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Chinese Water Systems

Volume 1: Liaohe and Songhuajiang River Basins

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EU-China Environmental Sustainability Programme:
Demonstration of Pollution Discharge Management for Water Quality Improvement in the Songhuajiang-Liaohe River Basin (SUSTAIN H2O)
(DCI-ASIE/2013/323-261)

Preface

Rapid economic development and population growth in China go hand-in-hand with industrialization, increasing demand for energy and resources, intensified agriculture and increasing urbanization, involving growing mega-cities. These developments have caused and continue to cause severe pressures and risks to natural resources and the long-term provision of highly required goods and services based on natural resources. Pollution containing hazardous substances for environmental and human health, depletion and deterioration of water resources as a result of overexploitation and contamination, soil degradation and air pollution in mega-metropoles (such as Jing-Jin-Ji,[1] Taihu area) are increasing at an alarming rate. At the same time, the long-time neglected development of rural areas has to be tackled with corresponding environmental friendly master plans.

Consequently, to stop negative trends jeopardizing the economic and societal development in China, protection, remediation and productive management strategies as well as sustainable planning need to be developed and implemented for China's natural resources in a highly diverse, complex and dynamic environment. This offers most important opportunities for international collaboration in environmental science, technology and education.

Major Water Program

The Chinese government recognized the importance and complexity of the water situation and has initiated a programme entitled "Major Water Program of Science and Technology for Water Pollution and Governance" (2006–2020). While shortages resulting from regional resource depletion have led to projects of large-scale water transport from distant water-rich areas of China (Water Diversion Project), the water quantity and quality problems in other areas require efficient, flexible, and

[1] The national capital region of China (Beijing-Tianjin-Hebei).

site-specific solutions and overall management concepts. In April 2015, the Action Plan for Water Pollution Prevention (Clean Water Action Plan)[2] was published by the State Council of the People's Republic of China. It requires that by 2020, China's water environment quality will gradually improve; the percentage of severely polluted water bodies will be greatly reduced, and the quality of drinking water will be improved. The plan seeks to protect surface water in seven river basins: Yangtze, Yellow, Pearl, Songhua, Huai, Hai and Liao Rivers. It sets urgent, strict targets for water scarce regions such as Beijing-Tianjin-Hebei, Yangtze River Delta, and the Pearl River Delta.

In September 2013, China has formulated and implemented an in-depth Action Plan for the Prevention and Control of Air Pollution (Clean Air Action Plan)[3] in order to set up an evaluation system focusing on improving air quality and assessment results will be used for performance evaluation of the local leaders.

On 31 May 2016, China launched a new action plan to tackle soil pollution (Clean Soil Action Plan)[4] and China aims to curb worsening soil pollution by 2020 and stabilize and improve soil quality by 2030. These plans highlight the determination to control pollution, improve environmental quality, and protect the people's health.[5]

The Chinese government released its 13th Five-Year Plan (2016–2020)[6] on 17 March 2016. It promotes a cleaner and greener economy, with strong commitments to environmental management and protection, clean energy and emission control, ecological protection and security and the development of green industries. Specific objectives for environmental protection in the 13th Five-Year Plan period include: reduction of water consumption by 35% by 2020 as compared to 2013; estimated total consumption of primary energy in 2020 of less than 5 billion tons of standard coal; energy consumption per unit of GDP to be reduced by 15% in 2020 (compared to 2015); reduction of carbon dioxide emissions per unit of GDP by 40–45% by 2020 (compared to 2015 which is consistent with China's Plan for Addressing Climate Change (2014–2020)). On 3 September 2016, the presidents of China, Xi Jinping, and the USA, Barack Obama, announced the ratification of the Paris Agreement (of the 2015 United Nations Climate Change Conference) by their countries, respectively.

On 08 August 2016, Chinese government released its 13th Five-Year National Science and Technology Innovation Plan.[7] China will continue to support the national science and technology major projects, which include the major project in water

[2] http://www.mep.gov.cn/gkml/hbb/qt/201504/t20150416_299173.htm.

[3] http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm.

[4] http://www.gov.cn/zhengce/content/2016-05/31/content_5078377.htm.

[5] http://www.mep.gov.cn/.

[6] http://www.gov.cn/xinwen/2016-03/17/content_5054992.htm.

[7] http://www.gov.cn/zhengce/content/2016-08/08/content_5098072.htm.

pollution control and treatment. The targets are: a number of key technologies shall be developed in terms of water circulation system restoration, water pollution control, drinking water safety, ecological service functions restorations as well as long-term management mechanisms. The comprehensive demonstration will be carried out in the region "Beijing-Tianjin-Hebei" and Taihu lake area. Comprehensive environmental information systems for water pollution control, environmental management and drinking water safety shall be established in order to set up the big-data-based platform for water environment monitoring and observation.

Sino-German Cooperation

German-Chinese governmental consultations are taking place on a regular basis, enabling discussion on recent topics for collaboration between the two countries at highest level. The first German-Chinese governmental consultations were held on 28 June 2011 in Berlin and provided the framework for the German-Chinese Forum for Economic and Technological Cooperation. During this first consultation, a joint declaration on the establishment of the bilateral "Research and Innovation Programme Clean Water" was signed. The second consultations between the two governments took place in August 2012 in Beijing, the third on 10 October 2014 in Berlin. The fourth consultations were held in June 2016. The major topic was how to link "made in China 2025" and "German Industry 4.0".

Recognizing the importance, opportunities and strength of Chinese-German bilateral research cooperation, the Federal Ministry of Education and Research published their "China-Strategy of the BMBF" in October 2015, a strategic framework for the cooperation with China in research, science and education.[8] The BMBF China-Strategy is dedicated to further improve the framework conditions for cooperation between Germany and China in science and research, networking and education. The main areas for cooperation are "Key Technologies", "Life Science", "Strengthening Social Sciences" and coping "Ecological Challenges".

The "Innovation Cluster Major Water" was established in 2016 in order to coordinate the German contributions to the "Major Water Program".[9] The cluster also provides actual information on Sino-German research projects, knowledge and technology transfer as well as training and education activities in the field of water science.

Sino-UK Cooperation

Britain and China have a long history of interactions commercially and governmentally. In modern times, since the creation of the People's Republic of China in 1949, Britain and China have sought to enhance historical ties particularly through trade and business. What was known as the "Group of 48" first started trade missions to China in the early 1950s, and was subsequently followed by missions from "The Sino-British Trade Committee" (formed in 1954). In the 1980s, these two groups merged to become what is now the "China-Britain Business Council" (although the 48 Group Club continues to operate as an independent business

[8] https://www.bmbf.de/de/china-strategie-des-bundesministeriums-fuer-bildung-und-forschung-2015-2020-1882.html.

[9] http://sino-german-major-water.net/de/.

network promoting Sino-UK trade and academic interests[10]). Currently the China-Britain Business Council[11] acts as the delivery partner in China for the UK government Department of International Trade and covers sectors including agriculture, energy and education, amongst others.

The rapidly developing research and academic status of China, and the collaboration between Chinese and UK researchers was enriched when in 2007 a dedicated Research Councils UK (RCUK) office was established in Beijing, the first overseas RCUK office, capitalizing on existing collaborations and working to develop strong networks and future joint research and innovation activity between the two nations. The activities of RCUK China have supported the development of many initiatives such as the 2008 Water Availability and Quality programme, deriving funds from representative UK and Chinese funding bodies.[12] The RCUK China office continues to work collaboratively on behalf of the Research Councils with UK government and Chinese research bodies to develop opportunities and partnerships.

More recently, and formally, bringing together government and research ambitions for collaboration, in 2015 during a state visit from President Xi Jinping to Britain multi-million pound trade deals were agreed in several areas[13] including energy, medicine, infrastructure, transport, telecommunications and, significantly for environmental research, bilateral research funding under the Newton Fund (UK-China Research and Innovation Partnership Fund) with priority areas including Energy, Environmental Technologies, Food and Water Security, and Urbanisation amongst others.

[10] http://the48groupclub.com/the-club/about-the-club/.

[11] http://www.cbbc.org/.

[12] http://www.rcuk.ac.uk/documents/international/rcukchinaimpactbrochure-pdf/.

[13] https://www.gov.uk/government/news/chinese-state-visit-up-to-40-billion-deals-agreed.

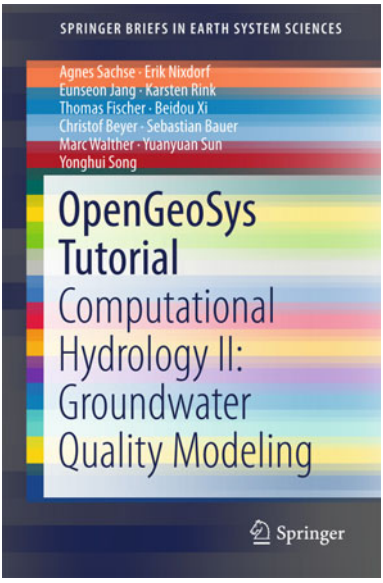
Previous Works: Research and Education

The Liaohe-Songhuajiang River Basin belongs to the priority areas of the Chinese Major Water Program. The Chinese central government launched a "Revitalizing Northeast China and Other Old Industrial Bases" campaign. The socio-economic development of Liao River Basin needs the supports of good water resource and environment. The "Major Water Program" took Liao River Basin as one of the most important demonstration basins, set up a full project under the river theme in the first stage of the programme (2008–2010), focusing on pollution source control technology development and continued such a project in the second stage (2011–2015), focusing on pollution load reduction and water environment restoration. The Topical Issue in Environmental Earth Sciences "Waste water treatment and pollution control in the Liao River Basin" compiles main results of the research of the "Major Water Program" within the 12th Five-Year-Plan dealing with wastewater treatment technologies, pollution control in the river basin, emerging pollutants and socio-economic studies.[14]

In addition to research work, educational material has been prepared for the Song-Liao River Basin. This tutorial presents the application of the open-source software OpenGeoSys (OGS) for hydrological simulations concerning conservative

[14]Yonghui Song, Ruixia Liu, Yuanyuan Sun, Kun Lei, Olaf Kolditz (2015): Waste water treatment and pollution control in the Liao River Basin. Environ Earth Sci, https://link.springer.com/article/10.1007/s12665-015-4333-7.

and reactive transport modelling. The tutorial was already applied on several international training courses on the subject held in China within the "SUSTAIN-H2O" project.[15]



This tutorial is the result of a close cooperation within the OGS community (www.opengeosys.org). These voluntary contributions are highly acknowledged. The book contains general information regarding hydrological modelling of a real case study and step-by-step model set-up with OGS and related components such as the OGS Data Explorer. Benchmark examples are presented in detail.

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[15] Sachse, A., Nixdorf, E., Jang, E., Rink, K., Fischer, Th., Xi, B., Beyer, C., Bauer, S., Walther, M., Sun, Y., Song, Y. (2017): OpenGeoSys Tutorial—Computational Hydrology II: Groundwater Quality Modeling. SpringerBriefs in Earth System Sciences. www.springer.com/us/book/9783319528083.

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Yonghui Song is Professor and the Vice-President of the Chinese Research Academy of Environmental Sciences (CRAES), which is affiliated to the Ministry of Environmental Protection (MEP) of China. He obtained his Ph.D. Degree in Environmental Science from the Research Center for Eco-Environmental Sciences of the Chinese Academy of Sciences in 1999 and his Dr.-Ing. in Environmental Engineering from the University of Karlsruhe (TH), Germany in 2003. His research focuses on water pollution control technologies, regional- and basin-level water environment management. He has undertaken over 20 national or ministerial/provincial scientific research projects as the principal investigator, published over 300 journal papers and obtained more than 20 patents. He received

the "Outstanding Research Team Award" of the "11th Five-Year Plan" of the Ministry of Science and Technology (MOST) of China in 2012 and the "Award of MEP for Science and Technology" in 2016. He was selected as the Youth Innovation of Science and Technology Leading Talent by MOST of China in 2012 and was selected as the Innovation of Science and Technology Leading Talent by Organization Department of the CPC Central Committee General Office of China in 2013.

Beidou Xi is the Chief Engineer's Office Manager in Chinese Research Academy of Environmental Sciences, the Chief Specialist of the Innovation Base of Groundwater and Environmental System Engineering in CRAES, and Director of the State Environmental Protection Key Laboratory of Simulation and Control of Groundwater Pollution. His research fields include techniques and materials for the remediation of contaminated groundwater, solid waste resource utilization and secondary pollution control and water environmental protection. He got his Ph.D. from Department of Environmental Sciences and Technology, Tsinghua University. After he did the Post Doc research in University of Regina, he worked in Chinese Research Academy of Environmental Sciences until now. He is sponsored by National Science Fund for Distinguished Young Scholars. He is the member of Chinese Association of Environmental Sciences, Chinese Association of Energy Environment Technology and China Renewable Resources Recycling Association. He undertakes several national research projects such as "973", "863" and "Major Water Program". He is also the editor of several scientific journals such as "Environmental Science Research", "Environmental Pollution Prevention and Control". He has published over 150 SCI-indexed articles and obtained over 70 patents.

Yuan Zhang is the Deputy Director of the Water Environment Research Centre, Chinese Research Academy of Environmental Sciences (CRAES) and the Chief Specialist of the Laboratory of Riverine Ecological Conservation and Technology in CRAES. He is also an Adjunct Professor and Ph.D. Supervisor at Beijing Normal University (BNU). The area of expertise is related to river ecosystem restoration technology and catchment water environmental management sciences. He got his Ph.D. from Department of Environmental Sciences, Beijing Normal University. After he did the Post Doc research and continue to work in Chinese Research Academy of Environmental Sciences until now. He has chaired over 10 projects including "Program 973" projects, Major S&T Special Projects, "National Natural Science Foundation" general projects and international collaborative projects. He has published or contributed to four monographs, four patents and 194 scholarly articles, amongst which over 70 in SCI-cited articles published like Environmental Science and Technology, Water Research and Chemosphere.

Kun Lei female, born in 1973, served as Professor of Chinese Research Academy of Environmental Sciences (CRAES), graduated from Ocean University of China in 2001. Longterm she dedicated in watershed environment management, especially the establishment of the water target management technology system in watershed and control units areas, material flux estimation methods from watershed to the coastal zone, environment quality evaluation technique of the estuarine and coastal zone, environment evolution trend and the mechanisms of the coastal and estuarine ecosystem under the influence of human activities, estuarine and costal hydrodynamic and water quality simulation, pollutants environmental capacity and total pollutant load allocation, integrated coastal and watershed management. In recent years, she has served as the person in charge of the subject of watershed water quality target management technology system and the watershed water environment capacity evaluation and regulation, the 12th Five-Year Plan of costal environmental pollution prevention and treatment, studies on

dynamic monitoring and evaluation technique of the estuarine and costal habitat in the Bohai Sea funded, Bohai land-sea flux estimate and total amount control technologies, which has lay the foundation for the watershed and coastal environment management, published more than 50 academic papers and 5 books (as a co-author or translator), got the second prize of the National Science and Technology in 2015, and the second prizes of the Ministry of Environmental Protection Science and Technology in 2009 and 2010.

Richard Williams is a Principal Scientist at the Natural Environment Research Council's Centre for Ecology and Hydrology (NERC-CEH), an organization he joined straight after receiving his degree in Chemical engineering from University College London, in 1980. His main area of research concerns the fate and behaviour of chemicals in the environment and in particular the application and development of mathematical models for helping to solve real-world problems related to river water quality. He has experience in modelling a wide range of potential contaminants of surface waters including nutrients, organic matter, micro-organic contaminants (including pesticides) and recently nano-particles. Currently, his research focuses on predicting the concentrations in rivers of "down-the-drain" chemicals e.g. personal care products, pharmaceuticals and steroid oestrogens. He uses GIS tools to make maps of contamination and combines maps with eco-toxicological effect levels to make risk maps. He makes these maps at a range of scales from small catchments up to the whole of the European continent. From 2013 to 2016, he led the NERC-CEH group on Water Resources Assessment. He was for 10 years a member of the Editorial Board of Pest Management Science (1999–2008). The Sustain H2O project was his first experience of working in China, although NERC-CEH has links with several universities and academies of science in China.

Mengheng Zhang has 25 years' working experiences in various capacities for international cooperation of climate change, ozone layer protection, sustainable development, marine protection, chemicals and air pollution. She has represented China as a chief negotiator at conferences of various multilateral environmental agreements, such as the Montreal Protocol on ozone layer protection, UNFCCC and Kyoto Protocol on climate change, Basel Convention on hazardous wastes and Rotterdam Convention on Chemicals. As a chief negotiator, she won USEPA's 2008 Ozone Layer Protection Award, which was presented to the Chinese Negotiating Team for the 19th Meeting of Parties. The award was recommended for her outstanding acumen shown in negotiating on the HCFC adjustments when she represented China at the 19th Meeting of the Parties to the Montreal Protocol. He has been the chairperson at the Intergovernmental Meeting of NOWPAP—a UNEP Regional Seas Programme. She has successfully coordinated the implementation of the project —"Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand" which was the biggest UNEP/GEF project, covered seven countries and lasted five years. She has rich experiences in coordinating large and multilateral environment programmes, such as ESP SUSTAIN H2O: EU-China Environmental Sustainability Programme on Demonstration of Pollution Discharge Management for Water Quality Improvement in Songhuajiang & Liaohe River Basin (2014–2017), GLOCOM Project: Global Partners in Contaminated Land Management under FP7 (2011–2015).

Weijing Kong is the Professor from Chinese Research Academy of Environmental Sciences. His research interests are related to freshwater ecosystem health assessment, freshwater ecosystem restoration skills and freshwater ecosystem function management region delineation. He got his ecological Ph.D. degree in 2009 studying river scape system pattern and process. He has led several projects in freshwater ecosystem theory and management, e.g. ESP SUSTAIN H2O: EU-China Environmental Sustainability Programme on Demonstration of Pollution Discharge Management for Water Quality Improvement in Songhuajiang & Liaohe River Basin (2014–2017); the NSFC project "Mechanism of habitat patches spatial heterogeneity during riparian natural rehabilitation process of riverine nature reserve" (41201187, 2012–2015), the National Water Pollution Control and Treatment Science and Technology Major Project "Freshwater ecosystem function management region delineation in Liaohe River basin" (2012ZX0750100102, 2012–2015).

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