BOOK OF ABSTRACTS

OCEANS & LAKES 2018

Disentangling the terminology of invasion ecology and 'human introduced species' under the European Marine Framework Directive

BY Selene Álvarez Peña

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The increase of introductions is considered to represent one of the most critical threats to the marine environment nowadays being directly related with biodiversity loss. To the progress of invasion ecology and to study human-introduced species in the European waters a precise and accurate terminology is needed. Currently, the terminology used in human-introduced ecology is ambiguous, hampering scientific progress in this field. In this study, we disentangle the terminology of invasion ecology and define a new and complete concept of human-introduced species to be used by scientists and legislators. The urgency of this study is based on the threat that human-introduced species pose to native species and to the well-being of the ecosystem. To this end we have three objectives, first research the concepts used by reviewing literature and describing terms used in invasion ecology, we integrated the most commonly used terms in scientific publications and legislation since 1952 and proposed a reduced list of concepts to be applied to marine species. Secondly create clear criteria avoiding repetitions by proposing a unified framework of terminology to human-introduced species ecology, the development of ecological criteria consisted on classifying the terms in four categories; origin, population status, impact status and vector in order to create a new concept for 'humanintroduced species'. These criteria will facilitate an unambiguous implementation of Descriptor 2 of the Marine Strategy Framework Directive (MSFD)*. And thirdly proposing activities to be fulfilled in order to properly study human-introduced species. The new concepts and the unified terminology framework aspire also to guide the efficient allocation of management and policy efforts towards human-introduced marine species. This study aspires also to create a consolidated terminology for the legislation applicable in the North Sea that would suppose the reform of regional, national and European policies and that would serve of great importance for international legal tools.

Trace metal concentrations in the abiotic and biotic components of the River Rwizi ecosystem in Western Uganda, and the risks for human health.

BY Anthony Basooma

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Trace metals are essential to humans, and thus their mining is inevitable. However, the environmental and human health risks associated with them are paramount. This study was aimed to establish the trace metal concentrations in the Rwizi River ecosystem, and to assess the human health risks. Surface water, sediment, larvae of *Ceriagrion glabrum*, and fish (*Brycinus sadleri* and *Barbus altianalis*), were sampled. Temperature, pH, and conductivity were measured in-situ. The samples were processed and trace metals: Al, As, Au, Cd, Co, Cu, Fe, Hg, Mn, Pb and Zn, were quantified. Except for pH, conductivity and temperature differed significantly among sites. The surface water had low metal loads since the heavy metal evaluation index (1.3 to 8.7) was below the critical value of 400. The metal levels in the water were within Uganda's potable water quality standards, but Mn levels at Sheema (740-831 µg/L) was above the 100 µg/L limit. The target hazard quotients for Al (7.3) and Cu (2.2) in the *B. sadleri* muscle were above 1, which suggested non-cancerogenic risks upon human consumption. Carcinogenic risks were expected for Pb with a target cancer risk of 2.2x10-3, above the critical value of 1.0x10-3. The current metal levels in the *B. altianalis* posed no human health risks. Also, the amount of contaminated edible fish muscle to be consumed without health risks was high than Uganda's daily fish consumption (31.5g/day). Metals accumulated more in the fish gills and liver than in muscles, and this was related to their metabolic roles in the fish body. Damselfly larvae bioaccumulated Cd, Cu, Co, Hg and Zn from the sediment since their biota-sediment accumulation exceeded 1 (critical value). Poor correlations in the metal levels were identified: between water and invertebrates; sediment and invertebrates, and water and sediment. Metal levels decreased from: sediment > invertebrates > water > fish. Sediment and damselfly larvae were reservoirs for metals which are indirectly passed on to humans through water and fish. This study concluded that both water and fish from the river were safe for human consumption, but strict monitoring of trace metal pollution should be initiated to avoid exceeding the safe levels.

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How suited are different international classification systems for assessing waterbird habitat availability?

BY Leonie Buschbeck

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The relationship between habitat suitability and habitat use is often blurry. Birds may be absent in areas that are considered suitable based on the species' ecology, or, on the contrary, occur where no qualitative habitat seems to be present. With bird populations declining and important habitats being lost it is necessary to identify suitable areas for waterbirds to target conservation efforts to the right places. Since habitat types are a reliable factor to predict the occurrence of species, the four habitat classifications systems (CS) Corine, EUNIS, Natura 2000 and Ramsar were used to identify suitable and unsuitable habitats for three waterbirds categories: Open Water (OW), Unvegetated Terrestrial (UT) and Vegetated Terrestrial (VT). Maps showing the delineations of habitat types under each CS were overlaid with a Reference map which served as a baseline. Based on the area of overlap, the false + area and false – area it could be determined which CS best identifies suitable habitats. Corine yielded the largest area of overlap for UT Suitable (87.91 km2), UT Unsuitable (137.46 km2) and for VT Unsuitable (219.66 km2). Ramsar found the largest area of overlap for OW Suitable (177.95 km2) and for VT Suitable (25.07 km2). EUNIS found the largest area of overlap for the category OW Unsuitable (99.81 km2). At the same time, large false + and false – compared to the area of overlap can inhibit the effectiveness of the CS to predict suitable habitats. Characteristics of the tested CS are discussed that help to explain why one CS is more successful in predicting suitable habitats than another. Furthermore, properties of an ideal CS are suggested which include the accurate description of a habitat type, the availability of crosswalks for comparison and the inclusion of man-made structure as habitat types. Furthermore, the use of remote sensing, drones or alternative CS can help to improve the assessment of habitat suitability. It can be concluded that Corine offers the most accurate habitat descriptions, a manageable list of habitat types, includes man-made structures and is available in crosswalks with another CS. Corine should be tested in other wetlands to confirm its suitability to identify suitable habitat types. Furthermore, an acceptable threshold of false + and false – needs to be defined and distances between suitable areas and man-made structures should be calculated to determine how man-made structure might affect the suitability of a habitats.

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Monitoring of harbor porpoise (*Phocoena phocoena*) density in the Belgian part of the North Sea using aerial surveys and passive acoustic monitoring

BY Jolien Buyse

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Passive acoustic monitoring (PAM) is used more and more often to track trends in harbour porpoise populations and to study the influences of man-made structures or management plans. PAM has various advantages over aerial surveys, such as its ability to gather information at night and in a continuous matter, while being less dependent on good weather conditions and offering a more cost-effective approach. However, up till now, only indications of relative abundance are available, because detection functions of individual C-POD devices are unknown and single organisms cannot be distinguished from one another based solely on their acoustic characteristics. This study combined the two techniques and showed that acoustic variables from C-POD echolocation recordings are strongly correlated with visual detections of harbour porpoises obtained through well-established line transect sampling techniques. Using this relationship, a regression model was established, based on the acoustic variable of detection positive hours, which explains about 61% in the variation of the dataset. With this model, absolute estimates can be derived from PAM data, if corrections are applied for the availability and perception bias. However, aerial surveys are still necessary, because the model is based on the robustness of the line sampling method used in these surveys and because they can cover the entire area of the BPNS in one survey. The regression model also needs further improvements to be representative for the entire BPNS, such as more data points and the use of only one mooring type, but it can already be used to fill in data gaps and observe finer trends in abundance and distribution. This study is a step between monitoring of harbour porpoise density solely based on line transect sampling and a fully operational passive acoustic network that can be used to obtain direct absolute density estimates.

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Molecular and physiological analyses on the effects of increased carbon dioxide on European sea bass (*Dicentrarchus labrax*) acclimated to reduced seawater salinities

BY Warren Caneos

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Increased atmospheric CO2 concentrations and shifts in salinity gradients in marine environments can strongly affect animals living in coastal and estuarine waters such as euryhaline teleosts. The effects of increased carbon dioxide (CO2) on the physiological responses of European sea bass (Dicentrarchus labrax) which were progressively acclimated to normal seawater (32 ppt), brackish water (10 ppt) and hyposaline water (near freshwater, 2.5 ppt) were investigated. Following acclimation to different salinities for two weeks, fish were exposed to present-day (control, 400 µatm) and future (high CO2, 1000 µatm) atmospheric CO2 for 1, 3, 7 and 21 days. Blood pH, plasma ions (Na+, K+, Cl-), branchial mRNA expression of Na+/K+/ ATPase (NKA), Na+/K+/2Cl− co-transporter (NKCC) and ammonia transporters (e.g. Rhbg, Rhcg1 and Rhcg2) were examined to understand the iono- and osmoregulatory consequences of the experimental conditions. Results showed a transient but significant increase in the blood pH of exposed fish acclimated at 10 ppt (day 1) and 2.5 ppt (day 21) possibly due to an overshoot of the blood HCO3- accumulation. However, no change was seen at 32 ppt. Additionally, plasma [Na+] of exposed fish reared at 10 ppt was significantly reduced at day 1 relative to control fish. Generally, the Na+ concentration of control fish was relatively higher at 10 ppt and lower at 2.5 ppt compared to 32 ppt control group at all sampling periods. We also found that NKA was upregulated in gill of juvenile sea bass and NKA mRNA level of control fish was relatively higher when acclimated to lower salinities (10 ppt and 2.5 ppt) compared to 32 ppt control group during the whole experiment. Elevated expression could be caused by the increased activity of acid-base transporters, which rely on the Na+ gradient created by the NKA enzyme. Meanwhile, a significant reduction of NKCC mRNA level of the exposed fish acclimated at 32 ppt (1-3 days) and 10 ppt (7-21 days) was noted. The reduced expression of NKCC could be an adaptive response to foster ion retention during hypercapnia in sea bass acclimated at lower salinities. Furthermore, Rhesus glycoproteins (Rhbg, Rhcg1 and Rhcg2) were generally upregulated in the fish acclimated at lower salinities. It suggests that environmental stressors, such as increased CO2, may enhance ammonia excretion rate. Overall, the physiological and ion-osmoregulatory performance of juvenile sea bass are strongly affected by the two environmental stressors and the duration of the exposure.

Keywords: CO2, salinity gradient, Na+/K+/ATPase, Na+/K+/2Cl− co-transporter, Rhesus glycoproteins, Dicentrarchus labrax

An ecosystem model of the Oosterschelde estuary (EMOES)

BY Pedro Carrasco de la Cruz

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The Oosterschelde has been for decades under a high human control and influence, yet its ecosystem remains highly valuable due to the mussel culture activities taking place in the subtidal areas and its designation as a NATURA-2000 conservation site. The last decade has seen an increased awareness about the considerable risk of overgrazing on the Oosterschelde, mainly due to the increased shellfish stock, the changes in water conditions and the expansion of an invasive species. This basin, highly under human control, remains vital for the economy of the Netherlands and the ecological balance of the region. A correct management approach is essential, hence, a tool that assesses the dynamics of the system becomes a priority for decisionmaking. The present study developed a 1-D transport-biogeochemical model, which was calibrated for the period 1996-2005 showing a good fit to data of Chla, DIN and PON. Dynamics in the western zone of the basin was found to be highly influenced by import from the North Sea in terms of primary production, but with the highest local pelagic primary production occurring in the eastern zone. A possible competition for nutrient uptake was detected between the pelagic and benthic primary producers in all zones of the Oosterschelde. The North Sea also influenced nutrient regeneration via the input of substrate, which is remineralizsed mainly in the western zone, leaving the central and eastern zone mostly dependent on benthic mineralization and transport processes from the western zone to supply their demand. Bivalve filter feeders were shown to exert a high grazing pressure on the phytoplankton. On the regional scale mussels had more impact, but oysters were equally or even more relevant on the scale of a reef. The biomass of the bivalve species experienced a downward trend during the last four years of simulation, which could be an indication of increasing competition for food.

Keywords: Oosterschelde, mussels, oysters, cockles, model

Towards putting order to the events leading up to the Late Ordovician mass extinction: Integrated biochemostratigraphy of the Maquoketa Group in IGWS core 440 from NW Indiana, USA

BY Charlotte De Boodt

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Dynamic oceanographic changes during the Late Ordovician culminated in the second largest of the "big five" Phanerozoic mass extinctions, eradicating greater than 85% of marine species. Marine sedimentary rocks from this interval feature a positive stable carbon isotope excursion with values exceeding 5‰, implicating a major perturbation to the global carbon cycle. Yet, the fundamental triggers are heavily debated and a deep understanding of the mechanisms that drove this ancient event remains a key research target. A detailed knowledge of the order of events and their environmental and biological characteristics is central to establishing cause-and-effect relationships leading up to this mass extinction. The pristine nature and accessibility of the little studied Upper Ordovician Maquoketa Group in the US midcontinent offers an unparalleled opportunity to advance understanding of the Late Ordovician mass extinction. Deposited in the tropical Illinois Basin of interior Laurentia, the Maquoketa Group records a complex succession of facies changes that have thwarted previous stratigraphic studies. Yet, the abundant shales of the Maquoketa Group, now available from across the basin due to recent advances in access to subsurface drill cores, yield exceptionally well preserved organic-walled microfossils.

Forty samples from the IGWS-440 drill core from northwestern Indiana (Newton County) are analyzed for chitinozoan species distributions. The samples produced a rich assortment of well-preserved chitinozoans, including key species such as Ancyrochitina merga, Tanuchitina ontariensis, Hercochitina minuta, Ancyrochitina spongiosa, Acanthochitina rashidi Clathrochitina sylvanica, and Belonechitina gamachiana. These assemblages show intriguing similarities and differences to other recently studied cores from closer to the basin margin. The assemblages in the lower Maquoketa Group of IGWS-440 (Elgin and Clermont formations) show a high similarity in species with very similar deposits in the Gardner Kiln core of Wisconsin (De Backer, 2017). The IGWS-440 shales (potential Brainard Formation equivalents) above the Fort Atkinson marker horizon are more difficult to correlate lithologically but are here shown to contain index species such as C. sylvanica and B. gamachiana. The assemblage with C. sylvanica, H. minuta, A. merga and A. rashidi allow us to correlate with the Katian Sylvan Shale Formation of Oklahoma, while the overlying assemblages with B. gamachiana can be traced into the Ellis Bay Formation on Anticosti Island. Critically, this demonstrates that the Maquoketa Group of NW Indiana ranges into the uppermost Katian and likely into the Hirnantian, and that the chitinozoans of the Maquoketa Group shales enable us accurately to correlate into carbonate facies of the same age, which hold extensive records of shelly invertebrate paleobiodiversity, extinctions and radiations.

These new data demonstrate tangible advances in revising the age assessment of the Maquoketa Group and are enabling coupled studies on the sequence stratigraphy, geochemistry and paleobiology of this interval to step closer to unlocking the drivers of the Late Ordovician mass extinction.

Impact of an invasive seagrass on th ediet of juvenile queen conch (Lobatusgigas) in the Caribbean

BY Jana Dewenter

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Persistent pollutants threaten

Seagrass meadows in the Caribbean are important nursery habitats for many organisms, including the iconic queen conch (*Lobatus gigas*). Since 2002 the seagrass species *Halophila stipulacea* is rapidly expanding throughout the Caribbean and is found to have a negative effect on native seagrasses. The trophic consequences of the invasion for juvenile queen conch are unspecified. Therefore, the aim of the present study was to investigate the diet of juvenile queen conch in native, mixed and invasive seagrass meadows at the islands of St Barthélemy, St Maarten and St Eustatius. Diet was examined by collecting tissue samples of queen conch and food sources (seagrass detritus, seagrass sepiphytes, sediment organic matter, microbial mats and macroalgae), which were analysed using stable isotopes composition of nitrogen and carbon. The proportions of food sources to the diet were calculated by Bayesian stable isotope mixing models with the R package 'simmr'. Large variation was found in stable isotope signatures in queen conch among the three islands. The main diet of juvenile queen conch in the three habitats consisted of surface sediment organic matter. Whereas juvenile queen conch in invasive habitat completely depended on sediment related food sources (surface sediment organic matter and microbial mats), specimen in the native seagrass meadow fed on a more diverse diet that also consisted of native seagrass detritus and macroalgae. Seagrass detritus of the invasive *Halophila stipulacea* only contributed minor proportions to the nutrition in invasive and mixed seagrass meadows. In none of the three habitats a change of diet proportionate to the shell size was found. The mixing of different food items in more diverse native habitats may increase fitness of juvenile queen conch. Consequently, monitoring and adopting measures to downscale the rapid spread of the invasive seagrass should b easpired, especially for long known juvenile queen conch nursery grounds.

Keywords: *Halophila stipulacea*, invasive species, *Lobatus gigas*,queen conch, diet

Social-ecological assessment of coastal ecosystem services and non-use values, within transboundary conservation: transboundary perspective of a 'society in transition' in the south coast of Kenya

BY Paula Tatiana González Sánchez

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We present patterns of a coastal 'society in transition' in southern Kenya, by means of a mixed-methods approach with innovative modifications. We performed the Nominal Group Technique inspired on TESSA (Toolkit for Ecosytem Service Site-based Assessment), with organized groups from five villages to determine which coastal ecosystem services (ES) were prioritized, and how these are perceived to have changed. Semi-structured interviews allowed to explore the inclusion and views on non-use values of coastal ecosystems. Additionally, a Delphi survey evaluated Western Indian Ocean Regional experts' opinion on the benefits and challenges of transboundary conservation (TBC). The results show that fisheries, ecotourism and carbon sequestration/trading are the most relevant ES reported, for the communities. All ecosystem services were perceived to have declined over the past five years, except for carbon sequestration/trading which has an increasing community awareness owing to a carbon-offset initiative from mangrove forest conservation and restoration (Mikoko Pamoja), and all who have been involved in the project. Traditions derived from the Mijikenda culture along the coastal region potentially maintain the spiritual values of certain elements within coastal ecosystems, but not for all ecosystems entirely. Finally, opinions of Delphi respondent experts regarding TBC converged most on migratory species, mediation of transboundary conflicts, trade and economic opportunities as TBC benefits. We support the idea that an approach mixing several methods is advantageous, when is steered properly according to the research objectives. The values of coastal ecosystems are not static, so it is crucial to acknowledge and assess them on a regular basis and for long-term plans, especially under the framework of TBC. By combining several deliberative tools, we have approached ES and their conservation from a "cultural perspective". We acknowledge the meanings and values of the benefits of coastal ecosystems by identifying priority ES, including cultural and spiritual values, as perceived by local communities in the south coast of Kenya. The WIO Region experts agreed on TBC benefits associated mostly to socio-economic aspect; whereas in terms of ecologic benefits survival of migratory species was eminent in consensus.

Keywords: Ecosystem Services, Non-use Values, Transboundary Conservation, Mixed Methods, Kenya

Diversity and composition of meiofauna communities of the Galapagos archipelago (Ecuador), with special emphasis on harpacticoid copepods (Crustacea)

BY Heleen Keirsebelik

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The Galapagos archipelago is widely known for its extraordinary biodiversity. Despite the location's popularity among international researchers, little recent information is available about meiofauna and particular benthic copepods in the intertidal sediments of the archipelago. These organisms contribute to ecosystem services and are of importance as a food source for higher trophic levels. The aim of the present study was to get more insight in the distribution, abundance and diversity of meiobenthic communities in tidal habitats along the archipelago, with special emphasis on harpacticoid copepods. Fieldwork was conducted in August 2017. Nine stations in the coastal zone of three of the inhabited islands (Santa Cruz, Floreana and Isabela) of the Galapagos archipelago were sampled. For every station diversity was assessed in terms of Hill's indices and k-dominance curves for both major meiofauna taxa and harpacticoid copepod species. Community structure was analysed using multivariate analyses and non-metric multidimensional scaling (MDS). Possible relations with measured abiotic factors were investigated by linear regressions and multivariate BEST analysis. A total of 60 harpacticoid copepod species was recorded. Multivariate analyses showed no distinct reoccurring meiofauna or copepod assemblages. Furthermore, no significant relations were found between any of the measured abiotic factors and diversity or density of the meiofauna and harpacticoid copepod communities. Compared to similar studies in the (sub)tropical region, average meiofauna and copepod densities were measured. Harpacticoid copepod diversity ranked intermediate among other studies of (sub)tidal habitats in the (sub)tropical region. Relative to the previous studies around the Galapagos archipelago, similar results were obtained, however some remarkable differences were observed as well. The concept of isocommunities, i.e. similar benthic communities in comparable substrates, was not applicable to the obtained results. Nonetheless, some similarities in dominant taxa were observed among stations and in comparison to other studies on harpacticoid copepods. The results of the present study show that the coastal habitats of the Galapagos archipelago are characterised by heterogeneous meiobenthic communities. In contrast to the majority of the literature concerning benthic copepods, no strong correlation was found with sediment grain size, indicating that not all harpacticoid copepod communities are structured by sediment characteristics. Possibly influences by other factors related to the location and formation of the islands rendered these complex patterns.

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Quality Control of Sea Level Variation Observations and Tidal Predictions Based on the IOC Sea Level Station Monitoring Facility

BY Carolina Machado Lima de Camargo

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SUPERVISOR: Francisco Hernandez

The IOC Sea Level Monitoring Facility (IOC-SLMF) connects about 800 tide gauge stations worldwide. The Facility provides real time (RT) visualization and access to the sea level data of such stations. However, a minimal Quality Control (QC) is applied to the data. QC is important to assure credibility of the data being used and stored. Nonetheless, applying QC to RT data can be a challenging activity, for example the distinction between real outliers and signal fluctuations caused by e.g. tsunamis and storm surges may not be very clear. A good approach for a simple QC of sea level measurements in RT is to compare the observations with a tidal prediction. The purpose of the present work was to obtain tidal predictions based on the data from the 12 selected tide gauge stations, and to use the prediction as a rough QC of the RT observations at the IOC-SLMF. In order to obtain the tidal pattern correctly, a QC procedure was applied in the archived data of the IOC-SLMF. The QC was composed of 5 modules: Correction to mean sea level (MSL) as reference; Stability Check; Outlier Detection; Speed of Change Check; Spike Detection. As the QC method developed here had the purpose of tidal studies, it should not be applied to real-time data. Tsunami and storm surge signals were removed during the QC mainly by the Speed of Change and Outlier Detection modules. On average, the QC flagged 15% of the data, thus detecting and removing the noise of the time series. Regarding tidal predictions, there was no significant difference in using data in minute intervals, as provided by most of the stations, or using data after passing by an hourly filter. Furthermore, because the oldest time series considered had 12 years of data, it is only possible to solve 37 of the harmonic components with high accuracy. The tidal forecast was able to predict the sea level variation for the first months of 2018 with a small source of error, making possible to distinguish unpredicted events, such as tsunamis and storm surges, from the tidal curve.

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Mapping seagrass beds and cover change analysis using landsat imagery: Gazi Bay, Kenya.

BY Ahmad Hussein Mohamed

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SUPERVISORS: James G. Kairo & William Harcourt

Global climate change as a consequence of increasing anthropogenic emissions is one of the most contested yet more pervasive threats to marine ecosystems. However, the ocean's ability to sequester and store significant amounts of carbon due to coastal ecosystems collectively labeled "coastal blue carbon ecosystems" makes it possible for us to mitigate this problem. Of particular interest are seagrass meadows, which are recognized as important carbon sinks. They have been reported not only to trap and store organic carbon generated within the seagrass beds but also to trap and bury allochthonous carbon. Seagrass beds are widely distributed and provide nursery ground and a habitat for marine organisms including epiphytic algae. They trap nutrients and accumulate sediments therefore improving the water quality and stabilize the bottom. Furthermore, they are a direct food source for fish and waterfowl and endangered animals such as turtles and dugongs. Nonetheless, seagrass beds are the least well-studied blue carbon ecosystems that are currently threatened to further decline due to changes in the systems caused by anthropogenic activities. Eutrophication, increasing turbidity, sedimentation and human infrastructure development (e.g. aquaculture and construction) affect seagrass meadows worldwide. In Kenya and with specific emphasis to Gazi bay, extensive research work has been done on ecosystems adjacent to seagrass meadows, such as mangroves. Seagrass beds themselves have been studied much less in the area in spite of functional connection. In fact, the only official records of detailed seagrass mapping and monitoring that exist for this bay date back two decades or more (Coppejans et al., 1992 and Dahdouh-Guebas et al., 1999). Hence, we must recognize that there are insufficient data to contribute to even a best guess of total seagrass coverage in Kenya. This study takes advantage of the free and open access satellite data to investigate the contemporary and historic cover of seagrass bed in Gazi Bay (Kenya): archived Landsat data from 1987 to 2017. Processing of data involved: sunglint correction for easy classification, water column correction for light attenuation with depth and image classification using ISODATA method. Field data were used to validate the produced maps by developing a confusion matrix as elaborated by Congalton (1991), followed by cover change analysis. Classification results highlight the north part of the bay as a suitable site for setting up a protected area for carbon trading. Seagrass beds in the bay currently (according to the results of this study) occupy approximately 1099 hectares with an overall accuracy of 73%. Overall the seagrass beds in the bay have declined by 12 hectares in a period of almost 10 years giving a loss rate of 1.1%. The causative factors for this loss cannot be precisely attributed to known factors by this study, however it is not unlikely that destructive fishing practices, erosion and sedimentation play a role in the observed trends. The results of this study are used to establish stable areas within the seagrass beds with the assumption that they will result in long term storage of carbon and therefore can be protected as suitable areas for a carbon offset project. This study identified 3 km2 north of the bay as a proposed area for the extension of the present mangrove carbon trading project in the Gazi Bay.

Keywords: Seagrasses, mapping, carbon sequestration, Gazi Bay.

Investigate the origin of carbon buried underneath seagrass meadows in a tropical mangrove-seagrass ecosystem

BY Riccardo Pieraccini

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SUPERVISORS: James Gitundu Kairo, Steven Goderis

Blue carbon ecosystems, such as mangrove forests and seagrass meadows, are amongst the most productive ecosystems on the planet. Substantial amounts of organic carbon are exported from the mangrove forests to the adjacent ecosystems. Seagrass meadows are estimated to bury up 50% of allochthonous organic carbon within its meadows. The interlink between mangroves and seagrass can results in a great fraction of allochthonous mangrove-derived carbon trapped in the seagrass meadows, by the dense maze of leaf canopy, rhizomes and creeping roots.
The protection and conservation of this blue carbon ecosystem can also generate incomes for the local communities through the sale of carbon offsetting credits. Understanding the seagrass role in trapping and buried carbon represent a further contribute to the community-led project, Punguuza, in Gazi bay. This project will support locally, coastal protection and conservation, and globally, with the mitigation of climate change.
In this study we evaluated the potential contribution of mangrove derived carbon in the seagrass meadows in the western creek of Gazi bay. The use of stable isotopes was crucial to determine the possible sources present in the seagrass meadow sediment. The plant materials (leaves) were used to determine the isotopic signature of the different species encountered. Mangrove leaves had an average signature of -27.5 ± 2.9 ‰, seagrass leaves -19.6 ± 2.7 ‰, roots-rhizomes -24.23 ± 0.9 ‰, epibionts 25.39 ± 0.6 ‰ and macroalgae -21.7 ± 4.5 ‰. The seagrass meadow sediments were found to be enriched in mangrove-derived carbon, with an isotopic signature between -24 and -27 ‰.
A mixed-model was performed to estimate the contribution of the various sources on the seagrass buried organic carbon on different scales. On a small scale, in a shallow and larger creek sections, the seagrass autochthonous buried carbon is significantly dominant, around 69 %. However, on a large scale, (on upstream-downstream gradient) the main contribution in the system is given by allochthonous carbon: mangrove-derived sources accounted for 37 % while the seagrass autochthonous contribution is 24 %.
To draw a better picture of the system, the data of carbon (%), nitrogen (%) and nitrogen isotope facilitated the interpretation of the sources present in the seagrass meadow's sediment.
These results provide, together with other recent papers, consistent insights on the inter-links between mangrove vegetations and seagrass meadows, and the important role of seagrasses on trapping and burying high percentages of allochthonous organic carbon. Hence, seagrass meadows further contribute to the carbon storage of the linked ecosystems. In this perspective, conservation and restoration of seagrass meadows contribute through the carbon sequestration potential of the complex.

Key words: blue carbon, carbon sources, mangroves, seagrass, Gazi bay

Evolution of San Lorenzo proglacial floods (Patagonia) during the Late Holocene: are they related to glacier variability?

BY Alejandro Rojas Aldana

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The occurrence of Glacial Lake Outburst Floods (GLOFs) has increased in Patagonia over the last decades. It is scientifically important to understand when and how often these events are triggered since many communities could be at risk if they are placed nearby glacierized areas in Patagonia. Such is the case of Monte San Lorenzo, where little is known regarding the occurrence of floods. The aim of this study is to derive the frequency of proglacial floods originating from the San Lorenzo Icefield (Chile, 47^{o}S) during the late Holocene and to evaluate if they are related to glacial variability in Patagonia. To do this, a 4.67 m long peat sediment core collected along the Del Salto River was analyzed using techniques such as gamma density, magnetic susceptibility, colour spectrophotometry, loss-on-ignition and 14C dating. A total of 28 floods were found over the last 3.6 ka cal BP, from which 22 occurred in a time period of glacier retreat. Our results suggest that there is a close relationship between flood frequency and glacier variability. To conclude, floods in Patagonia are expected to increase under the current global climate change conditions and so the urgency to monitor ice mass changes in Patagonia should be enhanced as a precautionary measure.

MSc Marine and Lacustrine Science and Managament in an interuniversity programme offered by

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Lake Chala Turbidite Stratigraphy: Developing A Method to Identify and Quantify Surficial Slope Sediment Remobilization

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Turbidites formed by remobilization of surficial slope sediment provide an opportunity to study the long-term changes of the uppermost slope sediments and their fossil content. Due to the similarity in composition of these turbidites and the slopes where they were sourced from, the analysis of their remobilization depth, at the shallow near-shore areas, enables a reconstruction of the deposition depth of slope components. The informative potential of these turbidites has however been underutilized because in most cases, they have been assumed to be a result of landslides or debris flows. A reliable method has thus been needed to study their remobilization process. We studied 346 turbidites from a composite core ~215 m depth (260 kyr), obtained from Lake Chala, a crater lake at the lower eastern slope of Mount Kilimanjaro in East Africa, during the implementation of the DeepCHALLA project. The majority of these turbidites had a similar color to their matrix sediment, therefore, we used sediment color in CIE L*a*b* color space measured by a spectrophotometer at an interval of 0.5 cm to identify and quantify the remobilization depth of the turbidites. To achieve this, the average values of color parameters (L*, a*, and b*) of turbidites and matrix sediment below turbidite (from 2-55 cm) were calculated and compared at various stratigraphic depths by using two different methods; the correlation between average color parameters of turbidites and matrix sediment from the turbidite base to 55 cm, and the correlation of turbidites and intervals of 5cm of matrix sediment up to 55 cm below the turbidites. In addition, the autocorrelation within matrix sediment was determined. Our results revealed that a* had the highest correlation (R2) compared to other parameters (L* and b*) especially at ~6-17 cm depth (R2 = 0.64) and it was consistent in sediment from nearly all slopes in the basin. This depth interval was interpreted as a remobilization depth of slope sediment of which turbidites were originated. We conclude that a* is the most reliable parameter to determine the remobilization depth of slope sediment.