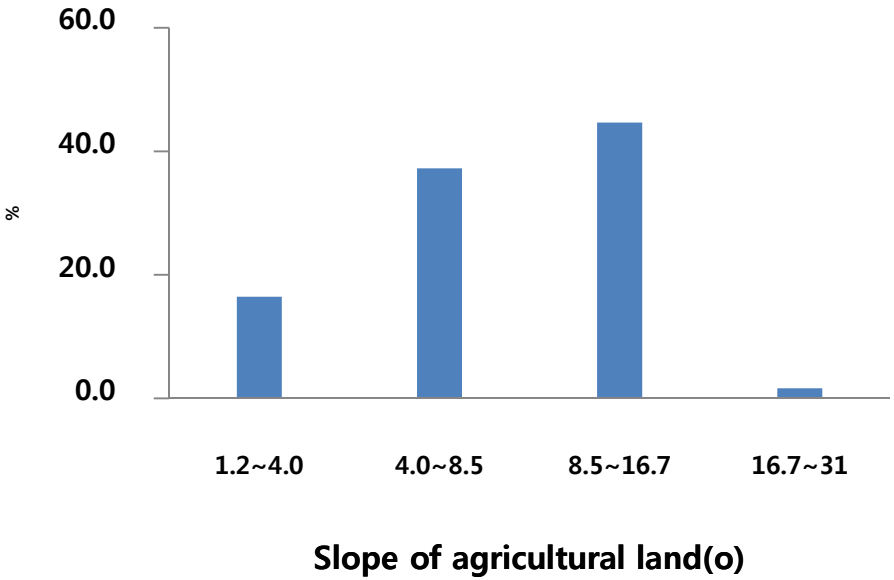
Landuse of Subwatersheds



Catchment	Area (ha)				Proportion (%)	
	CA	AG_Land	Rice paddy	Upland	Upland/AG_Land	AG_Land/CA
Naedong	463	193	34	160	83	42
Doonjeong	101	54	12	42	79	**53**
Seonghwang	651	193	43	150	78	30
Wolsan	669	142	29	113	79	**21**
Cheongryong	356	179	54	125	70	50
Kunji	697	188	60	128	68	27
Mandae	5330	1967	569	1397	71	37

Averaged Slope of agricultural land





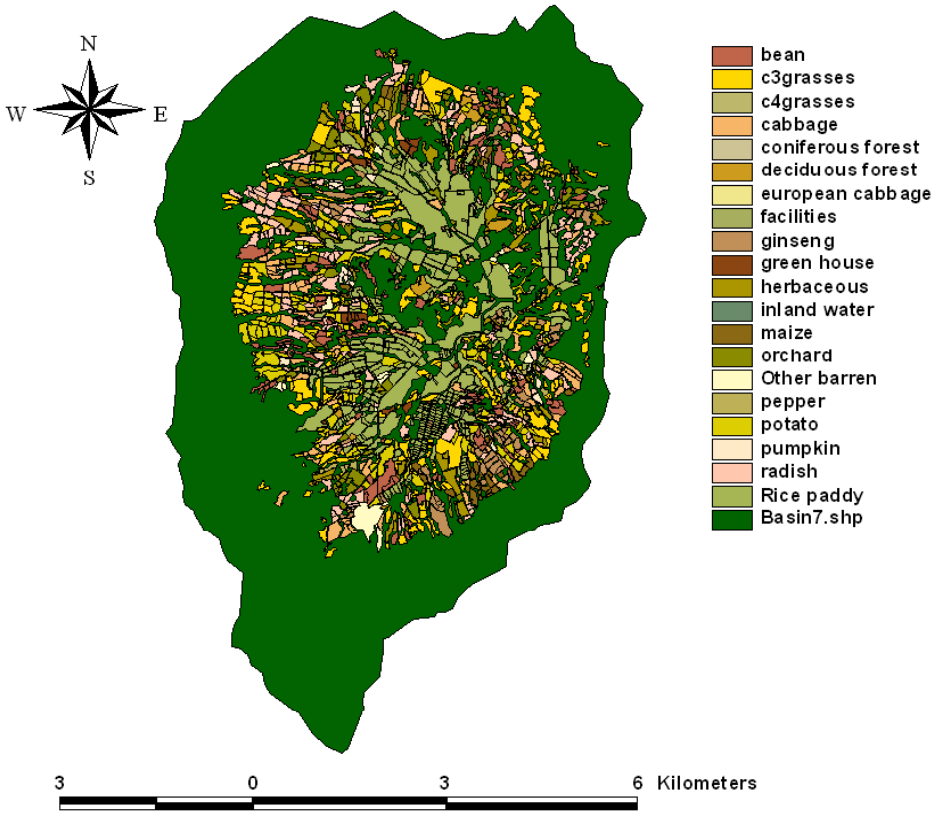
The estimation of soil loss with different slope(NAAS; National Academy of Agricultural Science, **1994~1997)**

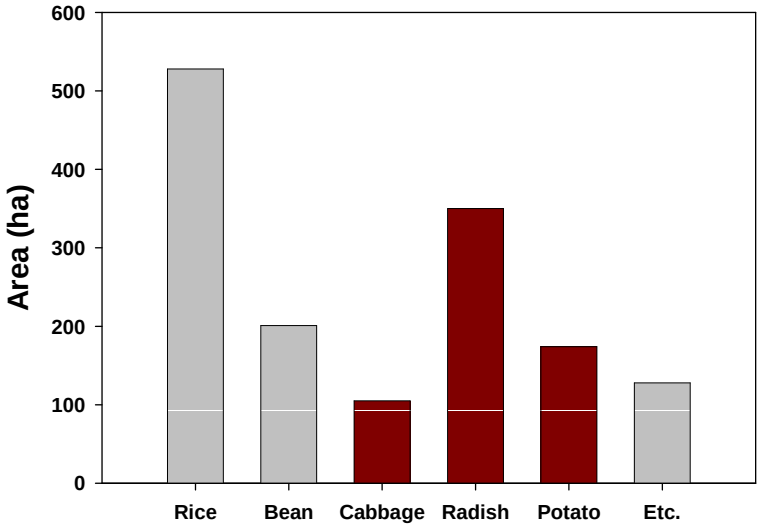
Grade	Low	Normal	**Serious**	Very serious
Slope (º)	1.2~4.0	4.0~8.5	**8.5~16.7**	16.7~31.0
Soil erosion (ton/ha)	<12	12~40	**40~100**	100~200

Crops of Haean

Upland cover 65% of agricultural land.

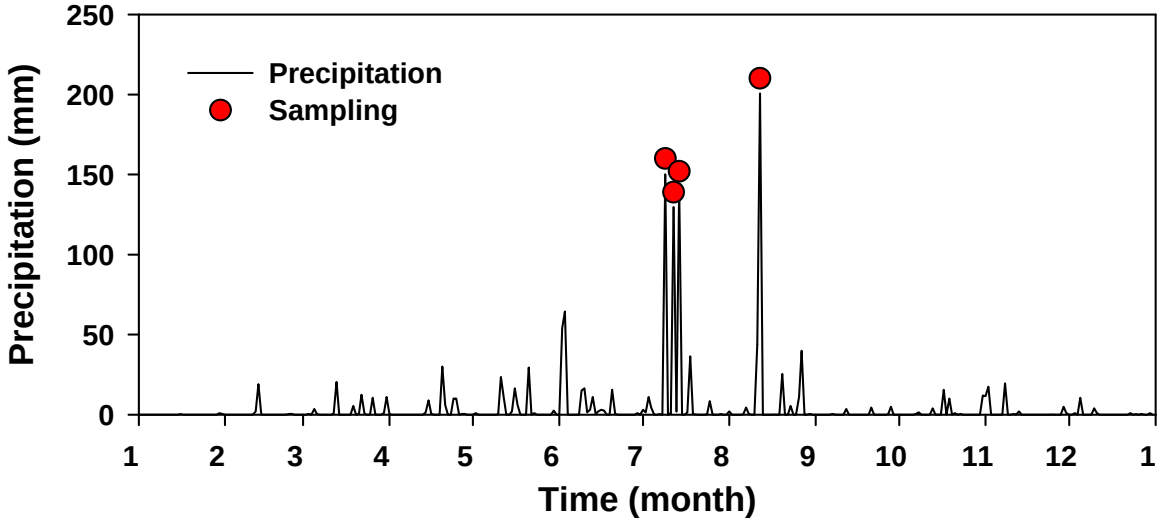
Main crops were cabbage, radish, potato(vegetables).



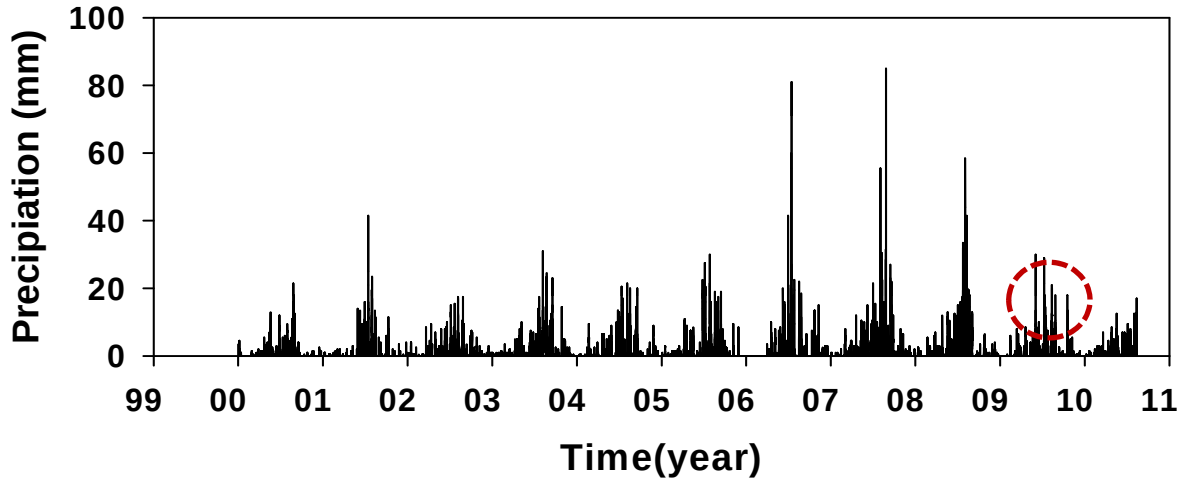


Crops	Area (ha)	Proportion(%)
Rice	528	36
Bean	201	14
Cabbage	**105**	7
Radish	**350**	24
Potato	**174**	12
Etc.	128	9

Precipitation



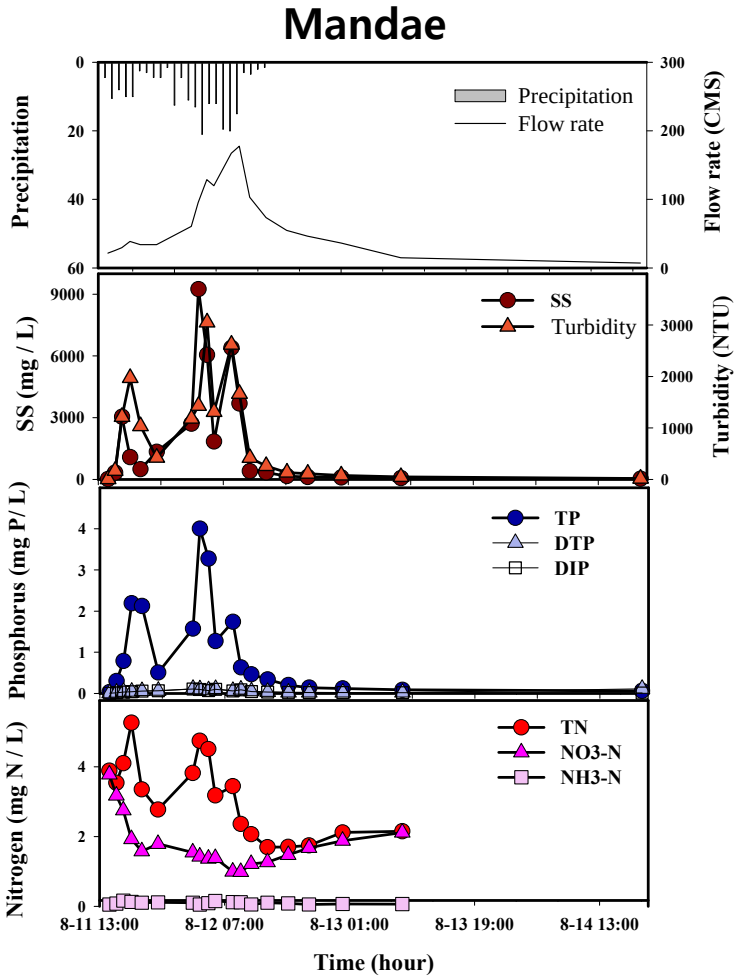
Events	Precipitation (mm)
9~10, July	149
12~13, July	118
14~16, July	148
11~14, August	210
Total	625

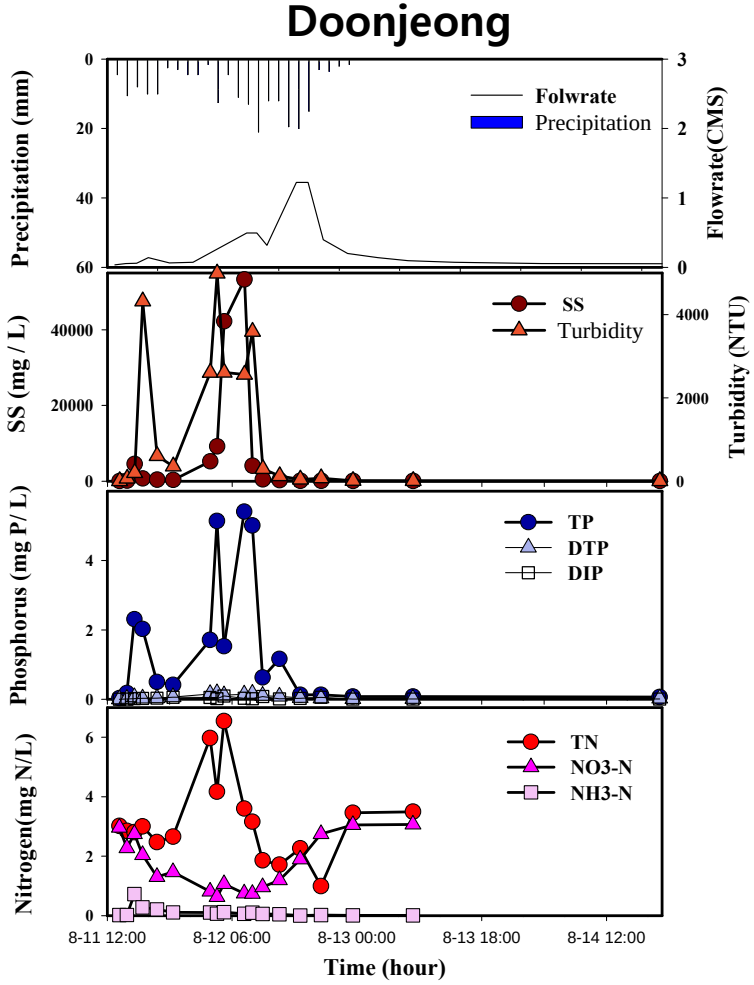


Year	Precipitation(mm)
2000	1,007
2001	1,016
2002	1,228
2003	1,752
2004	1,612
2005	1,542
2006	2,061
2007	2,299
2008	2,076
2009	**1,568**
Average	**1,616**

Variations of runoff pollutants in rainy season

Most of the phosphorus and nitrogen export from the subwatersheds were in the particular form.



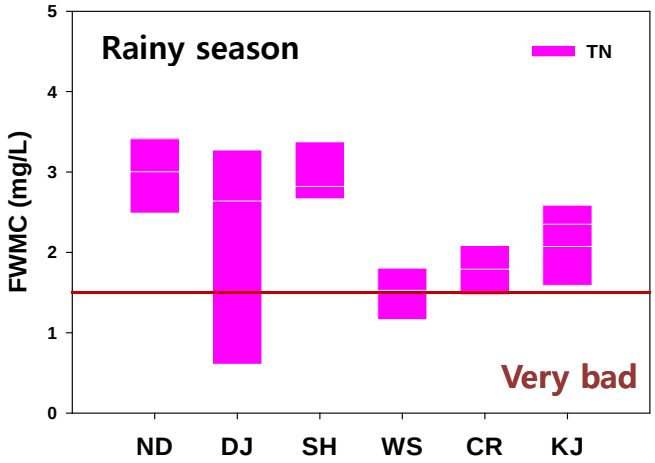


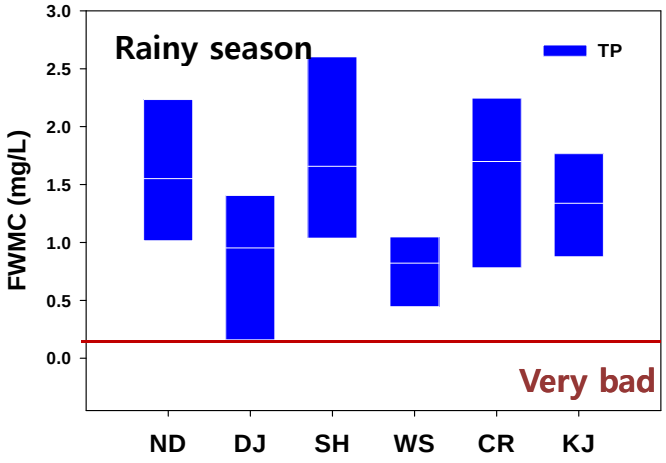
Flow weighed mean concentration(FWMC)

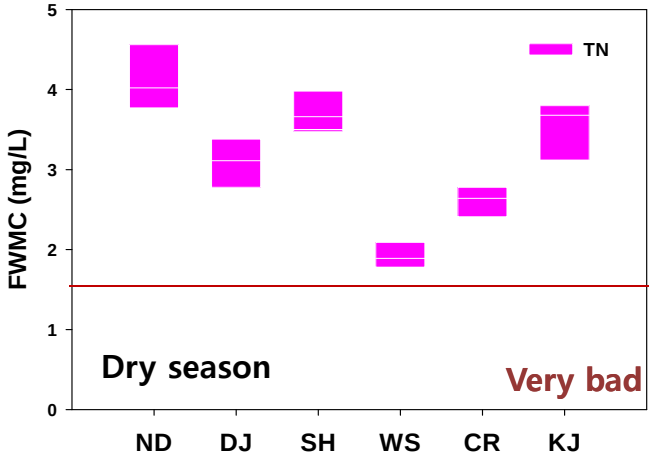
Spatial variations of FWMC was very large in rainy season.

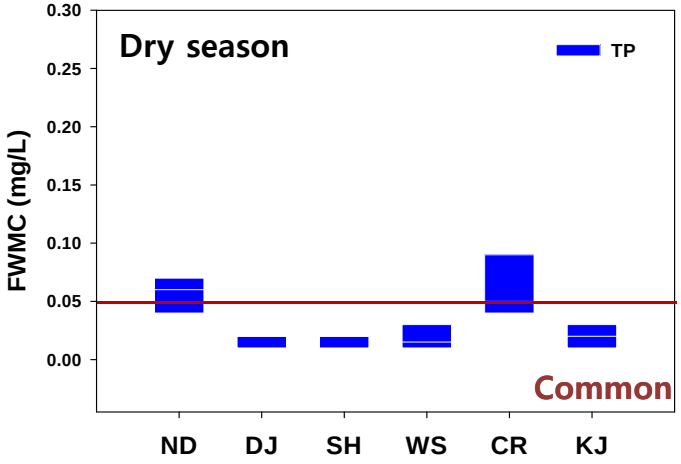
In rainy season, T-P were very high compare with dry season.

T-N were higher than rainy season in almost of subwatersheds.





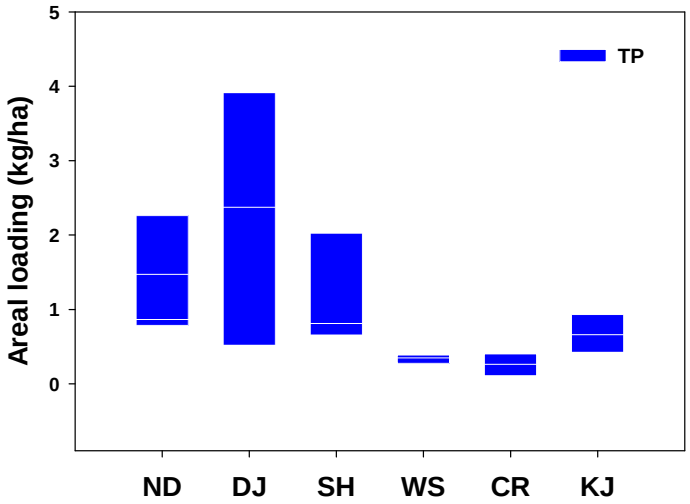


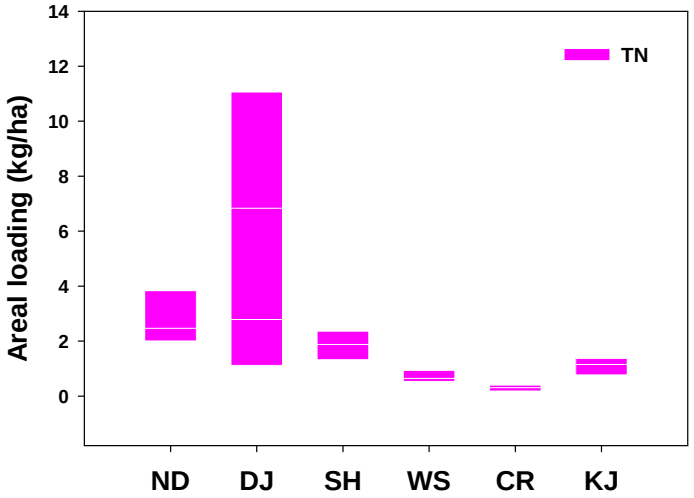


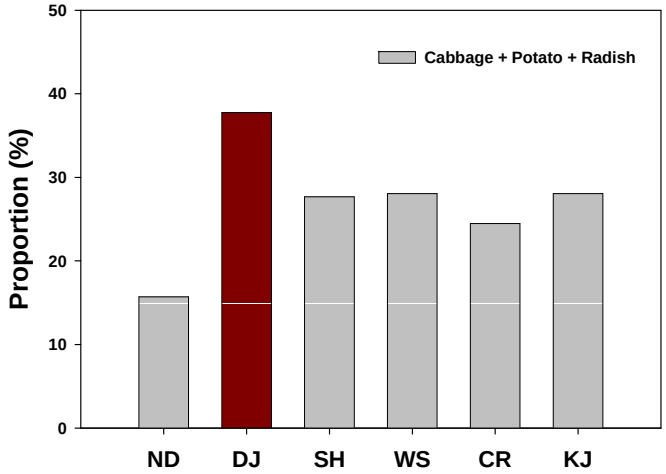
Areal loading(AL)

Doonjeong watershed showed the highest AL.

The Dominant crops were vegetables(cabbage, radmiish, potato) which is about 48%.







Comparision with other studies(FWMC)

T-P was about higher than other studies.

T-N was similar or lower than other studies.

Unit: mg/L

Study site	Land Use	TN	TP	reference
EPA, USA	Urban, mixed	-	0.337	Smullen et al.(1999)
Central and south florida, USA	Urban, industrial	1.79	0.31	Harper (1998)
	Pasture	2.46	0.47	
The twin cities metropolitan area. USA	urban Mixed	0.43~18.6	0.04~1.8	Brezonic and Stadelmann (2001)
Central and south florida, USA	General Agricultural	2.3	0.34	Harper (1998)
West, USA	≥75% Agricultural	2.8	0.17	Omemik (1977)
Mandae	Agricultural - forest	2.85	0.52	2003
		3.28	0.36	2004
		2.27	1.04	2009

Areal loading

T-P was much higher than other studies.

T-N was similar or lower than other studies.

Unit: kg/ha/yr

Watershed	Land use	TN	TP	Reference
EPA, USA	Mixed agricultural	16.5	1.13	Reckhow et al.(1980)
	forested	2.86	0.24	
	urban	9.97	1.91	
USA and Europe	forest	1.0~6.3	0.007~0.88	Loehr et al.(1989)
	Rural cropland	21~79.6	0.06~2.90	
Wisconsin, USA	agricultural	6.69	0.26	Clesceri et al.(1986)
	forest	4.07	0.176	
Eastern, USA.	forest	3.00	0.05~0.10	Rast and Lee (1978)
	agricultural	5.00	0.50	
Mandae	agricultural - forest	16.51	4.48	2003
		67.94	8.59	2004
		9.2	21.3	2009

Summary

1. During storm event, export of phosphorus and nitrogen were in particular form(about 97%)
2. Spatial variations of FWMC for nitrogen and phosphorus was very large
3. During storm event, FWMC of Phosphorus were about 10 times higher than dry season
4. Annual areal loadings of phosphorus were much higher than other studies (10~100times)
5. It is evident that more research is needed to characterize of the nonpoint N, P load from agricultural catchments
6. Even if this research was conducted for 1yr, it could be useful to validate on simulation hydrologic or ecosystem model.

Thank you