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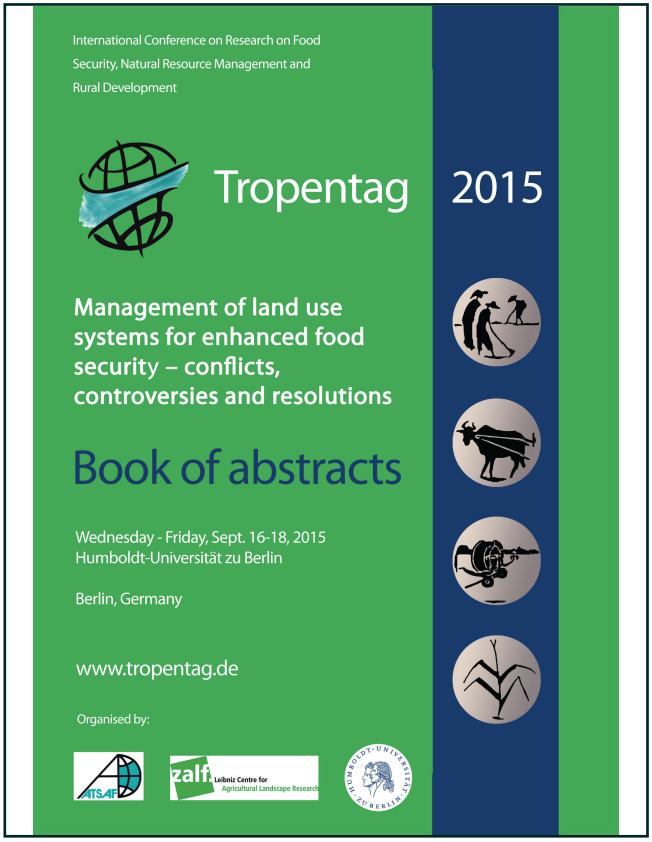

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Natural resource management under climate pressure

Land and water management

Oral Presentations

Posters

Livestock and Water Linkages - Opportunities for Sustainable Intensification

JENS HEINKE[1], MATS LANNERSTAD[2], MARIO HERRERO[3]

[1] *Potsdam Institute for Climate Impact Research (PIK), Germany*

[2] *International Livestock Research Institute (ILRI), Livestock System and Environment (LSE), Kenya*

[3] *Commonwealth Scientific and Industrial Research Organization (CSIRO), Food Systems and the Environment, Australia*

Large quantities of water are appropriated to produce the feed annually consumed in global livestock production. Rising concerns about increasing competition for water resources and projected increase in demand for livestock products make it imperative to look for strategies to sustainably increase livestock production, with water being one key natural resource to consider.

Using a combination of different datasets, a mechanistic livestock model, and a dynamic vegetation model, we estimate the annual consumptive water use (CWU) in the global livestock sector associated with crops and fodder cultivated on cropland and grazed biomass from pastures.

We go beyond earlier studies and explicitly account for the generally lower suitability of pasture CWU for crop production. Thus, from a water resource perspective, we can demonstrate that ruminant rearing can be a quite resource efficient alternative, in many cases even a better choice than to grow crops.

In the next step we use our analytic framework to quantify the effect of increasing the amount of crop-based feed to the diet of ruminants. For dairy cattle the results show an increase in protein production per m^3 of cropland CWU that lie in the upper range of protein water productivity for crops. For the less efficient beef cattle production, estimated increases correspond to the lower range for crops, but generally exceed protein water productivity of pigs and poultry.

For scenarios with constant global production of both the dairy and beef sectors, we find that the increase in productivity in some cases can result in an overall decreased pressure on water resources, despite the increase in cropland CWU needed to produce the additionally required crop-based feed. Whether a shift towards more cropland CWU can help to decrease pressure on water resources essentially depends on the amount and suitability of the saved pasture CWU for crop production.

Keywords: Consumptive water use, livestock, sustainable intensification, water productivity

Contact Address: Jens Heinke, Potsdam Institute for Climate Impact Research (PIK), Telegraphenberg A62, 14473 Potsdam, Germany, e-mail: heinke@pik-potsdam.de

Reversing Natural Degradation into Resilience: The Afar Case

ELISABETH VAN DEN AKKER[1], WOLF BERDEL[2], JEMAL NUR MURELE[1]
[1]*Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), GIZ Ethiopia, Ethiopia*
[2]*Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Rural Development and Agriculture, Ethiopia*

In Afar region, pastoralists and agro-pastoralists, a semi-mobile population, belong mostly to hierarchically structured clans. They use traditional farming systems that were previously sustainable. More than half of the 1.4 million inhabitants (56 %) live below the poverty line. The main cause of the increasing degradation of natural resources is their excessive use, which is on the rise due to strong population growth, high livestock density and reduced access to land. The validity of former land-use arrangements is being weakened by conflicts among clans and competition between traditional ownership rights and the official land ownership claims of the government. Increasing degradation of vegetation and soils is accompanied by lower yields. Pasture land for herds is reduced; some areas are no longer available for production at all, and the growth of fodder plants decreases both in quantity and quality. Crust formation on the soil surface reduces water infiltration and most of the rain runs off. This surface water rapidly accumulates and causes deep erosion gullies through which the water quickly drains off the land. Groundwater levels drop, making less water available for people, animals and plants. Droughts and floods lead to crop failure and the loss of animals. Acute malnutrition is therefore widespread in the Afar Region, which especially effects women, infants and young children due to insuffient diets. Also conflicts are getting more.
Approach: GIZ implements a new approach to Ethiopia, using soil and water harvesting methods successfully tested in the Sahel. In the fertile but degraded valley areas, the effects of strong runoff of rain water and sporadic flash floods are reversed by a holistic approach based on water-spreading weirs. This leads to the rehabilitation of the valleys which can then be used for cultivation of animal feed and food and provide access to water for people and animal. River banks with their trees are protected and the groundwater level rises providing water for shallow wells. This approach combined with intensive training strengthens the resilience of the pastoralists and agro-pastoralists to the impacts of climate change offering economic options and reducing conflicts.

Keywords: Food security, gender, reduce conflicts, soil rehabilitation

Contact Address: Elisabeth van den Akker, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), GIZ Ethiopia, Rahem Building, Addis Ababa, Ethiopia, e-mail: elisabeth.akker-van@giz.de

Agricultural Water Productivity Across Landscape Positions and Management Alternatives

TEKLU ERKOSSA JIJO[1], AMARE HAILESLASSIE[2], TILAHUN AMEDE[3]

[1] *International Water Management Institute (IWMI), Office for East Africa and Nile Basin, Ethiopia*

[2] *International Water Management Institute (IWMI), Ethiopia*

[3] *International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Agroecosystem Theme, Kenya*

We examine the variation in water productivity across landscape positions as influenced by slope and prevailing crop management practices for the major crops grown in the Blue Nile Basin. Two watersheds were selected in the basin and each was divided into three landscape positions; summit, backslope and footslope. For each position, crops that together cover at least 70 % of that particular area were selected and monitored on five farmers' fields, in terms of variety selection and crop management practices. Soil and climate data for each landscape position were used to estimate crop water requirements of nine crops (maize (*Zea mays* L.), wheat (*Triticum aestivum* L), barley (*Hordeum vulgare*), potato (*Solanum tuberosum*), tef (*Eragrostis tef* Zucca), sorghum (*Sorghum bicolor*), finger millet (*Eleusine coracana*), niger seed (*Guizotia abyssinica*) and sesame (*Sesamun indicum*)). The effective rainfall during the growing period was estimated using FAO-CROPWAT model. The feed value of the crop residues was assessed under three livestock breeds and feeding scenarios. We found that water productivity was significantly affected by the landscape positions, crop type and management practices. Water productivity was the lowest in the backslope area, which is characterised by steep slopes and severe soil erosion. Irrespective of the landscape positions, improved crop varieties and livestock breeds and improved management practices substantially increased water productivity of the crop-livestock system. Widespread adoption of these improved options tailored for the landscape positions may significantly enhance income and livelihoods of the farming communities, provided their access to input and output markets is facilitated. This underpins the need for rigorous enforcement of the land use policy that favours the use of land according to its potentials and with suitable management practices.

Keywords: Backslope, blue Nile Basin, CROPWAT, Ethiopia, footslope, land use, summit

Contact Address: Teklu Erkossa Jijo, International Water Management Institute (IWMI), Office for East Africa and Nile Basin, P.O. Box 5689, Addis Ababa, Ethiopia, e-mail: t.erkossa@cgiar.org

Watershed Management: Efforts Beyond Plot/Farm Level in the Sudanian Zone of Mali: Review of Practices

Birhanu Zemadim Birhanu, Murali Khrishan Gumma
International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Resilient Dryland Systems, Mali

Most agronomic researches in support of development in Mali have emphasised on farm-level productivity issues with limited scope for managing interactions among components and actors beyond the level of the farm. While component integration at farm level addresses the interaction of components within a single farm, integration at watershed level addresses component interactions between farms and between farms and other landscape units (forests, springs, ground water sources, rivers etc.). Obtaining maximum benefits out of these component interactions requires the people of the watershed to collaborate with each other and often with outside parties providing services as well. The current paper discuses mechanisms of establishing a community managed watershed learning site in the Sudanian zone of Mali for research and capacity building. Review of the existing problems of rainfed agricultural practices at plot/farm level was conducted to define major constraints and methodologies to achieve a collective action through community participation. Biophysical characterisation was conducted using data collected from climate, soil, shallow wells, rivers and available intervention measures in the study area. New sets of hydro-meteorological monitoring stations that include weather station, ordinary rain gauges, soil moisture and ground water monitoring were established to generate new set of data. Remote sensing based study of land use / land cover (LULC), changes in LULC over time (1991, 2002, and 2013) was conducted using Landsat imagery to quantify changes over time and evaluate post intervention changes. Steady increase in cropland has been observed from 1991 to 2013 from 1618 ha to 2498 ha. This is due to increased availability of water from shallow wells and farm level constructed contour bunds which have increased over time. The role of NARS as a reliable partner was assessed to develop sustainable watershed programs. The paper concludes with a discussion on key implications of the methodology, policy frameworks and further actions for watershed development programme in Mali.

Keywords: Agricultural productivity, land use/land cover, Mali, watershed management

Contact Address: Birhanu Zemadim Birhanu, International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Resilient Dryland Systems, BP 320, Bamako, Mali, e-mail: z.birhanu@cgiar.org

Conflict Potential over Water Resources and Effects of the Water Management at the Bathi River

SEBASTIAN FABIAN ZASTRUZNY[1], ANN-CHRISTIN STRUWE-VOSCUL[2], CHRISTINA NATALIE KOMPF[1], CHRISTIAN BRYN[1]

[1] *University of Copenhagen, Dept. of Geoscience and Natural Resource Management, Denmark*

[2] *University of Copenhagen, Dept. of Plant and Environmental Sciences, Denmark*

Water is one of the most substantial resources for life. It is under threat by different effects, which include, but are not limited to: Anthropogenic pollution, deforestation, higher demand and climate change. Communities affected by changing water patterns are exposed to higher stresses, which may lead to increased conflict potential. The township of Kimende, south of the Aberdare Ranges in Kenya has high precipitation and is not yet prone to water scarcity. The Bathi River, which springs north of the township, supports many adjacent farmers and is a tributary feeding the Athi-Galana River.

The willingness of investment is restricted to water abstraction, like. e.g. pumps, but is not expanded to conservation, as e.g. by higher efficient irrigation techniques; this may lead to a situation where water scarcity becomes a hindering factor for economic growth. Illegal activities such as farming close to the stream and construction of dams without permits provide potential local conflicts between farmers. Forested areas between Kimende and Kagwe prevent from regional conflicts, since discharge increases significantly after the forest.

Local farmers report uniformly reduced discharge during the last years. Quality changes are mostly perceived as increased sediment load in the stream. The awareness of the connection between personal practises and environmental impacts increases with education.

Attempts to manage the water resources fail with the improper implementation and enforcement of laws and the poor acceptance of trainings and education by farmers. Key challenges lie in the communication between authorities and farmers to sensitize for individual impacts on the water resources.

Keywords: Bathi River, conflict, irrigation, Kenya, Kimende, management, water scarcity

Contact Address: Sebastian Fabian Zastruzny, University of Copenhagen, Dept. of Geoscience and Natural Resource Management, Øster Voldgade 10, 1350 Copenhagen K, Denmark, e-mail: qnb322@alumni.ku.dk

Application of Water Recovery Option for Agricultural Use in Developing Countries: Case Study of a Nigerian Community

PRAISEGOD EMENIKE[1], IMOKHAI TENEBE[1], DAVID OMOLE[1], JULIUS NDAMBUKI[2], ADEBANJI OGBIYE[1], ADEBAYO SOJOBI[3]

[1]*Covenant University, Civil Engineering, Nigeria*

[2]*Tshwane University of Technology, Civil Engineering, South Africa*

[3]*Landmark University, Civil Engineering, Nigeria*

Africa's current population of 1 billion people is estimated to increase to 1.8 billion in 2050. This compliments the fastest growing population rate which stands at 2.4 %. Moreover, 40 % of Africa's land is arid while another 27 % is desert leaving a common conclusion that water is a crucial resource with tremendous implication on African development. The rapid urbanisation and growing population in African cities has resulted in new water management challenges. About 85 % of water in Africa is used on agriculture. Only 10 % and 5 % are used in households and industries, respectively. The objective of this study was to appraise the different methods available for water collection, treatment and reuse for agricultural purposes in sub-Saharan Africa. The study involved the assessment of available methods used by farmers for the promotion of agriculture. The study deployed the use of in-depth interviews, onsite investigation and group discussions in various areas in a typical semi-urban city in southwest Nigeria. The procedure combines descriptive data on the amount of water used per day on farms, sources of the water used, purpose of the water used and the size of the farm. Results of this study showed that a comparatively large volume of water being used for agricultural sustenance is withdrawn from natural aquifer storages. This poses a challenge and threatens global effort of achieving the United Nation's water-related Millennium Development Goals (MDG 7c) in developing countries aimed at making potable water available for millions of people. It was concluded that a sustainable, de-centralised wastewater treatment plant can be deployed for irrigation purposes in order to reduce pressure from agriculture on groundwater resources and, at the same time, encourage artificial recharge of wells. Also, adequate and efficient water management procedures which would help to overcome emerging water challenges were proposed.

Keywords: Agriculture, Nigeria, reuse, treatment, wastewater

Contact Address: David Omole, Covenant University, Civil Engineering, Department of Civil Engineering, 112101 Ota, Nigeria, e-mail: gbengaomole@googlemail.com

Streamflow and Lake Water Level Changes and their Attributed Causes in Eastern and Southern Africa

MEIKE PENDO SCHÄFER[1], OTTFRIED DIETRICH[1], BONIFACE MBILINYI[2]

[1]*Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Landscape Hydrology, Germany*

[2]*Sokoine University of Agriculture, Tanzania*

Over the last century, changes in the water balance of river basins have been observed in many African countries, often resulting in water scarcity. Agricultural development hereby often has a direct impact on basin water resources. On the other hand, sufficient water availability is a pre-condition for sustained agricultural production and food security.

The presented review was conducted in frames of the BMBF funded Trans-SEC project (FKZ: 031A249A). It aims at compiling information on water resources development in Eastern and Southern Africa over the past century, and systematically analysing the obtained data base for patterns, trends and correlations between the nature and quantity of the described changes, as well as the attributed reasons.

The findings indicate that anthropogenic actions, foremost land use change and water abstractions for agriculture, are the primary drivers of change in drainage basin water balance and commonly associated with increased runoff and flooding as well as decreased dry season flow. The described pressures in Eastern and Southern Africa are mainly driven by population growth, whereby the vast majority of agricultural activities are conducted by small-scale subsistence farmers. Already, conflicts between the use of scarce land and water resources are evident, which are often further amplified by the expanse of irrigated cash crop and intensified food crop cultivation.

The regions with the reportedly most intense changes and highest number of water conflicts comprise the northern Rift Valley, and an area stretching from Lake Victoria and the Southern Rift Valley region towards the Indian Ocean coast in Tanzania. With respect to the sustainable enhancement of food security, colliding stakeholder interests here need to be gauged against the limits of available natural resources, underlining the need to diligently consider agricultural development strategies in regard to the available natural, and especially water, resources.

Keywords: Agricultural development, climate change, floods, land use change, water resources, water scarcity

Contact Address: Meike Pendo Schäfer, Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Landscape Hydrology, Eberswalder Str. 84, 15374 Müncheberg, Germany, e-mail: meike.schaefer@zalf.de

Role of Drainage in Managed Agrosystems Affected by Technical Changes: Case Study of Gharb's Irrigated Area, Morocco

HAYET DJEBBI

SupAgro Montpellier/Copenhagen University, Dept. of Life Sciences, France

The drip irrigation technique is currently spreading at high speed around the world, including the Maghreb. This dynamic is observed among farmers outside irrigated areas as for those in the large irrigation schemes, with strong state's financial support for farmers to access these facilities (grants for collective or individual conversion). The irrigation drip, unlike the surface flow irrigation, brings a small and regular amount of water at the foot of the plant, and thus requires more drainage system to drain excess water. However, drainage as designed in large irrigation schemes, also played a role in the mastery of salinity on irrigated soils. Thus, the monthly monitoring of land (climate and water parameters) with the modelling of hydrosaline balance (SALTIR-SOIL) highlights the interest of the drainage in semi-arid areas for the control of salinity, and the interest to equip some drained plots with a measuring device.

Our study analyses the role of drainage on soil quality, agricultural production and the surrounding ecosystems in irrigated or remediated systems under constraints related to technical changes: the state of knowledge, practices and perceptions of farmers in the plain of Gharb in Morocco.

The research aims primarily a review of literature on traditional techniques on alternative drainage, to take advantages of alternative practices, and failures related to absence or unsuitable drainage design.

For the investigation open-ended interviews, surveys, PRA methods and natural science methods such as soil salinity detection were carried out between 20th April 2015 and 15 August 2015 in Gharb zone, Morocco.

The initial findings show that, in a food resource security context, the question of the re-engineering of former hydraulic schemes that control the ion and water balances in agro-hydrological systems seems major to ensure equitable sharing of natural resources, and the preservation of biodiversity.

Geographical information on the biophysical environment and irrigation practices may help to identify risk areas. The objective is to characterise salinity processes and to propose technical methods of land segmentation and water management according to the risk factors involved.

Keywords: Drainage, farmers perception, food security, Gharb irrigated area, irrigation practices, managed agrosystems, Morocco, salinity, technical changes

Contact Address: Hayet Djebbi, SupAgro Montpellier/Copenhagen University, Dept. of Life Sciences, C201 2 Place Pierre Viala, 34060 Montpellier, France, e-mail: hayet.djebbi@yahoo.fr

Assessment of Irrigation Schemes in Turkey: Cropping Intensity, Irrigation Intensity and Water Use

CAGATAY TANRIVERDI[1], HASAN DEGIRMENCI[2]

[1] *University of Kahramanmaras Sütcü Imam, Agricultural Engineering, Turkey*

[2] *University of Kahramanmaras Sütcü Imam, Biosystem Engineering, Turkey*

In Turkey, 1/3 of total agricultural areas have the potential to be economically irrigated. However, only half of this avaliable areas are open for irrigation and when irrigation intensity are taken into account, nearly 65% of the areas that are open for irrigation are actually irrigated. In our country, 70% percent of water consumption is based on agricultural purposes. In following years, water management will gain further importance to be able to answer to the increasing demand of water industry and tertiary sectors. In this study, variance between 2000 and 2013 were evaluated with regard to water usage, irrigation intensity, and cropping intensity indicators on irrigation areas which cover 2.847.382 ha of land in Turkey. In the evaluation of cropping intensity, the distrubition of crops in irrigated areas was identified as a percentage value. Most planted crops in irrigation schemes are corn, cotton, cereals, fodder crops and sugar beet, respectively. Cropping intensity was different from each other over all years. In specifying the field usage levels, irrigation intensity indicators and differences between irrigation intensity in the past 14 years in transferred and non-transferred irrigation schemes to a water-users' organisation were identified. The annual irrigation intensity was compared for 257 irrigation schemes (245 transferred and 12 non-transferred schemes) in Turkey. Irrigation intensity in the transferred schemes was higher than that of the non-transferred schemes. In order to evaluate the amount of water per unit area a use indicator was considered. This indicator increased every year. The amount of water supplied to the unit area also varied from 27.237 to 34.699 million m^3. Consequently, cropping intenstiy, water usage and irrigation intensity were changed in between 2000 and 2013 because of global climate changes, water scarcity and increasing water demand. In order to ensure the effective water usage in irrigated areas, efficient and rational irrigation management, information system for monitoring and evaluation which encompasses all stakeholders should be set up and irrigation scheduling and modernisation of the irrigation systems should be designed.

Keywords: Cropping intensity, irrigation intensity, irrigation management, irrigation scheme, water use

Contact Address: Hasan Degirmenci, University of Kahramanmaras Sütcü Imam, Biosystem Engineering, Kahramanmaras, Turkey, e-mail: degirmenci@ksu.edu.tr

Optimisation for Coastal Land by Applying Smart Combine Irrigation Systems for Eco-Friendly Agriculture in Yogyakarta, Indonesia

ARFAN ARFAN HELMIDAMARA[1], CATUR CATUR SETYO DEDI PAMUNGKAS[2], FATHI FATHI ALFINUR RIZQI[2], DYAH MAHARANI[1], MURTININGRUM MURTININGRUM[2]

[1]*Gadjah Mada University (UGM Yogyakarta), Animal Science, Indonesia*

[2]*Gadjah Mada University (UGM Yogyakarta), Agricultural Technology, Indonesia*

Agricultural lands begins to shrink with population growth, while the need for food is increasing. Marginal land such as coastal land has a great potential to be developed as agricultural land. However, the use of coastal areas for agriculture impacts on the increase of water demand in that area. Besides its low water storage ability, salt content on the surface of leaves and soil caused by salt sea breeze also requires water for the salt washing process. Further, high evapotranspiration levels increase the need for irrigation.

Water in coastal areas is obtained by pumping groundwater. However, excessive and uncontrolled pumping will cause environmental damage such as sea water intrusion (intrusion of salt water from the sea into fresh groundwater), and impact the scarcity of clean water. Such conditions also contributed to the decline in agricultural production in coastal areas, since the amount of fresh water for irrigation is limited.

A solution is needed to overcome the danger of this sea water intrusion. Smart combine irrigation system technologies can be applied for an accurate and water-saving irrigation. Drip irrigation systems will save water consumption. Irrigation sprayer can be used to eliminate the salt levels on the surface of the plant. Both irrigation systems will be sensor controlled systems so that the provision of water will be more precise and will save groundwater in order to create eco-friendly agriculture

A smart combine irrigation system is an appropriate technology in the land management of coastal areas, and gives a positive contribution in solving the problems of agricultural development of coastal land. Therefore, besides contributing to food security, environmental conditions will also be maintained with eco-friendly agriculture.

Keywords: Coastal areas, combine smart irrigation systems, eco-friendly, intrusion, needs for food, water availability

Contact Address: Arfan Arfan Helmidamara, Gadjah Mada University (UGM Yogyakarta), Animal Science, Fauna Street 3, 55281 Sleman, Indonesia, e-mail: arfanhelmi@gmail.com

Biochar and Woodchips as Alternative Filter Materials for Pre-Treatment of Wastewater with Roughing Filter

KORBINIAN KÄTZL, MANFRED LÜBKEN, EDITH NETTMANN, MARC WICHERN
Ruhr-Universität Bochum, Institute of Urban Water Management and Environmental Engineering, Germany

Wastewater reuse could help to reduce the pressure from global water scarcity, especially in arid and semi-arid regions. Efficient and cheap water treatment technologies need to be developed, particularly in low-income countries where wastewater treatment is often lacking. Slow sand filtration (SSF) is a proper, efficient and well known technology to reduce the amount of pathogens and turbidity. However, an efficient use of SSF requires low water turbidity to prevent rapid filter clogging, which could be achieved by an upstream roughing filter (RF).
The focus of this study was on the evaluation of biochar and woodchips as alternative and locally available filter materials in RF as pre-treatment for SSF and low cost production of safer irrigation water for urban agriculture in developing countries.
The experimental setup consisted of nine glass columns, which were filled in triplicates with biochar, woodchips and gravel (grain sizes: 5–16 mm). Filters were fed with raw wastewater from the municipal treatment plant Ölbachtal (Bochum, Germany). Samples of influent and effluent were taken once per week and analysed for the fecal indicator bacteria (FIB) *E. coli* and intestinal enterococci, using the Most Probable Number (MPN) method and physico-chemical parameters (e.g. turbidity, chemical oxygen demand, electrical conductivity, pH).
FIB concentration of raw wastewater was in the range of 10^6 to 5×10^7 MPN 100 mL^{-1}. Removal rates for enterococci and *E. coli* were in the range of 0.5 to 1.5 $\log_{10}$ units MPN 100 mL^{-1}, which is similar to other published results with respect to RF. Influent turbidity was in the range of 60 to 360 NTU. Beside FIB, turbidity (effluent turbidity below 35 NTU) and COD (reduction up to 89 %) could be significantly reduced and effluent of all filter types were expected to be suitable for further treatment with slow sand filtration. Over the entire observation, biochar filter showed slightly higher removal rates than other materials. Overall, roughing filter seems to be a proper pre-treatment step for wastewater treatment with SSF.

Keywords: Biochar, BMBF-GlobE, roughing filtration, UrbanFood^{Plus}, water reuse

Contact Address: Korbinian Kätzl, Ruhr-Universität Bochum, Institute of Urban Water Management and Environmental Engineering, Universitätsstr. 150, 44780 Bochum, Germany, e-mail: korbinian.kaetzl@rub.de