The Effects of Wastewater Discharge, Agriculture and Papyrus Harvesting on the Nutrient Regulation Function of Namatala Wetland, Uganda

Susan Namaalwa[1], Anne A. van Dam[2], Ajie Guruh[2], **Rose C. Kaggwa**[1] and Andrew Sekayizzi[1]

[1]National Water and Sewerage Corporation, Kampala, Uganda
[2]UNESCO-IHE Institute for Water Education, Delft, The Netherlands

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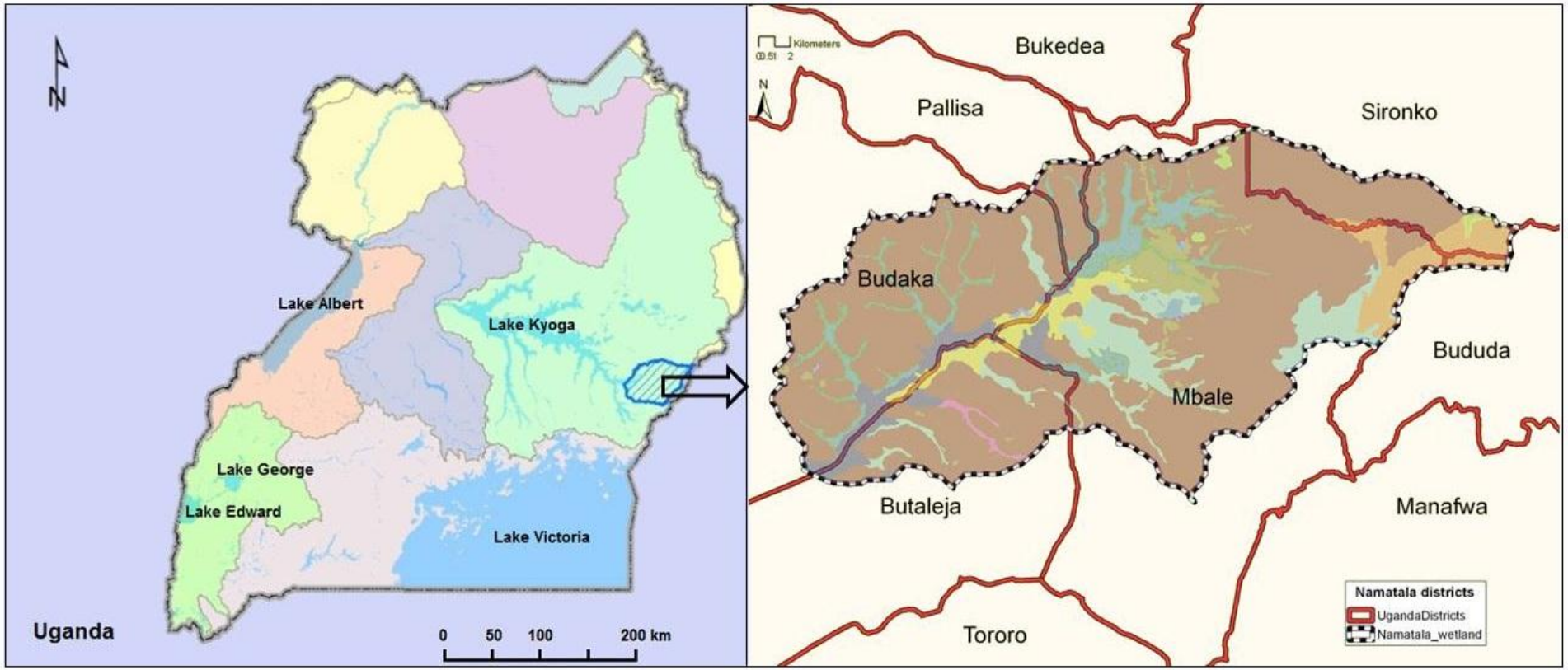
Introduction: Geographical context

- Wetland area : 260 km^2
- Altitude: 3,550 – 3,700 m
- Population: 380,000



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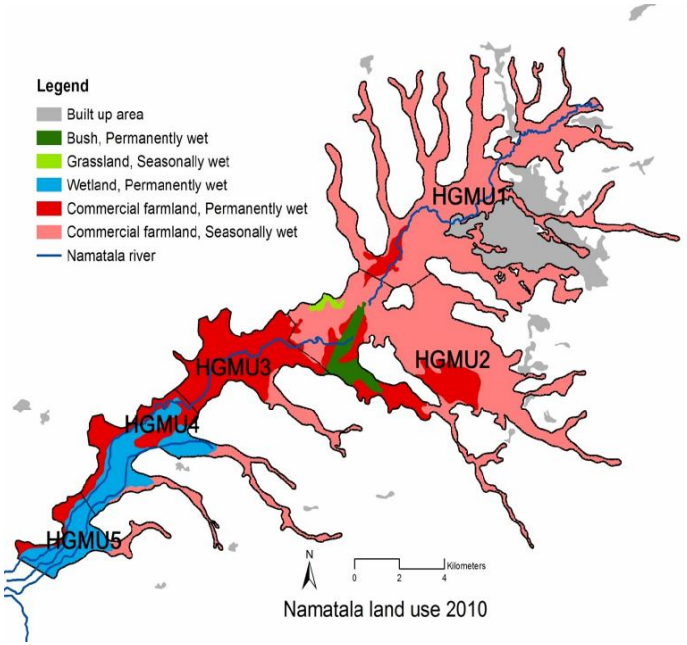
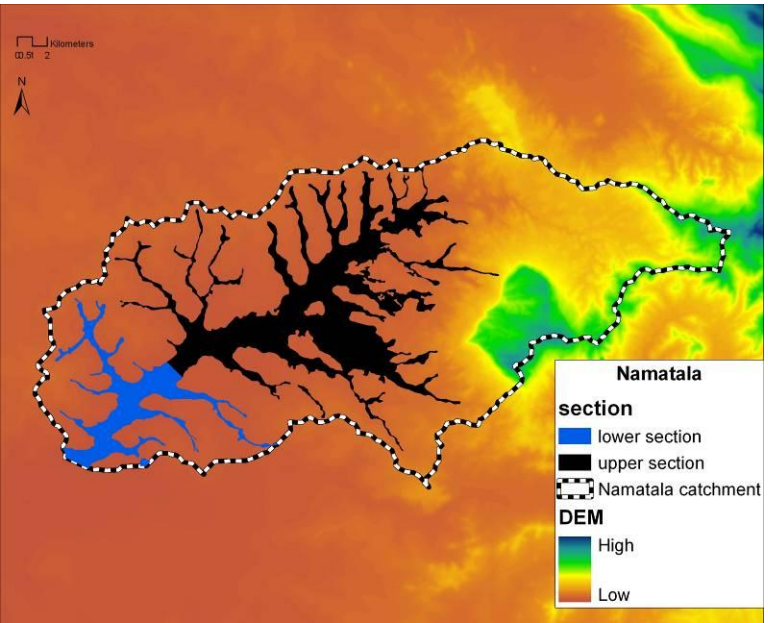
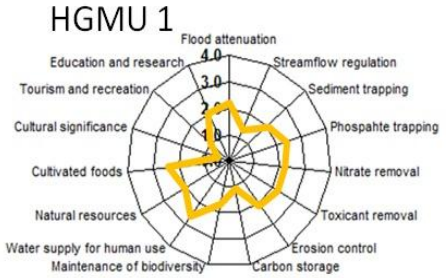
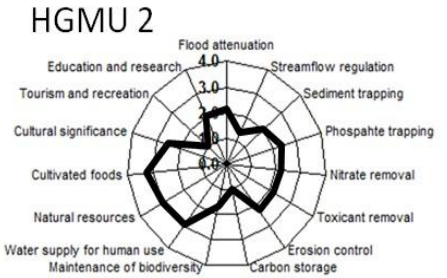
Introduction...../2: Ecosystem Services

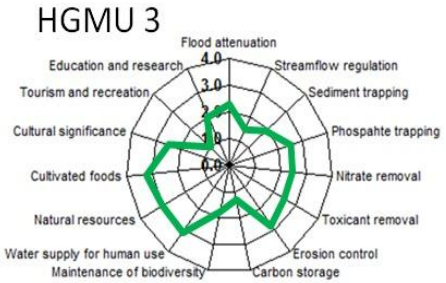


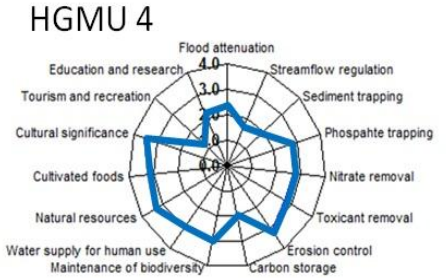
Namatala land use 2010

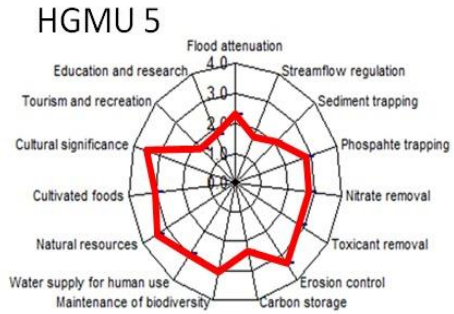












Ecosystem service	Score for HGMU no.				
	1	2	3	4	5
Provisioning	2.3	3.0	3.1	3.2	3.1
Regulating	1.9	1.9	2.1	2.5	2.5
Cultural	1.2	1.8	1.8	2.3	2.3
Habitat	1.6	1.8	1.8	3.0	3.0

(Source: Namaalwa et al. 2012, submitted)

Problem analysis

Wetland Problem	Ranking by					Priority ranking	Agreement ranking
	Resource users	Wetland institutions (district)	Wetland institutions (national)	Local council adminis-trators	NGOs		
Agricultural encroachment	3	1	1	1	1	1	5
Loss of biodiversity	5	2	2	3	2	2	4
Wetland pollution	4	2	3	4	3	3	1
Conflicts in use and ownership	2	5	5	2	4	4	2
Diversion of streams and rivers	1	4	4	5	5	5	3

(Source: Namaalwa et al. 2012, submitted)

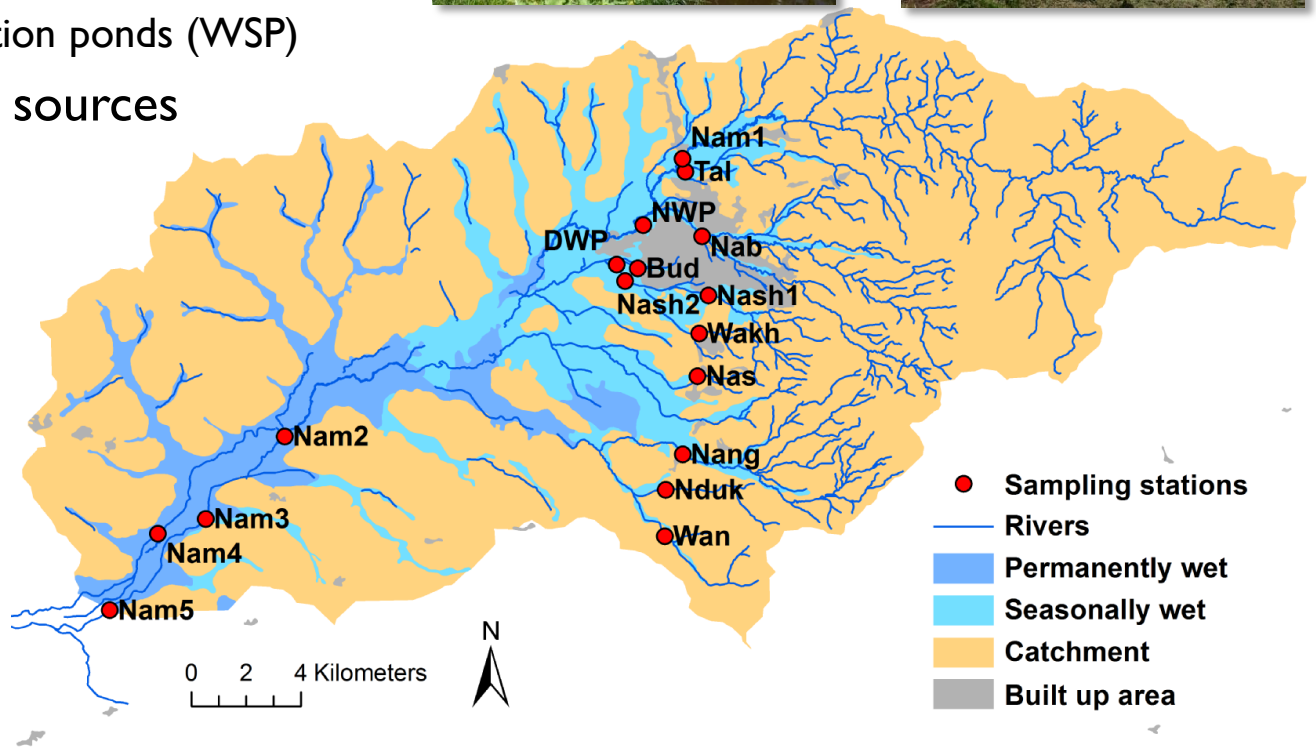
- Priority ranking (1=high to 5=low)
- Priority ranking: Based on average of the five scores
- Agreement ranking based on coefficient of variation (lower variation representing higher agreement on issues

Objectives

- Characterize the water quality status of the case study – Upstream - downstream interactions
- Compare total nitrogen (TN) and phosphorous (TP) input into Namatala wetland from the main river, other tributaries, and from the wastewater treatment systems
- Estimate the export of TN and TP through rice and papyrus harvesting

Research methods

- Field work (November 2009 – August 2011)
  - Delineation of study area
  - Selection of sampling points
    - main river channel
    - other streams
    - polluted streams
    - waste stabilization ponds (WSP)
  - Mapping of pollution sources



Research methods ...../2

- Water sampling & Analysis
- Discharge monitoring
- Plant sampling & analysis for nutrients

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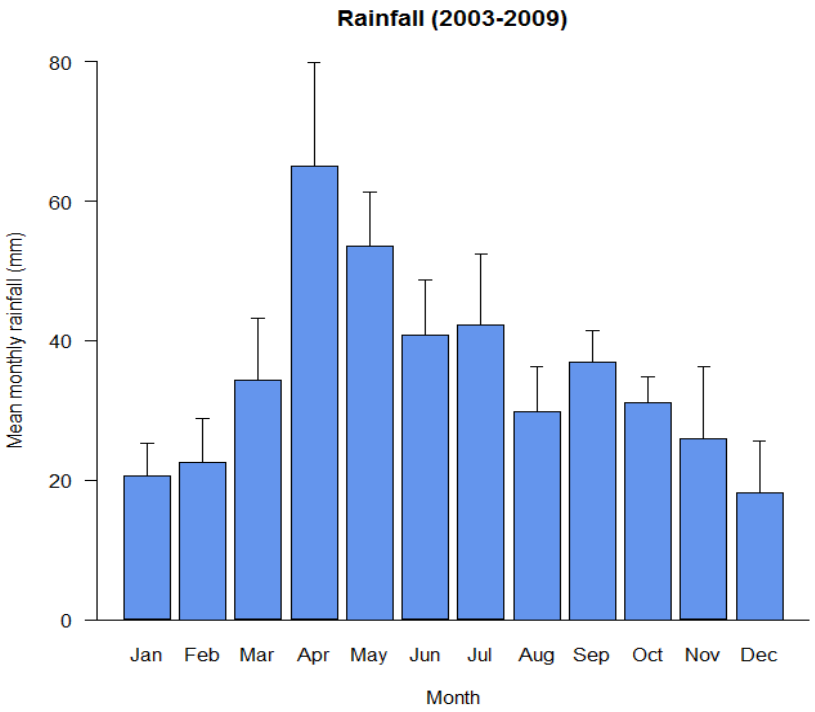
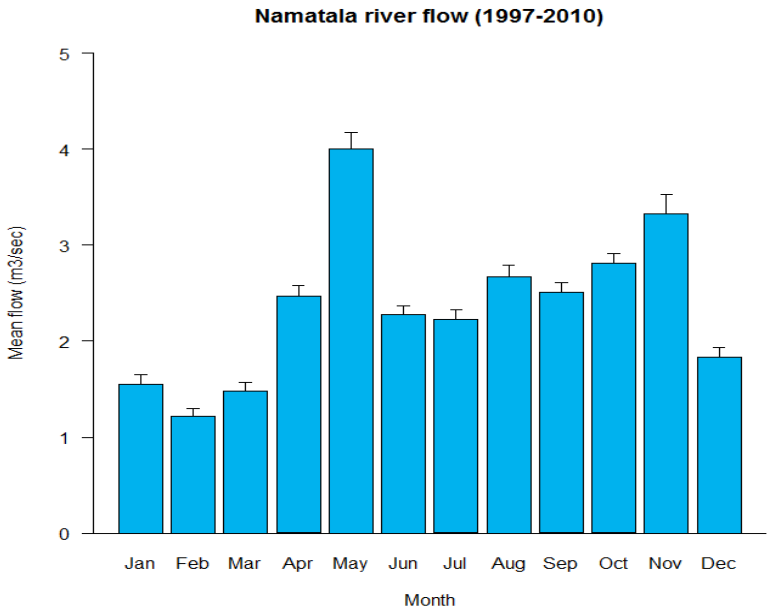
Precipitation & discharge





- High rainfall variability
- Peak rainfall observed between April & June; Sept & Nov
- High flows observed in May and October & November i.e. rainy seasons

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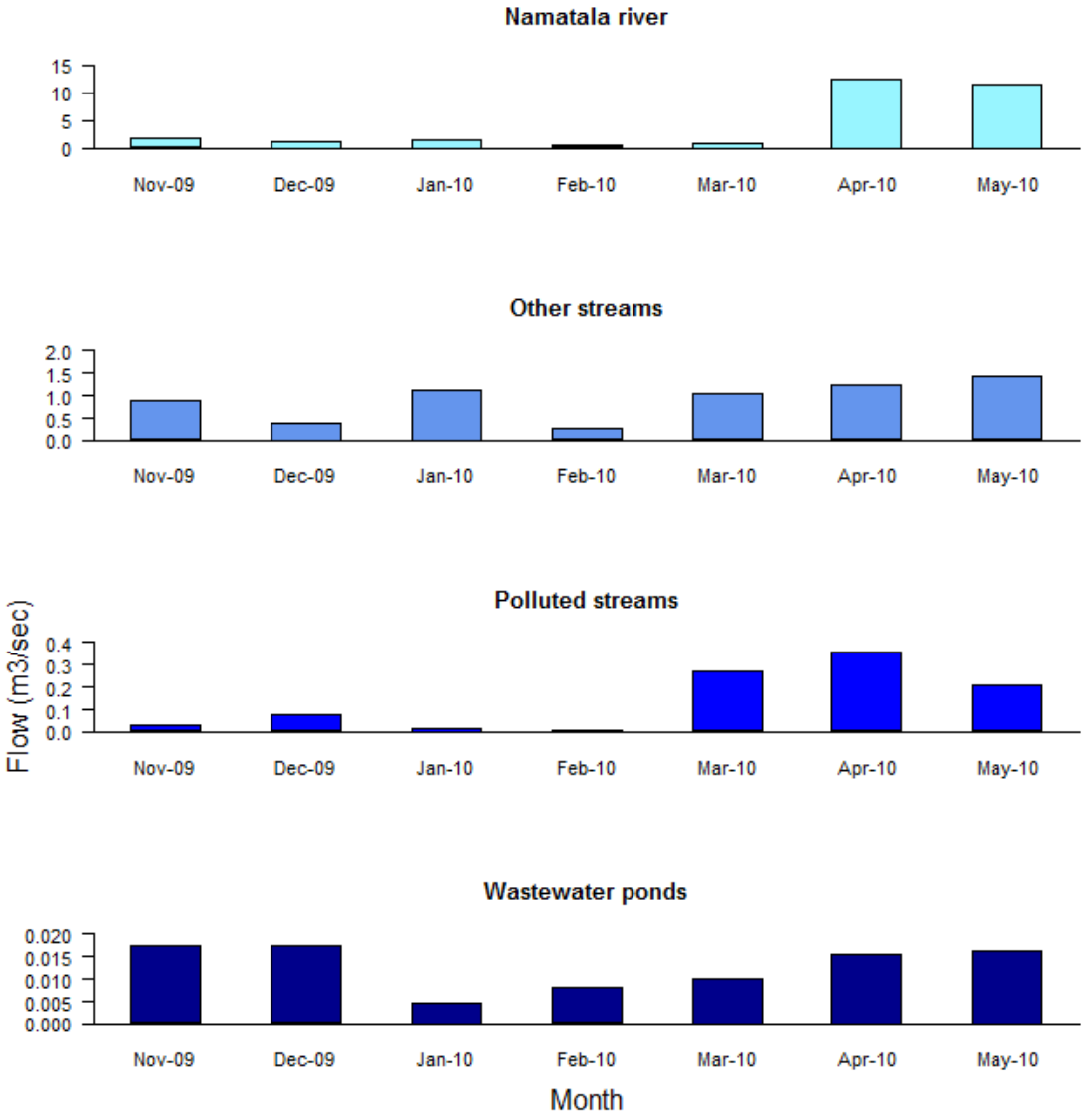
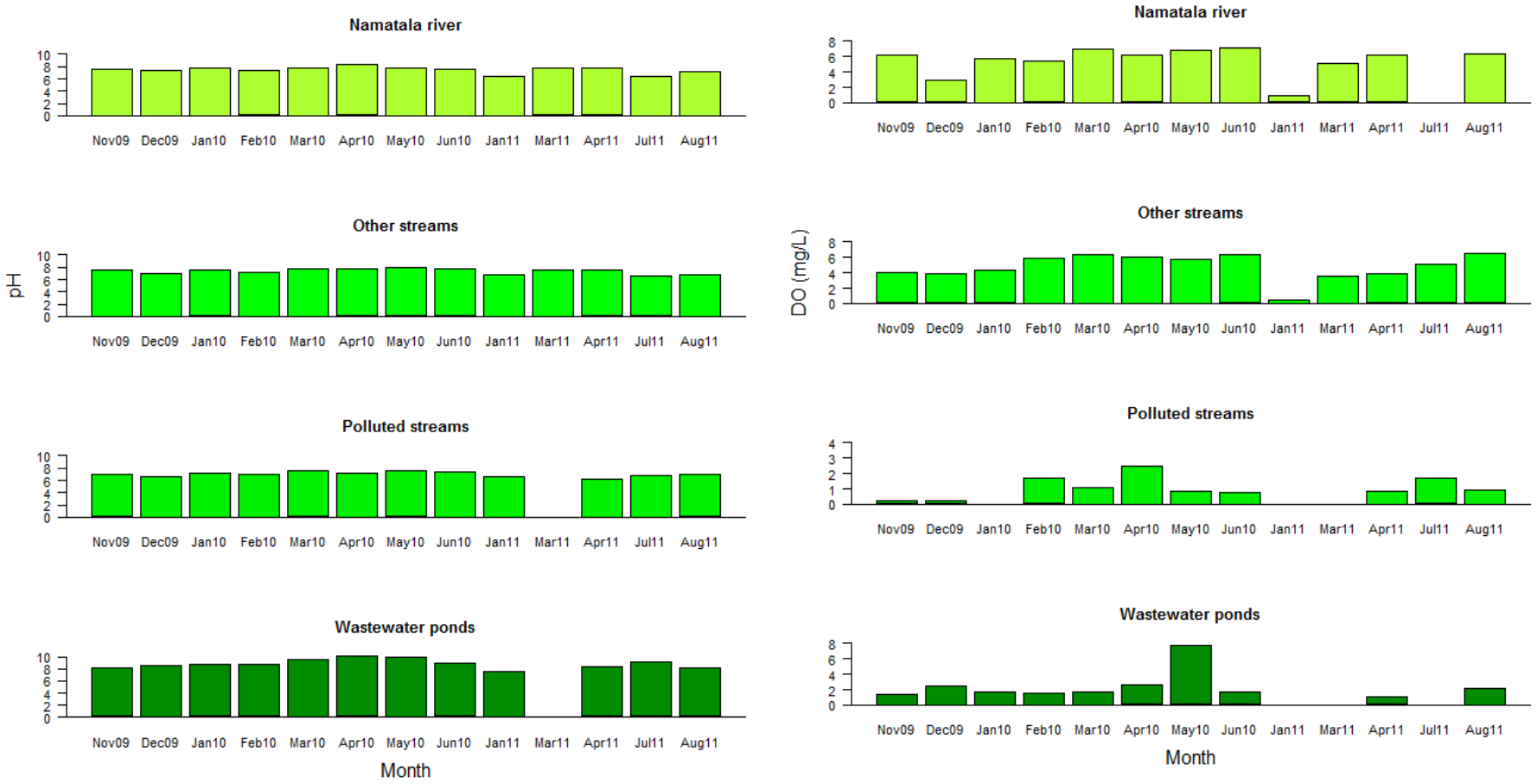
Discharge of wetland inflows



- Higher discharge for all the inflows observed during the peak rainfall period (April-May)
- Namatala river is the major source of surface water input contributing 70% of the flow
- Average discharge (m^3/sec) : River (1.1 & 5.6) ; other streams (0.11 & 0.78) for dry & wet season respectively
- Average discharge (m^3/sec): polluted streams (0.094 & 0.006); WSP (0.008 & 0.003) for dry & wet seasons respectively

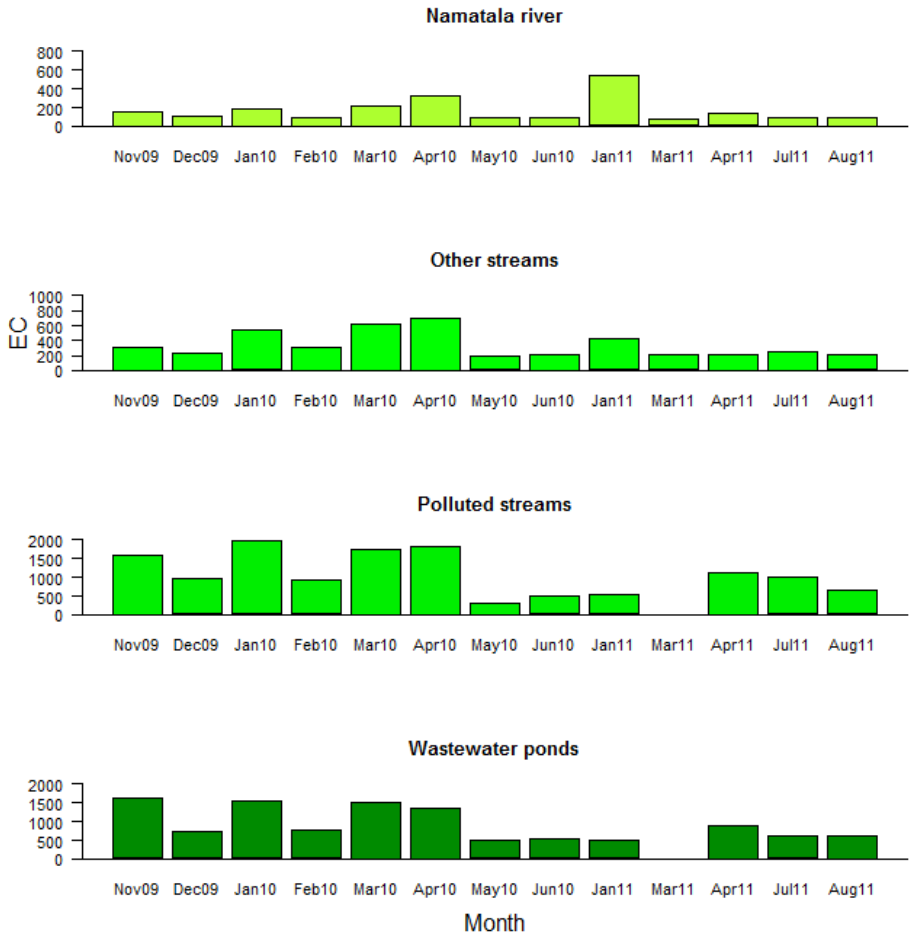
Water quality: pH & DO

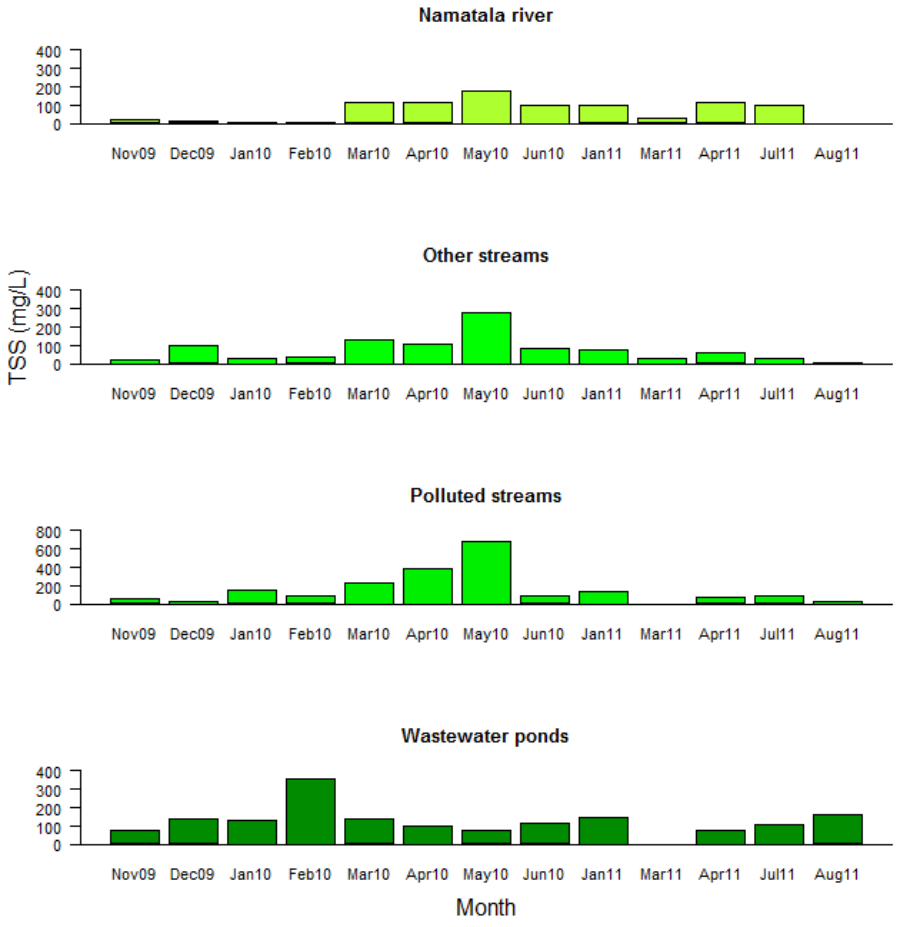


- Neutral pH for Namatala river and other inflowing tributaries (7.3 – 7.5). High pH observed in the effluents WSP (8.8 -10).

- High DO values in Namatala river & other streams (4.5 – 5.6mg/l). Low values in polluted streams & WSP effluent (0.7 – 2.5mg/l)

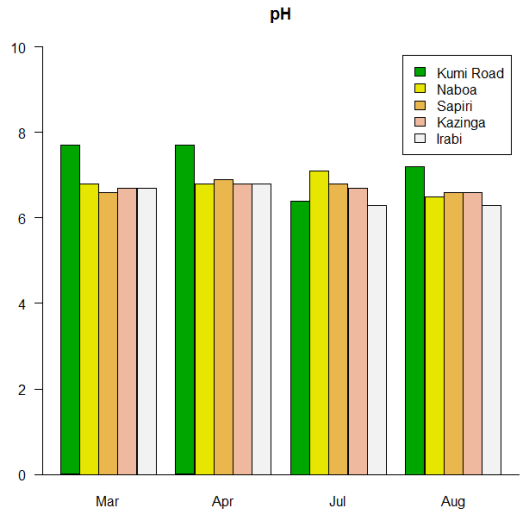
Water quality: EC & TSS

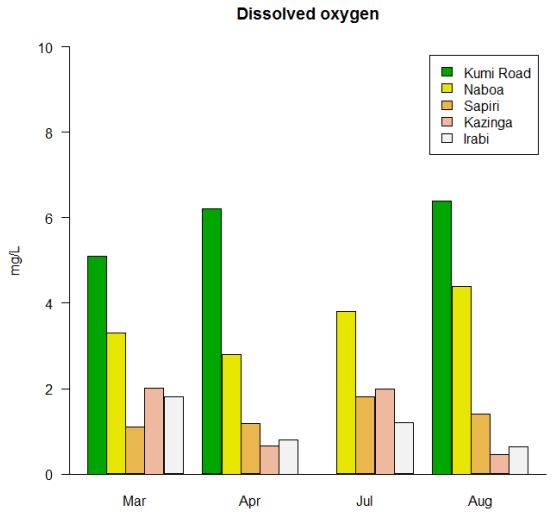


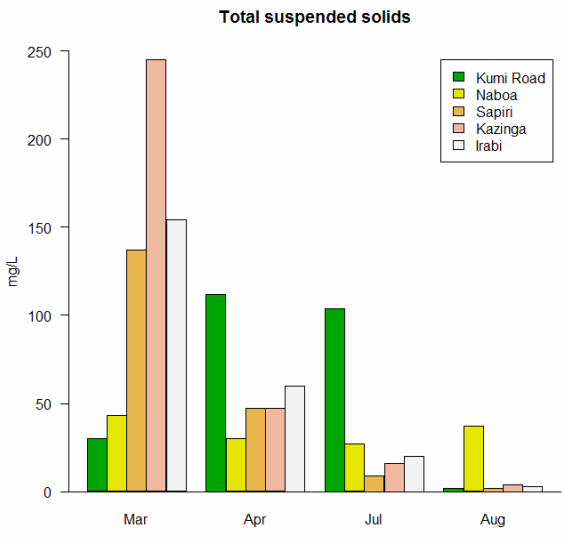


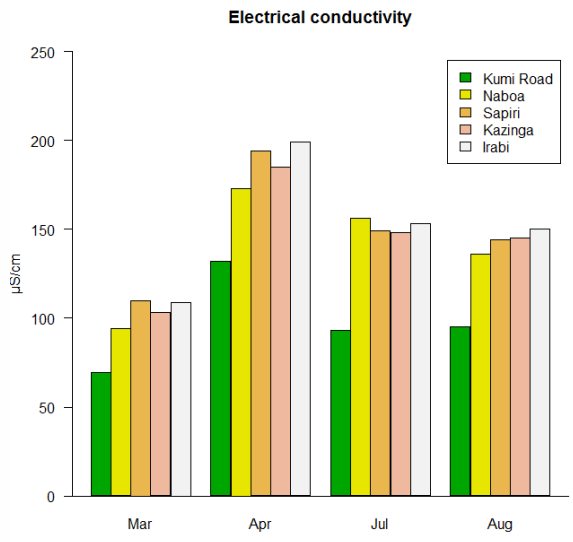
- High EC values in the polluted streams (1005 – 1106 µs/cm) and WSP effluent (785 – 951µs/cm)
- High TSS values observed in the polluted streams (170 – 216mg/l) & WSP effluents (140 mg/l).

Upstream–downstream variation of pH, DO, TSS & EC



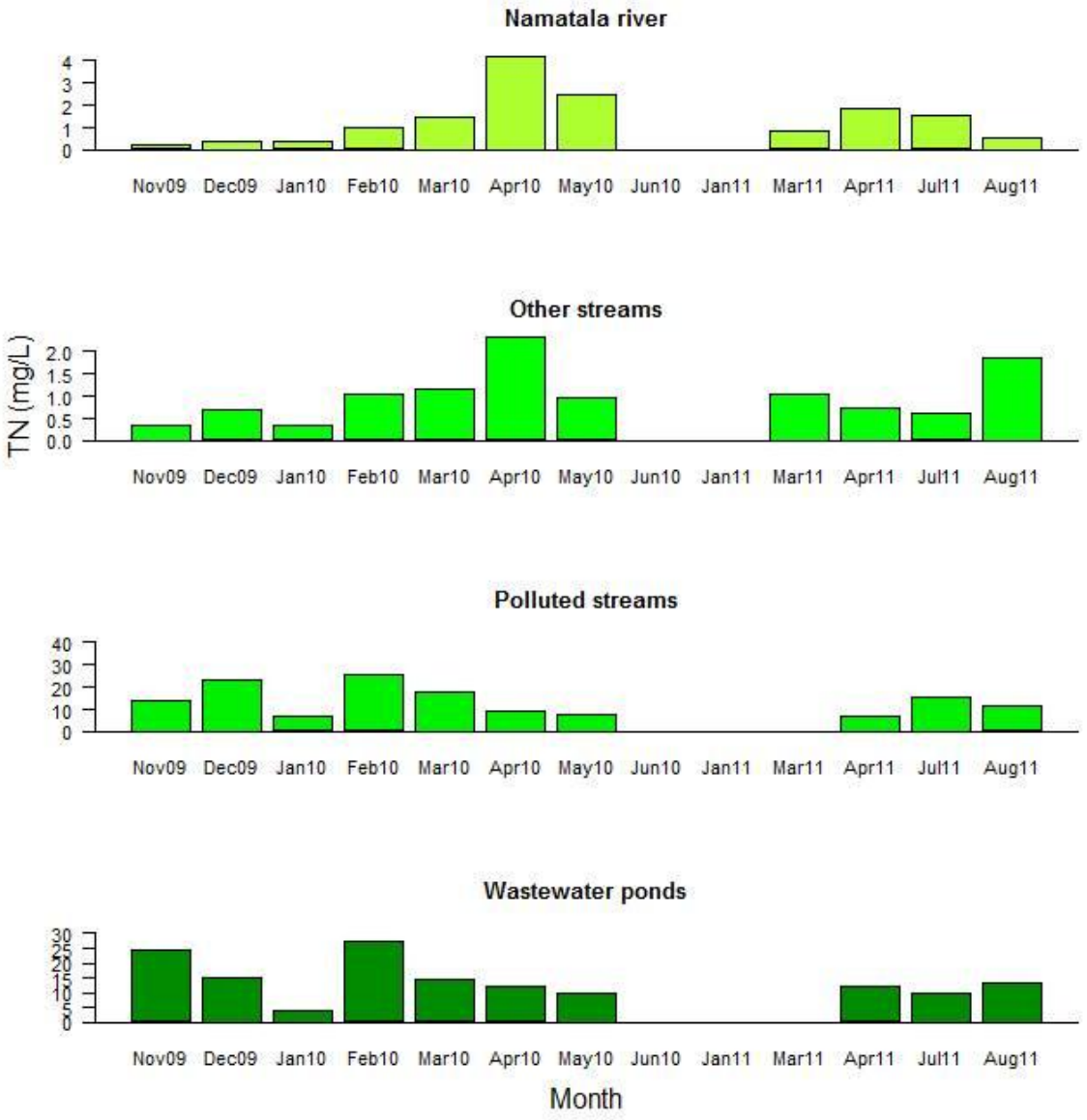






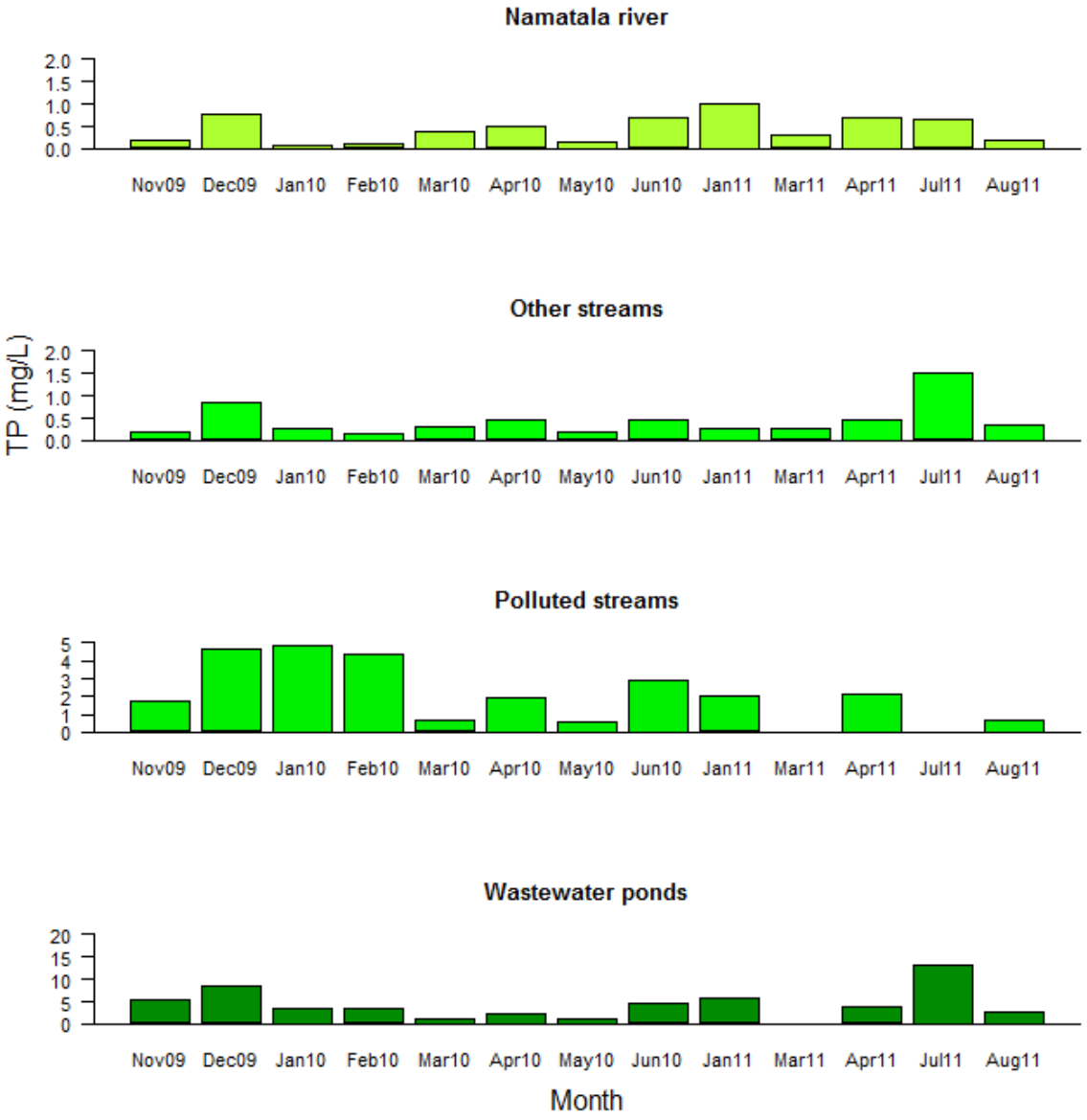
- Lower pH (6.5 -6.8) & DO (1.1 – 2.9 mg/l) recorded at the downstream points
- EC (145 -237 µs/cm) & TSS (40-78 mg/l) values are comparably high in the downstream

Water quality: TN



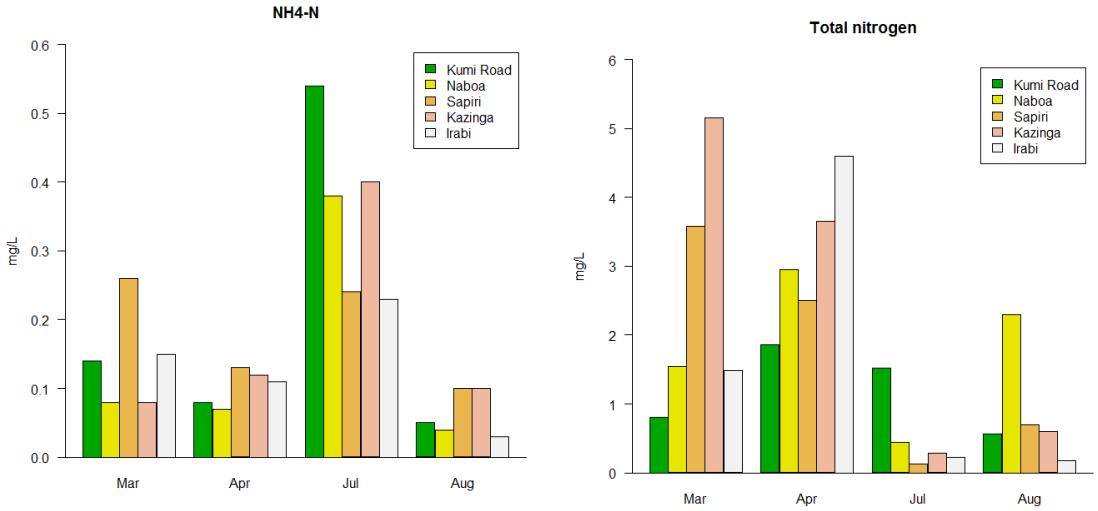
- Low concentration in the river (1.35 ± 0.11 mg/l)
- Slightly higher values in other inflowing streams (1.052 – 1.5 mg/l)
- Much higher concentrations in the inflows of WSP (11.7 -14.9 mg/l) and the two polluted streams (7.6 – 19.3 mg/l)

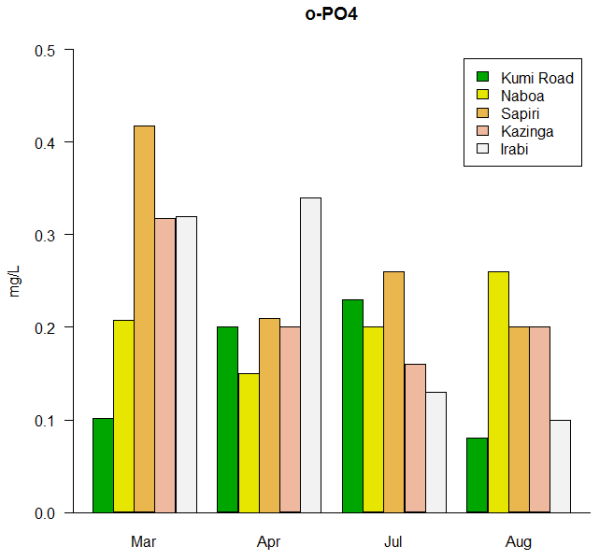
Water quality: TP

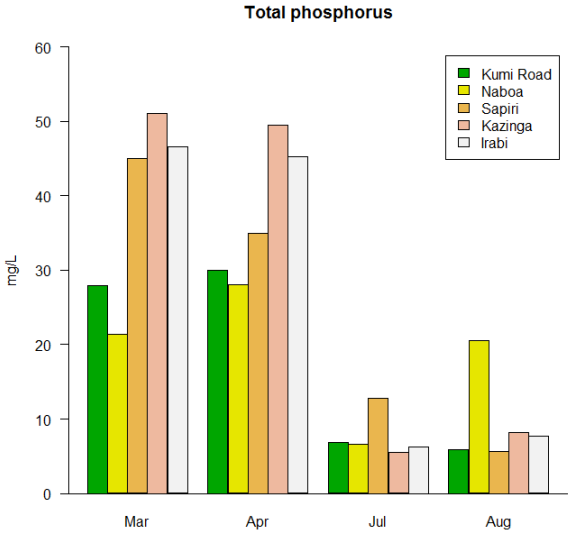


- Low concentration in the river (0.44 ± 0.30 mg/l)
- Slightly higher values in other inflowing streams (0.406 – 0.533 mg/l)
- Much higher concentrations in the inflows of WSP (4.44 -4.68 mg/l) and the two polluted streams (1.59 – 2.86 mg/l)

Upstream–downstream variation of NH_4, TN, PO_4 & TP

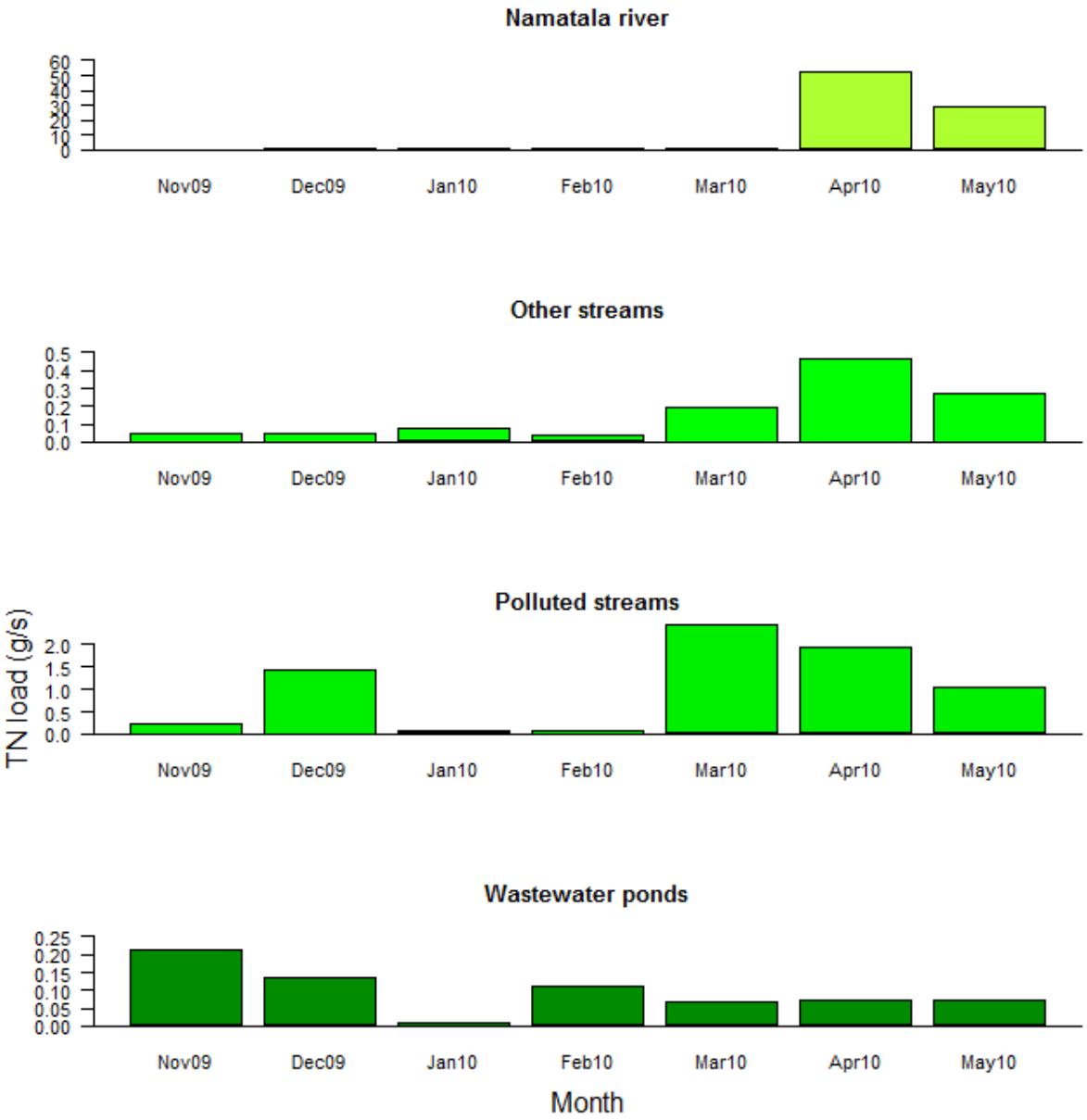






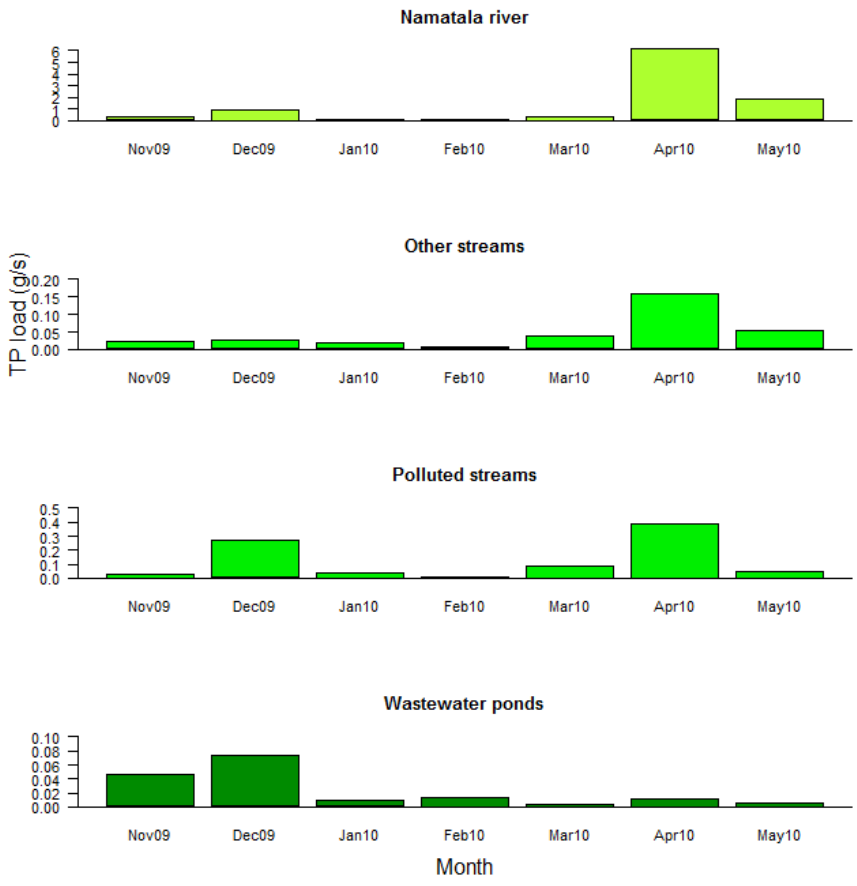
- High concentration of TP (0.728 ± 0.362) in the river outflow

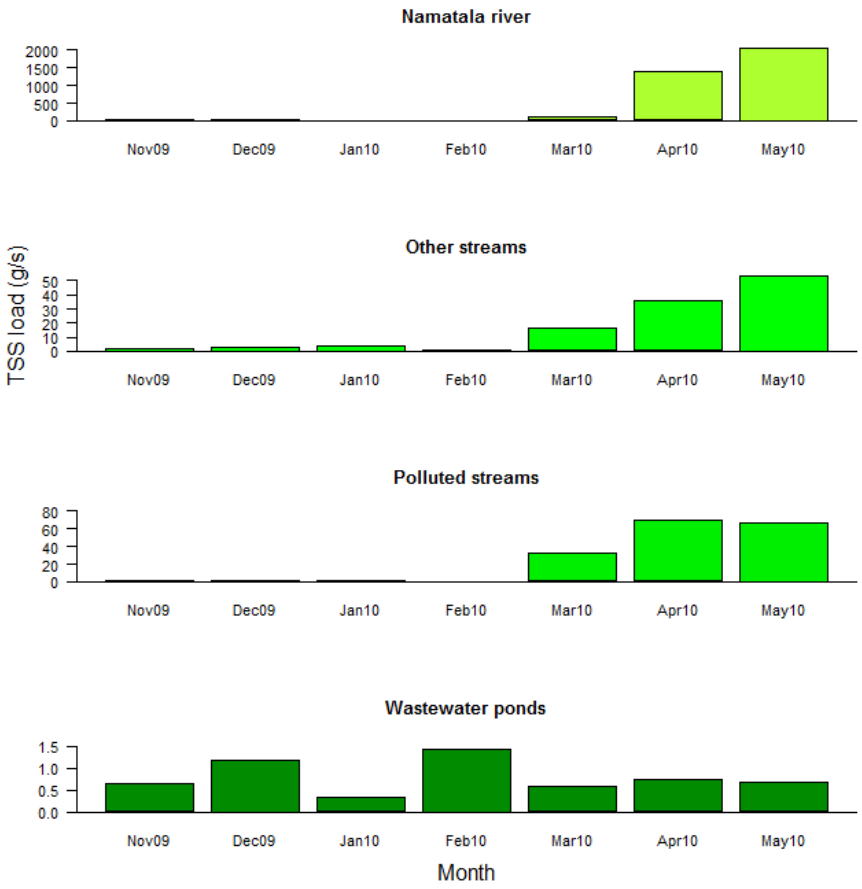
TN loading from inflows of the wetland



- High TN loading for all the inflows observed during the peak rainfall period (April-May) reaching 52 g/s in the River
- Namatala river is the major source of TN loading contributing about 78%
- Considerably high loading observed in the polluted streams

TP & TSS loading from inflows of the wetland





- High TP & TSS loading observed during the peak rainfall period (April-May).
- Higher loads found in the river reaching 6.15 g/s & 2056 g/s of TP & TSS respectively

Removal of nutrients: rice & papyrus harvesting

	Nitrogen (tonnes)			Phosphorous		
	Dry season	Wet season	Total (year)	Dry season	Wet season	Total (year)
Loading						
river	9.1	264.2	273.3	1.5	30.6	32.1
other streams	1.1	2.4	3.5	0.3	0.9	1.2
polluted streams	1.1	22.6	23.7	0.4	2.6	3.0
WSPs	0.9	1.8	2.7	0.2	0.4	0.6
Total loading	12.3	290.9	303.2	2.4	34.5	36.9
Removal						
rice			134.4			40.0
papyrus			3.7			1.6
river outflow	30.1	146.4	176.5	5.3	28.5	33.8
Total removal			314.6			75.4

- N removal by rice & papyrus harvesting is estimated at 45.5% of the total N- load
- P removal by rice & papyrus harvesting is much higher than the load
- Much higher export of P than N through rice and papyrus harvesting

Summary & Discussion

- High concentrations of N & P were consistently observed in the polluted streams draining the urban centre of Mbale, an indication of the influence of activities within the catchment
- High discharge during the peak rainfall season influences nutrient loading into and out of the wetland
- Lower concentrations of N & P in the river outflow is indication of the wetland potential to remove nutrients
- N load and removal is balanced; more P is removed than loaded

THANK YOU