

Report by UWI doctoral researcher Clara Romero (N4)

Project number: N4

First and last name of doctoral researcher: **Clara Romero**

(Working) title of doctoral project: **Ecosystem metabolism in natural and technical aquatic systems of urban environments**

Name of supervisors: Prof. Mark Gessner (IGB), Dr. Gabriel Singer (IGB), Dr. Peter Casper (IGB), Prof. Birgit Kleinschmit (TUB)

2. Description of doctoral project and research results achieved to date:

Motivation and aims

Urban areas are growing worldwide. Urban water bodies receive large loads of nutrients, organic carbon, suspended solids and a wide variety of macro- and micropollutants (1-3). Additionally, their morphology has frequently been changed (4) and habitat heterogeneity has been reduced (5). The growth of urban areas also brings changes in physical properties of the land surface (6) such as increased sealing by paved surfaces. This hampers infiltration and accelerates surface runoff with implications for contaminant delivery to the receiving water bodies and their flow regimes. Under all these stressors, urban water interfaces, i.e. boundary zones between water and surrounding terrestrial areas, sediment, atmosphere but also technical urban infrastructure, play key roles in the transformation and transport of water, matter, and energy in urban areas (7).

Gas exchange across the water-atmosphere interface is one such process which connects water bodies with the atmosphere, particularly with regard to CO₂ emissions. Aquatic CO₂ emissions have only recently been included in estimates of global carbon fluxes periodically assembled by the Intergovernmental Panel on Climate Change (IPCC) (8). Currently, however, there is a lack of large-scale estimates CO₂ fluxes from urban waters including systematic assessments of its underlying processes such as ecosystem metabolism. Microbial respiration of dissolved organic matter (DOM) is a major component of ecosystem metabolism and it is an important factor to consider when studying carbon dynamics across the water-atmosphere interface. However, DOM plays multiple roles in aquatic ecosystems, but very few studies focus on DOM dynamics in urban aquatic ecosystems, and there is a lack of knowledge on how DOM is affected by urban factors.

The main objectives of my doctoral dissertation are: (i) To characterize dissolved organic matter (DOM) composition in a variety of urban water bodies, including lakes and ponds as well as running waters, which experience varying degrees of anthropogenic impacts. (ii) To estimate carbon dioxide concentrations, their dynamics and resulting fluxes across the water-atmosphere interface for the same water bodies, including the identification of hotspots expected to occur at the interface of natural and technical aquatic systems, especially where treated wastewater is discharged into receiving waters. (iii) To estimate whole-ecosystem metabolism based on diel O₂-dynamics. (iv) To identify drivers of metabolism and CO₂ fluxes by exploring the environmental variation across sites in Berlin.

Preliminary results

A total of 32 sites were selected within the city limits of Berlin following a stratified random sampling design. The sites include lakes, ponds, streams and rivers. These water bodies were sampled during four periods over one year: in spring (April-May 2016), summer (July-August 2016), autumn (September-October 2016) and winter (February-March 2017).

Significant variation was found in the DOM composition at the 32 sites. Relationships with variables such as land cover or the concentrations of pharmaceuticals were weak. Furthermore, we found that in all seasons CO₂ fluxes from all sites were generally positive (the water bodies are thus always emitting CO₂) and higher than measured in natural waters. However, both temporal and spatial variability of CO₂ fluxes and DOM composition were high. Strong relationships with individual environmental variables, including concentrations of dissolved nutrients and a range of micropollutants, were not detected.

Collaborations:

A close collaboration was established with Sonia Herrero (N3) for extensive field work and laboratory analyses. Analysis of pharmaceuticals was carried out in collaboration with Geert Aschermann (T5)

References

1. Buser H-R, Poiger T, & Müller MD (1999) Occurrence and Environmental Behavior of the Chiral Pharmaceutical Drug Ibuprofen in Surface Waters and in Wastewater. *Environmental Science & Technology* 33(15):2529-2535
2. Hatt BE, Fletcher TD, Walsh CJ, & Taylor SL (2004) The Influence of Urban Density and Drainage Infrastructure on the Concentrations and Loads of Pollutants in Small Streams. *Environmental Management* 34(1):112-124
3. Grimm NB, *et al.* (2005) N retention and transformation in urban streams. *Journal of the North American Benthological Society* 24(3):626-642
4. Steele MK & Heffernan JB (2013) Morphological characteristics of urban water bodies: mechanisms of change and implications for ecosystem function. *Ecological Applications* 24(5):1070-1084
5. Walsh CJ, *et al.* (2005) The urban stream syndrome: current knowledge and the search for a cure. *Journal of the North American Benthological Society* 24(3):706-723
6. Niemczynowicz J (1999) Urban hydrology and water management – present and future challenges. *Urban Water* 1(1):1-14
7. Gessner MO, *et al.* (2014) Urban water interfaces. *Journal of Hydrology* 514:226-232
8. Ciais P, C. , *et al.* (2013) Carbon and Other Biogeochemical Cycles. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)] Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

3. Comments on the qualification programme and supervision strategy:

The core courses and summer school were very useful to connect with other graduate students in the training school and to get familiar with their topics. The summer school presentations were especially useful. They made me realize the status my own work, allowed a systematic reflection on my achievements, and offered an opportunity to share my results with other UWI students and supervisors of the training school. It was very useful to see how other students were facing their problems and to get feedback on my own presentation. The time management course helped me realize how important it is to get organized, and it tremendously increased the efficiency of my work flow. I highly recommend this course.

Participation in the following Research Training Group events:

1. Core courses
 - I – Urban interface processes – fluxes, transport, interactions (3 ECTS)
 - II – Modelling and measuring concepts of interface processes (3 ECTS)
 - III – Urban freshwater ecology (3 ECTS)
2. Elective courses
 - Oral and poster presentation (IGB Berlin)
 - QGIS course (IGB Berlin)
 - General linear mixed models (IGB Berlin)
3. Gender courses
 - Time is honey – the new approach to time, self and workload organization
 - Self positioning
 - Negotiation
 - Project management
4. UWI lectures and IGB talks: Participated in most of UWI lectures as well as IGB colloquia (3 ECTS)
5. Other UWI events
 - Orientation Seminar and UWI Opening Ceremony (08. – 09.09.2015)
 - Exposé Talks (08.12.2015)
 - Summer School (13. - 14.09.2016)
 - Interim Meeting (19.05.2017)
 - Student Research Council (17. - 18.03.2017)

Research stays or internships at other research institutions both at home and abroad. For **IRTGs**: stays at the partner university: Collaboration with Eldoret University, Kenya, October-November 2016

Participation in conferences, congresses, etc., at home and abroad:

2016:

- 6th German-Russian Week of the Young Researcher, Moscow, Russia, 12-16.09.2016.

2017:

- SEFS (Symposium for European Freshwater Sciences Olomouc, Czech Republic, 2-7.07.2017.

4. Individual publications:

I. Articles:

- Bravo,A.G., Kothawala,D.N., Attermeyer,K., Tessier,E., Bodmer,P., Ledesma,J.L.J., Audet,J., Casas-Ruiz,J.P., Catalán,N., Cauvy-Fraunié,S., Colls,M., Deininger,A., Evtimova,V.V., Fonvielle,J.A., Fuß,T., Gilbert,P., Herrero Ortega,S., Liu,L., Mendoza-Lera,C., Monteiro,J., Mor,J., Nagler,M., Niedrist,G.H., Nydahl,A.C., Pastor,A., Pegg,J., Gutmann Roberts,C., Pilotto,F., Portela,A.P., Romero González-Quijano,C., Romero,F., Rulík,M. & Amouroux,D.(2018): The interplay between total mercury, methylmercury and dissolved organic matter in fluvial systems: A latitudinal study across Europe. *Water Research*, 144: 172-182

II. Conference, poster presentations etc.:

- Romero González-Quijano, C., Despot, D., El-Athman F., Herrero, S., Nega, M. & Singer, G. Urban Water Interfaces: Biogeochemical processes. 6th German-Russian Week of the Young Researcher, Moscow, Russia, 12-16 September 2016 Paper and oral presentation
- Romero González-Quijano, C. Ecosystem metabolism and CO2 emissions from urban water bodies. Scientific presentation at Eldoret University, Eldoret, Kenya, 17 November 2016
- Romero González-Quijano, C., Herrero Ortega, S., Casper, P., Gessner, M. O., Kleinschmit, B. & Singer, G. A.. Mapping dissolved organic matter diversity across Berlin's aquascape. Symposium for European Freshwater Sciences, Olomouc, Czech Republic, 2-7 July 2017. Oral presentation