Project outlines
for the second PhD cohort
October 2022 - September 2025

Please find below a detailed description of each PhD project and the respective contact persons. Please send your applications (1 pdf file, max 10 MB), specifying for which PhD position you apply, with a 1-page letter of motivation, a reference letter from a mentor, degree certificates, a CV and a list of publications/presentations **until 28 February 2022** via email to **referat-L21@uni-landau.de.** It is possible to apply for several PhD positions. Please make sure to mention your **name and the reference number 05/2022** in the subject line of the email. Potential candidates shall be prepared to participate in a three-day workshop online or in Landau.

SystemLink website

Important abbreviations:

FPM Floodplain Mesocosms (see Facilities for details)
joint PE joint pot experiment (see Facilities for details)
PUFA polyunsaturated fatty acids
RSM Riparian Stream Mesocosms (see Facilities for details)
SIA stable isotope analysis

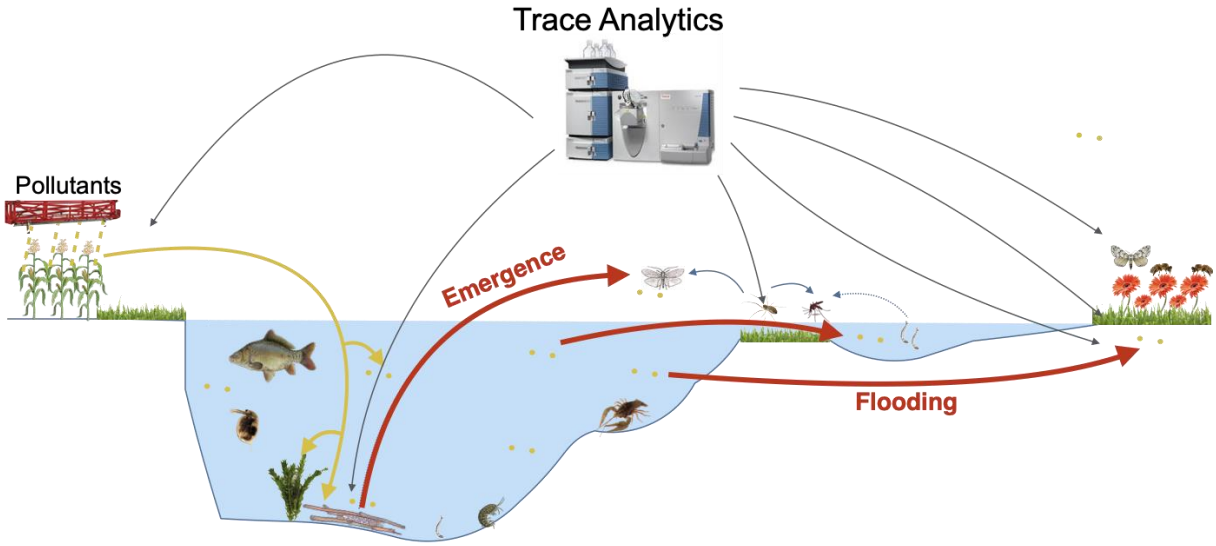
PhD project: Aquatic-terrestrial pollutant transfer

Working title: Flood-related pollutant transfer and its role for effects in terrestrial ecosystems relative to the biological transfer pathway

Supervising scientists: Ralf Schulz, $NN_{external}$, Carsten A. Brühl and Alessandro Manfrin

Approach: During a preceding PhD project it has been shown that the pollutants transfer via emergence depends on both physico-chemical and biological properties. This project will focus on the pollutant transfer via flooding events and follow the pathway soil-plants-herbivores (bottom-up), on the spatial extent to which pollutants are transferred to the terrestrial system, and on the relative contribution of the flood-related pathway with potential bottom-up effects and the emergence-related pathway with potential top-down effects in the terrestrial environment.

Laboratory batch or stream microcosm experiments will be conducted applying a variety of micropollutants in order to quantify, using trace chemical analytics, the potential transfer of micropollutants via the flood-related pathway. A joint Riparian Stream Mesocosm experiment (**SystemLink** *site-scale*) will be used to merge the flood-related and the emergence-related pathway for micropollutants. A joint field study will be conducted to quantify aquatic-terrestrial contaminant transfer via various pathways. Both RSM and field study level will be used to ascertain potential population effects on terrestrial predators, such as spiders.



Interested? You are the right person for this project if you are interested in ecosystem linkages and have a background in ecotoxicology and environmental chemistry. Ideally, you should have experience in experimental ecology and trace chemical analytics. You would have normally acquired these skills during a Bachelor and Master in Environmental Sciences, Ecotoxicology or Environmental Chemistry or similar course programs.

Contact: Ralf Schulz, Ecotoxicology & Environment

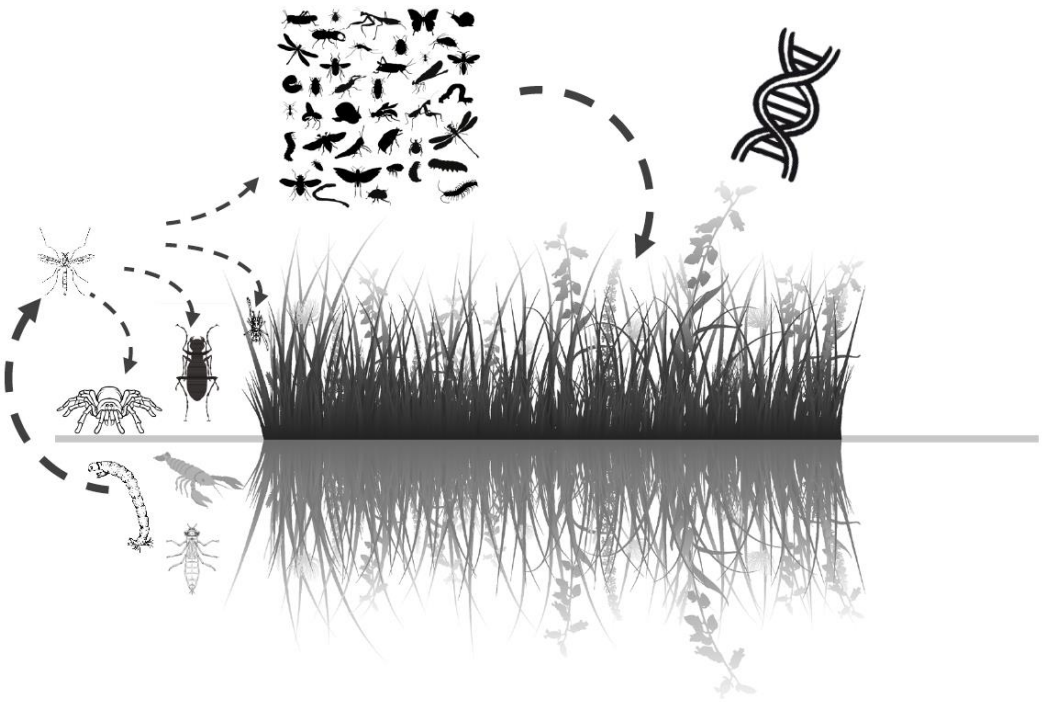
PhD project: Aquatic subsidies determine terrestrial biodiversity

Working title: Response of terrestrial communities and populations to variation in aquatic insect subsidies

Supervising scientists: Klaus Schwenk, Martin Entling, Jens Schirmel and Carsten Brühl

Approach: Riparian diversity and community composition are largely determined by aquatic insects. Changes in aquatic resources (e.g. emergence of insects) may result in variation of species composition among terrestrial predators (e.g. spiders and beetles). In addition, changes in aquatic subsidies might alter genetic variation in terrestrial populations and cause natural selection. These processes potentially alter lower trophic levels, such as herbivores and land plants (top-down effects) and even impact nutrient and micropollutant transport.

This thesis will focus at community and population processes to unravel the effects of drought and flooding on the community composition (and biodiversity) and genetic variation in aerial web-building and mobile ground hunting spiders and beetles. Varying drought and flooding conditions in floodplain or riparian stream mesocosms will allow us to measure community and population responses of terrestrial organisms using DNA-metabarcoding and population genomics.



Interested? This is the right project for you if you are interested to study ecological and evolutionary questions using genetic and genomic tools. Ideally, you should have experience in DNA metabarcoding, population genetics, bioinformatics and arthropod biology. You would have normally acquired these skills during a Bachelor and Master in Biology, Ecology, Environmental Sciences or similar course programs.

Contact: Klaus Schwenk, Molecular Ecology

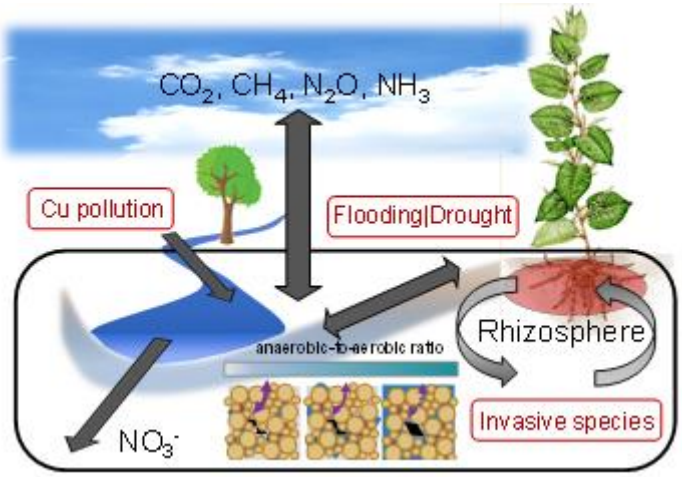
PhD project: Rhizosphere biogeochemistry

Working title: On the influence of invasive species on biogeochemical cycling in floodplain landscapes under changing water levels

Supervising scientists: Melanie Brunn, Hermann Jungkunst, Clara Mendoza-Lera

Approach: Soils are integral for many ecosystem services, such as reducing greenhouse gas emissions or nitrate leaching. Previous work revealed that *Fallopia japonica* (Houtt.) Ronse Decr., a widespread invasive species across Europe, inhibits nitrification and denitrification. Consequently, biogeochemical cycling in floodplain soils shifts towards greater nitrogen availability increasing the number of electron acceptors that determine the bioenergetic yield during carbon processing. Mechanistically, the rhizosphere activity (quantity and quality of root exudates) and nutrient-use efficiencies of *F. japonica* are assumed to control the biogeochemical cycling in floodplain soils but the response to flooding and subsequent drought in addition to anthropogenic micropollutant transfers is unknown. This project will focus on bottom-up and top-down controls in riparian ecosystems invaded by *F. japonica* under predicted variabilities in precipitation and associated fluctuations of water levels with implications for ecosystem functioning.

A microcosm experiment within the Joint Riparian Stream Mesocosm facility (**SystemLink** *site-scale*) will be established to test how plant-soil systems biogeochemically respond to fluctuations in flooding frequency and intensity. Fine-scaled insights will be gained in laboratory batch experiments in international cooperation applying micropollutants (copper) and nutrient loads to identify compounds involved in nitrification and denitrification inhibition, ammonia volatilization and nitrous oxide emissions. Field studies (**SystemLink** *field-scale*) will identify potential legacy effects and the inclusion of other abiotic and biotic parameters will allow to spatially scale up the identified processes to evaluate the relevance of micropollutant transfer and climate change in ecosystem boundaries between aquatic and terrestrial systems.



Interested? You are the right person for this project if you are interested in working interdisciplinary at ecosystem linkages with a background in soil and plant science, environmental chemistry, physical geography, or (geo-)ecology. Ideally, you should have experiences in conducting experiments, practical skills to operate field studies, and knowledge in applying statistical analysis. Joint experiments require you to be part of a larger international team, i.e. team working skills are mandatory as well as excellent English communication and writing.

Contact: Melanie Brunn or Hermann Jungkunst, Geoecology

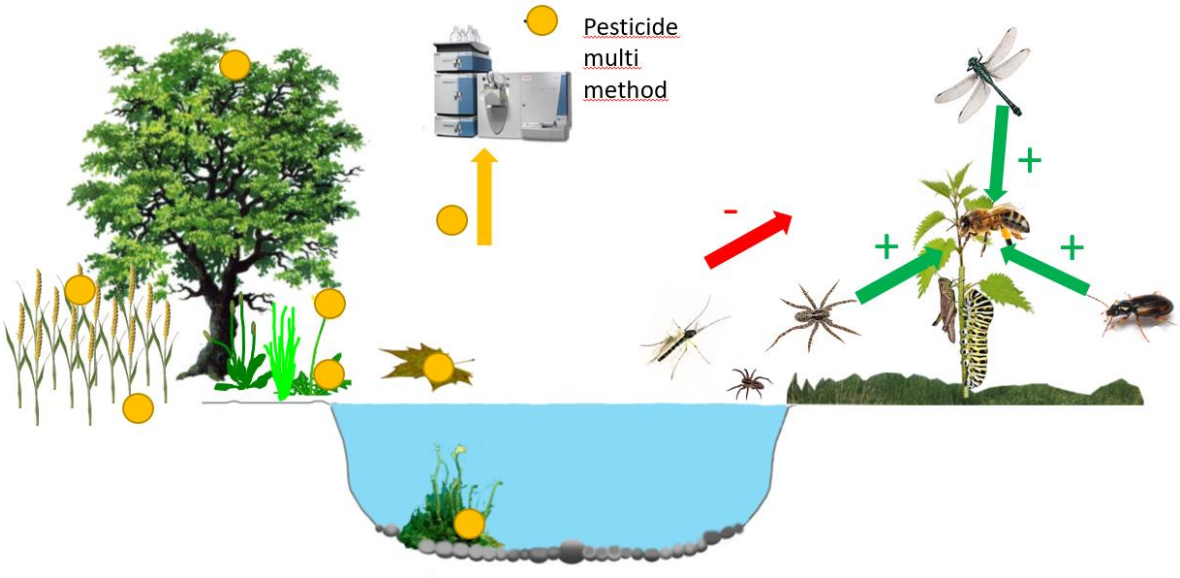
PhD project: Top down effects and pollutant system analysis

Working title: Impacts of aquatic stressors on community composition, related top-down interactions in adjacent terrestrial ecosystems and pesticide system analysis

Supervising scientists: Carsten A. Brühl, Ralf Schulz, Martin Entling

Approach: Pollutants have impacts on aquatic biodiversity and community composition. This project will focus on effects of reduced emergence of aquatic prey on community composition of three terrestrial predator groups: adult dragonflies (Odonata), web-building spiders (Araneae) and ground beetles (Carabidae). Dragonflies are affected in both aquatic and terrestrial stages whereas spiders and carabids are affected only in the terrestrial system. We hypothesize that impacts on community composition are therefore stronger in dragonflies (resulting in stronger effects on abundance and community composition) than in the two terrestrial predators. Top-down interaction of the predators with herbivorous and pollinating insects, present in the flood-plain area of the Flood Plain Mesocosm experiment (**SystemLink** *site-scale*) will be measured.

Field studies using similar predator communities will try to evaluate these impacts and resulting changes in community composition of predators, their prey and top-down interactions. In parallel, we aim to describe the flow of realistic pesticide mixtures with an established multi-method through the entire system, from terrestrial into the aquatic compartment and back, focusing on residues in different matrices (sediment /soil, plants, insect and potentially vertebrates) in aquatic, bank/ shore and terrestrial habitats to understand linkages between sub-systems.



Interested? You are the right person for this project if you are interested in community ecology and have a background in ecotoxicology and / or experience with analytical chemistry. Ideally, you should have some interest in taxonomy and ecology of spiders, carabid beetles or dragonflies as well as trace chemical analytics. You would have normally acquired these skills during a Master in Biology, Environmental Sciences or Ecotoxicology or similar course programs.

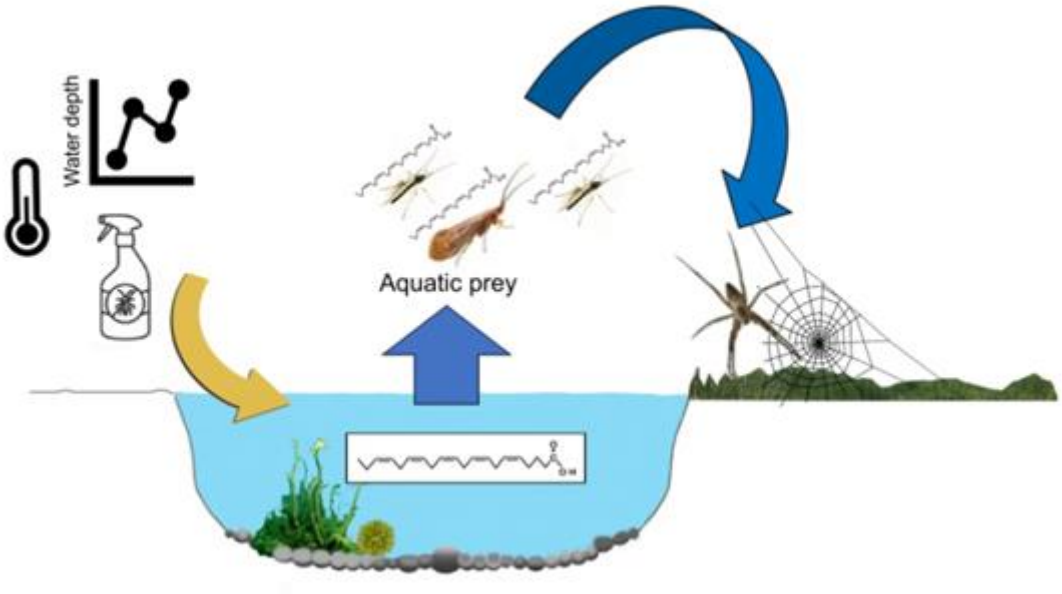
Contact: Carsten Brühl, Ecotoxicology & Environment

5. PhD project: Subsidy quality in aquatic-terrestrial foodwebs

Working title: Subsidy quality – the impact of aquatic emergence on riparian insectivore arthropods

Supervising scientists: Mirco Bundschuh, Alessandro Manfrin, Jens Schirmel

Approach: Aquatic and terrestrial food webs are linked by the emergence of merolimnic insects, which serve as prey for riparian insectivore predators. Stressors such as drought or chemical pollution (including Bti application) can affect the magnitude, temporal dynamics as well as the quality of this subsidy with potential consequences for riparian insectivore arthropods, such as spiders. Building on the knowledge of the first cohort of the **SystemLink** project, this project will take advantage of laboratory and semi field (focus on enclosures) experiments. Thereby, the project targets the physiology, reproduction and predation of spiders on aquatic as well as terrestrial prey involving besides fatty and amino acid, also stable isotope analyses. Synergisms with parallel projects supervised by Manfrin and Schirmel are expected particularly for the envisaged semi-field experiments. All in all, this project will contribute to a more comprehensive understanding of the trophic implications (i.e., top-down) in recipient riparian food webs induced by subsidy from stressed aquatic ecosystems.



Interested? You would be a good candidate if you have experience in any of the above-mentioned methods and some understanding of species interactions in complex systems. Ideally, you should have experience in arthropod sampling and identification as well as confidence in laboratory work. These skills could have been or are currently acquired during a Bachelor and Master in Biology, Ecology, Environmental Sciences or similar course programs.

Contact: Mirco Bundschuh, Functional Aquatic Ecotoxicology

PhD project: Floodplain greenhouse gas emissions

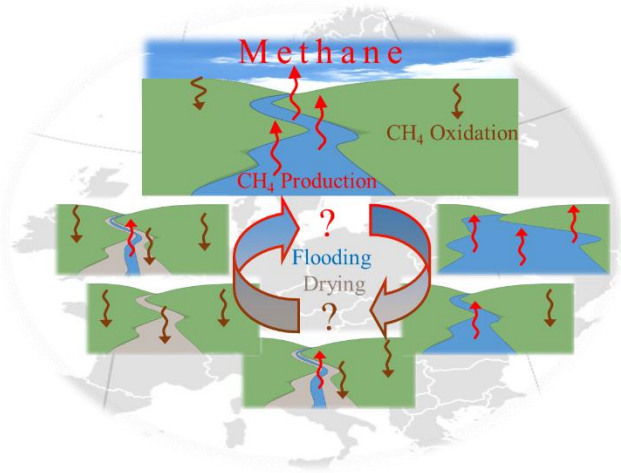
Working title: Greenhouse gas dynamics in floodplain landscapes under hydrological stress

Supervising scientists: C. Mendoza-Lera, A. Lorke, M. Brunn, Martin Entling

Approach: Floodplain landscapes are globally significant sources of methane to the atmosphere. This project assesses how the duration and frequency of flooding affects the processes that regulate the production, consumption, and emission of this potent greenhouse gas from local to global scales.

Inland waters, including freshwater wetlands, are the largest natural source of the greenhouse gas methane (CH_4). Terrestrial soils, on the contrary, act as a sink for atmospheric CH_4. Therefore, dynamic floodplain landscapes can be expected to play an important role in larger-scale greenhouse gas budgets. The extent and dynamics of flooding and drying have been changing globally due to anthropogenic activities and climate change. The resulting hydrological stress is therefore expected to alter the biogeochemical dynamics and greenhouse gas fluxes from floodplain soils and exposed aquatic sediments. The project will analyze how floodplain biogeochemistry and the resulting bottom-up mediated trophic interactions vary with flooding frequency and duration.

The research question will be addressed by experiments conducted at three distinct spatial scales. As part of a joint Riparian Stream Mesocosm experiment (**SystemLink** *site-scale*), the project studies CH_4 and CO_2 fluxes from aquatic and soil compartments in replicated outdoor mesocosm under different flooding scenarios. Among all potential drivers of methane fluxes, aerobic CH_4 oxidation is expected to play a key role. The dynamic interaction between CH_4 production and oxidation will be analyzed in more detail by exposing sediment and soil samples to dynamic flooding under controlled laboratory conditions. The broader implications and relevance of the findings will be investigated by a crowd-sourced survey of the influence of flooding dynamics on greenhouse gas fluxes at a variety of field sampling sites distributed along climatic and latitudinal gradients (**SystemLink** *field-scale*).



Interested? As an ideal candidate, you have a profound background in biogeochemistry (Bachelor and Master in Environmental Sciences or similar), and are experienced in field scale and laboratory experimental work. Joint experiments and crowd-sourced research activities require you to be a team player with excellent English communication skills.

Contact: Clara Mendoza-Lera or Andreas Lorke, Environmental Physics

PhD project: Aquatic-terrestrial food-web interactions

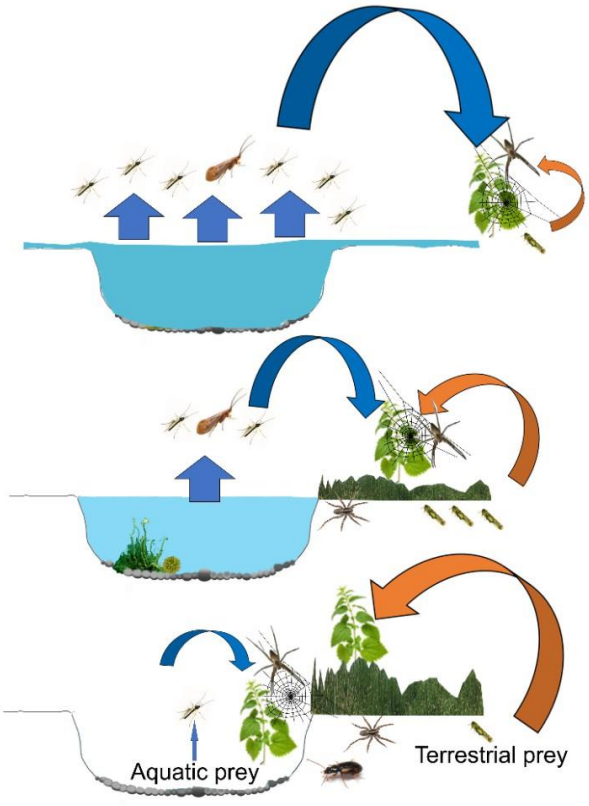
Working title: Effect of hydrological fluctuations on lateral connectivity between aquatic and terrestrial ecosystems and cascading effects on riparian arthropod communities

Supervising scientists: Alessandro Manfrin, Mirco Bundschuh, Martin Entling, Ralf Schulz

Approach: Hydrological fluctuations as flooding and drying events, are becoming more and more frequent in regions affected by global warming and anthropogenic water abstractions.

Hydrological fluctuations in rivers can affect longitudinal dynamics, but also lateral connectivity by changes in aquatic and riparian habitat configuration. This can result in changes of fluxes of aquatic insects, from the donor aquatic to the recipient terrestrial ecosystem, where they are a key resource for consumers such as spiders. The effect of hydrological fluctuations can thus cascade on the riparian ecosystem affecting the structural and functional composition of riparian arthropod communities via top-down and bottom-up effects.

Experiments and arthropod collection will be performed in field mesocosms within a joint Riparian Stream Mesocosm (RSM) experiment (**SystemLink** site-scale), in cooperation with other **SystemLink** PhD projects. Also, collection will be performed seasonally to assess dynamics related to different emergence phenology of the aquatic and riparian arthropod community.



Interested? The ideal candidate for this project has a strong background in ecology of both aquatic and terrestrial ecosystems as well as knowledge of aquatic and terrestrial arthropod communities. Also, a strong motivation in being part of joint experiments in a group of international students is an important requirement.

Contact: Alessandro Manfrin, Ecotoxicology & Environment

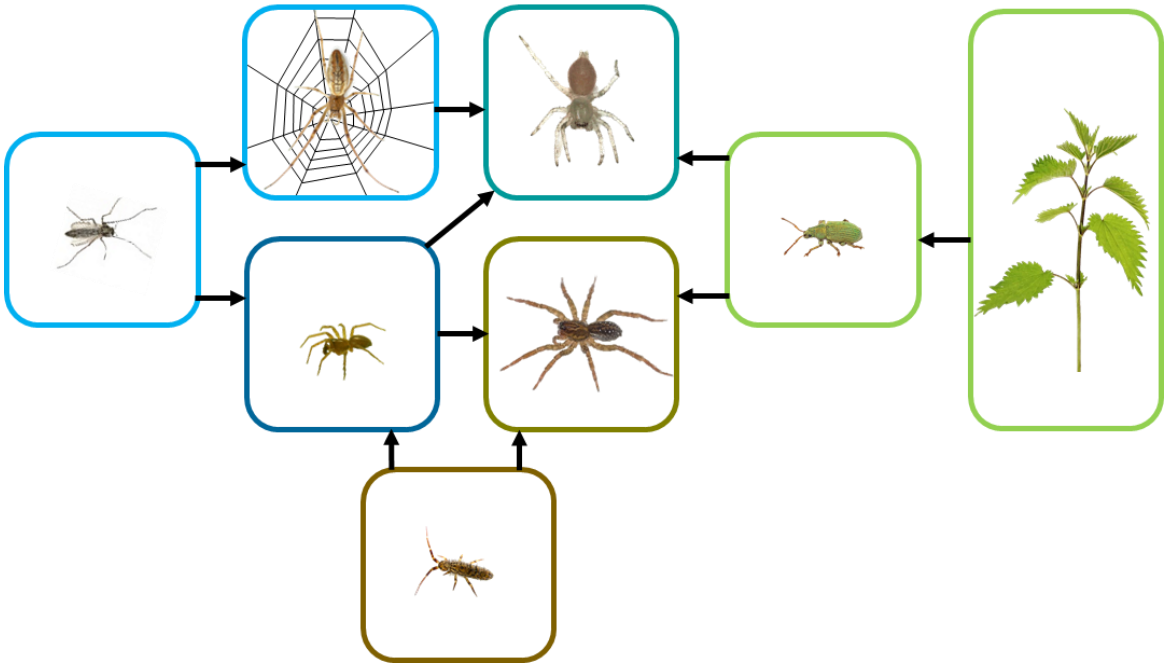
PhD project: Aquatic subsidies in terrestrial food webs

Working title: Propagation of aquatic insect subsidies into terrestrial food webs, and consequences for top-down effects on herbivores and plants

Supervising scientists: Martin Entling, Klaus Schwenk, Andreas Lorke, Jens Schirmel

Approach: Emerging aquatic insects are a key resource for predators in riparian ecosystems. However, the use of aquatic subsidies can differ greatly between functional groups of terrestrial predators (e.g. web building and hunting spiders) and between ecosystems (e.g. forest and open land). In addition, intra-guild predation is common among arthropods. Aquatic subsidies are expected to affect the dynamics of terrestrial food webs, e.g. via top-down effects of spiders on herbivores and land plants. The structure of the food web will also affect the transport of e.g. nutrients and aquatic micropollutants into terrestrial ecosystems.

In this thesis, we will analyse the use of aquatic versus terrestrial and intra-guild prey by different functional groups of terrestrial predators using gut content metabarcoding. We will compare the propagation of aquatic prey subsidies into riparian ecosystems from streams with different levels of anthropogenic stress, such as drought and pollution. In addition, we will estimate the effects of subsidies on terrestrial trophic interactions via the patterns of predator and herbivores abundance, and plant damage.



Interested? This is the right project for you if you are interested in food webs and have a background in ecology and entomology. Ideally, you should have experience in DNA metabarcoding, arthropod sampling in the field and identification of spiders and/or insects. You would have normally acquired these skills during a Bachelor and Master in Biology, Ecology, Environmental Sciences or similar course programs.

Contact: Martin Entling, Ecosystem Analysis

PhD project: Floodplain C-N dynamics

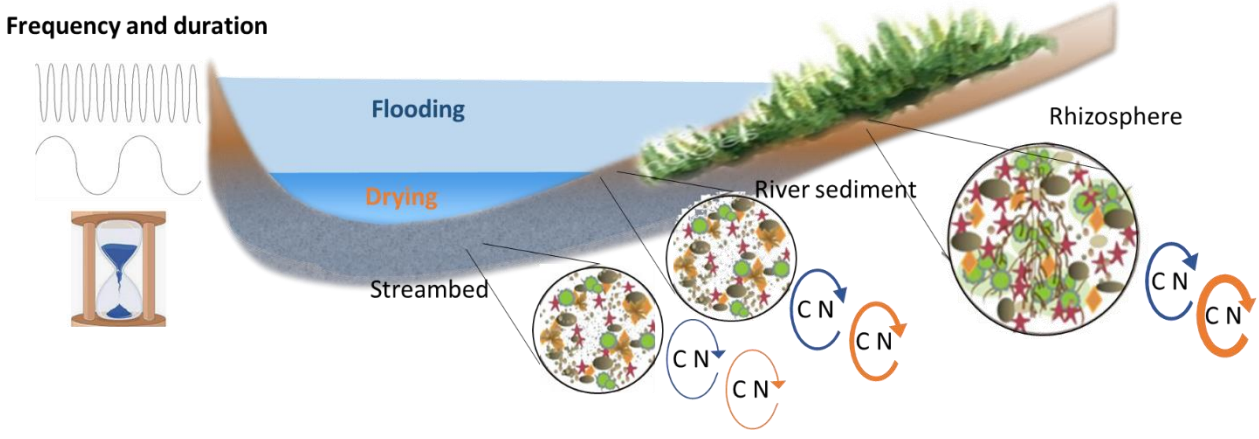
Working title: Carbon and Nitrogen dynamics under hydrological stress in the floodplain mosaic

Supervising scientists: Mathilde Knott, Dörte Diehl, C. Mendoza-Lera, Katherine Muñoz

Approach: Floodplains are dynamic biogeochemical mosaics and can be pivotal biogeochemical hotspots in the landscape. This projects explores the hydrological and biological controls of their biogeochemistry.

Floodplains are spatio-temporal dynamic ecosystems defined by repetitive and inhomogeneous (location-dependent) flooding, which shapes floodplains in mosaics composed of three main compartments: sediment, soil and rhizosphere, which differ strongly in their biogeochemical processes. The biogeochemistry of these compartments is also constrained by the flooding regime. Local properties such as the microbial community inhabiting and the availability of contaminants, nutrients, carbon and oxygen modulate the biogeochemistry of these compartments. Yet, it remains unclear how constraints (Flooding and anthropogenic factors such as Cu) and local properties hydrological stress interact to determine the biogeochemistry of this ecosystem. Therefore, our overarching research question is: how does biogeochemical processing vary in the floodplain mosaic compartments as a function of large-scale constraints (flooding/drying, top-down controls of trophic interactions) and local properties (microbial communities, Cu contaminant, nutrient and carbon content and quality, bottom-up controls of trophic interactions)?

The research question will be addressed by experiments conducted at the joint Riparian Stream Mesocosm experiment (**SystemLink** *site-scale*), together with other **SystemLink** PhD projects, combining methods and concepts from freshwater and soil science, e.g., respirometry (CarbOBot), thermal analyses (TGA-DSC-MS), and spectrometric analyses (ATR-IR, UV-VIS and fluorescence).



Interested? As an ideal candidate, you have a profound background in biogeochemistry (Bachelor and Master in Environmental Sciences or similar), and are experienced in field work and laboratory experimental work. Joint experiments require you to be a motivated team player with excellent English communication skills.

Contact: Mathilde Knott or Dörte Diehl, Environmental and Soil Chemistry

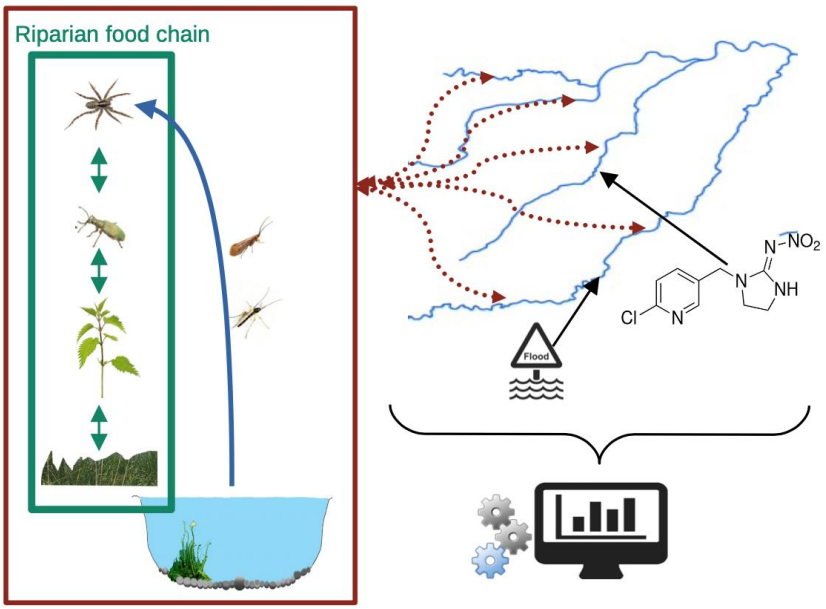
PhD project: Modelling of aquatic-terrestrial flows

Working title: Integration and analysis of bottom-up and top-down cross-ecosystem models in the context of environmental stressors

Supervising scientists: Ralf B. Schäfer, Shawn Leroux, Andreas Lorke and Alessandro Manfrin

Approach: During a previous PhD project, a generic food web model has been developed for the aquatic terrestrial system, incorporating resource quantity and quality, with the aim to study top-down effects. In addition, a spatially explicit stream network model has been developed to study bottom-up effects. This project will focus on the integration of the two models into a spatially-explicit ecosystem model with riparian patches of terrestrial food chains, which are influenced by biotic and abiotic flows from the stream, located along a stream network. The model will be used to study patch and network dynamics from a theoretical and applied perspective.

The results of different spatial and temporal scenarios of the environmental stressors (toxicants, hydrological changes) will be examined to derive predictions that can be confronted with observational data from the **SystemLink** project as well as to evaluate the contribution of bottom-up and top-down effects to the dynamics and stability of the food chain. We aim to identify generalisable conditions (e.g. ratio of stressor intensities, ratio of interaction strengths between trophic levels) that determine their contribution. Moreover, we will integrate data from the different experimental approaches of **SystemLink** to leverage the experimental results in terms of predictability and generalisability. In this context, we will focus on the identification of mismatches between results from different experimental approaches that call for clarification in future studies.



Interested? You are the right person for this project if you are interested in ecosystem linkages and have a background in modelling and data analysis. Ideally, you should have experience in ecological modelling and be fluent in programming language. You would have normally acquired these skills during a Bachelor and Master in Environmental Sciences, Ecotoxicology, Mathematics or Informatics or similar course programs.

Contact: Ralf B. Schäfer, Quantitative Landscape Ecology

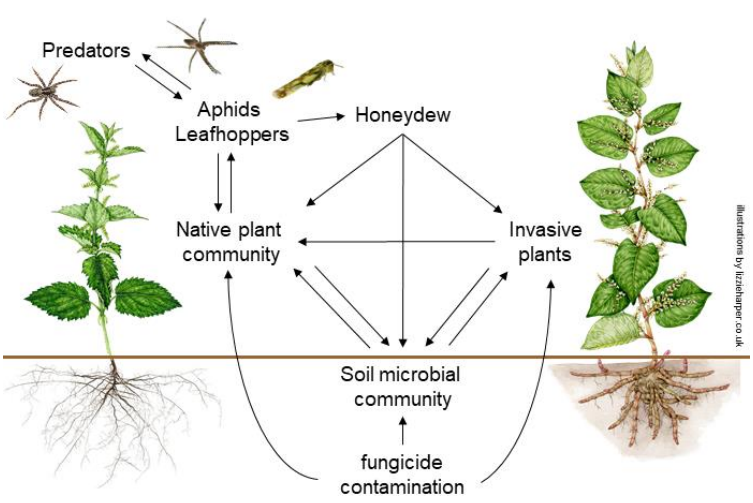
PhD project: Soil contamination effects on food webs

Working title: Interactive effects of fungicide contamination and invasive plants on soil and food webs

Supervising scientists: Kai Riess, Verena Rösch, Klaus Schützenmeister and Stefanie Müller-Schüssele (TUK)

Approach: The aim of the proposed project is to study how the bottom-up and top-down trophic cascades in native riparian communities including bacteria, fungi, plants, herbivores and their predators are affected by fungicide contamination from flooding events and invasive plants. Aphids are not only an important prey for predators, but the large amounts of honeydew they excrete are likely to play a role as a resource for soil microorganisms as well. Beside the biological processes, knowledge about the influence of terrestrial ecosystems and their regulating function as a net sink or source for greenhouse-gas fluxes is limited. In this context, data on soil-plant interactions on carbon and nitrogen cycles would increase the understanding of the system. The measurement of soil respiration fluxes is another part of this project since it provides information on the vitality of the soil system (plant-root/microorganism).

The hypotheses are: (i) Soil fungicide contamination and invasive plants modify the soil microbial community and affect the fitness of riparian plants and thereby of their herbivores and predators. Changes in plant fitness affect the amount and quality of honeydew produced by phloem-feeding herbivores and alter carbon availability in the soil for the microbial community. (ii) The occurrence of invasive plants and subsequent changes in the soil microbial community cause changes in greenhouse gas fluxes. Flooding events stop CH_4 uptake into the soil, turning it into a methane source. On the other hand, fungicides in the soil have a positive effect on nitrous oxide fluxes from soil.



The above-mentioned pathways will be studied in a joint greenhouse pot experiment (**SystemLink** *batch-scale*). Measurements will include biological parameters, e.g. plant and animal morphology and physiology, microbial diversity and biomass, rounded off by aphid reproduction, daily honeydew secretion and composition. Regarding the soil, measurements of respiration fluxes, C/N, grain size, pH-value and soil conductivity are planned. The greenhouse experiment will be complemented by laboratory work, e.g. fungal growth studies based on aphid excretions and feeding experiments with herbivores and predators.

Interested? You are the right person for this project if you are interested in ecosystem linkages on different scales (soil-microorganisms-plants-herbivores-predators). A basic understanding of the biology and ecology of fungi, plants and insects is required. You normally would have acquired these skills during a Bachelor and Master in Biology, Environmental Sciences or similar course programs. Ideally, you should have experience in experimental ecology including pot experiments.

Contact: Kai Riess, Ecosystem Analysis

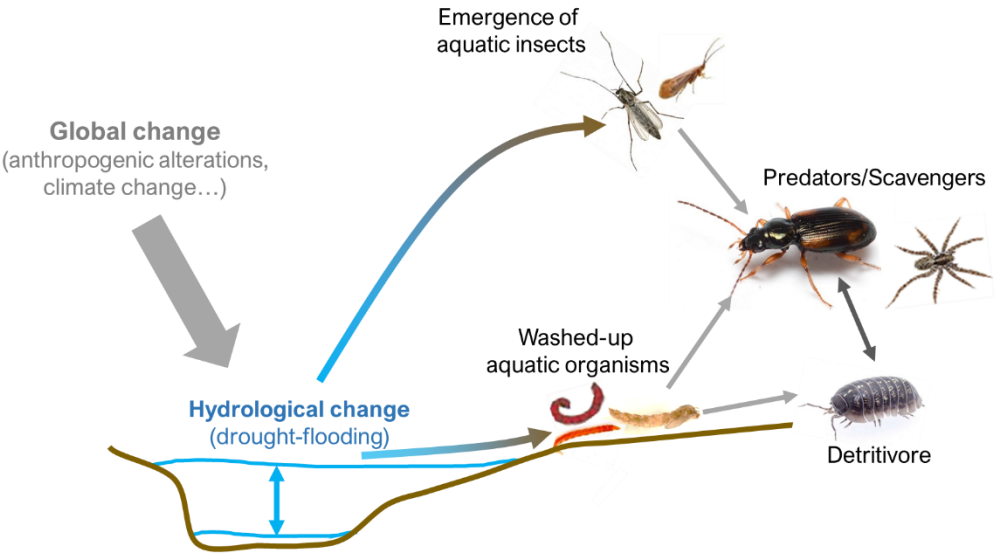
PhD project: Hydrological effects on riparian food-webs

Working title: Role of aquatic insect emergence and washed-up organisms for riparian food webs under anthropogenic stress

Supervising scientists: Jens Schirmel, Martin Entling, Mirco Bundschuh, Alessandro Manfrin

Approach: Emerging aquatic insects can be important food subsidies for terrestrial species. Another potential pathway which links aquatic and terrestrial food webs are (dead) aquatic organisms washed ashore (e.g. midge larvae, pupae). In the face of global change, streams are subject to hydrological changes such as temporary drying or increased flood events due to climate change and due to anthropogenic alterations (e.g. water removal for agriculture, stream regulation and bank reinforcement). These changes can affect the magnitude of emerging aquatic insects and organisms washed ashore, which may consequently influence the riparian food web. The project therefore combines top-down (emergence pathway) and bottom-up (flooding pathway) directed effects in the terrestrial food-web.

This project aims to i) disentangle the importance of emerging insects vs. organisms washed ashore for riparian predators and scavengers of different functional groups (e.g. carabid beetles, spiders, rove beetles), ii) to analyse the effect of anthropogenically induced hydrological changes (drought-flooding) on these subsidies and iii) to investigate consequences for the functioning of riparian food webs, with a special focus on carnivore-detritivore interactions. Therefore, modern analytical approaches will be used (e.g. metabarcoding, stable isotope analysis) in a combination of experiments and field studies.



Interested? You are the right person for this project if you are interested in food-webs and have a background in ecology and entomology. Ideally, you should have experience in sampling and determination of arthropods. You would have normally acquired these skills during a Bachelor and Master in Biology, Ecology, Environmental Sciences or similar course programs.

Contact: Jens Schirmel, Ecosystem Analysis