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COMMENTARY

# The Yangtze-Hydro Project: a Chinese–German environmental program

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**Abstract** Water of good quality is one of the basic needs of human life. Worldwide, great efforts are being undertaken for an assured water supply. In this respect, one of the largest water technology projects worldwide is the Yangtze Three Gorges Dam in China. There is a need for extensive scientific and technical understanding of the challenges arising from this large hydrological engineering project. German and Chinese groups from various scientific fields are collaborating to provide knowledge for the sustainable management of the reservoir. In this project description, the Yangtze Three Gorges Dam Project, its goals and challenges, are described in brief, and the contributions of the German research projects are presented.

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## 1 Introduction

Under normal conditions, obtaining water of high quality is not a concern in Western Europe. However, in view of climate change, additional efforts are necessary to assure a permanent supply of high-quality drinking water.

The situation is quite different in China. Due to a growing demand for water in households and industry, more and more people are suffering from water scarcity. The Chinese authorities regard the diversion of water from the southern areas in China to the North by water channels as a promising alternative to mitigate this problem (Subklew et al. 2010). Closely linked to these challenging planning and engineering activities are numerous dam construction projects in the southern part of China. The largest dam in China—and one of the largest worldwide—is the Three Gorges Dam, which dams the Yangtze River between Sandouping (near Yichang) and Chongqing along a length of about 660 km (http://www.yangtze-project.de/wasser/, accessed on 6 July 2011).

As there are many technical, ecological, and social challenges linked with such a large project, the German Federal Ministry of Education and Research has been providing financial support for five German research institutions to perform applied research on changing land use, soil erosion, mass movements, and matter fluxes in a highly dynamic ecosystem since 2008/2009. Since August 2010, another six German partners receive funding for research on sustainable water management (Yangtze-Hydro).

Within Yangtze-Hydro, they cooperate with Chinese research groups from a number of universities, institutes of the Chinese Academy of Sciences, the China Research Academy of Environmental Sciences, and other research centres. In this presentation, the objectives of the joint project are introduced.

## 2 Background

The People's Republic of China has an area of about 9.6 million square kilometres, making it one of the biggest countries on earth with some of the largest rivers on the planet. The 6,300-km-long Yangtze, which rises in the Qinghai-Tibetan Plateau, passes through 11 Chinese provinces with a population of about 400 million including the city of Shanghai, where it flows into the East China Sea. The upper Yangtze down to Yichang (with a catchment area of about 100,104 $km^2$) is more than 4,300 km in length, the central section down to Hu-kou (outlet of Lake Poyang) more than 950 km (catchment area roughly 68,104 $km^2$) and the lower section down to the estuary is about 930 km long (catchment area, 12,104 $km^2$).

Over the past 100 years, the annual water discharge of the upper Yangtze at Yichang has varied between 5,000 $m^3/s$ in January and 40,000 $m^3/s$ in the rainy summer months. In the months from June to September, there are also considerable amounts of suspended matter transported. In the course of the last few decades, the periods of both low and high discharges have become more and more extreme so that by the end of the 1970s, the saltwater intrusion from the East China Sea combined with a very low water level had already severely affected the water supply of the city of Shanghai.

The first plans for damming the Yangtze in the region of the Three Gorges and regulating its flow were put forward in 1919, the National People's Congress finally approved the construction plans in 1992 and the dam was completed in 2009. With this gigantic project, the national executive is pursuing the aims of:

- Preventing flooding
- Safeguarding the water supply
- Enhancing navigation and
- Generating electric energy

In the future, fluctuations of the water level of up to 30 m will be deliberately applied in the dammed-up section of the river. Up to the start of the rainy period, from the end of May until early June, the water level is lowered to 145 m above sea level in order to provide storage volume for the peak discharge during the following months and to allow sediment flushing. After the maximum water volume has passed, the water level is raised in October to the highest level of 175 m above sea level. Peak energy production then begins. In the months from January to May, the water level is then gradually reduced again to 145 m in order to compensate for the lack of precipitation during the dry winter and thus to increase the flow downstream of the dam. This is intended to combat sediment formation in the reservoir in the months from June to September and to wash away some of the existing deposits.

The Yangtze-Hydro Project is related to the most relevant changes in water and sediment quality as:

- Eutrophication by wastewater and agrochemicals, which may lead to algae blooming and water hyacinth growth
- Re-solution of pollutants from flooded urban, industrial and agricultural areas
- Sediment accumulation along the reservoir and especially in front of the dam
- Possibly unknown contamination of toxic inorganic and organic trace compounds from industry, municipal wastewater discharge, landfill deposits, and waste (Müller et al. 2008)

## 3 The Yangtze-Hydro Consortium and the aims of the joint research

The German Consortium consists of four work packages and the project coordination:

1. Dynamics of physico-chemical parameters within the new reservoir
   - Karlsruhe Institute of Technology in collaboration with the China Research Academy of Environmental Sciences (CRAES) has two tasks. One task is to analyse the spatio-temporal dynamics of physico-chemical parameters within the reservoir by means of a towed underwater sensor system (called MiniBAT). This sensor system is able to detect online and in situ parameters such as temperature, turbidity, chlorophyll a, pH, electrical conductivity, oxygen and hydrogen sulphide. The sensor system will be extended to include a TOC sensor and a sampling system during the project (Casagrande 1995; Stüben et al. 1998). Furthermore, a free flow sampler will be used to monitor water quality at various depths. The other task is the numerical modelling of transport dynamics supported by the data obtained in task one and from further German and Chinese partners (Westrich and Förstner 2007).
2. Concentration of substances
   - IWW Water Centre, Water Resources Management, will perform a contaminant survey focusing on organic pollutants on the Yangtze River as they do on the River Rhine and a comparison of Chinese and German standards for water quality aspects (Ministry of Environmental Protection of the PR of China 1999) and will investigate suitable water technologies to obtain clean and safe drinking water (Wateruse) (Bergmann 2011).
3. Behaviour and transformation of contaminants
   - RWTH Aachen University, Biology V, is a project partner with strong connections to Chinese groups, especially to Nanjing University, Chongqing University and Tongji University in Shanghai. They will work on the process understanding of biological transformation, bioaccumulation and ecotoxicological evaluation of pollutants (Wolz et al. 2009).
   - Technische Universität München (TUM) has developed a monitoring tool for evaluating the bioaccumulation of non-polar organic compounds. The so-called "Biovirtous", a virtual passive sampling fish, will be installed at different places in the reservoir, thus obtaining information on the contamination of the reservoir with non-polar persistent pollutants such as pesticides in fish, other lipophilic biota and sediments (Wang et al. 2009).
   - Research Center Jülich with IBG-3 Agrosphere and the Central Division of Analytical Chemistry (ZCH) addresses the physico-chemical processes of pollutant evaluation at the sediment/water interface (Zhang et al. 2010) and the modelling of their chemical degradation (Hoffmann et al. 2011).
4. Degradation of contaminants
   - Water Technology Center, Karlsruhe (TZW), will study microbiological processes to understand the degradation of chlorinated hydrocarbons under oxidative and reductive conditions in the water phase and the sediment (Schmidt and Tiehm 2008; Tiehm and Schmidt 2011).
5. Project coordination

   The project coordination of the Yangtze projects is performed in Jülich by Günter Subklew. The coordination of Yangtze-Hydro is performed by Rolf-Dieter Wilken from IWW.

## 4 Chinese partners (in alphabetical order of the home town of the institution) complement the German projects:

- Chinese Research Academy of Environmental Sciences, Beijing
- Standing Office of the State Council Three Gorges Project Construction Committee, Beijing
- Chinese Research Academy of Environmental Sciences, Beijing
- Chongqing University, Chongqing
- Zhejiang University, Hangzhou
- Nanjing University, Nanjing
- Tongji University, Shanghai
- Yangtze Water Resources Protection Institute, Wuhan
- Chinese Academy of Sciences, Institute of Hydrobiology/ Institute of Hydroecology, Wuhan
- China Three Gorges University, Yichang

In the future, additional partners are expected to join the project network.

The overall aims of the German Yangtze-Hydro projects is to support the Chinese partners in the field of sustainable management of the Yangtze Three Gorges Dam ecological system, where the Chinese partners have already obtained a great deal of experience and have developed a variety of strategies to deal with the upcoming challenges caused by the dam project.

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