



ENVIS NEWSLETTER



ENVIS CENTRE ON BIOGEOCHEMISTRY

(Supported by: Ministry of Environment & Forests, Govt. of India)

SCHOOL OF ENVIRONMENTAL SCIENCES
JAWAHARLAL NEHRU UNIVERSITY, NEW DELHI, INDIA

Vol. 19

Number 3

2013-14

Special Issue on Biogeochemistry abstracts

From Editor's Desk

Biogeochemistry abstract volume deals with biotic controls on the chemistry of the environment, or with the geochemical control of the structure and function of ecosystems. The biogeochemical cycles are considered, either of individual elements or of specific classes of natural or anthropogenic compounds in ecosystems. Particular emphasis is given to coupled interactions of element cycles. This issue tries to compile the papers on global scales to elucidate the mechanisms driving patterns in biogeochemical cycles through space and time. Studies on both natural and anthropogenic chemical process in our environment were collected and compiled for a general understanding of biogeochemistry. The manuscripts present results that are substantially advanced in this field and are expected to present new information in a concise format and appeal to a broad audience. We expect these papers to give insight to our readers to get publications from cutting-edge research in the field of Biogeochemistry

This issue is also available on our website: www.jnuenvis.nic.in. We solicit feedback and suggestions from our esteemed readers, if any, to improve our functioning further.

Prof. AL Ramanathan

ISSN - 0974-1364

Visit Us: www.jnuenvis.nic.in

Climate extremes and the carbon cycle

Authors: Markus Reichstein, Michael Bahn, Philippe Ciais, Dorothea Frank, Miguel D. Mahecha, Sonia I. Seneviratne, Jakob Zscheischler, Christian Beer, Nina Buchmann

Journal: Nature, Volume 500, 15 August 2013, Pages 2876295

The terrestrial biosphere is a key component of the global carbon cycle and its carbon balance is strongly influenced by climate. Continuing environmental changes are thought to increase global terrestrial carbon uptake. But evidence is mounting that climate extremes such as droughts or storms can lead to a decrease in regional ecosystem carbon stocks and therefore have the potential to negate an expected increase in terrestrial carbon uptake. Here we explore the mechanisms and impacts of climate extremes on the terrestrial carbon cycle, and propose a pathway to improve our understanding of present and future impacts of climate extremes on the terrestrial carbon budget.

Geochemistry of shallow aquifers and soil gas surveys in a feasibility study at the Rivara natural gas storage site (Po Plain, Northern Italy)

Authors: A. Sciarra, D. Cinti, L. Pizzino, M. Procesi, N. Voltattorni, S. Mecozzi, F. Quattrocchi

Journal: Applied Geochemistry, Volume 34, July 2013, Pages 3622

A geochemical survey, in shallow aquifers and soils, has been carried out to evaluate the feasibility of natural gas (CH₄) storage in a deep saline aquifer at Rivara (MO), Northern Italy. This paper discusses the areal distribution of CO₂ and CH₄ fluxes and CO₂, CH₄, Rn, He, H₂ concentrations both in soils and shallow aquifers above the proposed storage reservoir. The distribution of pathfinder elements such as ²²²Rn, He and H₂ has been studied in order to identify potential faults and/or fractures related to preferential migration pathways and the possible interactions between the reservoir and surface. A geochemical and isotopic characterization of the ground waters circulating in the first 200 m has allowed to investigation of (i) the origin of the circulating fluids, (ii) the gas-water-rock interaction processes, (iii) the amount of dissolved gases and/or their saturation status. In the first 200 m, the presence of CH₄-rich reducing waters are probably related to organic matter (peat) bearing strata which generate shallow-derived CH₄, as elsewhere in the Po Plain. On the basis of isotopic analysis, no hints of thermogenic CH₄ gas leakage from a deeper reservoir have been shown. The ¹³C(CO₂) both in ground waters and free gases suggests a prevalent shallow origin of CO₂ (i.e. organic and/or soil-derived). The acquisition of pre-injection data is strategic for the natural gas storage development project and as a baseline for future monitoring during the gas injection/withdrawing period. Such a geochemical approach is considered as a methodological reference model for future CO₂/CH₄ storage projects.

Small-scale variability in peatland pore-water biogeochemistry, Hudson Bay Lowland, Canada

Authors: T.A. Ulanowski, B.A. Branfireun

Journal: Science of The Total Environment, Volumes 454–455, 1 June 2013, Pages 211–218

The Hudson Bay Lowland (HBL) of northern Ontario, Manitoba and Quebec, Canada is the second largest contiguous peatland complex in the world, currently containing more than half of Canada's soil carbon. Recent concerns about the ecohydrological impacts to these large northern peatlands resulting from climate change and resource extraction have catalyzed a resurgence in scientific research into this ecologically important region. However, the sheer size, heterogeneity and elaborate landscape arrangements of this ecosystem raise important questions concerning representative sampling of environmental media for chemical or physical characterization. To begin to quantify such variability, this study assessed the small-scale spatial (1 m) and short temporal (21 day) variability of surface pore-water biogeochemistry (pH, dissolved organic carbon, and major ions) in a *Sphagnum* spp.-dominated, ombrotrophic raised bog, and a *Carex* spp.-dominated intermediate fen in the HBL. In general, pore-water pH and concentrations of dissolved solutes were similar to previously reported literature values from this region. However, systematic sampling revealed consistent statistically significant differences in pore-water chemistries between the bog and fen peatland types, and large within-site spatiotemporal variability. We found that microtopography in the bog was associated with consistent differences in most biogeochemical variables. Temporal changes in dissolved solute chemistry, particularly base cations (Na^+ , Ca^{2+} and Mg^{2+}), were statistically significant in the intermediate fen, likely a result of a dynamic connection between surficial waters and mineral-rich deep groundwater. In both the bog and fen, concentrations of SO_4^{2-} showed considerable spatial variability, and a significant decrease in concentrations over the study period. The observed variability in peatland pore-water biogeochemistry over such small spatial and temporal scales suggests that under-sampling in northern peatland environments could lead to erroneous conclusions concerning the abundance and distribution of natural elements and pollutants alike.

Impact of improved air–sea gas transfer velocity on fluxes and water chemistry in a Baltic Sea model

Authors: Maria Norman, Anna Rutgersson, Erik Sahlée ,

Journal: Journal of Marine Systems, Volumes 111–112, February 2013, Pages 175–188

The air–sea exchange of gases is largely controlled by the efficiency of the transfer across the interface (parameterized by the transfer velocity). A biogeochemical model of the Baltic Sea is used to study the impact of an improved formulation of the transfer velocity on the air–sea fluxes and water chemistry. Two parameterizations using the concept of resistance are applied in the model for calculating carbon dioxide and oxygen air–sea fluxes. One parameterization includes the water-side convection, which has demonstrated to increase the transfer velocity during unstable atmospheric stratification and at great mixing depths. Including the water-side convection changes the seasonal cycle of CO_2 and O_2 fluxes, although the changes are relatively small due to feedback processes in the model. When not taking the feedback processes into account, the impact of water-side convection on the fluxes is significantly greater, with a maximum difference in the order of 20%. The vertical water profiles are also slightly modified when including water-side convection, the accumulated effect being greatest in the deeper part of the basin. Furthermore, CO_2 uptake and O_2 emissions decrease by 6.5% and 4.5%, respectively, when water-side convection is included

in the model. Compared to the great difference between previous studies, the differences between the model runs in the present study are small, indicating that the choice of formulation for the transfer velocity in a model is not crucial although it is more physically correct.

Using hydrogeochemistry to understand inter-aquifer mixing in the on-shore part of the Gippsland Basin, southeast Australia

Authors: H. Hofmann, Ian Cartwright

Journal: Applied Geochemistry, Volume 33, June 2013, Pages 84610

Groundwater in the Latrobe Valley in the Gippsland Basin of southeast Australia is important for domestic, agricultural and industrial uses. This sedimentary basin contains a number of aquifers that are used for water supply, dewatered for open pit coal mining, and which are potentially influenced by off-shore oil and gas production. Major ion chemistry together with stable and Sr isotope data imply that the main hydrogeochemical processes are evapotranspiration with minor silicate and carbonate weathering; methanogenesis and SO₄ reduction in reduced groundwater associated with coal deposits have also occurred. Groundwater has estimated ¹⁴C ages of up to 36 ka and is largely ³H free. Carbon-14 ages are irregularly distributed and poorly correlated with depth and distance from the basin margins. The observations that the geochemistry of groundwater in aquifers with different mineralogies are similar and the distribution of ¹⁴C ages is irregular implies that the aquifers are hydraulically connected and horizontal as well as vertical inter-aquifer mixing occurs. The connection of shallow and deeper aquifers poses a risk for the groundwater resources in Gippsland as contaminants can migrate across aquifers and dewatering of shallow units may impact deeper parts of the groundwater system.

Geochemical characterization of arsenic-rich coal-combustion ashes buried under agricultural soils and the release of arsenic

Authors: Veronika Veselská, Juraj Majzlan, Edgar Hiller, Katarína Peková

Journal: Applied Geochemistry, Volume 33, June 2013, Pages 1536164

A combination of geochemical and mineralogical methods was used to determine the concentrations, mobility, and sources of As in coal-combustion ashes and soils in the vicinity of a thermal power plant at Nováky, central Slovakia. Fresh lagooned ash, ashes buried under agricultural soils for 45 a, and the overlying soils, contain high concentrations of As ranging from 61 to 1535 mg/kg. There is no differences in the water extractable percentages of As between the fresh lagooned ash and buried ashes, which range from 3.80% to 6.70% of the total As. This small amount of As may perhaps reside on the surfaces of the ash particles, as postulated in the earlier literature, but no evidence was found to support this claim. Electron microprobe analyses show that the dominant primary As carriers are the aluminosilicate glasses enriched in Ca and Fe. The acid NH₄⁺-NH₄⁺-oxalate extraction hints that the oxyhydroxides of Si, Al, and Fe are the most probable secondary carriers of labile As. The X-ray absorption spectroscopy (XAS) analyses show that As in the lagooned and buried ashes occurs mostly as As(V). The long-term burial of the coal-combustion ash under agricultural soil did not cause any major change of its chemical composition compared to the fresh lagooned ash.

Arsenic attenuation in geothermal streamwater coupled with biogenic arsenic(III) oxidation

Authors: Satoshi Mitsunobu, Natsuko Hamanura, Takafumi Kataoka, Fumito Shiraishi.

Journal: Applied Geochemistry, Volume 35, August 2013, Pages 1546160

In the present study, we investigated As behavior in a high-As hot spring (Sambe hot spring, Shimane, Japan) by coupling direct chemical speciation by synchrotron-based XAFS and HPLC-ICP-MS with microbial As-redox transformation gene analysis. The concentration of soluble As in the spring streamwater decreased immediately along the flow in correlation with Fe behavior, indicating that As in the streamwater was naturally attenuated in the streamwater. Iron XAFS analysis suggested deposition of Fe(III) oxyhydroxides along the flow. Thus, considering the strong affinity of As to Fe oxyhydroxides, the observed attenuation in As was possibly caused by sorption (or incorporation) of As on Fe(III) oxyhydroxides. Both dissolved As(III) and As(V) were present in the aqueous phase, and As(III) was rapidly oxidized to As(V) (<30 s) along the flow. The oxidation kinetics indicated the occurrence of biotic As(III) oxidation, because obtained As(III) oxidation rate ($6.7\text{--}7.8 \text{ M min}^{-1}$) was much faster than the reported abiotic oxidation rates. Furthermore, the bacterial arsenite oxidase gene (*ainA*) was detected in DNA extracted from all samples (average of 2.0×10^5 copies dry g^{-1}), which also supported potential attributes of biological As(III) oxidation in situ. In solid phase samples from sampling points analyzed by XAFS, most of the As existed as oxidized pentavalent form, As(V). This result indicated that this form was preferentially partitioned to the solid phase because of the much higher affinity of As(V) than of As(III) to Fe(III) oxyhydroxides. Considering the kinetic and microbiological findings, it is indicated that biotic process was predominantly responsible for As(III) oxidation at the present site, and this biotic As(III) oxidation to As(V) controlled the observed attenuation of As, because oxidized As(V) was removed from the aqueous phase by Fe(III) oxyhydroxides more efficiently.

Trace metal biogeochemistry in mangrove ecosystems: A comparative assessment of acidified (by acid sulfate soils) and non-acidified sites

Authors: Bibhash Nath, Bibhash Nath, Gavin Birch, Punarbasu Chaudhuri.

Journal: Science of The Total Environment, Volumes 463–464, 1 October 2013, Pages 667–674

The generation of acidity and subsequent mobilization of toxic metals induced by acid sulfate soils (ASSs) are known to cause severe environmental damage to many coastal wetlands and estuaries of Australia and worldwide. Mangrove ecosystems serve to protect coastal environments, but are increasingly threatened from such ASS-induced acidification due to variable hydrological conditions (i.e., inundation–desiccation cycles). However, the impact of such behaviors on trace metal distribution, bio-availability and accumulation in mangrove tissues, i.e., leaves and pneumatophores, are largely unknown. In this study, we examined how ASS-induced acidifications controlled trace metal distribution and bio-availability in gray mangrove (*Avicennia marina*) soils and in tissues in the Kooragang wetland, New South Wales, Australia. We collected mangrove soils, leaves and pneumatophores from a part of the wetland acidified from ASS (i.e., an affected site) for detailed biogeochemical studies. The

results were compared with samples collected from a natural intertidal mangrove forest (i.e., a control site) located within the same wetland. Soil pH (mean: 5.90) indicated acidic conditions in the affected site, whereas pH was near-neutral (mean: 7.17) in the control site. The results did not show statistically significant differences in near-total and bio-available metal concentrations, except for Fe and Mn, between affected and control sites. Iron concentrations were significantly (p values ≤ 0.001) greater in the affected site, whereas Mn concentrations were significantly (p values ≤ 0.001) greater in the control site. However, large proportions of near-total metals were potentially bio-available in control sites. Concentrations of Fe and Ni were significantly (p values ≤ 0.001) greater in leaves and pneumatophores of the affected sites, whereas Mn, Cu, Pb and Zn were greater in control sites. The degree of metal bio-accumulation in leaves and pneumatophores suggest contrasting hydrological behaviors and near-surface geochemical conditions favoring differential metal uptake by mangrove plants in the two sites.

Geochemical and isotopic variations in shallow groundwater in areas of the Fayetteville Shale development, north-central Arkansas

Authors: Nathaniel R. Warner, Timothy M. Kresse, Phillip D. Hays, Adrian Down, Jonathan D. Karr.

Journal: Applied Geochemistry, Volume 35, August 2013, Pages 207-220

Exploration of unconventional natural gas reservoirs such as impermeable shale basins through the use of horizontal drilling and hydraulic fracturing has changed the energy landscape in the USA providing a vast new energy source. The accelerated production of natural gas has triggered a debate concerning the safety and possible environmental impacts of these operations. This study investigates one of the critical aspects of the environmental effects; the possible degradation of water quality in shallow aquifers overlying producing shale formations. The geochemistry of domestic groundwater wells was investigated in aquifers overlying the Fayetteville Shale in north-central Arkansas, where approximately 4000 wells have been drilled since 2004 to extract unconventional natural gas. Monitoring was performed on 127 drinking water wells and the geochemistry of major ions, trace metals, CH₄ gas content and its C isotopes (¹³C_{CH4}), and select isotope tracers (¹¹B, ⁸⁷Sr/⁸⁶Sr, ²H, ¹⁸O, ¹³C_{DIC}) compared to the composition of flowback-water samples directly from Fayetteville Shale gas wells. Dissolved CH₄ was detected in 63% of the drinking-water wells (32 of 51 samples), but only six wells exceeded concentrations of 0.5 mg CH₄/L. The ¹³C_{CH4} of dissolved CH₄ ranged from -42.3‰ to -74.7‰, with the most negative values characteristic of a biogenic source also associated with the highest observed CH₄ concentrations, with a possible minor contribution of trace amounts of thermogenic CH₄. The majority of these values are distinct from the reported thermogenic composition of the Fayetteville Shale gas (¹³C_{CH4} = -35.4‰ to -41.9‰). Based on major element chemistry, four shallow groundwater types were identified: (1) low (<100 mg/L) total dissolved solids (TDS), (2) TDS > 100 mg/L and Ca/HCO₃ dominated, (3) TDS > 100 mg/L and Na/HCO₃ dominated, and (4) slightly saline groundwater with TDS > 100 mg/L and Cl > 20 mg/L with elevated Br/Cl ratios (>0.001). The Sr (⁸⁷Sr/⁸⁶Sr = 0.709760.7166), C (¹³C_{DIC} = -21.3‰ to -4.7‰), and B (¹¹B = 3.9632.9‰) isotopes clearly reflect water-rock interactions within the aquifer rocks, while the stable O and H isotopic composition mimics the local meteoric water composition. Overall, there was a geochemical gradient from low-mineralized recharge water to more evolved Ca/HCO₃, and higher-mineralized Na/HCO₃ composition generated by a combination of carbonate dissolution, silicate weathering, and reverse base-exchange

reactions. The chemical and isotopic compositions of the bulk shallow groundwater samples were distinct from the NaCl type Fayetteville flowback/produced waters (TDS ~10,000–20,000 mg/L). Yet, the high Br/Cl variations in a small subset of saline shallow groundwater suggest that they were derived from dilution of saline water similar to the brine in the Fayetteville Shale. Nonetheless, no spatial relationship was found between CH₄ and salinity occurrences in shallow drinking water wells with proximity to shale-gas drilling sites. The integration of multiple geochemical and isotopic proxies shows no direct evidence of contamination in shallow drinking-water aquifers associated with natural gas extraction from the Fayetteville Shale.

Nitrogen losses in anoxic marine sediments driven by *Thioploca*-anammox bacterial consortia

Authors: M. G. Prokopenko, M. B. Hirst, L. De Brabandere, W. M. Berelson, J. Granger, B. X. Chang, S. Dawson, E. J. Crane III,

Journal: Nature, Volume 500, 08 August 2013, Pages 234-236

Ninety per cent of marine organic matter burial occurs in continental margin sediments, where a substantial fraction of organic carbon escapes oxidation and enters long-term geologic storage within sedimentary rocks. In such environments, microbial metabolism is limited by the diffusive supply of electron acceptors. One strategy to optimize energy yields in a resource-limited habitat is symbiotic metabolite exchange among microbial associations^{1, 2}. Thermodynamic and geochemical considerations indicate that microbial co-metabolisms are likely to play a critical part in sedimentary organic carbon cycling^{3, 4, 5}. Yet only one association, between methanotrophic archaea and sulphate-reducing bacteria, has been demonstrated in marine sediments *in situ*^{6, 7}, and little is known of the role of microbial symbiotic interactions in other sedimentary biogeochemical cycles⁸. Here we report *in situ* molecular and incubation-based evidence for a novel symbiotic consortium between two chemolithotrophic bacteria—anaerobic ammonium-oxidizing (anammox) bacteria and the nitrate-sequestering sulphur-oxidizing *Thioploca* species—in anoxic sediments of the Soledad basin at the Mexican Pacific margin. A mass balance of benthic solute fluxes and the corresponding nitrogen isotope composition of nitrate and ammonium fluxes indicate that anammox bacteria rely on *Thioploca* species for the supply of metabolic substrates and account for about 57 ± 21 per cent of the total benthic N₂ production. We show that *Thioploca*-anammox symbiosis intensifies benthic fixed nitrogen losses in anoxic sediments, bypassing diffusion-imposed limitations by efficiently coupling the carbon, nitrogen and sulphur cycles.

Bridging marine ecosystem and biogeochemistry research: Lessons and recommendations from comparative studies

Authors: B. Salihoglu, S. Neuer, S. Painting, R. Murtugudde, E.E. Hofmann, J.H. Steele

Journal: Journal of Marine Systems, Volumes 109–110, January 2013, Pages 161–175

There is growing interest in linking marine biogeochemistry with marine ecosystems research in response to the increasing need to understand and predict the effect of global change on the marine ecosystem. Such a holistic approach combines oceanographic and biogeochemical processes and information on organisms, ranging from microbes to higher-trophic-levels. Comparative studies offer a means to improve understanding of critical mechanisms that influence marine systems by showing differences in ecosystem response to changing ocean conditions. Comparing similar biomes that differ in a particular set of physical or biological characteristics can provide insight into the susceptibility of the key features of a system to perturbation. Also, comparative studies based on long-term observations at fixed time-series stations enable the evaluation of long-term changes in the physical and biological environment, such as those driven by climate patterns. Moreover, the comparative approach provides a feasible alternative to costly and complex research programs designed to provide detailed end-to-end evaluations of marine systems. Planned and unplanned perturbations allow the investigation of the sensitivity of ecosystems and their biogeochemical processes to change at different time and space scales. In well-studied regions where sufficient data are available, models can provide comprehensive syntheses, mechanistic insights and even predictions. We present examples of successful comparative studies that incorporate both biogeochemical and ecosystems aspects. A framework for a basic approach for comparative studies is proposed that considers the interactions between biogeochemical cycles and ecosystems. This approach is based on constructing a minimalistic observational framework grounded within a conceptual model.

Microcosm assessment of the biogeochemical development of sulfur and oxygen in oil sands fluid fine tailings

Authors: Michael Chen, Gillian Walshe, Ernest Chi Fru, Jan J.H. Ciborowski

Journal: Applied Geochemistry, Volume 37, October 2013, Pages 1611

Bitumen recovery from Alberta oil sands generates fluid fine tailings, which are retained in tailings ponds where solids settle and release process water. The recovered water is recycled for bitumen extraction, while the resulting tailings are incorporated into various landforms for reclamation, with one option being conversion of tailings basins to viable end pit lakes. Tailings ponds commonly host diverse microbial communities, including SO₄-reducing prokaryotes. The highly reducing nature of the hydrogen sulfide produced by these prokaryotes may impact the biogeochemical cycling of key nutrients. However, the behavioral dynamics of hydrogen sulfide production in ponds containing fluid fine tailings remain to be clearly explained. In this study, microcosms are used as analogues of the sediment-water interface of a tailings pond undergoing reclamation to determine sulfide generation patterns and the behavior of O₂. In the microcosms, hydrogen sulfide fluxes correlated positively with biotic activity, reaching levels of over $2 \times 10^3 \text{ nmol cm}^{-2} \text{ s}^{-1}$, leading to Fe sulfide formation. Depth-related hydrogen sulfide profiles in the microcosms were comparable to those encountered *in situ*, in Syncrude's West In-Pit, an active tailing pond. Oxygen diffusion across the fluid fine tailing sediment-water interface was controlled to different degrees by both biotic and abiotic processes. The results have implications for quantitatively estimating the impact of hydrogen sulfide production, O₂ availability, and biogeochemical cycling of key nutrients important for the success of life in fluid fine tailings-affected ecosystems. This paper shows that this production of hydrogen sulfide may be a self-limiting process, which will begin to decrease after a period of time.

Forms of phosphorus in sediments from the Goczałkowice Reservoir

Authors: N. Męcnarczyk, M. Bartoszek, J. Polak, W.W. Sućkowski

Journal: Applied Geochemistry, Volume 37, October 2013, Pages 876-93

The occurrence of Total P (P-Tot) and the mineral forms of P (P-Min) in sediments from Goczałkowice Reservoir were investigated using inductively coupled plasma-optical emission spectrometer (ICP-OES). The method is based on sequential extractions of the sediment samples, each releasing four forms of inorganic P: loosely bound P, P bound to Al (P-Al), P bound to Fe (P-Fe) and P bound to Ca (P-Ca). Sediment samples for studies presented in this work were collected in April, August and November of 2009 from four sites of the Goczałkowice Reservoir. Significant variations in the P forms with sediment grain size were observed. The most abundant form of inorganic P in the bottom sediment was P-Fe. Other P forms were as follows: P-Ca > P-Al > loosely bound-P. Moreover, P compounds were studied using ^{31}P NMR. It was found that the predominant form was inorganic orthophosphate.

Sustainable bioenergy production from marginal lands in the US Midwest

Authors: Ilya Gelfand, Ritvik Sahajpal, Xuesong Zhang, R. César Izaurralde,

Journal: Nature, Volume 493, 24 January 2013, Pages 514–517

Legislation on biofuels production in the USA¹ and Europe^{2, 3} is directing food crops towards the production of grain-based ethanol^{2, 3}, which can have detrimental consequences for soil carbon sequestration⁴, nitrous oxide emissions⁵, nitrate pollution⁶, biodiversity⁷ and human health⁸. An alternative is to grow lignocellulosic (cellulosic) crops on marginal lands⁹. Cellulosic feedstocks can have positive environmental outcomes^{10, 11} and could make up a substantial proportion of future energy portfolios^{12, 13}. However, the availability of marginal lands for cellulosic feedstock production, and the resulting greenhouse gas (GHG) emissions, remains uncertain. Here we evaluate the potential for marginal lands in ten Midwestern US states to produce sizeable amounts of biomass and concurrently mitigate GHG emissions. In a comparative assessment of six alternative cropping systems over 20 years, we found that successional herbaceous vegetation, once well established, has a direct GHG emissions mitigation capacity that rivals that of purpose-grown crops (851 ± 46 grams of CO_2 equivalent emissions per square metre per year ($\text{gCO}_2\text{e m}^{-2}\text{ yr}^{-1}$)). If fertilized, these communities have the capacity to produce about 63 ± 5 gigajoules of ethanol energy per hectare per year. By contrast, an adjacent, no-till corn-soybean-wheat rotation produces on average 41 ± 1 gigajoules of biofuel energy per hectare per year and has a net direct mitigation capacity of $397 \pm 32 \text{ gCO}_2\text{e m}^{-2}\text{ yr}^{-1}$; a continuous corn rotation would probably produce about 62 ± 7 gigajoules of biofuel energy per hectare per year, with 13% less mitigation. We also perform quantitative modelling of successional vegetation on marginal lands in the region at a resolution of 0.4 hectares, constrained by the requirement that each modelled location be within 80 kilometres of a potential biorefinery. Our results suggest that such vegetation could produce about 21 gigalitres of ethanol per year from around 11 million hectares, or approximately 25 per cent of the 2022 target for cellulosic biofuel mandated by the US Energy Independence and Security Act of 2007, with no initial carbon

debt nor the indirect land-use costs associated with food-based biofuels. Other regional-scale aspects of biofuel sustainability², such as water quality^{11, 14} and biodiversity¹⁵, await future study

A coupled biogeochemical-Dynamic Energy Budget model as a tool for managing fish production ponds

Authors: Dalila Serpa, Pedro Pousão-Ferreira, Miguel Caetano, Miguel Caetano, Luís Cancela da Fonseca

Journal: Science of The Total Environment, Volumes 463–464, 1 October 2013, Pages 861–874

The sustainability of semi-intensive aquaculture relies on management practices that simultaneously improve production efficiency and minimize the environmental impacts of this activity. The purpose of the present work was to develop a mathematical model that reproduced the dynamics of a semi-intensive fish earth pond, to simulate different management scenarios for optimizing fish production. The modeling approach consisted of coupling a biogeochemical model that simulated the dynamics of the elements that are more likely to affect fish production and cause undesirable environmental impacts (nitrogen, phosphorus and oxygen) to a fish growth model based on the Dynamic Energy Budget approach. The biogeochemical sub-model successfully simulated most water column and sediment variables. A good model fit was also found between predicted and observed white seabream (*Diplodus argus*) growth data over a production cycle. In order to optimize fish production, different management scenarios were analysed with the model (e.g. increase stocking densities, decrease/increase water exchange rates, decrease/increase feeding rates, decrease phosphorus content in fish feeds, increase food assimilation efficiency and decrease pellets sinking velocity) to test their effects on the pond environment as well as on fish yields and effluent nutrient discharges. Scenarios were quantitatively evaluated and compared using the Analytical Hierarchical Process (AHP) methodology. The best management options that allow the maximization of fish production while maintaining a good pond environment and minimum impacts on the adjacent coastal system were to double standard stocking densities and to improve food assimilation efficiency.

Effect of long term organic amendments and vegetation of vineyard soils on the microscale distribution and biogeochemistry of copper

Authors: Aline Navel, Jean M.F. Martins

Journal: Science of The Total Environment, Volumes 466–467, 1 January 2014, Pages 681–689

In this study we evaluated the effect of the long term organic management of a vineyard-soil on the biogeochemistry of copper at the micro-aggregate scale. The model vineyard-soil (Mâcon-France) experienced a long-term field-experiment that consisted in amendments and vegetations with various materials and plants. We studied specifically the effect of Straw (S) and Conifer Compost (CC) organic amendments and Clover (Cl) and Fescue (F) vegetation on the fate of copper (fungicide) in the surface layer of this loamy soil, through a comparison with the Non Amended soil (NA). After collection the five soils were immediately physically fractionated in order to obtain 5 granulometric size-fractions. All soils and size-fractions were

quantitatively characterized in terms of granulometry, chemical content and copper distribution, speciation and bioavailability to bacteria and plants. The results showed strong increases of soil-constituents aggregation for all treatments (C1 > CC > S > F > NA), in relation with the increased cementation of soil-constituents by organic matter (OM). The distribution patterns of all major elements and organic carbon were found highly variable within the soil sub-fractions and also between the 5 treatments. Due to their specific inorganic and organic composition, soil sub-fractions can thus be considered as a specific microbial habitat. Added OM accumulated preferentially in the 20-62 μ m and in the > 250 μ m of the 5 soils. The distribution patterns of copper as well as its speciation and bioavailability to bacteria in the soil sub-fractions were shown to be strongly different among the five soils, in relation with OM distribution. Our results also suggest that Cu-bioavailability to plants is controlled by soil-rhizosphere structure. Altogether our results permitted to show that long-term organic management of a vineyard soil induced stable modifications of soil physical and chemical properties at both macro and micro-scales. These modifications affected in turn the micro-scale biogeochemistry of copper, and especially its bioavailability to bacteria and plants.

Stochastic estimation of biogeochemical parameters from Globcolour ocean colour satellite data in a North Atlantic 3D ocean coupled physical-biogeochemical model

Authors: [Maéva Doron](#), [Pierre Brasseur](#), [Jean-Michel Brankart](#), [Svetlana N. Losa](#), [Angélique Melet](#)

Journal: [Journal of Marine Systems](#), Volumes 117-118, May 2013, Pages 81-69

Biogeochemical parameters remain a major source of uncertainty in coupled physical-biogeochemical models of the ocean. In a previous study (Doron et al., 2011), a stochastic estimation method was developed to estimate a subset of biogeochemical model parameters from surface phytoplankton observations. The concept was tested in the context of idealised twin experiments performed with a 1/4° resolution model of the North Atlantic ocean. The method was based on ensemble simulations describing the model response to parameter uncertainty. The statistical estimation process relies on nonlinear transformations of the estimated space to cope with the non-Gaussian behaviour of the resulting joint probability distribution of the model state variables and parameters. In the present study, the same method is applied to real ocean colour observations, as delivered by the sensors SeaWiFS, MERIS and MODIS embarked on the satellites OrbView-2, Envisat and Aqua respectively. The main outcome of the present experiments is a set of regionalised biogeochemical parameters. The benefit is quantitatively assessed with an objective norm of the misfits, which automatically adapts to the different ecological regions. The chlorophyll concentration simulated by the model with this set of optimally derived parameters is closer to the observations than the reference simulation using uniform values of the parameters. In addition, the interannual and seasonal robustness of the estimated parameters is tested by repeating the same analysis using ocean colour observations from several months and several years. The results show the overall consistency of the ensemble of estimated parameters, which are also compared to the results of an independent study.

Deep instability of deforested tropical peatlands revealed by fluvial organic carbon fluxes

Authors:Chris D. Evans,Susan E. Page,Mark H. Garnett,Tim G. Jones,Chris Freeman,

Journal:Nature, Volume 493, 31 January 2013, Pages 6606663

Tropical peatlands contain one of the largest pools of terrestrial organic carbon, amounting to about 89,000 teragrams¹ (1 Tg is a billion kilograms). Approximately 65 per cent of this carbon store is in Indonesia, where extensive anthropogenic degradation in the form of deforestation, drainage and fire are converting it into a globally significant source of atmospheric carbon dioxide^{1,2,3}. Here we quantify the annual export of fluvial organic carbon from both intact peat swamp forest and peat swamp forest subject to past anthropogenic disturbance. We find that the total fluvial organic carbon flux from disturbed peat swamp forest is about 50 per cent larger than that from intact peat swamp forest. By carbon-14 dating of dissolved organic carbon (which makes up over 91 per cent of total organic carbon), we find that leaching of dissolved organic carbon from intact peat swamp forest is derived mainly from recent primary production (plant growth). In contrast, dissolved organic carbon from disturbed peat swamp forest consists mostly of much older (centuries to millennia) carbon from deep within the peat column. When we include the fluvial carbon loss term, which is often ignored, in the peatland carbon budget, we find that it increases the estimate of total carbon lost from the disturbed peatlands in our study by 22 per cent. We further estimate that since 1990 peatland disturbance has resulted in a 32 per cent increase in fluvial organic carbon flux from southeast Asia— an increase that is more than half of the entire annual fluvial organic carbon flux from all European peatlands. Our findings emphasize the need to quantify fluvial carbon losses in order to improve estimates of the impact of deforestation and drainage on tropical peatland carbon balances.

Introduction: Large-scale regional comparisons of marine biogeochemistry and ecosystem processes — Research approaches and results

Authors:Raleigh R. Hood, Kenneth F. Drinkwater, Nikolaos Mihalopoulos

Journal:Journal of Marine Systems, Volumes 1096110, January 2013, Pages 163

Large-scale regional comparisons of marine biogeochemistry and ecosystem processes - research approaches and results. With the exceptions of open-ocean iron fertilization experiments and studies of marine protected areas, experimental controls cannot be imposed in studies of large marine systems. An alternative method of investigation is the comparative approach. Within such an approach, insights into biogeochemical, physical and ecological processes, as well as the overall structure and function of marine ecosystems are sought through comparing different geographical regions. In an effort to review and assess the state of the art in regional marine comparative studies, the Integrated Marine Biogeochemistry and Ecosystem Research Project (IMBER) convened its second international meeting (IMBIZO

II) entitled "Integrating Biogeochemistry and Ecosystems in a Changing Ocean: Regional Comparisons" in Crete, Greece during 10-14 October, 2010, hosted by the Cretaquarium and the Hellenic Centre for Marine Research (Fig. 1). IMBER is an IGBP-SCOR project whose goal is to investigate the sensitivity of marine biogeochemical cycles and food webs to global change on time scales ranging from years to decades. IMBIZO is a Zulu word describing a gathering of people and IMBER's first IMBIZO was held in Miami in USA in 2008. IMBIZO's format involves convening 3 concurrent workshops, limited to approximately 40 participants each, that focus on specific themes related to IMBER's overarching goal, with emphasis on encouraging the linkage between biogeochemistry and food web research. At IMBIZO II ~ 120 participants from all over the world met to review current knowledge and identify key questions for future research at workshops on (1) the effects of varying element ratios on community structure at low trophic levels and food quality at mid and high trophic levels, (2) sensitivity of marine food webs and biogeochemical cycles to enhanced stratification and (3) large-scale regional comparisons of marine biogeochemical and ecosystem processes: research approaches and results.

A three-dimensional model of Lake Superior with ice and biogeochemistry

Authors: Brooke White, Jay Austin, Katsumi Matsumoto

Journal: Journal of Great Lakes Research, Volume 38, Issue 1, March 2012, Pages 61-71

The formation of the lake. We present a new three-dimensional model of Lake Superior that includes a dynamic and thermodynamic ice model and a biogeochemical model. Results from the model forced by observed meteorological conditions for the period 1985 to 2008 are discussed and compared with available observations. Modeled long-term interannual trends in increasing water temperature and decreasing ice cover are compared with observed rates. In the model, total annual gross primary productivity is found to correlate positively with mean annual temperature and negatively with mean winter ice-cover magnitude.

Sensitivity of tropical carbon to climate change constrained by carbon dioxide variability

Authors: Peter M. Cox, David Pearson, Ben B. Booth, Pierre Friedlingstein, Chris Huntingford,

Journal: Nature, Volume 494, 21 February 2013, Pages 341-344

The release of carbon from tropical forests may exacerbate future climate change¹, but the magnitude of the effect in climate models remains uncertain². Coupled climate-carbon-cycle models generally agree that carbon storage on land will increase as a result of the simultaneous enhancement of plant photosynthesis and water use efficiency under higher atmospheric CO₂ concentrations, but will decrease owing to higher soil and plant respiration rates associated with warming temperatures³. At present, the balance between these effects varies markedly among coupled climate-carbon-cycle models, leading to a range of 330 gigatonnes in the projected change in the amount of carbon stored on tropical land by 2100.

Explanations for this large uncertainty include differences in the predicted change in rainfall in Amazonia^{4,5} and variations in the responses of alternative vegetation models to warming⁶. Here we identify an emergent linear relationship, across an ensemble of models⁷, between the sensitivity of tropical land carbon storage to warming and the sensitivity of the annual growth rate of atmospheric CO₂ to tropical temperature anomalies⁸. Combined with contemporary observations of atmospheric CO₂ concentration and tropical temperature, this relationship provides a tight constraint on the sensitivity of tropical land carbon to climate change. We estimate that over tropical land from latitude 30° north to 30° south, warming alone will release 53 ± 17 gigatonnes of carbon per kelvin. Compared with the unconstrained ensemble of climate-carbon-cycle projections, this indicates a much lower risk of Amazon forest dieback under CO₂-induced climate change if CO₂ fertilization effects are as large as suggested by current models². Our study, however, also implies greater certainty that carbon will be lost from tropical land if warming arises from reductions in aerosols or increases in other greenhouse gases.

Biogeochemistry: The depths of nitrogen cycling

Authors: Maren Voss, Susanna Hietanen

Journal: Nature, Volume 493, 31 January 2013, Pages 616-618

The largest pool of fixed nitrogen on Earth is dissolved organic nitrogen in the oceans, but its dynamics and transport between ocean zones are largely unknown. Writing in *Global Biogeochemical Cycles*, Letscheret *al.*¹ report that the observed concentration gradients of dissolved organic nitrogen in the oceans are the result of the interplay between high production in upwelling regions, the transfer of these waters from the surface to lower depths, and degradation by specifically adapted microbial communities. This contradicts the existing theory of the dynamics of nitrogen cycling.

The role of dissolved organic nitrogen (DON) in ocean productivity has long puzzled marine biogeochemists. DON accounts for roughly 60% of the reactive nitrogen in the ocean, which is a much higher percentage than that of readily available nitrogen-containing inorganic nutrients (such as nitrate) and particulate organic matter². DON has therefore been proposed to be one of the major sources of nutrients in the open ocean, and to be responsible for the concentration gradients of nitrate that are observed at different regions and depths³. For a long time, DON was regarded as unsuitable for microbial uptake, but we now know that part of it fuels primary production – the formation of organic molecules from carbon dioxide – especially in oceanic regions that are low in inorganic nutrients, such as open-ocean gyres (large systems of rotating currents).

Long-term warming restructures Arctic tundra without changing net soil carbon storage

Authors: Seeta A. Sistla, John C. Moore, Rodney T. Simpson, Laura Gough, Gaius R. Shaver

Journal: Nature, Volume 497, 30 May 2013, Pages 615-618

High latitudes contain nearly half of global soil carbon, prompting interest in understanding how the Arctic terrestrial carbon balance will respond to rising temperatures^{1, 2}. Low temperatures suppress the activity of soil biota, retarding decomposition and nitrogen release, which limits plant and microbial growth³. Warming initially accelerates decomposition^{4, 5, 6}, increasing nitrogen availability, productivity and woody-plant dominance^{3, 7}. However, these responses may be transitory, because coupled abiotic-biotic feedback loops that alter soil-temperature dynamics and change the structure and activity of soil communities, can develop^{8, 9}. Here we report the results of a two-decade summer warming experiment in an Alaskan tundra ecosystem. Warming increased plant biomass and woody dominance, indirectly increased winter soil temperature, homogenized the soil trophic structure across horizons and suppressed surface-soil-decomposer activity, but did not change total soil carbon or nitrogen stocks, thereby increasing net ecosystem carbon storage. Notably, the strongest effects were in the mineral horizon, where warming increased decomposer activity and carbon stock: a biotic awakening at depth.

Biogeochemistry: Nitrogen deposition and forest carbon

Authors:Beverly Law

Journal:Nature, Volume 496, 18 April 2013, 307-308

Nitrogen-containing compounds deposited from the atmosphere can affect the amount of carbon that is absorbed into ecosystems by photosynthesis. Writing in *Global Biogeochemical Cycles*, Fleischer et al.¹ reveal that photosynthesis by boreal and temperate evergreen forests rises with increased atmospheric nitrogen deposition, but levels out when a threshold value of 8 kilograms of nitrogen per hectare per year is reached. These findings highlight the need to clarify the connections between carbon and nitrogen in the environment, and to disentangle the effects of climate from those of nitrogen deposition on forests. The terrestrial biosphere is thought to take up about 30% of human-produced carbon dioxide from the atmosphere annually, lessening the greenhouse effect of fossil-fuel emissions². However, estimates of the size of this terrestrial sink are uncertain because of major gaps in our knowledge of the magnitude of the effects of the factors involved. One of these factors is the variation in human-caused additions of nitrogen to the atmosphere over time and space. Climate change and atmospheric fertilization of plants by human sources of nitrogen and CO₂ probably affect plant growth rates all over the world, but our understanding of these effects is likely to remain incomplete for the foreseeable future³. Most plants cannot use nitrogen gas in the atmosphere for growth. They require it to be converted to usable forms, such as ammonia – a process that forms part of the nitrogen cycle. However, the natural nitrogen cycle has been heavily influenced by human activities, which produce highly unstable forms of nitrogen known collectively as reactive nitrogen. The deposition of reactive nitrogen from the atmosphere to forests occurs mainly as a result of agricultural fertilizer use and fossil-fuel combustion, and has increased from 15 million tonnes of human-produced reactive nitrogen per year in the 1860s to 187 million tonnes by 2005 (ref. 4). Nitrogen deposition is expected to continue to increase in many regions, and has been predicted⁵ to almost double globally by 2050.

Changes in global nitrogen cycling during the Holocene epoch

Authors:Kendra K. McLauchlan,Joseph J. Williams,Elizabeth S. Jeffers

Journal:Nature, Volume 495, 21 March 2013, Pages 3526355

Human activities have doubled the pre-industrial supply of reactive nitrogen on Earth, and future rates of increase are expected to accelerate¹. Yet little is known about the capacity of the biosphere to buffer increased nitrogen influx. Past changes in global ecosystems following deglaciation at the end of the Pleistocene epoch provide an opportunity to understand better how nitrogen cycling in the terrestrial biosphere responded to changes in carbon cycling. We analysed published records of stable nitrogen isotopic values (¹⁵N) in sediments from 86 lakes on six continents. Here we show that the value of sedimentary ¹⁵N declined from 15,000 years before present to $7,056 \pm 597$ years before present, a period of increasing atmospheric carbon dioxide concentrations and terrestrial carbon accumulation². Comparison of the nitrogen isotope record with concomitant carbon accumulation on land and nitrous oxide in the atmosphere suggests millennia of declining nitrogen availability in terrestrial ecosystems during the Pleistocene-Holocene transition around 11,000 years before present. In contrast, we do not observe a consistent change in global sedimentary ¹⁵N values during the past 500 years, despite the potential effects of changing temperature and nitrogen influx from anthropogenic sources. We propose that the lack of a single response may indicate that modern increases in atmospheric carbon dioxide and net carbon sequestration in the biosphere have the potential to offset recent increased supplies of reactive nitrogen in some ecosystems.

Biogeochemistry: Carbon dioxide and water use in forests

Authors:Belinda Medlyn&Martin De Kauwe

Journal:Nature, Volume 499, 18 July 2013, Pages 2876289

The concentration of CO₂ in the atmosphere is rising at an unprecedented rate. In May this year, it reached 400 parts per million, 43% above the pre-industrial concentration of 280 p.p.m. (ref. 2). Much of this increase has occurred in recent decades, with the rate of increase over the past 20 years being 5% per decade². This drastic upsurge in atmospheric CO₂ should have stimulated plant productivity worldwide, because we know from experiments that rising CO₂ concentrations increase the rate of photosynthesis and reduce water use in plants³. Such effects are fundamental to our current understanding of the carbon cycle – for example, most terrestrial carbon-cycle models explain the current land sink for carbon by assuming that rising CO₂ levels have enhanced plant productivity⁴.

However, detecting the effects of rising CO₂ concentrations on terrestrial vegetation outside controlled experiments has proven remarkably difficult, provoking numerous debates about whether such effects are really occurring^{5, 6, 7, 8, 9, 10}. There are few high-quality, long-term records of plant productivity and water use that can be used to test for such effects. The main types of data come from plot surveys, tree-ring records, satellite images, aerial photographs and measurements of stream flow. Each of these is an indirect measurement and has a relatively coarse time resolution. Even where trends in these data have been detected, it has been extremely difficult to attribute them to rising CO₂ levels, because simultaneous changes

in many confounding factors δ such as rainfall, temperature, land use and fire frequency δ have occurred.

Calcium, strontium and barium biogeochemistry in a forested catchment and insight into elemental discrimination

Authors:Shaun A. Watmough.

Journal:An International Journal of Biogeochemistry, Volume 77, 2013, Pages 2876289

Elemental ratios of calcium (Ca), strontium (Sr) and barium (Ba) in plant tissue have been used to help identify sources of Ca in trees. However, recent work has clearly shown that ratios of Ca:Sr or Ca:Ba in plant tissues differ from soil values and discrimination factors (alteration of elemental ratios of Ca, Sr and Ba) have been established to account for differences between soil and foliar values. In this study, concentrations of Ca, Sr and Ba (and molar ratios) in bulk deposition, throughfall, soil water and stream water were measured along with tree chemistry and biomass (foliage, branches, bark, wood, roots and litter) at a forested catchment in central Ontario, Canada. Concentrations of Ca, Sr and Ba vary greatly among the eight dominant tree species and plant tissue and molar ratios of Ca:Sr or Ca:Ba vary more than tenfold. In general Ca:Sr ratios were highest in foliage (up to 3,175) and lowest in wood (low as 91) and the mass-weighted Ca:Sr ratio of the total tree biomass was approximately 340. The molar ratio of Ca:Sr in bulk precipitation was \sim 820, increased to over 1,000 in throughfall and then decreased steadily through the various soil horizons, falling to 320 in the B horizon. Conservative mass balances for the forest floor for Ca, Sr and Ba suggest that more than half the Ca, Sr and Ba annual uptake by trees is obtained from mineral soil, which is consistent with the observation that the weighted-average ratios of Ca:Sr, Ca:Ba or Ba:Sr in the forest biomass fall between values in water draining the forest floor and water draining the rooting zone (B horizon). This work shows that discrimination between Ca, Sr and Ba is primarily internal to trees and discrimination factors between soil and foliage should be interpreted with caution.

Incorporating urban infrastructure into biogeochemical assessment of urban tropical streams in Puerto Rico

Authors:J. D. Potter, W. H. McDowell, A. M. Helton and M. L. Daley

Journal:An International Journal of Biogeochemistry, Volume 1077, 2013,Pages 87696

The influence of built urban infrastructure on stream chemistry was quantified throughout the drainage network of the tropical Río Piedras watershed, San Juan metropolitan area, Puerto Rico. Urbanization and failing domestic wastewater infrastructure appeared to drive changes in surface water chemistry throughout the watershed. Mean baseflow concentrations of chloride (Cl), ammonium (NH₄), dissolved organic carbon (DOC), dissolved organic nitrogen (DON), and phosphate (PO₄) all increased with urban infrastructure, while nitrate (NO₃) and dissolved oxygen (DO) decreased. These patterns in stream chemistry suggest that sewage effluent from failing or illegally connected sewer pipes has a major impact on surface water

quality. Concentrations of Cl, DO, and NH₄ in stream water were most strongly related to sewer pipe volume, demonstrating the tight connection between urban infrastructure and stream chemistry. The loading and transformation of NO₃ and NH₄ were modeled along the river network and NH₄ loading rates from the landscape were strongly related to urban infrastructure, whereas NO₃ loading rates showed only weak relationships, highlighting the importance for incorporating NH₄ dynamics into river network models in urban environments. Water quality appears to be severely impacted by sewage in this tropical basin, despite large investments in built infrastructure. The high temperatures in the Río Piedras exacerbate water quality problems by reducing saturation DO levels in streams, and intense rainstorms tax the ability of built infrastructure to adequately manage overland flows. These problems are likely typical of much of the urbanized humid tropics.

Biogeochemical processes in the groundwater discharge zone of urban streams

Authors: Michael J. Donnad Olga V. Barron

Journal: An International Journal of Biogeochemistry, Volume 23, 2013, Pages 57-65

The influence of biogeochemical processes on nitrogen and organic matter transformation and transport was investigated for two urban streams receiving groundwater discharge during the dry summer baseflow period. A multiple lines of evidence approach involving catchment-, and stream reach-scale investigations were undertaken to describe the factors that influence pore water biogeochemical processes. At the catchment-scale gaining stream reaches were identified from water table mapping and groundwater discharge estimated to be between 0.1 and 0.8 m³ m⁻² d⁻¹ from baseflow analysis. Sediment temperature profiles also suggested that the high groundwater discharge limited stream water infiltration into the sediments. At the stream reach-scale, dissolved organic carbon (DOC) and dissolved organic nitrogen (DON) concentrations were higher in stream water than in groundwater. However, DOC and DON concentrations were greatest in sediment pore water. This suggests that biodegradation of sediment organic matter contributes dissolved organic matter (DOM) to the streams along with that delivered with groundwater flow. Pore water ammonium (NH₄⁺) was closely associated with areas of high pore water DOM concentrations and evidence of sulfate (SO₄²⁻) reduction (low concentration and SO₄:Cl ratio). This indicates that anoxic DOM mineralization was occurring associated with SO₄²⁻ reduction. However the distribution of anoxic mineralization was limited to the center of the streambed, and was not constrained by the distribution of sediment organic matter which was higher along the banks. Lower sediment temperatures measured along the banks compared to the center suggests, at least qualitatively, that groundwater discharge is higher along the banks. Based on this evidence anoxic mineralization is influenced by groundwater residence time, and is only measurable along the center of the stream where groundwater flux rates are lower. This study therefore shows that the distribution of biogeochemical processes in stream sediments, such as anoxic mineralization, is strongly influenced by both the biogeochemical conditions and pore water residence time.

Strong gradient of benthic biogeochemical processes along a macrotidal temperate estuary: focus on P and Si cycles

Authors: Mélanie Raimone, Françoise Andrieux-Loyer, Olivier Ragueneau, Emma Michaud, Roger Kerouel, Xavier Philippon, Michel Nonentand Laurent Mémery.

Journal: An International Journal of Biogeochemistry, Volume 28, 2013, Pages 101-111.

This study aims to investigate the role of spatial and temporal physical, biological and biogeochemical gradients on sediment biogeochemistry along a macrotidal and Si-rich estuary. Scanning and biogeochemical analyses were performed in the inner, mid and outer Aulne Estuary (France) at four seasons. The inner estuary shows high diagenetic activity linked to fluid mud dynamics and river loads. The highest authigenic phosphorus (Aut-P) concentrations ever found in the literature are observed in the inner estuary (18 mol g^{-1} PS sediment). This is explained by a combination of favorable factors, i.e. the high organic matter and nutrient loads, the reductive conditions, the freshwater properties (low pH, OH⁻, sulfate and Mg²⁺ concentrations), the increase of particle residence time by the upward convergence of particles due to residual currents, and allochthonous riverine Aut-P. We suggest that the high Si(OH)₄ concentrations (>400 M) may even increase Aut-P precipitation through the increase of Fe₃P formation in these low salinity conditions. In the mid estuary, erosion-deposition dynamics dominate in point bars and lead to the succession of poor and rich organic and authigenic phosphorus layers, recording thus the seasonality of matter loads and its seasonal translocation from the inner estuary. In the outer estuary, deposition rates are high and constant and biogeochemical properties are characteristic of marine environments. The precipitation of Aut-P from free phosphate (PO₄³⁻) is lower than in the inner estuary and might be limited by higher Mg²⁺ concentrations in saline waters. This study highlights that small macrotidal estuaries, and especially their freshwater sediments, may constitute an important phosphorus sink through the precipitation of Aut-P. This precipitation could even be enhanced in fresh or brackish environments, thus increasing long term phosphorus storage and altering benthic fluxes of PO₄³⁻ to the pelagic ecosystem.

Strong latitudinal patterns in the elemental ratios of marine plankton and organic matter

Authors: Adam C. Martiny, Chau T. A. Pham, Francois W. Primeau, Jasper A. Vrugt, J. Keith Moore, Simon A. Levin & Michael W. Lomas

Journal: Nature Geoscience, Volume 6, (2013), Pages 279-283

Redfield observed a similarity between the elemental composition of marine plankton in the surface ocean and dissolved nutrients in the ocean interior. This stoichiometry, referred to as the Redfield ratio, continues to be a central tenet in ocean biogeochemistry, and is used to infer a variety of ecosystem processes, such as phytoplankton productivity and rates of nitrogen fixation and loss. Model, field and laboratory studies have shown that different mechanisms can explain both constant and variable ratios of carbon to nitrogen and phosphorus among ocean plankton communities. The range of C/N/P ratios in the ocean, and

their predictability, are the subject of much active research. Here we assess global patterns in the elemental composition of phytoplankton and particulate organic matter in the upper ocean, using published and unpublished observations of particulate phosphorus, nitrogen and carbon from a broad latitudinal range, supplemented with elemental data for surface plankton populations. We show that the elemental ratios of marine organic matter exhibit large spatial variations, with a global average that differs substantially from the canonical Redfield ratio. However, elemental ratios exhibit a clear latitudinal trend. Specifically, we observed a ratio of 195:28:1 in the warm nutrient-depleted low-latitude gyres, 137:18:1 in warm, nutrient-rich upwelling zones, and 78:13:1 in cold, nutrient-rich high-latitude regions. We suggest that the coupling between oceanic carbon, nitrogen and phosphorus cycles may vary systematically by ecosystem.

High rates of microbial carbon turnover in sediments in the deepest oceanic trench on Earth

Authors: Ronnie N. Glud, Frank Wenzhöfer, Mathias Middelboe, Kazumasa Oguri, Robert Turnewitsch, Donald E. Canfield & Hiroshi Kitazato

Journal: Nature Geoscience, Volume 6, (2013), Pages 284-288.

Microbes control the decomposition of organic matter in marine sediments. Decomposition, in turn, contributes to oceanic nutrient regeneration and influences the preservation of organic carbon¹. Generally, rates of benthic decomposition decline with increasing water depth, although given the vast extent of the abyss, deep-sea sediments are quantitatively important for the global carbon cycle^{2, 3}. However, the deepest regions of the ocean have remained virtually unexplored⁴. Here, we present observations of microbial activity in sediments at Challenger Deep in the Mariana Trench in the central west Pacific, which at almost 11,000 m depth represents the deepest oceanic site on Earth. We used an autonomous micro-profiling system to assess benthic oxygen consumption rates. We show that although the presence of macrofauna is restricted at Challenger Deep, rates of biological consumption of oxygen are high, exceeding rates at a nearby 6,000-m-deep site by a factor of two. Consistently, analyses of sediments collected from the two sites reveal higher concentrations of microbial cells at Challenger Deep. Furthermore, analyses of sediment ²¹⁰Pb profiles reveal relatively high sediment deposition in the trench. We conclude that the elevated deposition of organic matter at Challenger Deep maintains intensified microbial activity at the extreme pressures that characterize this environment.

Response of global soil consumption of atmospheric methane to changes in atmospheric climate and nitrogen deposition

Authors: Qianlai Zhuang, Min Chen, Kai Xu, Jinyun Tang, Eri Saikawa, Yanyu Lu¹, Jerry M. Melillo, Ronald G. Prinn, A. David McGuire.

Journal: Global Biogeochemical Cycles, Volume 27(3), 2013, Pages 650-663.

Soil consumption of atmospheric methane plays an important secondary role in regulating the atmospheric CH₄ budget, next to the dominant loss mechanism involving reaction with

the hydroxyl radical (OH). Here we used a process-based biogeochemistry model to quantify soil consumption during the 20th and 21st centuries. We estimated that global soils consumed 32636 Tg CH₄ yr⁻¹ during the 1990s. Natural ecosystems accounted for 84% of the total consumption, and agricultural ecosystems only consumed 5 Tg CH₄ yr⁻¹ in our estimations. During the twentieth century, the consumption rates increased at 0.0360.20 Tg CH₄ yr⁻² with seasonal amplitudes increasing from 1.44 to 3.13 Tg CH₄ month⁻¹. Deserts, shrublands, and xeric woodlands were the largest sinks. Atmospheric CH₄ concentrations and soil moisture exerted significant effects on the soil consumption while nitrogen deposition had a moderate effect. During the 21st century, the consumption is predicted to increase at 0.05-1.0 Tg CH₄ yr⁻², and total consumption will reach 456140 Tg CH₄ yr⁻¹ at the end of the 2090s, varying under different future climate scenarios. Dry areas will persist as sinks, boreal ecosystems will become stronger sinks, mainly due to increasing soil temperatures. Nitrogen deposition will modestly reduce the future sink strength at the global scale. When we incorporated the estimated global soil consumption into our chemical transport model simulations, we found that nitrogen deposition suppressed the total methane sink by 26 Tg during the period 19986 2004, resulting in 6.6 ppb higher atmospheric CH₄ mixing ratios compared to without considering nitrogen deposition effects. On average, a cumulative increase of every 1 Tg soil CH₄ consumption decreased atmospheric CH₄ mixing ratios by 0.26 ppb during the period 199862004.

The geochemistry during management of lake acidification caused by the rewetting of sulfuric (pH < 4) acid sulfate soils

Authors: Luke M. Mosley, Paul Shand, Peter Self, Rob Fitzpatrick

Journal: Applied Geochemistry, Volume 41, February 2014, Pages 49661

Understanding the geochemistry and kinetics of acidification events arising from acid sulfate soils is important to enable effective management and risk assessment. Large-scale exposure and oxidation of acid sulfate soils occurred during a drought in the Lower Lakes (Murray-Darling Basin) of South Australia. We examined the geochemical changes that occurred in one region (Boggy Lake) that experienced surface water acidification and was subsequently neutralised via aerial limestone (CaCO₃) dosing and dilution via natural lake refill. Very low pH (< 3) and high concentrations (€1061000 mg/L Fe, Al, Mn) of dissolved metals were initially found in surface water. The water chemistry exhibited pH-dependent enhancement of constituents typically associated with acid sulfate soils (SO₄, Al and Fe). Geochemical speciation calculations indicated that most (60680%) of the acidity was present as dissolved metal-sulfate complexes at low pH. X-ray diffraction (XRD) analyses showed that the orange-brown precipitates present after an initial limestone dosing were secondary oxyhydroxysulfate minerals (schwertmannite, jarosite). Further limestone dosing resulted in neutralisation of the pH, reduction in dissolved metal concentrations, dissolution of jarosite and schwertmannite precipitates, and formation of other metal oxyhydroxide phases. The results were consistent with a pE-pH diagram constructed for metal-sulfur geochemistry. Assessment of the measured and simulated (using PHREEQC) pH and Ca/Cl ratio during limestone dosing indicated that only about 25% of the limestone dissolved. XRD analyses suggested this passivation of the limestone was due to coating with gypsum and schwertmannite.

Mineralogy and geochemistry of alteration induced by hydrocarbon seepage in an evaporite formation; a case study from the Zagros Fold Belt, SW Iran

Authors: Majid H. Tangestani , Khadijeh Validabadi.

Journal: *Geochemistry*, Volume, February 2014, Pages 1896195

Leaking hydrocarbon and associated fluids produce a reduced environment which initiates diagenetic reactions in the rocks and soils overlying hydrocarbon reservoirs. This article introduces mineralogical and geochemical alterations induced by hydrocarbon seepages in the Gachsaran evaporite Formation, Masjed Soleiman, Zagros Folded Belt, SW Iran, using various geochemical methods. X-ray diffraction (XRD) analysis revealed two dominant groups of mineralogical changes in the anomalous zone including: (1) spotty occurrences of jarosite, natroalunite, and sulfur; (2) simultaneous decrease of sulfate and increase of carbonate. The ^{13}C values of carbonate phases vary between -8.9‰ and -32.3‰ which support a partial contribution of hydrocarbon in these phases. pH measurements of rock samples indicated that hydrocarbon seepage causes decrease of pH, though not very significantly. However, pH in areas that show ongoing sour hydrocarbon seepage among rarely pure gypsum beds decrease to 0.09 which produces acid sulfate soil. Trace element concentrations indicated that Cr, Co, Ni, V, Cd, U, Cu, and Zn increase in various patterns around the hydrocarbon seepages excepting the areas with very low pH.

Biogeochemical multi-element signatures in common juniper at Mäkärärova, Finnish Lapland: Implications for Au and REE exploration

Authors: Paavo Närhi, Maarit Middleton , Raimo Sutinen

Journal: Journal of Geochemical Exploration, Volume 138, March 2014, Pages 50658

Biogeochemical exploration methods involve chemical analyses of soil organic matter and plant species with a minimal environmental influence. Common juniper (*Juniperus communis* L.) was assessed as a medium for gold and rare earth element exploration in a shear zone of the Tanaelv Complex, northern Finland. Highest gold concentrations in the juniper twigs spatially coincide with weathered Au-rich hematite-quartz veins in the bedrock. Although gold concentrations were generally low (0.5 ppb), the results suggest that the chemical analysis of common juniper is a feasible biogeochemical exploration tool for gold. Concentrations of rare earth elements (REEs) were high in the area where juniper growth was restricted as evidenced by low tissue nutrient concentrations. The restricted growth of REE-rich twigs indicates that they comprised more years of growth compared to other same-sized twig samples. The results indicate that the twigs of common juniper accumulate REEs over time and therefore, in biogeochemical sampling, the twig age should be taken into account. Furthermore, the results suggest that exceptionally dense coverages of *Solidago virgaurea* L. and *Trientalis europaea* L. can potentially be used for focusing REE exploration on suitable areas.

Hydrogeochemistry and arsenic contamination of groundwater in the Jiangnan Plain, central China

Authors:YiqunGan, Yanxin Wang, YanhuaDuan, Yamin Deng, XinxinGuo

Journal:Journal of Geochemical Exploration, Volume 138, March 2014, Pages 81693

Although high arsenic groundwater has been reported in the northwest of China, no data describing groundwater arsenic in the river plains of central China have been published to date. In this study, 186 groundwater samples were collected from the Jiangnan Plain between the Yangtze and Han rivers. Major constituents, trace elements, dissolved organic carbon (DOC), and stable hydrogen and oxygen isotopic compositions were analyzed to characterize groundwater chemistry and evaluate the factors controlling arsenic concentration and distribution in the plain. The results show that the groundwater is mainly HCO_3CaMg type with circum-neutral pH and moderate to high electrical conductivity. Negative Eh and high concentrations of DOC clearly indicate strongly reducing conditions with abundant organic matter in the groundwater aquifers. The characteristics of H/O stable isotopes demonstrate that the groundwater in the study area is recharged by local precipitation and there is a slow evaporation effect. Groundwater with high arsenic was found in wells at depths of 10 to 45 m along rivers. About 87% of the groundwater samples had As concentrations exceeding the WHO recommended value of 10 g/L, up to 2330 g/L. High concentrations of dissolved Fe (maximum value, 23 mg/L), Mn (maximum value, 5 mg/L) and P (maximum value, 4 mg/L) were also observed in groundwater. Among the wells, 89% and 98% exceeded the WHO guideline for Fe and Mn, respectively. The concentrations of total As measured in sediments from the Jiangnan Plain were much higher than the global average, ranging from 11 to 108 mg/kg. All of the sediments had high Fe (Fe_2O_3 469%) and Mn (50461064 mg/kg) levels, which is consistent with Fe and Mn oxides/hydroxides considered to be the dominant minerals containing As in sediments and the main sources for As in groundwater of the Jiangnan Plain. The main potential mechanism for the release of As is the reductive dissolution of Fe and Mn oxides/hydroxides under reducing conditions, while microbial degradation of organic matter may also facilitate the release of arsenic into groundwater. The competitive effects of other anions may also be important factors since the concentrations of DOC, HCO_3^- and dissolved P were high in many of the groundwater samples.

Hydrogeochemical interpretation of South Korean groundwater monitoring data using Self-Organizing Maps

Authors:Byoung-Young Choi, Seong-Taek Yun, Kyoung-Ho Kim, Ji-Wook Kim, HyangMi

Journal:Journal of Geochemical Exploration, Volume 137, February 2014, Pages 73684

The National Groundwater Monitoring Network (NGMN) of South Korea provides data since 1995 to monitor the water level and quality of groundwater on a national scale. Major ions such as Ca, Mg, Na, K, HCO_3^- , Cl, SO_4^{2-} and NO_3^- have been monitored since 2008 to assess groundwater quality. Hydrochemical data of bedrock groundwater samples collected from

299 monitoring stations in 2009 were examined using the Self-Organizing Map (SOM) approach. Based on hydrochemical characteristics, bedrock groundwater is clustered into two groups and six subgroups. Group I containing 70.2% of groundwater samples (and monitoring stations) is characterized by lower TDS values and NO_3 concentrations than Group II, indicating that Group I waters are less affected by contamination. Subgroup I-1 (39.1%) represents CaHCO_3 -type groundwater with relatively low pH, TDS and concentrations of most ions compared with groundwater of Subgroups I-2-1 (26.1%) and I-2-2 (5.0%). Subgroup I-2-2 represents a moderately alkaline, F-rich, NaHCO_3 -type groundwater. Group II records either anthropogenic or natural processes. Subgroup II-1 (16.1%) contains groundwater with low values of TDS, HCO_3 and pH, and moderately high NO_3 concentrations due to nitrification, while groundwater of Subgroups II-2-1 and II-2-2 is characteristically high in Ca and Mg. Subgroup II-2-1 is also very high in SO_4 and HCO_3 but very low in NO_3 , while Subgroup II-2-2 is substantially enriched in Cl and NO_3 . The hydrochemistry of groundwater of Subgroup II-2-1 likely results from dissolution of carbonates and gypsum in clastic sedimentary rocks and is affected by dissolution of pyrite and/or S-bearing fertilizers in crystalline rocks. The enrichment of NO_3 , Cl, Ca and Mg in groundwater of Subgroup II-2-2 is the result of substantial contamination from agrochemicals and manure. Thus, about 20.5% (Subgroups II-1 and II-2-2) of bedrock groundwater in South Korea records anthropogenic contamination. This study shows that the SOM approach can be successfully used to classify and characterize the groundwater in terms of hydrochemistry and quality on a regional scale.

Geochemistry of trace elements and water quality assessment of natural water within the Tarim River Basin in the extreme arid region, NW China

Authors: Jun Xiao, Zhangdong Jin, Jin Wang

Journal: Journal of Geochemical Exploration, Volume 136, January 2014, Pages 1186126

Concentrations of twenty-one trace elements were measured by ICP-MS in 57 river and 20 well water samples collected in 2011 to define the spatial variability, sources, and the quality of natural water within the Tarim River Basin (TRB), one of the driest arid zones on the earth. The results showed that waters within the TRB were slightly alkaline with high total dissolved solids (TDS). TDS values in 76% of the samples, especially the well waters, were brackish water. The measured trace elements could be divided into dominant trace elements ($> 10 \text{ g/L}$; Sr, B, Al, Li, Fe, Ba, and Mn), moderate trace elements ($10\text{--}60.1 \text{ g/L}$; Ti, Pb, As, Ni, Cu, Zn, V, and Cr), and low trace elements ($< 0.1 \text{ g/L}$; Sn, Cd, Tl, Co, Sb, and Ga). The trace element concentrations in both the southern sub-basin and the Tarim River were high whereas those in the northern sub-basin were low. The trace elements have slightly higher concentrations in well waters than those in river waters. Principal component analysis (PCA) showed that B, Li, Sr, Co, Cd, and Tl derive from evaporite dissolution and carbonate weathering, while Ni, Cu, Zn, Sn, and Ga originate from mining industries. According to the water quality index (WQI), about 79% of the waters within the TRB can be classified of good and excellent quality, and are suitable for drinking. However, the high boron concentrations in the southeastern and the Yarkant sub-basins, high fluorine in the southeastern sub-basin and well waters, and high total hardness (TH) in the southern and the Yarkant sub-basins, and the Tarim River could constitute a threat to human health.

Influences of coal mining water irrigation on the maize losses in the Xingdong Mine area, China

Authors: Yuzhuang Sun, Pei Ling, Yanheng Li, Qingxue Li, Quande Sun and Jinxi Wang

Journal: Journal of the Society for Environmental Geochemistry and Health.

In 2008, a maize underproduction disaster occurred in the Xianyu village after irrigation using the coal mining water from the Xingdong Mine, China. This disaster resulted in about 40 hectare maize underproduction and 20 hectare total loss of the maize yields. In order to study the reason, a total of 25 soil, water and plant samples were taken from the study area. These samples were analysed by inductively coupled plasma mass spectrometry and ion chromatography. The results indicate that the contents of both water-soluble fluorine and total fluorine are very high and resulting of maize underproduction and total loss of production. The possible pollution sources of fluorine in the study area could be from the coal mine water used for irrigation and glass chemical factory near the study area.

Soil extracellular enzyme activities correspond with abiotic factors more than fungal community composition

Authors: Stephanie N. Kivlin and Kathleen K. Treseder

Journal: Biogeochemistry: An International Journal, Volume 5, January 2014, Pages 18626

Soil extracellular enzymes are the proximal drivers of decomposition. However, the relative influence of climate, soil nutrients and edaphic factors compared to microbial community composition on extracellular enzyme activities (EEA) is poorly resolved. Determining the relative effects of these factors on soil EEA is critical since changes in climate and microbial species composition may have large impacts on decomposition. We measured EEA from five sites during the growing season in March and 17 sites during the dry season in July throughout southern California and simultaneously collected data on climate, soil nutrients, soil edaphic factors and fungal community composition. The concentration of carbon and nitrogen in the soil and soil pH were most related to hydrolytic EEA. Conversely, oxidative EEA was mostly related to mean annual precipitation. Fungal community composition was not correlated with EEA at the species, genus, family or order levels. The hyphal length of fungi was correlated with EEA during the growing season while relative abundance of taxa within fungal phyla, in particular Chytridiomycota, was correlated with the EEA of beta-glucosidase, cellobiohydrolase, acid phosphatase and beta-xylosidase in the dry season. Overall, in the dry season, 35.3 % of the variation in all enzyme activities was accounted for by abiotic variables, while fungal composition accounted for 27.4 %. Because global change is expected to alter precipitation regimes and increase nitrogen deposition in soils, EEA may be affected, with consequences for decomposition.

No effects of experimental warming but contrasting seasonal patterns for soil peptidase and glycosidase enzymes in a sub-arctic peat bog

Authors: James T. Weedon, Rien Aerts, George A. Kowalchuk and Peter M. van Bodegom

Journal: Biogeochemistry: An International Journal, Volume 3, January 2014, Pages 8621

The nature of linkages between soil C and N cycling is important in the context of terrestrial ecosystem responses to global environmental change. Extracellular enzymes produced by soil microorganisms drive organic matter decomposition, and are considered sensitive indicators of soil responses to environmental variation. We investigated the response of eight hydrolytic soil enzymes (four peptidases and four glycosidases) to experimental warming in a long-term climate manipulation experiment in a sub-arctic peat bog, to determine to what extent the response of these two functional groups are similar. We found no significant effect of experimental spring and summer warming and/or winter snow addition on either the potential activity or the temperature sensitivity (of V_{max}) of any of the enzymes. However, strong and contrasting seasonal patterns in both variables were observed. All of the peptidases, as well as alpha-glucosidase, had lower potential activity at the end of summer (August) compared to the beginning (June). Conversely, beta-glucosidase had significantly higher potential activity in August. Peptidases had consistently higher temperature sensitivities in June compared to August, while all four glycosidases showed the opposite pattern. Our results suggest that warming effects on soil enzymes are small compared to seasonal differences, which are most likely mediated by the seasonality of substrate supply and microbial nutrient demand. Furthermore the contrasting seasonal patterns for glycosidases and peptidases suggest that enzyme-based models of soil processes need to allow for potential divergence between the production and activity of these two enzyme functional groups.

Contrasting responses of two Sitka spruce forest plots in Ireland to reductions in sulphur emissions: results of 20 years of monitoring

Authors: J. A. Johnson, J. Aherne and T. Cummins

Journal: Biogeochemistry: An International Journal, Volume 8, January 2014, Pages 13-25

Long-term trends in ion concentrations of bulk precipitation, throughfall, forest floor leachate (humus water) and shallow and deep soil water were assessed at two Sitka spruce (*Picea sitchensis*) stands: one on an Atlantic peat bog in the west of Ireland (Cloosh), the other on the east coast on a peaty podzol (Roundwood). Deposition at Cloosh was dominated by marine ions (sodium, $[Na^+]$, chloride $[Cl^-]$, and magnesium $[Mg^{2+}]$), whereas bulk precipitation and throughfall at Roundwood was characterized by inputs of non-marine sulphate ($nmSO_4^{2-}$), acidity and inorganic nitrogen (NH_4^+ , NO_3^-). Significant declines in concentrations of $nmSO_4^{2-}$ and acidity in bulk precipitation and throughfall were observed at both sites. The decline in throughfall $nmSO_4^{2-}$ was significantly related to reductions in European sulphur dioxide (SO_2) emissions. At Roundwood, SO_4^{2-} declined significantly in humus, shallow and deep soil water. In deep soil water this was accompanied by a long-term increase in pH and a reduction in total aluminum (Al_{tot}). The recovery from acidification was

delayed by high concentrations of NO_3^- , which strongly influenced acidity and Al_{tot} concentrations. At Cloosh, there was a significant decline in SO_4^{2-} in humus water but long-term trends were not evident in shallow or deep soil water; SO_4^{2-} concentrations at these depths fluctuated in response to drought-events. Marine ions strongly influenced soil water chemistry at both sites; at Cloosh soil water acidity was strongly related to Na^+ and Cl^- , while at Roundwood, Na^+ , Cl^- and Mg^{2+} influenced Al_{tot} concentrations. Dissolved organic carbon increased significantly in humus and soil water at Roundwood, where it was associated with declining acidity. Soil water at both sites was influenced by a combination of anthropogenic sulphur (S) and nitrogen (N) deposition, drought and sea-salt events. The study highlights the value of long-term monitoring in assessing the response of forest soils to S and N deposition against a background of climate influences on soil water through drought and sea-salt events.

The importance of denitrification for N_2O emissions from an N-saturated forest in SW China: results from in situ ^{15}N labeling experiments

Authors: Jing Zhu, Jan Mulder, Lars Bakken and Peter Dörsch

Journal: Biogeochemistry: An International Journal, Volume 15, January 2014, Pages 21-31

Long-term elevated atmospheric deposition ($\sim 5 \text{ g m}^{-2} \text{ year}^{-1}$) of reactive nitrogen (N) causes N saturation in forests of subtropical China which may lead to high nitrous oxide (N_2O) emissions. Recently, we found high N_2O emission rates (up to $1,730 \text{ g N}_2\text{O} \text{ N m}^{-2} \text{ h}^{-1}$) during summer on well-drained acidic Acrisols ($\text{pH} = 4.0$) along a hill slope in the forested Tieshanping catchment, Chongqing, southwest China. Here, we present results from an in situ ^{15}N labeling experiment to assess the contribution of nitrification and denitrification to N_2O emissions in these soils. Two loads of 99 at.% K^{15}NO_3 (equivalent to 0.2 and 1.0 g N m^{-2}) were applied as a single dose to replicated plots at two positions along the hill slope (at top and bottom, respectively) during monsoonal summer. During a 6-day period after label application, we found that 71–100 % of the emitted N_2O was derived from the labeled NO_3^- pool irrespective of slope position. Based on this, we assume that denitrification is the dominant process of N_2O formation in these forest soils. Within 6 days after label addition, the fraction of the added ^{15}N emitted as $^{15}\text{N}_2\text{O}$ was highest at the low-N addition plots (0.2 g N m^{-2}), amounting to 1.3 % at the top position of the hill slope and to 3.2 % at the bottom position, respectively. Our data illustrate the large potential of acid forest soils in subtropical China to form N_2O from excess NO_3^- most likely through denitrification.

Plant rhizosphere influence on microbial C metabolism: the role of elevated CO_2 , N availability and root stoichiometry

Authors: Yolima Carrillo, Feike A. Dijkstra, Elise Pendall, Dan LeCain and Colin Tucker

Journal: Biogeochemistry, Volume 10, February 2014, Pages 23-35

Microbial decomposer C metabolism is considered a factor controlling soil C stability, a key regulator of global climate. The plant rhizosphere is now recognized as a crucial driver of soil C dynamics but specific mechanisms by which it can affect C processing are unclear. Climate change could affect microbial C metabolism via impacts on the plant rhizosphere. Using continuous ^{13}C labelling under controlled conditions that allowed us to quantify SOM derived-C in all pools and fluxes, we evaluated the microbial metabolism of soil C in the rhizosphere of a C4 native grass exposed to elevated CO_2 and under variation in N concentrations in soil and in plant root C:N stoichiometry. Our results demonstrated that this plant can influence soil C metabolism and further, that elevated CO_2 conditions can alter this role by increasing microbial C efficiency as indicated by a reduction in soil-derived C respiration per unit of soil C-derived microbial biomass. Moreover, under elevated CO_2 increases in soil N, and notably, root tissue N concentration increased C efficiency, suggesting elevated CO_2 shifted the stoichiometric balance so N availability was a more critical factor regulating efficiency than under ambient conditions. The root C:N stoichiometry effect indicates that plant chemical traits such as root N concentration are able to influence the metabolism of soil C and that elevated CO_2 conditions can modulate this role. Increased efficiency in soil C use was associated with negative rhizosphere priming and we hypothesize that the widely observed phenomenon of rhizosphere priming may result, at least in part, from changes in the metabolic efficiency of microbial populations. Observed changes in the microbial community support that shifting microbial populations were a contributing factor to the observed metabolic responses. Our case study points at greater efficiency of the SOM-degrading populations in a high CO_2 , high N world, potentially leading to greater C storage of microbially assimilated C in soil.

Effects of urban stream burial on nitrogen uptake and ecosystem metabolism: implications for watershed nitrogen and carbon fluxes

Authors: Michael J. Pennino, Sujay S. Kaushal, Jake J. Beaulieu, Paul M. Mayer and Clay P. Arango.

Journal: Biogeochemistry , Volume 21 , February 2014, Pages 42-54

Urbanization has resulted in the extensive burial and channelization of headwater streams, yet little is known about the impacts of stream burial on ecosystem functions critical for reducing downstream nitrogen (N) and carbon (C) exports. In order to characterize the biogeochemical effects of stream burial on N and C, we measured NO_3^- uptake (using $^{15}\text{N}\text{-NO}_3^-$ isotope tracer releases) and gross primary productivity (GPP) and ecosystem respiration (ER) (using whole stream metabolism measurements). Experiments were carried out during four seasons, in three paired buried and open stream reaches, within the Baltimore Ecosystem Study Long-term Ecological Research site. Stream burial increased NO_3^- uptake lengths by a factor of 7.5 ($p < 0.01$) and decreased NO_3^- uptake velocity and areal NO_3^- uptake rate by factors of 8.2 ($p < 0.05$) and 9.6 ($p < 0.001$), respectively. Stream burial decreased GPP by a factor of 11.0 ($p < 0.01$) and decreased ER by a factor of 5.0 ($p < 0.05$). From fluorescence Excitation Emissions Matrices analysis, buried streams were found to have significantly altered C quality, showing less labile dissolved organic matter. Furthermore, buried streams had significantly lower transient storage (TS) and water temperatures. Differences in NO_3^- uptake, GPP, and ER in buried streams, were primarily explained by decreased TS, light availability, and C quality, respectively. At the watershed scale, we estimate that stream burial decreases NO_3^- uptake by 39 % and C production by 194 %. Overall, our results suggest that stream burial significantly impacts NO_3^- uptake, stream metabolism, and the

quality of organic C exported from watersheds. Given the large impacts of stream burial on stream ecosystem processes, daylighting or de-channelization of streams, through hydrologic floodplain reconnection, may have the potential to alter ecosystem functions in urban watersheds, when used appropriately.

Seasonal and geomorphic controls on N and P removal in riparian zones of the US Midwest

Authors: X. Liu, P. Vidon, P.-A. Jacinthe, K. Fisher and M. Baker

Journal: Biogeochemistry , Volume 33, February 2014, Pages 122-135.

Riparian zones are an important strategy to mitigate N and P export to streams. However, their efficiency with respect to nitrate (NO_3^-), ammonium (NH_4^+), or soluble reactive phosphorus (SRP) in groundwater remains uncertain in the US Midwest. This study investigates water table fluctuations and NO_3^- , NH_4^+ , and SRP concentration dynamics in two riparian zone types (outwash vs. glacial till) common in the upper US Midwest. During low water table periods, NO_3^- removal was 93 % at WR (outwash site), and 75 % at LWD (glacial till site); but during high water table periods, NO_3^- removal efficiencies dropped to 50 % at WR, and 14 % at LWD. Median seasonal mass fluxes of NO_3^- removed at WR (9.46–21.7 $\text{mg N day}^{-1} \text{m}^{-1}$ of stream length) and LWD (0.46–1.9 $\text{mg N day}^{-1} \text{m}^{-1}$) were small compared to other riparian zones in glaciated landscapes. The WR site was a small SRP sink (0.114 and 0.118 $\text{mg day}^{-1} \text{m}^{-1}$ during the dry period and wet period, respectively), while LWD acted as a small SRP source to the stream (0.004 $\text{mg day}^{-1} \text{m}^{-1}$ during the dry period; 0.075 $\text{mg day}^{-1} \text{m}^{-1}$ during the wet period). Both LWD and WR acted as sources of NH_4^+ to the stream with mass fluxes ranging from 0.17 to 7.75 $\text{mg N day}^{-1} \text{m}^{-1}$. Although riparian zones in the US Midwest provide many ecosystem services, results suggest they are unlikely to efficiently mitigate N and P pollution in subsurface flow.

Impact of changing atmospheric deposition chemistry on carbon and nutrient loading to Ganga River: integrating land-atmosphere-water components to uncover cross-domain carbon linkages

Authors: Jitendra Pandey, Usha Pandey and Anand V. Singh

Journal: Biogeochemistry , Volume 15, January 2014, Pages 102-110

Terrestrial contribution of dissolved organic carbon (DOC) to riverine carbon transport remains relatively uncertain despite recent research highlighting its importance. Here we present data on changing state of atmosphere-land-water transfer and associated shift in DOC build-up in Ganga River (India) for a period of 6 years (March, 2007–February, 2013). Although the N:P stoichiometry of atmospheric deposition (AD) showed a declining trend, there was over 1.4 to 1.6-fold increase in AD- NO_3^- , 1.5 to 1.8-fold increase in AD-OC and, over 1.5 to 2.2-fold increase in AD- NH_4^+ and AD- PO_4^{3-} input over time. Water soluble organic carbon and microbial activity in sub-catchments and, DOC and nutrient concentrations in runoff increased consistently over time along the gradient of AD-input. We found a variable but strong linkage between atmospheric deposition and hydrological control

of terrestrial carbon and nutrient input to the river. The results showed that the increasing input of AD-nutrients enhance primary production whereas, such input in sub-catchment enhance DOC in runoff and, the coupled effect of these favor DOC build-up in Ganga River at Varanasi. The study that forms the first report establishing trans-boundary drivers of DOC in Ganga River suggests that future climate model should consider large scale inter-regional time series data on changing atmosphere-land-water transfer and associated shift in carbon balance of major rivers for more accurately predicting cross-domain carbon linkages and planning for integrated river basin management.

Seasonal oxygen, nitrogen and phosphorus benthic cycling along an impacted Baltic Sea estuary: regulation and spatial patterns

Authors: S. Bonaglia, B. Deutsch, M. Bartoli, H. K. Marchant and V. Brüchert

Journal: Biogeochemistry , Volume8 ,January 2014, Pages 12-23

The regulatory roles of temperature, eutrophication and oxygen availability on benthic nitrogen (N) cycling and the stoichiometry of regenerated nitrogen and phosphorus (P) were explored along a Baltic Sea estuary affected by treated sewage discharge. Rates of sediment denitrification, anammox, dissimilatory nitrate reduction to ammonium (DNRA), nutrient exchange, oxygen (O₂) uptake and penetration were measured seasonally. Sediments not affected by the nutrient plume released by the sewage treatment plant (STP) showed a strong seasonality in rates of O₂ uptake and coupled nitrification-denitrification, with anammox never accounting for more than 20 % of the total dinitrogen (N₂) production. N cycling in sediments close to the STP was highly dependent on oxygen availability, which masked temperature-related effects. These sediments switched from low N loss and high ammonium (NH₄⁺) efflux under hypoxic conditions in the fall, to a major N loss system in the winter when the sediment surface was oxidized. In the fall DNRA outcompeted denitrification as the main nitrate (NO₃⁻) reduction pathway, resulting in N recycling and potential spreading of eutrophication. A comparison with historical records of nutrient discharge and denitrification indicated that the total N loss in the estuary has been tightly coupled to the total amount of nutrient discharge from the STP. Changes in dissolved inorganic nitrogen (DIN) released from the STP agreed well with variations in sedimentary N₂ removal. This indicates that denitrification and anammox efficiently counterbalance N loading in the estuary across the range of historical and present-day anthropogenic nutrient discharge. Overall low N/P ratios of the regenerated nutrient fluxes impose strong N limitation for the pelagic system and generate a high potential for nuisance cyanobacterial blooms.

Chemical characterisation of meltwater draining from Gangotri Glacier, Garhwal Himalaya, India

Author: Virendra Bahadur Singh, Al Ramanathan, Jose George Pottakkal, Parmanand Sharma, Anurag Linda, Mohd Farooq Azam, C Chatterjee

Journal: Journal of Earth System Science June 2012, Volume 121, Issue 3, pp 625-636

A detailed analytical study of major cations (Ca²⁺, Mg²⁺, Na⁺, K⁺) and anions (SO₄²⁻, HCO₃⁻, Cl⁻, NO₃⁻) of meltwater draining from Gangotri Glacier was carried out to understand major ion chemistry and to get an insight into geochemical weathering processes

controlling hydrochemistry of the glacier. In the meltwater, the abundance order of cations and anions varied as follows: $\text{Ca}^{2+} > \text{Mg}^{2+} > \text{K}^+ > \text{Na}^+$ and $\text{SO}_4^{2-} > \text{HCO}_3^- > \text{Cl}^- > \text{NO}_3^-$, respectively. Calcium and magnesium are dominant cations while sulphate and bicarbonate are dominant anions. Weathering of rocks is the dominant mechanism controlling the hydrochemistry of drainage basin. The relative high contribution of (Ca+Mg) to the total cations (TZ+), high (Ca+Mg)/(Na+K) ratio (2.63) and low (Na+K)/TZ+ ratio (0.29) indicate the dominance of carbonate weathering as a major source for dissolved ions in the glacier meltwater. Sulphide oxidation and carbonation are the main proton supplying geochemical reactions controlling the rock weathering in the study area. Statistical analysis was done to identify various factors controlling the dissolved ionic strength of Gangotri Glacier meltwater

A study on the high fluoride concentration in the magnesium-rich waters of hard rock aquifer in Krishnagiri district, Tamilnadu, India

Author: S. Manikandan, S. Chidambaram, AL. Ramanathan, M. V. Prasanna, U. Karmegam, C. Singaraja, P. Paramaguru, I. Jainab

Arabian Journal of Geosciences: January 2014, Volume 7, Issue 1, pp 273-285

Excess fluoride in groundwater affects the human health and results in dental and skeletal fluorosis. Higher concentration of fluoride was noted in hard rock terrain of the south India, in the Krishnagiri district of Tamilnadu. The region has a complex geology ranging from ultra basic to acid igneous rocks, charnockite and gneissic rocks. Thirty-four groundwater samples were collected from this study area and analysed for major cations and anions along with fluoride. The order of dominance of cations is $\text{Na}^+ > \text{Mg}^{2+} > \text{Ca}^{2+} > \text{K}^+$ and the anions in the following order $\text{HCO}_3^- > \text{Cl}^- > \text{NO}_3^- > \text{SO}_4^{2-}$. It is found that nearly 58 % of the samples have more fluoride ranging from 1 to 3 mg/L. It is also noted that high fluoride waters correspond to magnesium water types. This is due to the release of fluoride from the magnesium-bearing minerals like, biotite, hornblende, etc., or weathering of apatite/hydroxyapatites found in charnockites.

Seasonal variation of the solute and suspended sediment load in Gangotri glacier meltwater, central Himalaya, India

Authors: Virendra Bahadur Singh, AL. Ramanathan, Jose George Pottakkal, Manoj Kumar

Journal: Journal of Asian Earth Sciences, 79(2014), 2246234.

A systematic study on the seasonal variation of major cations and anions was carried out to understand the source of dissolved ions as well as the geochemical weathering processes controlling the meltwater chemistry of Gangotri glacier. Calcium and magnesium are the major cations while sulphate is the dominant anion followed by bicarbonate. The high ratios of (Ca + Mg)/(Na + K), Ca/Na, Mg/Na, HCO_3^-/Na and low ratio of (Na + K)/TZ⁺ for pre-monsoon, monsoon and post-monsoon seasons indicate the dominance of carbonate weathering, which is a major source of the dissolved ions in the meltwater of Gangotri glacier followed by silicate weathering. High equivalent ratios of Na/Cl and K/Cl as compared to sea water indicate relatively lesser contribution from atmospheric input to the chemical composition of meltwater. Correlation matrix and factor analysis were used to identify various factors controlling the major ion chemistry. Marked seasonal and diurnal variations were observed in the dissolved ions and suspended sediment concentration. Daily mean suspended sediment concentration for pre-monsoon, monsoon and post-monsoon was

observed as 1719, 3281 and 445 mg l⁻¹, respectively. Highest suspended sediment load was observed in monsoon season followed by pre-monsoon and post-monsoon seasons. The cation denudation rates of Gangotri glacier meltwater were calculated to be 42.2, 46.5 and 15.9 t km⁻² y⁻¹ for pre-monsoon (June only), monsoon and post-monsoon respectively. These values are higher than that of other Himalayan glaciers. Whereas physical weathering rate of the Gangotri glacier catchment was observed to be 7056, 15,344 and 588 t km⁻² y⁻¹ for pre-monsoon (June only), monsoon and post-monsoon respectively, much higher than the Indian and world averages of river.

Millennial-scale changes in atmospheric CO₂ levels linked to the Southern Ocean carbon isotope gradient and dust flux

Authors: Martin Ziegler, Paula Diz, Ian R. Hall and Rainer Zahn

Journal: Nature Geoscience, Volume 6, 2013, Pages 457-461

The rise in atmospheric CO₂ concentrations observed at the end of glacial periods has, at least in part, been attributed to the upwelling of carbon-rich deep water in the Southern Ocean^{1, 2}. The magnitude of outgassing of dissolved CO₂, however, is influenced by the biological fixation of upwelled inorganic carbon and its transfer back to the deep sea as organic carbon. The efficiency of this biological pump is controlled by the extent of nutrient utilization, which can be stimulated by the delivery of iron by atmospheric dust particles³. Changes in nutrient utilization should be reflected in the ¹³C gradient between intermediate and deep waters. Here we use the ¹³C values of intermediate- and bottom-dwelling foraminifera to reconstruct the carbon isotope gradient between thermocline and abyssal water in the subantarctic zone of the South Atlantic Ocean over the past 360,000 years. We find millennial-scale oscillations of the carbon isotope gradient that correspond to changes in dust flux and atmospheric CO₂ concentrations as reported from Antarctic ice cores^{4, 5}. We interpret this correlation as a relationship between the efficiency of the biological pump and fertilization by dust-borne iron. As the correlation is exponential, we suggest that the sensitivity of the biological pump to dust-borne iron fertilization may be increased when the background dust flux is low.

Metals in benthic macrofauna and biogeochemical factors affecting their trophic transfer to wild fish around fish farm cages

Authors: I. Kalantzi, N. Papageorgiou, K. Sevastou, K.D. Black and S.A. Pergantis

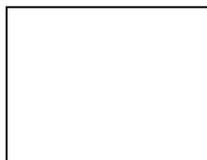
Journal: Science of the Total Environment, Volumes 470-471, 1 February 2014, Pages 742-753

Benthic macroinvertebrates and wild fish aggregating in the vicinity of four Mediterranean fish farms were sampled. Concentrations of metals and other elements were measured in macrofaunal taxa and in fish tissues (muscle, liver, gills, bone, gonad, stomach, intestine, and stomach content). Biological and geochemical characteristics play an important role in metal accumulation in benthic invertebrates, and consequently in metal transfer to higher trophic levels. Macroinvertebrates accumulated lower concentrations of most metals and elements than their respective sediment, except As, P, Na, Zn and Cd. Elemental concentrations of

benthic organisms increased with increasing sediment metal content, except Cd, and with % silt, refractory organic matter and chlorophyll-*a* of sediment due to the influence of sediment geochemistry on metal bioavailability. Tolerant species were found to accumulate higher concentrations of most metals and elements, except for Cd, than equilibrium species. The ecological and morphological characteristics of the benthic invertebrates can affect the bioaccumulation of metals and elements in macrobenthos. Hg and P were found to increase their concentrations from zoobenthos to wild fish aggregating around fish cages feeding on macrofauna.

+++++

<p>Our ENVIS Team at SES, JNU</p>	<p>Any further information, query and suggestions, please contact</p>
<ul style="list-style-type: none"> • Prof. A. K. Attri, Coordinator • Prof. AL Ramanathan • Dr. Sudesh Yadav • Dr. I Ghosh 	<p><i>The Coordinator</i> ENVIS Centre on Biogeochemistry School of Environmental Sciences Jawaharlal Nehru University New Delhi-110067 Email: envis@mail.jnu.ac.in</p> <p>Telephone: 011 26704315</p> <p>Visit us: www.jnuenvis.nic.in</p>



PRINTED MATTER BOOKPOST

To

If undelivered please return to:

The Coordinator
ENVIS Centre on Biogeochemistry
School of Environmental Sciences
Jawaharlal Nehru University
New Delhi-110067