Research Areas

Pollutants / Water / Sedimentary Systems

The pollution of major rivers, like the Yangtze, caused by various problem substances is frequently underestimated, because studies often only measure low concentrations and consequently only take these into consideration. However, these low concentrations combined with large volumes of water produce substantial loads with the risk of pollutants accumulating all the way into the human food chain. Despite the measures that have already been taken to reduce the pollutant runoff into the Yangtze (construction of water treatment plants, the repair of drainage systems, the removal of old plants and contaminated sites) it must be assumed that the water in the reservoir continues to be directly polluted by harmful substances contained in municipal waste water and sewage discharges, industrial effluent discharges (including from river navigation), various unspecific pollutant runoffs (agricultural areas, flood areas) and the continuing use of old plants and contaminated sites. However, it must be remembered in this respect that the Yangtze is the major and in some cases only source of drinking and non-drinking water for the local population. Since the future pollutant levels in the river cannot yet be predicted due to the large number of different parameters, a forwardlooking water quality management system needs to collect data continuously over a longer period of time and to simultaneously carry out studies on how reaction processes and transport mechanisms influence the water quality of the Yangtze. Both the reservoir itself as well as areas further downriver must be taken into consideration in this respect. Furthermore, it is necessary to observe more than just the processes taking place within the water column. It is also necessary to consider the sedimentary bodies and the riparian areas with their plant growth.

This is why funding is primarily intended for research projects aimed at

- explaining key biological-chemical processes in the riparian area, in the water column and in the sediment;
- determining the transport behaviour of problem substances and the dynamics of suspended matters all the way through to the formation of sediments;
- modelling reaction and transport processes as well as developing monitoring processes;
- transferring and adapting analytical methods and ecotoxicological test methods to assess the hazards of the pollutants contained in the water and sediments in line with Chinese frameworks:
- applying modern methods to treat the raw (natural) water in order to produce drinking and non-drinking water;
- upgrading current and introducing new automatic monitoring systems and concepts for to facilitate the early recognition of hazards for the aquatic systems and to identify and document trends in the water quality.

Vegetation / Biodiversity

Consideration of the water level to be impounded by the dam in the future as a result of reservoir management shows that pronounced changes to the natural flooding regime can be foreseen. Flood events along the banks of the Yangtze and its tributaries used to occur in the summer months. In the past, the plants in the riparian zone (Water Fluctuation Zone = WFZ) have normally been flooded in the warm season (28°C in July / August), while the terrestrial phase of the WFZ has been characterised by cool temperatures (3°C to 5°C in January), which only allowed little plant activity.

In the future, the highest water levels will occur above the dam in the Yangtze and its relevant tributaries in the winter. In their physiologically active season during the summer months, plants in the WFZ will find much better climate conditions with higher temperatures. This reversal of the flooding cycle over the course of the year will have an enormous impact on the fauna and flora and on associated processes. Other factors of influence that arise from managing the reservoir, include sedimentary deposits and how these differ in scale across the various zones of the WFZ. For example, the differing degree of compaction of the riparian sediment will have a substantial impact on the exchange of oxygen, nutrients and metabolic products between the plants and the water body and so will also impact key ecosystem functions. The locally differing thickness of the sedimentary body will decisively influence the ability of the plant shoots to penetrate the sediment. By contrast, areas with high flow speeds will see habitats formed that are characterised by strong detrital dynamics. Consequently, the Three Gorges Dam will result in changes to the key living conditions of vegetation in the WFZ. In turn, the changing vegetation may then itself have potential long-term impacts on the local population that live off and benefits from the vegetable resources, on tourism and on the hydro and sedimentary regime in the reservoir.

This is why funding priority will be given to research projects on

- plant behaviour under conditions of stress (pollutants, lack of oxygen and nutrients, covering of water and sediments) and their adaptation strategies;
- determining the processes occurring in the rhizosphere, including microorganism-biotic communities;
- gas exchange between plant and environment, including the release of climate relevant gases;
- the decontamination potential of water and riparian plants in periodically-flooded areas;
- the spread of annual plants to temporarily dry riparian areas;
- the effects of differing water levels over the year on the regional aspects of vegetation and phytodiversity;
- the quantification of disturbance regimes and how these affect the dynamics of ecosystem functions.

Changes in Land Use / Mass Wasting

The impoundment of the Yangtze by the Three Gorges Dam has triggered large-scale changes in land use in the upstream catchment area and has caused a clear increase in landslips and soil erosion in the adjoining tributary valleys. At a reservoir level of 175m, a total of 13 counties, 3 city districts and 3 independent cities will be affected by a loss of land areas amounting to around 632 km². Some 28,000 ha of farmland, orchards and woods have been flooded and need to be replaced by very steep farming sites further up the slope.

The additional buoyancy caused by the impoundment leads to dramatic changes in the stress levels of the soils in the affected, previously dry slopes. A reactivation of old land slips and the formation of new ones must be expected. A rapid drop in the water level as a result of the continuing operation of the barrier could lead to a destabilisation of the riparian areas. Prior to the impoundment by the Three Gorges Dam, the slopes directly adjacent to the banks of the Yangtze were examined by engineering geologists. This resulted in some 2,000 land slips being found. Numerous as yet unknown danger areas are also to be found in the hardly studied tributary valleys that also lie in the impoundment area. Besides the topography, the trigger mechanisms for mass wasting and soil erosion, and so also their consequences for polluting the Yangtze with harmful substances, are generally coupled with the type and intensity of land use and other landscape characteristics and features. Shifting the erosion basis and farming to higher slope areas increases the erosion potential. This additionally leads to substantial risks of off-site damage in the waters through pollution runoff involving sediment and particle-bound agrochemicals caused, on the one hand, by continual

minor erosion events in the landscape and, on the other, by extreme events involving mass wasting in the riparian area.

This is why the development and establishment of strategies on the sustainable use of the Yangtze and of the neighbouring cities needs a catchment-area specific risk assessment on the danger of land slips, soil erosion and diffuse pollutant runoff into the waters. This is why a GIS-based method for assessing the potential danger is to be developed and data-based pattern recognition methods, such as neuronal networks, are to integrated and made monitoring-capable. This is turn facilitates the planning of sustainable land use options, thereby making it possible to contribute substantially to establishing a valid river area management method for the risk assessment process, so providing a solid foundation for sustainable environmental and land use planning in the region. After successful test runs, it would make sense to transfer this tool to other catchment areas, in particular to the area around Chongqing.

Research Institutions in Germany

Students, doctoral candidates and postdocs from China will mainly carry out their individual studies and research at the following research institutions in Germany under the supervision of local university teachers:

- Research Centre Jülich, Jülich www.fz-juelich.de/icg/icg-iv/index.php?index=3 www.fz-juelich.de/icg/icg-iii/index.php http://www.fz-juelich.de/zch/index.php?index=83
- RWTH Aachen University www.bio5.rwth-aachen.de
- Water Technology Centre, Karlsruhe <u>www.tzw.de</u>
- GSF-National Research Centre for Environment and Health, Neuherberg <u>www0.gsf.de/neu/Forschung/Institute</u>/igoe_intro.php
- University of Stuttgart <u>www.iws.-uni-stuttgart.de/institut/index_lehrstuhl.php?Abteilung=6</u>
- GKSS Research Centre Geesthacht
 <u>http://w3k.gkss.de/koi/</u>
- TU Munich <u>www.wzw.tum.de/oec/</u>
- Rhine-Main Water Research gGmbH (Affiliated Institute of the University of Mainz)
 <u>www.waterresearch.de/</u>
- University of Karlsruhe
 <u>www.img.uni-karlsruhe.de</u>
- University of Hamburg
 <u>www.geowiss.uni-hamburg.de/i-bioge/start.html</u>
- University of Bayreuth

www.uni-bayreuth.de/departments/biogeo

- Centre for Environmental Research Leipzig-Halle <u>www.ufz.de/index.php?de=1690</u>
- Max Planck Institute for Limnology, Plön <u>www.mpil-ploen.mpg.de/mpiltalg.htm</u>
- University of Ulm
 <u>www.biologie.uni-ulm.de/spezbot/index.html</u>
- University of Kiel
 <u>http://www.hydrology.uni-kiel.de:9673/Hydrology</u> or <u>http://www.hydrology.uni-kiel.de:9673/Hydrology/english_version/</u>
- University of Giessen
 <u>http://www.uni-giessen.de/zeu/homepage.html</u> or <u>http://www.uni-giessen.de/zeu/english/homepage-e.html</u>
- University of Erlangen <u>http://www.angewandte-geologie.geol.uni-erlangen.de/index.html</u> or <u>http://www.angewandte-geologie.geol.uni-erlangen.de/index_e.html</u>
- University of Tübingen
 <u>http://www.uni-tuebingen.de/egpinfo/index.html</u>
- Research Centre Jülich
 <u>http://www.fz-juelich.de/icg/icg-ii/homepage</u>
- University of Duisburg-Essen
 <u>http://www.uni-duisburg-essen.de/zmu/</u>

Research Institutions in China

German doctoral students and postdocs will mainly carry out their individual studies and research at the following research institutes in China under the supervision of local university teachers:

- CAS Institute of Hydroecology, Wuhan
- CAS Institute of Hydrobiology
- CAS Institute of Oceanology
- CAS Institute of Biology, Chengdu
- CAS Institute of Soil Sciences, Nanjing
- CAS Institute of Botany, Beijing
- Chongqing University, Chongqing
- Southwest China University, Chongqing-Beibei
- Zhejiang University Hangzhou
- Nanjing University, Nanjing
- Tongji University, Shanghai
- Changjiang Water Resources Protection Institute, Wuhan
- Wuhan University, Wuhan
- Three Gorges University, Yichang