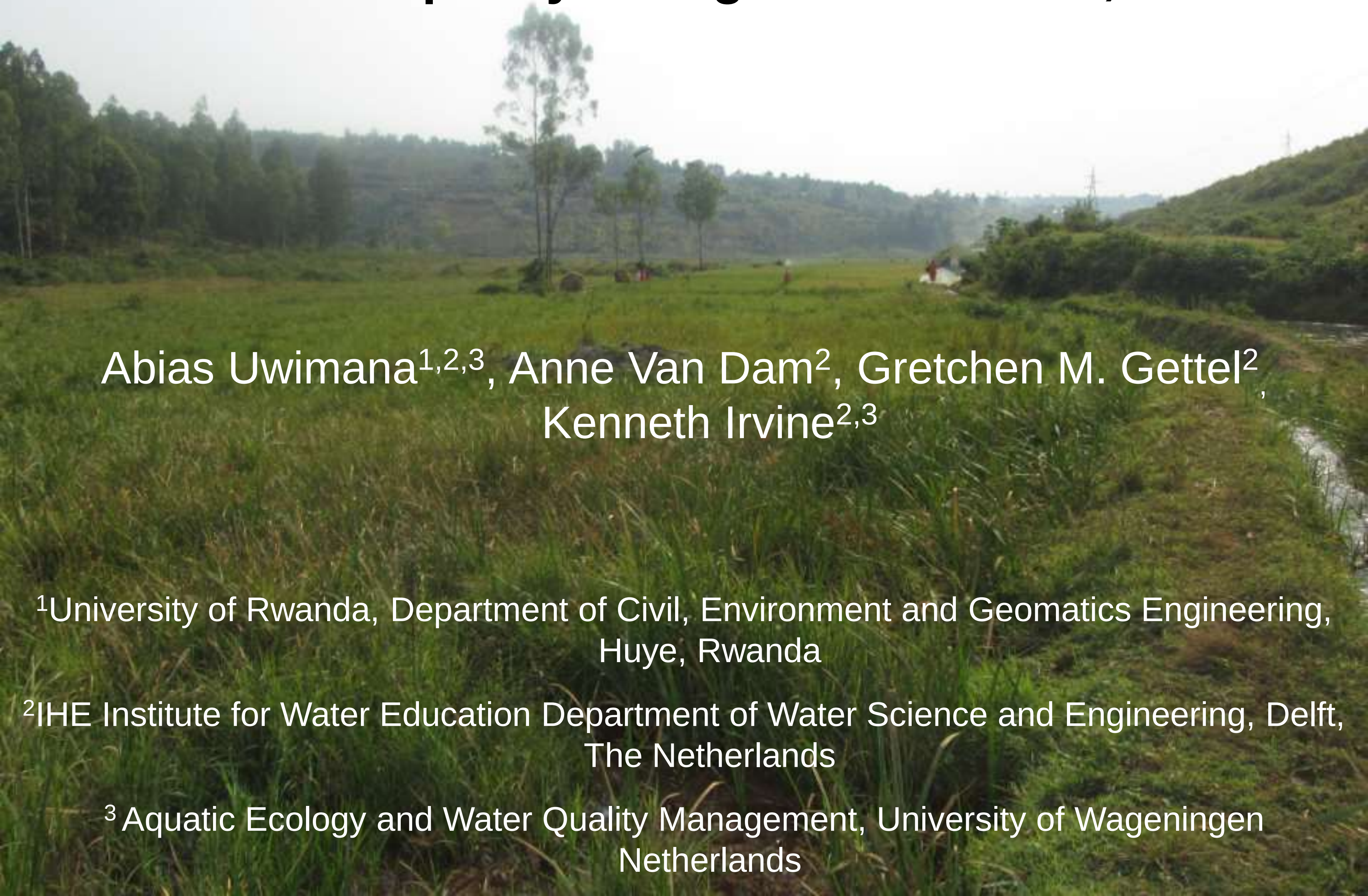
Effects of river discharge and land use and land cover on water quality in Migina catchment, Rwanda



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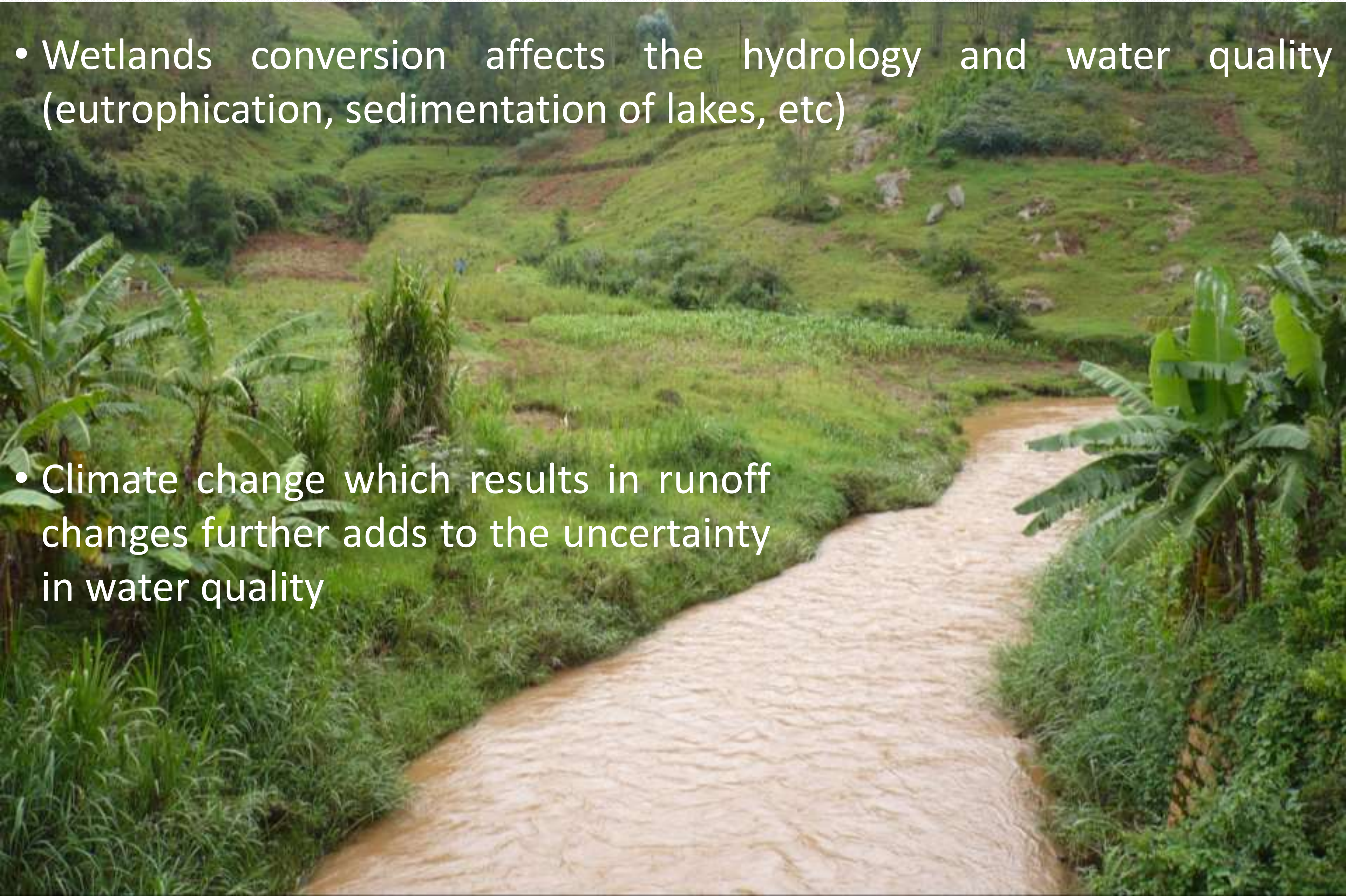
In sub-Saharan Africa, agricultural intensification is critical to increasing food security and economic development

- Many countries have policies to increase agricultural production
  - expanding area of cultivation
  - increase fertilizer inputs

- Valley bottom wetland conversion to other uses is common throughout eastern, western and southern Africa

Different uses of valley bottom wetlands

Wetland conversion and water quality degradation



- Wetlands conversion affects the hydrology and water quality (eutrophication, sedimentation of lakes, etc)

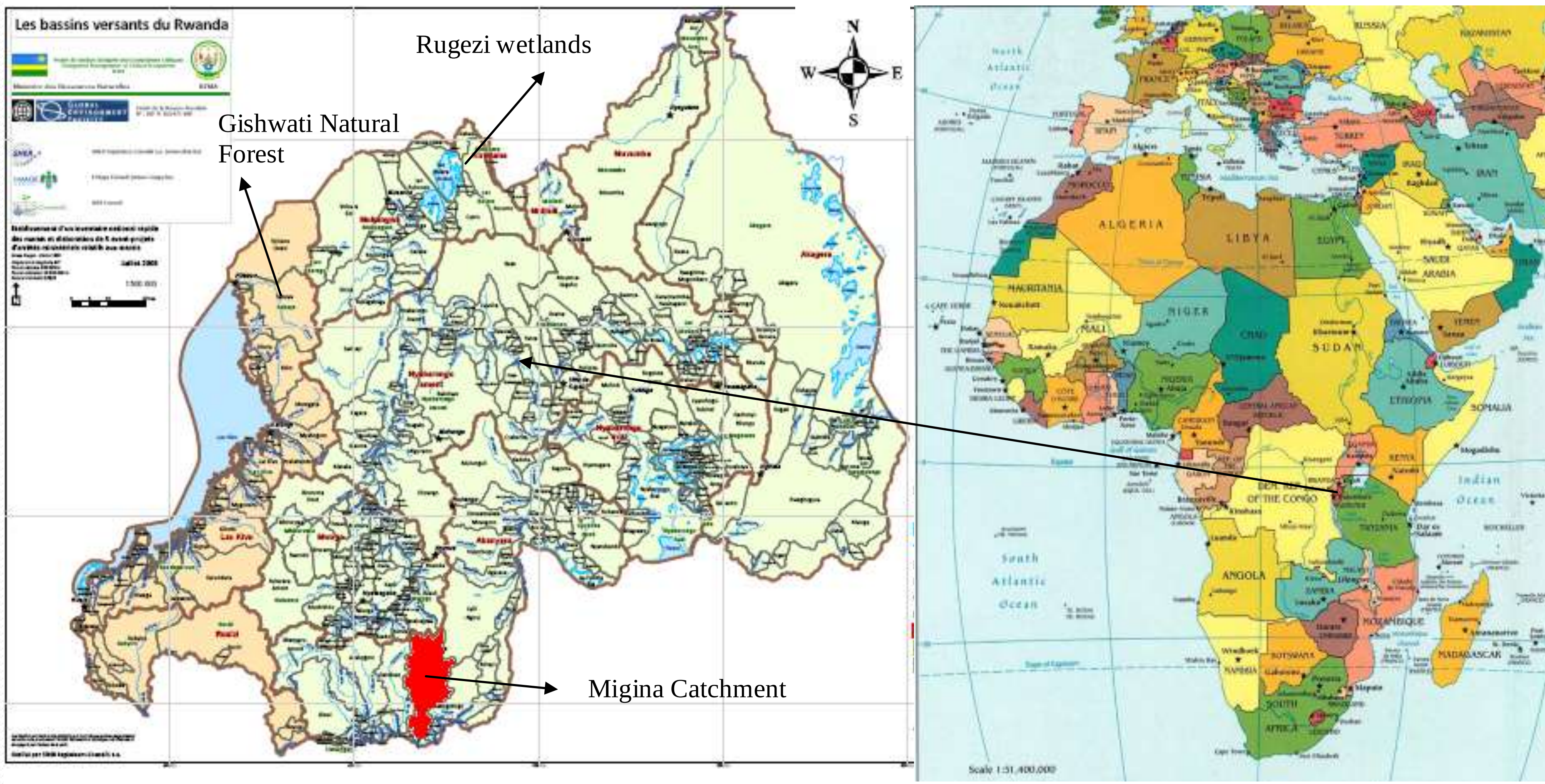
- Climate change which results in runoff changes further adds to the uncertainty in water quality

Objectives

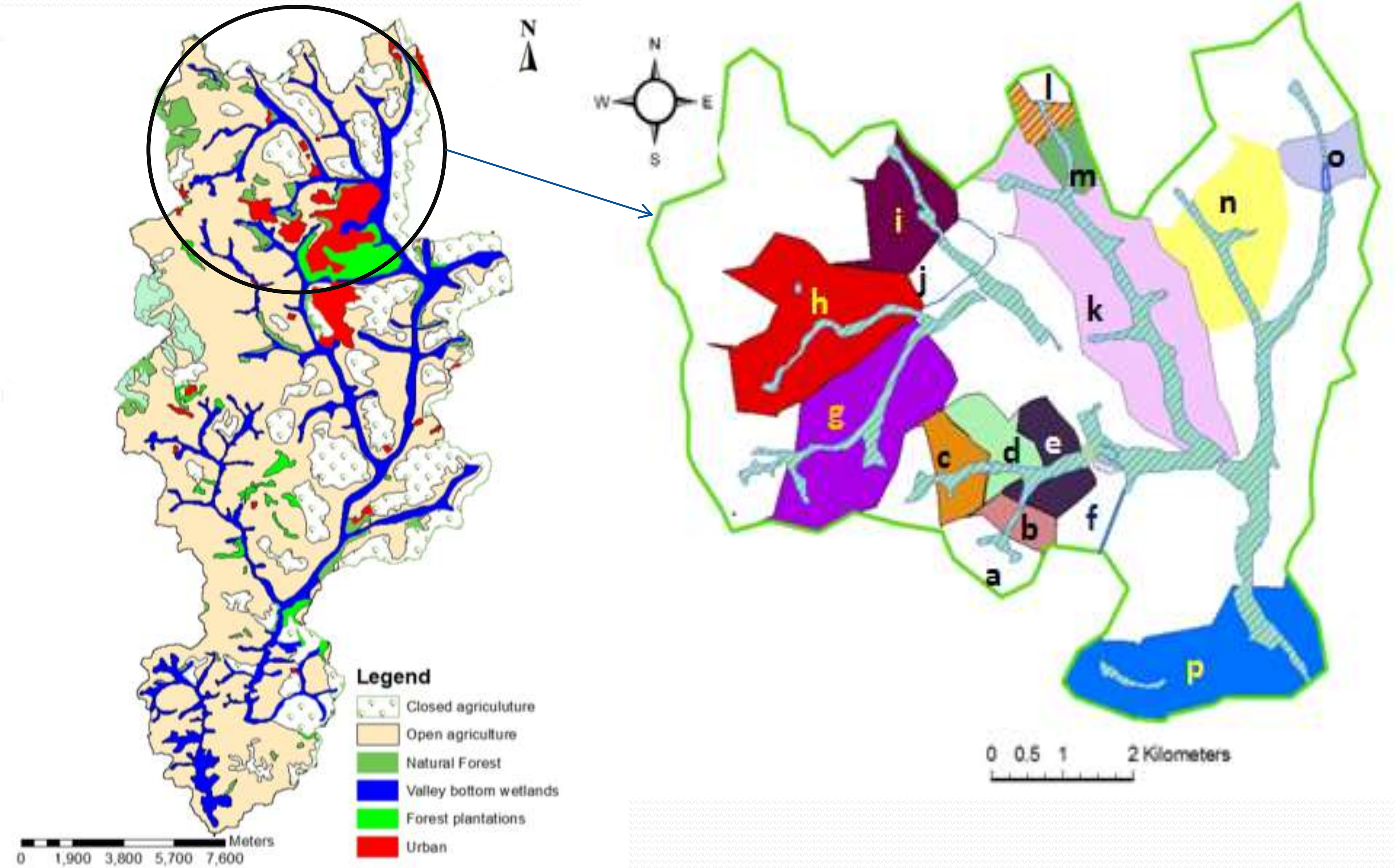
- The study objective was to assess the effects of seasonal changes in rainfall (water discharge) and dynamics of land use and land cover (LULC) on water quality
- Migina catchment was used as model

Source: Aaron T. Wolf et al., 1999; Revenga et al., *Watersheds of the World*, World Resources Institute (WRI), Washington DC, 1998; Philippe Rekacewicz, *Atlas de poche*,

Migina catchment is found in the Central East Africa, Southern Province of Rwanda

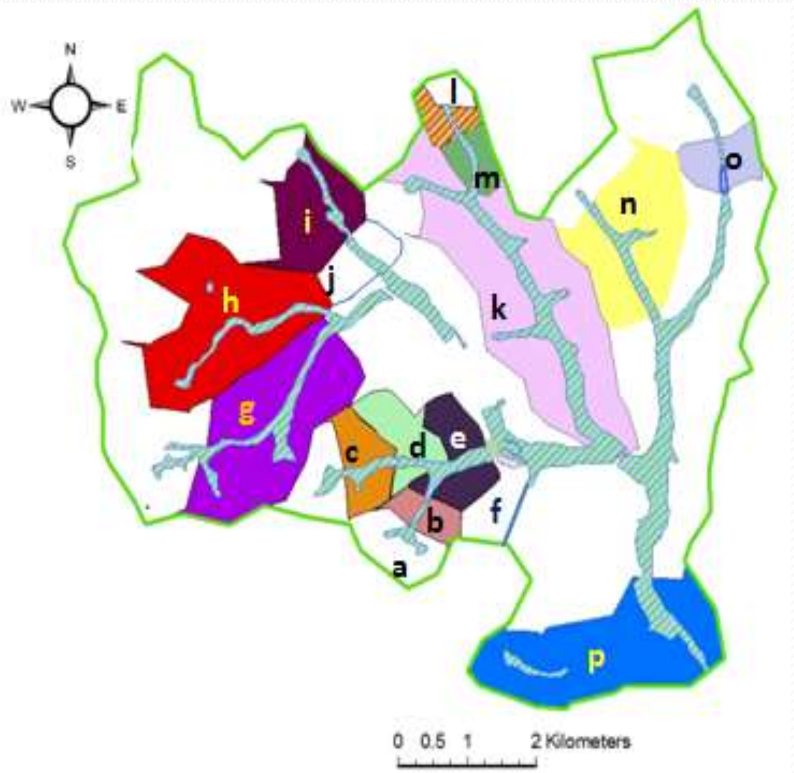


The study focused in the upstream part of Migina with remarkable different land use and land cover (LULC)

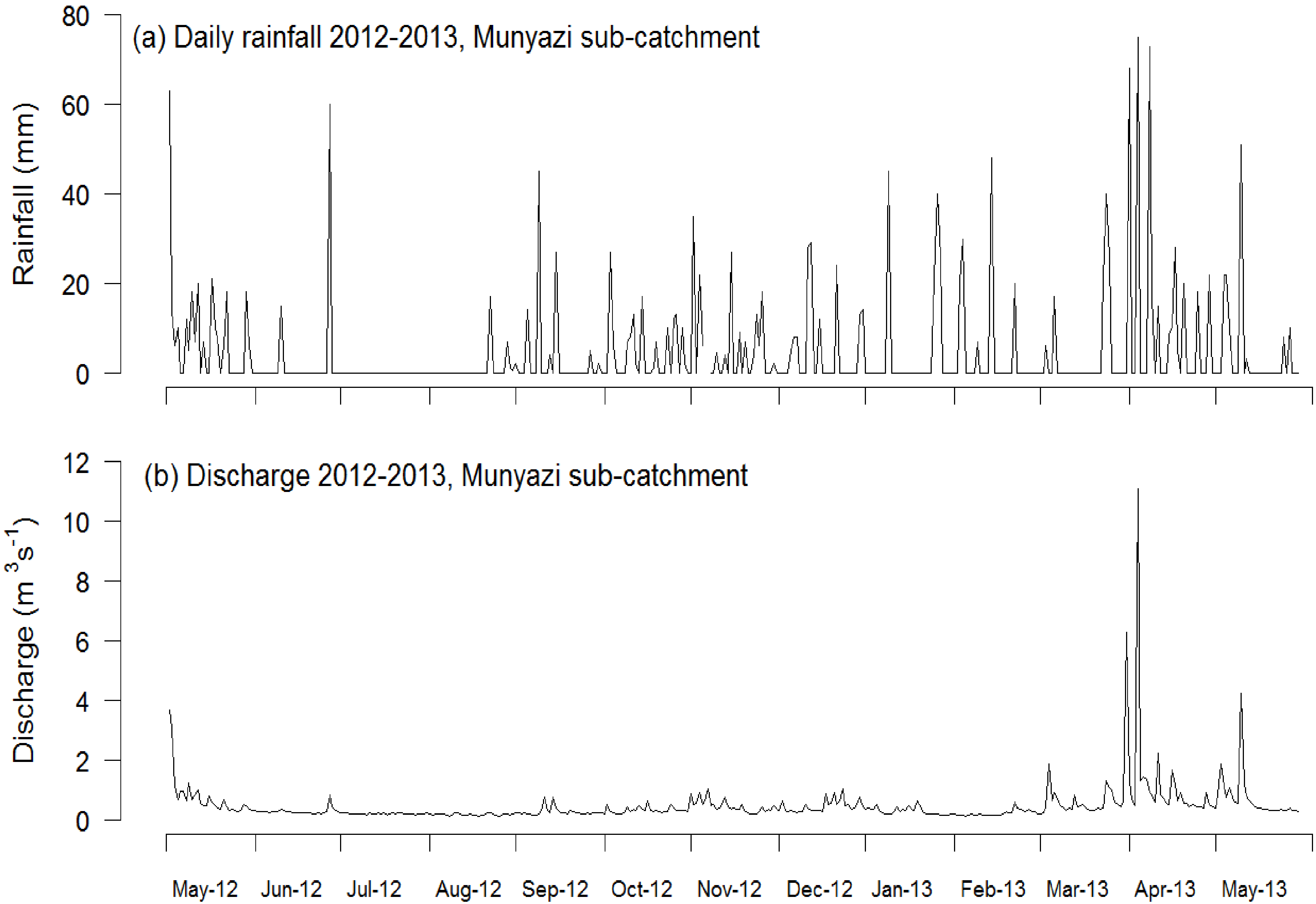


The assessment focused on the 16 reaches with different categories of LULC from May 2012 – May 2013

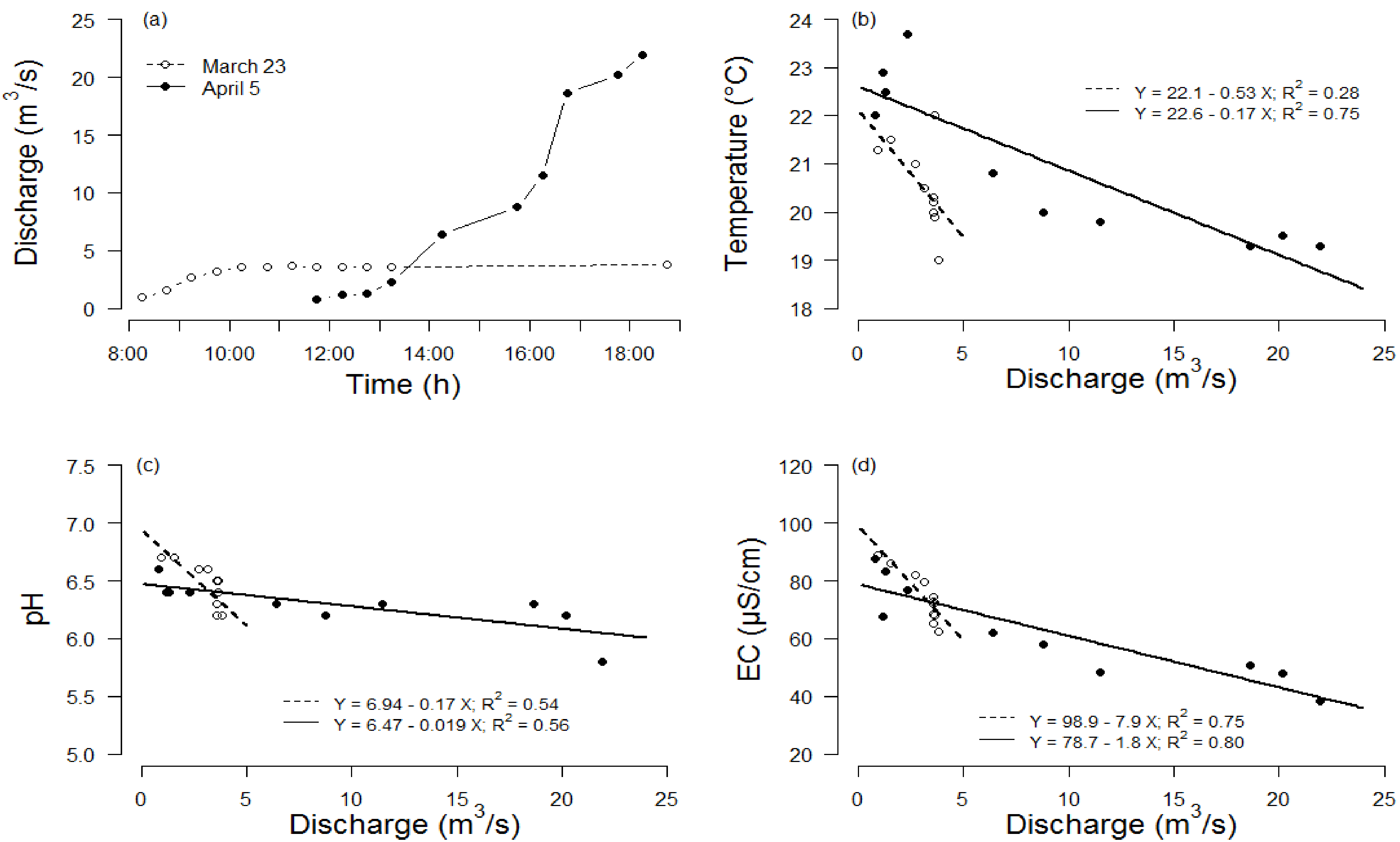
- The 16 reaches were monitored on monthly basis
  - LULC change (rice, vegetables, water and grass/forest)
  - Rainfall and water flow (monthly change)
- Two storm events were also monitored for rainfall, discharge and water quality (T, pH, EC, DO, TSS, TN, TP)
  - on 23 March 2013 (light rain)
  - and 5 April 2013 (heavy rain)
- Regression analysis and analysis of covariance (ANCOVA), were used in data analysis



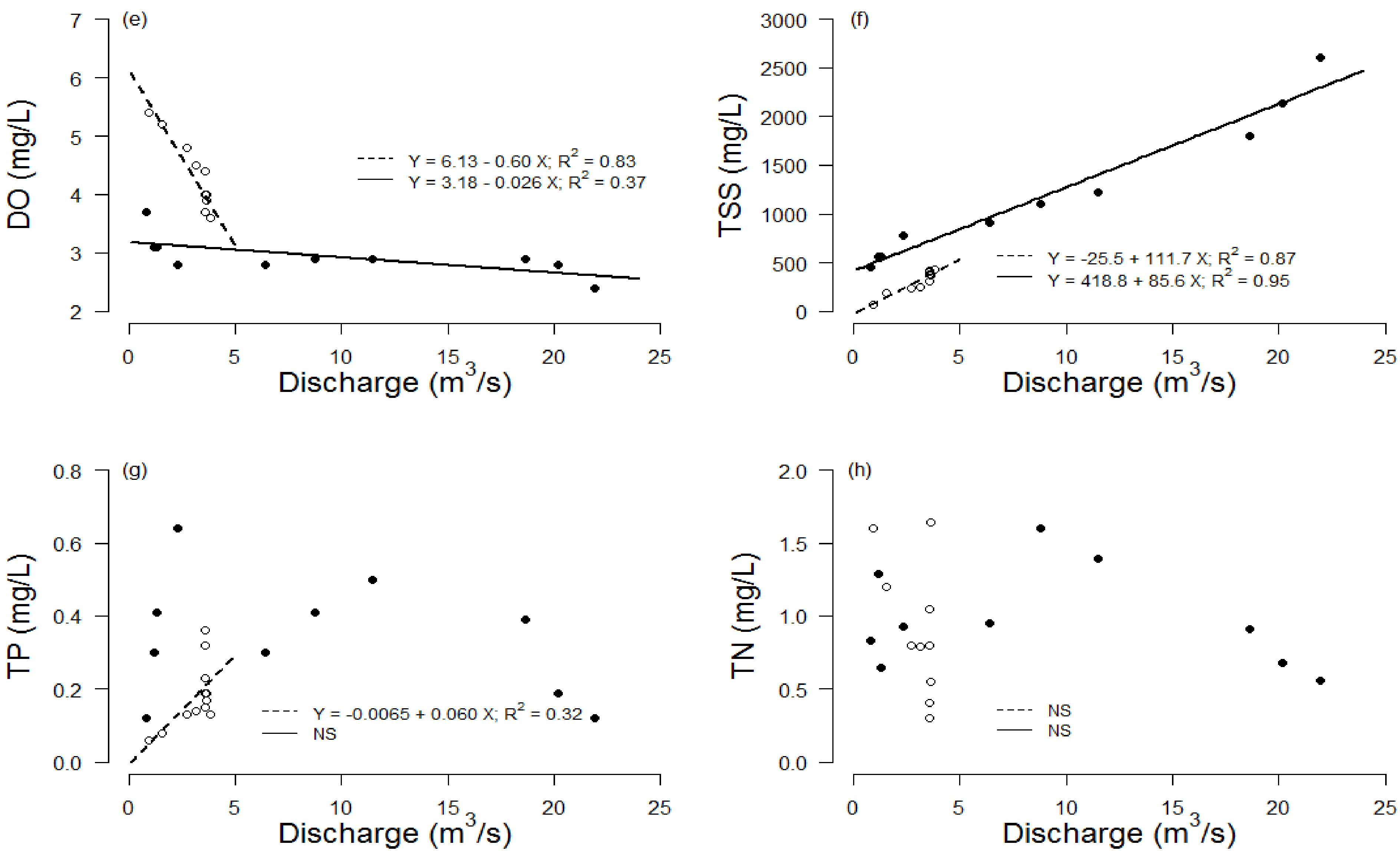
Rainfall and discharge



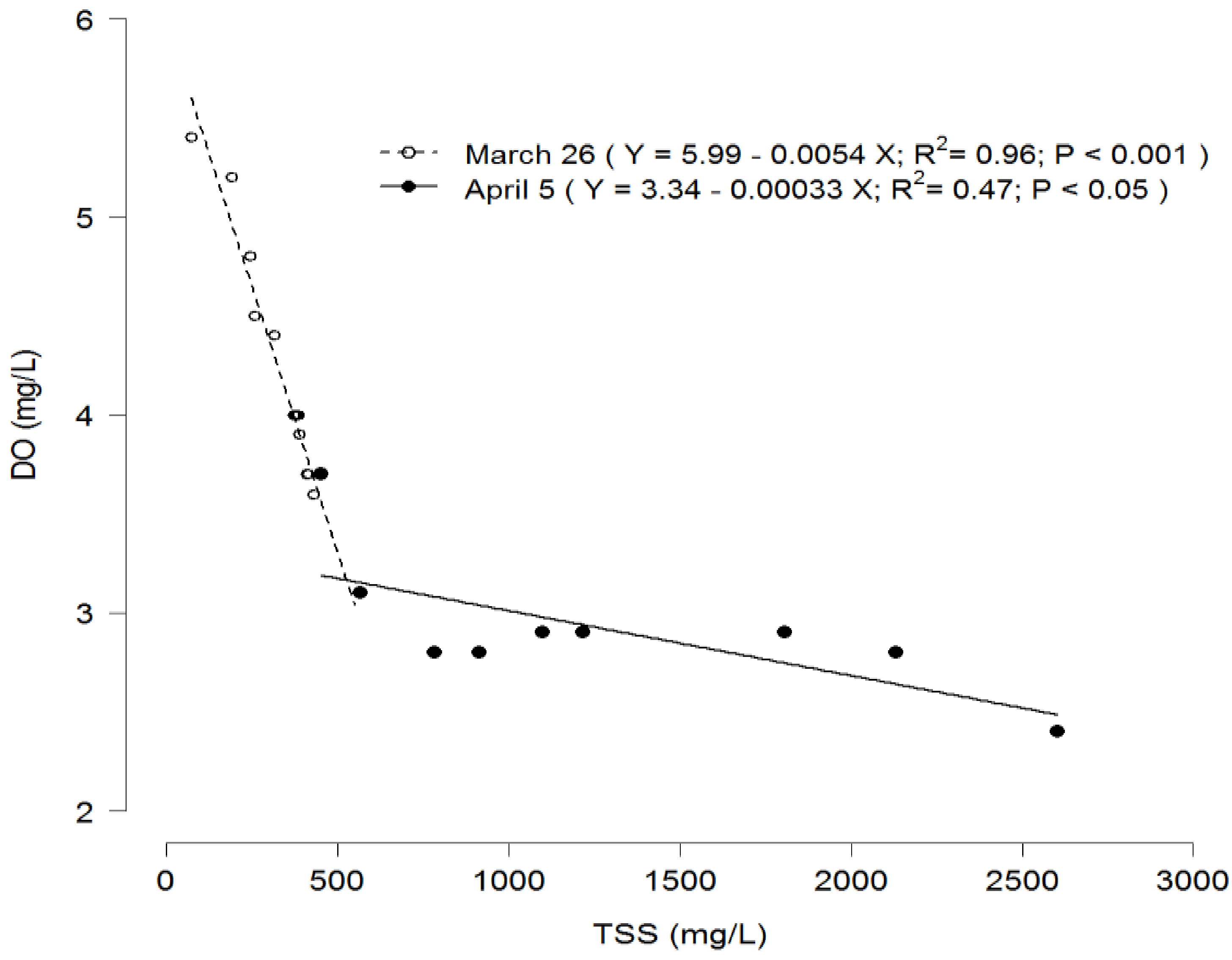
Relationship between water quality and discharge



Relationship between water quality and discharge

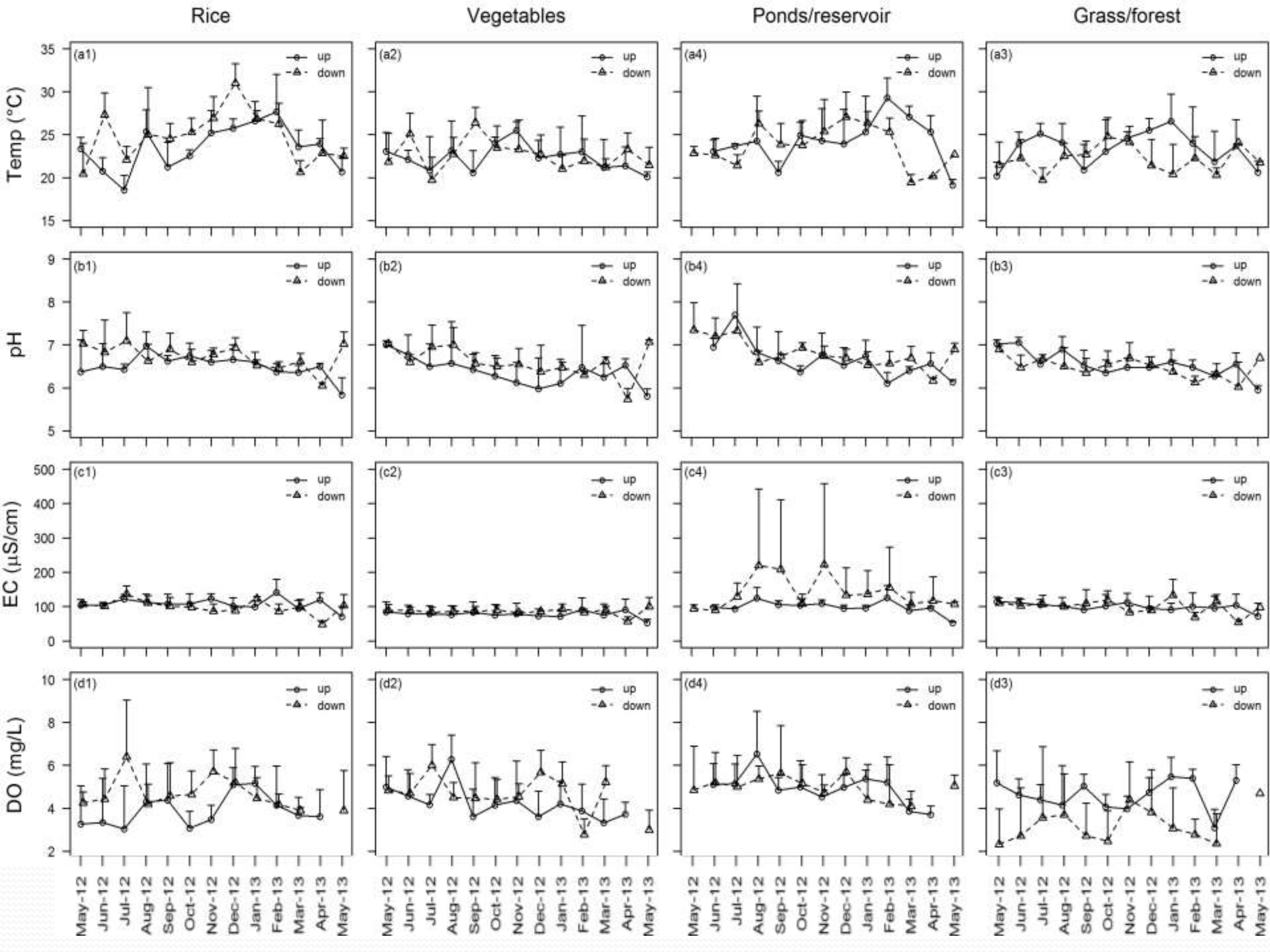


Relationships between TSS and DO



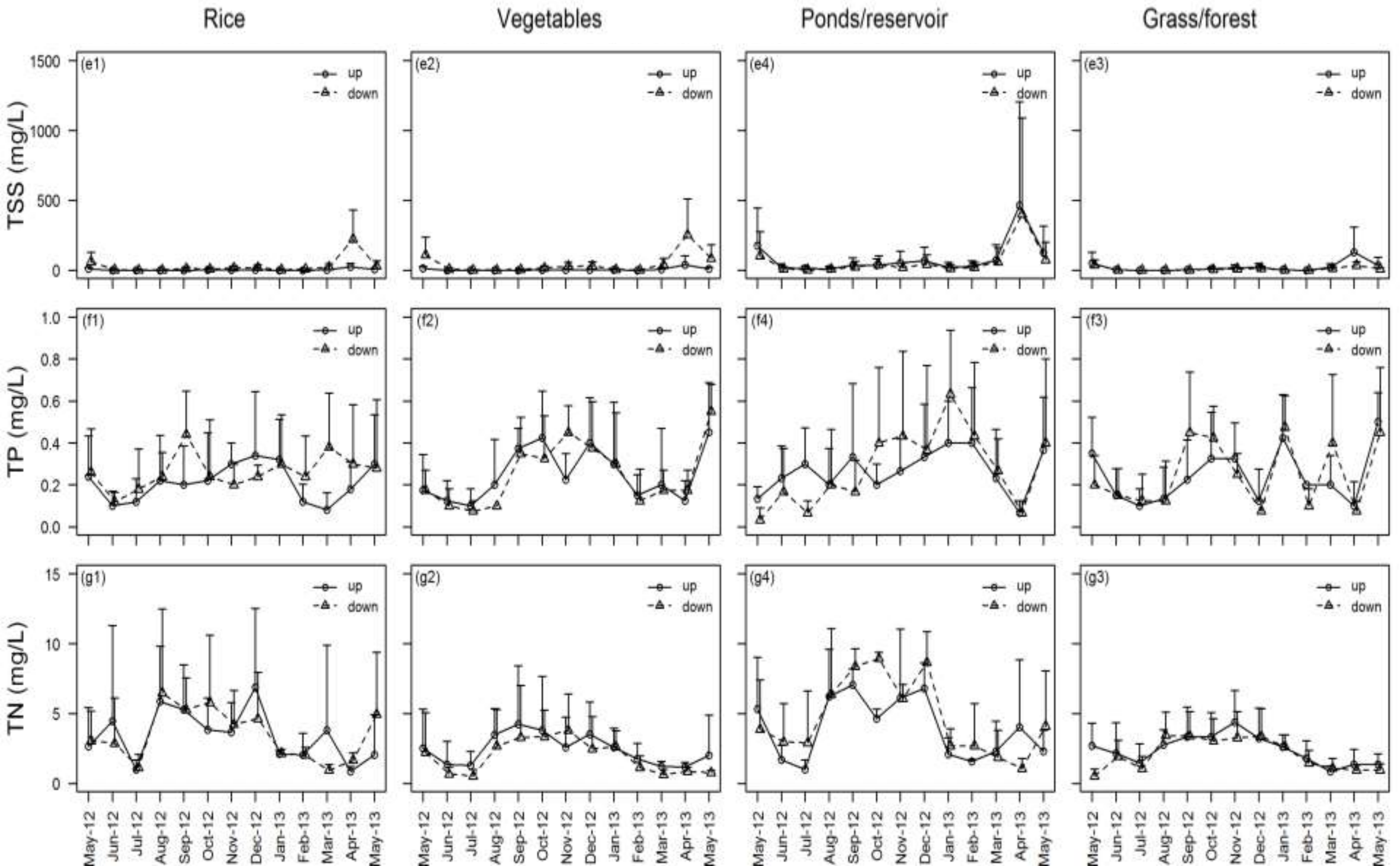
Results

- Across all sites, TSS related positively to discharge
- EC, temperature, DO and pH decreased with increasing discharge
- TN and TP concentrations were higher in the dry and early rainy (and farming), were washed out at the first flush of the storms with subsequent dilution at the end of the rains.

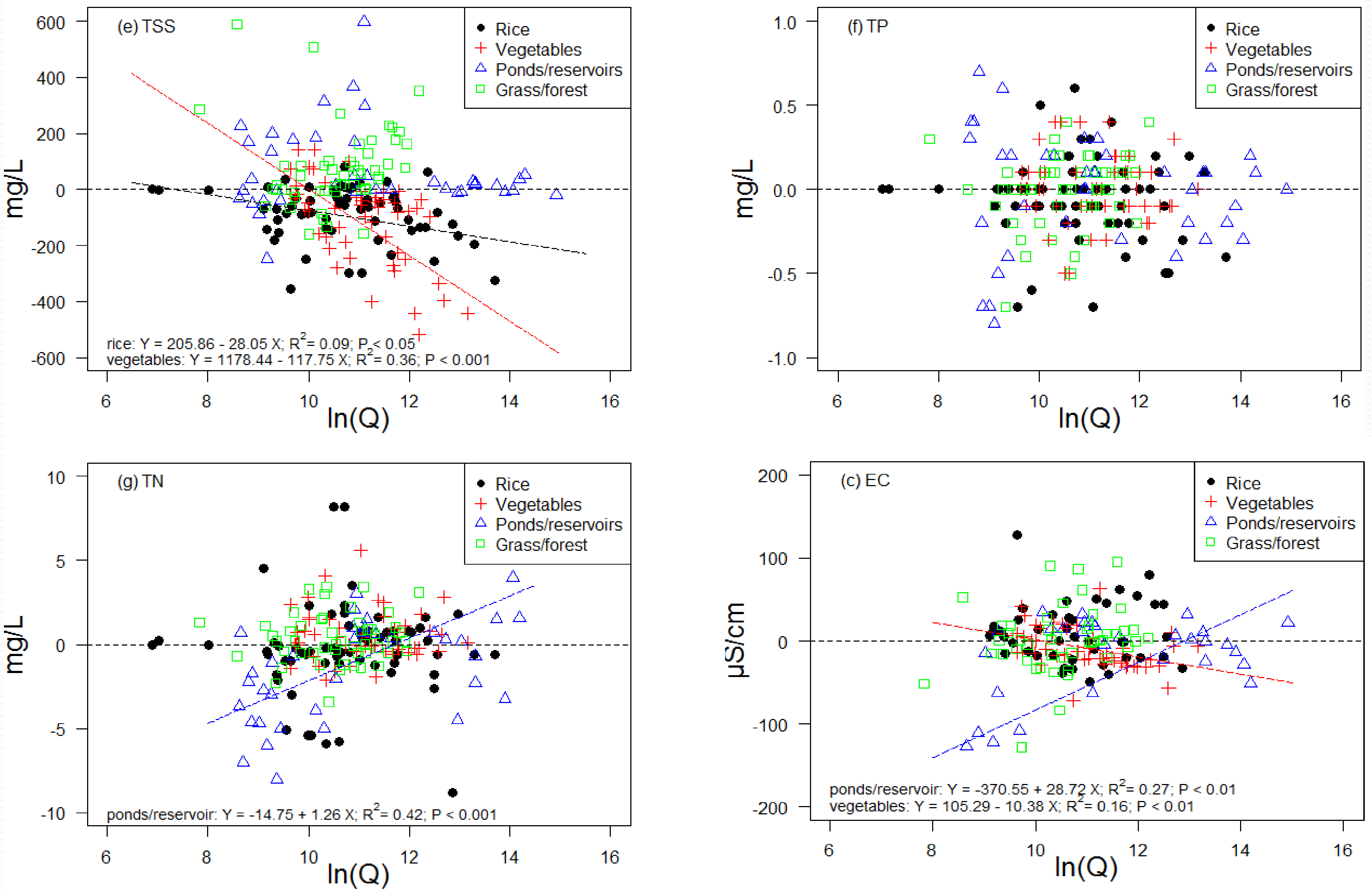


Rice
Vegetables
Ponds/reservoir
Grass/forest
Temp (°C)
pH
EC (µS/cm)
DO (mg/L)
(a1)
(a2)
(a4)
(a3)
(b1)
(b2)
(b4)
(b3)
(c1)
(c2)
(c4)
(c3)
(d1)
(d2)
(d4)
(d3)
up
down
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Feb-13
Mar-13
Apr-13
May-13

Variation of water quality upstream and downstream of different LULC categories



Analysis of Covariance (ANCOVA) for differences between upstream and downstream values in 16 reaches



Analysis of Covariance (ANCOVA) for differences between upstream and downstream values in 16 reaches

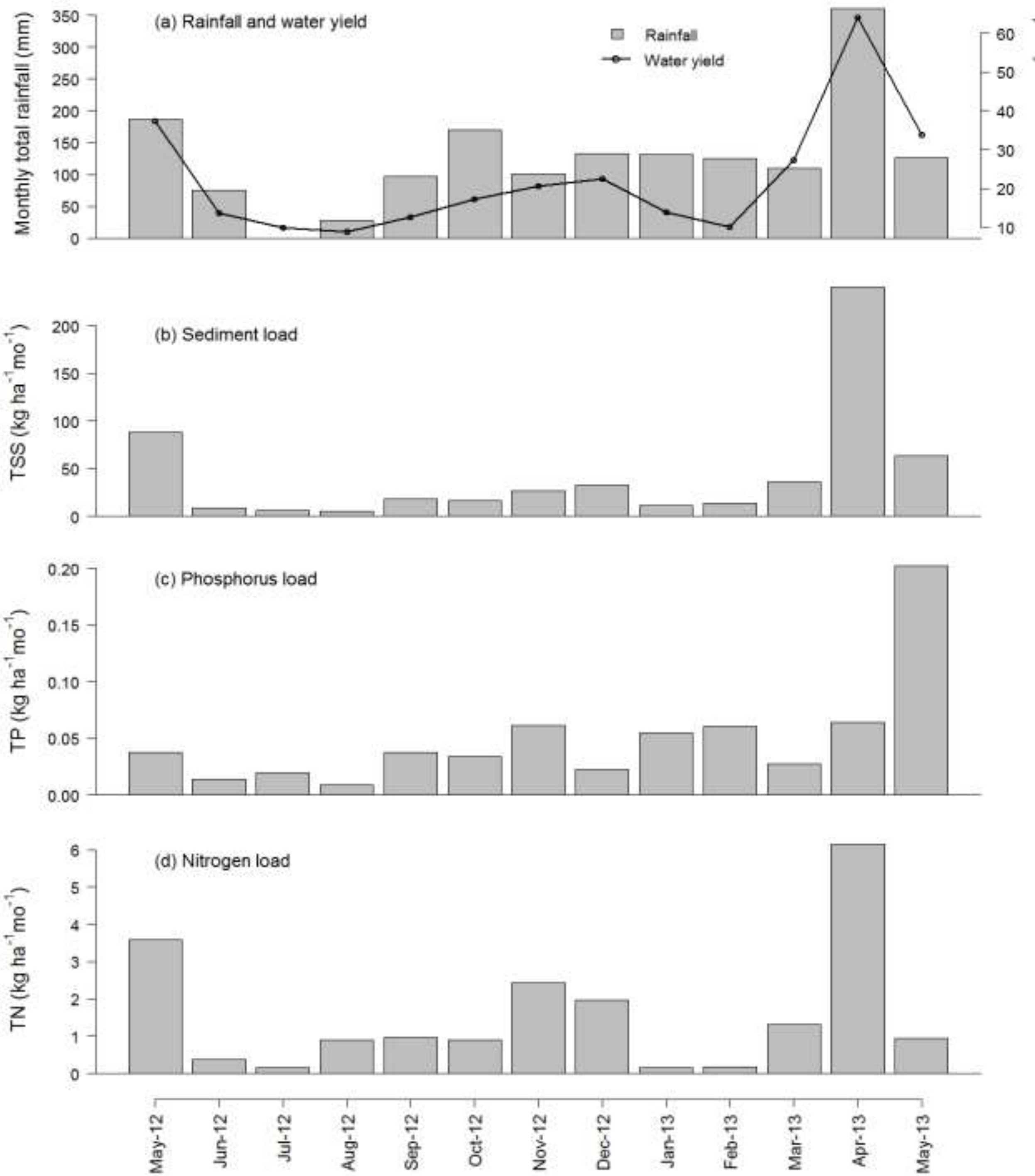
- TSS was consistently higher downstream of rice and vegetable reaches (mean differences 95 and 127 mg L^{-1}, respectively), and consistently lower downstream of grass/forest and ponds/reservoir reaches (75 and 67 mg L^{-1}, respectively
- EC was particularly higher downstream of ponds/reservoir reaches
- The significant differences between LULC types of water quality change suggest that rice and vegetable farming generate or facilitate the transport of higher TSS concentrations as opposed to ponds/reservoirs and grass/forest cover.

Buildup , washout and dilution mechanism in Migina

- Water was identified the most important factor providing the carrier and energy for transfer of sediments and nutrients.
- During base flow conditions, urban and agricultural areas, wetland grass and dams act as sinks for sediments and nutrients, which are released (flushed out) during the early stages of high flows
- In the Migina, nutrient buildup occurs at the start of the dry season (June-September) until the middle of the main agricultural season in October.
- Washout occurs in early periods of high flows and from the middle of the main agricultural season in November-December.
- Dilution occurs during the late stages of high flows and at the end of the high rainfall season (May and June).

Yield of sediments and nutrients

- 93% of the annual TSS yield was associated with rain (115 days).
  - 7% were transported during base flows (250 days).
- Fewer proportions (60% and 67%) of the annual TP and TN yield respectively were associated with rain.



Challenges and Solution

- Population increase, need for food pressure on land
  - force farmers to cultivate more areas of natural ecosystems like forests and wetlands,
  - Degradation of wetland systems with effect on water quantity and quality
- The combined effect of future climate change with conversion of more valley bottom wetlands to farming presents a further risk
  - Extreme events, such as droughts and floods, are expected to increase in intensity and frequency in sub-Saharan Africa as a result of which stronger buildup and washout of nutrients can be expected.
- Programmes to convert wetlands for agricultural exploitation should take into account the importance of ponds/reservoirs, grass/forest and dedicate a certain percentage (?%)of a catchment to these alternative uses

Thank you