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Yale-NUIST Center on Atmospheric Environment

Senior thesis proposal: Study on indirect N_2O emissions within a rice paddy-dominated agricultural watershed.

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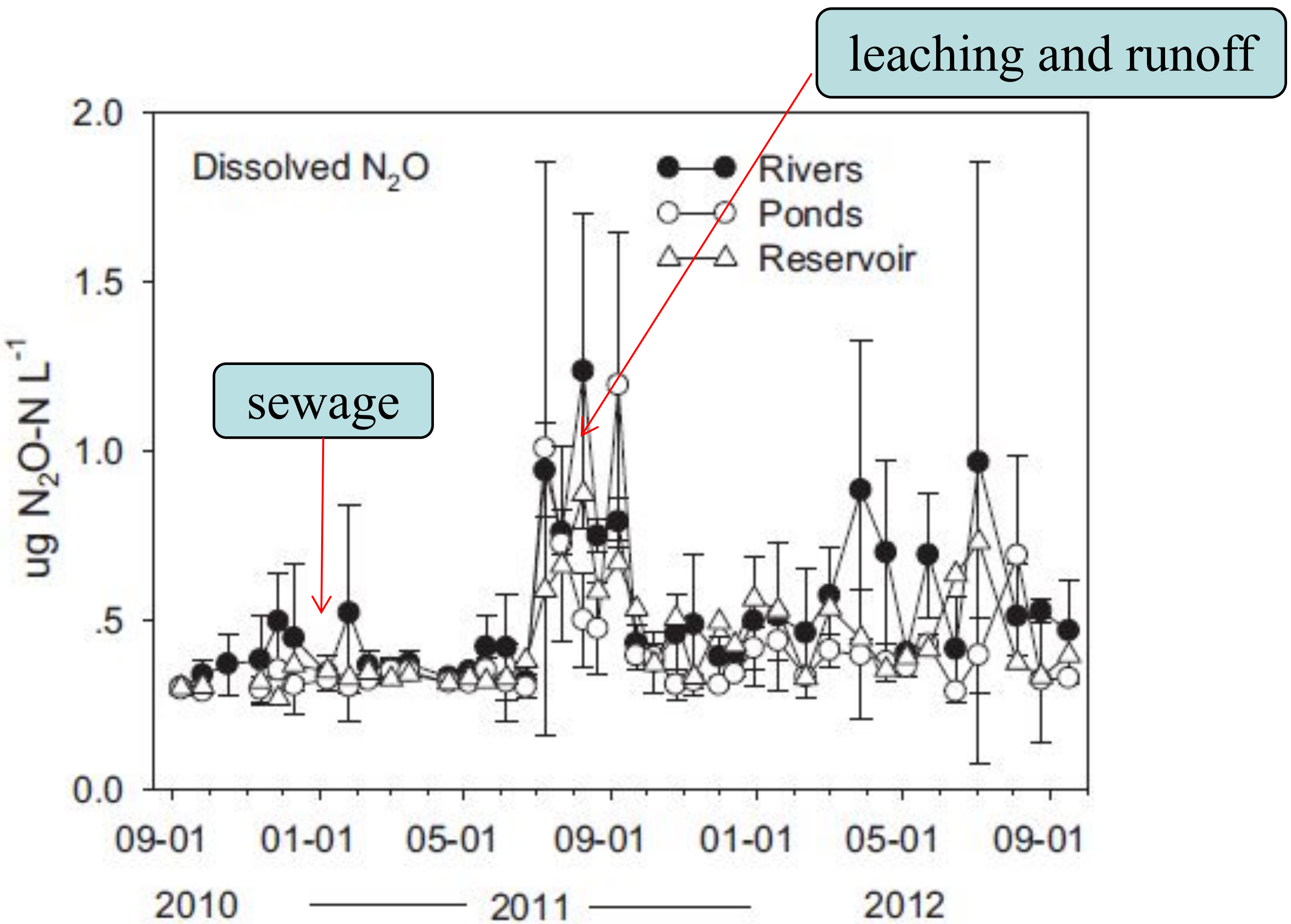
Outline

- Introduction
- Research purpose
- Research contents
- Experiment plan

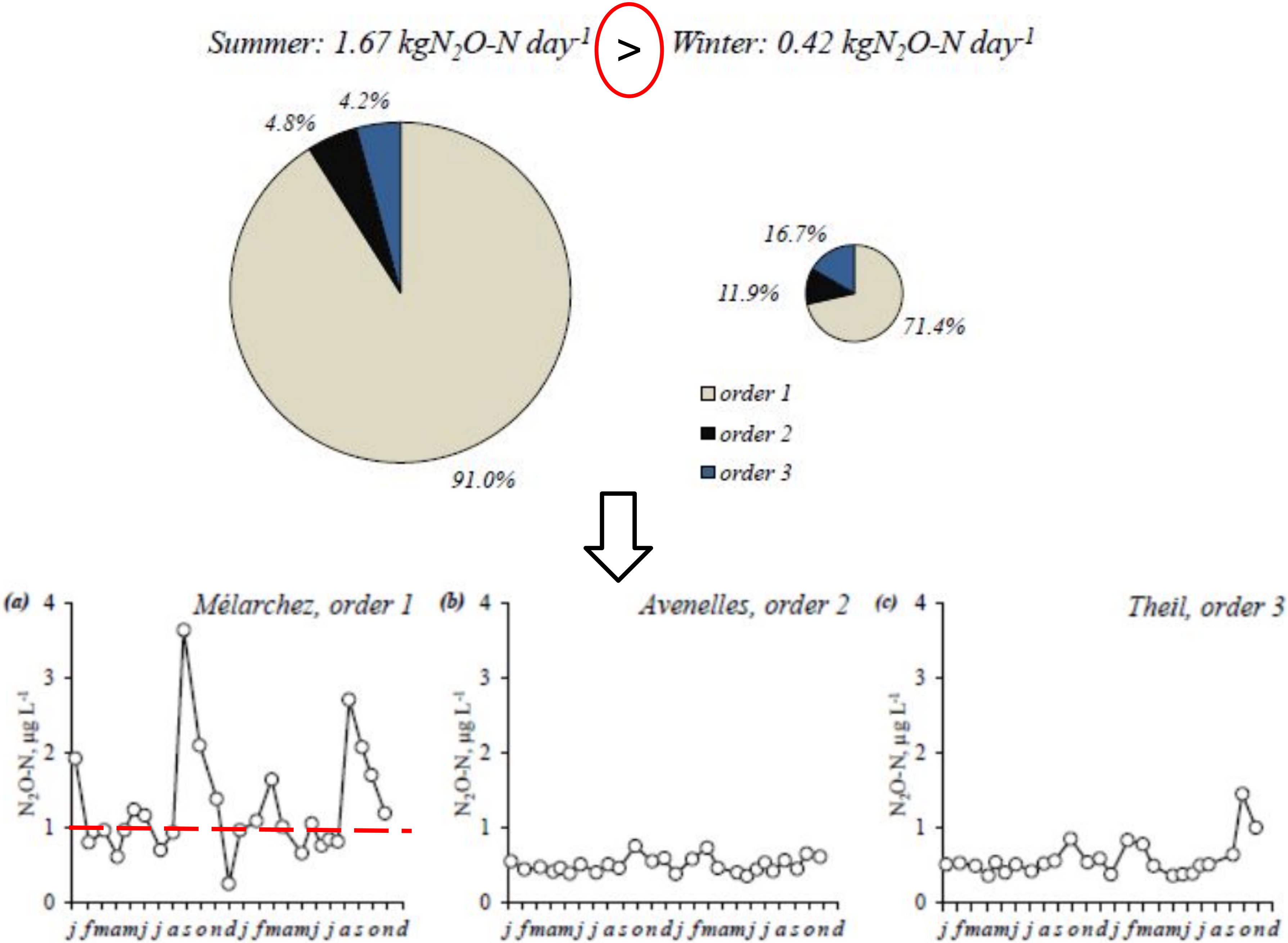
Introduction

- N_2O is an important greenhouse gas which has a 100 years global warming potential (GWP_{100}) 298 times that of an equal mass of carbon dioxide (IPCC 5). And it involves in stratospheric ozone depletion (Ravishankara et al., 2009).
- Agriculture accounts for nearly 80% of the global anthropogenic N_2O budget (Davidson, 2009; Crutzen et al., 2008).
- N_2O emissions include direct and indirect emission pathways. Direct N_2O emissions are fairly well understood (Cai et al., 1997; Dobbie & Smith, 2003). While, less knowledge is known about indirect N_2O emissions.

Research status: temporal variations

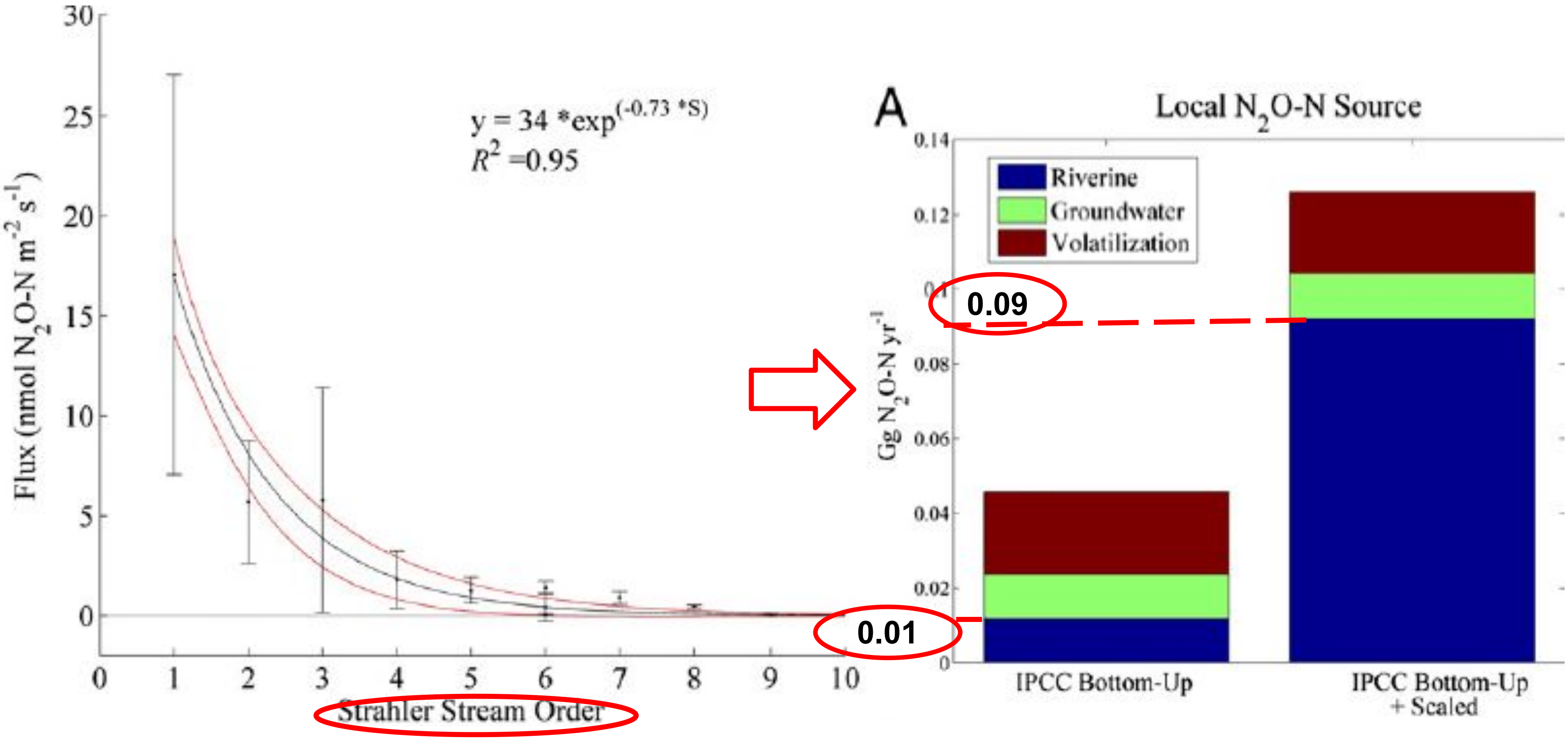


Xia et al., 2013, Atmospheric Environment

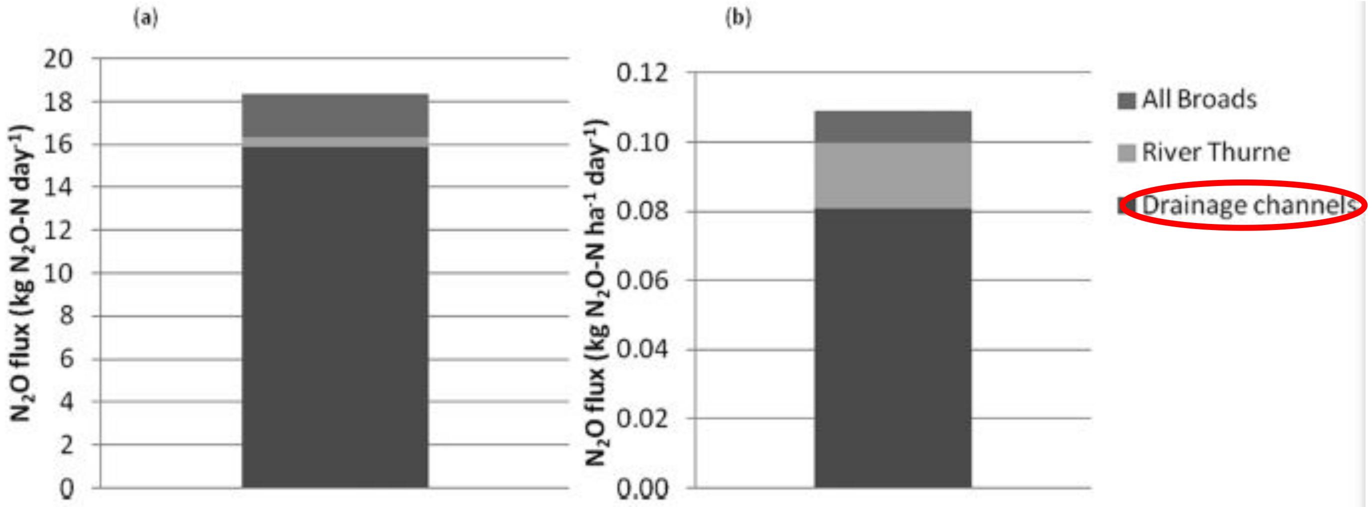


Vilain et al., 2012, Biogeosciences

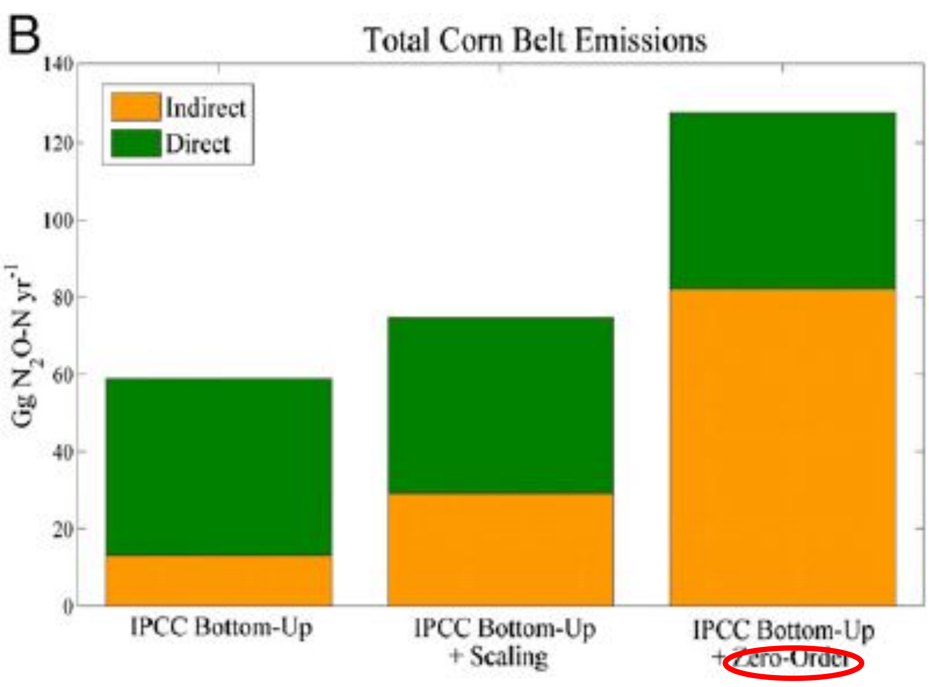
Research status: spatial variations



Turner et al., 2015, PANS



Outram & Hiscock, 2012, Environmental Science & Technology



Drainage ditches are potential N_2O hotspots.

Turner et al., 2015, PANS

Research status

- Some studies suggesting riverine N_2O loss is underestimated, which notably contradicts the EF_{5r} (indirect emission factor for rivers) reduction (Beaulieu et al., 2011; Outram & Hiscock, 2012; Turner et al., 2015).

Research status: environmental factors

- The variations of NO_3^--N and NH_4^+-N concentrations may have changes on N cycling, which could affect N_2O flux (Baulch et al., 2012).

- In surface water, NO_3^--N concentrations and Eh (Oxidation-Reduction Potential) were the most significant drivers of indirect N_2O emission (Xia et al., 2013).

Research purposes

- To determine the potential drivers of indirect N_2O emissions and calculate the regional EF_s (emission factors).

Research contents

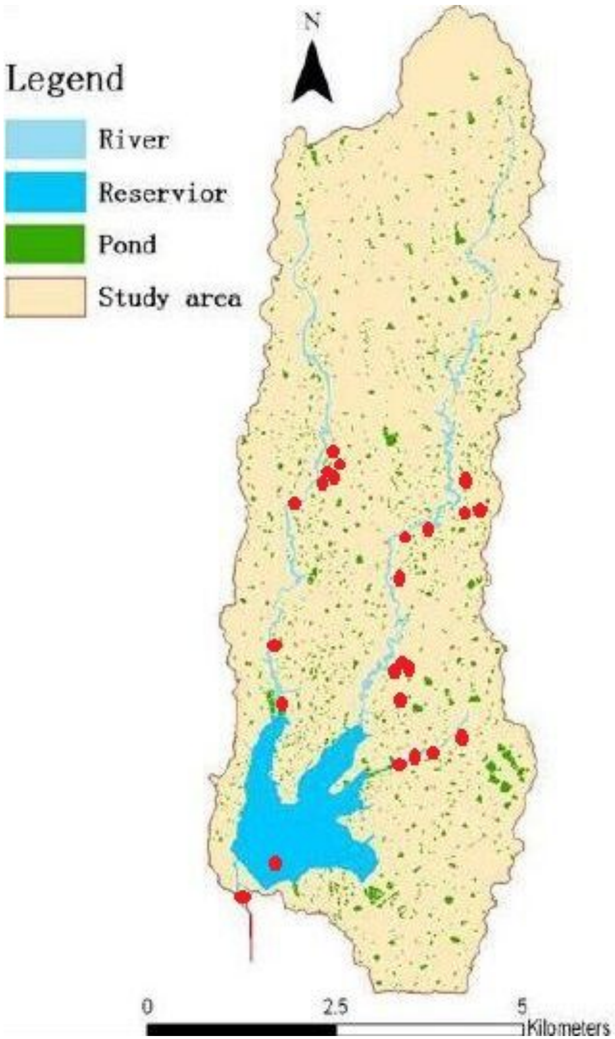
- Research the temporal and spatial variations of indirect N_2O emissions in the Jurong Reservoir watershed.

- Analysing the relationships of N_2O emissions and the environmental factors.

- Calculating the EF_s within the Jurong Reservoir watershed.

Experiment plan

- Study area: Jurong Reservoir watershed



characteristic:

an area of 45.5 km^2

including three kinds of

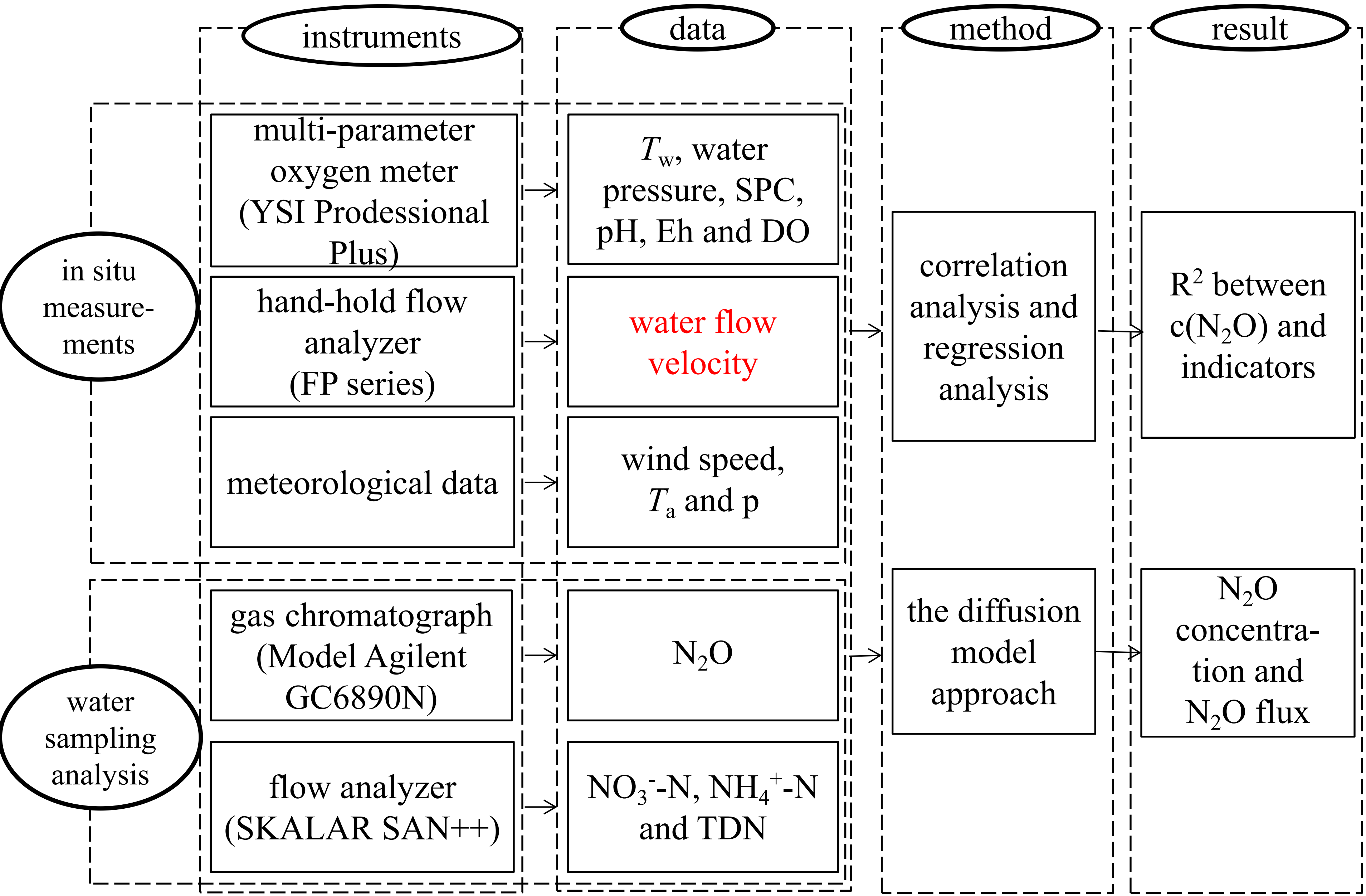
water bodies(8.2%):

a reservoir, three rivers,

and thousands of small ponds.

(Yan et al., 2011)

Flow chart



instruments
data
method
result
in situ measure-ments
water sampling analysis
multi-parameter oxygen meter (YSI Prodessional Plus)
hand-hold flow analyzer (FP series)
meteorological data
gas chromatograph (Model Agilent GC6890N)
flow analyzer (SKALAR SAN++)
T_w, water pressure, SPC, pH, Eh and DO
water flow velocity
wind speed, T_a and p
N_2O
NO_3^--N, NH_4^+-N and TDN
correlation analysis and regression analysis
the diffusion model approach
R^2 between $c(N_2O)$ and indicators
N_2O concentra-tion and N_2O flux

Experiment plan

Calculating N_2O flux (Liss & Slater, 1974):

$$F = k(C_w - C_{eq}) \tag{1}$$

k: the gas transfer coefficient (cm/h)

C_w : the measured N_2O concentration (in water; μmol/L)

C_{eq} : saturation concentration of N_2O (in water; μmol/L)

Experiment plan

Emission factors of N_2O:

$$EF(A) = [(f \times a \times t) / N] \times 0.63 \times 44 \tag{2}$$

f: averaged N_2O fluxes emission

a: an area of Jurong Reservoir watershed

t: time

N: net inputs of N in Jurong during the time

0.63: transfer coefficient

44: molar mass of N_2O

(Xiao, 2014)

Experiment plan

Emission factors of N_2O:

$$EF(B) = \frac{c(N_2O - N)}{c(NO_3^- - N)} \qquad (3)$$

$$EF(C) = \frac{m(N_2O - N)}{m(TN_{input})} \qquad (4)$$

(Outram & Hiscock, 2012)

Schedule:

- 2015.10-2016.03 conducting experiments
- 2016.03-2016.04 data processing
- 2016.03-2016.05 thesis writing

Expected results:

- Showing the temporal and spatial distribution of indirect N_2O emissions in the Jurong Reservoir watershed.
- Determining which indicators are potential drivers of indirect N_2O emissions.
- Calculating EF of indirect N_2O emissions.

Thank you