CARBON AND NUTRIENTS SOURCES AND TRANSFORMATION IN RIVER SABAKI, KENYA

Tamooh, Fredrick[1], Cherono Shawlet[1,2], Alberto. V. Borges[3], Steven Bouillon[4]
[1]Kenyatta University, Department of Zoological Sciences, P.O Box 16778-80100, Mombasa, Kenya
[2]Kenya Marine and Fisheries Research Institute, PO Box 81651, Mombasa-80100, Kenya
[3]Université de Liège, Unité d'Océanographie Chimique, Institut de Physique (B5), B-4000, Belgium
[4]Katholieke Universiteit Leuven, Dept. of Earth & Environmental Sciences, Celestijnenlaan 200E, 3001 Leuven, Belgium

Correspondence to: Fredrick Tamooh (tamooh.fredrick@ku.ac.ke or ftamooh@yahoo.com)

TENTH WIOMSA SCIENTIFIC SYMPOSIUM

Introduction

- Rivers play an important role in the global carbon cycle, and process ~2.7 Pg C yr^{-1} (Aufdenkampe et al., 2011; Fig. 1 A)

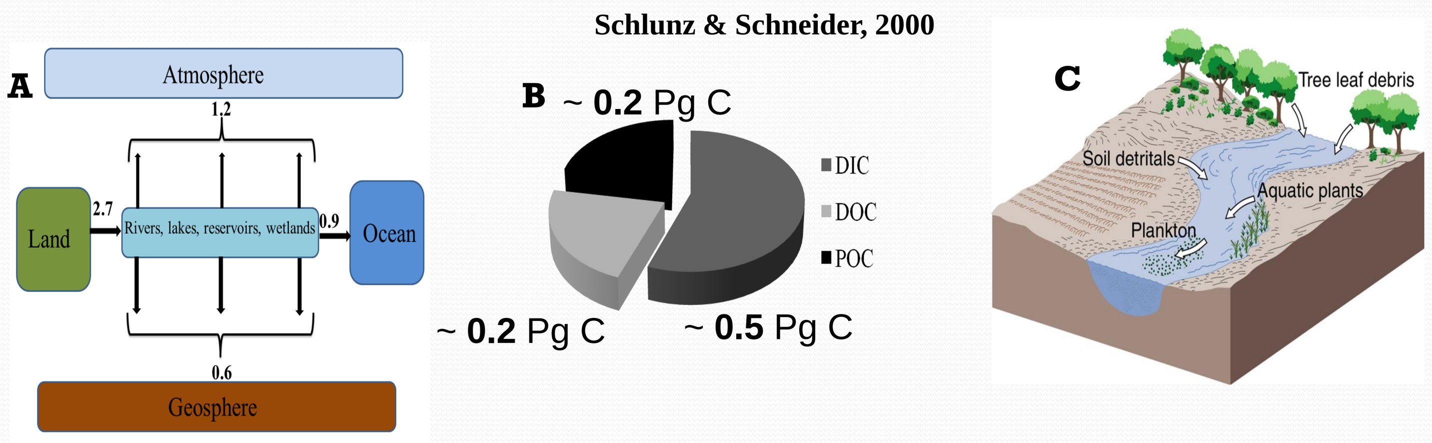


Figure 1: (A) Carbon flow path from land through rivers, lakes, reservoirs, and wetlands to the ocean (B) global riverine carbon transport (C) the main sources of organic carbon

- Freshwater systems function as biogeochemical "hot spots"
- Similarly, eutrophication of riverine systems is a global environmental problem and its severity continues to increase in the recent years (Xu et al., 2016).
- In this study, we report the sources of carbon and nitrate and their transformation along the longitudinal gradient of River Sabaki (Kenya).

Study area and Methods

- Sabaki River is the second-largest river network in Kenya with a total catchment area of 46 600 km^2.
- Its headwaters are located in Aberdare range in central Kenya and Kilimanjaro in Tanzania (**Fig 2 A**)
- The upper catchment is dominated by agricultural areas while industrial activities and informal settlements dominate the sub-catchment around Nairobi city (**Fig 2 B**) .
- The basin is characterized by bimodal hydrological cycle of two dry seasons interspersed by a long (March–May) and short (October–December) rain seasons (**Fig 2 C**)

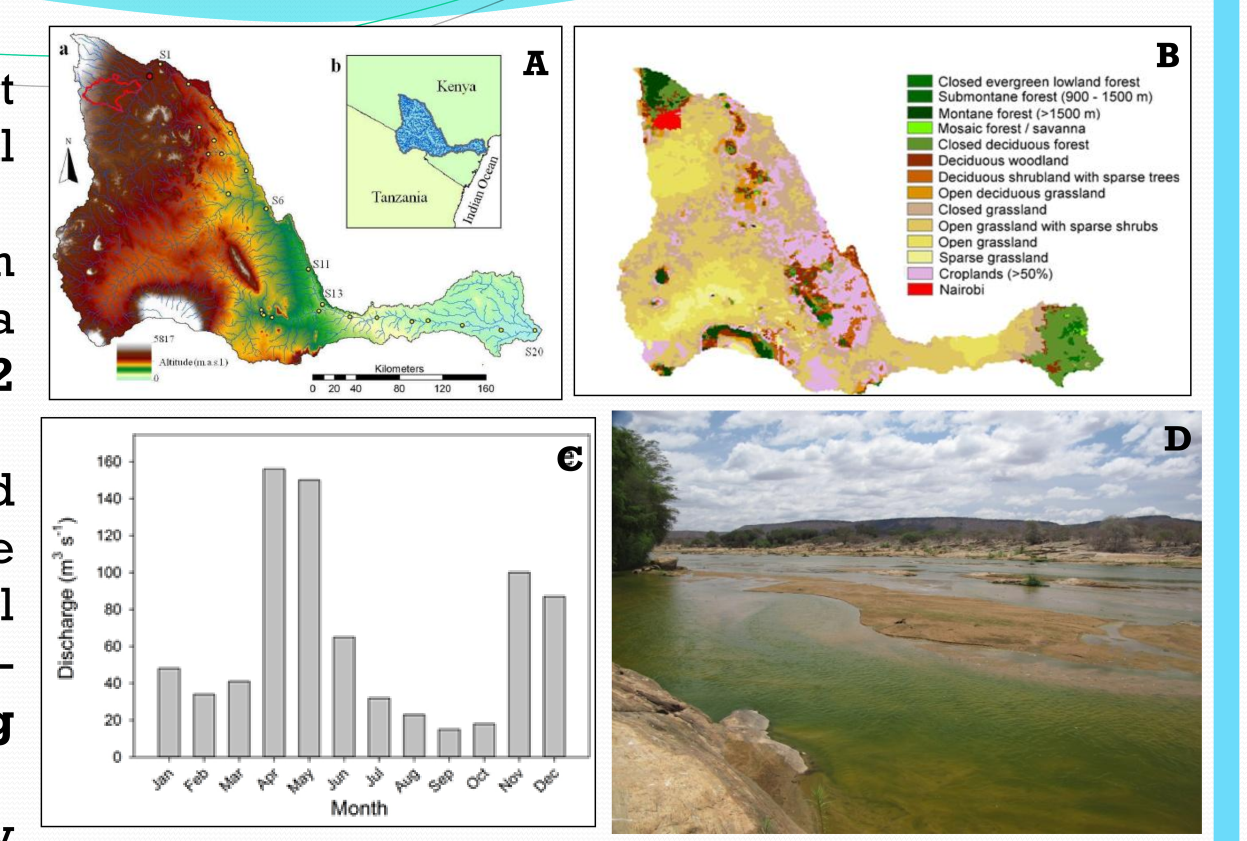


Figure 2: (A) Digital elevation model (DEM) of the Sabaki River catchment (B) vegetation biomes , (C) discharge (D) algal growth in lower reaches

- Sabaki River experiences serious cyanobacterial blooms annually due to excessive nitrate inputs associated with industrial and domestic sewage discharge (**Fig 2 D**)
- Samples for organic carbon pools and nutrients were collected throughout the longitudinal gradient of River Sabaki at equidistant of ~40km during the dry season (August-September 2016) and analyzed using the standard techniques.

Results & Discussion

In situ measurements

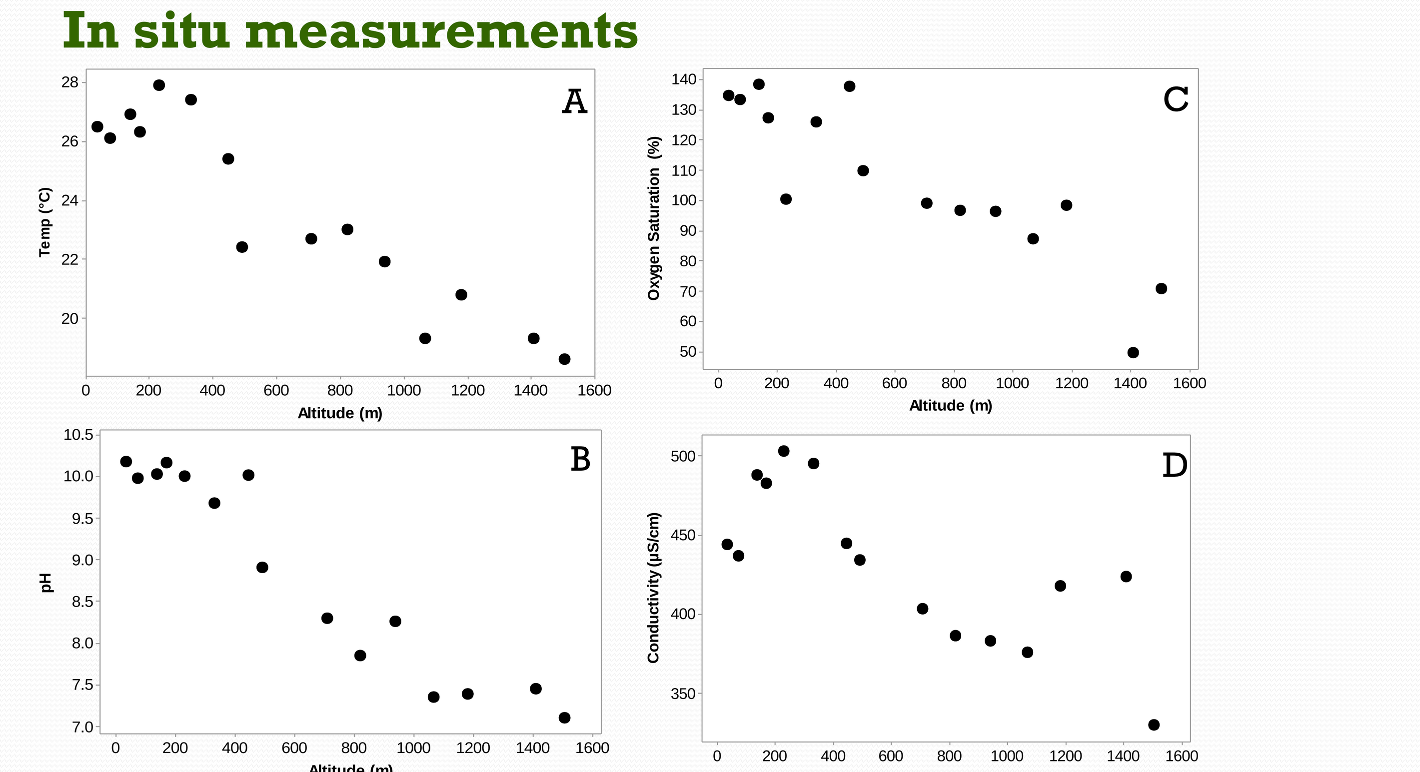


Figure 3: Altitudinal profiles of (A) temperature (B) pH (C) dissolved oxygen and (D) specific conductivity along the Sabaki River during the dry season sampling

➢Generally, temperature, pH, dissolved oxygen and specific conductivity increased consistently downstream (*Pearson correlation: r^2 =0.94, 0.96, 0.89 and 0.77 for temperature, pH, dissolved oxygen and specific conductivity, respectively; $p < 0.05$; $n = 15$; Fig. 3*).

➢The low pH and low O_2 level in upper reaches is associated with disposal of untreated wastewater.

Longitudinal changes of total suspended matter and particulate organic carbon

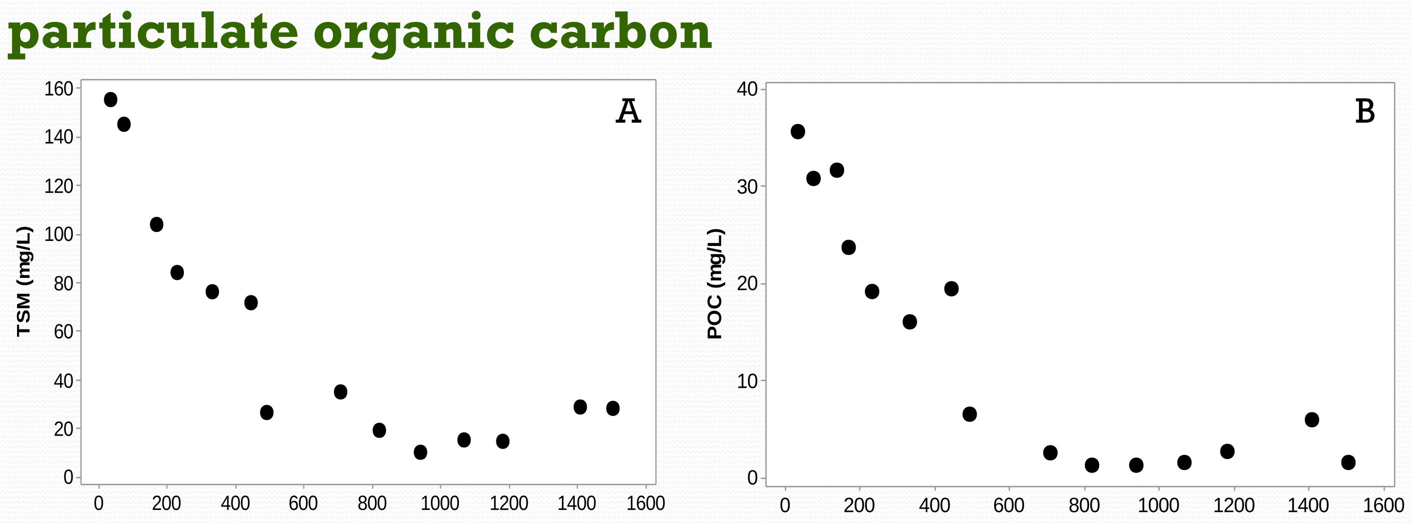


Figure4: Altitudinal profile of (A) TSM (B) POC

- A consistent downstream increase in TSM and POC was observed (p<0.01; Fig. 4).
- This indicate that most particulate matter exported towards the coastal zone originated from the mid and low altitude zones.
- This phenomenon is attributed to sediment resuspension in lower stream rather than from upper catchment.

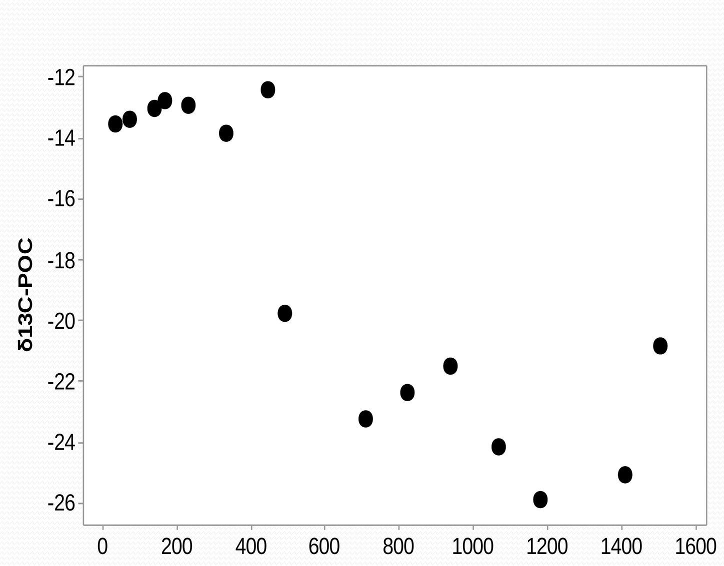


Figure 5: Altitudinal profile of δ^{13}C-POC

- The downstream increase in δ^{13}C-POC values (p<0.01, Fig 5) could be explained by a combination of two processes: (i) altitudinal differences in the δ^{13}C signature of C3 vegetation, and/or (ii) a shift towards a higher contribution of C4 vegetation at lower altitudes as observed in Tana River, Kenya (Tamooh et al., 2012).

Nutrients dynamics along river flow path

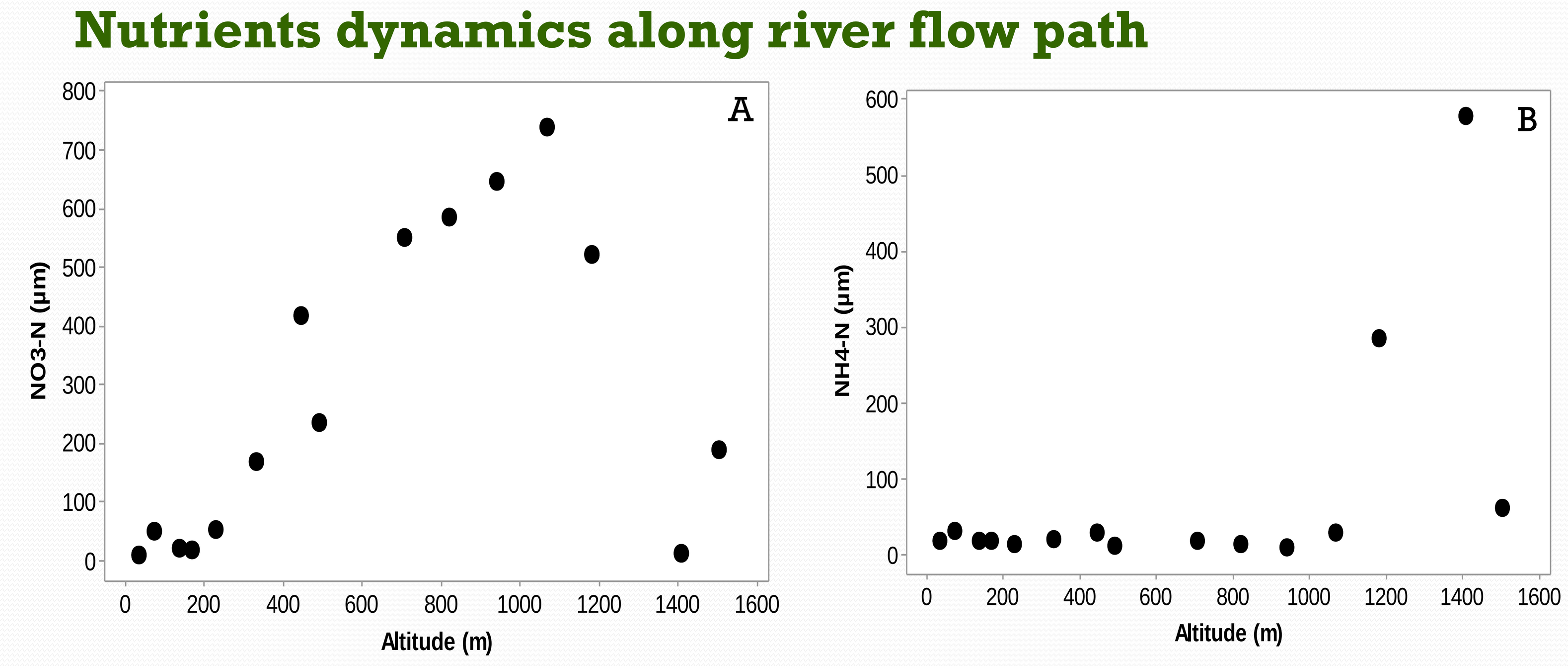
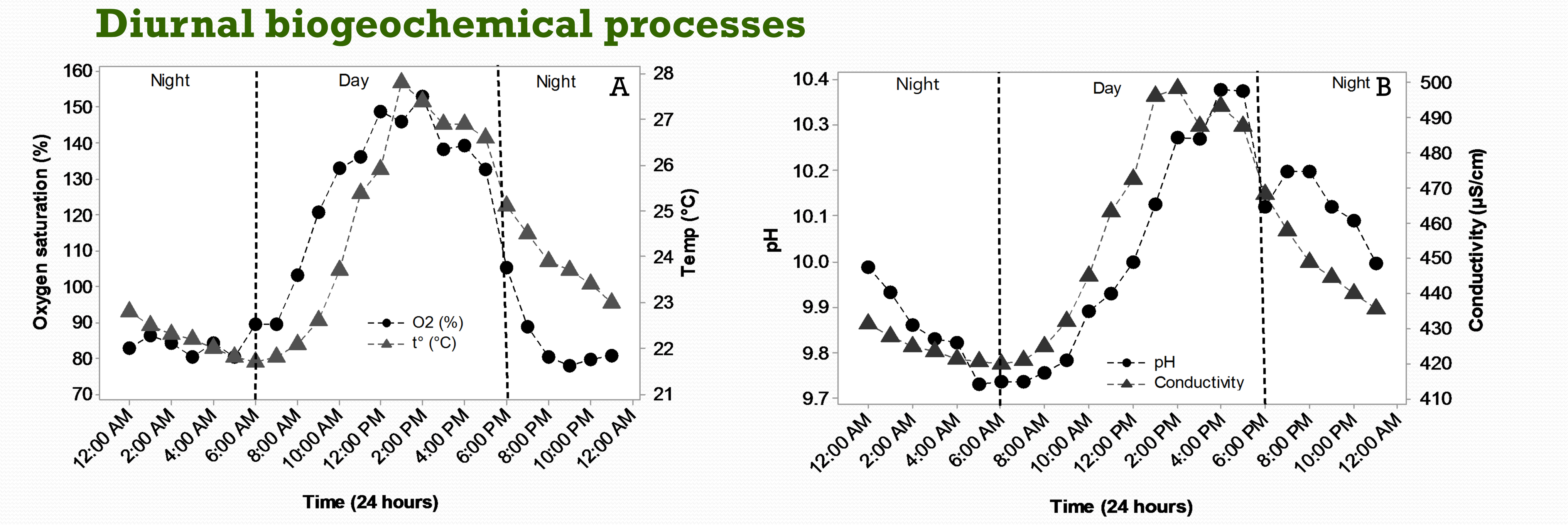


Figure 6: Altitudinal profile of (A) NO$^-_3$ and (B) NH$^+_4$ along the Sabaki River during the dry season sampling

➢The rapid decrease of NH$^+_4$ in upper reach is accompanied by an increase of NO$^-_3$ over the same stretch (Fig. 6 A & B).

➢Longer water residence time increases biological nutrient cycling (e.g. nitrification, denitrification and primary production) (McGuire and McDonnell, 2007, Marwick et al., 2014).

Diurnal biogeochemical processes



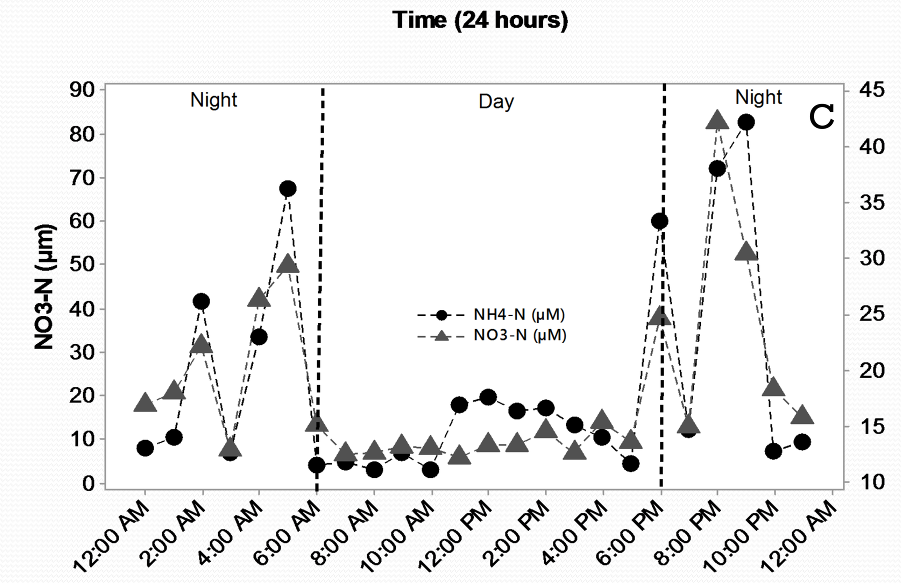


Figure 7: Diurnal fluctuations of (A) temperature and % saturation of dissolved oxygen, (B) pH and specific conductivity and (C) NO3 and NH4 at lower stream of Sabaki River.

➢The in situ field measurements of pH, temperature, specific conductivity and % saturation of dissolved oxygen increased steadily during daytime (indicative of CO_2 consumption by photosynthesis) and decreased at night (indicative of CO_2 release by respiration) (Tamooh et al., 2013).

References

Aufdenkampe, et al.,2011, Front. Ecol. Environ., 9, 53–60.
Marwick, et al., 2014, *Biogeosciences*, 11, 443–460, 2014, doi:10.5194/bg-11-443-2014
McGuire, K. and McDonnell, J, Blackwell Publishers, Boston, Massachusetts, 334–374, 2007
Tamooh, et al 2013, *Biogeosciences*, 10, 6911–6928, 2013doi:10.5194/bg-10-6911-2013.
Tamooh, et al 2012 *Biogeosciences*, 9: 2905-2920, 2012,doi:10.5194/bg-9-2905-2012.
Schlünz, B., and Schneider, R. R., Int. J. Environ. Sci., 88, 599–606, 2000.
Xu et al., 2016, Environ Sci Pollut Res 23:1133–1148

Acknowledgements

Funding for this work was provided by the International Atomic Energy Agency. We are grateful to Katholieke Universiteit Leuven, Department of Earth & Environmental Sciences and Université de Liège, Unité d'Océanographie Chimique, Institut de Physique, Belgium for handling isotopic and nutrients analyses and WIOMSA for the travel grant to the symposium.