



Wageningen Institute for Environment and Climate Research

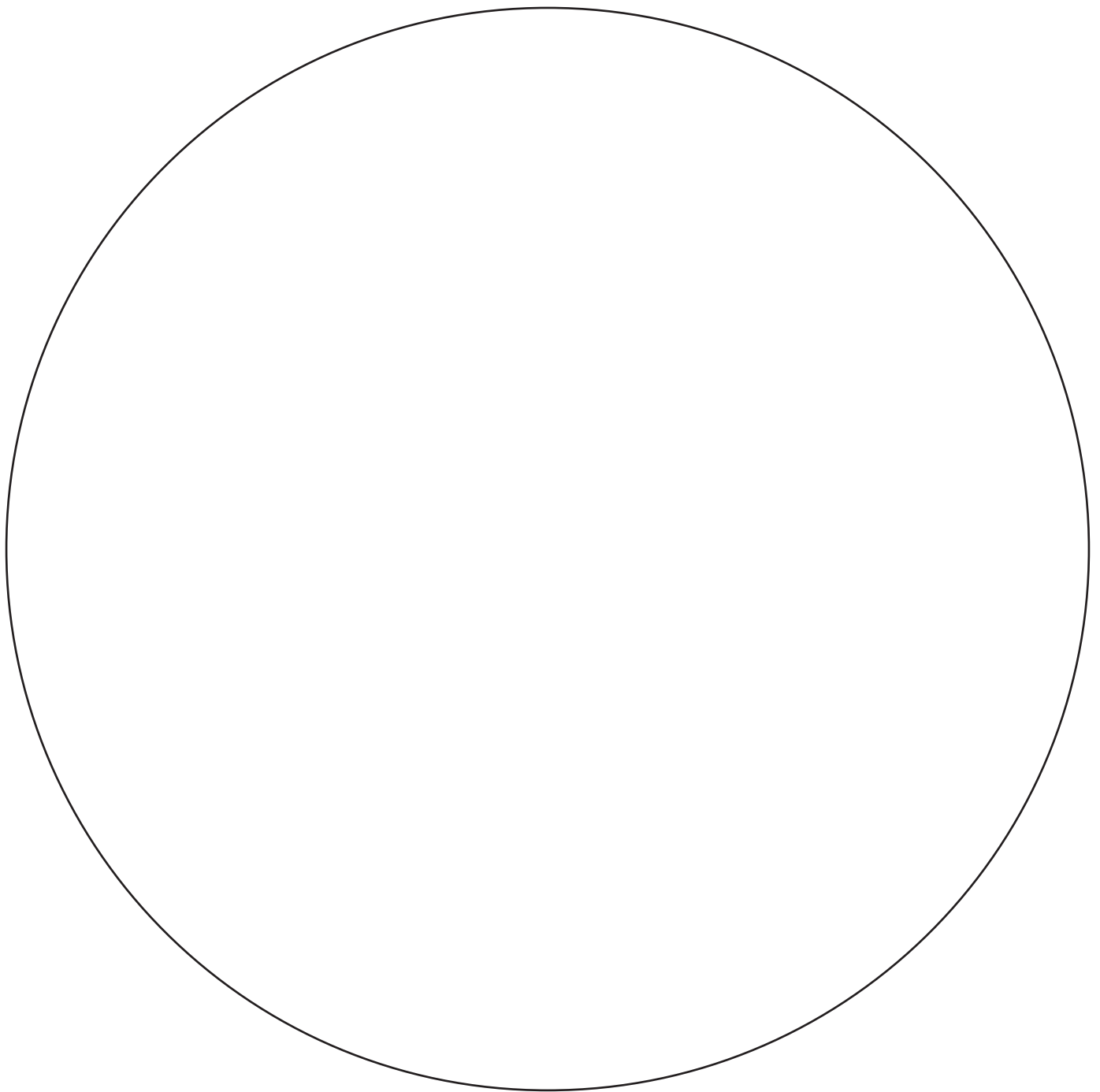
WIMEK UPDATE

2016 * 2017



WAGENINGEN **UR**

For quality of life



Wageningen Institute for Environment and Climate Research

WIMEK UPDATE

2016 * 2017



WAGENINGENUR

For quality of life

Our Position

The Wageningen Institute for Environment and Climate Research (WIMEK) is one of the six Graduate Schools at Wageningen University (WU). WIMEK was founded in 1993 to coordinate the research activities and PhD education of the WU chair groups involved in this research field.

WIMEK aims to develop an integrated understanding of environmental change, its impact on the quality of life and sustainability, and offers solutions for environmental improvement by (i) conducting innovative scientific and technological research, (ii) offering PhD training and education, and (iii) disseminating emerging insights, recent research results and novel technological & policy approaches to companies, regulating authorities and society. Research on complex sustainability problems requires an integrated approach, based on an input from various scientific disciplines combined with the knowledge of relevant actor groups or stakeholders, i.e. a transdisciplinary research approach.

At present, sixteen chair groups participate in WIMEK, eleven with their full research capacity or a significant part of their research capacity and some other with a few senior researchers, postdocs and PhD candidates (see annex 1).

Currently, about 350 PhD candidates have been enrolled in WIMEK, of which 68% coming from abroad. WIMEK aims to support PhD candidates in their personal and scientific development by offering them a challenging scientific research environment, a national and international scientific network of environmental researchers and an advanced training and education programme.

Moreover, WIMEK is co-founder of the national Dutch inter-university network of environmental research groups SENSE (Netherlands Research School for the Socio-Economic and Natural Sciences of the Environment). At present, environmental research groups from eight Dutch universities, the Institute for Water Education (IHE-Delft) and the Netherlands Environmental Assessment Agency (PBL) collaborate in SENSE.

Since its foundation in 1993, the research quality and the PhD Education & Training Programme, offered by WIMEK and its research groups, the WIMEK Graduate School and the SENSE Research School have all been evaluated very positively by international peer review committees.

WIMEK – SENSE

WIMEK has been a full member of the SENSE Research School until 01-01-2018. However, the national development of local graduate schools and the wish to better profile the environmental and climate research at WUR has led to the conclusion that WIMEK should retake the full responsibility of a Graduate School from 01-01-2018. Moreover, WIMEK wants to concentrate its future participation in SENSE on its role as a network partner and further strengthening and improving this important national network on sustainability sciences in the Netherlands.

External review 2014

The WIMEK Graduate School was evaluated by external peers in 2014, as part of the SENSE review over the period 2008 - 2013. The WIMEK chair groups scored in general very good to excellent on the criteria Scientific Quality (Q), Scientific Productivity (P), Societal Relevance (R) and Viability (V), with a few exceptions (score in between good and very good).

At WIMEK Graduate School level the external review committee concluded: *"This is an excellent overall programme with high performing faculty and PhD students. It has a very commendable international and national reputation. It succeeds in its performance measures for the review period, and it more than succeeds in its outreach and community involvement."* The review committee recommended (i) to set-out a clear vision for the coming research period and (ii) to pay more attention to the societal impact of PhD research and the interaction with stakeholders.

Following the recommendation of the review committee, we initiated new PhD courses, such as "Grasping Sustainability", "Making an Impact" and "Entrepreneurship in and outside Science" (a joint course offered together with the other Wageningen Graduate Schools).

WIMEK midterm review 2018

The new requirement of the SEP protocol for the assessment of larger units has led to the formation of partly cross-graduate school (GS) clusters of chair groups. WIMEK has the final responsibility for the coordination of the review of the following four cross GS clusters: (i) Environmental Technology and Microbiology; (ii) Water and Climate; (iii) Soil sciences and (iv) Land Use. This new approach will be tested in the midterm review in 2018 and will be the basis for the next external review of WIMEK research units in 2021.

Our research

WIMEK combines fundamental, strategic, applied and participatory research in environmental, climate and sustainability sciences, both from a social sciences and a natural sciences point of view, focussing on pressing environmental problems and sustainable solutions with local to global significance. Moreover, WIMEK believes that fundamental disciplinary research efforts and innovative inter- and transdisciplinary (including stakeholders) research efforts are both needed to contribute to real solutions for the current emerging complex environmental issues.

Our research programme concentrates on the following research themes:

Theme 1: Environmental contaminants and nutrients, including biotechnological and physico-chemical processes for sustainable use and reuse of water, energy, minerals and materials.

Theme 2: Environmental processes and ecosystem dynamics

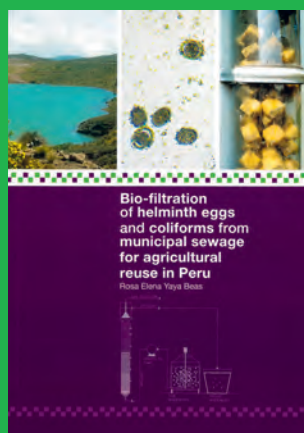
Theme 3: Global and regional environmental change

Theme 4: Sustainable development and social change: actors, institutions and governance

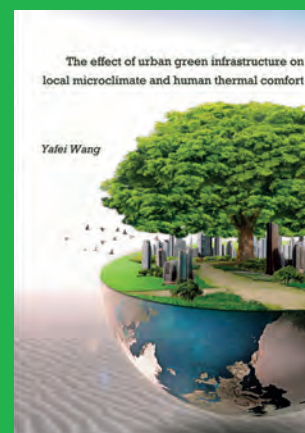
In the past period WIMEK has promoted the transdisciplinary research approach by the publication of a booklet "challenges and successes in interdisciplinary and transdisciplinary research and education", presenting inspiring examples of transdisciplinary approaches from WIMEK staff (May 2014). In addition WIMEK puts its vision into practice by initiating and participating in some large transdisciplinary initiatives, such as (i) the Amsterdam Institute for Advanced Metropolitan Solutions (AMS: a collaboration of WUR, TUD, MIT, local government and business partners) and (ii) Water Nexus: a new NWO-STW research programme of 6 Million Euro, that will run from January 2015 to 2020, and is supported by 25 partners from multinational and small/middle sized companies, consultancy firms, research institutes, water boards, and the Ministry of Infrastructure and Environment.



13/01/2016 | **Remme, R.P.**
Accounting for ecosystem services and biodiversity in Limburg province, the Netherlands



20/01/2016 | **Yaya Beas, R.E.**
Bio-filtration of helminth eggs and coliforms from municipal sewage for agricultural reuse in Peru



09/02/2016 | **Wang, Y.**
The effect of urban green infrastructure on local microclimate and human thermal comfort

Scientific output & impact

The scientific output of WIMEK researchers is rather constant over the past four years (see figure 2). On average 45 PhD candidates defended their PhD thesis successfully every year. The number of articles in refereed journals fluctuated between 333 and 509 per year.

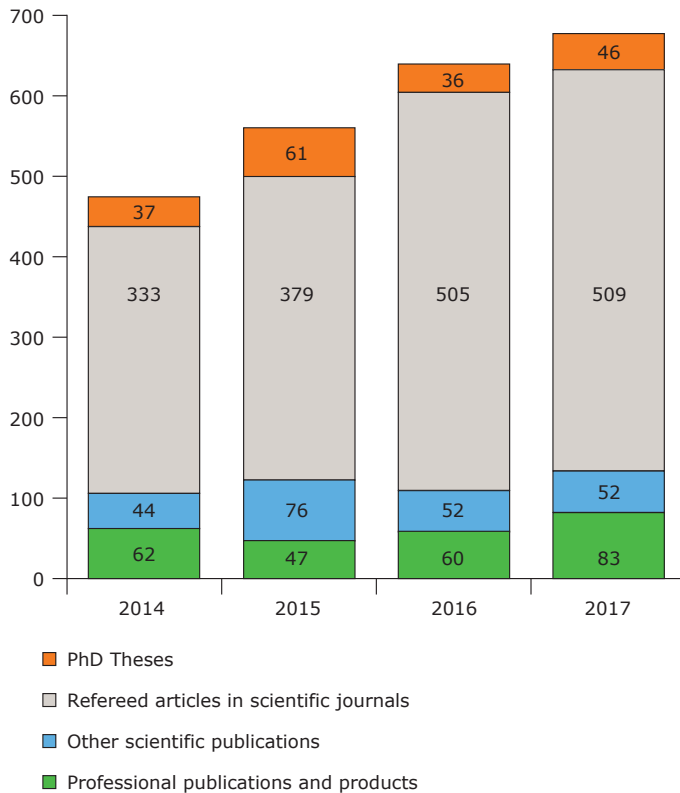


Figure 2: Number of WIMEK publications 2014 – 2017

The scientific impact of WIMEK publications is constantly at a high level. Table 1 shows that the Relative Impact of all WIMEK publications is on average 3.1, which is more than three times the world average. The same holds for the top 10% publications of WIMEK. The number of top 1% publications is even 7 times the world average.

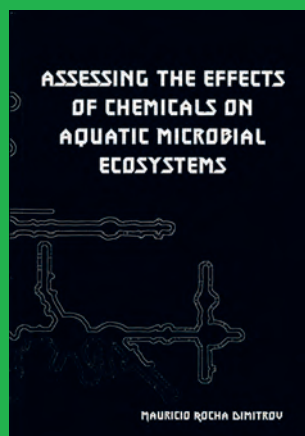
Table 1: Scientific impact of all WIMEK publications

Year of publication	N	C	RI	%T10	%T1
2014	324	6992	2.98	32% (105)	8% (26)
2015	365	4983	2.83	28% (104)	6% (23)
2016	467	3377	3.29	34% (161)	8% (37)
All years	1156	15352	3.06	32% (370)	7% (86)

- N Total number of publications in a series that is analysed.
- C Total number of citations to the N publications.
- RI Relative impact or the item oriented field normalised citation score. This indicator corresponds to the number of citations to publications from a unit during the analysed time span, compared to the world average of citations to similar publications (of the same age and within the same research areas as for the group's publications). The term "item oriented" indicates that the normalisation of the citation values is done on an individual article level after which the average over all articles gives the score of RI.
- %T10 Percentage of the 10% best cited papers compared to total number of publications (Total number of publications within the top 10% best cited publications in their field).
- %T1 Percentage of the 1% best cited papers compared to total number of publications (Total number of publications within the top 1% best cited publications in their field).



18/02/2016 | **Khiewwijit, R.**
New wastewater treatment concepts: Towards energy saving and resource recovery



17/03/2016 | **Rocha Dimitrov, M.**
Assessing the effects of chemicals on aquatic microbial ecosystems



08/04/2016 | **Jong, M.F. de**
The ecological effects of deep sand extraction on the Dutch continental shelf: Implications for future sand extraction

Some highlights

AEW: Aquatic Ecology and Water Quality Management Group

Resilience thinking: from lakes to geriatrics

After grounding the now classical idea of tipping points in empirical research on lakes, the group of Marten Scheffer has moved to a broad range of other fields for applications. Using mathematical models, they developed generic indicators of resilience in order to probe the fragility of a system, and help anticipating critical transitions. In 2016 and 2017, major steps to bridge to entirely different scientific disciplines were made. In close cooperation with specialists in the specific fields, recent articles of this group describe for instance i) how the resilience of coral reefs depends on feedbacks and drivers^{1,2}, ii) how older human beings may be monitored to probe their resilience^{3,4}, iii) how the local resilience of lowland floodplains may influence the systemic resilience of the Amazon⁵, and iv) how social norms and policy may influence the likelihood of shifts in human behaviour⁶. Resilience thinking is high on the international research agenda, and the group's leading position in this field ensures exciting times ahead.

Answers to urgent questions on microplastics

Pollution with microplastics is considered one of today's major environmental problems. The group of Bart Koelmans provided answers to three critical challenges in microplastic research: understanding global transport processes, the global mass budget, and risks of plastic-associated chemicals. A river transport model has been developed accounting for biofouling and heteroaggregation of small plastic debris.⁷ An ocean model has been developed capable of simulating vertical oscillatory movement and sedimentation of microplastic to the ocean floor.⁸ A mass balance model has been developed linking plastic production and emission data to loss processes such as sinking and fragmentation at sea, for the first

time allowing predictions of plastic debris abundance in ocean surface layers as well as those of 'lost' plastic in the deep.⁹ Finally, microplastic-inclusive bioaccumulation models have been developed and validated, capable of assessing exposure and risks of plastic-associated chemicals.^{10,11,12} The tools developed here inform policy makers and will reduce the present ignorance and uncertainty about ecological and human health risks of microplastics.¹³

Environmental side effects of neonicotinoids on aquatic life

In the Western world, the neonicotinoid insecticide imidacloprid is generating a lot of backlash because it has been proven to have harmful effects on the environment like bees and other insects such as mayflies.¹⁴ Unlike most other compounds, imidacloprid shows reinforced toxicity with longer time of exposure.¹⁵ Given its persistence in water in the absence of sunlight, resulting threshold levels of effects can be very low. Another deviation in the toxicity profile of imidacloprid is its higher toxicity for the summer generations of aquatic organisms compared to their winter counterparts, which might be related to their change in physiology over the year. A recent study also revealed that, again without a clear explanation, in Bangladesh, imidacloprid is hazardous to water organisms at much lower concentrations than in temperate zones.¹⁶ These results call for the post-registration monitoring of the ecological risks of pesticides as a safety lock to ensure the protection of our natural environment.¹⁷

BCT: Biobased Chemistry & Technology Group

Multi-Loop Aquaponic Systems

Dr Simon Goddek graduated in 2017 on a PhD thesis: "Opportunities and Challenges of Multi-Loop Aquaponic Systems".

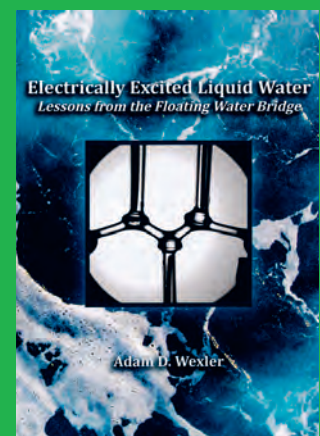
Coupling the production of aquatic animals and plants in greenhouses forms the basis for all conventional aqua-



11/04/2016 | **Daniëls, E.E.**
Land surface impacts on precipitation in the Netherlands



12/04/2016 | **Kerstens, S.M.**
Sanitation planning in Developing countries: Added value of resource recovery



19/04/2016 | **Wexler, A.D.**
Electrically excited liquid water : lessons from floating water bridge

ponic systems. In these systems, nutrient-rich wastewater from the aquaculture section for, for instance fish production, is used for fertilization of the plants.

The general approach in Simon Goddek's thesis was to assess and improve the physical feasibility of conventional one-loop aquaponic systems by conceiving and developing multi-loop aquaponic systems, where the water from the hydroponic section with its own recirculation is not fed back to the fish tanks in the recirculating aquaculture system (RAS), and where the fish sludge is remineralized in an anaerobic bioreactor system for additional fertilization of the plants. Furthermore, it was found that the implementation of desalination processes could contribute to concentrating the hydroponic nutrient solution, while purifying the aquaculture water. The integration of such a technology in a multi-loop aquaponic system will further reduce the water footprint as well as the fertilization demand of multi-loop aquaponic systems.

New wastewater treatment concepts

Dr Rungnapha Khiewwijit graduated in 2016 on a PhD thesis: "New wastewater treatment concepts towards energy saving and resource recovery"

Recently, municipal wastewater has started to be considered as a potential resource of water, energy and nutrients nitrogen (N) and phosphorus (P). For example, the organic pollutants in municipal wastewater represent a potential chemical energy of 1.5–1.9 kWh per m³ of wastewater. At present, conventional activated sludge (CAS) systems are widely applied to treat municipal wastewater. However, CAS systems cannot be considered sustainable, because these require large amounts of energy (mainly for aeration and sludge treatment), have a high CO₂ emission and do not recover valuable resources. In this thesis new municipal wastewater treatment concepts that combine wastewater treatment with recovery of valuable resources and can save considerable amounts of energy were investigated by modelling and experi-

ments. In particular the recovery of volatile fatty acids (VFA), up to 35%, from biofloculated sewage organic matter has been investigated through experimental work.

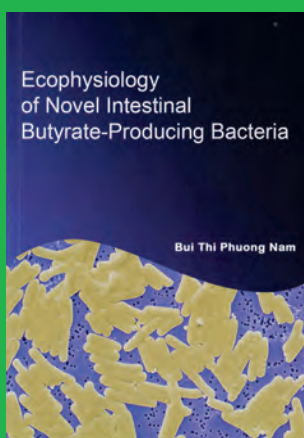
ENP: Environmental Policy Group

Improving nutrition security of poor people

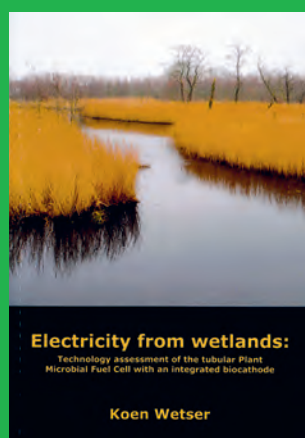
Dr. Sigrid Wertheim and Prof. Peter Oosterveer are collaborating on "preventing nutrition deserts for the urban poor within the transforming food retail environment in Vietnam project" funded by the Bill and Melinda Gates Foundation. The project addresses nutrition insecurity among a growing number of urban poor in modernizing Southeast Asian metropolises. Serving to enlarge the capacity of local authorities in planning and implementing all-inclusive food-safe and nutrition-sensitive food retailing infrastructures, the research seeks to answer the question 'why do the urban poor eat the food they do', in the context of transformations in the food retail environment and the organization of daily life. In doing so the research focuses on how retail modernization and restructuring policies can impact the diet diversity and quality of the urban poor that depend on daily food shopping (purchasing foods on a day-to-day basis) often due to irregular and fluctuating daily income levels due to the nature of employment?

Co-development of climate Arctic forecast products tailored to key social, environmental and economic needs

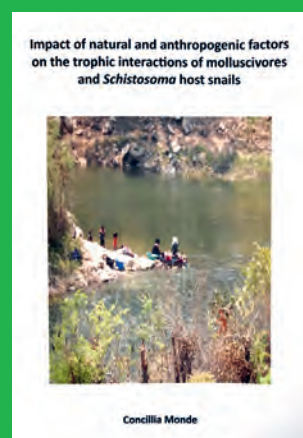
Through the SALIENSEAS project, a project funded by ERA4CS, Dr. Machiel Lamers and new postdoc researcher Dr. Berill Blair are working on increasing our understanding of the current mobility patterns and challenges, as well as the need, uptake and enhancement of climate services in several sectors operating in the Arctic ocean. The warming Arctic ocean has profound socio-economic consequences for local communities and various marine sectors, such as tourism, transport and fisheries. To make



22/04/2016 | **Bui Thi Phuong Nam**
Ecophysiology of Novel Intestinal Butyrate-Producing Bacteria



22/04/2016 | **Wetser, K.**
Electricity from wetlands : technology assessment of the tubular Plant Microbial Fuel Cell with an integrated biocathode



25/04/2016 | **Monde, C.**
Impact of natural and anthropogenic factors on the trophic interactions of molluscivores and Schistosoma host snails

appropriate operational and strategic decisions to effectively adapt to the changing environment, stakeholders require more, and customised climate services. Currently available high-quality Arctic climate information is very limited. In the SALIENSEAS project a team of social and natural scientists, met-ocean service personnel, and end-users will develop Arctic climate forecast products tailored to the existing needs of local communities and decision makers in a co-production process. The developed tailored forecast products will be merged into Norway's and Denmark's met-ocean and sea-ice forecasting infrastructures and maintained and developed beyond the lifetime of this project.

ENR: Environmental Economics and Natural Resources Group

Time constraints and the competition determine a hunter's decision to shoot

What prompts a hunter to shoot an animal after it is spotted? ENR and Norwegian researchers studied more than 180,000 choice situations where hunters had spotted an animal and had to decide whether or not to shoot. They found that competition among hunters and the season coming to an end led to an increased likelihood of pulling the trigger. The research team published an article this week in the scientific journal *PNAS* in which they recommend that future wildlife management should take into account the social conditions surrounding hunting.

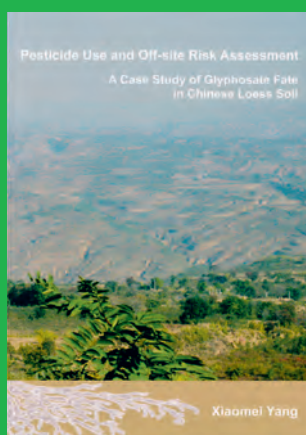
Hunting is a way to control wildlife populations. A deer or boar is more likely to be killed by a hunter than by a natural predator. However, very little is known about what motivates hunters to shoot a particular animal or not. Analysing a unique dataset of 256 hunting locations in western Norway between 1999 and 2010, the researchers found that a shorter remaining season and competition among hunters contribute significantly to the hunter's decision to shoot an animal. Hunters are more likely to

shoot an animal as the hunting season comes to an end and if sightings occur less frequently. The researchers tested their model with hunting and weather data from Norway. The results confirmed their hypotheses: a shorter remaining season and larger groups of hunters increase the probability of shooting an animal. For small groups this amounts to 20% two months before the end of the season and 40% on the last day of the season. For large groups, these figures are 33% and 55% respectively.

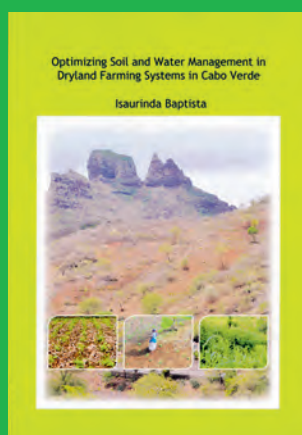


The human factor in hunting

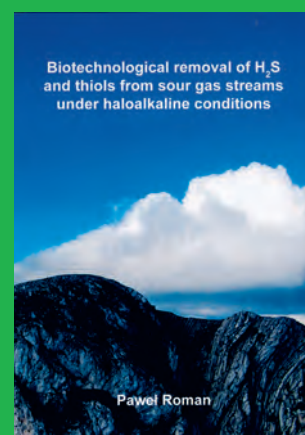
'The findings tell us that the human factor plays an important role in hunting,' says Wageningen researcher Andries Richter. The researchers concluded that wildlife management can be improved by taking into account the behaviour of hunters. 'Theoretical options for adapting wildlife management policies include carrying over the unused quota from one season into the next season or introducing an individual quota per hunter,' adds Richter. 'Understanding the interactions between hunters, animals, and regulation is the key to optimise policy-making and striking the



09/05/2016 | **Yang, X.**
Pesticide use and off-site risk assessment: a case study of glyphosate fate in Chinese Loess soil



10/05/2016 | **dos Santos Baptista Costa, I.**
Optimizing Soil and Water Management in Dryland Farming Systems in Cabo Verde



12/05/2016 | **Roman, P.**
Biotechnological removal of H₂S and thiols from sour gas streams under haloalkaline conditions

right balance between people and nature,' he concludes. The results have been published in an article in PNAS¹⁸.

Approach for the Evaluation of PBTs Subject to Authorisation and Restriction Procedures in the context of Socio-economic analysis¹⁹

In a recently completed research project coordinated by Dr. Silke Gabbert (ENR), a consortium of Dutch and German researchers developed a novel approach to support decision making on the use of a specific group of particularly harmful chemicals: PBTs and vPvBs. These substances are (very) persistent (P), (very) bioaccumulative (B), and possibly also toxic (T). Their impact is uncertain and depends on complex processes in time and space. This implies a challenge for regulatory decision-making when comparing the potential environmental and health impacts of a continued use with the costs of a restricted use or no use. The approach addresses the evaluation of PBT/vPvB substances that are subject to socio-economic analysis (SEA) for authorisation and restriction procedures under the European chemicals legislation REACH. The approach is based on the notion that PBT/vPvB substances are stock pollutants: due to their persistence, environmental exposure concentrations of PBT/vPvB substances cannot adequately be described by pointing at current emissions or release only since the previously released PBT/vPvB substances persist to the current period. As a consequence, impacts of PBT/vPvB substances on the environment and on human health via the environment arise from the stock (i.e. current and historic releases in different compartments). In contrast to non-persistent substances of very high concern (SVHCs), an evaluation of PBT/vPvB substances subject to authorisation and restriction procedures under REACH requires, therefore, to base impact assessments on a stock pollution approach in order to adequately address the PBT/vPvB concern. The approach consists of five building blocks (stages), combining (eco)toxicological methods with economic mod-

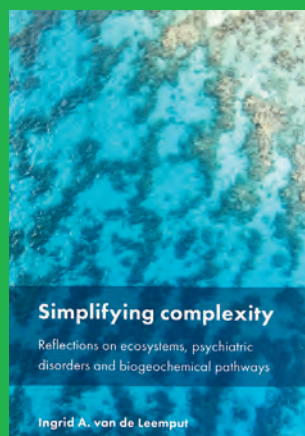
elling. The approach offers consistent decision-support for evaluating individual PBTs/vPvBs as part of a socio-economic assessment within REACH authorisation or restriction processes. The approach may also be used for a comparative evaluation of PBT/vPvB substances regarding impacts from different uses, and of the cost-effectiveness of emission reduction and abatement measures across substances having the same use.²⁰

ESA: Environmental Systems Analysis Group *Modelling health-related water microbiology now and in the future – Dr Nynke Hofstra*

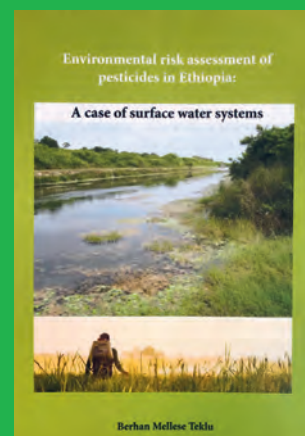
Diarrhoeal disease is very common around the world. Knowing more about the global burden of diarrhoeal disease and about the geographical distribution of pathogen pollution is important for decision making and water and sanitation planning. In the ESA group three PhD projects were completed that are related to this topic, with the objective to increase the knowledge on sources, fate and transport of microorganism in rivers. Shahid Iqbal and Majedul Islam measured and modelled faecal indicator bacteria in rivers in Pakistan and Bangladesh respectively, while Lucie Vermeulen developed the Global Waterborne Pathogen model for *Cryptosporidium* (GloWPa-Crypto), the first global model of waterborne pathogen emissions and concentrations in rivers. The global model is used to provide information on pathogen concentrations in data-sparse regions, identify hotspot regions, identify the relative contribution of different sources, and in scenario analysis to study the impacts of global change or management strategies. Also the local models have been used in scenario analysis and a common conclusion is that wastewater treatment is essential to reduce emissions to and concentrations in surface waters, in particular when the population grows. The models can be applied in the analysis of risk, burden of disease and health-based treatment targets, and make a valuable contribution in meeting the Sustainable Development Goals.



25/05/2016 | **Steen, J.J.M. van der**
"Beehold" The colony of the honeybee (*Apis mellifera* L) as a bio-sampler for pollutants and plant pathogens



03/06/2016 | **Leemput, I.A. van de**
Simplifying complexity: reflections on ecosystems, psychiatric disorders and biogeochemical pathways



20/06/2016 | **Teklu, B.M.**
Environmental risk assessment of pesticides in Ethiopia: a case of surface water systems

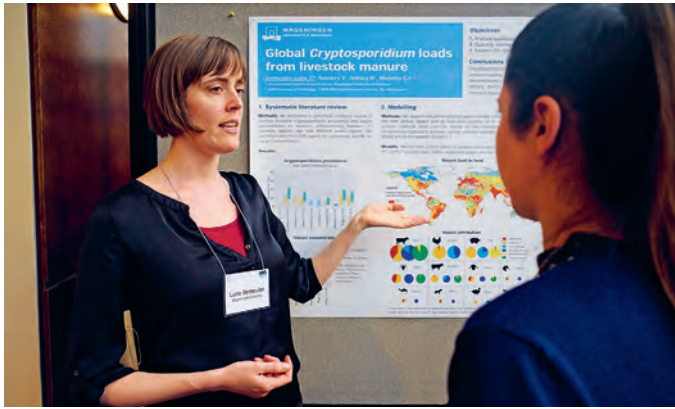


Photo Tom Fuldner: Lucie Vermeulen explains the Global Waterborne Pathogen model for Cryptosporidium. She graduated cum laude on 16 February 2018.



Photo: ETE's spin-off Chaincraft started a full scale caproate factory.

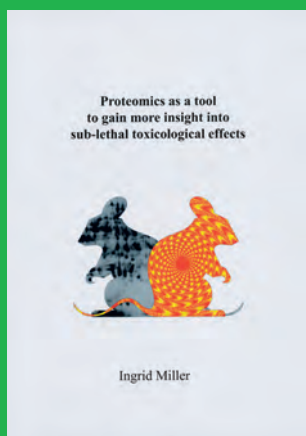
ETE: Environmental Technology Group

Chaincraft: from organic waste to valuable chemical building blocks

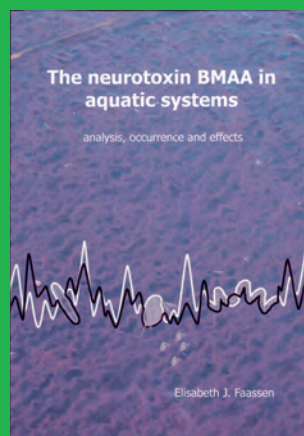
Chaincraft is starting this spring a first full-scale demonstration factory to produce 1000 ton/year of fatty acids, especially caproic acid. Unique is that organic residual/waste streams are used to produce a high value chemical suited as feed additive. Such streams are nowadays typically digested into methane that is often electrified (i.e. a low value product). The factory is constructed in the Port of Amsterdam and is world-wide the first example on the valorisation of organic residual streams with this new anaerobic open culture technology. The underlying microbial chain elongation process was developed with pioneering (and patented) research at the Sub-department of Environmental Technology of Wageningen University & Research. Within just 10 years a new technology was brought from idea into practice. It is envisioned that the microbial chain elongation can be expanded to produce a variety of fatty acids which can be used for multiple applications including the production of plastics and fuels.

Biogas from saline waste water

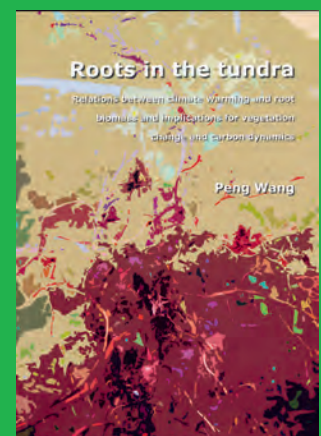
Around 5% of (waste)water generated globally is saline or highly saline. Conventionally it is accepted that removal of bulk organic pollutants from (waste)water by means of biological processes is desired over physical-chemical methods. The preference for biological processes is due to lower operational costs and less chemicals used to purify the (waste)water. Anaerobic biological (waste)water treatment allows for conversion of organics into useful biogas and is utilized extensively for treatment of industrial effluents. The most popular types of bioreactors for such treatment rely on formation of microbial aggregates (granules) with highly active microorganisms. Thus far, it has been shown, that microbial granules at high salinity disintegrate and microorganisms lose their activity. Our research has demonstrated: (i) Formation of microbial granules at salinity as high as 50 g/L; (ii) Possibility to maintain active microorganisms able to reach good treatment efficiency; (iii) Active microorganisms responsible for conversions in these bioreactors. This technology allows for novel sanitation based using seawater to flush toilets and produce biogas from the organic rich salty



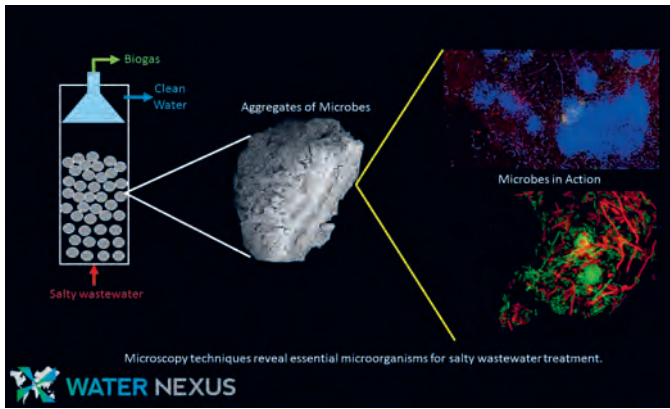
07/07/2016 | **Miller, I.**
Proteomics as a tool for gaining more insight into sub-lethal toxicological effects



08/07/2016 | **Faassen, E.J.**
The neurotoxin BMAA in aquatic systems. Analysis, occurrence and effects



29/08/2016 | **Wang, P.**
Roots in the tundra. Relations between climate warming and root biomass and implications for vegetation change and carbon dynamics



wastewater. This research is part of the Water Nexus program where 16 PhD and Post Doc researchers study solutions for water provision in salt water pressured delta's (see our website)²¹.

Removal of pharmaceuticals from wastewater using a hybrid technology (BO₃B technology)

Incomplete pharmaceutical removal at wastewater treatment plants (WWTP) results in their discharge into the environment, causing unwanted effects. Ozonation is an effective technique to oxidize such compounds at high removal rates. However, selectivity is limited and high ozone doses are needed when other compounds are present, e.g. organic matter. An addition to physical-chemical techniques like ozonation is biological treatment, that requires low energy and chemical inputs.

We have designed and evaluated a lab-scale three-step biological-ozone-biological (BO₃B) reactor. This hybrid technology (Figure 3) combines the efficiency of biological removal and the power of ozonation to remove a broad range of pharmaceuticals, while also being a sustainable and cost effective technology. WWTP effluent is fed into the first reactor (bio), where TOC is removed to reduce the required ozone dose in the second reactor (ozone).

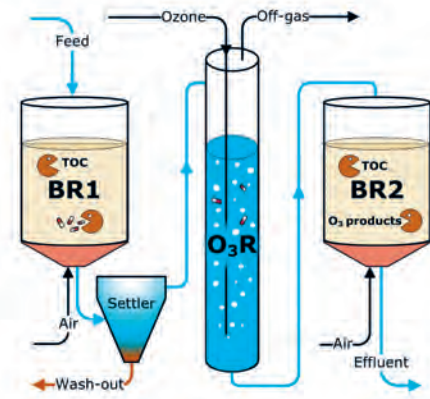


Figure 3 Schematic overview of the BO₃B (bio-ozone-bio) technology.

In the third reactor (bio), potentially toxic ozonized transformation products are further broken down by microorganisms.

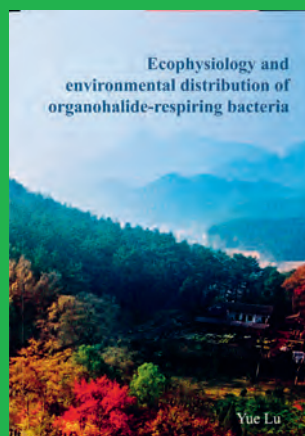
HWM: Hydrology and Water Quantity Management Group

Uncertainties in hydrological modelling tested

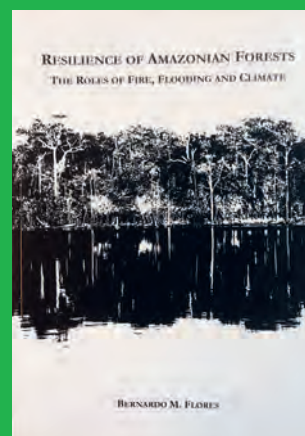
Dr Lieke Melsen graduated in 2017 on a thesis 'Putting hydrological modelling practice to the test'. Hydrologic models are useful for a wide range of applications: For short term forecasts to support water management decision making concerning, for instance, extreme events like floods and drought, but also for long-term projections to estimate the impact of global change on future water availability. Despite the practical use of hydrologic models, the model results are still surrounded by many sources of uncertainty. This dissertation examines different sources of uncertainty related to current hydrological modelling practice. A key result is that many modelling decisions, for example on spatial resolution, calibration strategy, or model time step, significantly impact the modelling results. Furthermore, it was demonstrated in a multi-model climate assessment study, that uncertainty in hydrologic projections are especially associated to the



02/09/2016 | **Suwarno, A.**
Optimising land use in Central Kalimantan Province, Indonesia : modelling ecosystem benefits and land use dynamics



13/09/2016 | **Lu, Y.**
Ecophysiology and environmental distribution of organohalide-respiring bacteria



14/09/2016 | **Monteiro Flores, B.**
Resilience of Amazonian forests. The roles of fire, flooding and climate

snow parameterization of the model, and that common hydrological models tend to have a weak performance in arid regions with intermittent flow behaviour. All findings provide a strong motivation to enhance our understanding of the hydrological system to improve our decision making based on these models.

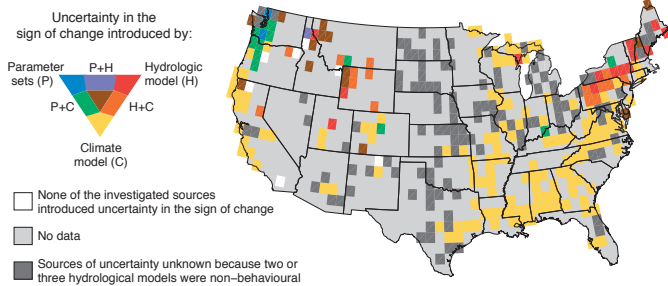


Figure 4: Spatial distribution of three sources of uncertainty (parameter uncertainty, model structural uncertainty, and climate model uncertainty) in the sign of change in mean runoff (increase or decrease for the period 2070-2100 compared to 1985-2008), based on 605 basins in the US.

A sharp view on river dune transition to upper stage plane bed – Dr Suleyman Naqshband

River dunes are rhythmic sediment structures that arise from the interaction between a flow field and the underlying mobile sand bed. Due to their large dimensions relative to flow depth and formation of turbulent flow separation zones, dunes are the main source of flow roughness and they are the essential ingredient for accurate predictions of water levels during floods. In addition, their preserved deposits contain essential information on formative environmental conditions providing constraints on current and past climate and landscape evolution, which is needed to interpret stratigraphy and reconstruct paleoclimates on Earth as well as on other planets. Using a novel acoustic instrument over migrating dunes in a laboratory setting, a number of dune dynamical properties were

quantified in this study that are crucial in our understanding and modelling of dune morphology and kinematics, particularly under non-equilibrium flows during dune transition to upper stage plane bed. A key result is the observed positive spatial lag between dune crest (topographic maximum) and maximum sediment transport rate, which explains dune decay and washing out of dunes under extremely high river discharges.

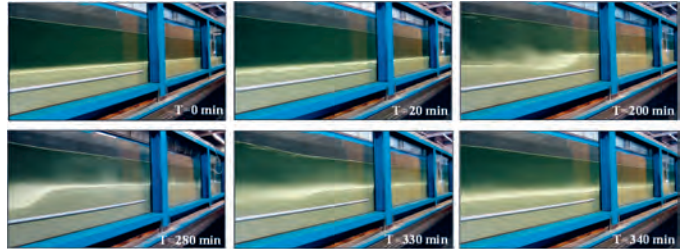


Figure 5: Snapshots of dune evolution in a laboratory setting from initial plane bed (T=0 min) to dynamic dune equilibrium (T=200 min) and upper stage plane bed (T=340 min).

Tracking subsurface signals of decadal climate change to infer groundwater flow rates – Dr Victor Bense

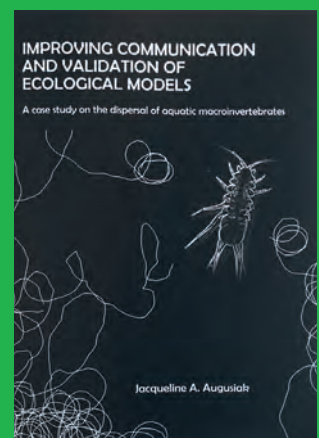
Surface environmental conditions have a clear impact on subsurface thermal regimes. Temperature-depth data can be obtained in groundwater boreholes to show these effects. Underneath forested parts of the Veluwe groundwater temperatures are on average 2-3 °C lower than in urbanised areas such as Deventer (Figure 6). Temperature-depth profiles also show the distinct signature of geothermal heat flow causing temperatures to gradually rise with depth (at a rate of about 2.5 °C per 100m). Vertical groundwater flow affects the geothermal gradient, lowering it where groundwater recharge occurs, and increasing it where groundwater seepage happens. Ground surface warming drives this system into a transient state. For the Veluwe area it has been possible, uniquely, to establish the relationship between the rate of



15/09/2016 | **Makama, S.L.**
An in vitro – in vivo integrated approach for hazard and risk assessment of silver nanoparticles for soil organisms



23/09/2016 | **Bajracharya, S.**
Microbial electrosynthesis of biochemicals: innovations on biocatalysts, electrodes and ion-exchange for CO2 supply, chemicals production and separation



06/10/2016 | **Augusiak, J.A.**
Improving communication and validation of ecological models. A case study on the dispersal of aquatic macroinvertebrates

increase in subsurface temperature and vertical groundwater flow velocities by comparing a novel set of temperature-depth data collected in 2016 to historical data from the period 1978-81. This results suggests that temperature-depth profiling that display the effects of surface warming can efficiently be used to quantify vertical flow rates, knowledge of which is paramount for efficient groundwater resource management.²²

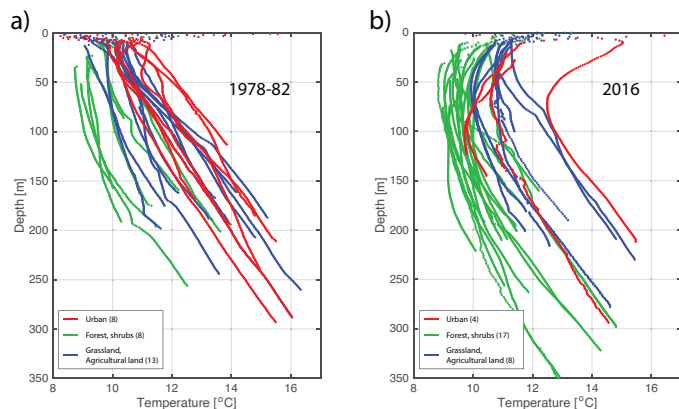


Figure 6: Temperature-depth profiles obtained in 1978-82 (a) and (b) 2016 across the Veluwe. Line colours indicate land use at the site of each borehole.

MAQ: Meteorology and Air Quality Group

Are clouds and vegetation responses an integrated system? NWO PhD Projects Xabier Pedruzo-Bagazgoitia and Martin Sikma

Clouds are rooted in vegetation through a myriad of interactions that link plant transpiration, carbon dioxide assimilation, turbulent transport of moisture and heat, aerosol formation, moist convection and precipitation. These processes are key in modulating weather, climate and atmospheric chemistry, but advances in our understanding are hampered by discipline barriers and challenges in understanding the role of small spatiotemporal scales.

Financially supported by two NWO projects, PhDs Xabier Pedruzo (WIMEK) and Martin Sikma (PERC) are investigating the coupling between cloud and vegetation under a wide range of ecosystems and weather conditions. Based on detailed numerical experiments performed, using the large-eddy simulation technique (Figure 7), they reach new evidence on how the system is coupled. Pedruzo-Bagazgoitia et al. (2017)²³ discovered that thin clouds lead to optimal regimes for evapotranspiration and Sikma et al. (2017)²⁴ unraveled how the transport of moisture is controlled by the asymmetrical aperture of stomata that is dynamically perturbed by the radiative effects of clouds.

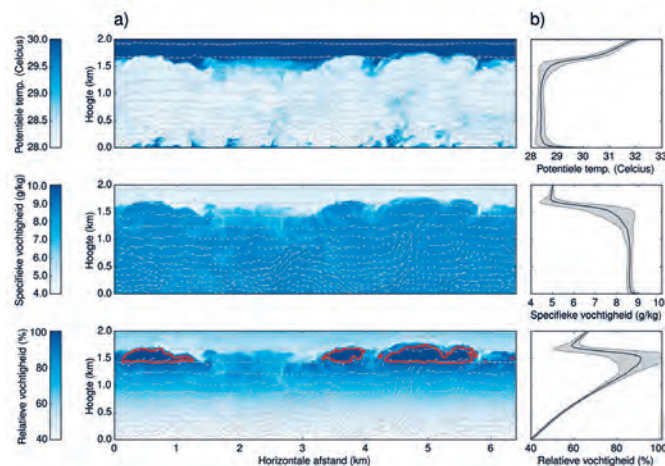
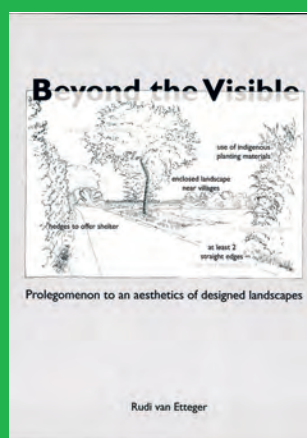


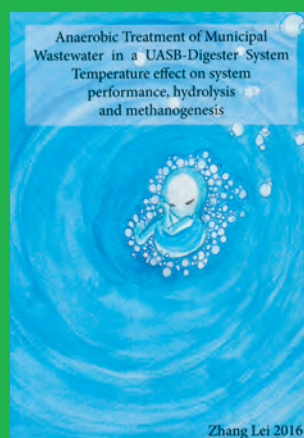
Figure 7. Large-eddy simulation of a shallow cumulus (left) mimicking (right) the effect of shading and turbulence on the vegetation by the presence of clouds. The red color in the left vertical panel shows the vertical velocity whereas the blue indicate the atmospheric moisture content. Dark green color at the surface indicates the closing of stomata at a meter and second resolution. These biophysical numerical experiments with unprecedented level of detail enable us a quantification of the coupling between vegetation responses and clouds ranging from leaf to cloud scales (Sikma et al., 2017).



10/11/2016 | **Etteger, R. van**
Beyond the visible: prolegomenon to an aesthetics of designed landscapes



21/11/2016 | **Zeinstra-Helfrich, M.**
Predicting natural and chemical dispersion of spilled surface oil



23/11/2016 | **Zhang, L.**
Anaerobic Treatment of Municipal Wastewater in a UASB-Digester System. Temperature effect on system performance, hydrolysis and methanogenesis

Launch of the Dutch TROPOMI satellite & related science

The 13th of October, 2017, the Dutch TROPOMI satellite was successfully launched. The TROMOMI instrument observes sunlight that is scattered back to space by Earth's surface and atmosphere, detecting the unique fingerprints of gases in different parts of the spectrum. With a resolution as high as 7 km × 3.5 km, it has the potential to detect air pollution in the form of nitrogen dioxide and carbon monoxide over individual cities. The mission is an essential contribution to monitoring air quality and providing critical information to services and decision makers to improve the life of European citizens. Alba Lorente from the MAQ group works on algorithms to obtain high-quality data from the raw measurements. She does this within the EU project QA4ECV that aims for a thorough error characterization of satellite products, like total NO₂ columns. Alba's publication in the journal Atmospheric Measurement Techniques was selected as a "high-light article" in 2017²⁵.

MIB: Microbiology Group

Adaptation to life in the deep

Symbiosis appears to be the rule, rather than a hand full of exceptions. Marine sponges are the oldest multicellular organisms on Earth and represent a successful animal phylum that is distributed globally and can be found from intertidal flats to the deepest oceans. Sponges often harbour large communities of associated bacteria (up to 50% of their body weight!) and we currently study whether these bacteria actually help sponges to life at greater depth. As part of the H2020 projects SponGES Detmer Sipkema, Menia Gavriilidou and Indra Anak Agung Gede study adaptations of the sponge *Geodia barretti* between 100 and 1400 m of depth in the Norwegian fjords and the Labrador Sea. A glimpse of preliminary data already show that a depth of 1000 m is a threshold and below microbial communities change substantially and, interestingly, the

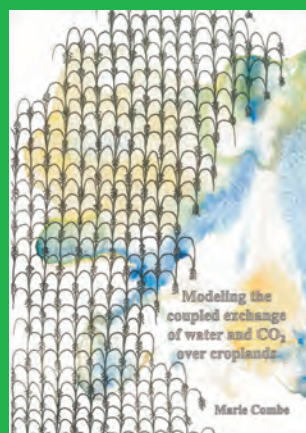


Photo: Sponge fishing expedition

chemical defence of the sponge disappears, perhaps because it no longer needed at greater depth.

Microbial Syngas Conversion to Chemical Building Blocks

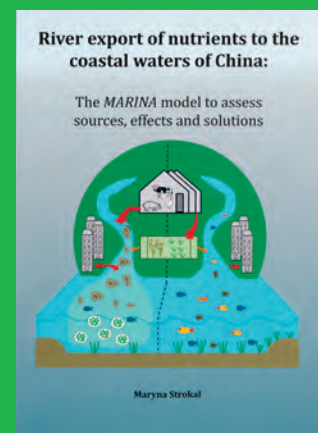
Diana Sousa and Alfons Stams obtained 3.7 M€ from NWO-TTW Perspectief Programme to study microbial syngas conversion to chemicals together with TU Delft and TU Eindhoven. This programme is co-funded by industry and aims to develop technologies for the valorisation of waste gas and biobased syngas (both containing carbon monoxide as a principal component). Currently, there are three main bottlenecks in syngas bioconversion: (i) low CO conversion rates, (ii) limited product spectra, (iii) low mass transfer rates. This NWO-domain TTW programme brings together a multidisciplinary team of microbiologists and (bio)process engineers to tackle these major gaps by: (i) discovering novel microbes with high CO-conversion rates and resistance; (ii) designing synthetic consortia or engineered microbes for the production of low-solubility molecules or volatiles; (iii) evaluating, developing and testing novel intensified high-cell density bioreactors with



02/12/2016 | **Combe, M.**
Modeling the coupled exchange of water and CO₂ over croplands



06/12/2016 | **Supriatin**
Selenium Speciation and Bioavailability in Dutch Agricultural Soils: The Role of Soil Organic Matter



13/12/2016 | **Strokol, M.**
River export of nutrients to the coastal waters of China: the MARINA model to assess sources, effects and solutions

enhanced gas-liquid mass transfer and smart product recovery strategies.

The microbial sulfur cycle in environmental biotechnology

Methanogenesis and sulfate reduction are two important microbial processes in nature and in environmental biotechnological processes. There are important differences in degradation of organic matter with or without sulfate. Methanogenesis requires the syntrophic cooperation of anaerobic bacteria and methanogenic archaea to degrade e.g. propionate and butyrate. Such a syntrophic association is not required when sulfate is the electron acceptor, as sulfate reducers use such substrates directly. We study the metabolic interaction between methanogenic and sulfate-reducing communities. This research is partly done in collaboration with ETE, Wetsus and companies, such as Paques, Shell, Paquel.

The occurrence of sulfate reduction is disadvantageous in biogas reactors as it lowers the methane yield and the sulfide that is formed is toxic, corrosive and odorous. However, sulfate reduction may help methanogenic communities to prevent heavy metal toxicity. Lara Paulo graduated in 2017 on "Anaerobic microbial processes for energy conservation and biotransformation of pollutants". The addition of sulfate to anaerobic enrichment cultures growing on H_2/CO_2 or acetate containing inhibiting concentrations of nickel (Ni) and cobalt (Co) helped to mitigate the toxic effect of the metals.

An important application of sulfidogenic processes is the treatment of acidic and metalliferous water streams, as sulfide reacts with heavy metals and generates insoluble metal sulfides that can be easily removed from the water streams. Anna Patr cya Florentino graduated in 2017 on "Physiology and application of sulfur-reducing microorganisms from acidic environments". She demonstrated

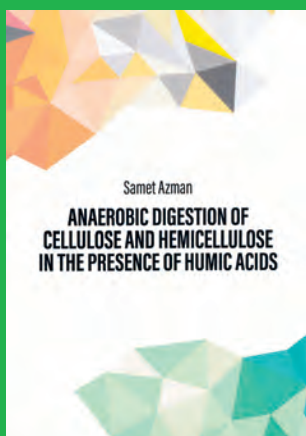
the feasibility of using sulfur reducers for metal precipitation by isolating a novel bacterium with high tolerance to heavy metals, *Desulfurella amilsii*.

In the biotechnological recovery of sulfur compounds for example from biogas, natural gas and flue gas, a high pH is required to trap H_2S or SO_2 . Jo o Sousa graduated in 2017 on the topic "Biotechnological application of microbial sulfidogenesis at haloalkaline conditions". It was demonstrated that the biotechnological application of sulfidogenesis under haloalkaline conditions using H_2 or syngas is possible. The use of such sulfidogenic bioreactors leads to savings in caustic consumption and disposal of sulfur-rich waste streams.

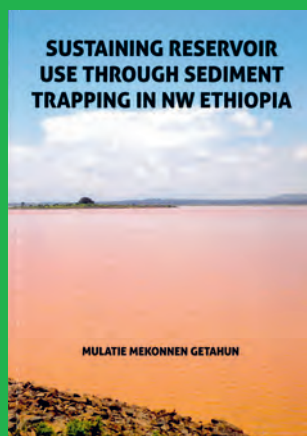
PEN: Plant Ecology and Nature Conservation Group

Siberian Tundra research

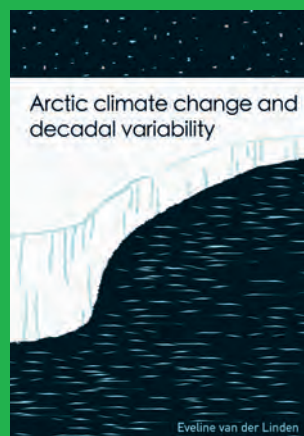
Since 2007 the PEN group has been doing research at a remote Siberian tundra site under supervision of Monique Heijmans. Peng Wang graduated in 2016 on his research on belowground biomass responses in tundra plants. He found that grasses can take advantage of increased thaw depth as they are deep-rooted and able to shift root distribution. The current dominance of dwarf shrubs may be explained by their shallow rooting pattern and early root growth which enables them to take advantage of the nutrient pulse after snowmelt. Bingxi Li graduated in 2017 on his research on vegetation succession at the lowland tundra site. Thaw of ice-rich permafrost initiates soil subsidence, ponding of water and drowning of the dwarf shrub vegetation. In the thaw ponds, however, also recovery takes place. Once a *Sphagnum* moss carpet has established, methane emissions decrease, and dwarf shrubs can establish again, all together suggesting a cyclic vegetation succession. The project continues with PhD Runa Magnussen who focusses on the climatological triggers that initiate thaw of ice-rich permafrost and explores if succession is fast enough to compensate for thaw pond development at a landscape scale.



14/12/2016 | **Azman, S.**
Anaerobic digestion of cellulose and hemicellulose in the presence of humic acids



14/12/2016 | **Getahun, M.M.**
Sustaining reservoir use through sediment trapping in NW Ethiopia



21/12/2016 | **Linden, E.C. van der**
Arctic climate change and decadal variability

Tropical forest – savanna transitions

Since ca 2008 PEN has participated in studies of the dynamic nature of tropical forest-savanna transitions and contributed to an at present active debate regarding driving forces such as climate and soils versus the role of anthropogenic fire regimes.



Photo Theo van der Sluis: community consultations

During 2016-2017 this culminated in a comprehensive review of tropical experiments in which long term fire effects were quantified (Veenendaal et al 2018)²⁶. Results suggest that although fire can have very marked effects on tropical vegetation structure, it alone cannot play a deciding role in driving biome transitions. Results are leading to the review of management practices in a strict nature reserve (Kogyae, Northern Ghana), while PEN played a major role in the formulation of an integrated land-use plan for the Chobe District (Botswana) addressing land use problems in an area, presently home of the largest thriving elephant population in Africa. (Van der Sluis et al 2017)²⁷



Photo: Theo van der Sluis

Coastal dune formation dynamics

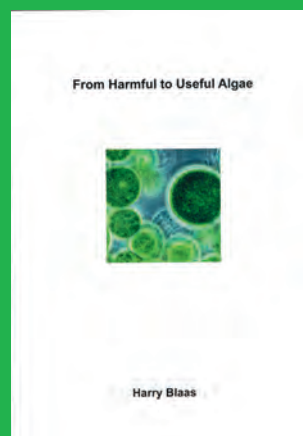
PEN works on coastal dune formation in close cooperation with the Soil Physics and Land Management group within the STW-funded Nature-Coast project since 2013. Coastal dunes protect large parts of the Netherlands against flooding. The formation of new dunes in front of the existing dunes may strengthen flood defences in the face of rising sea levels. Marinka van Puijenbroek, defended her thesis in 2017. Her thesis explores the ecological and geomor-



Photo Bart Volgers: Wind work



18/01/2017 | **Nigussie, Y.M.**
Behavioural mechanisms of adaptation decision to climate change: Evidence from lab-in-the-field experiments in the upper Blue-Nile Basin



25/01/2017 | **Blaas, H.H.T.J.**
From harmful to useful algae



25/01/2017 | **Eeman, S.**
Dynamics of rain water lenses on upward seeping saline groundwater



Photo Bart Volgers: Wind work

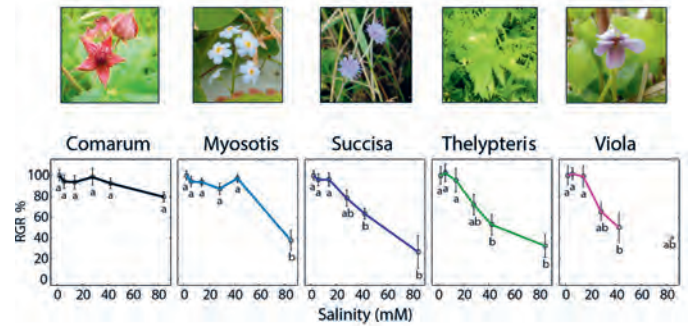
phological drivers of new dune development along the natural and nourished Dutch sandy coast and ends with exploring the potential of mega-nourishments for dune development.

Her thesis provides mechanistic information that improves predictions of dune building in response to changing climate as well as practical design principals for stimulating dune- and -habitat development. Three of her chapters are currently published.

SLM: Soil Physics and Land Management Group
Effects of increased salinity exposure on natural vegetation

In 2017, Sija Stofberg defended her thesis entitled "Hydrological controls on salinity exposure and the effects on plants in lowland polders". In her thesis, she investigated the hydraulic properties and water flow in root mats, which can be found in many lowland wetlands of the Netherlands. There is concern that incidental exposure of such root mats to too brackish water leads to adverse effects, among others to the biotic diversity. Little system understanding of the physical behaviour of such root mats was

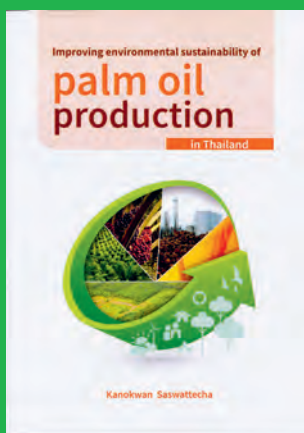
available, to make a risk assessment of which concentrations, which exposure time, and which other conditions might lead to reduced diversity. Her investigation was the first to assess the effect of salt concentration on 5 wild plants that were collected in Nieuwkoopse Plassen for a hydroponic bio-assay in the laboratory. Some of these species are so-called red list species. It appeared that the salinity levels where adverse effects occur might explain to a large degree, why these plants are found in Nieuwkoopse Plassen, but not in other similar nature areas, with higher salt exposure.



Graph: Sija Stofberg. Effect of salinity on peat soil plant species

Soil erosion under winter conditions in Norway

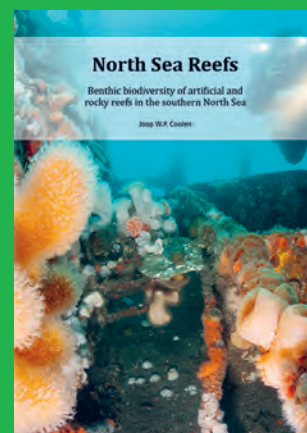
Torsten Starkloff received his doctoral degree in 2017 on basis of his thesis on "Winter hydrology and soil erosion processes in an agricultural catchment in Norway". In this study he combined field investigations, X-ray imaging and spatial distributed modelling to better understand how hydrological processes in a catchment are influenced by winter conditions and might lead to severe runoff and soil erosion. During three consecutive winter periods, changes in soil water content, soil temperature, and snow cover properties were monitored. In addition, numerous soil samples were taken to determine the soil hydraulic characteristics of the investigated soils and to quantify the



13/02/2017 | **Saswattecha, K.**
 Improving environmental sustainability of the palm oil industry in Thailand



15/02/2017 | **Figueiredo Oliveira, B.R.**
 Lift up of Lowlands: Beneficial use of dredged sediments to reverse land subsidence



15/03/2017 | **Coolen, J.W.P.**
 North Sea reefs: benthic biodiversity of artificial and rocky reefs in the southern North Sea

changes in their macro-pore networks due to freeze-thaw cycles, using X-ray imaging. The field observations revealed how combinations of tillage, state of soils and snow cover dynamics can lead to either prevention or generation of surface runoff and soil erosion. Overall, collected data and analysis led to advanced process understanding, and integrated simulation of spatial and temporal development of snow packs and surface runoff and soil erosion generation during winter conditions.

Risk assessment of pesticide use in Chinese Loess soil

In 2016, Xiaomei Yang defended her PhD thesis on "Pesticide use and off-site risk assessment: a case study of glyphosate fate in Chinese Loess soil". Repeated applications of pesticides might affect soil and water systems by threatening soil quality and aquatic life. The PhD study aimed to advance the state of knowledge with regard to

the fate and transport of glyphosate and its main metabolite AMPA, in particular in relation to runoff and erosion processes. It appeared that glyphosate in loess soils decays rather fast and that on-site risks of the use of glyphosate mainly relates to its main metabolite AMPA. However, in the hilly and incised landscape of the Loess Plateau in China, glyphosate and AMPA can be transported downslope by runoff and erosion processes, leading to accumulation of these compounds off-site. A parsimonious integrative model of pesticide displacement by runoff and erosion was developed and incorporated in existing erosion models in order to predict its off-site effects. In addition, it became clear through targeted interviews that farmer awareness and knowledge on pesticide use and risks needs to be improved substantially to safeguard the environment as well as the pesticide users.



Photo: Torsten Starkloff

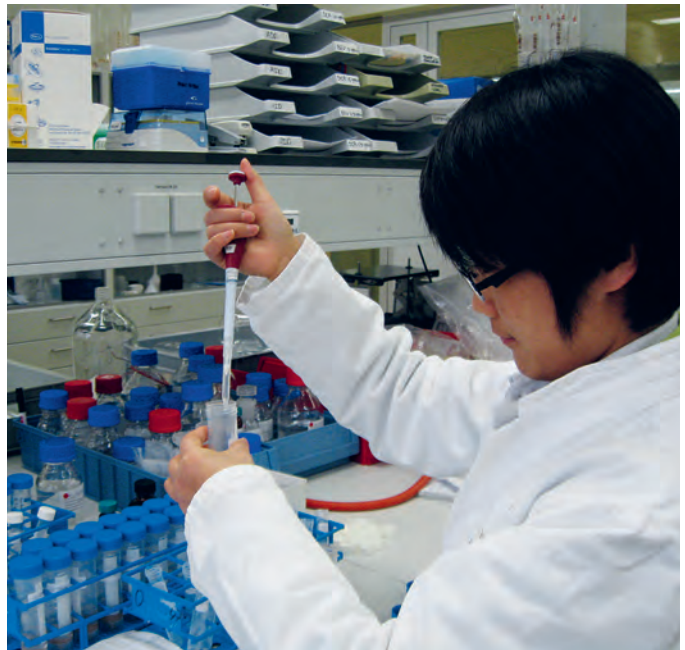
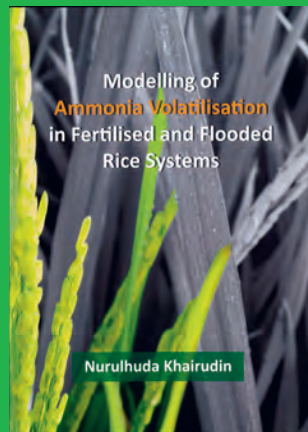


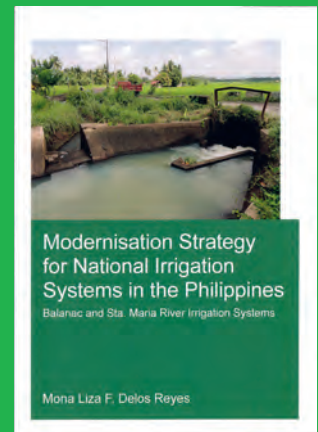
Photo: Xiaomei Yang



15/03/2017 | **Khairudin, N.B.**
Modelling of ammonia volatilisation in fertilised and flooded rice systems



21/03/2017 | **Florentino de Souza Silva, A.P.**
Physiology and application of sulfur-reducing microorganisms from acidic environments

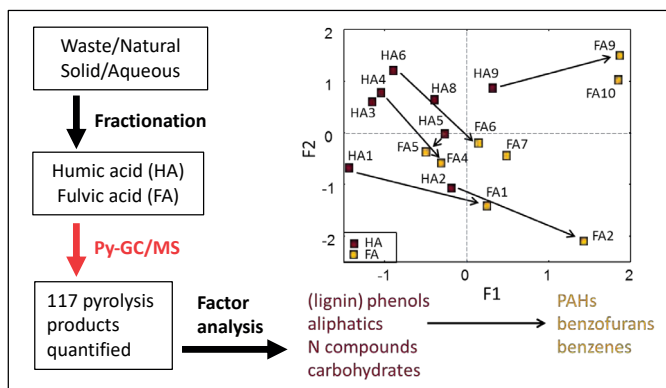


06/04/2017 | **Delos Reyes, M.L.**
Modernisation strategy for National Irrigation Systems in the Philippines. Balanac and Sta. Maria river irrigation systems

SOQ: Soil Chemistry and Chemical Soil Quality Group

New light on the molecular composition of humic substances

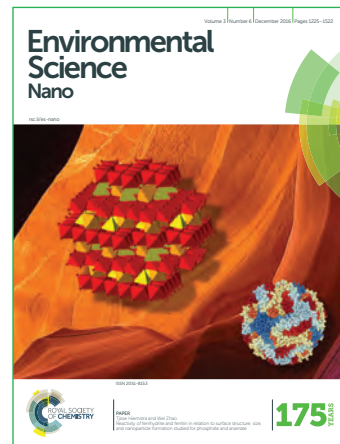
We have analysed for the first time the molecular composition of humic acids (HA) and fulvic acids (FA), isolated from a variety of natural and contaminated environments²⁸. Insight in the molecular structure of these organic matter fractions can contribute to identify relationships with important functions such as soil carbon sequestration, through association with mineral surfaces, and control of trace metal/micronutrient availability. Pyrolysis gas chromatography/mass spectrometry analysis revealed that FA's consistently differed from corresponding HA's, suggesting that their binding properties may, in addition to the carboxyl and phenolic groups, be influenced by their molecular architecture. Py-GC-MS may thus contribute to identify relationships between HA and FA binding- and molecular-properties and help to bridge the scientific debate about the concept of humic substances and their soil functions.



Particle size-dependent ion adsorption model for iron(hydr)oxides

Iron(hydr)oxides are omnipresent in nature, important in nanotechnology, and used in various engineered applica-

tions including purification of drinking water. To obtain a better understanding of the formation of nano-crystalline Fe(hydr)oxides and their binding properties, we have developed a particle size-dependent ion adsorption model, based on recent insights in the polyhedral surface composition of ferrihydrite²⁹. As the model allows downscaling to very small cluster sizes, it has also been used to investigate the formation of engineered Fe-oxide clusters in ferritin, an Fe-storage protein with a very high affinity for oxyanions. This material can be used to prevent biofouling of membranes by pre-removal of phosphate. These findings sheds new light of the exceptionally high phosphate binding capacity of highly fertilized agricultural soils. The paper made it to the cover of Environmental Science: Nano, Volume 3, 2016.



TOX: Toxicology Group

Hazard and risk assessment of silver nanoparticles for soil organisms

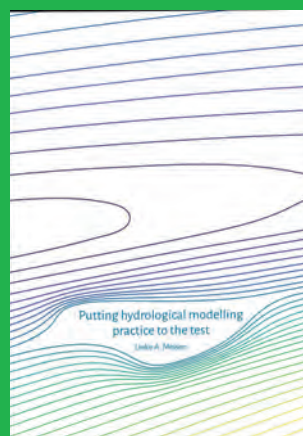
Sunday Makama defended his PhD-thesis "An in vitro - in vivo integrated approach for hazard and risk assessment of silver nanoparticles for soil organisms" successfully in 2016. Dr. Makama performed this project in the framework of NanoNext-NL, a Dutch consortium of 130 companies, universities, knowledge institutes and university medical centres, aimed at research into micro and nanotechnology. The thesis presents state-of-the-art science on the hazard and exposure assessment of nanomaterials in soil organisms, i.e. the earthworm. It is the first study to quantify particulate Ag-nanomaterials in soil organ-



12/04/2017 | **Hoang, L.P.**
The Mekong River's future flows: Quantifying hydrological changes and exploring adaptation options



19/04/2017 | **Leontaridou, M.**
An economic approach to non-animal toxicity testing for skin sensitisation



19/04/2017 | **Melsen, L.A.**
Putting hydrological modelling practice to the test



isms, which is an important improvement in assessing internalisation of Ag-nanoparticles. Silver nanoparticles were bespoke made in house, to assess effects of major properties (size and surface charge/chemistry) of nanomaterials on their uptake and effects. Observations at different levels of biological integration (gene, tissue and organismal levels) showed a cascade of

effects, depending more on the surface charge/chemistry than on the size range used in the studies. This project clearly pointed out the importance of assessment of internal body burdens of particulate nanomaterials, and provided a firm base for the participation of the department of Toxicology in the H2020 project NanoFase (www.nano-fase.eu).

WRM: Water Resources and Management Group

The Water Resources Management Group studies on the basis of a socio-technical approach a broad range of topics, which span the following three main themes (1) Water and Technology; (2) Water in Global Food Trade, and (3) The Politics of Water Expert Knowledges.

Drain for Gain

Under the first theme, Dr. Ritzema presented a keynote "Drain for Gain" at the 10th International Drainage Symposium, September 6–9, 2016, in Minneapolis, Minnesota, USA³⁰ on the rightful role for drainage in meeting future challenges in agricultural water management. The challenge is to find a balance between the individual need for drainage, which varies from field to field, and the fact that drainage at farm level is a collective activity. This calls for

better operational control. He shows that integrating research, education and advisory services to link the local tacit knowledge of the stakeholders with the explicit knowledge of the researchers to create this new knowledge is a prerequisite for success, but at the same time also extremely profitable.

Checks and Balances for Resource Use Efficiency (RUE) assessment

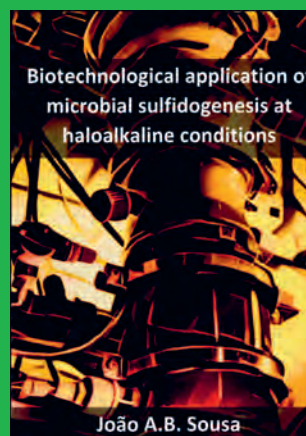
Under the second theme, WRM postdoc Dr. Chukalla works on the project 'Checks and Balances for RUE assessment: reducing yield gaps while accounting for nutrient- and water fluxes across spatiotemporal scales'. The project is part of the Wageningen Strategic Investment theme on Resource-Use Efficiency. We work together closely with researchers from other chair groups (Water Systems and Global Change, Plant Production Systems, and Business Economics). In order to evaluate interventions for sustainable intensification of crop production, the project develops indicators for relevant levels within socio-ecological systems. Simulation models are used to simulate hydrological processes that affect water- and nutrient fluxes across scales. This approach serves to translate the information from Global Yield Gap and Water Productivity Atlas into information that supports decision-making by multiple actors. Results of the assessments will also support the development of sustainability indicators and the implementation of Corporate Social Responsibility (CSR) strategies.

The need to co-create water knowledges and co-design water governance

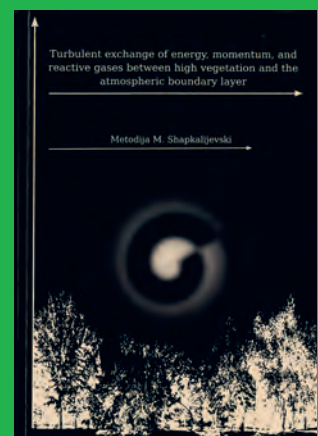
Under the third theme, prof. Boelens was appointed Personal Professor of Water Governance and Social Justice at Wageningen University & Research on 8 June 2017. In his opinion utopians organized space, nature and society to perfection, including land and water governance. These days, well-intended utopian water governance regimes



21/04/2017 | **Rodenas Motos, P.**
Bioreelectrochemical Metal Recovery with Microbial Fuel Cells



21/04/2017 | **Bastos Sousa, J.A.**
Biotechnological application of microbial sulfidogenesis at haloalkaline conditions



01/05/2017 | **Shapkalijevski, M.**
Turbulent exchange of energy, momentum and reactive gases between high vegetation and the atmospheric boundary layer

suggest radical transformations to combat the global Water Crisis, controlling deviant natures and humans. Boelens examines water utopia and dystopia as mirror societies. Modern utopias ignore real-life water cultures, squeeze rivers dry, concentrate water for the few, and blame the victims. But water-user collectives, men and women, increasingly speak up. They ask scholars and students to help question Flying Islands experts' claims to rationality, democracy and equity; to co-create water knowledges and co-design water governance.'

WSG: Water Systems and Global Change Group

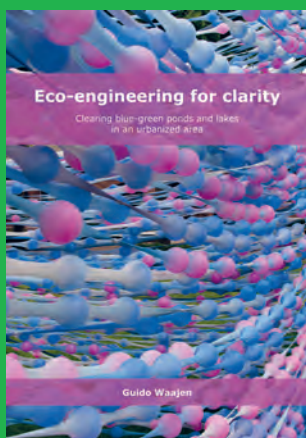
Development of the MARINA model to analyse nutrient export from land to sea

Dr Maryna Stokral graduated cum laude (with distinction) on a thesis "River export of nutrients to the coastal waters of China: The MARINA model to assess sources, effects and solutions" in 2016.

Maryna Stokral developed her own Chinese MARINA model, to analyse past and future trends in nutrient export from land to sea, and the resulting coastal eutrophication. She started with the existing Global NEWS model, but redesigned the model completely. The novelty of her work is in an elegant downscaling approach, and a better modelling approach for animal manure and sewage, which are important causes of river pollution in China. When we started the research, we did not realize how important point source emissions of manure are in China. Other than in Europe, point sources are an important cause of harmful algal blooms in Chinese seas. The MARINA model contributed to awareness of the need for improved manure management and waste water treatment. In optimistic scenarios, the thesis shows how future pollution can be avoided.

New indicator to assess water scarcity

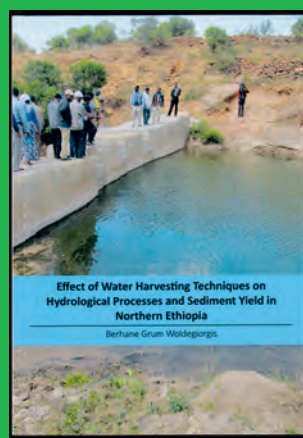
Clean water is fundamental for society. We need it for irrigation, livestock, energy and manufacturing, as well for domestic uses. For each of these users, water quality requirements differ, depending on the reason why they use it. Important water quality parameters include water temperature and salinity, nutrient levels and other pollutants. This study presents a new indicator for water scarcity, that accounts for water quality. This indicator assesses water scarcity as the ratio of sectoral water withdrawals of acceptable water quality to the overall water availability. Across the world, we find regions where the demand for water by the various sectors cannot be met in terms of water quality and quantity. The results were published by Michelle van Vliet et al. in Nature Geoscience.³¹



03/05/2017 | **Waajen, G.W.A.M.**
Eco-engineering for clarity. Clearing blue-green ponds and lakes in an urbanized area



08/05/2017 | **Da Luz Ferreira Martins Paulo, L.**
Anaerobic microbial processes for energy conservation and biotransformation of pollutants



09/05/2017 | **Woldegiorgis, B.G.**
Effect of Water Harvesting Techniques on Hydrological Processes and Sediment yield in Northern Ethiopia

Societal impact

WIMEK aims to contribute substantially to environmental and sustainability improvements by the dissemination of emerging scientific insights to companies, policy makers and society.

WIMEK researchers play an important role in the scientific underpinning of national and international policy documents regarding climate change, reduction of biodiversity, the disturbance of ecosystems, circular economy, sustainable city development and a sustainable reform of production and consumption. They participate actively in advisory boards of governmental and non-governmental organisations and are frequently asked to comment on recent developments in newspapers, on radio and television. Moreover, new system concepts and technological and management solutions are being developed and disseminated to companies, governments and non-government institutions practising the science for impact mission of WIMEK and Wageningen University.

Some highlights

Smart Solutions for Sustainable Cities (AMS)

WIMEK researchers are strongly involved in the AMS initiative: the Amsterdam Institute for Advanced Metropolitan Solutions. AMS Institute is a relatively new ambitious scientific institute located in Amsterdam. In this institute science, education, government, business partners and societal organisations are working closely together to create solutions for the complex challenges a metropolitan region like Amsterdam is facing now and in the future. The scientific partners are Wageningen UR, TU Delft, MIT and TNO. Moreover, WIMEK is the coordinator of the WUR wide Knowledge Investment Theme "Metropolitan Solutions" (MetSol, 2016-2018), which is closely connected to the AMS initiative. Within the MetSol theme, five postdocs

and two part time staff members are working on initiating so called "living labs" focussing on:

- Fresh Food City (postdoc: Xuenzhen Guo)
- Healing Garden (staff members Nicole de Roos and Esther Veen)
- The Ludic City (postdoc: Iulian Barba Lata)
- Green & Blue Urban Design (postdoc: Wiebke Klemm)
- Urban Heat and Dry Feet (postdoc: Iris Manola)
- Green Street (postdoc: Wei-Shan Chen)

ENP: Environmental Policy Group

Consumer facing traceability system for handling tuna

Prof. Simon Bush was the principle investigator of the action research IFITT programme that implemented a consumer facing traceability system for handling tuna in Indonesia. The project was successful in tracing tuna to the US and Australian markets and also resulted in a number of spin-off pilots on seafood traceability in the Southeast Asia region.

Climate change, conflict and migration

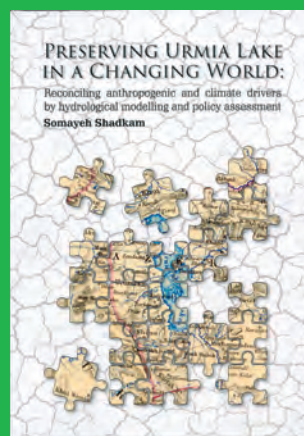
Dr. Ingrid Boas has written for the NRC, as well as given a number of lectures to various branches of the Dutch government on climate, conflict and migration. Her ongoing VENI research grant has raised her exposure on environmental change and migration both in the Netherlands and abroad.

Benefit-sharing standards in the Arctic

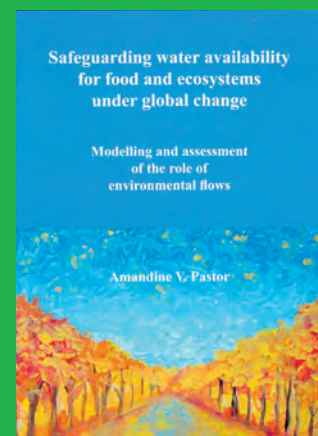
Dr. Maria Tsyachnyuk, Dr. Machiel Lamers and Prof. Jan van Tatenhove have been involved in the developing benefit-sharing standards in the Arctic project. They have actively engaged the Arctic Council on how industry stan-



17-07-2017 | **Brake, B. te**
Estimation of soil water storage change from clay shrinkage using satellite radar interferometry



29-05-2017 | **Shadkam Torbati, S.**
Preserving Urmia Lake in a changing world: reconciling anthropogenic and climate drivers by hydrological modelling and policy assessment



30-05-2017 | **Pastor, A.V.**
Safeguarding water availability for food and ecosystems under global change : modelling and assessment of the role of environmental flows

dards of the oil and gas sector can be improved to more effectively channel benefits to indigenous communities in a way that it simultaneously fosters economic development, empowers local actors and conserves traditional indigenous practices.

ETE: Environmental Technology Group

In April 2016, scientist Bert Hamelers was awarded the Zilveren Zandloper Innovation Award of the NBV, a prize for turning biotechnology science successfully into business. During his previous scientific work at ETE Hamelers was the driving force behind the foundation of several spin-off companies.

Josephine Nijstad and Martijn Savenije (both studying Urban Environmental Management) together with Livio Bod (UVA) and Dan Mulder (UU) won the WEGE prize 2016 with a cohesive proposal for an on-site waste treatment system that would allow hospitals to deal with waste in a way that reduces cost and environmental impact while maximizing the potential for resource recovery and reuse.

AquaBattery won the Herman Wijffels innovation award 2016 in the category Circular Economy. Jan Willem van Egmond is affiliated to AquaBattery.

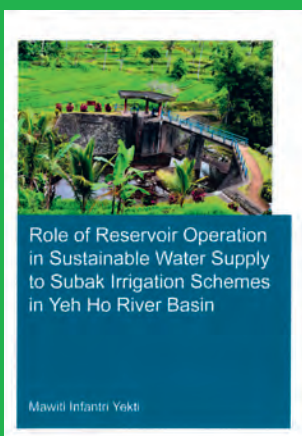
David Strik, Mathijs van der Zwart and Cees Buisman won the Lettinga Award with their proposal 'Dark photosynthesis: anaerobic biosynthesis of food from wastewater and electricity'. This award is to stimulate and implement anaerobic cleaning technology in society.

ETE spin-off company Plant-e won the Dutch Innovation Award in the category Social Impact. The prize is an initiative of the Dutch broadcasting company AVROTROS and the Erasmus University in Rotterdam

HWM: Hydrology and Water Quantity Management Group Wageningen Lowland Runoff Simulator
The Wageningen Lowland Runoff Simulator (WALRUS), a rainfall-runoff model for catchments with shallow groundwater, was developed as part of a PhD project in 2014. After publication in scientific literature, several Dutch water boards showed interest in the model and contributed financially to make the model operational. The code was combined into an R-package and, together with a manual and examples, posted on open source software development platform GitHub (www.github.com/ClaudiaBrauer/WALRUS). In addition, HWM held 3 workshops where water managers and consultants learnt to work with WALRUS and shared experiences. In 2017, WALRUS has been reprogrammed and added as a module to the commonly used modelling suite SOBEK and flood forecasting system Delft-FEWS. This facilitates application in operational water management in the Netherlands and abroad.

RAINLINK: Retrieval algorithm for rainfall mapping from microwave links in a cellular communication network

Although they have not been designed to measure rainfall, microwave links from cellular communication networks can be employed to obtain valuable rainfall information. Rainfall attenuates the electromagnetic signals transmitted from the antenna of one telephone tower to another. From the decrease in received signal levels, as stored by the telecommunication company, the attenuation and hence the path-averaged rainfall intensity between the telephone towers can be computed. The developed rainfall retrieval and interpolation algorithm is freely available as package "RAINLINK", written in scripting language R. It includes a sample dataset of microwave link data (<https://github.com/overeem11/RAINLINK>). This novel technique can potentially be used for operational rainfall mapping. This is particularly relevant in areas



01-06-2017 | **Yekti, M.I.**
Role of reservoir operation in sustainable water supply to Subak irrigation schemes in Yeh Ho River Basin



07-06-2017 | **Stofberg, S.F.**
Hydrological controls on salinity exposure and the effects on plants in lowland polders



20-06-2017 | **Rios Gaona, M.F.**
Rainfall over the Netherlands - a remote sensing perspective

where few surface rainfall observations are available, which is often the case in developing countries. Better rainfall information is badly needed to improve warnings for severe weather and associated flooding, as well as to optimize food production. We hope that RAINLINK will promote the application of rainfall monitoring using microwave links in poorly gauged regions around the world, and hence will contribute to reducing loss of life and property.

MAQ: Meteorology and Air Quality Group
Linking up academic research to secondary school classrooms

Although our primary task is to share our scientific insights with the rest of the academic world (as well as with our own students), we like to share further. In particular, we have a long-standing tradition in transferring our enthusiasm about the intriguing processes at the interface of land-surface and atmosphere with secondary schools: both to teachers and to students. Whereas in the past our contribution was mainly focused on the contents, we have

started to transfer our way of doing research as well with a hands-on interactive simulation tool.

Together with the Food-Valley School Network we have developed an online tool for investigative learning (<https://www.betasimulaties.nl>). The simulation tool is conceived to guide high-school students step-by-step in their understanding of cloud formation over land. This includes the roles of soil moisture, vegetation and large-scale weather. A key

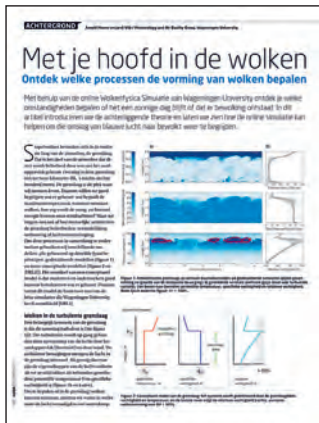


Figure 8 Paper in NVOX professional journal for science teachers illustrating the concepts used in the simulation tool.

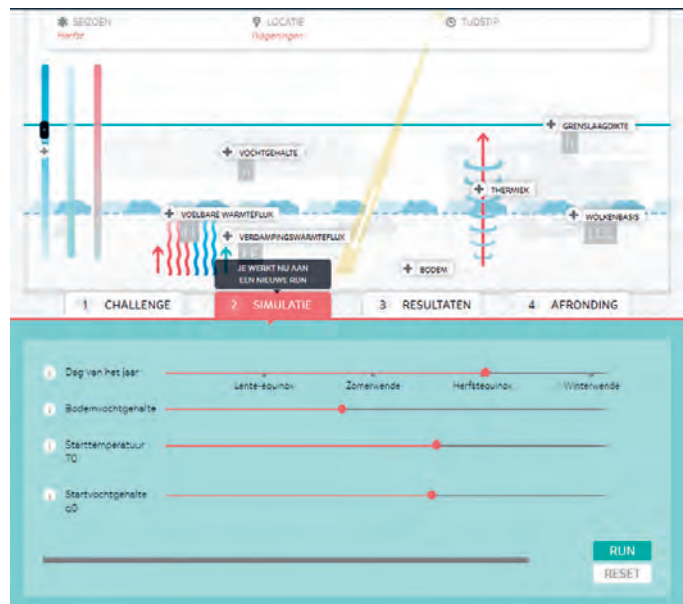


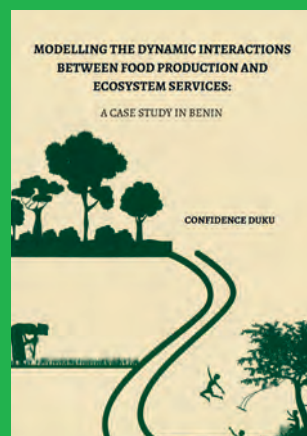
Figure 9 User interface of the online simulation tool showing step 2, the specification of the simulation settings for the current experiment (up to four experiments can be compared).

aspect in the design of the user interface is that the interface enables the students to perform systematic research, focusing on the effect of a single variable at a time (figure 1). In doing so, the high-school students become familiar with the way research is performed at university level with the companion tool developed at the Meteorology and Air Quality Group: Chemistry Land-surface Atmosphere Soil Slab model (CLASS, <https://classmodel.github.io>). In fact, the research version of CLASS is at the core of the online simulation tool, bringing up-to-date research into the classroom.

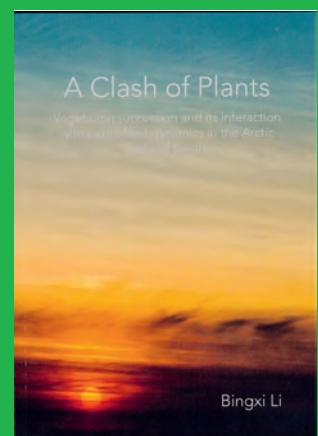
As a follow-up to the development of the simulation tool we support teachers and technical teaching assistants through training workshops. Furthermore, we recently published a paper in the professional journal for science teachers in the Netherlands (Moene and Vila 2017) intro-



21/06/2017 | **Chen, W.S.**
 Microbial chain elongation based on methanol



05/07/2017 | **Duku, C.**
 Modelling the dynamic interactions between food production and ecosystem services: a case study in Benin



29/08/2017 | **Li, B.**
 A clash of plants. Vegetation succession and its interaction with permafrost dynamics in the Arctic lowland tundra

ducing the background and motivation for the simulation tool (figure 2).

Amsterdam Atmospheric Monitoring Supersite

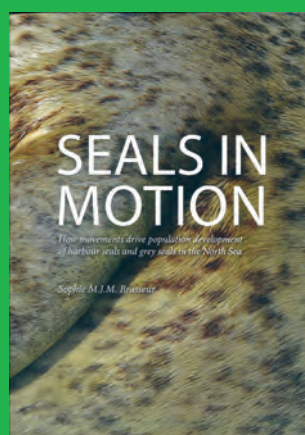
Since the majority of the World's population is currently living in cities, monitoring the weather and climate of urban areas is crucial for understanding and improving the environmental quality in cities. For instance the urban air quality and heat stress in warm episodes may be harmful to human health. In cooperation with the Institute for Advanced Metropolitan Solutions (AMS), the Meteorology and Air Quality Section launched Amsterdam Atmospheric Monitoring Supersite in 2014. It consists of a network of 30 weather stations across Amsterdam, measuring temperature, humidity, wind speed and gustiness. In this climatological analysis, the city is obviously warmer than the countryside during the evening hours. The signal is most clear in summer. However, the observations also indicate an *urban cool island* effect during daytime! This phenomenon is not only observed but has also been explained with a conceptual model developed at MAQ. Contrasts in thickness of near surface atmospheric layers between city and countryside result in a higher early morning heating rate in the countryside than in the city, resulting in a cooler city. In the coming year, the network will be extended with observations of evapotranspiration and turbulent heat fluxes, and observations of methane and CO₂ releases from the city towards the atmosphere. As such greenhouse gas emission will be monitored. Moreover, each day numerical weather forecasts at a unique fine grid spacing of 100 m will be produced, which provides insights in the fine scale weather patterns in and around Amsterdam. For example temperature differences between neighbourhoods will emerge, which is valuable input for city planners.



Photo: Illustration of the weather stations installed in Amsterdam



30/08/2017 | **Islam, M.M.M.**
Assessing the impact of socio-economic development and climate change on faecal indicator bacteria in the Betna River, Bangladesh



30/08/2017 | **Brasseur, S.M.J.M.**
Seals in motion. How movements drive population development of harbour seals and grey seals in the North Sea



30/08/2017 | **Iqbal, M.S.**
Quantifying the Impact of Socio-economic Development and Climate change on Escherichia Coli Concentrations in The Pakistani Kabul River

PEN: Plant Ecology and Nature Conservation Group Landscape – art project

PEN helped building a landscape-art project (www.slem.org/projecten/windwerk/introductie/) to illustrate the interaction between vegetation and sand for the cultural art festival Oerol in 2016. The art project doubles as an experiment exploring scale-dependency in dune formation. PEN currently uses state-of the art octocopter-mounted cameras to monitor the co-development of vegetation and topography at different spatial scales together with the Geo Information Science group.

SLM: Soil Physics and Land Management Group

Patent application for a polymer tensiometer

The chair group Soil Physics and Land Management and NWO-TTW (formerly STW) have signed a licence agreement with the German instrument company Umwelt Geräte Technik GmbH (UGT), which led to a patent application for a polymer tensiometer. The full-range tensiometer measures the soil water pressure over the range in which crops can take up water. The instrument has been developed in a STW Open Technology Programme, in which Wageningen University acted as the project leader,

in collaboration with WENR, Twente University, and several instrument companies. Inclusion of a hydrophilic polymer in the full-range tensiometer aids in measuring directly how easy or difficult plants can take up water. In comparison, other instruments available on the market can only measure a related soil property, and infer the water availability to plants. Although convention-



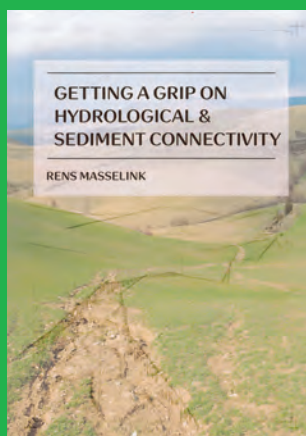
al, water-filled, tensiometers did exist, the full-range tensiometer has a 20 times larger measurement range. Since 2016, UGT offers the polymer tensiometer to clients, as shown on the front cover of their catalogue.

Glyphosate accumulation in soils

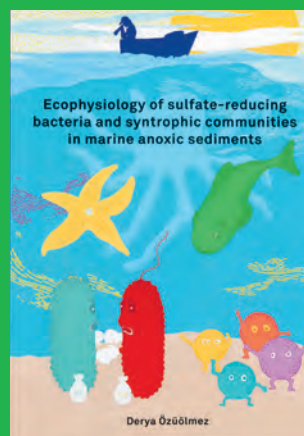
There is increased concern over the wide-spread use of pesticides and the potential accumulation of these compounds in the soil system and beyond. At present, little information is available about pesticide residues in soils. A study of an international group of scientists led by Wageningen University has recently been published, containing glyphosate details of more than 300 soil samples of agricultural land in ten European countries. The study showed that 45% of agricultural land in Europe contains glyphosate and AMPA, the most stable degradation product of glyphosate. The presence and concentrations of AMPA were higher than that of glyphosate, sometimes reaching 2 mg per kilogram of soil. Glyphosate and AMPA are highly persistent once they are attached to soil particles, and therefore susceptible for being transported by water and wind erosion processes, resulting in off-site impacts elsewhere. The study triggered massive attention in the media globally, and has been referred to excessively by scientists, farmers, nature and farmer organizations, national governments and international policy makers.

Accumulation of microplastics in terrestrial ecosystems

Whereas a lot of studies have been published on the accumulation of plastics in the aquatic food chain, studies on plastics in the terrestrial ecosystem are scarce. The SLM group of Wageningen University published the first study on field evidence for transfer of plastic debris along a terrestrial food chain. The study was carried out in Mayan home gardens in Southeast Mexico. Due to an insufficient waste collection system in suburban regions, people often incorporate plastic into the soils of their home gardens.



07/09/2017 | **Masselink, R.J.H.**
Getting a grip on hydrological and sediment connectivity



12/09/2017 | **Özüoğlu, D.**
Ecophysiology of sulfate-reducing bacteria and syntrophic communities in marine anoxic sediments



18/09/2017 | **Kempenaar, J.**
Design in the Planning Arena

Studying the soils in the Mayan home gardens, the authors found that microplastic content increased from soil to earthworm cast to chicken faeces. Furthermore, in chicken crop and gizzard macro- and microplastic residues were detected with more than 30 particles per gizzard. In Mexico, chicken consumption per capita is about 15 chickens per person per year. This translates into an annual ingestion of 840 plastic particles per person. Results of the study attracted wide attention in the media and newspapers in Mexico, and abroad, including triggering debates on food safety aspects related to microplastic contamination.

Integrated decision making for landscape management in Madagascar

In 2017, the SLM group embarked upon the Land Use Planning for Enhanced Resilience of Landscapes (LAUREL) project, which aims to support integrated decision making for landscape management in Madagascar. This large project, funded by the World Bank and executed with other partners, is organized into two broad components. Under the first component, improved spatial data on land degradation will be produced through a multi-scale ap-

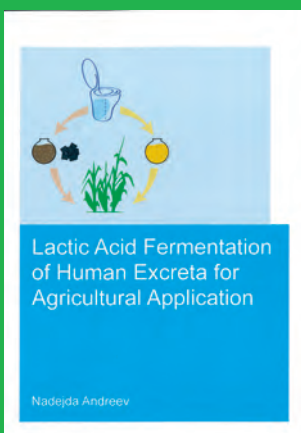


Photo: Luuk Fleskens

proach including remote sensing, expert and participatory mapping. The second component concerns the development of a prototype platform for simulating, evaluating, and re-orienting land use and land use change processes. From a research perspective, assessing the impact of land degradation and sustainable land management in a dynamic context offers a completely new approach to planning landscape investments. The simulation platform is to be used by the Government to assess the consequences of alternative investment decisions on the achievement of development and environmental objectives (e.g. food security, forest cover, carbon storage).

WaterNexus

In 2016, SLM started its contribution to the NWO funded WaterNexus programme 1.2: Local Operational Water Management and Control. In this programme, two PhD students investigate (i) optimal water supply in fields and areas with adaptive drainage systems (iDrain) and (ii) re-use of treated effluent in agriculture (iRe-Use). In view of the focus of WaterNexus (involving several universities, institutes, and companies and 12 PhD students), which is brackish and saline water as a resource, both PhD students focus on this issue. For iDrain, this concerns the optimization of adaptive drainage strategies to shallow saline water and erratic weather. For iRe-Use, the attention is on understanding the major and often irreversible problem of soil sodicity and the development of guidelines for assessing whether irrigation water will lead to unsustainable situations on the long term. This research is strengthened by the funding by NWO of the project RUST, that combines research of adaptable drainage for qualitatively marginal water (effluent containing contaminants of emerging concern) and the project SUSPECT, that investigates the fate of veterinary pharmaceuticals in soil and surface water.



29/09/2017 | **Andreev, N.**
Lactic acid fermentation of human excreta for agricultural application



10/10/2017 | **Eenennaam, J.S. van**
Marine snow formation during oil spills: additional ecotoxicological consequences for the benthic ecosystem



10/10/2017 | **He, Y.**
Removal of pharmaceutically active compounds in constructed wetlands: mechanisms and application

SOQ: Soil Chemistry and Chemical Soil Quality Group

Environmental protection criteria for sustainable landfill management

We have derived, in collaboration with RIVM and ECN, site-specific Environmental Protection Criteria (EPC) for a new sustainable aftercare of landfills, based on geochemical modelling of the retention capacity of the local soil. With traditional aftercare management, landfills require perpetual and expensive aftercare. To lower aftercare costs and release future generations from the responsibility for present day waste, the Dutch government and landfill owners have made a formal "Green Deal" to test the feasibility of sustainable landfill management. For the next ten years, three landfill sites are given the opportunity to test whether source-oriented active waste treatment can reduce the concentration of contaminants in the leachates to below the EPC that we have developed to secure the quality of adjacent groundwater.

In the Netherlands, agricultural soils are highly enriched with phosphorus (P), resulting from excessive fertilization. Pipe drains are an important hydrological pathway for the transfer of drainage water with dissolved P from agricultural land to surface waters, contributing to eutrophication³⁴. To mitigate P transfer, we have developed a pipe drain enveloped with a layer of iron-coated sand, a by-product from the drinking water industry with a high ability to bind P³⁵. Field-scale tests on a flower bulb field in the Dutch coastal area have shown this mitigation measure to remove 94% of P from drainage water³⁶. Following on this successful demonstration, the bulb growing sector received in 2017 a grant to enable five farmers to apply this measure in order to improve local surface water quality. (<https://www.rijnland.net/actueel/nieuws/nieuws-2017/een-betere-waterkwaliteit-in-de-bollenteelt-door-ijzerzand>).

TOX: Toxicology Group

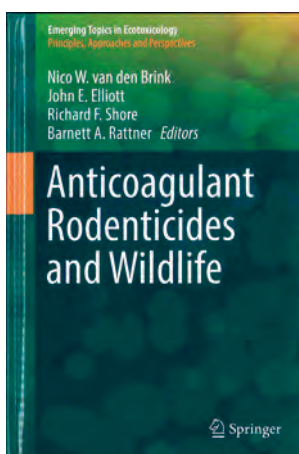
Integrated Pest Management (IPM)

One of the focal points within the framework of environmental risks of chemicals within the department is on the effectiveness of Integrated Pest Management (IPM) approaches in the regulation of rodents. This is a major, and increasing, societal problem demanding for effective and affordable management options. The use of currently available rodenticides however, results in environmental risks which need to be mitigated and minimised. The development of the IPM approaches to address this is managed by the Ministry of Infrastructure and Water (formerly the Ministry of Infrastructure and Environment), which is advised by the department Toxicology on this issue. This cooperation was clearly visible in the answers of the Ministry on questions from parliament on the progress of



the development of the IPM for rodent control in which activities of WUR (i.e. the department of Toxicology were mentioned)³⁷

With respect to environmental risks of rodenticides to wildlife, also a book was published at the end of 2017 co-edited by Nico van den Brink, entitled "Anticoagulant rodenticides and wildlife" (Springer, ISBN 978-3-319-64377-9). This book is aimed to provide environmental managers, risk assessors and regulators with state-of-the-art information on the environmental risks of anticoagulant rodenticides. It covers all aspects of e.g. hazard and exposure assessment of rodenticides for wildlife, post mortem assessment of clinical signs and development of alternatives of rodent control.



WRM: Water Resources Management Group

Development of a new drainpipe concept

The WRM group cooperates with Harran University, and the private company Hidroluis Drainage Pipe System, both from Turkey, in research to develop of a new drainpipe – envelope concept that works for a wide range of soil textures and gives a better protection against root growth inside the drain pipe in irrigated agricultural lands. Because of its greater flexibility the new concept can result in a better control in the management of subsurface drainage systems. The concept has drawn the attention of the Dutch private sector: GrainPlastics, a leading manufacturer of flexible extruded plastic pipes used in agriculture, sewerage and water supply, and Barth Drainage, a contractor specialized in the construction of subsurface drainage systems. In cooperation with the WRM Group and the Turkish partners, the new concept will be tested in 3 pilot areas in the Netherlands. A PhD student of the WRM Group from Iran, Seyed Abdollah Alavi, is using this concept in his research to improve subsurface drainage management practices in irrigated agriculture in the Khuzestan Province, Iran with the aim to reduce the salt load in the drainage effluent.

Development of a drought monitor for north-eastern Brazil

Knowledge exchange with drought-prone Northeast Brazil: WRM researcher Dr Pieter van Oel is involved in the development of the drought monitor for north-eastern Brazil. In 2016 Pieter was invited to present his downstreamness concept (Van Oel et al. 2018)³⁸ at the seminar 'Evaluation of the 2010-2016 Drought in the Brazilian Semi-Arid' in Brazil. Discussions on how to integrate this downstreamness concept into the drought monitor are ongoing. Together with Brazilian researchers Pieter builds on the three pillars of drought preparedness to translate research findings into applications. To achieve this meetings with representatives of the government of Ceará, Brazil, took place in 2016 and 2017. These included personal talks with the governor of Ceará who visited Wageningen University on invitation in August 2016.

Our education

The PhD education and training programme

All WIMEK PhD students participate in the WIMEK-SENSE PhD training programme. The objective of the training programme is to provide training for PhD candidates to become qualified scientific researchers with a developed capacity to (i) carry out scientific research independently and in a systematic and productive way; (ii) contribute to an improved understanding of the causes, consequences and solutions of environmental issues; (iii) interact with relevant stakeholders and put into practice the societal impact of their PhD research and (iv) present the results of research to an international audience.

Essentially, we aim to help PhD candidates in performing their research, in understanding the wider environmental context of their research, and in preparing them for future careers. The programme therefore consists of specialised PhD courses, designed to increase the in depth knowledge of PhDs in their own field; and general skill courses, designed to develop skills for conducting their research that are independent of their specific research topic. An oral presentation at an international conference is a requirement for obtaining a WIMEK diploma.

Examples of specialised PhD courses

In the period 2016 - 2017, WIMEK has been involved in the coordination and organisation of several international PhD courses, for example:

Grasping Sustainability (since 2015 yearly; 1.5 EC)

The PhD course Grasping Sustainability was offered for the first time in 2015. The course aims to explore and understand sustainability, the different concepts, objectives and methodologies to improve the sustainability goals of the PhD research. This on-site course enables the participants to grasp how their own research is set within societal and stakeholder needs, in a collaborative and interdisciplinary learning environment. Our intention is to offer this course once a year.

Stable isotope applications in microbiology and environmental studies (11 – 14 December 2017, Wageningen)

This four day course intended to provide an overview of current stable isotope applications and concepts in form of lectures, case studies and exercises and laboratory visits.

Speciation and Bioavailability of Metals, Organics and Nanoparticles (6 – 10 November 2017, Antwerp, Belgium)

The course programme focused on the analytical and physical chemistry of metal ions, organic compounds and

nanoparticles in complexing aqueous environments and the bioavailabilities of different species.

Climate KIC - AMS - SENSE Summer School "Urban Transitions: Reshaping Urban Districts"

Date: 16 July 2017 - 30 July 2017. Location: Amsterdam (The Netherlands) and Bologna (Italy)

This summer school intended to turn PhD research into practice by working on the improvement Urban Districts. Two case studies in Amsterdam and Bologna challenged the participants to shape the urban landscape and its community in a transdisciplinary setting, including stakeholders.

Climate KIC - AMS - SENSE Summer School on Urban Metabolism and Water Management: Smart Solutions for the Urban Metropole

Date: 04 July 2016 - 15 July 2016. Location: Amsterdam and Bologna

In the summer school two key urban challenges were tackled: 'Urban Metabolism' which addresses the circular economy of a city and 'Urban Water Management', which examines problems that urban areas face with water. For both challenges local cases have been presented in Amsterdam (e.g. de Ceutel and Park 2020) and Bologna (e.g. Zamboni district)

ENP Summer School "Tackling Transparency: the Challenges of Operationalising Research on Disclosing Sustainability" (21 June 2016 - 25 June 2016, Wageningen)

The aim of the Summer School was to explore the methodological challenges of operationalizing research on disclosing sustainability. The Summer School highlighted a number of themes and contexts in which these challenges manifest themselves:

- Analyzing the role of information in sustainability practices
- Using big data and social media in research
- Developing and analyzing sustainability indicators
- Involving and analyzing citizen science approaches

Furthermore, our PhDs have access to the international PhD courses that are organised by our SENSE partner institutes and other Wageningen Graduate Schools, at a reduced fee.

General skills courses

All PhD candidates need to further develop skills for conducting their research that are independent of their research topic. We call these general skills. WIMEK has joined forces with the other five Wageningen Graduate

schools to organise these general skill courses together. Categories of these courses are PhD Competence Assessments, Writing and Presenting, Communication Skills, Project and Management skills (including information literacy), Teaching, PhD well-being, Ethics, and Career orientation. For a list of all courses see <https://wgs.crs.wur.nl/>. Within these courses, WIMEK coordinates the courses Bridging across cultural differences, Making an Impact and PhD Peer Consultation.

Collaborations

WIMEK collaborates with other Wageningen Graduate Schools, the Research School Ecology and Evolution (RSEE-RUG) and the Postgraduate Education programme on Toxicology (PET) to offer a broad spectrum of PhD courses, such as:

- Ecotoxicology and Risk Assessment (PET)
- Statistical courses (PE&RC)
- Advanced courses in ecology (together with PE&RC and RSEE)
- Advanced courses in social sciences (WASS).

MOOC: Citizens co-creating sustainable cities 10 October 2017 – 05 December 2017

The MOOC *Co-creating Sustainable Cities*, initiated by WIMEK and funded by WIMEK and AMS, has had a successful first run. This MOOC focuses on the dynamics of co-creation and the key principles of citizens interacting with service providing companies, technology and infrastructure developers, policy makers and researchers. The MOOC aims at gaining an understanding of major types of co-creation and their interdependency with their socio-technical and political contexts. Moreover, the participants become equipped to indicate how they can use co-creation to develop innovative technologies, policy arrangements or social practices for a sustainable city in their own communities.

Approximately 3300 students from 142 countries were enrolled for the course on edX.³⁹ Of these, 84 are verified learners (ie, these learners are pursuing a purchased certificate). Of the enrolled learners 1244 initially started watching the clips and making the assignments. When the MOOC closed a total of 58 students (of which 42 verified) had successfully passed the course. This is 1.7% of the enrolled learners, which is not high, but also not unusually low. Learners who passed were most likely Dutch males with an MSc degree, which fits the envisaged target group of the MOOC (working professional) and probably reflects where most marketing actions were done (by AMS in her network). The learners who completed the final evaluation (~50% of those who passed) gave the course a score of 8.26/10. The difficulty, workload, breadth of topics and

length were all deemed about right. The examples and global content related to co-creation were valued. The greatest challenge for completing the MOOC successfully was allocating sufficient time and combining it with other life obligations.

Overall more than 100 staff from 6 universities and 2 knowledge institutes (Wageningen UR, TUDelft, Tsinghua University, TU Eindhoven, University College of Amsterdam, Renmin University; AMS-Institute and KWR Research Institute) as well as 4 public or private organisations (Waternet, Waag society, Alliander and Xuetaang) have produced more than 100 knowledge clips and animations. In addition, more than 50 units that include texts, discussion forums, graded assignments or background information were developed.

WIMEK - SENSE Symposia

EURO-AGRIWAT conference "Water Footprint of agricultural products: progress, challenges and solutions"

07 – 09 March 2016, Wageningen

Co-organised by WIMEK-SENSE

In 2011 a European Concerted Research Action (COST) started, aimed at the Assessment of EUROpean AGRICul-ture WATER use and trade under climate change (EURO-AGRIWAT).

EURO-AGRIWAT intends to prepare and disseminate recommendations and guidelines for enabling a more efficient water resource management in relation with agricultural activities under climate change and variability, and involves collaboration between scientists and stakeholders.

From 7-9 March 2016 the final EURO-AGRIWAT conference was held in Wageningen.

The Transformative Power of Transparency?

An international conference organized by the ENP group (WIMEK-WASS)

24 - 25 June 2016, Wageningen

More than 200 people attended the ENP hosted Disclosing Sustainability Conference in June 2016. Participants addressed assumptions that transparency leads to greater openness and deliberative acts of information disclosure, which empowers those previously uninformed about the sites and sources of environmental gains or losses. Presentations were given across a wide array of environmental challenges and sectors, but focused in particular on: 1. transparency, accountability and empowerment in global environmental governance, 2. Transparency and traceability in commodity chains, and 3. Citizen generated (and citizen-centered) transparency. Linked to the conference was also a summer school entitled Tackling Transparency the Methodological Challenges of Research on Disclosing Sustainability.

Workshop Regional air quality modelling with WRF-Chem: successes, opportunities and challenges

15 – 16 September 2016, Wageningen

Organised by WIMEK PhD candidate Ingrid Super (WUR-MAQ)

The WRF model is used for a wide range of research topics as it contains many options for both meteorology and atmospheric chemistry. Modelling at the urban scale poses some additional challenges. This workshop provided insight in the opportunities that WRF(-Chem) provides for urban modelling in general and more specifically for air quality related research.

Nutrient Pollution in Water Systems: Sustainable solutions for Europe, China and the world

14 December 2016, Wageningen

Organised by WIMEK PhD candidate Maryna Strokal and professor Caroline Kroeze (WUR-WSG).

Speakers: Prof dr Huub Rijnaarts (Environmental Technology group of Wageningen University & Research0, Dr Michelle L. McCrackin (Baltic Sea Centre, Stockholm University), Prof dr Lin Ma (Chinese Academy of Sciences) and Prof dr Wenqi Ma (Agricultural University of Hebei).

SENSE Workshop Circular Economy (13 March 2017, PBL building, The Hague)

Huub Rijnaarts, WIMEK director and chairman of the SENSE Board initiated a SENSE workshop on how SENSE researchers, companies and governments can join forces to assist the transition towards the circular economy. The workshop was organised in close collaboration with the Ministry of Infrastructure and Environment (I&M) and the Netherlands Environmental Assessment Agency (PBL). The workshop was attended by 30 junior and senior SENSE researchers, 11 staff members of I&M, 5 staff members of RWS and 3 staff members of PBL. After 7 plenary pitch presentations on the circular economy by SENSE, I&M, KWR and industry, 19 SENSE PhD candidates presented their research results related to the circular economy in four parallel sessions.

3rd International Conference on Biogas Microbiology (ICBM-3)

01 – 03 May 2017, Wageningen

Organised by PhD candidates and staff members of the WUR-MIB group.

Biogas technology offers unique possibilities to tackle several environmental issues, i.e. energy production, waste treatment, and nutrient recycling. A complex microbial network is involved in the biogas production process, and knowledge on the genetics and physiology of these microorganisms and metabolic interactions in this network is essential for efficient and stable biogas production from waste sources. The Biogas Microbiology Conference offered a common ground for bioprocess engineers and microbiologists to share their knowledge, and gives the opportunity to discuss and focus on important recent developments in biogas microbiology.

BBOS Spring Symposium on Energy Meteorology: From Model Field to Power Yield

11 May 2017, Wageningen

Organised by WIMEK PhD candidates Arjan Droste and Peter Kalverla (WUR, MAQ Group)

This symposium shed some light on the science and policy

of renewable energy such as solar panels and wind turbines. The programme especially focussed on the meteorology, that plays a key role in resource estimation, power prediction and load assessments.

SENSE Symposium Soil contamination: advances and challenges

01 September 2017, Wageningen

Organised by WIMEK PhD candidates Vera Silva, Mousumi Akter, Carlos Faúndez Urbina and Pavan Cornelissen (WUR)

The key topics of this symposium were the transport and fate of contaminants in the soil, the related risk to human health or the environment, and remediation of the soil. The symposium covered both experimental studies and modelling.

International workshop Water Quality: a new challenge for global scale modelling

18 – 21 September 2017, Wageningen

Organised by Dr Nynke Hofstra, WIMEK researcher at the ESA group.

The objective of the workshop was to set an agenda for future modelling efforts that integrate our knowledge on global water quality modelling for various pollutants, in search for sustainable pathways for the long-term future. The workshop focussed on (1) the relevance of global water quality modelling for water security studies and sustainable development goals, (2) the current state-of-the-art (objectives, scales, etc) of the available global water quality models, (3) common denominators, such as input and validation data, drivers (agriculture, sanitation), processes, hydrology, (4) joint development of 'clean water scenarios' to achieve sustainable water futures, and (5) knowledge exchange and lessons learnt.

Social events

WIMEK-SENSE Sustainability BBQ

10 June 2016, Wageningen Campus

Organised by Lieke Melsen, WIMEK PhD candidate.

WIMEK climate movie event: Before the flood

12 December 2016, Filmhuis Movie-W, Wageningen

Organised by the WIMEK PhD Council. This remarkable film takes you on a journey to how climate change affects our environment and what society can do to prevent the demise of endangered species, ecosystems and native communities across the planet. The movie was followed by a short talk and discussion led by a prof.dr. Niklas Höhne.

Proofs of Esteem

VENI, VIDI and ERC Grants

Dr Ingrid Boas (ENP) was awarded a Veni grant under the NWO talent scheme for her research project entitled 'Environmentally-related migration in the digital age'. She is researching the ways in which ICT-enabled information exchange shapes practices and flows of environmentally-related migration.

Dr Nora Sutton (ETE) was awarded the prestigious VENI grant for her project 'Cleaning groundwater of organic micropollutants. Fundamental understanding of biodegradation.' This project aims at understanding the complex set of environmental conditions that selects for micropollutant biodegradation in oligotrophic groundwater. The research aims at elucidating the microbial ecology of groundwater systems as it relates to groundwater composition. To this end, new isotope-based analytical techniques are developed. The Veni project, co-funded by two drinking water organizations and has the ultimate goal of developing groundwater in situ micropollutant bioremediation technologies.

Dr Ingrid van der Laan-Luijkx (MAQ) was awarded a VENI grant for her research project Lungs of the earth: measuring oxygen to unravel the forest carbon balance. The major unknowns in the global carbon cycle are the exchange with the biosphere: photosynthesis and respiration, which are the two largest and most variable fluxes. In the VENI programme (2017-2020), Ingrid van der Laan will provide new insights in the forest carbon balance by separately quantifying photosynthesis and respiration through atmospheric measurements of CO₂ and O₂, and its exchange ratio: the oxidative ratio (OR). She will conduct both field campaigns, and develop a numerical bio-

sphere-atmosphere modelling framework for O₂ and CO₂ exchange.

Such a model currently does not exist, and will allow interpretation of new and existing measurements, and enable upscaling to larger forest areas. Field campaigns are planned for 2018 and 2019 and will take place in a boreal forest in Finland (Hyytiälä), a highly relevant area given the rapid warming of boreal regions under climate change.

Dr Jeroen van der Heijden (ENP) joined ENP with a VIDI grant to research 'Joined-up governance for low-carbon cities'. He is researching how complex urban challenges, including the necessary transition to low-carbon cities can be dealt with through, amongst other arrangements, global city networks.

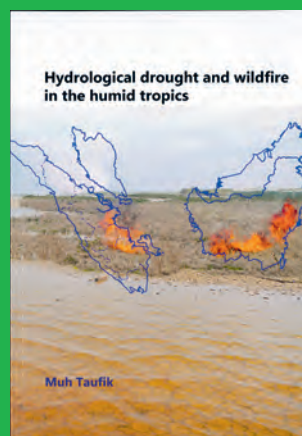
ERC-Advanced grant

Prof. Maarten Krol (MAQ) received a prestigious ERC advanced grant for his research programme Carbonyl Sulfide: New ways of Observing the Climate System (COS-OCS).

The future climate of the Earth strongly depends on the capacity of the global ecological system to sequester atmospheric CO₂, and on the abundance of stratospheric sulphate aerosols (SSA). These aerosols form a layer that resides at about 16 km altitude that, contrary to CO₂, has a cooling effect on the climate. These two climate-regulating mechanisms are intricately linked to an atmospheric gas that makes up only a tiny fraction of the Earth's atmosphere, carbonyl sulphide (COS). Maarten Krol from Wageningen University aims to fundamentally improve our limited understanding of the COS atmospheric budget which would therefore signal a major step forward in our



24/10/2017 | **Goddek, S.**
Opportunities and Challenges of
Multi-Loop Aquaponic Systems



31/10/2017 | **Taufik, M.**
Hydrological drought and wildfire in
humid tropics



01/11/2017 | **Naus, J.**
Smartening Energy Practices: On the
dynamics of households, information
flows and sustainability transitions

ability to diagnose CO₂ uptake and SSA formation. The project also combines innovative modelling and measurements that will eventually allow breakthroughs in the coupled COS and CO₂ budgets, and unlock the potential of COS as a new climate diagnostic (see: <http://cos-ocs.eu>).

PhD awards

During the yearly ISMET congress, PhD candidate **Sam Molenaar (ETE)** won a prize for his 'poster' presentation. Molenaar's research resulted in the design of a completely new rechargeable battery by combining two existing technologies: The Microbial fuel cell and microbial electrosynthesis.

During the Wetsus Congress of last October PhD researcher **Jan Willem van Egmond (ETE)** received the Marcel Mulder Award 2016. This annual prize is awarded to the 'best Wetsus scientist' of that year.

A completely other order of esteem deserves the WRM PhD student, **Wahib Al-Qubatee**, who despite the civil war that devastate his home country, Yemen, managed to complete his field research and to publish his research on a participatory rural appraisal to assess groundwater resources in Al-Mujaylis, Tihama Coastal Plain, Yemen in Water International.

Other proofs of esteem

ETE

David Strik and Mathijs van der Zwart were awarded an STW Open Mind fellowship with the idea of food production by 'dark' photosynthesis in 2016.

Annemerel Mol has won the UFW-KLV thesis Award 2015-2016 in the domain environmental sciences for her MSc thesis 'Bioelectrochemical battery – Proof of concept'.

Victor Ajao was awarded the best oral presentation in the IWA Young Water Professionals conference in Belgium in 2017.

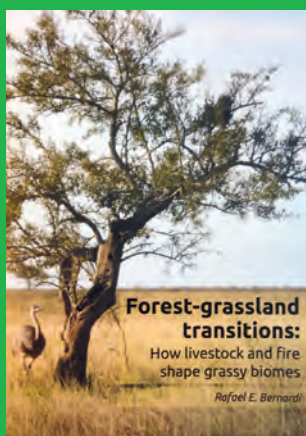
MAQ

Prof. Bert Holtslag (MAQ) was given the Research Award of the Netherlands Organization for the Advancement of Meteorology (NVBM) in 2016 for his work and outreach on atmospheric boundary layers. This award is given once every 5 year, see <https://www.nvbm.nl/nvbm/nvbm-awards/winnaars-2016>

WRM

Dr Henk Ritzema (WRM): on the occasion of the 13th ICID International Drainage Workshop held in Ahwaz, Iran, 4-7 March, 2017, Dr. Ritzema received an award from the Deputy Ministry of Energy for Water and Wastewater Affairs and Chairman of IRNCID for his dedication, excellence and outstanding lifelong performance in agricultural drainage.

In 2017 WRM postdoc Dr Odongo received a WIMEK Postdoc Talent award for his project Lessons from LAKES - Lake Assessments using Knowledge from Earth Observation and Statistics. He studies how Lake-level fluctuations have large impacts on society.



15/11/2017 | **Bernardi De León, R.E.**
Forest - grassland transitions: How livestock and fire shape grassy biomes



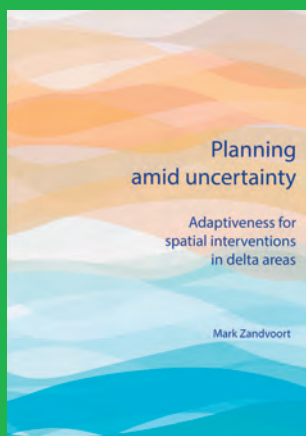
15/11/2017 | **Bernardi De León, R.E.**
Forest - grassland transitions: How livestock and fire shape grassy biomes



05/12/2017 | **Starkloff, T.**
Winter hydrology and soil erosion processes in an agricultural catchment in Norway

The WIMEK/SENSE PhD Council

The WIMEK PhD Council represents all PhD candidates involved in the Graduate School WIMEK at Wageningen University. The main aims of the council are: (1) being a bridge between all PhD candidates and the WIMEK Board; (2) providing PhD candidates relevant information of new developments in WIMEK and asking their opinions; and (3) creating a strong work of PhD candidates to collaboratively find solutions for problems regarding education, supervision and planning that PhD candidates might face during their research project. The WIMEK PhD council has six members who meet every month. The council is closely involved with the WIMEK management and a representative of the council joins the WIMEK Board meetings and participate in both the SENSE PhD council as the Wageningen PhD council.



08/12/2017 | **Zandvoort, M.**
Planning amid uncertainty : Adaptive-
ness for spatial interventions in delta
areas



08/12/2017 | **Puijenbroek, M.E.B.
van**
Dunes above and beyond - The
interactions between ecological and
geomorphological processes during
early dune development



15/12/2017 | **Laarhoven, B.**
Valorisation of waste streams from
by-product to worm biomass

How to contact us

WIMEK

WIMEK Board (per 01-01-2018):

Prof. A.A.M. (Bert) Holtslag (chair), professor of Meteorology and chair of the Meteorology and Air Quality Group (MAQ)

Prof. P.J. (Paul) van den Brink, professor of chemical stress ecology at Wageningen Environmental Research and the Aquatic Ecology and Water Quality Management Group (AEW)

Prof. S.R. (Simon) Bush, professor and chair of the Environmental Policy Group (ENP)

Prof. C. (Carolien) Kroeze, professor and chair of the Water Systems and Global Change Group (WGC)

Prof. R. (Rik) Leemans, professor and chair of the Environmental Systems Analysis Group (ESA)

Prof. A.J.M. (Fons) Stams, professor of Microbial Physiology at the Laboratory of Microbiology (MIB)

PhD candidate (representative of the WIMEK PhD council)

Scientific Director: Professor H.H.M. (Huub) Rijnaarts (Huub.Rijnaarts@wur.nl)

Executive Secretary: Mr. J. (Johan) Feenstra (Johan.Feenstra@wur.nl)

WIMEK PhD co-ordinator & PhD advisor: Dr. M.M.C. (Monique) Gulickx (Monique.Gulickx@wur.nl)

WIMEK Secretariat & website: Ir. M. (Marjolijn) Dannenburg (Marjolijn.Dannenburg@wur.nl)

WIMEK PhD mentor: Dr L.C.P.M. (Lodewijk) Stuyt (lodewijk.stuyt@wur.nl)

Financial issues: Mr. P.G. (Peter) van der Plas

WIMEK PhD Council: WiPCo@wur.nl

Address:

WIMEK, PO Box 47, 6700 AA, Wageningen

Office: Room A229, LUMEN Building (WUR building 100);

Droevendaalsesteeg 3a, 6708PD, Wageningen.

Phone: +31 317 484836 (Mr. Johan Feenstra)

SENSE

Deputy Director and SENSE Director of Education:

Dr. Ad van Dommelen (Ad.van.Dommelen@vu.nl)

Coordinator SENSE Research School:

Mr. J. (Johan) Feenstra (Johan.Feenstra@wur.nl)

SENSE website: www.sense.nl

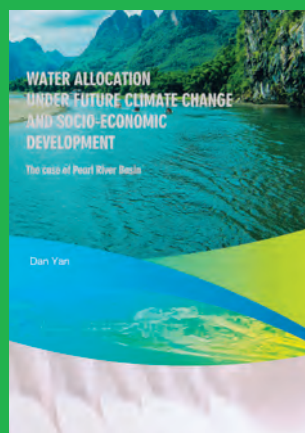
International Advisory Board (IAB) WIMEK

Prof. Alex Zehnder, chair (Emeritus Professor of Environmental Biotechnology at ETH Zurich);

The composition of the other members of the IAB will be renewed soon.



20/12/2017 | **Yao, M.**
Water use in a heavily urbanized delta : scenarios and adaptation options for sectorial water use in the Pearl River Basin, China



21/12/2017 | **Yan, D.**
Water allocation under future climate change and socio-economic development

ANNEX 1: WIMEK Research Groups

Code	Chair Group	WIMEK Research Group Leader(s)	%
AEW	Aquatic Ecology and Water Quality Management Group	Prof. M. (Marten) Scheffer & Prof. A.A. (Bart) Koelmans	100%
BCT	Biobased Chemistry & Technology Group	Prof. J.H. (Harry) Bitter Dr. K. (Karel) Keesman	10%
ENP	Environmental Policy Group	Prof. A.P.J. (Arthur) Mol (until 28-05-2015) Prof. S.R. (Simon) Bush (from 01-06-2016) & Prof. G. (Gert) Spaargaren	50%
ENR	Environmental Economics and Natural Resources Group	Prof. E.C. (Ekko) van Ierland	35%
ESA	Environmental Systems Analysis Group	Prof. R. (Rik) Leemans	100%
ESS	Earth System Science Group	Prof. C. (Carolien) Kroeze (from 01-04-2016)	100%
ETE	Environmental Technology Group	Prof. H.H.M. (Huub) Rijnaarts & Prof. C.J.N. (Cees) Buisman	100%
HWM	Hydrology and Quantitative Water Management Group	Prof. R. (Remko) Uijlenhoet	100%
LAR	Landscape Architecture Group	Prof. A. (Adri) van den Brink	100%
MAQ	Meteorology and Air Quality Group	Prof. A.A.M. (Bert) Holtslag & Prof. M. (Maarten) Krol	100%
MIB	Microbiology Group (only Environmental Microbiology part)	Prof. W.M. (Willem) de Vos & Prof. A.J.M. (Fons) Stams Prof. H. (Hauke) Smidt	30%
NCP	Nature Conservation and Plant Ecology Group	Prof. F. (Frank) Berendse (until 01-07-2015) Prof. D. (David) Kleijn (from 01-07-2015)	20%
SLM	Soil Physics en land Management Group	Prof. C.J. (Coen) Ritsema Prof. S.E.A.T.M. (Sjoerd) van der Zee	70%
SOQ	Soil Chemistry and Chemical Soil Quality Group	Prof. R.N.J. (Rob) Comans	100%
TOX	Toxicology Group	Prof. I.M.C.M. (Ivonne) Rietjens & Dr. N.W. (Nico) van den Brink	20%
WRM	Water Resources and Management Group	Prof. P.J.G.J. (Petra) Hellegers	20%

(Endnotes)

- 1 Hughes, TP, Barnes, ML, Bellwood, DR, Cinner, JE, Cumming, GS, Jackson, JBC, Kleypas, J, van de Leemput, IA, Lough, JM, Morrison, TH, Palumbi, SR, van Nes, EH and Scheffer, M. Coral reefs in the Anthropocene. *Nature* 546, 82–90 (2017).
- 2 van de Leemput, IA, Hughes, TP, van Nes, EH and Scheffer, M. Multiple feedbacks and the prevalence of alternate stable states on coral reefs. *Coral Reefs* 35, 857–865 (2016).
- 3 Gijzel, SMW, van De Leemput, IA, Scheffer, M, Roppolo, M, Olde Rikkert, MGM, Melis, RJF and Kritchevsky, S. Dynamical resilience indicators in time series of self-rated health correspond to frailty levels in older adults. *J Gerontol A Biol Sci Med Sci* 72, 991–996 (2017).
- 4 Olde Rikkert, MGM et al. Slowing down of recovery as generic risk marker for acute severity transitions in chronic diseases. *Crit. Care Med.* 44, 601–606 (2016).
- 5 Flores, BM, Holmgren, M, Xu, C, van Nes, EH, Jakovac, CC, Mesquita, RCG and Scheffer, M. Floodplains as an Achilles' heel of Amazonian forest resilience. *Proc. Natl. Acad. Sci.* 114, 4442–4446 (2017).
- 6 Nyborg, K et al. Social norms as solutions. *Science* 354, 42–43 (2016)
- 7 Besseling, E., Quik, J.T.K., Sun, M., Koelmans, A.A. 2017. Fate of nano- and microplastic in freshwater systems: A modeling study. *Environmental Pollution*, 220, 540-548
- 8 Kooi, M., Van Nes, E.H., Scheffer, M., Koelmans A.A. 2017. Ups and Downs in the Ocean: Effects of Biofouling on Vertical Transport of Microplastics *Environ. Sci. Technol.*, 51, 7963–7971.
- 9 Koelmans, A.A., Kooi, M., Lavender-Law, K., Van Sebille, E. 2017. All is not lost: Deriving a top-down mass budget of plastic at sea. *Environ. Res. Lett.*, 12 114028, <https://doi.org/10.1088/1748-9326/aa9500>
- 10 Besseling, E., Foekema, E.M., van den Heuvel-Greve, M.J., Koelmans, A.A. 2017. The effect of microplastic on chemical uptake by the lugworm *Arenicola marina* (L.) under environmentally relevant conditions. *Environ. Sci. Technol.* 51, 8795–8804.
- 11 Herzke, D., Anker-Nilssen, T., Haugdahl, T., Nøst, T., Götsch, A., Christensen-Dalsgaard, S., Langset, M., Fangel, K., Koelmans, A.A. 2016. Negligible Impact of ingested microplastics on tissue concentrations of persistent organic pollutants in Northern Fulmars of coastal Norway. *Environ. Sci. Technol.* 50, 1924–1933
- 12 Koelmans, A.A., Bakir, A., Burton, G.A., Janssen, C.R. 2016. Microplastic as a Vector for Chemicals in the Aquatic Environment. Critical Review and Model-Supported Re-interpretation of Empirical Studies. *Environ. Sci. Technol.* 50, 3315–3326.
- 13 Koelmans, A.A., Besseling, E., Foekema, E., Kooi, M., Mintenig, S., Ossendorp, B.C., Redondo-Hasselerharm, P.E., Verschoor, A., van Wezel, A.P., Scheffer, M. 2017. Risks of Plastic Debris: Unravelling fact, opinion, perception and belief. *Environ. Sci. Technol.* 51, 11513–11519.
- 14 Van den Brink, P.J., J.M. Van Smeden, R.S. Bekele, W. Dierick, D.M. De Gelder, M. Noteboom and I. Roessink (2016). Acute and chronic toxicity of neonicotinoids to nymphs of a mayfly species and some notes on seasonal differences. *Environ. Toxicol. Chem.* 35: 128–133
- 15 Focks, A. D. Belgers, M-C. Boerwinkel, L. Buijse1, I. Roessink, P.J. Van den Brink (subm.). Calibration and validation of toxicokinetic-toxicodynamic models for three neonicotinoids and some aquatic macroinvertebrates
- 16 Sumon, K.A., A.K. Ritika, E.T.H.M. Peeters, H. Rashid, R.H. Bosma, S. Rahman, K. Fatema and P.J. Van den Brink (2018). Effects of imidacloprid on the ecology of sub-tropical freshwater microcosms. *Environmental Pollution* 236: 432-441
- 17 Vijver, M.G., E.R. Hunting, T.A.P. Nederstigt, W.L.M. Tamis, P.J. van den Brink and P.M. van Bodegom (2017). Post-registration monitoring of pesticides is urgently required to protect ecosystems. *Environ. Toxicol. Chem.* 36: 860-865.
- 18 How constraints affect the hunter's decision to shoot a deer FK Diekert, A Richter, IM Rivrud, A Mysterud, *Proceedings of the National Academy of Sciences* 113 (50), 14450-14455
- 19 Project conducted by S. Gabbert (Wageningen University & Research, The Netherlands), Stefan Hahn (Fraunhofer-ITEM, Germany), Michael Klein (Fraunhofer-IME, Germany), Monika Nendza (Analytic Laboratory Luhnstedt, Germany), Frans Oosterhuis (Vrije Universiteit Amsterdam, The Netherlands).
- 20 Gabbert, S., Hahn, S., Klein, M., Nendza, M., Oosterhuis, F. (2018): "Approach for the Evaluation of PBTs Subject to Authorisation and Restriction Procedures in the context of Socio-economic analysis". European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Brussels. DOI: 10.2873/33669.
- 21 <https://www.wur.nl/en/Expertise-Services/Chair-groups/Agrotechnology-and-Food-Sciences/Sub-department-of-Environmental-Technology/Water-Nexus.htm>
- 22 Bense, V. F., & Kurylyk, B. L. (2017). Tracking the subsurface signal of decadal climate warming to quantify vertical groundwater flow rates. *Geophysical Research Letters*, 44, 12,244–12,253. <https://doi.org/10.1002/2017GL076015>

(Endnotes)

- 23 Pedruzo Bagazgoitia X. et al. (2017) Direct and Diffuse Radiation in the Shallow Cumulus–Vegetation System: Enhanced and Decreased Evapotranspiration Regimes. *Journal of Hydrometeorology* 18, 1731-1746.
- 24 Sikma M. et al. (2017) Interactions between vegetation, atmospheric turbulence and clouds under a wide range of background wind conditions. *Agricultural and Forest Meteorology* (online).
- 25 Lorente, A., Folkert Boersma, K., Yu, H., Dörner, S., Hilboll, A., Richter, A., Liu, M., Lamsal, L. N., Barkley, M., De Smedt, I., Van Roozendaal, M., Wang, Y., Wagner, T., Beirle, S., Lin, J.-T., Krotkov, N., Stammes, P., Wang, P., Eskes, H. J., and Krol, M.: Structural uncertainty in air mass factor calculation for NO₂ and HCHO satellite retrievals, *Atmos. Meas. Tech.*, 10, 759-782, <https://doi.org/10.5194/amt-10-759-2017>, 2017.
- 26 Veenendaal, EM. et al. (2018), On the relationship between fire regime and vegetation structure in the tropics. *New Phytol*, 218: 153–166. doi:10.1111/nph.14940
- 27 Van der Sluis T. et al (2017) Chobe District Integrated Land Use Plan. *Alterra-rapport-Wageningen University and Research Centre* 2813.
- 28 Schellekens, J., Buurman, P., Kalbitz, K., van Zomeren, A., Vidal-Torrado, P., Cerli, C., Comans, R.N.J. (2017) Molecular Features of Humic Acids and Fulvic Acids from Contrasting Environments. *Environ. Sci. Technol.* 51, 1 330-1339.
- 29 Hiemstra, T., Zhao, W. (2016) Reactivity of ferrihydrite and ferritin in relation to surface structure, size, and nanoparticle formation studied for phosphate and arsenate *Environmental Science: Nano*, 3(6), 1265-1279.
- 30 RITZEMA, H. P. 2016. Drain for Gain: Managing salinity in irrigated lands. *Agricultural Water Management*, 176, 18–28.
- 31 van Vliet MTH, Flörke M, Wada Y. Quality matters for water scarcity. *Nature Geoscience* 2017; 10: 800.
- 32 Moene, Arnold and Jordi Vila (2017). Met je hoofd in de wolken – ontdek welke processen de vorming van wolken bepalen. *NVOX* 2017(10) 580-581.
- 33 Brand, E., de Nijs, T.C.M., Dijkstra, J.J., Comans, R.N.J. (2016) A novel approach in calculating site-specific aftercare completion criteria for landfills in The Netherlands: Policy developments. *Waste Management* 56, 255–261.
- 34 Buda, A.R., G.F. Koopmans, R.B. Bryant, and W.J. Chardon. 2012. Emerging technologies to remove nonpoint phosphorus from surface water and groundwater. *Journal of Environmental Quality* 41, 621-627.
- 35 Chardon, W.J., J.E. Groenenberg, E.J.M. Temminghoff, and G.F. Koopmans. 2012. Use of reactive materials to bind phosphorus. *Journal of Environmental Quality* 41, 636-646.
- 36 Groenenberg, J.E., W.J. Chardon, and G.F. Koopmans. 2013. Reducing phosphorus loading of surface water using iron-coated sand. *Journal of Environmental Quality* 42, 250-259.
- 37 see: <https://www.rijksoverheid.nl/regering/bewindspersonen/carola-schouten/documenten/kamerstukken/2017/12/21/beantwoording-kamervragen-over-het-bericht-de-overheid-is-de-regie-kwijt-in-het-bestrijden-van-overlast-van-ratten>
- 38 VAN OEL, P.R., MARTINS, E.S.P.R., COSTA, A.C. WANDERS, N. & VAN LANEN, H.A.J. (2018; accepted manuscript) Diagnosing Drought using the Downstreamness Concept: the effect of reservoir networks on drought evolution. *Hydrological Sciences Journal*
- 39 Nb, the MOOC is still open for enrolment, but no moderation is provided and students cannot get a certificate.

Colophon

Text editor

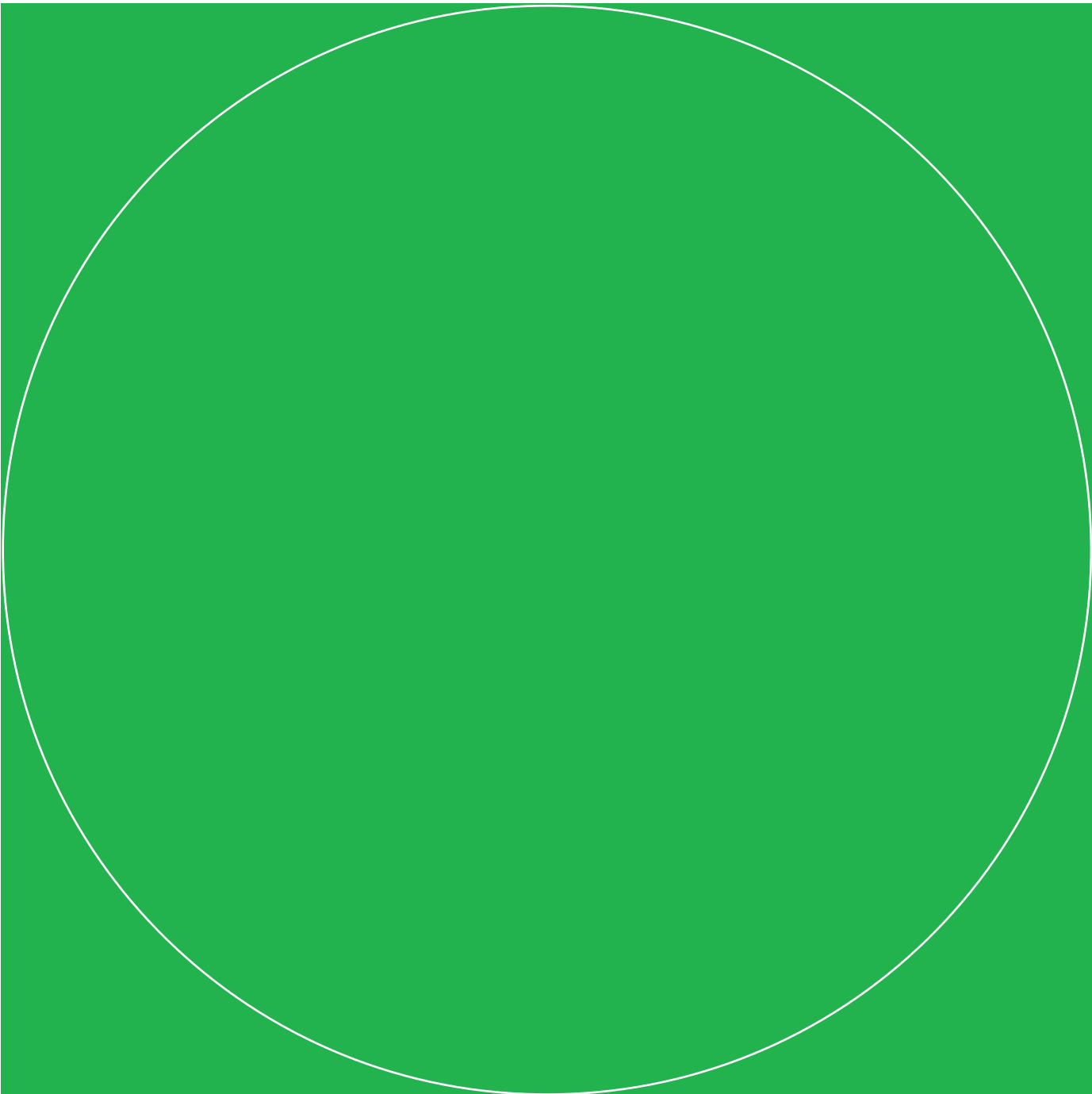
WIMEK | Mr. Johan Feenstra

Photography

Front cover: Dreamstime, Madagascar

Design & print

GAW ontwerp+communicatie



WAGENINGEN UR

For quality of life