Reviewing the chemistry of Phosphate and Nitrogen compounds in Sediments

HAN L. GOLTERMAN

Association “Leiden – Camargue”, Chemin de Tintarlot 5, Arles F-13200, France; golterman@wanadoo.fr

Abstract

The eutrophication of freshwater, accelerated by human action, still remains a major problem of water pollution. The assessment of the progress of this phenomenon is indispensible for good water management. This asks for a quantification not only of the loading of the responsible nutrients (as done in the OECD programme), but also for a quantification of the different compartments in the aquatic ecosystems.

Phosphate concentrations in water and sediments are mainly controlled by the adsorption of phosphate onto the sediments, while N-concentrations depend strongly on the process called denitrification, which is of paramount importance especially in eutrophic lakes.

The P-adsorption depends on several processes such as the adsorption onto FeOOH, adsorption onto or co-precipitation with CaCO₃ and on its accumulation as organic phosphates such as complexes of humic compounds with phosphate, phytates and perhaps polyphosphates.

The adsorption onto FeOOH, producing Fe(FeOOH)=P can reasonably be described by the Freundlich adsorption isotherm:

\[ P_{\text{ads}} = A (10 \times 0.41^{(\text{pH})})(2.77 - 1.77 \times e^{Ca}) \sqrt{3,i-P} \]

with ‘A’ usually ranging between 10 000 and 25 000 depending on the Fe-concentration in the sediment, the Ca²⁺ concentration in the water and the pH. The interaction with Ca²⁺ under formation of CaCO₃=P is controlled by the solubility product of apatite, \( \text{Ca}_n(\text{PO}_{4.3})\text{OH} \), which is about 10⁻⁵⁰ (Mol⁻¹). The maximal concentration of i-P can thus be calculated by the equation:

\[ (\text{Ca}) \times (i-P_{\text{max}}/F)\times(\text{OH}) = 10^{-50} \]

with F = the factor converting i-P into PO₄³⁻.

These two mechanisms can be combined in a solubility diagram, which depicts the concentration of i-P as function of the FeOOH concentration in the sediments, the Ca²⁺ concentration in the water and the pH. This diagram is a snapshot, which does not describe the increase in concentration with time. This increase can be calculated using a model based on the chemical characteristics described above and the annual P-loading.

Knowledge of these diagrams could have prevented some expensive restoration experiments with negative results on two eutrophic lakes in the Netherlands.

These two inorganic P-pools are easily available for algae and macrophytes; expressions like “sediment acts as ‘sink’ or ‘source’ for phosphate do not take into account the equilibrium situation, sediment adsorbing P when in supply and releasing it when in shortage.

Sequential chemical fractionation (summarised during the AEL meeting in Valencia, 2000) permits to estimate these concentrations and to predict the quantity of P- available.

Interesting problems concern P bound onto humic material and phytate. It seems that there are two P-humic complexes, one behaving as an inorganic pool, and the second as an organic pool. Another possibility is that all P is adsorbed onto FeOOH and that the stability constant with which this com-
plex is bound onto the organic matter may be high or low. A high stability constant would mean an organic, a low stability constant a more inorganic Fe(OOH)=P complex. As far as phytate is concerned we know very little about its origin and fate in sediments, although it seems that production by macrophytes could well be its source. The presence of phytase in many mud bacteria opens interesting perspectives for further research. The adsorption onto FeOOH renders it, however, hardly available for bacterial breakdown.

Denitrification is the process by which bacteria use nitrate for the oxidation of organic matter, obtaining their energy through the reaction:

\[ 4 \text{HNO}_3 + 5 \text{C(H}_2\text{O)} \rightarrow 5 \text{CO}_2 + 2 \text{N}_2 + 7 \text{H}_2\text{O} \]  

(I)

The energy derived from this reaction is, obviously, used for the growth of the denitrifying bacteria; the quantity of N used for their growth is often not taken into account.

In shallow lakes and wetlands, we have shown a different possibility for denitrification if FeS is present:

\[ 5 \text{FeS} + 9 \text{HNO}_3 + 3 \text{H}_2\text{O} \rightarrow 5 \text{FeOOH} + 5 \text{H}_2\text{SO}_4 + 4.5 \text{N}_2 \]  

(II)

The difference between these two processes is important for two reasons:

1) In case (I), nitrogen is not accumulating in the sediment, if the bacteria use N already present in the sediment organic matter for their growth:

\[ \text{C}_3\text{H}_7\text{NO}_2 + \text{HNO}_3 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2 + \Delta \text{N}_{\text{bact}} \]

and \( \Delta \text{N}_{\text{bact}} \) is then incorporated into the sediment to become again Nsed. There is no nett gain of N in the sediment.

In case (II) all N used by the bacteria obviously comes from the HNO3- there is an increase in Nsed.

2) In case (II) \( \text{H}_2\text{SO}_4 \) is formed which, if the sediment is not buffered, will cause an increase in acidity.

Other processes of the N-cycle in sediment remain insufficiently studied, e.g., the mineralization of org-N to NH\(_3\). The number of articles addressing the N-release from sediment is a fraction only of those on P-release.

A relatively new process, hardly studied in freshwater, is the oxidation of NH\(_3\) by NO\(_2\), the so-called anamox reaction. Qualitatively it is well known from studies on sewage purification systems; it is a rather slow process. It has been recorded in the Black Sea, but there are no studies on freshwater ecosystems. Perhaps colleagues have been looking for it, did not find it and did not publish the result, but the importance of this process for lakes must certainly be studied seriously.

The denitrification with FeS as reducing substrate presents unexpected links between P, N, S and Fe cycles. And although the denitrification process as such was not yet known to bind phosphate, it has already been used as a means for restoration, oxidizing black mud, and oxidizing FeS to FeOOH, which then adsorbs i-P, rendering P-release in the short term less important. In the long term, however, the only way to abate eutrophication is strongly decreasing the P-input.

The fact that denitrification leads to a loss of and an accumulation of phosphate in shallow lakes and wetlands induces an environment ideal for the development of blue-green algae, an undesirable consequence of these links.

Abbreviations used:

i-P = inorganic dissolved phosphate = \( \text{H}_2\text{PO}_4^- \), \( \text{HPO}_4^{2-} \), \( \text{PO}_4^{3-} \) (often wrongly called SRP)

Fe(VOO)=P, iron bound phosphate

CaCO\(_3\)=P, Calcium bound phosphate or apatite absorbed onto CaCO\(_3\)
Sediment Nutrients Release Induced by Internal Waves

PAOLO GRIS ENTI, MAURIZIO RIGHETTI, PAOLO BERTOLA

Faculty of Engineering, Department of Civil and Environmental Engineering, University of Trento, Via Mesiano 77 - 38050 Trento, Italy;
paolo.grisenti@ing.unitn.it

Abstract

Sediment nutrients release often plays an essential role on eutrophication processes in lakes. Solutes fluxes at the sediment water interface are dependent on the turbulent field and the horizontal currents in the Benthic Boundary Layer (BBL) and increase with the current velocity. Surface waves or density currents can cause the currents over the bottom in the shallow zones of the lake, but in the deepest zones internal waves contribute mainly to the phenomenon.

The internal wave field generated in Caldonazzo Lake (Trento, Italy) after strong wind events is studied. Spectral analysis of temperature data shows the development of internal seiches of the first and second vertical mode. The amplitude and energy contents of the first vertical mode are much higher than the second vertical mode. Following the approach of MÜNNICH ET AL. (1992) a numerical model is developed to calculate period and velocity distribution of each modes of internal seiches. The model approximate the lake as a two dimensional rectangular basin and is based on measured density profiles. In order to estimate wave induced shear stresses at the bottom a non stationary turbulent model is adopted and the fluxes are calculated using a classic analytical formula.

The approach adopted clearly shows the effect of waves induced bottom currents on sediment-water fluxes. A remarkable increase of the fluxes are estimated as a consequence of the internal waves regime, in despite of rather low values of velocity calculated near the bottom.
Ecological Quality of Water and Sediment at Mai Po Nature Reserve of Hong Kong

JI-DONG GU*, ZHENYE ZHAO, HO YAN LAI, PINGPING SHEN

Laboratory of Environmental Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong SAR; jdg@hkucc.hku.hk

Abstract

A baseline ecological monitoring (BEM) programme was initiated in October 2001 onward for the protection of Mai Po Inner Deep Bay Ramsar Site in Hong Kong. The major objectives of the monitoring were: to establish the trend of the ecological characters of the Ramsar site; to determine any change occurring at the Ramsar site as a result of technological development, pollution or other human interference; to protect the area for biodiversity of flora and fauna as well as water birds. Specifically, the monitoring programme emphasizes on the ecological characters and comprised 7 major categories of parameters, namely water quality; sediment quality; sedimentation rate; benthic fauna; habitat extent and condition, land use changes and external data including general avifauna records.

High concentration of organic and inorganic pollutants was detected in the open water of Inner Deep Bay as revealed by the low dissolved oxygen and high biological oxygen demand, ammonia-\(\text{N}\), total Kjeldahl-N, suspended solid and chlorophyll \(a\). High BOD, and chlorophyll \(a\) were also detected in *gei wais* 12 and 13. The possible sources of pollutants in the Inner Deep Bay were mainly derived from the sewage discharges by Shenzhen River and Shan Pui River which flown into the mudflat of the Ramsar site. The findings generally tallied with the trend as shown by data collected by Hong Kong EPD’s routine water quality monitoring during the same period in the Deep Bay Water Control Zone. On the other hand, the abnormalities in *gei wais* were likely associated with the reduce frequency in the interchange of water with the open water. In addition, high concentrations of Cd and Hg were found in the sediment. Both are toxic even at very low concentrations and thus have potential ecological and toxicological impacts.

The Mai Po mudflat infauna community was characterized by low species richness and high dominance of a few pollution-tolerant opportunistic species - a typical feature of impacted community by organic pollution and/or other disturbance. As for the epifauna, the population sizes of crabs and mudskippers showed a decrease in February but recovered in May and afterwards. The one-year monitoring work recorded a total of 48 morphospecies belonging to 7 phyla, based on easily identified morphological features under a dissecting microscope. These infauna included *Annelida* (polychaetes and oligochaetes), *Mollusca* (bivalves and gastropods), *Arthropoda* (crustaceans, insects and mite), *Sarcostegiphora* (foraminiferan), *Nematoda, Nemertea and Chordata* (fish). The 5 most common groups were *Polychaeta, Oligochaeta, Bivalvia, Gastropoda and Crustacea*. *Oligochaeta* definitely encompasses more than one species provided a compound microscope is employed and more taxonomic expertise is input. Abundance ranged between 1,490 individuals-m\(^{-2}\) at B2 in November 2001 and 46,217 individuals-m\(^{-2}\) at C in August 2002; biomass fluctuated from 21 g wet wt-m\(^{-2}\) at B2 to 417 g wet wt-m\(^{-2}\) at C both in February 2002. The grand total mean abundance and biomass of the mudflat infauna were estimated to be 13,786 individuals-m\(^{-2}\) and 85 g wet wt-m\(^{-2}\), respectively.

In general, the environmental conditions at the monitoring area have experienced pressure of pollution during this period. Organic pollution is a serious problem to the area and concentrations of organic pollutants in the sediment were low and were in line with other monitoring programme.
The intraannual unevenness of runoff and suspended sediment yields in river basins of East Europe

A. V. Gusarov

Department of Geography and Geoecology, Kazan State University, Russia;
avgusarov@mail.ru

Abstract

Some spatial regularities of the intraannual unevenness of runoff and suspended sediment yields (SSY) (the natural zonality, dependence on the degree of agricultural activity (the degree of wood-land or cultivated areas), dependence on a river basin and absolute mean height etc.) in river basins of East Europe (basins of Volga, Don and Ural Rivers) have been determined using function-empircic relationships. They are based on analysis of a long-term series of observations (1940-1980s) for runoff and suspended sediment yields in 115 basins of small (area less 5 000 km$^2$ – azonal basins) and medium (area from 5 001 to 35 000 km$^2$ – zonal basins) rivers (on materials of Hydro-Meteorological Service of the former Soviet Union) with different landscape-climatic conditions (a zone of taiga and mixed forests (34 basins), a zone of broad-leaved forests (26 basins), a zone of forest-steppes (21 basins), a zone of steppes (25 basins), a zone of semi-deserts (9 basins)). The river basins considered have a total area of 777 956 km$^2$. The average duration of observations for SSY is 18 years (76 basins – 11-20 years, 33 basins – 21-30 years, 6 basins – 31-40 years). As a main parameter of intraannual unevenness, the average long-term ratio of the maximum and minimum monthly values of runoff (max/min(R)) and suspended sediment yields (max/min(SSY)) in each river basin during similar periods of observations were chosen. The dimensionlessness of these parameters allows a uniform approach for evaluating some spatial regularities of intraannual unevenness of runoff and suspended sediment yields.
A dynamic model to predict phosphorus fluxes, concentrations and eutrophication effects in Baltic coastal areas

LARS HÅKANSON¹, O. MAGNUS KARLSSON²

¹Department of Earth Sciences, Uppsala University, Villavägen 16, 752 36 Uppsala, Sweden
²AF-Environmental Research Group, P.O.Box 8309, SE-104 20 Stockholm, Sweden; magnus.o.karlsson@af.se

Abstract

This study presents a new dynamic mass-balance model for coastal water eutrophication handling all important fluxes of phosphorus to, from and within coastal areas, as such areas can be defined according to the topographical bottleneck method. The dynamic model is based on ordinary differential equations and the calculation time (dt) is one month to achieve seasonal variations. An important demand, related to the practical utility of the model in contexts of coastal water management, where the model is meant as a tool to simulate and test various remedial strategies to minimise eutrophication effects from nutrient emissions, is that it should be driven by variables readily accessed from standard monitoring programs and maps. This work also presents several empirical regression models for commonly used operational effect variables of coastal water eutrophication such as mean monthly concentration of chlorophyll-a, Secchi depth and oxygen saturation in deep water. The obligatory driving variables include morphometric parameters (catchment area for estuaries, coastal area, mean and maximum depth) and phosphorus inflow (via precipitation, tributaries, other pollution sources and the Sea outside the defined coastal area). The processes accounted for include inflow and outflow via surface and deep water, sedimentation of particulate phosphorus, burial, resuspension and diffusion. Mixing, mineralisation, bioturbation and biouptake and retention in biota are treated in a simplified manner. The model has been calibrated using data from three Baltic coastal areas and then validated with very good results against empirical data from ten Baltic coastal areas of different character. During the model derivation many types of sensitivity and uncertainty tests were performed. Many of the structures in the model are general and should be applicable also for other types of coastal areas.
Can nutrient spiraling measurements detect seasonal pattern of nutrient use? A case study in Lyrebird Creek, a forested stream in the Dandenong Ranges, Victoria

Sulfi Kar Hanafi, Barry T. Hart, Michael R. Grace

Faculty of Science, Monash University, PO Box 23 Monash University Clayton, Victoria, Australia; sulfi kar@sci.monash.edu.au

Abstract

The ability of nutrient spiraling measurements to detect seasonal patterns of nutrient use was examined in a forested stream in the Dandenong Ranges, Victoria. Several single and multilevel-nutrient enrichments (NH₄⁺, PO₄³⁻) were used to correlate nutrient spiraling and uptake velocities (V'), to the seasonal variation in stream factors thought to control the uptake of nutrients, i.e. temperature, light, and algal biomass. It was hypothesized that nutrient use would be higher in summer as the increased temperatures were considered more favorable for biotic and abiotic processes and higher light levels in summer would stimulate biotic processes. Hence, higher V' measurements were expected for both NH₄⁺ and PO₄³⁻ in summer than in winter. However, results for Lyrebird Creek did not support this hypothesis. The spiraling technique was insensitive to a relatively small seasonal gradient of nutrient use. This technique may only work to compare streams with large differences of biophysical factors.
The characteristics of polychlorinated biphenyls pollution in surface sediments of mid- and down-stream of Yellow River, China

Mengchang He, Yan Sun, Zhifeng Yang, Xingru Li

State Key Joint Laboratory of Environmental Simulation and Pollution Control, School of Environment, Beijing Normal University, Beijing 100875, P.R. CHINA

Abstract

This paper presents the study of polychlorinated biphenyls (PCBs) in 17 surface sediment samples collected in June, 2004 at 12 locations from mid- and down-stream of Yellow River. The samples were extracted by Soxhlet extraction and the concentrations (on a dry weight basis) of total PCBs were quantitatively measured by GC-MS. PCBs, measured as an Aroclor 1242, 1248, 1254, 1260 (1:1:1:1) mixture, are found to be in a range of ND-5.98 mkg⁻¹. The results indicate that the surface sediments in this area have been slightly contaminated. Meanwhile, in 16 surface sediment samples being detected, PCB congeners show the similar characteristics that the congeners containing 3 to 5 chlorine atoms account for more than 94.68% of total PCBs. And in most of the samples the order of the content is: TetraCB > TriCB > PentaCB. Otherwise, no obvious correlation with PCBs concentration to TOC and the grain size shows the particularity and complexity of this study area.
(Bio)degradation of non-steroidal anti-inflammatory drug residues in lacustrine and river environments

ESTER HEATH\textsuperscript{1}, JAN ANTONIČ\textsuperscript{1}, TINA KOSJEK\textsuperscript{1}, BORIS KOMPARE\textsuperscript{2}, LUCIJA ZUPANČIČ-KRALJ\textsuperscript{3}

\textsuperscript{1}“Jožef Stefan” Institute, Jamova 39, 1000 Ljubljana, Slovenia; ester.heath@ijs.si

\textsuperscript{2}Institute of Sanitary Engineering, Faculty of Civil and Geodetic Engineering, University of Ljubljana, Hajdrihova 28, 1001 Ljubljana, Slovenia

\textsuperscript{3}Faculty of Chemistry and Chemical Technology, University of Ljubljana, Aškerčeva 5, 1000 Ljubljana

Abstract

Pharmaceuticals enter the wastewater either by excretion with feces and urine, by disposal of unwanted products into the sewerage system or as pharmaceutical industrial waste. However, pharmaceutical residues are not totally eliminated in sewage treatment plants and are discharged into the receiving waters where they accumulate in sediments. Even though levels of these compounds are much lower than those used in medical applications, concern is growing over possible ecological effects through chronic exposure.

This study reports on the development of a robust method for the determination of commonly used acidic pharmaceuticals (e.g. non-steroidal anti inflammatory drugs (NSAIDs): ibuprofen, ketoprofen, naproxen and diclofenac) in sediment and water samples. Of the extraction procedures applied (solid phase extraction, supercritical fluid extraction, pressurized liquid extraction, microwave assisted extraction, Soxhlet extraction, ultrasonic extraction, …) solid phase extraction with Strata X\textsuperscript{TM} (Phenomenex) absorbent and elution with 1.5 mL of methanol (extraction efficiency of all tested compounds above 85%) was selected for extraction of water samples while sequential pressured liquid extraction (acetone:methanol, 1:1, static mode 15 min: \(T = 150^\circ\text{C}, p = 136\text{ atm}\)) and supercritical fluid extraction (\(\text{CO}_2\), static mode 15 min: 150 °C, 350 atm) was chosen for sediment samples (extraction efficiencies above 75 %). In all cases, analytes of interest were converted to volatile silyl esters with N-Methyl-N(trimethylsilyl) trifluoroacetamide for identification and quantification by gas chromatography with mass spectrometric detection. We applied our method to river and lake water and sediment samples where pharmaceutical residues were expected (vicinity of pharmaceutical industry, hospitals, …). Our results show that despite wastewater treatment NSAIDs residues are released in the environment.

In parallel, a series of NSAIDs degradation experiments were performed in pilot waste water treatment plant using spiked water samples (\(1\mu g\ L^{-1} – 1\text{ng}\ L^{-1}\)). With the exception of diclofenac, a steady removal of NSAIDs (up to 90\%) was achieved after 6 months of continuous operation.
Model verification for EROSION 3D: Comparing calculated surface runoff and sediment yield to measured data from an agricultural watershed in the Swiss Jura Region

Bernd Hebel¹, Matthias Weibel², Rainer Weissaidinger², Christian Katterfeld²

¹Department of Environmental Sciences, Swiss Federal Institute of Technology (ETH), Rämistrasse 101, 8092 Zurich, Switzerland; bernd.hebel@env.ethz.ch
²Institute of Geography, University of Basel, Klingelbergstrasse 27, 4056 Basel, Switzerland

Abstract

The process-related soil erosion simulation model EROSION 3D is applied to calculate surface runoff and sediment yield from the agricultural Laenenbachtal watershed (2.61 km²; Jura Region, northwestern Switzerland) for major erosive events during the period 2002 – 2004. GIS supported input generation is effected with continuous meteorological observation data, land use mapping data, as well as official soil and digital elevation maps.

The methodical approach for model verification follows up a perennial research project to evaluate the suitability of erosion models for observance supervision of erosion limits defined by Swiss legislation. Results complement earlier validations of EROSION 3D. Correlations between calculation results and event based sampling gauge data of brook runoff and suspended sediment yield lead to model verification. Gauge measurements as well as model simulations are conducted with specific regard to scale effects in application of EROSION 3D, as results already exist for various other erosion models. To realize this, model application and verification data sampling are conducted with a multi scale approach by operating three gauging stations covering the entire catchment, as well as selected sub catchments within.
The assessment of nutrient retention capacity of lakes and reservoirs

JOSEF HEIZLAR¹, PAUL BOERS², BRIAN KRONVANG³

¹Hydrobiological Institute AS CR and Faculty of Biological Sciences USB, Na Sádkách 7, 370 05 České Budějovice, Czech Republic; hejzlar@hbu.cas.cz
²RIZA, P.O. Box 17, 8200AA Lelystad, the Netherlands; P.Boers@riza.rws.minvenw.nl
³NERI, P.O.Box 314, Vejlsøvej 25, 8600 Silkeborg, Denmark; bkr@DMU.dk

Abstract

Bottom sediments are the major component of aquatic ecosystem that is responsible for retention of phosphorus and nitrogen. The P and N retention in water bodies depends primarily on their hydraulic regimes but also on numerous other factors like geography, depth, nutrient concentrations and forms, water and sediment chemistry, and structure of biota. A data set (N>100) of P and N retentions in lakes and reservoirs from literature and own measurements was analyzed using a simple mass balance model according to Kelly et al. (Biogeochemistry 3, 1987, 129–140) that requires knowledge only of water residence time, mean depth, and mass transfer coefficients for P and N loss. Obviously, a great scatter was obtained for the mass transfer coefficient values, as in many previous studies. However, by a detailed, seasonal-course based analysis of mechanisms of water-sediment interactions in different types of lakes and reservoir we were able to refine the model by categorisation of water bodies, mainly according to their morphology, concentrations and forms of nutrients and nutrient-binding substances (Fe, Al, Ca) in the input, and the dominance of planktonic or benthic food webs in the aquatic ecosystem.
Concentrations of phenylurea and triazine herbicides in two contrasting European estuaries: The Seine Estuary (France) and the Medway Estuary (UK)

C.M. Hepell, K.L. Spencer, S.L. Cutter

1Centre for Aquatic and Terrestrial Environments, Department of Geography, Queen Mary, University of London, Mile End Road, London, E1 4NS, UK; c.m.hepell@qmul.ac.uk

Abstract

Estuarine sediments are an important sink for a range of organic contaminants that interact with both the clay and organic components of particulate matter. Therefore the erosion and deposition of these sediments has important environmental implications for the transport and storage of organic contaminants in the estuarine environment. Intertidal mudflats are particularly dynamic environments in which erosion and accretion processes may be cyclical over seasonal and spring/neap tidal timescales, and vary with short term storm events. This paper examines the factors controlling organic contaminant concentrations in the surface sediments of two contrasting European estuaries: the Seine (France) and the Medway (UK). In the Seine, suspended sediment concentrations (SSC) are high and saltmarsh areas are rapidly accreting. The open mouth of the Seine and strong onshore winds results in massive erosion episodes on mudflat surfaces. In comparison, SSC in the Medway are relatively low and mudflat surfaces are characterised by low mobility. There is a net removal of sediment from saltmarsh sufaces resulting in a general loss of saltmarsh environment.

A microwave-assisted technique, using water as the solvent, was developed in order to extract the herbicides of interest from the sediment. The extract was then analysed by on-line solid phase extraction (SPE), followed by ion trap mass spectrometry (MS²) for phenylurea and s-triazine herbicides. Herbicides were quantified by summing the product ions of a single fragmentation step in order to eliminate false positives from the analysis. Concentrations of herbicides in the surface sediments were found to be in the range of 2 to 5 pmol g⁻¹ dry weight for samples from the Seine, and an order of magnitude lower in the Medway. This paper will compare these data in terms of sediment composition and erosion/accretion cycles given the short half-lives of the contaminants in question.
Microbially-mediated redox cycling at the oxic-anoxic boundary in sediments: Comparisons of disparate habitats

Mark E. Hines

Department of Biological Sciences, University of Massachusetts Lowell,
Lowell, MA 01854, USA;
mark_hines@uml.edu

Abstract

Microorganisms are responsible for the bulk of transformations that occur in surficial sediments. They are most active at redox boundaries where they can benefit from access to various oxidants and reductants generated during redox cycling events. To illustrate the dynamics of microbially mediated processes, especially those involving sulfur and metal cycles, processes were compared in different habitats such as bioturbated clastic and carbonate marine sediments, wetlands and seagrass beds, and freshwater riverbanks undergoing changes in hydrologic conditions. The presence of macrofauna and macroflora greatly altered the three-dimensional array of redox gradients in sediments, but the type and form of reductants and oxidants provided varied greatly; clastic sedimentary infauna subducted solid phase organic material and iron oxides, whereas plant roots released dissolved organic matter and oxygen. These differences resulted in a bioturbated system that exhibited a rapid sulfur cycle (residence time of minutes), but a slower iron cycle (days), whereas vegetation caused a slow sulfur cycle and rapid iron cycle. Bioturbation also greatly affected the redox cycling of transition metals with rapidly changing mobilization and immobilization events. Bioturbation enhanced the role of iron as a terminal electron acceptor, but periodic bottom-water hypoxia attenuated iron cycling, which enhanced the effects of sulfate reduction. Due to the scarcity of iron in island carbonate sediments, it was possible to use the sulfur cycle to indirectly estimate the rate at which plants excluded oxygen from roots. Riverbank sediments experiencing periodic flooding events displayed dynamic redox transitions as well, and these were illustrated by changes in the formation and degradation of methylmercury. Although redox cycling at interfaces can be somewhat predictable, variations in response to biological and physical perturbations demonstrated wide differences in the dynamics of redox-mediated processes.
Ecological change in freshwaters following persistent antifoulant biocide contamination

Daniel J. Hoare¹, C.D. Sayer¹, C.M. Heppell²

¹Environmental Change Research Centre, Department of Geography, University College London, 26 Bedford Way, London, WC1H 0AP, UK; d.hoare@ucl.ac.uk
²Centre for Aquatic and Terrestrial Environments, Department of Geography, Queen Mary, University of London, Mile End Road, London, E1 4NS, UK

Abstract

Use of antifouling paint on boats in freshwaters has led to biocide contamination in water and sediments. One area that has seen intensive use of antifoulants is the Norfolk Broads, an interconnected system of shallow lakes in eastern England (UK). The Broads aquatic ecosystem has experienced considerable degradation since the 1960’s, typified by widespread loss of submerged plants. We implicate the antifoulant additive tributyltin (TBT) as a hitherto unsuspected factor in this decline. TBT was banned in the UK in 1987 on craft under 25 m, which encompassed all boats in the Broads waterways. In this study palaeolimnological evidence of TBT pollution in several of these lakes has been combined with detailed multi-proxy analysis to determine the relationship between boat-derived contamination and ecological change. Core analysis has found the pre-TBT period to be characterised by macrophyte remains with abundant plant-associated diatoms, cladocera and invertebrates, which switch to predominantly planktonic assemblages after initial detection of TBT. Biotic activity upon coated surfaces was maintained by continual release of TBT to the water, where the dissolved, ionic form was readily adsorbed to particulate matter. Environmental persistence of TBT is such that contemporary surface sediment concentrations (729 – 3319 TBT ng l⁻¹, n = 5) are within the range measured just after the ban (440 – 5880 TBT ng l⁻¹, n = 4), with highest concentrations being found in areas of greatest boat density and repair activities. The ratio of TBT to its primary breakdown product dibutyltin remains high in the most contaminated areas (>5), suggesting disturbance of buried contaminated sediment, continued release from paint flakes within sediments and minimal biodegradation. Secondary release of TBT and inputs of modern organic antifoulants threatens recovery of this aquatic system and presents an on-going pollution problem. This research highlights potential impacts to other contaminated freshwater ecosystems across the world.
Study of eutrophication process in the Plitvice Lakes by water and sediment composition

NADA HORVATINČIĆ¹, JOSÉ LUIS BRIANSO², BOGOMIL OBELIĆ¹, JADRANKA BAREŠIĆ¹, INES KRAJCAR BRONIĆ¹

¹ Ruder Bošković Institute, Bijenička 54, Zagreb, Croatia; nada.horvatincic@irb.hr,
²Universitat Autònoma de Barcelona, Spain

Abstract

The process of eutrophication in the Plitvice Lakes, central Croatia, has been observed in some lakes, tufa barriers and water streams. The process of calcium carbonate precipitation from the water forming tufa barriers/waterfalls in the whole area can be disturbed or even stopped in case of intensive eutrophication. Here we investigate whether the eutrophication process is a consequence of anthropogenic pollution or due to naturally produced organic matter/humus in the lakes.

Water samples were collected seasonally during 2003 and 2004 at 15 sampling points (springs, lakes, streams between lakes and tributaries) that included eutrophic and non-eutrophic water. At two largest lakes sampling was also performed along the vertical water profiles. Samples of surface lake sediments (uppermost 45 cm) were collected at 5 points in 4 lakes.

Temperature, pH, conductivity and dissolved oxygen were measured in situ. Concentrations of cations (Ca²⁺, Mg²⁺, K⁺, Na⁺), anions (HCO₃⁻, SO₄²⁻,Cl⁻, F⁻), nutrients (NO₃⁻, NO₂⁻, HPO₄²⁻, NH₄⁺), trace elements (B, Al, Cr, Sr, Mn, Fe, Ni, Cu, Zn, Cd, Ba, Pb), as well as dissolved organic carbon (DOC) were measured in the laboratory. Distribution of trace elements (Al, B, Ba, Cd, Cr, Cu, Mn, Ni, Sr, P, Pb, Zn) was determined also in the surface lake sediments.

The values of calculated saturation index of calcium carbonate show that water is supersaturated in all areas where tufa precipitated, and it is not dependent on eutrophic or non-eutrophic water. There is no significant difference in concentrations of nutrients and trace elements between eutrophic and non-eutrophic waters, whereas the concentration of DOC is higher in eutrophic (1-2 mg/L) then in non-eutrophic water (<1 mg/L). Concentrations of trace elements in lake sediments show different distribution for different lakes. Concentration of some elements such as P, Pb, Zn, Cu and Ba is higher in lake sediment with high eutrophication.

The chemical composition of water does not indicate recent anthropogenic pollution of water. Higher concentrations of DOC in water as well as P and some other elements in the lake sediment can be a consequence of input of natural organic matter/humus to the lake water. This work was founded by EU project ICA2-CT-2002-10009.
Phosphorus retention and early diagenetic phosphorus transformation in Lake Arendsee (Germany)

MICHAEL HUPFER, JÖRG LEWANDOWSKI

Leibniz-Institute of Freshwater Ecology and Inland Fisheries,
Müggelseedamm 310, D-12561 Berlin, Germany;
hupfer@igb-berlin.de

Abstract

Sediment core investigations, phosphorus (P) mass balances, and vertical flux measurements by traps were used to determine P retention rates, P release potential and early diagenetic transformation processes in the sediment of Lake Arendsee (Germany). Sediment cores were dated by varves counting, by 

\[ ^{137}\text{Cs} \]

and by an artificial calcareous layer originating from a restoration attempt in 1995. P retention rates and the internal P cycle have not been altered by the sediment capping. The sharp decline of total P content within the first two centimeters of the sediment showed that diagenetic P mobilization was a fast process. The temporary P pool calculated from core analysis (669 ± 170 mg m\(^{-2}\), \( n=6 \), ± SD) was a small pool compared to the rates of hypolimnetic SRP accumulation during summer stratification (10.7 ± 1.1 mg m\(^{-2}\) d\(^{-1}\), 1992-1997) and to the total P losses in the epilimnion caused by sedimentation (11.7 ± 1.3 mg m\(^{-2}\) d\(^{-1}\), 1992-1997), both latter calculated by mass balances during summer stratification. Without additional supply of fresh material by sedimentation the mobilisable P pool in the sediment would be empty within less than three months. The high importance of freshly settled material for P release was also demonstrated during summer by the three times higher P sedimentation calculated by mass balance data compared to sedimentation determined by cylindrical traps in which some P is released during exposition. The driving process for the fast P release is the remineralisation of organic P. The case study has demonstrated that high hypolimnetic P accumulation rates not always require a high mobilisable P pool in the sediment. In lakes with a low temporary P pool in the sediment a decrease of P in the water body would immediately decrease hypolimnetic P accumulation in summer whereas a capping or dredging is ineffective in such lakes.
Emission of nitrous oxide from costal water and sediments in mangrove forest ecosystem

MASAHIRO IMAMURA, YUTAKA TATEDA, TAKASHI ISHII

Laboratory of Environmental Science, Central Research Institute of Electric Power Industry, 1646 Abiko Abiko-shi 270-1194 Chiba, Japan; mima@criepl.denken.or.jp

Abstract

Emission of nitrous oxide (N₂O) from the mangrove forest ecosystem are important in the global budgets of Green house gas and the Clean Development Mechanism with mangrove plantation. We made measurements N₂O of coastal water and sediment in mangrove forest, as nature forest area of Fukidou River (in Japan) and as plantation area of Len River (in Vietnam). Concentrations of N₂O in costal water were 32-76 nM(nature forest) and 5.4-8.9 nM(plantation). According to stratification measurements N₂O contents in sediments, the highest concentration of N₂O was observed in the near surface (anoxic layer); contents N₂O in sediment were 10-110 nM/g-wet (nature forest) and 1.2-24.9 nM/g-wet (plantation). N₂O in creek water flowing mangrove forest was increase at low tide, indicated that high N₂O concentrations at low tide depend on the N₂O of surface sediments flowed out. N₂O flux form costal water and sediments in mangrove forest are calculated to be 130 mM/m²/year (natural) and 2 mM/m²/year (afforest).
Phosphorus release rate from Latian dam sediment

S. Isazadeh, M. Tajrishi, A. Nazari

Department of civil engineering, Sharif University of Technology,
Azadi Avenue, Tehran, Iran;
Siavash_i@mehr.sharif.edu

Abstract

Latian dam is located on the Jajrood River northeast of Tehran, the capital of Iran. It is one of the most important water supply reservoirs for this city and supplies 30 % of the water demand of 11 million people. The availability of phosphorus is generally believed to be the controlling factor in eutrophication. The objective of this study was to quantify the fractionation of phosphorus so as to determine the potential of the aquatic sediment as a source of phosphorus supply and to measure the release rate under aerobic and anaerobic conditions and the effect of microorganisms on this release rate of phosphorus from sediment. Surface sediment from two points of the reservoir analyzed and the general characteristic were investigated. Fractionation of phosphorus was carried out to determine the various components such as NH₄Cl-P, NAI-P, apatite-P and residual–P in the sediment from the two points in the Latian reservoir. Total phosphorus (TP) concentration in terms of dry sediment ranged from 180-200 Mgp/gdw. In addition, apatite – P formed the major component in the sediment (70 % of TP) for both sampling points. The P bound with Fe and Al was 3 to 4 % of TP. The residual fractionation was 16-18 % of total phosphorus. Furthermore, in this research the effect of Tubifex on the phosphorus release rate from sediment was investigated.

Key words: Release rate, Sediment, Phosphorus, Tubifex
Carbon Isotopic Composition of Early-Diagenetic Methane - Changes with Depth of Sediments

MARIUSZ O. JĘDRYSEK¹, STANISLAW HALAS², EITARO WADA³

¹Laboratory of Isotope Geology and Biogeochemistry, Institute of Geological Sciences, University of Wroclaw, 50-205 Wroclaw, Poland
²Mass Spectrometry Laboratory, M.Curie-Sklodowska University, 20-031 Lublin, POLAND.
³Center for Ecological Research, Kyoto University, 4-1-23 Shimosakamoto Ohtsu, Shiga 529-01, Japan

Abstract

These observations concern the annual cycle of methane in sediments of a freshwater Lake Moszne in E Poland (less frequent samplings have been carried out in Lake Skrzynka in W Poland and the wetland tropical forest To Daeng in S Thailand). The δ¹³C(CH₄) values varied widely from about -4.5 ‰/-1m (late summer 1993) to about +2.5 ‰/-1m (late winter) in vertical sediment profiles of about 3-meters length. These vertical variations apparently are not due to oxidation or temperature changes, but rather to the higher gradient of the downward decrease of production rates via the acetic acid fermentation pathway rather than via the CO₂-H₂ pathway. The production of methane and δ¹³C(CH₄) values are highest during summer and lowest during winter, reflected especially during surface sampling. The downward increase of δ¹³C in winter, late autumn and, at greater depths, in late summer is a consequence of isotope enrichment of the residual pool of precursors of methane (predominantly CO₂).
Sulphur, hydrogen and carbon isotopes in peat – diagenesis, water level and temperature records

MARIUSZ-ORION JĘRYSEK, GRZEGORZ SKRZYPEK

Laboratory of Isotope Geology and Biogeochemistry, Institute of Geological Sciences, University of Wroclaw, 50-205 Wroclaw, Poland

Abstract

Peat sediments are potentially abundant archive to reconstruct past climates – especially when the peat is composed of single species. It is not clear in what extend, stable isotope composition of carbon, sulphur and hydrogen in the primary organic matter in peat, is determined by (i) environmental conditions, (ii) physiology of the living Sphagnum Sp., (3) isotopic composition of assimilated CO₂, SO₂ and H₂O, and (iv) isotopic fractionation during assimilation and diagenesis. We evidence that carbon, hydrogen and sulphur isotope ratios both, in the total peat (δ¹³Cₚ = -25.52 to -28.27 ‰, δDₚ = -78.67 and -109.24 ‰, δ³⁴S = 4.35 to 19.87 ‰), and in cellulose from the peat (δ¹³Cₑ = -25.06 to -27.33 ‰ and δDₑ = -92.43 to -118.02 ‰) are not affected by postdepositional changes. Therefore, the original isotope composition of plants are in general preserved in the peat and consist an archive of the past environmental variations. These can be supported by (i) good correlations between δ¹³Cₚ and δ¹³Cₑ, and between δDₚ and δDₑ, (ii) high horizontal homogeneity of δ¹³Cₚ and δ¹³Cₑ in the scale of one peat-bog - the same major factor(s) control(s) C isotopic ratios, (iii) no correlation between organic sulphur concentrations and δ³⁴S value - δ³⁴S results from variations in the water level.
Transformation of particle-bound phosphorus at the land-sea interface in a Danish estuary

HENNING S. JENSEN, TINE BENDIXEN, FREDE Ø ANDERSEN

Institute of Biology, University of Southern Denmark, Campusvej 55, DK-5230, Denmark; hsj@biology.sdu.dk

Abstract

Forms and concentrations of dissolved and particulate phosphorus (P) were measured during a year in river water and along a salinity gradient in Holckenhavn Fjord, Denmark. Half of the total P load was carried by suspended particles with iron-bound P contributing 45%. In a transect along the estuary some particulate P-forms like refractory organic P behaved conservatively relative to the salinity mixing line. Others, like iron-bound P behaved non-conservatively with iron-bound P concentration in suspended solids increasing at low salinities (2-6 ppt). A large fraction of particulate P was deposited in the estuary during the spring flood, however, a comparison of river particles and estuarine sediments revealed that the solid phase P-concentration decreased from 214 μmol (g DW)^{-1} in the river particle to 22 μmol (g DW)^{-1} in the buried sediment. Dissolution of iron-bound P by sulfide is likely an important loss process but also, the dominant primary producer, Ulva lactuca, was able to grow on particulate P as the only P-source. The fastest growth was observed with small particles (1-40 μm) that had a high proportion of iron-bound P. Other Danish rivers that drain more iron-rich soils carry 60% of the total P load as iron-bound P. This stresses the importance of measuring the different forms particle-bound P fractions when assessing nutrient loads to lakes and estuaries.
Estimating caesium-137 reference inventories at the catchment scale

PAULA A JONES, ADRIAN L COLLINS, DESMOND E WALLING

Department of Geography, University of Exeter,
Amory Building, Rennes Drive, Exeter, UK, EX4 4RJ;
Paula.A.Jones@exeter.ac.uk

Abstract

The establishment of an accurate caesium-137 ($^{137}$Cs) reference inventory is an important requirement of the $^{137}$Cs technique when quantifying rates of soil redistribution and sedimentation. A reference inventory represents the input of $^{137}$Cs to the local environment from atmospheric fallout minus loss to radioactive decay. This is established by measuring the $^{137}$Cs inventory at undisturbed sites that have experienced neither erosion nor deposition. At the local scale (< 1 ha), the distribution of $^{137}$Cs is assumed to be relatively uniform but at the catchment scale, a degree of $^{137}$Cs spatial variability invariably exists.

As part of a larger study investigating the fine sediment budgets of lowland permeable catchments in the UK, the $^{137}$Cs technique is being used to quantify rates of soil redistribution and sedimentation on representative slopes and floodplains throughout each catchment. The study catchments comprise of the Frome and Piddle in Dorset (~ 600 km$^2$), the Tern (~192 km$^2$) in Shropshire and the Pang and Lambourn (~ 405 km$^2$) in Berkshire.

Due to the large number of field and floodplain sampling sites in each of the study catchments, it was not feasible to collect reference inventory samples for each individual location. Therefore, an alternative approach has been undertaken whereby a number of $^{137}$Cs reference sites have been sampled throughout each of the study catchments. A statistical approach has been employed to examine the relationship between $^{137}$Cs reference inventories and sampling site characteristics including mean annual rainfall, elevation, latitude and longitude for each of the study catchments. Based on these findings, a model has been developed enabling the estimation of $^{137}$Cs reference inventories for all of the field and floodplain sampling sites within each of the study catchments, enabling rates of soil redistribution and sedimentation to be quantified.
Assessing the use of DET and DGT techniques in phosphorus process studies in the sediments of the Gulf of Finland, the Baltic Sea

H. Kaasalainen\textsuperscript{1}, M. Leivuori\textsuperscript{1}, K. Likkari\textsuperscript{1}, M. Motelica-Heino\textsuperscript{2}

\textsuperscript{1}Finnish Institute of Marine Research, P.O. Box 33, 00931 Helsinki, Finland; first.lastname@fimr.fi
\textsuperscript{2}BRGM, 3 avenue Claude Guillemin, 45060 Orléans cedex 2, France; m.motelica@brgm.fr

Abstract

The techniques of diffusive equilibration in thin-films (DET) and diffusive gradients in thin-films (DGT) were implemented to study dissolved phosphorus and metals in sediment pore waters in the Gulf of Finland (GoF), a sub-basin of the Baltic Sea. DET and DGT are chemical sensors based on hydrogels. In the DET device the sediment pore water equilibrates with a single layer of diffusive gel that is about 95 \% water, giving a measure of the actual concentration of dissolved constituents in the pore water.\textsuperscript{[1]} DGT uses an additional layer of gel impregnated with a binding agent that preconcentrates solutes in-situ and fixes them on the binding gel layer. Thus DGT measures the induced flux of solute from the solid phase to the solution directly which can be related to its concentration in the pore water and availability from the solid phase.\textsuperscript{[2]}

The Baltic Sea, one of the largest brackish-water systems in the world, has a limited water exchange with the Atlantic Ocean. The Baltic Sea is seriously eutrophicated leading to the depletion of oxygen when the organic matter is decomposed. The GoF is bordered by highly populated areas, which release heavy metals and nutrients that are discharged to the GoF by rivers. The large surficial freshwater discharge in contrast to the penetration of more saline waters along the bottom from the Baltic Proper, the main basin of the Baltic Sea, results in strong horizontal and vertical salinity gradients. The salinity and near-bottom oxygen content in the GoF are affected by the exchange of water with the Baltic Proper, the inflow of fresh water and local conditions. Large areas of the GoF have suffered from the oxygen depletion since the mid 1990s.

The sediment may be a source or a sink for metals and nutrients. There is a concern of how the changing environmental conditions, well known phenomena in the Baltic Sea, affect the cycling of iron, manganese and phosphorus at the sediment-water interface. The DET and DGT techniques were used to measure dissolved phosphorus, iron and manganese in the sediment pore waters in the Gulf of Finland in order to find an effective way to study processes and interactions of these elements.
DET measured concentration profiles and DGT induced fluxes of dissolved phosphorus at the sediment water interface are presented and compared to the results obtained using centrifugation. The phosphorus availability from the solid phase to solution is estimated. Different forms of phosphorus in the sediments, as well as early diagenetic processes, are commonly studied using chemical sequential extraction methods combined with pore water data. In an parallel project, phosphorus fractions in the sediment are studied by a modification of Jensen & Thamdrup (1993)-method.[1] The use of DET and DGT results and data from sediment phosphorus extraction in assessing the sediment processes of phosphorus are discussed.


Study of compaction bands originating from cracks and notches in High-porosity Sedimentary Rock

R.Katsman, E.Aharonov

Department of Environmental Sciences and Energy Research, Weizmann Institute of Science, Rehovot, Israel; Regina.Katsman@weizmann.ac.il

Abstract

Compaction bands (CBs) are localized grain crushing and porosity reduction zones, which form spontaneously in high porosity rock under certain compressive stress conditions. Recent experiments show that compaction bands may also nucleate at the edges of notches, holes and cracks subjected to compressive stress. We constructed a new elasto-plastic model to investigate compaction bands formation under a variety of boundary conditions. It was found that in both a notched specimen and in a specimen with a hole in the middle, compaction initiated at these macroscopic void’s tips, propagating in a step-wise manner (which is different from compaction band run-away in samples without macroscopic voids). In case when the de-bonded and compacted grains at the edges of the hole were removed by circulated fluids (high flow rate), the total length of their empty flaw increased as well, causing accelerating CB propagation already from the onset of compaction. Contrary to that, in a case where material is not removed (low flow rate of the circulating fluid), the CB propagates incrementally, resulting in runaway propagation only once CB length is large enough. In addition, heterogeneity in rock properties, such as local compressive strength, controls the morphology of compaction features. As a result, the character of compaction is sensitive to whether the CB is filled or emptied, and besides being a basic scientific question, is an important issue in boreholes, where the formation of very long CBs may lead to considerable sand production, and affect borehole stability in oil-producing fields.
The contribution of bank and channel erosion to the suspended sediment and phosphorus yield

CHRISTIAN KATTERFELD¹, BERND HEBEL², PHILIPP SCHNEIDER¹, RAINER WEISSHAIDINGER¹

¹Institute of Geography, University of Basel, Klingelbergstrasse 27, CH-4056 Basel, Switzerland, c.katterfeld@unibas.ch
²Swiss Federal Institute of Technology Department of Environmental Sciences, Rämistrasse 101, CH-8092 Zurich, Switzerland

Abstract

Previous event based studies of non-point phosphorus (P) losses and suspend sediment (SS) yield were conducted in two small catchments of the Swiss Jura (2.6 km²) and the southern Black Forest (4.0 km²), Germany. Like in most studies riverine sources were neglected. According to OWENS ET AL. (2000) channel sediments are a key requirement in sediment budget investigation and for understanding of sediment associated nutrient transport in catchments. Objective of this study is to estimate the contribution of bank and channel processes to the matter yield at catchment outlet.

Since spring 2004 bank erosion was measured at two approx. 200 m long brook sections for each catchment using the erosion pin method. To examine channel erosion and deposition 20 cross sections were sounded seasonally in 10 cm intervals. Samples of the top 5 cm of channel bed and bank sediments (n = 50) were collected in summer 2003 and 2004. Grain size distribution, inorganic and organic carbon as well as soluble and total P contents were analysed. Discharge gauges and automated water sampling during runoff making the link to SS and P input (above) and output (below) of brook sections.

In the Swiss Jura catchment bank erosion rates explain a major part of SS yield at the catchment outlet, due to lateral erosion caused by discharges events as well as denotative processes from higher bank sites. In the Black Forest study site channel erosion processes are less visible, because banks are more resistant against denotative processes. Although SS yield in the southern Black Forest is significant lower as in the Länenbach catchment, P yield is unexpected higher.

Effect of collars on time variation of local scour around abutments

Yurdagül Kayaturk¹, M. Ali Kokpinar¹, Mustafa Gogus²

¹State Hydraulic Works, TURKEY
²Middle East Technical University, TURKEY

Abstract

During passage of the flow through obstructions, local scour holes are formed around bridge piers and abutments. This phenomenon has attracted the attention of many researchers and therefore many studies have been carried out up to now. As a result of these studies, many equations that give the depth of local scour by taking into account flow and sediment properties as main parameters have been derived. Most of these equations related to the equilibrium depth of the scour. However, the time necessary to reach the equilibrium state is very long, it may take days, weeks even months. Since flood times are much shorter than the time necessary for equilibrium and there is a sediment supply upstream of the bridge, the equilibrium state of the local scour is never reached in reality. Hence, the study of time variation in the whole scour becomes necessary.

In this study, time variations of abutments were investigated. To reduce and slow down the development of scouring around the abutments, collar-plates were placed around the abutments under clear-water flow conditions. The abutments used were always rectangular in plan, having lengths of Lₐ=15 cm, 20 cm and 25 cm. To see the performance of collar-plates on reducing scour depth and on time variation, four different collar-widths were tested around the abutments. Collar plates levels are Zₑ=+5 cm, +2.5 cm, ±0.0 cm, -2.5 cm, -5 cm with respect to the bed level. The experimental study showed that, when the wider collar-plates are placed at or below the bed level, the maximum scour depth is reduced effectively around the abutments. The collar-plates can also be used to slow down the scouring efficiently.
Assessing the risk of suspended sediment and salinity, alone and in combination, on freshwater fauna in Australian low gradient rivers

BEN J. KEFFORD¹, KATHRYN HASSELL¹, SATISH C. CHoy², DAYANTHI NUGEGODA¹

¹ Biotechnology and Environmental Biology, RMIT University,
PO Box 71, Bundoora, 3083, Victoria, Australia
² Department of Natural Resources and Mines, Long Pocket Laboratories,
120 Meiers Rd, Indooroopilly, 4068, Queensland, Australia

Abstract

Many Australian rivers have very low gradients and the influence of sediments on freshwater organisms may differ from the better studies higher gradients rivers from elsewhere. Additional clearing of native vegetation has increased salinity in many Australian rivers, with some Australian rivers experiencing both elevated suspended fine sediment and salinity. Condamine River in the upper Murray-Darling Basin, for example, regularly has turbidity levels in the 100’s of NTU and a maximum salinity of around 12 mS/cm. Yet little is know regarding the combined effect of these contaminants on freshwater fauna. We present a conceptual model and hypothesise on the effects of suspended sediment and/or salinity on freshwater macroinvertebrates and fish which are applicable in low gradient Australian rivers. We present data on the effect of sediment burial on the hatching of eggs of three native fish species (Murray Cod, Trout Cod and Northern Purple Spotted Gudgon). Finally we describe planned experiments on the effects of suspended sediment and salinity on macroinvertebrates to test the conceptual model and hypothesise.
Three-Dimensional Sediment Transport Modeling on the South Coast of Korea

CHA-KYUM KIM

Department of Civil and Environmental Engineering, Namhae College, Nambyun-ri 195, Namhae-up, Namhae-gun, Kyungnam, Republic of Korea; kick@namhae.ac.kr

Abstract

Kwangyang Bay, located in the south sea of Korea, has undergone severe environmental changes due to the construction of Kwangyang Harbor in 1982. A three-dimensional layer-level hybrid model developed by the author was applied to Kwangyang Bay to estimate the impact of the development of the bay. Simulations were performed to quantify the changes in the spreading pattern of the runoff from the Sumjin River and sediment transport. In addition, intensive field measurements on hydrodynamic and sediment conditions were carried out around the Kwangyang Bay from November 1986 to August 2004. The model predicted tidal currents and sediment transport rate agreed reasonably well with the measurements. The spreading pattern of the river plume after the construction of Kwangyang Harbor is toward the eastern part (Noryang Channel) of the bay whereas the spreading pattern before the construction was mainly southward (Yeosu Channel). Averaged over three months the sediment transport is seaward in the channel and land-ward in the tidal flat. Water and sediment from upstream are transported downstream via channels causing an ebb-dominance in the Yeosu Channel, and therefore, the residual flow and the residual sediment transport in the channel is in the ebb-direction. Due to the river inflow and the large amount of fine sediment from upstream, extended tidal flats exist in the Sumjin River estuary. Erosion occurs in the entrance areas (channel) where the current velocities are very strong whereas deposition occurs in the inner part of the bay and the tidal flat due to weak current. This model can be used as an important tool to study the impact on the local local fishery and ecological system which require further detailed investigation.
Periphytic filamentous green algae in an acid (pH 2.9) mining lakes – impact on biogenic alkalinity generation

Andreas Kleeberg

Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Müggelseedamm 301, D-12587 Berlin, Germany; kleeberg@igb-berlin.de

Abstract

In extremely acid mining lakes the carbon limitation of pelagic primary production favours superior competitors as benthic filamentous green algae (FGA; Zygnemataceae, Chlorophyta) which could supply the surplus carbon necessary for the microbial-mediated benthic alkalinity generation. However, biomass, productivity, and relevance of the acidobiontic FGA at pH ≤ 3 were previously not determined. Periphytic FGA was mapped by harvesting their biomass from 85 1 × 1 m squares in mining lake Grünewalder Lauch. Zygnion ericetorum colonized water depths between 1.6 and 10.5 m covering 88 % of total area (0.94 km²). Biomass peaked at 5-6 m depth. Total FGA biomass amounted to 72.2 t dry weight, which corresponds to 16.1 t C and a primary product of FGA of 2.2 years. Growth of FGA is moderately N, extremely C and P deficient, and seriously stressed by high rates of Fe deposition during summer. Consequently, net primary production of FGA calculated from measured photosynthesis vs. irradiance characteristics and calculated underwater irradiance (0.13 g C m⁻² a⁻¹) and in-situ oxygen measurements (7.8 g C m⁻² a⁻¹) corresponds to only 0.3 and 18.1 % of pelagic net primary production. Both pelagic and benthic primary production of FGA can not supply enough C for an efficient acidity removal. However, at maximum rate of benthic net primary production, 851 mg C m⁻² d⁻¹, Zygnion ericetorum reached already 59 % of the lakes ‘carrying capacity’ contributing at least seasonally to a C supply.
Determination of Flow and Transport Processes in an Alpine Reservoir

Helmut Knoblauch, Hannes Badura, Josef Schneider, Erich Wagner

1Department of Hydraulic Engineering and Water Resources Management, Graz University of Technology, Streitweg 10, 8010 Graz, Austria:
Phone: +43-316-873-8362, Fax: +43-316-873-8357;
helmut.knoblauch@tu Graz.at
2Verbund – Austrian Hydro Power, Kraftwerk 1, 5620 Schwarzach, Austria:
erich.wagner@verbund.at

Abstract

The runoff from Austria’s largest glacier, Pasterze, is collected in the Margaritze reservoir. From there, the 11.6-km long Möll gallery diverts the flows to two high-level reservoirs of the Glockner-Kaprun group of power schemes. Having a capacity of no more than 3.2 million cubic metres, the Margaritze reservoir offers little space for holding the substantial amounts of sediments contained in the glacial runoff. In the past, reservoir sedimentation has already caused problems in the operation of the bottom outlet.

For more than 13 years, owner Verbund Austrian Hydro Power AG (AHP) has conducted studies to develop an efficient sediment management scheme for this reservoir. The studies have yielded various ideas regarding possible remedial action in this particular situation. Some of the solutions considered have already been applied; others are still at the planning stage.

At present, the sediments are being transferred within the reservoir to the shallow part. Partly due to unknown reasons the deposited material is remobilized and conveyed back to the steep part of the water body.

In summer 2004 measurements were conducted in order to survey the flow patterns, which connote the flow velocities and the concentrations of the suspended solids. The flow velocities were determined by an Acoustic Doppler Current Profiler, which gives 3 dimensional velocity patterns. The measurements were taken considering various boundary conditions, such as water level, transfer under progress, amount of inflows and outflows. Different cross sections and singular spots were carefully chosen for receiving the best overview of the reservoir’s flow patterns.

The results of the measurements demonstrate that the remobilization and transport of the deposited sediment are directly linked to the transfer of sediment to the shallow part of the reservoir.
The distribution of macrophytes over a lake bed

Tiiu Koff

Institute of Ecology, Tallinn University, Kevade 2, Tallinn 10137, Estonia; koff@eco.edu.ee

Abstract

Macrophytes are part of the lake ecosystem. They create microhabitats and microclimates inshore and improve water clarity by stabilising sediments and storing nutrients. Their composition and distribution depend on the topography of the lake bottom, ecosystem variability and changing climatic conditions. Therefore macrophytes play an important role in the processes at the water-sediment interface. The leading factors in the development of the lake ecosystem are lake-level fluctuations. The fluctuations of the lake level and thus the changes in water volume have a high impact on the development of the ecosystem; they can also cause changes in aquatic vegetation assemblages and may shift macrophyte zones. Macrophytes also have an active role in sediment accumulation: recent studies demonstrate that water movement affects sediment dynamics in and around submerged macrophyte beds, its composition and particle size in a freshwater environment.

Parts of macrophytes are preserved as macrofossils in sediments thus giving the possibility to study the dynamic of the water-sediment surface in the past. The aim of this study was to investigate the macrofossil content of the sediments from a small lake in Estonia in order to reconstruct lake-level fluctuations in the past. Results indicate that the water depth, basin slopes and distance to the shore have the most important impact on the macrofossil content in the sediments. Comprehensive analysis of the data about the distribution of the present aquatic vegetation and plant remains in the uppermost 10-cm of the lake surface sediments was used to calibrate the macrophyte distribution response to lake-level changes.
Sediment-water interactions during remediation of an acidic mining lake

Matthias Koschorreck, Elke Bozau, René Frömmichen, Walter Geller, Peter Herzsprung, Katrin Wendt-Pothoff

UFZ - Centre for Environmental Research Leipzig-Halle GmbH, Department of Lake Research, Magdeburg, Germany

Abstract

In acidic mining lakes microbial sulphate reduction is inhibited by low pH and a lack of organic substrates. Stimulation of sulphate reduction by addition of organic substrate is a strategy to remove acidity from acid mine drainage. This principle was applied in an enclosure in a lake (pH 2.6) under in situ conditions.

Addition of lime in combination with a complex organic substrate (Carbokalk - a byproduct of sugar production) together with straw raised the pH at the sediment surface and stimulated microbial reduction of iron and sulphate. Rates of iron reduction exceeded sulphate reduction rates. Porewater analysis and in situ microsensor measurements showed that both $\text{H}_2\text{S}$ and $\text{Fe}^{2+}$ were diffusing out of the sediment and were re-oxidized in the water. This process was enhanced by the formation of an acidic sediment cover by precipitating iron minerals.

Basing on a conceptual model of the processes at the sediment-water boundary perspectives or the remediation of the lake is discussed.
Geochemical interactions between underground water and sediments around Mt. Fuji, central Japan

Satoshi Koshimizu\textsuperscript{1}, Kenji Tomura\textsuperscript{2}, Hiroshi Kobayashi\textsuperscript{3}

\textsuperscript{1}Earth Science Division, Yamanashi Institute of Environmental Sciences, Fujiyoshida 403-0005, Japan; koshi@yies.pref.yamanashi.jp
\textsuperscript{2}Institute for Atomic Energy, Rikkyo University, Yokosuka 240-0101, Japan
\textsuperscript{3}Yamanashi Institute for Public Health, Kofu 400-0027, Japan

Abstract

The behavior of trace elements in natural water samples such as underground water, spring, river and lake water from the Kofu basin and the foot of Mt. Fuji, central Japan was geochemically investigated. We found distinct differences in arsenic, phosphorus, uranium and vanadium concentrations in the water samples between the foot of Mt. Fuji and the Kofu basin. The differences in phosphorus, uranium and vanadium were essentially explained by geochemical characteristics in igneous rocks distributed in the areas examined. While, we found spring water collected from locations around the Kofu basin contains arsenic of much higher concentration than the foot of Mt. Fuji and along the Fuji River. This regional difference in arsenic concentration in the spring water was examined by viewing arsenic in igneous rocks distributed in the area. However, basaltic rocks which were dominant in the area around Mt. Fuji, had higher arsenic content than the granitic rocks in the Kofu basin. Therefore, it is hard to explained the differences in the concentration in the spring water between the Kofu basin and the foot of Mt. Fuji based on the difference in igneous rocks distributed in the area. It might be explained by the Pre-Tertiary sedimentary rocks which include marine sediments and were dominant in the Kofu basin. Therefore, in the future, it will be important to examine the formation mechanism of arsenic polluted groundwater from arsenic in Pre-Tertiary Shimanto Belt in the Kofu basin.
Estimation of the material exchange between the River Elbe and its dead zones in time scales between minutes and decades

HANS-PETER KOZERSKI¹, RENÉ SCHWARTZ², THOMAS HINTZE¹

¹Leibniz-Institute of fresh water ecology and inland fishery, Mueggelseedamm 301, D-12587 Berlin, Germany; kozerski@igb-berlin.de
²Arbeitsbereich Umweltschutztechnik, Technische Universität Hamburg-Harburg, Germany; schwartz@tu-harburg.de

Abstract

In the groyne fields of the River Elbe near Havelberg (Germany), intensive investigations took place from 2000 to 2003, to quantify and understand retention processes of fine particles. The real and the potential rate of sedimentation were quantified by means of plate and cylindrical sediment traps, respectively. The real rates ranged between 20 and 1600 gDW/m²/d and depends on the flow velocity within the dead zone and on SPM concentrations. The potential rate was three times higher on average and depended only on the supply of material from the river channel, which was estimated by means of in-situ tracer experiments. The characteristic time as the main parameter of the water exchange with the river channel ranged from 15 to 69 minutes and indicates intensive exchange with the main stream as well as favourable conditions for various organisms and retention processes. The simplified tracer technique based of a one point tracer injection and measurements with two fluorometers. Estimations for the reliability of results are presented. The long term deposition of organic material was quantified by stick penetrometry of the whole groyne field bottom. Layers of mud are found up to one meter thickness in central regions with low velocity. This fact and the augmentation of mud layers with time indicate that primary sedimentation of suspended particles regulates the distribution of the more than 80 years old mud deposits, which showed fractional resistance also during the high flood in 2002.
Development and use of a hydro-acoustic measuring system for the investigation of the dynamics of the bed load transport and the characterisation of the moved particles regarding their quantity and quality

KREIN ANDREAS

Faculty of Hydrology, University of Trier, Behringstraße, D-54286 Trier, Germany; krein@uni-trier.de

Abstract

This investigation deals with the questions, if acoustic measurements in running waters are appropriate for a highly resolved investigation of the bed load transport with regard to the time, and which characterizations of the bed load regarding mass and shape are possible via the acoustic signals. The signals were recorded by means of data recorders, which were connected with hydrophones by cables. These underwater microphones were directly mounted onto the bottom side of stainless steel plates of a size of 30 x 30 cm each and of a thickness of 3 mm, serving as a contact surface for the bed load moving above them. After several series of tests in the laboratory, which indicated the basic relations between the dimension, shape and weight of the bed load and the resulting signal, a field test of the measuring system was conducted. By several artificially produced flood waves in the small brook „Riverisbach“ and by a winter flood wave in the river „Moselle“ near Trier / Southwest Germany, it is possible to elaborate similar structures of the signal course of the bed load movement. The highest transport rates can be observed at the beginning of the increasing limb and behind the peak of the waves. At the beginning of the waves, the increasing transport power of the water and the loose material can be considered as the cause for this result. The decreasing pressure of the waves on the sediment body behind the wave peaks can explain the increase in the bed load transport so that material from the channel beds will loosen and will be mobilised. The field tests reveal that in the increasing branch mostly coarse and angular material will be moved in reptation, behind the wave peaks, mainly small and round components in saltation can be observed.
Use of an *in-situ* erosion flume for measuring stability of sediment deposits in Hamilton Harbour, Canada

BOOMANNA G. KRISHNAPPAN¹, IAN G. DROPO²

¹Aquatic Ecosystem Impacts Research Branch, National Water Research Institute, Burlington, Ontario, Canada; Bommanna.Krishnappan@ec.gc.ca
²Aquatic Ecosystem Management Research Branch, National Water Research Institute, Burlington, Ontario, Canada; Ian.Dropp@ec.gc.ca

Abstract

An in-situ erosion flume was used to measure the stability of sediment deposits in Hamilton Harbour in Ontario, Canada. The flume consists of a rectangular duct measuring 3.5 m in length, 0.30 m in width and 0.08 m in depth, and has an opening of 1.0 m by 0.30 m at the bottom starting at a distance of 1.75 m from the flume entrance. A submerged pump is attached to the downstream end of the flume and it circulates the ambient water through the flume, thereby generating turbulent shear flows inside the flume. When the flume rests on a sediment deposit, the exposed part of the sediment deposit is subjected to the flow shear stress. By applying a continually increasing flow shear stress on the sediment deposit and by measuring the amount of sediment erosion, it is possible to assess the erosional stability of the sediment deposits. An under water video camera was mounted on the flume to get visual images of the sediment erosion process. The flume was used at two sites in the Harbour; a shallower site and a deeper site. The erosional resistances measured by the flume for the two sites were different. The shallower site showed higher resistance to erosion than the deeper site. These results were verified by collecting sediment cores from these two sites and testing them in a rotating circular flume in the laboratory. The rotating flume experiments confirmed the conclusions of the in-situ erosion flume. In addition, the measurement of dry density of the sediment deposits using an ultrasonic device was carried out to explain the differences in the stability of sediment deposits from the two sites. Other factors such as floc size distributions of the sediment forming the deposits, bioturbation, and fecal pellets were also included in the investigation.
Calculation of nutrient retention in European catchments applying a standard tool: EUROHARP-NUTRET

B. KRONVANG\textsuperscript{1}, J. HEIZLAR\textsuperscript{2}, P. BOERS\textsuperscript{3}, J.P. JENSEN\textsuperscript{1}, T. ANDERSEN\textsuperscript{4}, B. ARHEIMER\textsuperscript{5}, H. BEHRENDT\textsuperscript{6}

\textsuperscript{1}National Environmental Research Institute, Department of Freshwater Ecology, Vejlsøvej 25, DK-8600 Silkeborg, Denmark; BKR@DMU.DK
\textsuperscript{2}Hydrobiological Institute, Academy of Sciences of the Czech Republic
\textsuperscript{3}Institute for Inland Water Management and Wastewater Treatment, Lelystad, The Netherlands
\textsuperscript{4}Norwegian Institute for Water Research, Oslo, Norway
\textsuperscript{5}Swedish Meteorological and Hydrological Institute, Norrköping, Sweden
\textsuperscript{6}Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany

Abstract

EUROHARP is a new major research project funded by the EU 5\textsuperscript{th} Framework Programme. One important challenge in the EUROHARP project is to validate existing and develop new quantification tools for nutrient retention in streams, rivers, stratified and unstratified lakes, reservoirs and floodplains. Retention in watersheds is a function of many biogeochemical parameters and hydromorphological characteristics of rivers, lakes and floodplains. Many of these parameters are difficult to measure, and therefore difficult to implement in calculation procedures. In general, nitrogen retention is more influenced by biological processes as denitrification, whereas phosphorus retention is more influenced by physico-chemical processes, such as sedimentation and sorption/desorption reactions in sediments. Factors influencing nitrogen and phosphorus retention are hydraulic residence time, input of nitrogen and phosphorus to freshwater systems, trophic level, oxygen condition, organic matter level, temperature, nitrogen fixation, general water chemistry, vegetation and human activities in the catchment. Many of these parameters vary considerably amongst European countries, and even between regions within the same country. This makes it difficult to fully harmonise the methods of quantifying the nitrogen and phosphorus retention in catchments. The EUROHARP Expert Group on Nutrient Retention has developed an assistant tool (EUROHARP-NUTRET) for catchment managers that enables them to calculate nutrient retention in rivers, lakes, reservoirs and wetlands using standardised methods. EUROHARP-NUTRET contains several different Tiers for calculation of nutrient retention the higher the Tier the higher are the requirements for input data from the catchment managers. In this poster we present the EUROHARP-NUTRET tool and the results of applying the retention tool in the 17 EUROHARP catchments that cover north-south and east-west gradients in European landscapes, climate, etc. The quantitative importance of nutrient retention processes in surface water exemplified by the EUROHARP catchments analysed. Moreover, the differences in catchment retention rates for nitrogen and phosphorus are shown.
Sediment, organic matter and particulate phosphorus sinks and sources following restoration of Danish rivers and floodplains

B. Kronvang, C.C. Hoffmann, H.E. Andersen, M.L. Pedersen, N.B. Ovesen

National Environmental Research Institute, Department of Freshwater Ecology,
Vejlsøvej 25, DK-8600, Silkeborg Denmark;
BKR@DMU.DK

Abstract

During the last decade more emphasis has been paid to the fluxes of suspended sediment, organic carbon and particulate phosphorus (P) through freshwater drainage systems because of severe eutrophication effects in rivers, lakes, reservoirs and coastal waters observed throughout the world. Overbank storage has been shown to be an important sink for suspended sediment, organic carbon and particulate P in natural river systems. In many river systems overbank flooding are, however, prevented due to the regulation of watercourses for various purposes as drainage of agricultural areas, ship traffic, dams and reservoirs, etc. In Denmark, more than 40 river restoration projects have been completed during the last 2 decades and a number of these projects involved restoring the natural hydrologic contact between a river and its floodplain allowing flooding to take place. The deposition of sediment, organic matter and particulate phosphorus was measured in cross-sections of the floodplain in the EU Pilot River Odense Å following a re-meandering of ca. 6 km formerly straightened and canalised river channel involving 128 ha floodplain during the winters of 2003/2004 and 2004/2005. Average area-weighted sedimentation rates in the cross-sections surveyed varied between 0-4.67 kg DW m\(^2\) and 0-2.89 g P m\(^2\) during the winter of 2003/2004. Excess river bank erosion following excavation of the re-meandered river channel was measured applying bank erosion pins in the re-meandered channel and at an upstream still canalised control section of the river. The results obtained will be compared and discussed with deposition and bank erosion rates measured in other projects where natural hydrological interaction between the river and floodplain was restored and with experience from natural river systems. Restoring the natural floodplain and the depositional processes could be an important mitigation measure for reducing sediment and sediment-associated substance transport to water bodies under the EU Water Framework Directive.
Mineralogical Analysis and Fractionation of Heavy Metals in Sediments of Mai Po Nature Reserve

M.Y. LAI 1, JI-DONG GU 1,2*

1 Laboratory of Environmental Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong SAR
2 The Swire Institute of Marine Science, The University of Hong Kong, Shek O, Cape d’Aguilar, Hong Kong SAR;
jdgu@hkucc.hku.hk

Abstract

Mai Po and Inner Deep Bay Nature Reserve cover approximately 1,500 hectares consisting of intertidal mudflats, mangroves, gei wai, fishponds and drainage channels. Each year, between 49,000 to 68,000 water birds regularly stay at the site during winter. Undoubtedly, this is the largest remaining wetland in Hong Kong and plays a very important role in supporting a wide range of wildlife including migratory birds and local important species like the Black faced spoonbill. Since part of the intertidal wetland is on Shenzhen’s side of the Mainland China and the Shenzhen River also discharges a large quantity of wastewater into the Deep Bay and Nature Reserve, protection of the ecological conditions at the area is an issue of regional importance for protection of wildlife and biodiversity. Ecological quality of the water and sediment at the area may also have a significant impact on the wildlife because recent scientific findings suggested fauna and migratory birds might have been affected by the pollution in the past. The objectives of this study were to determine the concentration of selective heavy metals in sediment cores of the mudflat of the area and to fractionate heavy metals for projecting bioavailability and potential ecological impact assessment.

Sediment samples were taken from the mudflat at designated locations using Acrylic tube sampler and each soft sediment core was then further sub-sectioned into depths from 0-10, 10-20, 20-30 and 30-40cm. Sediment materials were sequentially extracted following the Tessier et al’s (1979) procedure for the following fractions: exchangeable, carbonate bound, oxidizable, reducible, and residual. Extractants of each fractionation were analyzed for Cd, Cr, Cu, Pb and Zn on ICP-MS. Results showed that the concentration sequence of total metal concentrations follows Zn > Pb > Cu ~ Cr > Cd at all sites analyzed for two samplings in 2002. Surprisingly, between 42 – 72 % of the total metals were found in exchangeable fraction, which is bioavailable to the indigenous flora and fauna. This is contradictory to our previous analyses conducted on samples from other sites in Hong Kong. We are current investigating the kinetics of chemical exchange of heavy metals with introduced cation species and the mineralogical basis for the higher fraction of metals in the exchangeable fraction.
Spatial patterns of porewater parameters and microbial turnover rates within the rhizosphere of submersed macrophytes

CHRISTINE LASKOV, MICHAEL HUPFER

RG Biogeochemistry, Leibniz-Institute of Freshwater Ecology and Inland Fisheries
Müggelseedamm 301, D-12587 Berlin, Germany;
laskov@igb-berlin.de

Abstract

Root oxygen release is a well reported phenomenon for wetland plants as well as submersed aquatic vegetation. Root oxygen release may partially oxidise strongly reducing sediments, creating microzones on the mm-scale with further implications for redox driven processes such as iron- and sulfate reduction rates. Hence, objective of this study was to investigate the influence of submersed macrophytes on the porewater chemistry and microbial metabolism pathways in littoral sediments of shallow eutrophic lakes. Micro-scale spatial patterns of nutrients (phosphorus, ammonia) and redox parameters (ferrous iron, sulfate) within the rhizosphere of the submersed macrophytes Potamogeton crispus and Myriophyllum spicatum were obtained from experimentally planted mesocosms. Porewater was sampled with a new high resolution 2-dimensional dialyses sampler (550 chambers, 0.9 cm spatial resolution) for phosphate, ammonia, ferrous iron as well as sulfate. The obtained lateral-vertical profiles showed a nutrient depletion of up to 50-80% within the rhizosphere as well as a large lateral variability with “hot spots” and “depletion areas” (e.g. phosphorus 0-1500 µg/l) directly adjacent to each other.

The formation of iron plaques at the roots, the spatial pattern of ferrous iron, low net-turnover rates (< 1 nmol cm⁻³ d⁻¹) along with high root associated iron reduction rates (3-5 mmol g⁻¹FW_root d⁻¹) indicates a rapid microbially mediated iron cycle within the rhizosphere. Furthermore, enhanced sulfate concentrations (up to 2-fold) within the rhizosphere gives first evidence for the reoxidation of sulfides. Complementary, in situ sulfate reduction rates measured by the 35S-technique will be presented.

Overall, nutrient uptake and rhizosphere oxidation by submersed macrophytes had a significant impact on the spatial pattern of porewater parameters as well as microbial metabolism pathways in littoral sediments of eutrophic lakes.

Abstract
Occurrence and impact of sediment-bound pyrethroids in Danish streams

RASMUS B. LAURIDSEN¹, BRIAN KRONVANG², NIKOLAİ FRIBERG ²

¹Department of Zoology, Ecology and Plant Science, University College Cork, Cork, Eire;
r.lauridsen@ucc.ie

²National Environmental Research Institute, Department of Freshwater Ecology,
Silkeborg, Denmark

Abstract

Pesticides are widely used in Denmark and streams in agricultural areas are in potential risk for contamination. Among the insecticides used for crop protection pyrethroids are becoming dominant and in 2001 they accounted for more than 80 % of the sprayed areas. In a total of 319 water samples collected from Danish streams no traces of the pyrethroid esfenvalerate were detected. In contrast, pyrethroids were found in sediments in 9 out of 30 streams investigated in concentrations up to 50 ng g⁻¹. This finding is explained by the chemical properties of pyrethroids as they are all highly hydrophobic and adsorb rapidly to sediments and other surfaces such as macrophytes. It also strongly suggests that the primary route of pyrethroids into stream food webs will be through sediments including organic matter. We found that shredding activity of the Trichopteran Sericostoma personatum and the amphipod Gammarus pulex was significantly reduced with increased concentration of the pyrethroid lambdacyhalothrin adsorbed to the leaves on which they fed. The CPOM to FPOM conversion rate by Sericostoma personatum was reduced by 50 % at a concentration of 3.3 ng g⁻¹ compared with controls. The predation rate on the Plecoptera Leuctra nigra by the leech Erpobdella octoculata was significantly increased with increasing concentration of lambda-cyhalothrin on the leaves L. nigra was fed. Our results clearly indicate that sediment-bound pyrethroids potentially have a negative impact on ecosystem function as well as an affect on biotic interactions in streams.
Geomorphologic Effects on Sedimentation and Purification of Run-off from Farm Land

JONG S. LEE, JIN H. KIM, GOO B. JUNG, JOUNG D. SHIN, WON I. KIM, SUN G. YUN

National Institute of Agricultural Science and Technology, RDA, Suwon 441-707, Rep. of Korea; jongslee@rda.go.kr

Abstract

Non-point source pollution of agriculture is defined as an effluence of nutrient and pollutant occurring in nature that enters into a water body. Therefore, the occurrence of non-point source pollution depends on the degree of precipitation and pollutant sources on arable lands. There is always the possibility of water contamination from an effluence of nutrient with soil erosion flowing into a water system with intensive rainfall. Therefore, it is very meaningful to reduce water contamination and to protect from nutrient loss and soil erosion by identifying characteristics of the effluence from farm land according to agricultural land use types.

To estimate the water quality of effluent from farm land according to agricultural land use types, a series of run-off samples were separately collected at paddies and upland with intense rainfall. These samples were used for analyzing SS, EC and major nutrients such as nitrogen and phosphorus. Also, the purification effects of run-off quality with chain geomorphologic features were determined.

Rainfall intensity influenced SS contents in run-off from the upland, which showed higher contents at high rainfall intensity. However, those in paddies didn’t show it the same. According to agricultural land use type, upland effluent had higher contents of SS than those of paddies. Regarding geomorphologic features, paddies, which were located at lowland of terraces, act as sediment retention ponds. Paddies settled the settleable solids in run-off delivered from the upland and reduced the delivery of sediment from agricultural lands to surface waters. With sedimentation of SS lost from cropland, water was purified. Nutrient contents such as nitrogen and phosphorus in upland run-off were decreased with passing paddy. This means that paddies have a purification effect on run-off before it flows into water body.
Phosphorus retention in an agriculturally loaded estuary

Jouni Lehtoranta¹, Petri Ekhom¹, Kaarina Lukkarila², Mirja Leivuori², Heikki Pitkänen¹

¹ Finnish Environment Institute, P.O. Box 140, FIN-00251 Helsinki, Finland
² Finnish Institute of Marine Research, P.O. Box 33, FIN-00931 Helsinki, Finland

Abstract

Our objective was to study the sediment reactions of P in an agriculturally loaded estuary (rich in Fe, poor in Ca) with relation to agricultural P reduction measures, erosion control in particular. We examined the fate of Fe-bound P in estuarine sediments by measuring total Fe and P concentrations and Fe-bound P (BD-P) with buffered dithionite (BD = 0.11 M Na-dithionite + 0.11 M NaHCO₃) from riverine suspended solids and estuarial sediment. In addition, we analyzed concentrations of dissolved P and Fe in pore waters. The results suggest that Fe has a good ability to bind P in the sediments of the agriculturally loaded estuary. First, the Fe / P ratio in both riverine particulate matter (~45, by mass) and estuarial sediment (17–27) was high. Second, the concentration of BD-P was higher in the estuarial surface sediment (0.3–1.1 mg g⁻¹ DW) than in the riverine matter (0.2 mg g⁻¹ DW). And third, ratio of dissolved Fe and P (15–320, by mass) was high in pore water of 0–10 cm sediment layer. It appears that the sediment Fe cycling in the estuarial sediment (0–10 cm) is closer to that in the fresh waters than that in marine waters – although there is ample SO₄ in the estuarial water. This may be due to fact that the Fe flux transported by agriculturally loaded Finnish rivers to their estuaries is so large that Fe(III) oxides rather than SO₄ is used as electron acceptor for organic matter mineralization in surface sediments. By reducing erosion (and flux of particulate Fe) this pattern may change in favour of SO₄ reduction, which may result in an accelerated P flux from sediment to water as observed in the open Baltic Sea.
Metal dynamics in surface sediments investigated by the techniques of diffusive equilibration and gradient in thin-films (DET and DGT) in the Gulf of Finland, Baltic Sea

M. LEIVUORI1, H. KAASALAINEN1, M. MOTELICA-HEINO2, A. KOTILAINEN3, J.KARHU4

1Finnish Institute of Marine Research, P.O. Box 33, 00931 Helsinki, Finland,
2 BRGM, 3 avenue Claude Guillemin, 45060 Orléans cedex 2, France;
m.motelica@brgm.fr,
3 Geological Survey of Finland, P.O. Box 96, 02151 Helsinki, Finland;
aarno.kotilainen@gsf.fi,
4Department of Geology, P.O.Box 64, 00014 University of Helsinki, Finland;
juha.karhu@helsinki.fi

Abstract

The techniques of diffusive equilibration in thin-films (DET) and diffusive gradients in thin-films (DGT) were implemented to study metal dynamics at the sediment-water interface in the Gulf of Finland. DET and DGT are chemical sensors based on hydrogels (95 % water). In DET device the equilibrium is established between the sediment pore water and a single layer of diffusive gel. DGT uses an additional layer of gel impregnated with a binding agent that preconcentrates solutes in-situ and fixes them on the binding gel layer. Thus DGT measures the induced flux of solute from the solid phase to the solution directly which can be related to its concentration in the pore water and availability from the solid phase.

Organic matter, iron and manganese oxyhydroxides are the scavengers of metals in the sediments. However, surface remobilisation of metals can occur during the oxidation of organic matter or the dissolutive reduction of iron and manganese, while the presence of sulphide is thought to limit the metal pore-water concentration. Moreover there is a concern that the metals might be released from the sediment when environmental conditions are changing i.e. during bottom water anoxia or by the oxidation of sulphidic sediments. These variable hydrographical conditions are well-known phenomena in the Baltic Sea and to study influence of those the new techniques were successfully implemented for the sediment of the central and eastern part of the Gulf of Finland. Metal concentrations were measured using the GF-AAS. The concentration profiles reflect the reactions taking place in the surface sediments during the degradation of organic matter and early diagenesis. Metal availability from the sediment solid phase to solution is also estimated.
Degradation of Endocrine-disrupting Phthalates: Microorganisms Isolated from Mangrove and the Biochemical Pathways

JIAXI Li¹, YINGYING WANG², JI-DONG GU¹,²,³*

¹ South China Sea Institute of Oceanography, Guangzhou, P.R. China
² Laboratory of Environmental Toxicology, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong SAR, P.R. China
³ The Swire Institute of Marine Science, The University of Hong Kong, Shek O, Cape d’Aguilar, Hong Kong SAR, P.R. China

Abstract

Degradation of dimethyl isophthalate (DMI) and dimethyl phthalate ester (DMPE) was investigated using microorganisms isolated from mangrove sediment of Hong Kong Mai Po Nature Reserve. One enrichment culture was capable of utilizing DMI as the sole source of carbon and energy, but none of the bacteria in the enrichment culture was capable of degrading DMI alone. In co-culture of two bacteria, degradation was observed proceeding through monomethyl isophthalate (MMI) ester and isophthalic acid (IPA) before the aromatic ring opening. Using DMI as the sole carbon and energy source, Klebsiella oxytoca Sc and Methylobacterium mesophilicum Sr degraded DMI through the biochemical cooperation. The initial hydrolytic reaction of the ester bond was by K. oxytoca Sc and the next step of transformation was by M. mesophilicum Sr, and IPA was degraded by both of them.

In another investigation, a novel bacterium, strain MPsc, was isolated for degradation of dimethyl phthalate ester (DMPE) also from the mangrove sediment. The consortium consisting of two species degraded 450 mg/l DMPE within 3 days as the sole source of carbon and energy, but none of the individual species alone was able to transform DMPE. Furthermore, the biochemical degradation pathway proceeded through monomethyl phthalate (MMP), phthalic acid (PA) and then protocatechuic acid before aromatic ring cleavage. On the basis of phenotypic, biochemical and 16S rDNA gene sequence analyses, the strain MPsc should be considered as a new bacterium on the genus level (8% differences). This strain, together with a Rhodococcus zopfii isolated from the same mangrove sediment, was able to degrade DMPE aerobically. Our results suggest that degradation of complex organic compounds including DMI and DMPE may be carried out by several members of microorganisms working together in the natural environments.
Variability of heavy metal concentrations in a lake affected by acid mine drainage

Dina L. Lopez, Carol Hollenkamp, Elizabeth Gierlowski-Kordesh

Department of Geological Sciences, Ohio University, Athens, Ohio 45701, USA

Abstract

Sandy Run (Vinton County, Ohio) is a stream receiving acid mine drainage (AMD) from an abandoned coal mine complex. This stream has been dammed to form Lake Hope. Profiles of temperature, pH, and dissolved oxygen at different times of the year do not show the typical seasonal stratification observed in temperate lakes. Cross-sections of these parameters along the lake show vertical isotherms and lines of equal concentration. This behavior reflects the input of acidic and cold (winter) or hot (summer) water from Sandy Run. Alkalinity titrations along the lake show that the rise in pH is likely to be produced by the input of alkaline groundwater. The sediments show lower concentration of heavy metals close to the AMD discharging point and higher concentrations in the deeper region, close to the dam. Sequential extraction of metals in the sediments show that the highest fractions correspond to the oxidized iron and manganese hydroxides and the detrital fraction or eroded fragments from the watershed. Heavy metals in the organic fraction are low in these sediments. These low concentrations of heavy metals in the organic fraction does not support the transport of the heavy metals by algae growing in the lake, moving and settling down towards the dam. Other possible mechanisms to explain this behavior are proposed. Heavy metals and sediments from the AMD source could be transported to regions of lower water velocities (dam) and stored at the bottom. In addition, sediments rich in heavy metals could be eroded from sedimentary rocks surrounding the lake and transported to the lake. A combination of these processes is likely to produce the observed chemistry.
Phosphorus extraction methods tested on sediments from the Gulf of Finland

KAARINA LUUKKARI\textsuperscript{1}, MIRJA LEIVUORI\textsuperscript{1}, HENNING S. JENSEN\textsuperscript{2}

\textsuperscript{1}Finnish Institute of Marine Research, PL 33, 00930 Helsinki, Finland; Kaarina.Luukkari@fimr.fi
\textsuperscript{2}University of Southern Denmark, Odense, Denmark

Abstract

Sediment phosphorus (P) may have an important role in eutrophication of the Gulf on Finland. Sediments from deeper parts of the gulf are often anoxic which, by classical theory, represented for lake sediments, releases iron-bound phosphate to the water column. Another - but related - question relevant to the Gulf of Finland is what controls the burial of reactive P in the sediment, since this will modify the transport of P to the central Baltic Sea. These questions can be answered by evaluating vertical profiles of, particularly, iron-bound and organic P in the sediments. Two well-documented methods for sequential extraction of sediment P in siliciclastic sediments, RUTTENBERG (1992) and JENSEN & THAMDRUP (1993), were tested for their suitability for sediments in the Gulf of Finland, which are CaCO\textsubscript{3}-poor but rich in iron and humic matter. First, the JENSEN & THAMDRUP (1993) method was tested using both fresh and freeze-dried sediment to evaluate the effect of sediment pre-treatment. The method defines 5-6 various P fractions operationally but no effect of freeze-drying was detected on any of the fractions. Secondly, the two different extraction procedures were compared for both shallow coastal and anoxic open sea sediments. Results suggest that JENSEN & THAMDRUP (1993) method is more specific for iron-bound P and it also provided a possibility to discriminate between different organic forms of P by using NaOH-extraction after the removal of iron-bound P. Amounts of total organic P extracted were similar in the two methods and so was the sum of all the different P fractions. The RUTTENBERG (1992) method discriminates between authigenic and detrital apatite. This, however, did not seem to be important for the Gulf of Finland sediment since results from the deeper site suggested that iron-bound P was the quantitatively most important reactive P-form in the burial flux.