Environmental effects of rice paddies in monsoonal climate

J. Jeong, M. Kim, S. Choi, K. Lim

SWAT2015, Sardinia, Italy, June 24-26, 2015

APEX-paddy Model

Problem: Rice paddies are considered agricultural NPS for water pollution

Objective:. Assess the effects of ag bmps to reduce NPS pollutants load from paddies in Korea

Tasks: We develop paddy algorithms in APEX, build databases for soils, weather, and paddy management for the whole country.

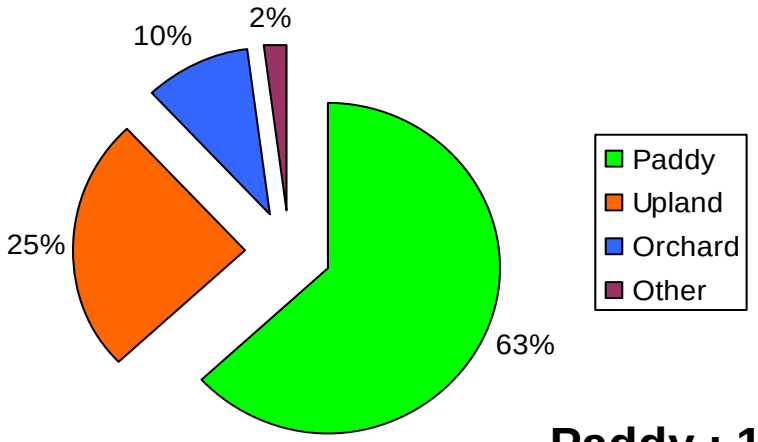
Benefits: Quantitative assessment of paddy discharge and GHG, BMP policy development, etc.

Agricultural Lands in Korea

Total area: 99,600 km^2

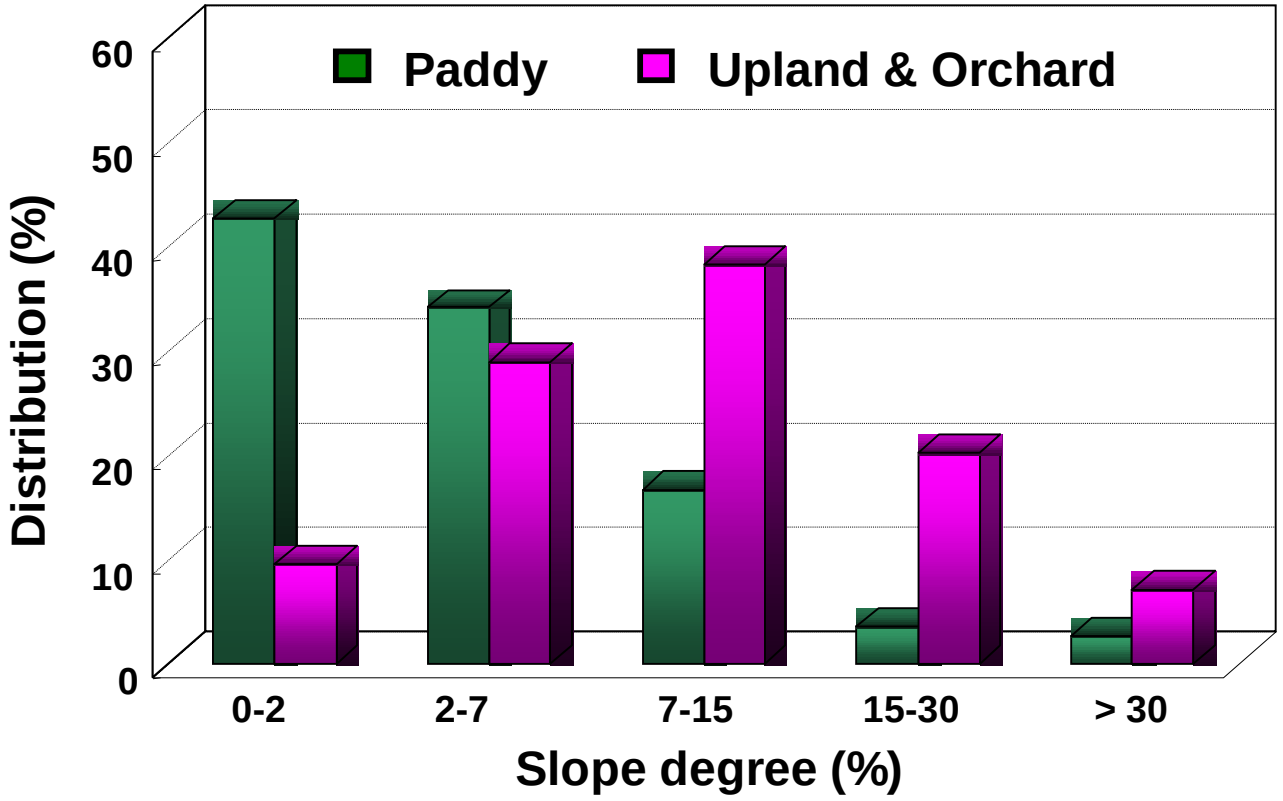
Forest : 69,720 km^2 (70%)

Agriculture: 18,240 km^2 (18%)



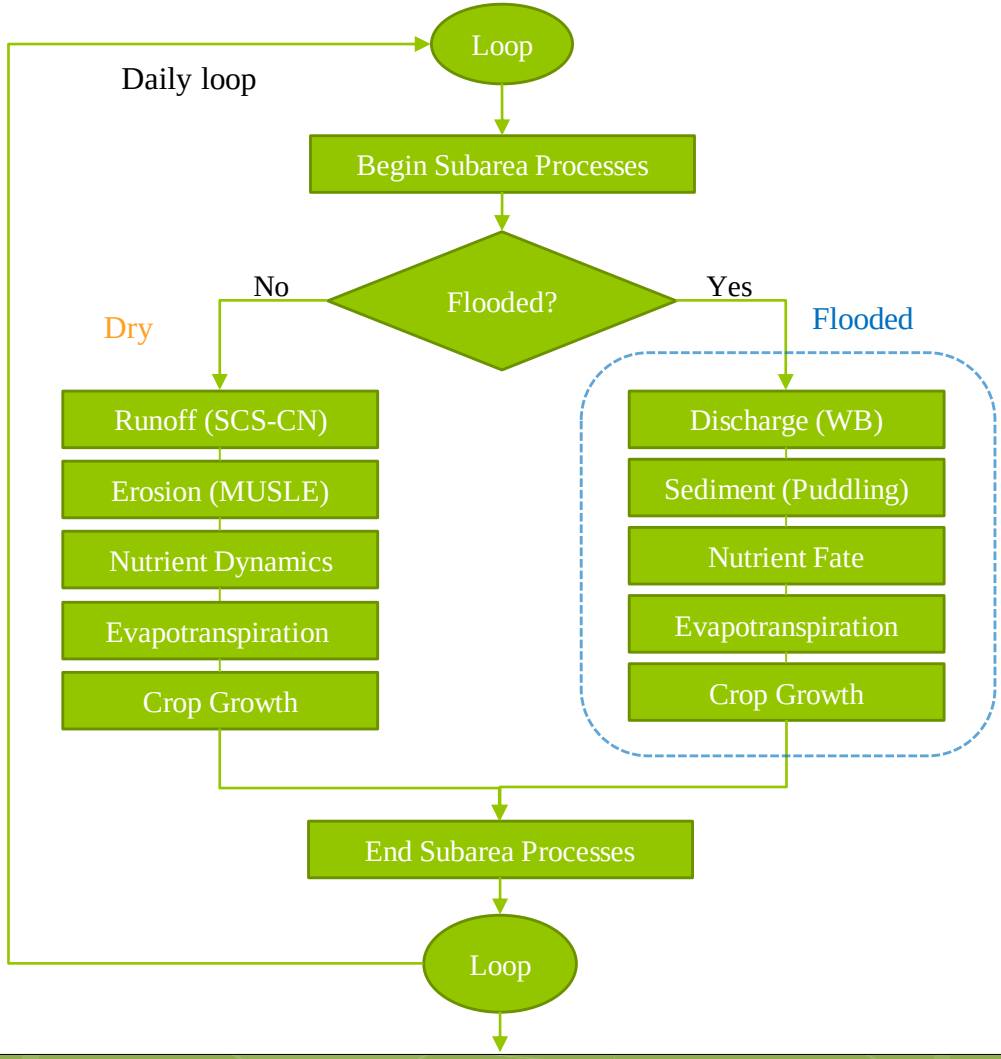
Paddy : 11,530 km^2

Topographical impact on agricultural NPS pollution



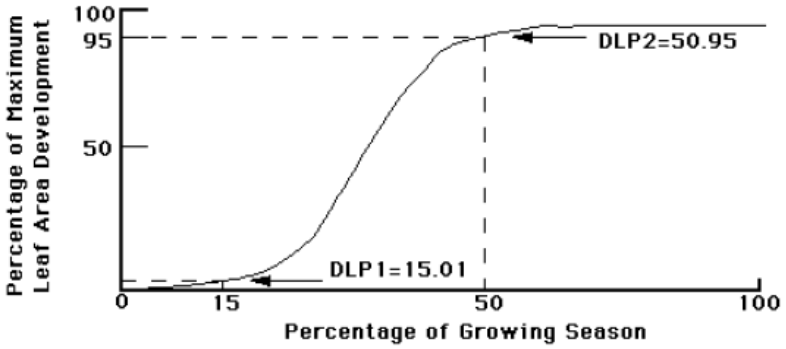
Paddy Algorithm

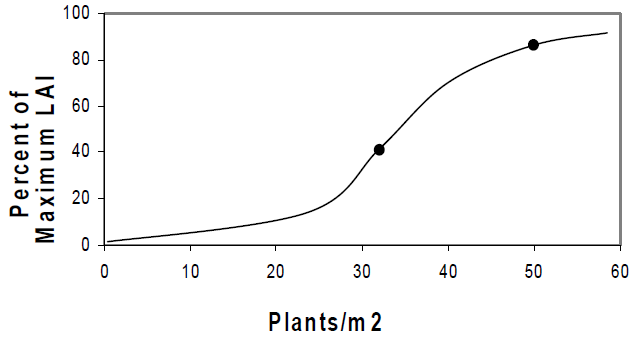
- Management
  - Discharge
  - Puddling
  - Irrigation
  - Fertilizer
- Crop growth
  - Transplanting
  - Parameters
- Processes
  - Sediment
  - Evaporation



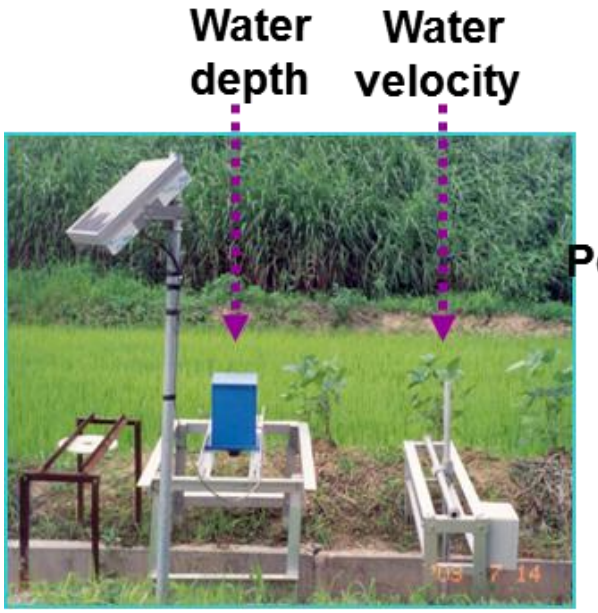
Rice Growth Simulation

- Transplanting
  - Initial LAI value (=0.1) to input on a PLANTING operation
  - Heat units required for maturity is reduced from 2,200 degrees to 1,500 degrees
- Plant population: 124 plants/m^2





Case Study: Icheon Field



Percolation

Ultra-sonic level sensor & logger

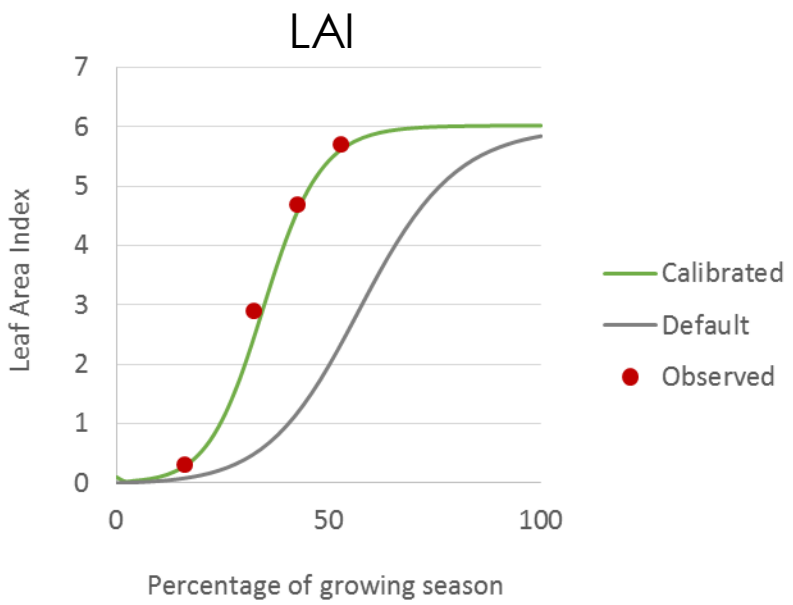
Flow meter & logger

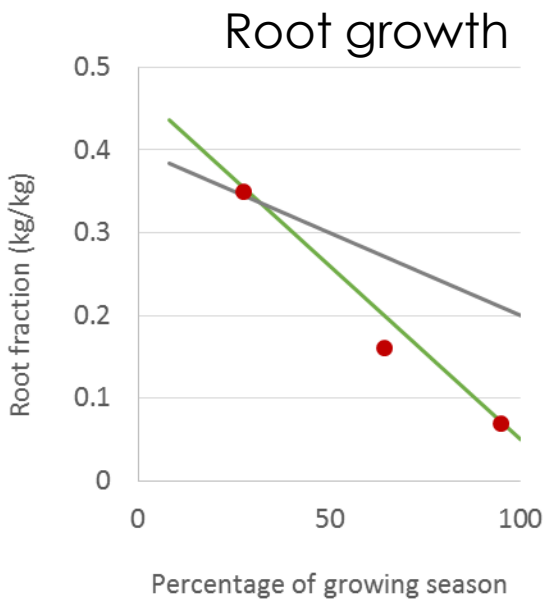
Ultra-sonic level sensor & logger

s
ets

- Area: 15 ha
- Soil type: coarse Loamy soil
- Monitoring period: 2002-2004
- Spin-up period:1999-2001
- Rainfall, irrigation, discharge, mineral N in runoff

Crop Growth



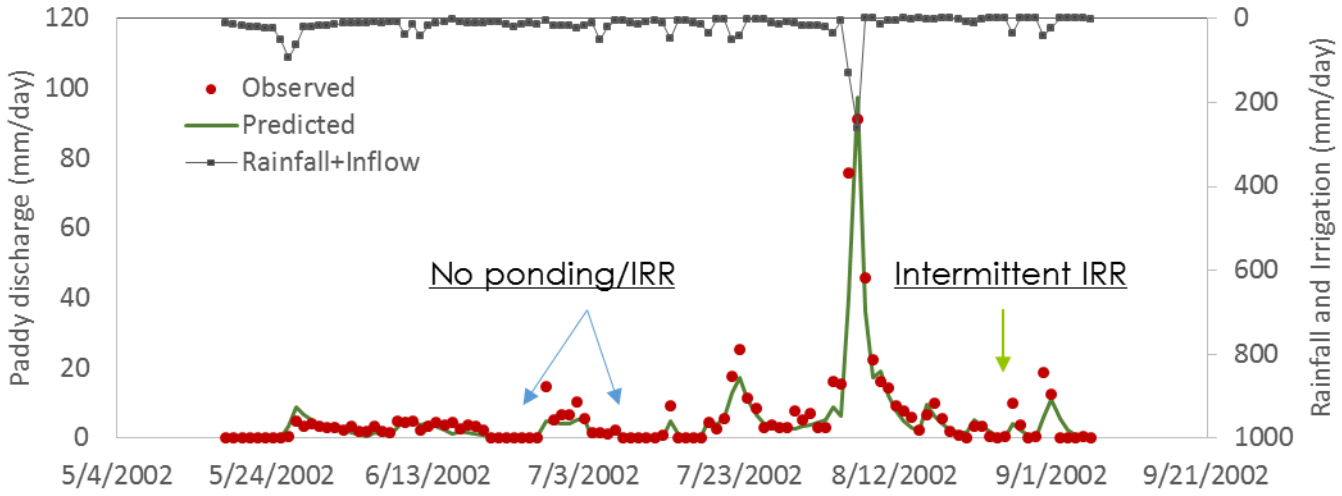


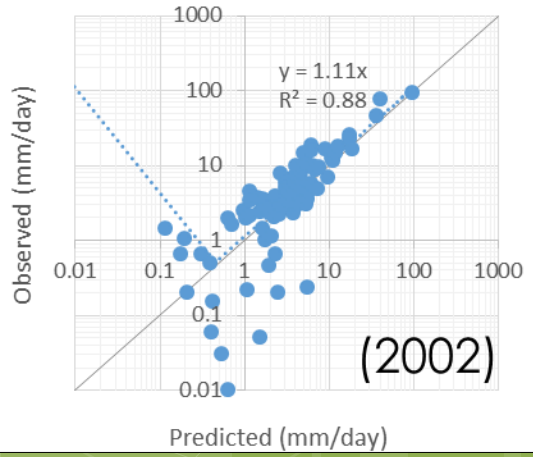
Simulated Rice Yield

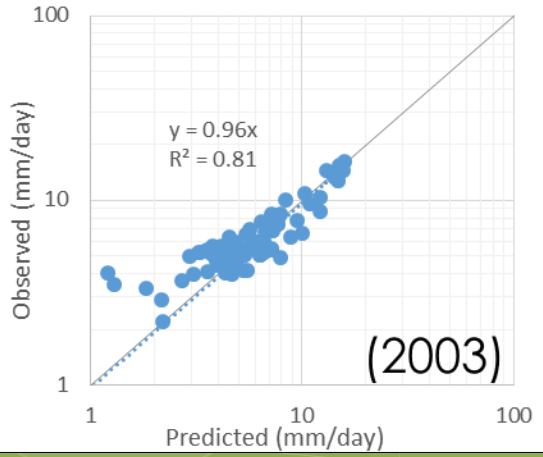
Obs (t/ha)	Pred (t/ha)*	Standard deviation	Percent error
6.63	6.46	1.03	2.6%

* Three year average during 2002-2004

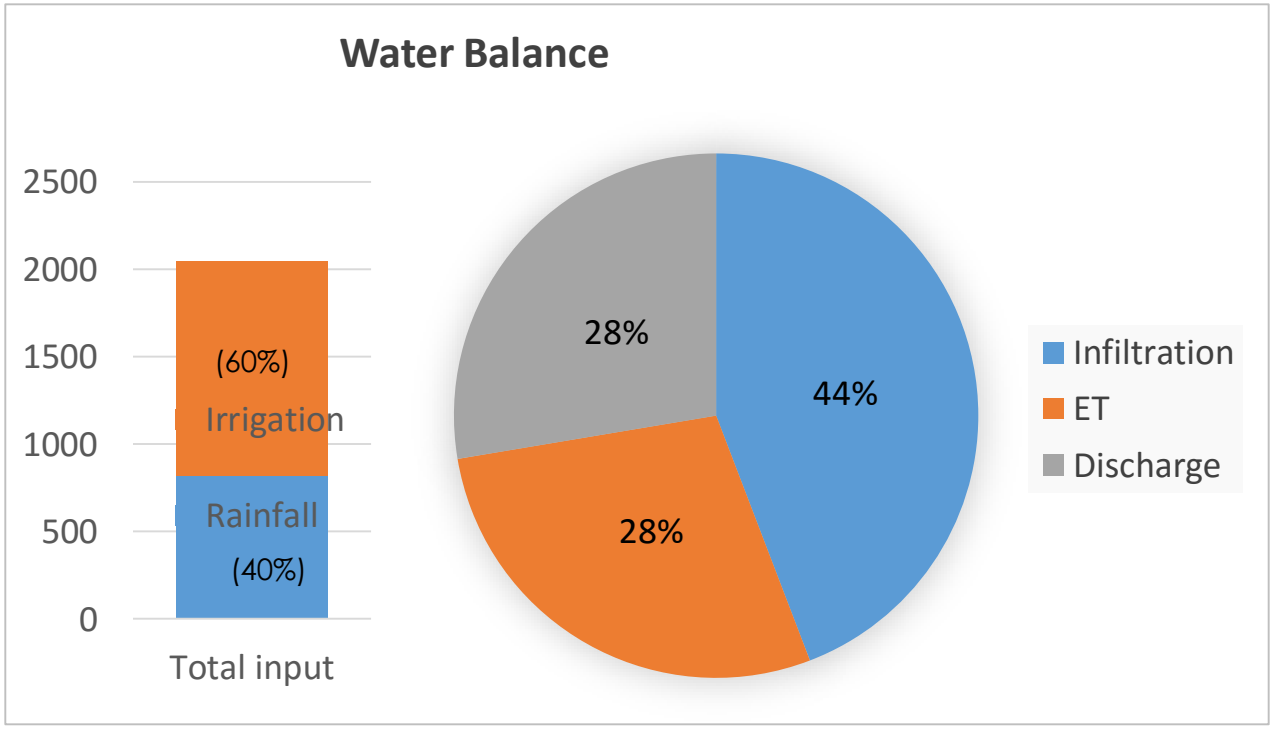
Discharge


Paddy discharge (mm/day)
Rainfall and Irrigation (mm/day)
Observed
Predicted
Rainfall+Inflow
No ponding/IRR
Intermittent IRR
120
100
80
60
40
20
0
0
200
400
600
800
1000
5/4/2002
5/24/2002
6/13/2002
7/3/2002
7/23/2002
8/12/2002
9/1/2002
9/21/2002

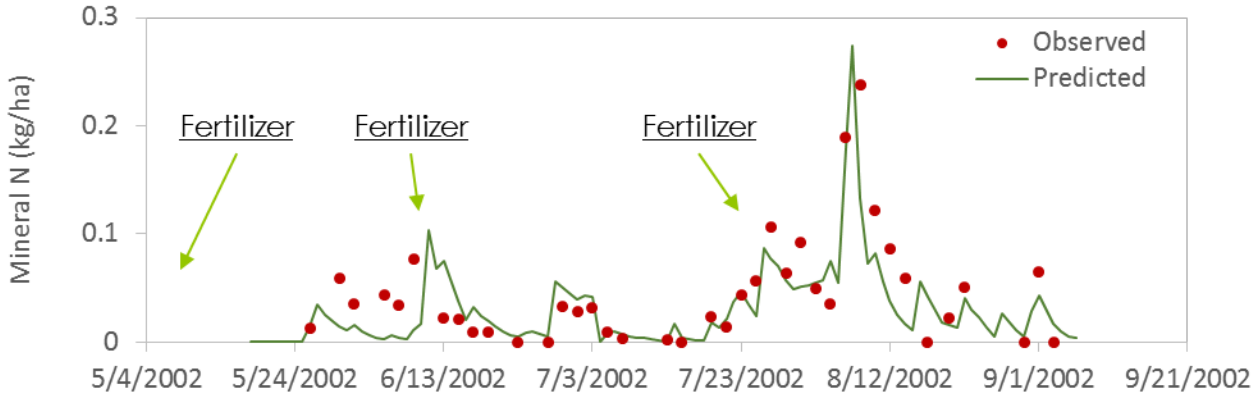

y = 1.11x
R² = 0.88
Observed (mm/day)
Predicted (mm/day)
1000
100
10
1
0.1
0.01
0.01
0.1
1
10
100
1000
(2002)

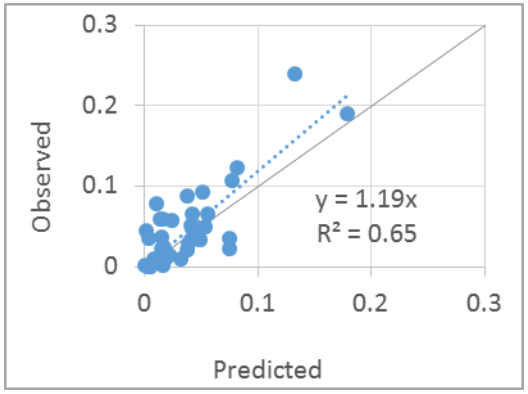

y = 0.96x
R² = 0.81
Observed (mm/day)
Predicted (mm/day)
100
10
1
1
10
100
(2003)

Water Balance

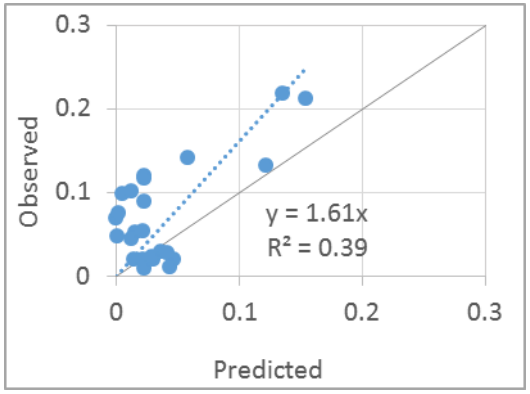


Nitrogen Yield



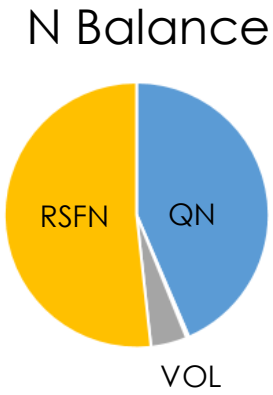


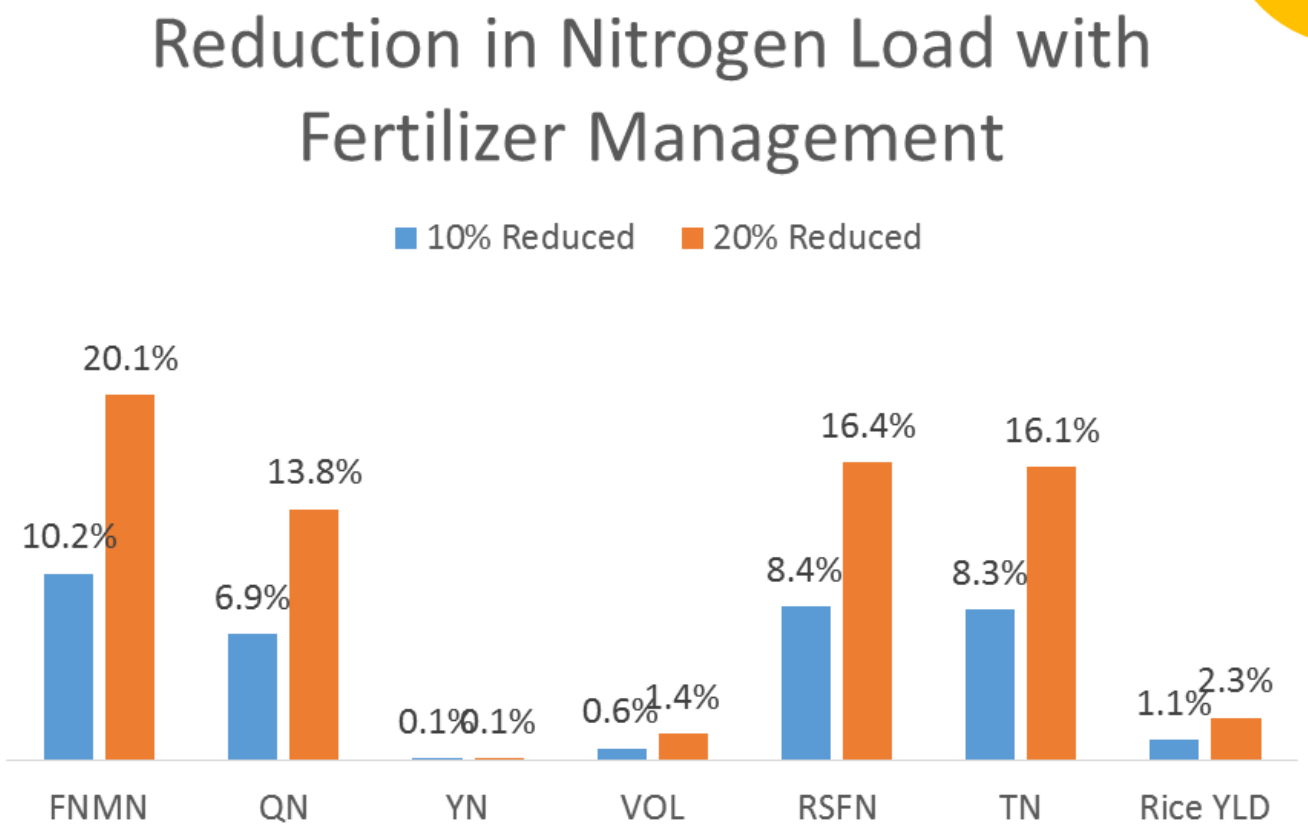
(2002)



(2003)

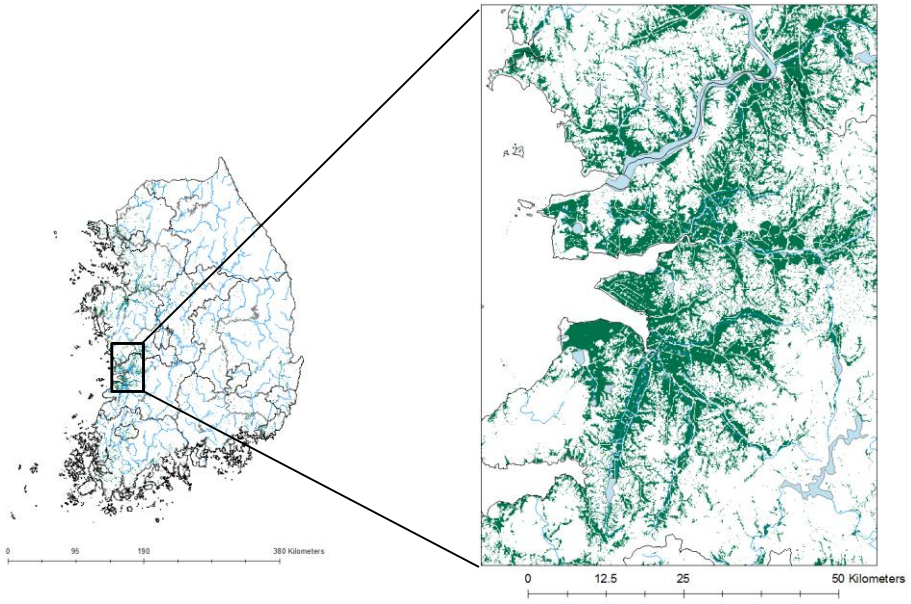
Scenarios

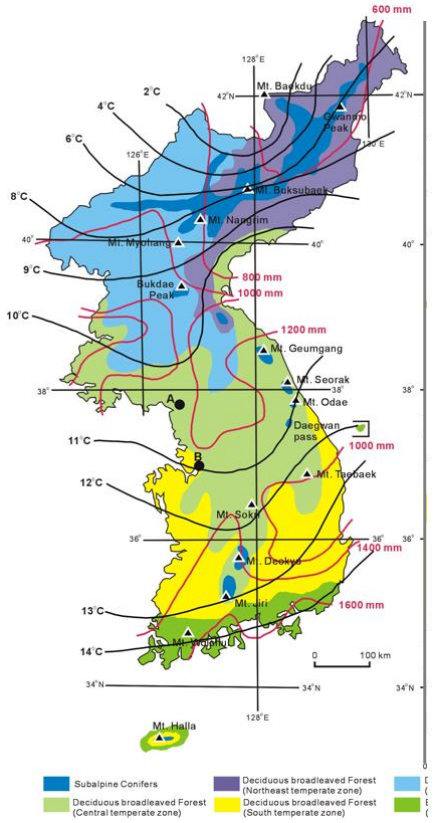

N Balance
RSFN
QN
VOL


Reduction in Nitrogen Load with Fertilizer Management
10% Reduced
20% Reduced
20.1%
10.2%
13.8%
6.9%
0.1%
0.1%
0.6%
1.4%
16.4%
8.4%
16.1%
8.3%
1.1%
2.3%
FNMN
QN
YN
VOL
RSFN
TN
Rice YLD

National Scale Paddy Modeling

- LU map for paddies – 10 m pixels
- Soils – 377 soils at 1:5000 scale compiled
- Daily Weather – 91 Stations (~30yr)
- Paddy Mgt. – 26 climatic regions





(Yi, 2011)

Conclusion

- Accurate simulation of paddy discharge and nutrient yield is achieved by linking agricultural operations to biophysical processes
- APEX predicts rice yields well with the implementation of transplanting and crop parameters calibration
- Nutrient/carbon dynamics needs improvement to better represent microbial effects in standing water and in the anoxic zone of the subsoil layers
- Fertilizer management can improve discharge water quality while maintaining rice production
- Ongoing: database development, national scale modeling framework development

Questions?