Reuse and Recycle of Farmland Return Flow to Control Lake Eutrophication

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Case Study I
Central Valley of California
175,000 ha rice growing area in the Sacramento Valley
Limiting discharge of rice pesticide residues

• Public issues in the 1970s:
  – Occasional fish kills in the Colusa Basin Drain.
  – Bitter taste to city of Sacramento’s treated drinking water supply.

• Regulations, began 1983:
  – Holding flood waters in paddies for specified periods after rice herbicide applications.
  – Performance goals (pesticide limits) imposed on the Sacramento River.
Required Rice Herbicide Holding Time in the Sacramento Valley (Source: Cal EPA)
Water holding times for rice pesticides in the field are successful in meeting performance goals; no bitter taste in drinking water at city of Sacramento and reduced fish kills in rice drains.
Lake Biwa, the largest lake in Japan, has been seriously contaminated since the 1970s.

- about 670 km$^2$
- water resource for 14,000,000 people in Kansai Region (Osaka and Kyoto)
Background

Shiga Prefectural Office has implemented various measures for improvement of the water quality of Lake Biwa.

Recycling Irrigation (RI)
Reuse of drainage water by pumps

Recycled water
Case Study Area

Paddy field district close to Lake Biwa
-Land use-

About 150ha

2/3 = paddy

1/3 = crop-rotated paddy

North
Drainage System

Main Drainage Canal

Lateral Drainage Canal

North Floodgate

Connection point

South Floodgate
Irrigation system

Recycling Irrigation (RI)

Gyaku-sui Irrigation (GI)

RI is being implemented from the puddling season to the mid-summer drainage season.
Irrigation system

North Pump

South Pump
Rainfall and outflow

- **Outflow (mm d⁻¹)**
- **Rain (mm d⁻¹)**

- 2006
- May Region (RI)
- Jun. Region (GI)
- Jul. Region (Mid-summer drainage)
- Aug. Region

**RI period**

**GI period**
Temporal variation in SS, TN, TP

- SS (mg L⁻¹)
- TN (mg L⁻¹)
- TP (mg L⁻¹)

Rain (mm d⁻¹)

Water balances (2006) in the RI period and the GI period
Mass balances of nitrogen (2006)

INPUT

Output

(kg ha\(^{-1}\))

RI Period

GI Period

Rain

Water Intake

Outflow
Mass flows in RI and GI systems
(SS;kg/ha/d, TN;g/ha/d, TP;g/ha/d)

RI

Paddy Fields

Irrigation

( SS=4.3
TN=100
TP=10 )

Water Reuse

Drainage Canals

( SS=4.8
TN=500
TP=54 )

no outflow

GI

Paddy Fields

Irrigation

( SS=0.3
TN=60
TP=10 )

Water Intake

Lake Biwa

( SS=0.5
TN=160
TP=11 )

Drainage Canals

Outflow

( SS=2.6
TN=120
TP=15 )
Inflow of water to a paddy plot

Year

(mm)

Rain

Irrigated Water
Nitrogen input and output in a paddy plot in the RI period

![Graph showing nitrogen input and output over years]

- **In 2004**: Irrigated Water
- **Out 2004**: Drained Water
- **In 2005**: Rain
- **Out 2005**: Irrigated Water
- **In 2006**: Drained Water

Nitrogen (kg ha$^{-1}$)