Determining Biodegradation Kinetics of Hydrocarbons at Low Concentrations: Covering 5 and 9 Orders of Magnitude of Kow and Kaw

A partitioning-based experimental platform was developed and applied to determine primary biodegradation kinetics of 53 hydrocarbons at ng/L to μg/L concentrations covering C8-C20, 11 structural classes, and several orders of magnitude in hydrophobicity and volatility: (1) Passive dosing from a loaded silicone donor was used to set the concentration of each hydrocarbon in mixture stock solutions; (2) these solutions were combined with environmental water samples in gastight auto sampler vials for 1-100 days incubation, and (3) automated solid phase microextraction (SPME) coupled to GC-MS was applied directly on these test systems for measuring primary biodegradation relative to abiotic controls. First order biodegradation kinetics were obtained for 40 hydrocarbons in activated sludge filtrate, 18 in seawater, and 21 in lake water. Water phase half-lives in seawater and lake water were poorly related to hydrophobicity and volatility but were, with a few exceptions, within a factor of 10 or shorter than BioHCwin predictions. The most persistent hydrocarbons, 1,1,4,4,6-pentamethyldecalin, perhydropyrene, 1,2,3,6,7,8-hexahydropyrene, and 2,2,4,4,6,8,8-heptamethylnonane, showed limited or inconsistent degradation in all three environmental media. This biodegradation approach can cover a large chemical space at low substrate concentrations, which makes it highly suited for optimizing predictive models for environmental biodegradation.
Biodegradation of hydrocarbon mixtures in surface waters at environmentally relevant levels - Effect of inoculum origin on kinetics and sequence of degradation

Biodegradation is a dominant removal process for many organic pollutants, and biodegradation tests serve as tools for assessing their environmental fate within regulatory risk assessment. In simulation tests, the inoculum is not standardized, varying in microbial quantity and quality, thereby potentially impacting the observed biodegradation kinetics. In this study, we investigated the effect of inoculum origin on the biodegradation kinetics of hydrocarbons for five inocula from surface waters varying in urbanization and thus expected pre-exposure to petroleum hydrocarbons. A new biodegradation method
for testing mixtures of hydrophobic chemicals at trace concentrations was demonstrated: Aqueous solutions containing 9 hydrocarbons were generated by passive dosing and diluted with surface water resulting in test systems containing native microorganisms exposed to test substances at ng-μg/L levels. Automated Headspace Solid Phase Microextraction coupled to GC-MS was applied directly to these test systems to determine substrate depletion relative to abiotic controls. Lag phases were generally less than 8 days. First order rate constants were within one order of magnitude for each hydrocarbon in four of the five waters but lower in water from a rural lake. The sequence of degradation between the 9 hydrocarbons showed similar patterns in the five waters indicating the potential for using selected hydrocarbons for benchmarking between biodegradation tests. Degradation half-times were shorter than or within one order of magnitude of BioHCwin predictions for 8 of 9 hydrocarbons. These results showed that location choice is important for biodegradation kinetics and can provide a relevant input to aquatic exposure and fate models.

General information
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Organisations: Department of Environmental Engineering, Environmental Chemistry, Mike Comber Consulting
Authors: Birch, H. (Intern), Hammershøj, R. H. (Intern), Comber, M. (Ekstern), Mayer, P. (Intern)
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Scopus rating (2016): CiteScore 4.39 SJR 1.417 SNIP 1.606
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Web of Science (2015): Indexed yes
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Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
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Scopus rating (2012): SJR 1.818 SNIP 1.623 CiteScore 3.5
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BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.867 SNIP 1.421
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.836 SNIP 1.573
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.651 SNIP 1.591
Biodegradation testing of chemicals with high Henry's constants – separating mass and effective concentration reveals higher rate constants

During simulation-type biodegradation tests, volatile chemicals will continuously partition between water phase and headspace. This study addressed how (1) this partitioning affects biodegradation test results and (2) it can be accounted for by combining mass balance and dynamic biodegradation models. An aqueous mixture of 9 (semi)volatile chemicals was first prepared using passive dosing and then diluted with environmental surface water to produce test systems containing concentrations in the ng/L to µg/L range. After incubation for 2 hours to 4 weeks, automated Headspace Solid Phase Microextraction (HS-SPME) was applied directly on the test systems to measure substrate depletion by biodegradation relative to abiotic controls. HS-SPME was also applied to determine air to water partitioning ratios. Water phase biodegradation rate constants, kwater, were up to 72 times higher than test system biodegradation rate constants, ksystem. True water phase degradation rate constants facilitate extrapolation to other air-water systems and are more suitable input parameters for aquatic exposure and fate models. As such, they should be considered more appropriate for risk assessments than test system rate constants.

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Organisations: Department of Environmental Engineering, Environmental Chemistry, Water Technologies, Mike Comber Consulting
Authors: Birch, H. (Intern), Andersen, H. R. (Intern), Comber, M. (Ekstern), Mayer, P. (Intern)
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Biodegradation, Surface water, Partitioning, Degradation
Electronic versions:
Abstract_1_volatile_chemicals_FINAL.pdf
Source: PublicationPreSubmission
Source-ID: 133788762
Publication: Research - peer-review › Conference abstract for conference – Annual report year: 2017
Biodegradation testing of hydrophobic chemicals in mixtures at low concentrations – covering the chemical space of petroleum hydrocarbons

Petroleum products are complex mixtures of varying composition containing thousands of hydrocarbons each with their own physicochemical properties and degradation kinetics. One approach for risk assessment of these products is therefore to group the hydrocarbons by carbon number and chemical class i.e. hydrocarbon blocks. However, the biodegradation kinetic data varies in quantity and quality for the different hydrocarbon blocks, hampering the characterization of their fate properties. In this study, biodegradation kinetics of a large number of hydrocarbons aiming to cover the chemical space of petroleum hydrocarbons, were therefore determined at ng/L to µg/L concentrations in surface water, seawater and activated sludge filtrate. Two hydrocarbon mixtures were prepared, comprising a total of 53 chemicals including paraffins, naphthenics and aromatic hydrocarbons from C8 to C20. Passive dosing from silicone rod loaded with the mixtures was used to prepare stock solutions. Test systems were then prepared using stock solution diluted with the surface water, seawater or activated sludge filtrate. Test systems were incubated at 20 °C on a roller for up to 98 days and analyzed using GC-MS and fully automated Solid Phase Micro Extraction. Results were normalized to parallel measurements of abiotic controls prior to evaluation of biodegradation kinetics. Degradation was generally faster in the activated sludge filtrate than in the seawater and lakewater. In the activated sludge filtrate lag phases were < 9 days for the 49 hydrocarbons that were degraded within test duration. Degradation rate constants and corresponding half-lives were determined for 44 of the hydrocarbons. In lakewater and seawater, less test chemicals were degraded within the test duration compared to the activated sludge filtrate.

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Biodegradation of volatile hydrocarbons in five surface waters tested as composed mixtures in the µg/L range

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Organisations: Department of Environmental Engineering, Environmental Chemistry
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Biodegradation of volatile hydrocarbons in five surface waters tested as composed mixtures in the μg/L range

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Organisations: Department of Environmental Engineering, Environmental Chemistry
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Main Research Area: Technical/natural sciences
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Effect of climate change on stormwater runoff characteristics and treatment efficiencies of stormwater retention ponds; a case study from Denmark using TSS and Cu as indicator pollutants. SpringerPlus, 5:1984, 1-12.

This study investigated the potential effect of climate changes on stormwater pollution runoff characteristics and the treatment efficiency of a stormwater retention pond in a 95 ha catchment in Denmark. An integrated dynamic stormwater runoff quality and treatment model was used to simulate two scenarios: one representing the current climate and another representing a future climate scenario with increased intensity of extreme rainfall events and longer dry weather periods. 100-year long high-resolution rainfall time series downscaled from regional climate model projections were used as input. The collected data showed that total suspended solids (TSS) and total copper (Cu) concentrations in stormwater runoff were related to flow, rainfall intensity and antecedent dry period. Extreme peak intensities resulted in high particulate concentrations and high loads but did not affect dissolved Cu concentrations. The future climate simulations showed an increased frequency of higher flows and increased total concentrations discharged from the catchment. The effect on the outlet from the pond was an increase in the total concentrations (TSS and Cu), whereas no major effect was observed on dissolved Cu concentrations. Similar results are expected for other particle bound pollutants including metals and slowly biodegradable organic substances such as PAH. Acute toxicity impacts to downstream surface waters seem to be only slightly affected. A minor increase in yearly loads of sediments and particle-bound pollutants is expected, mainly caused by large events disrupting the settling process. This may be important to consider for the many stormwater retention ponds existing in Denmark and across the world.

General information
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Organisations: Department of Environmental Engineering, Urban Water Systems, Environmental Chemistry
Authors: Sharma, A. K. (Intern), Vezzaro, L. (Intern), Birch, H. (Intern), Arnbjerg-Nielsen, K. (Intern), Mikkelsen, P. S. (Intern)
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Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.433 SNIP 0.731 CiteScore 1.3
Model-based monitoring of stormwater runoff quality
Monitoring of micropollutants (MP) in stormwater is essential to evaluate the impacts of stormwater on the receiving aquatic environment. The aim of this study was to investigate how different strategies for monitoring of stormwater quality (combining a model with field sampling) affect the information obtained about MP discharged from the monitored system. A dynamic stormwater quality model was calibrated using MP data collected by automatic volume-proportional sampling and passive sampling in a storm drainage system on the outskirts of Copenhagen (Denmark) and a 10-year rain series was used to find annual average (AA) and maximum event mean concentrations. Use of this model reduced the uncertainty of predicted AA concentrations compared to a simple stochastic method based solely on data. The predicted AA concentration, obtained by using passive sampler measurements (1 month installation) for calibration of the model, resulted in the same predicted level but with narrower model prediction bounds than by using volume-proportional samples for calibration. This shows that passive sampling allows for a better exploitation of the resources allocated for stormwater quality monitoring.

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State: Published
Organisations: Department of Environmental Engineering
Authors: Birch, H. (Intern), Vezzaro, L. (Intern), Mikkelsen, P. S. (Intern)
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Main Research Area: Technical/natural sciences
Velocity dependent passive sampling for monitoring of micropollutants in dynamic stormwater discharges

Micropollutant monitoring in stormwater discharges is challenging because of the diversity of sources and thus large number of pollutants found in stormwater. This is further complicated by the dynamics in runoff flows and the large number of discharge points. Most passive samplers are non-ideal for sampling such systems because they sample in a time-integrative manner. This paper reports test of a flow-through passive sampler, deployed in stormwater runoff at the outlet of a residential-industrial catchment. Momentum from the water velocity during runoff events created flow through the sampler resulting in velocity dependent sampling. This approach enables the integrative sampling of stormwater runoff during periods of weeks to months while weighting actual runoff events higher than no flow periods. Results were comparable to results from volume-proportional samples and results obtained from using a dynamic stormwater quality model (DSQM). The paper illustrates how velocity-dependent flow-through passive sampling may revolutionize the way stormwater discharges are monitored. It also opens the possibility to monitor a larger range of discharge sites over longer time periods instead of focusing on single sites and single events, and it shows how this may be combined with DSQMs to interpret results and estimate loads over extended time periods.
Water sensitive urban design retrofits in Copenhagen-40% to the sewer, 60% to the city

Water Sensitive Urban Design (WSUD) is emerging in Denmark. This interdisciplinary desk study investigated the options for WSUD retrofitting in a 15 km(2) combined sewer catchment area in Copenhagen. The study was developed in collaboration with the City of Copenhagen and its water utility, and involved researchers representing hydrogeology, sewer hydraulics, environmental chemistry/economics/engineering, landscape architecture and urban planning. The resulting catchment strategy suggests the implementation of five sub-strategies. First, disconnection is focused within sites that are relatively easy to disconnect, due to stormwater quality, soil conditions, stakeholder issues, and the provision of unbuilt sites. Second, stormwater runoff is infiltrated in areas with relatively deep groundwater levels at a ratio that doesn't create a critical rise in the groundwater table to the surface. Third, neighbourhoods located near low-lying streams and public parks are disconnected from the sewer system and the sloping terrain is utilised to convey runoff. Fourth, the promotion of coherent blue and green wedges in the city is linked with WSUD retrofits and urban climate-proofing. Fifth, WSUD is implemented with delayed and regulated overflows to the sewer system. The results are partially adopted by the City of Copenhagen and currently under pilot testing.

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Comparing chemical analysis with literature studies to identify micropollutants to be treated or upstream source controlled in a catchment of Copenhagen (DK)

General information
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Organisations: Department of Environmental Engineering, Urban Water Engineering, Environmental Chemistry
Authors: Lützhøft, H. H. (Intern), Birch, H. (Intern), Eriksson, E. (Intern), Mikkelsen, P. S. (Intern)
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Abstract: TH 317
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2012

Model based monitoring of stormwater runoff quality
Monitoring of micropollutants (MP) in stormwater is essential to evaluate the impacts of stormwater on the receiving aquatic environment. The aim of this study was to investigate how different strategies for monitoring of stormwater quality (combination of model with field sampling) affect the information obtained about MPs discharged from the monitored system. A dynamic stormwater quality model was calibrated using MP data collected by volume-proportional and passive sampling in a storm drainage system in the outskirts of Copenhagen (Denmark) and a 10-year rain series was used to find annual average and maximum event mean concentrations. Use of this model reduced the uncertainty of predicted annual average concentrations compared to a simple stochastic method based solely on data. The predicted annual average obtained by using passive sampler measurements (one month installation) for calibration of the model resulted in the same predicted level but narrower model prediction bounds than calibrations based on volume-proportional samples, allowing a better exploitation of the resources allocated for stormwater quality management.

General information
State: Published
Organisations: Urban Water Engineering, Department of Environmental Engineering
Authors: Birch, H. (Intern), Vezzaro, L. (Intern), Mikkelsen, P. S. (Intern)
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Main Research Area: Technical/natural sciences
Conference: 9th International Conference on Urban Drainage Modelling, Belgrade, Serbia, 04/09/2012 - 04/09/2012
Modelling, Monitoring, Passive sampling, Stormwater
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012

Monitoring, chemical fate modelling and uncertainty assessment in combination: a tool for evaluating emission control scenarios for micropollutants in stormwater systems
Stormwater discharges can represent significant sources of micropollutants (MP), including heavy metals and xenobiotic organic compounds that may pose a toxicity risk to aquatic ecosystems. Control of stormwater quality and reduction of MP loads is therefore necessary for a sustainable stormwater management in urban areas, but it is strongly hampered by the general lack of field data on these substances. A framework for combining field monitoring campaigns with dynamic MP modelling tools and statistical methods for uncertainty analysis was hence developed to estimate MP fluxes and fate in stormwater runoff and treatment systems under sparse data conditions.
The framework was applied to an industrial/residential area in the outskirts of Copenhagen (Denmark), where stormwater is discharged in a separate channel system discharging to a wet detention pond. Analysis of economic activities and GIS data on land usage allowed characterizing the catchment and identifying the major potential sources of stormwater MP. Monitoring of the pond inlet and outlet, as well as sediment analyses, allowed assessing the current situation and highlighted potential risks for the downstream surface water environment. The collected data was used in combination with an integrated dynamic MP fate model to estimate the MP fluxes in the catchment and the MP fate in the pond over a 10-year period. The model was also used to evaluate the potential effects of anticipated future climate changes as well as different scenarios for reduction of MP emissions while considering the uncertainty of the model predictions.

**General information**

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Organisations: Department of Environmental Engineering, Urban Water Engineering, Environmental Chemistry, Albertslund Municipality
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**Monitoring of priority pollutants in dynamic stormwater discharges from urban areas**

The European Water Framework Directive (WFD) from 2000 has put focus on the chemical status of surface waters by the specified Environmental Quality Standard (EQSs) and the requirements for monitoring of surface water quality throughout Europe. When considering the water quality of urban stormwater runoff it is evident that surface waters receiving large amount of urban stormwater runoff will be at risk of failing to meet the EQSs. Therefore stormwater treatment is crucial. However, as stormwater quality varies orders of magnitude between sites, stormwater monitoring is important in order to design the right treatment level to protect surface waters. Stormwater runoff is very dynamic both quality and quantity wise. In order to optimize the sampling of such phenomena, advanced sampling equipment is required. Such equipment is expensive, and furthermore, it is time consuming to conduct the sampling campaigns. Therefore this PhD project aimed at improving monitoring programs for priority pollutants in stormwater runoff. By comparing results from a literature study and a screening campaign to the EQSs, it was found that heavy metals (especially Cu and Zn), polyaromatic hydrocarbons (PAHs), Di(2-ethylhexyl)-phthalate (DEHP) and pesticides were the main pollutants of general concern in stormwater runoff and of concern at the studied catchment (glyphosate was found to be the most relevant pesticide in a Copenhagen setting). These priority pollutants are therefore relevant to monitor in stormwater discharges. Sorption of pollutants to particulate matter and dissolved organic carbon is important for both the toxicity of the pollutants and for removal in stormwater treatment systems. Furthermore sorption is important for sampling using the most common types of passive samplers, which are based on uptake of analytes by diffusion, since they only sample the freely dissolved and labile fraction of analytes. Passive dosing was therefore developed during this PhD project as an easy, fast and precise method for partition measurements of hydrophobic organic compounds (HOC) in aqueous samples such as stormwater runoff. The principle of the method is that the freely dissolved concentration of the HOC is controlled by partitioning from a pre-loaded polymer and the total concentration in the sample at equilibrium is measured. Partition measurements in stormwater runoff samples revealed a partition ratio log KTSS for fluoranthene of 4.59, and free fractions in stormwater runoff of 0.04-0.5. The partition ratio can be used in modeling of stormwater treatment systems. The passive dosing method can be used for surface water monitoring to relate freely dissolved concentrations to total concentrations. For stormwater monitoring, diffusion based passive samplers are not appropriate to use. The reason is that the sampler measures time-weighted concentrations over periods of weeks to months with no regard to whether it rains or not. Therefore a flow-through passive sampler, SorbiCell, was tested. It consists of a cartridge containing a sorbent and was installed directly in the stormwater drainage ditch letting the momentum from the water velocity force water through the
sampler. This novel installation method ensures sampling mainly during runoff events and dependant on the velocity of the runoff. Even though a filter prevented large particles from entering the sampler, it revealed concentrations comparable to volume proportional total concentrations measured in stormwater runoff and modeled using a dynamic stormwater quality model. There are still many questions and assumptions when using this installation method. However it has potential for monitoring the load of priority pollutants to surface waters from the large amounts of stormwater discharge points often contributing to the deterioration of the water quality. When evaluating the pollutant level at specific sites based on measurements, an interpretation of the system is always involved. This interpretation can be formulated in stormwater quality models. Event mean concentrations (EMCs) are often found to follow a lognormal distribution. However more complicated models including dynamics of accumulation in the catchment and influence of rain characteristics on the runoff concentrations can also be used. The advantage of using models for monitoring purposes is that information about the system beyond the time interval of sampling can be obtained based on knowledge of processes and observed patterns. It was found here that model prediction bounds for annual average concentrations obtained by a dynamic stormwater quality model were narrower than uncertainty on the mean when assuming lognormal distribution of EMCs. Furthermore, the use of passive sampler measurements in combination with volume proportional measurements for calibration reduced the model prediction bounds on annual average concentrations more than simply increasing the number of volume proportional samples. This work demonstrated how models and passive samplers can be used for monitoring purposes.

### Partitioning of fluoranthene between free and bound forms in stormwater runoff and other urban discharges using passive dosing

Partitioning of fluoranthene in stormwater runoff and other urban discharges was measured by a new analytical method based on passive dosing. Samples were collected at the inlet (n = 11) and outlet (n = 8) from a stormwater retention pond in Albertslund (Denmark), and for comparison samples were also obtained at a municipal wastewater treatment plant, a power plant, a contaminated site and a waste deposit in Copenhagen (n = 1 at each site). The freely dissolved concentration of 14C-fluoranthene in the samples was controlled by equilibrium partitioning from a pre-loaded polymer and the total sample concentration measured. The measurements yielded free fractions of fluoranthene in stormwater in the range 0.04–0.15 in the inlet during the first part of the runoff events increasing to 0.3–0.5 at the end of the events and in the outlet from the retention pond. The enhanced capacity of the different stormwater samples for carrying fluoranthene was 2–23 relative to pure water and decreasing during rain events. The enhanced capacity of stormwater showed a different relationship with suspended solid concentrations than the other types of urban discharges. Partitioning of fluoranthene to dissolved organic carbon was lower than partitioning to particulate organic carbon. Partitioning of fluoranthene to particulate organic matter in the 19 stormwater samples yielded a log KPOM of 5.18. The presented results can be used in stormwater quality modeling and assessment of efficiency of stormwater treatment systems. This work also shows the potential of the passive dosing method to obtain conversion factors between total concentrations, which are needed for comparison with water quality criteria, and freely dissolved concentrations, which are more related to toxicity and obtained by the use of most passive samplers.
Comparing chemical analysis with literature studies to identify micropollutants in a catchment of Copenhagen (DK)

In the year 2000 the European Union implemented the European Water Framework Directive of which the overall aim is to maintain or obtain good ecological and chemical status of European near coastal waters, lakes, rivers, streams,
groundwater as well as artificial water bodies as docks and canals (EU, 2000). It is also required to establish inventories of sources to pollution, to design and perform monitoring programs as well as to outline strategies to reduce emissions if the environmental quality standards are exceeded. The aim of this study was to compare chemical analysis performed on urban surface runoff originating from a well defined catchment of Copenhagen (Denmark) with an inventory of potential pollution sources for the same catchment. The selected catchment covers an area with roads, a shopping centre, a parking lot, office buildings, a gymnasium and some restaurants. The literature approach is limited to the range of included Ps and to how and which information is compiled, whereas the analytical chemical approach is limited to the selection of analyzed substances, sensitivity and precision. Comparing the two approaches of chemical analysis with literature study to identify contaminants reveals a discrepancy in the exact identity, though the overall findings are similar.

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering, Environmental Chemistry
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Main Research Area: Technical/natural sciences
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Effect of climate change on stormwater characteristics and treatment efficiencies of stormwater retention ponds
The aim of this study was to investigate the potential effect of climate changes on stormwater characteristics and treatment efficiency of retention ponds. This was performed by using an integrated model for two scenarios representing the current situations and a climate change scenario with increased intensity of extreme events. The study was conducted in a catchment in Albertslund, Denmark. The collected data showed a clear relation between stormwater quality parameters and rainfall intensity and antecedent dry period. Extreme events resulted in high particulate concentrations and high loads. The dissolved concentrations showed no strong relationship to rainfall intensity. The simulations with the integrated model showed that the climate change increase of rainfall intensity led to an increase in the concentrations discharged from the catchment. The higher flows caused a decrease in the pond removal performance with an overall increase in the particulate concentrations discharged to the environment. The changes in the two scenarios affected only the particulate phase, so no major impact on toxicity due to stormwater discharge is expected due to climate change. Further research is needed to address the seasonal fluctuations and provide a better analysis of the potential impacts due to climate change.

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Organisations: Department of Environmental Engineering, Urban Water Engineering, Residual Resource Engineering
Authors: Sharma, A. K. (Intern), Vezzaro, L. (Intern), Birch, H. (Intern), Arnbjerg-Nielsen, K. (Intern), Mikkelsen, P. S. (Intern)
Publication date: 2011

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Main Research Area: Technical/natural sciences
Storm water quality, Climate change effects, Treatment, Integrated model, Retention ponds
Links:
Source: orbit
Source-ID: 284979
Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Micropollutants in stormwater runoff and combined sewer overflow in the Copenhagen area, Denmark
Stormwater runoff contains a broad range of micropollutants. In Europe a number of these substances are regulated through the Water Framework Directive, which establishes Environmental Quality Standards (EQSs) for surface waters. Knowledge about discharge of these substances through stormwater runoff and combined sewer overflows (CSOs) is essential to ensure compliance with the EQSs. Results from a screening campaign including more than 50 substances at four stormwater discharge locations and one CSO in Copenhagen are reported here. Heavy metal concentrations were detected at levels similar to earlier findings, e.g., with copper found at concentrations up to 13 times greater than the Danish standard for surface waters. The concentration of polycyclic aromatic hydrocarbons (PAHs) exceeded the EQSs by factors up to 500 times for stormwater and 2,000 times for the CSO. Glyphosate was found in all samples whilst diuron, isoproturon, terbutylazine and MCPA were found only in some of the samples. Diethylhexylphthalate (DEHP) was also
found at all five locations in concentrations exceeding the EQS. The results give a valuable background for designing further monitoring programmes focusing on the chemical status of surface waters in urban areas. © IWA Publishing 2011.

**General information**

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Organisations: Urban Water Engineering, Department of Environmental Engineering, DHI Denmark  
Authors: Birch, H. (Intern), Mikkelsen, P. S. (Intern), Jensen, J. (Ekstern), Lützhøft, H. H. (Intern)  
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Main Research Area: Technical/natural sciences

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BFI (2017): BFI-level 1  
Web of Science (2017): Indexed yes  
BFI (2016): BFI-level 1  
Scopus rating (2016): CiteScore 1.3 SJR 0.394 SNIP 0.621  
Web of Science (2016): Indexed yes  
BFI (2015): BFI-level 1  
Scopus rating (2015): SJR 0.466 SNIP 0.599 CiteScore 1.19  
Web of Science (2015): Indexed yes  
BFI (2014): BFI-level 1  
Scopus rating (2014): SJR 0.587 SNIP 0.685 CiteScore 1.14  
Web of Science (2014): Indexed yes  
BFI (2013): BFI-level 1  
Scopus rating (2013): SJR 0.568 SNIP 0.7 CiteScore 1.3  
ISI indexed (2013): ISI indexed yes  
Web of Science (2013): Indexed yes  
BFI (2012): BFI-level 1  
Scopus rating (2012): SJR 0.601 SNIP 0.669 CiteScore 1.13  
ISI indexed (2012): ISI indexed yes  
Web of Science (2012): Indexed yes  
BFI (2011): BFI-level 1  
Scopus rating (2011): SJR 0.591 SNIP 0.626 CiteScore 1.25  
ISI indexed (2011): ISI indexed yes  
Web of Science (2011): Indexed yes  
BFI (2010): BFI-level 1  
Scopus rating (2010): SJR 0.522 SNIP 0.602  
Web of Science (2010): Indexed yes  
BFI (2009): BFI-level 1  
Scopus rating (2009): SJR 0.589 SNIP 0.686  
Web of Science (2009): Indexed yes  
BFI (2008): BFI-level 2  
Scopus rating (2008): SJR 0.579 SNIP 0.697  
Web of Science (2008): Indexed yes  
Scopus rating (2007): SJR 0.749 SNIP 0.781  
Web of Science (2007): Indexed yes  
Scopus rating (2006): SJR 0.693 SNIP 0.796  
Web of Science (2006): Indexed yes  
Scopus rating (2005): SJR 0.763 SNIP 0.85
Passive sampling and modeling of PAHs and heavy metals in stormwater runoff

Requirements in the European Water Framework Directive include monitoring of priority substances in the aquatic environment. Use of passive samplers for monitoring purposes in the highly dynamic storm sewer systems is limited by the time-proportional sampling adopted by the majority of the available samplers. This paper reports the preliminary results from work with the SorbiCell passive sampler, which samples runoff with a velocity-proportional approach. The inlet and outlet of a retention pond was monitored by using autosamplers and SorbiCell passive samplers. Total concentrations of PAHs in samples from the autosampler ranged from LOD - 0.63 μg/L in the pond inlet and LOD - 0.08 μg/L in the outlet. Dissolved concentrations of PAHs measured using the passive samplers at the inlet varied from LOD - 0.93 μg/L. Dissolved copper concentrations ranged from 4.7-22 μg/L according to the data from the autosamplers and between 18-43 μg/L according to the passive samplers. Dissolved lead and zinc concentrations ranged from 0.3-35 μg/L and 36-122 μg/L respectively. The different sampling techniques were compared by using an integrated stormwater quality model. Representative samples can be obtained by using both sampling methods after an accurate definition of the sampling configuration (sampling frequency, flow velocity around the sampler).

Passive dosing as a tool to determine the binding of hydrophobic organic chemicals to dissolved organic carbon, colloids and suspended particles in aqueous solutions: WE 073

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Gouliarmou, V. (Ekstern), Birch, H. (Intern), Vendelboe, A. (Ekstern), de Jonge, L. (Ekstern), Mayer, P. (Ekstern)
Number of pages: 320
Publication date: 2010
Passive Dosing to Determine the Speciation of Hydrophobic Organic Chemicals in Aqueous Samples

A new analytical approach to determine the speciation of hydrophobic organic analytes is presented. The freely dissolved concentration in a sample is controlled by passive dosing from silicone (poly(dimethylsiloxane)), and the total sample concentration at equilibrium is measured. The free fraction is determined as the ratio between measured concentrations in pure water and sample. C-14-labeled fluoranthene served as model analyte, and total sample concentrations were easily measured by liquid scintillation counting. The method was applied to surface water, stormwater runoff, and wastewater. In the untreated wastewater, 61% of the fluoranthene was bound to suspended solids, 28% was associated to dissolved organic matter, and 11% was freely dissolved, while in treated wastewater, the speciation was 16% bound to suspended solids, 4% bound to dissolved organic matter, and 80% freely dissolved. The free fraction in roof runoff (85%) and surface water (91%) was markedly higher than in runoff from paved areas, which ranged from 27 to 36%. A log K-DOC value of 5.26 was determined for Aldrich humic acid, which agrees well with reported values obtained by fluorescence quenching and solid phase microextraction (SPME). This analytical approach combines simplicity with high precision, and it does not require any phase separation steps.
Strategies for monitoring of priority pollutant emission barriers

The objective of Task 7.5 was to develop tools for model-based planning of sampling campaigns in the design of monitoring strategies for priority pollutant emission barriers. Using integrated urban wastewater system (IUWS) models, measurement campaigns can be designed to improve the calibration of the model’s parameters (Optimal Experiment Design for Parameter Estimation (OED/PE)). Furthermore, the knowledge contained in the IUWS models can be used to optimize the planning of sampling campaigns aiming at assessing the efficiency of emission control strategies. To do this, the emission barriers need to be implemented in the IUWS model, as well as the sampling and measuring devices that will be used. The simulation results are presented as a Substance Flow Analysis (SFA). These SFAs can be compared with empirical SFAs and can also be used to set up measurement campaigns aiming at gathering information to establish or improve empirical SFAs (OED/SFA). Moreover, the national Danish environmental monitoring programs were compared to the US programs under the Clean Water Act and the proposed environmental monitoring of the European water courses as described in the European Water Framework Directive. Also, kinetic passive sampling methods for the measurement of average water concentrations are presented.
Xenobiotics in Stormwater Run-off and Combined Sewer Overflow

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Birch, H. (Intern), Mikkelsen, P. S. (Intern), Jensen, J. (Ekstern), Lützhøft, H. H. (Intern)
Pages: 247-252
Publication date: 2010

Host publication information
Title of host publication: The 14th International Conference IWA Diffuse Pollution Specialist Group: Diffuse Pollution and Eutrophication, DIPCON 2010, September 12-17, 2010, Beaupré, Quebec, Canada : Proceedings & Book of Abstracts. CD-ROM
Publisher: IWA International Water Association
Main Research Area: Technical/natural sciences
Conference: The 14th International Conference IWA Diffuse Pollution Specialist Group: Diffuse Pollution and Eutrophication, Quebec, Canada, 12/09/2010 - 12/09/2010
Source: orbit
Source-ID: 267394
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010

Harrestrup Å. Casestudie.: Koblede afkoblinger. Vilkår for landskabsbaserede afkoblinger af regnvand i det københavnse kloakopland til Harrestrup Å. Arbejdsrapport

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Fryd, O. (Ekstern), Backhaus, A. (Ekstern), Birch, H. (Intern), Panduro, T. (Ekstern), Fratini, C. (Intern)
Pages: 38-40
Publication date: 2009

Publication information
Publisher: 2BG-projektet
Original language: Danish
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 267650
Publication: Research › Report – Annual report year: 2009

Holland: Landskabsbaseret afvanding

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Jensen, J. (Ekstern), Fryd, O. (Ekstern), Backhaus, A. (Ekstern), Ingvertsen, S. (Ekstern), Pauleit, S. (Ekstern), Dam, T. (Ekstern), Bergman, M. (Ekstern), Birch, H. (Intern), Mikkelsen, P. S. (Intern)
Pages: 38-40
Publication date: 2009
Landscape based urban drainage - adapting cities to heavier rain storms. P33.09

General information
State: Published
Organisations: Department of Environmental Engineering
Authors: Backhaus, A. (Ekstern), Bergman, M. (Ekstern), Birch, H. (Intern), Fryd, O. (Ekstern), Ingvertsen, S. (Ekstern), Jeppesen, J. (Ekstern), Bergen, M. (Ekstern)
Pages: 332020
Publication date: 2009
Main Research Area: Technical/natural sciences

Screening for Xenobiotics in Stormwater and Combined Sewer Overflows

General information
State: Published
Organisations: Urban Water Engineering, Department of Environmental Engineering
Authors: Birch, H. (Intern), Mikkelsen, P. S. (Intern), Lützhøft, H. H. (Intern)
Publication date: 2009
Host publication information
Title of host publication: International Conference on Xenobiotics in the Urban Water Cycle - XENOWAC 2009, March 11-13, 2009, Paphos, Cyprus
Volume: Proceedings, CD-ROM
Place of publication: Cyprus
Publisher: University of Cyprus
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 240592
Source control options for reducing emissions of pollutants from urban areas: Abstract WE 225

General information
State: Published
Organisations: Department of Environmental Engineering, Environmental Chemistry, Urban Water Engineering
Number of pages: 258
Publication date: 2009

Host publication information
Title of host publication: SETAC Europe 19th Annual Meeting Göteborg, Sweden 31 May - 4 June 2009. Protecting ecosystem health: facing the challenge of a globally changing environment
Volume: Abstract Book
Place of publication: Brussels
Publisher: SETAC Europe Office
Main Research Area: Technical/natural sciences
Conference: 19th Annual meeting of Society of Environmental Toxicology and Chemistry, Göteborg, Sweden, 31/05/2009 - 31/05/2009
Source: orbit
Source-ID: 244377
Publication: Research - peer-review › Conference abstract in proceedings – Annual report year: 2009

Removal of steroid hormones and personal care products in wastewater by chemical precipitation

General information
State: Published
Organisations: Department of Environmental Engineering, Urban Water Engineering
Authors: Eriksson, E. (Intern), Birch, H. (Intern), Andersen, H. R. (Intern), Henze, M. (Intern)
Pages: 757-768
Publication date: 2007

Host publication information
Volume: vol. 2
Place of publication: Kalmar, Sweden
Publisher: Kalmar University
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 207231
Publication: Research › Article in proceedings – Annual report year: 2007

Projects:

Mixture Effects in Biodegradation Testing of Aromatic and Aliphatic Hydrocarbons
Department of Environmental Engineering
Period: 15/06/2016 → 13/12/2019
Number of participants: 4
Phd Student: Hammershøj, Rikke Høst (Intern)
Supervisor: Andersen, Henrik Rasmus (Intern)
The effect of sorption and dosing on the degradation of poorly water soluble substances in different environmental matrices using standard OECD guidelines

Department of Environmental Engineering
Period: 01/01/2016 → 31/12/2018
Number of participants: 4
Phd Student:
Shrestha, Prasit (Intern)
Supervisor:
Birch, Heidi (Intern)
Hennecke, Dieter (Ekstern)
Main Supervisor:
Mayer, Philipp (Intern)
Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

Optimised Model-based Monitoring of Water Quality in Dynamic Discharges from Urban Areas

Department of Environmental Engineering
Period: 01/01/2008 → 19/09/2012
Number of participants: 6
Phd Student:
Birch, Heidi (Intern)
Supervisor:
Lützhøft, Hans-Christian Holten (Intern)
Main Supervisor:
Mikkelsen, Peter Steen (Intern)
Examiner:
Trapp, Stefan (Intern)
Deletic, Ana (Ekstern)
Østergaard, Peter Holm (Ekstern)
Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 DTU-stip, 2/3 FUR/andet
Project: PhD

Activities:

Biodegradation of hydrophobic chemicals in mixtures at low concentrations - Covering the chemical space of petroleum hydrocarbons
Period: 8 May 2017
Heidi Birch (Speaker)
Department of Environmental Engineering
Environmental Chemistry
Degree of recognition: International
Related event

SETAC Europe: 27th Annual Meeting – Environmental Quality Through Transdisciplinary Collaboration
07/05/2017 → 13/07/2017
Brussels, Belgium
Activity: Talks and presentations › Conference presentations