Water management in tropical South China
The challenge of rubber monocultures

Rubber monoculture increased rapidly in Dai Autonomous Prefecture Xishuangbanna of Yunnan Province (South China) since 1976 and in 2010 occupied more than 22 % of land area. This development was accompanied by various socio-economic and ecological changes. While people benefited from economic growth they also encounter increasingly environmental changes.

In rubber plantation areas in China´s SW-Province of Yunnan water quality but also availability is a major issue. In order to quantify these challenges and to develop stakeholder validated measures to improve the situation for humans and the environment an integrated water management concept has been developed and implemented in an agricultural-dominated watershed in Xishuangbanna. Key components of the concept are, besides conventional water and soil monitoring, measures for improving ecosystem services and functions, workshops for capacity development, interviews and workshops with several stakeholders.

Acronyms

SURUMER	https://surumer.uni-hohenheim.de
FONA	Research for Sustainability
BMBF	German Ministry for Education and Research

A

Workshops conducted with local farmers and village heads regarding the impact of rubber cultivation on water bodies and drinking water supply

Workshops conducted with local and regional administration to present the impact of rubber cultivation and how the water bodies can be protected with riparian buffer zones and water protection zones

A Water Monitoring System has been developed and implemented in the area to observe, describe, evaluated and communicate the status of the surface water bodies

Water Monitoring System

Two water monitoring stations and a field laboratory have been installed in the research area. At the two stations water level, oxygen content, turbidity, conductivity, pH and temperature are continuously monitored, to investigate the highly dynamic pattern during the rainy season. In addition grap samples are taken and analyzed in the field laboratory for nutrient and organic matter content. Organic trace substances like pesticides are further analyzed in a specialized laboratory.
The water quality monitoring (amongst others nitrogen, phosphorous, selected pesticides like atrazine, turbidity, conductivity, oxygen, total coliforms) showed that after rain events turbidity as well as concentrations of microbial pollutants and agricultural chemicals (nitrogen, phosphorous, pesticides) are increased.
In terms of water quality for humans and the environment especially peak concentrations of turbidity, total coliforms and some pesticides need to be reduced. E.g. chlorpyrifos was detected at 50% of the LC50 for rainbow trout (Oncorhynchus mykiss).

Creek in research area

B

Water protection zone and riparian buffer zone concept have been adapted to the area

Workshop regarding sustainable use of agrochemicals conducted in 2015

Educational movie for local farmers regarding sustainable use of agrochemicals has been created

Measures for improving water bodies

Prospective measures to avoid hazards to humans and the environment are the establishment of water protection zones and riparian buffer zones. With regard to drinking water quality this is particularly important because non-treated surface water is used as drinking water in this region.
The riparian buffer zone and the water protection zone concept are based on literature, field experiments, and workshops with experts and stakeholders. National and international literature, guidelines and recommendations provide the foundation of the structure of these concepts. Special attendance has been given to develop the concepts in accordance with local regulations and management strategies. For example, reduced chemical weeding instead of maintaining a weed free understory in rubber plantations lead to reduced run-off and soil erosion and hence sediment supply to water pathways. In combination with intercropping trials in rubber plantations, these experiences are being used to define the width of different protection zones and to develop specific management measures. Furthermore, local investigations of the availability of different pollinators have been used to select specific local plants for the riparian buffer strips in order to benefit as many ecosystem functions and services as possible.
The developed concepts have been presented and discussed frequently with local stakeholders and the results have been considered and incorporated. The concepts have been further refined using hydrological and water quality models and can be evaluated with the Water Monitoring System after implementation by the responsible administration.

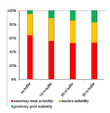
Pesticide bottle disposed in river

C

Model based assessment of aquatic habitat improvement due to reduction of sediment load into rivers

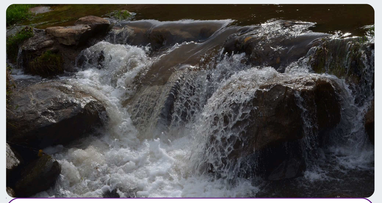
Improvement of aquatic habitat

One of the negative effects of monoculture is soil erosion and the loss of fertile soil surface. Fine sediment runoff from agricultural land enters the rivers with serious negative impacts on the aquatic environment. The settlement of fine sediments on or even into the river bed clogs the pore space and reduces the living space for juvenile fishes and macroinvertebrates.
Continuously measured turbidity data at the study site show a high increase in turbidity during rain events. Samples of suspended solids are used to correlate them with the turbidity data. Detailed sediment samples withdrawn from the river bed with the so-called freeze-core technique show a high amount of fine sediments within the river bed with a percentage of fines under 2mm up to 26%.To quantify the effectiveness of buffer strips, a GIS-based model is used that calculates the reduction of erosion risk when implementing buffer strips.This model is based on the well-known RUSLE approach,which calculates the annual runoff based on different parameters such as land use and soil properties. The model estimates the annual soil loss and allows for investigating the effect of the different scenarios with buffer strips. The results show a significant retention of fine sediments within the buffer strips and a reduction of the erosion risk compared to the current state. The model results are used as input data for an evaluation of the aquatic habitat quality with the model CASIMIR. It can be concluded that riparian buffer strips are an efficient and easy-to-implement measure to reduce the introduction of fine sediments into rivers.



Aquatic habitat suitability

D



Implementation of Water Protection Zones

Improving ESS Drinking Water

Main objective of the Water Protection Zone Concept is to minimize anthropogenic and natural hazards and risks which could deteriorate the water resources within the catchment area of drinking water abstraction points by avoidance of contaminants and enhanced natural attenuation of contaminants. This is achieved by a set of different regulations, land use and land management restrictions, capacity development, awareness rising and further measures.
The “Water protection zone concept for a rural mountainous area in tropical South East Asia – Surface Water” consists of four different zones. The purpose of Water Protection Zone 1 (WPZ 1) is to protect the abstraction point against direct pollution and access of animals and unauthorized persons. This area should be fenced within a radius of 20 to 50 meters around the abstraction point.
The delineation of WPZ 2 should be set in a way that the drinking water standard for pathogens should be met. Depending on the local slope and land use conditions WPZ 2 should be at least 100m on each side of the river and expands between 5 and 20 km upstream. The Riparian Buffer Zone is located within WPZ 2. It expands at least 20 meters on each side of the stream and natural vegetation reduces the input of solids, organic matter and contaminants. The only land cover inside RBZ is bush and grassland as well as forest.
Main objective of WPZ 3 is to protect- the drinking water resources against persistent substances, e.g. specific pesticides, heavy metals, industrial chemicals or radioactive substances. Therefore the whole catchment area is part of WPZ3.
The concept needs to be adapted for individual local legal conditions.

Chinese Source Water Protection Area Sign

E

Water Management Measures have been adapted and improved with an transdisciplinary approach

Management of Water and Sanitation has been investigated in villages with different cultural backgrounds

The results are going to be published in research articles, books and guidelines and are presented locally and internationally

Participatory Planning

When dealing with stakeholders it is important to consider the different knowledge backgrounds and adapt the approaches respectively. While government representatives are well trained on their topic of expertise, the majority of farmers is not, but grew up in a subsistence environment in the ‘pre-chemical’ era. The negative effects of pesticides, which often appear with a considerable lag and thus might not be easily linked to a specific action in the field, might therefore be difficult to understand. In this case it is therefore crucial to integrate capacity development components in any work.
The implementation of integrated water resources management in combination with stakeholder and transdisciplinary expert involvement from science, practice and administration led to water protection zone and riparian buffer zone concepts which not only will improve the aquatic ecological condition and human health situation, but also may lead to improved overall ecological conditions.

Contribution of workshop participants to the Water Protection Zone Concept

AICHI BIODIVERSITY TARGETS
STRATEGIC GOALS

A Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio-economic conditions.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

B Reduce the direct pressures on biodiversity and promote sustainable use

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

C To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity

Target 11: By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

D Enhance the benefits to all from biodiversity and ecosystem services

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

E Enhance implementation through participatory planning, knowledge management and capacity building

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

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