MoMo
Integrated Water Resources Management Mongolia

Integrated Water Resources Management – Model Region Mongolia –

2nd Edition, November 2013

Project Profile

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Publisher: Helmholtz Centre for Environmental Research (UFZ)
Editors: Dr. Daniel Karthe | Prof. Dr. Dietrich Borchardt
Layout: perner&schmidt werbung und design gmbh
Sponsor: German Federal Ministry of Education and Research (BMBF)
Support: Project Management Jülich (PTJ)
Links: www.iwrm-momo.de
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The Kharaa River in December

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1. Introduction

Since 2006, the IWRM MoMo (Integrated Water Resources Management in Central Asia – Model Region Mongolia) project has been working on the development and implementation of strategies leading towards an IWRM for the Kharaa River Basin as a model region for Mongolia and Central Asia. The first project phase (2006 to 2009) aimed at the analysis of the catchment characteristics, future development scenarios and water governance structures in Mongolia. During the second project phase (from 2010 until 2013), this information was used to achieve an improved scientific understanding of the regional preconditions for an IWRM, to implement pilot measures in selected problem fields and to carry out multi-level Capacity Development.

The project was funded by the German Ministry of Education and Research (BMBF) in the framework of the FONA (Research for Sustainable Development) initiative, co-financed by contributions of participating SMEs and supported by the Mongolian side by providing infrastructure and personnel.

On the Mongolian side, an advisory council consisting of representatives from relevant national ministries (Ministry of Environment and Green Development; Ministry of Construction and Urban Development; Ministry of Education and Science), the interministerial National Water Committee, the state company for water infrastructures "Mongol Us", local authorities (municipal and provincial administrations for Darkhan and Orkhon Sum) as well as academics (National University of Mongolia, Mongolian University of Science and Technology) was established in December 2010 in order to ensure the bi-directional exchange of information between the project consortium and important local stakeholders.

Opening ceremony of the pilot wastewater treatment plant at Orkhon Sum by the Mongolian Minister of Nature, Environment and Tourism, Mr. Gansukh

2. German Partners

The following German partners are involved in the project:

- Helmholtz Centre for Environmental Research (UFZ)
- Fraunhofer Center for Applied Systems Technology (FhAST), Ilmenau
- Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)
- German Development Institute – Deutsches Institut für Entwicklungspolitik (DIE)
- Department Urban Water Management, Weimar University
- Center for Environmental Systems Research (CESR), Kassel University
- Department of Geography, Heidelberg University
- Training and Demonstration Centre for Decentralized Sewage Treatment (BDZ) e.V.
- Bergmann Clean Waste Water Technology (BCAT)
- Passavant-Roediger GmbH
- p2m Berlin GmbH
- terrestris GmbH & Co. KG
- seeconsult Germany GmbH
- geoflux GbR

3. Mongolian Partners

In the context of scientific research and implementation measures, the German partners cooperated with Mongolian institutions representing acedemics, administration and the water sector. These include:

- National University of Mongolia (NUM)
- Mongolian University of Science and Technology (MUST)
- Mongolian State University of Agriculture
- Mongolian Academy of Sciences
- Mongolian Institute of Meteorology and Hydrology
- Mongolian Ministry of Education and Science
- Mongolian Ministry of Environment and Green Development
- Mongolian Ministry of Construction and Urban Development
- Mongolian Ministry of Finance
- State Company "Mongol Us" (formerly: National Water Authority of Mongolia)
- National Water Committee
- Darkhan-uul Aimag
- Darkhan Sum and Orkhon Sum
- Municipal water supply company of Darkhan city (USAG)
- Undurkash Ltd.

AIM ("Assistance for Implementation") and MoMo project team visiting the SBR reactor at Darkhan's central wastewater treatment plant

4. Project Structure

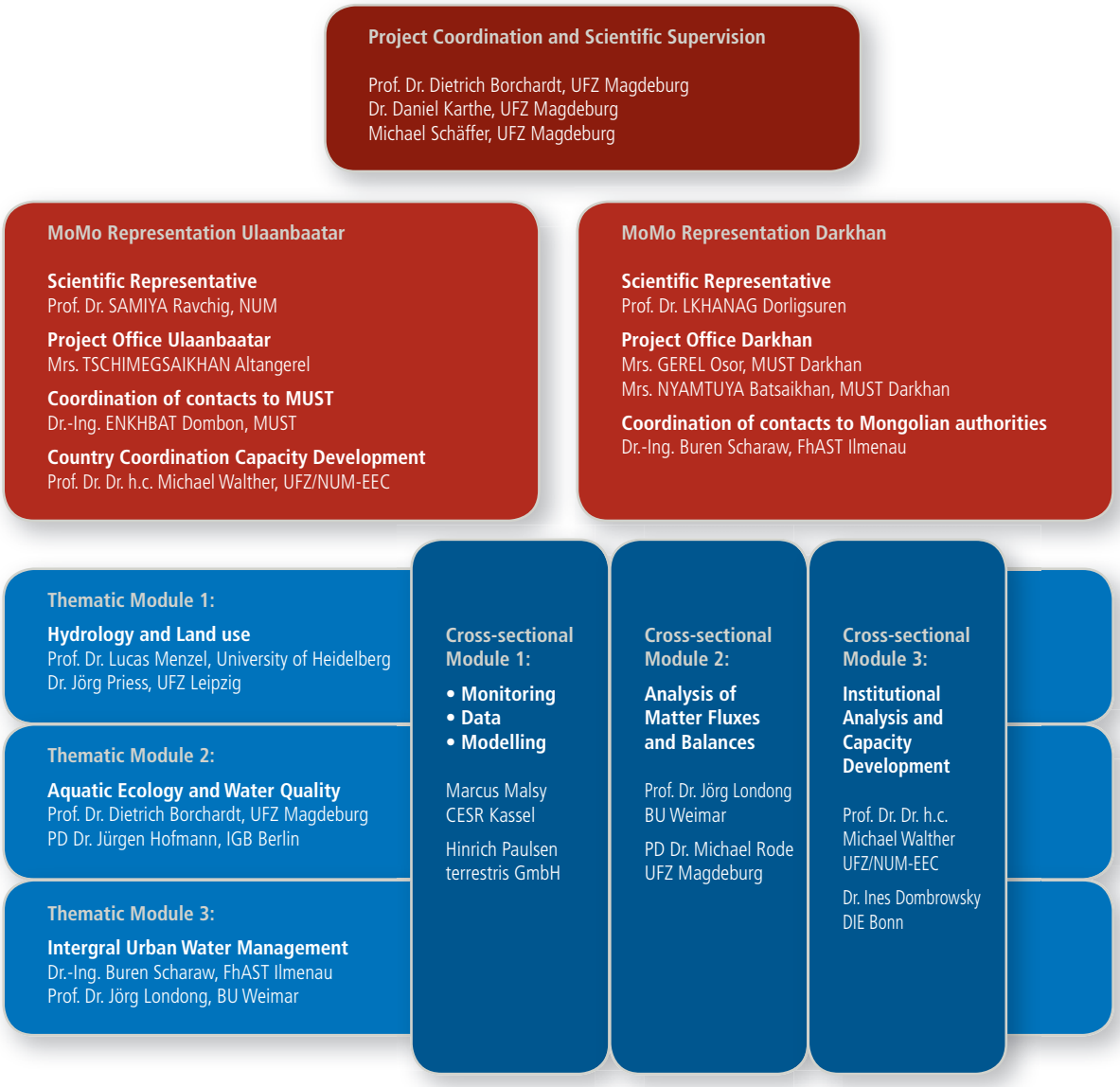


Figure 1: In order to deal with the complex challenges of an IWRM in a systematic way, the IWRM MoMo 2 project was structured into 3 thematic and 3 cross-sectional modules

5. MoMo and the IWRM Concept

Integrated Water Resources Management (IWRM) is "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (German Water Partnership 2000).

Thus, IWRM promotes the consideration of water in a holistic fashion and within natural ecosystem limits, i.e. river basins. IWRM takes into account anthropogenic water usage (drinking water supply, irrigation, hydropower generation, industrial water needs), ecological functions of water bodies as well as cultural and emotional values. Water resources are dealt with from a perspective that is not only hydrological but transdisciplinary, including the political and economic dimensions.

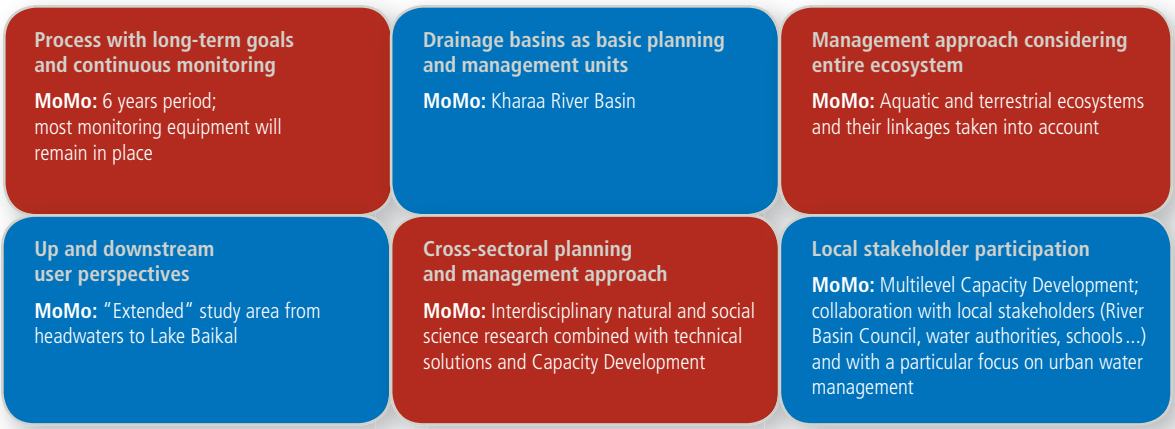


Figure 2: The IWRM concept and its realization in the MoMo project

6. Project Area

The project area is the basin of the Kharaa river system (see figure 3). A particular focus lies on the city of Darkhan and its surroundings.

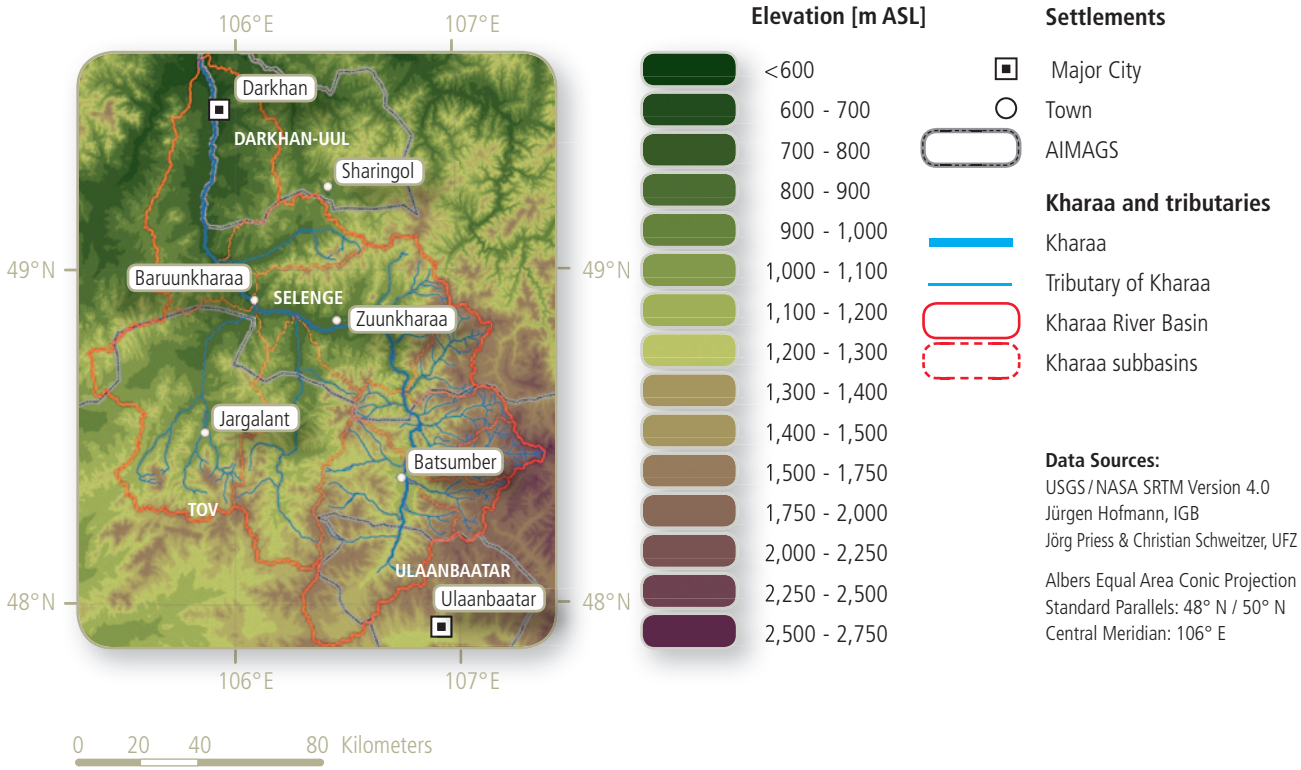


Figure 3: Map of the Kharaa River Basin

Location:	North of the capital Ulaanbaatar
	South of the Russian border and Lake Baikal
Area:	about 15,000 km²
Lowest elevation:	654 m (confluence of Kharaa and Orkhon)
Highest elevation:	2799 m (in the Khentii Mountains)
Population:	in total: about 120,000
	in Darkhan: about 92,000

7. Main Objectives

Boroo Gold Mine

The Kharaa river basin suffers from a series of problems, including the effects of global climate change, diffuse pollution, mining impacts, lacks of adequate water supply and sanitation infrastructure in the rural and urban context, endangered ecological functions of rivers and continuing deterioration of riparian land resources. These are well representative of the difficulties faced in other river basins in Mongolia and Central Asia.

The general objective of the IWRM MoMo project is the development of an integrated concept for sustainable water management consisting of modular elements with duplication potentials for a range of different settings. This involves three subgoals:

- The assessment and understanding of trends in water availability and quality. Relevant drivers include both environmental and socio-economic changes.
- Capacity development for planners, decision makers and actors at various levels to generate the local competence required to sustainably manage the water resources in the Kharaa river basin and throughout Mongolia.
- Technical solutions which are adapted to the harsh physical environment and the socio-economic setting. These include both decentralized approaches for sparsely settled rural regions and solutions for improving water supply and waste water disposal in urban regions.

Because the exploitation of mineral resources (esp. gold und copper) plays a major role in the region and nationwide, the mining sector has a particular relevance in the contexts of operative environmental monitoring and water management.

8. Scientific Issues

The following issues are considered scientifically in the project:

Impact of climate change: A rise in temperatures (of more than 2K since the 1940s) causes higher evapotranspiration and ultimately less surface and groundwater generation. Higher sublimation rates in the headwater region during the winter months reduce the amount of surface water available during snowmelt. All these factors are quantified and transferred in process-based hydrological models which are also driven with output from climate (change) models.

Overexploitation of water resources: Currently, the Mongolian government encourages the expansion of irrigated agriculture and mining activities. Combined with high and increasing livestock densities and changing lifestyles, a higher water demand is generated and water quality deteriorates. For example, some small streams have fallen dry during recent years, and the emergence of algal blooms below urban areas indicates nutrient influxes due to poor waste water management. The project analyzes such changes and the institutional responses.

Diffuse pollution: Significant non-point sources of water pollution observed in the region include soil erosion, drainage and run-off caused by mining operations, industrial waste disposal, accidental spills of contaminants, and run-off from streets and roads around human settlements.

Mining: The catchment is located within Mongolia's 'copper and gold triangle'. The presence of these deposits drives rapidly expanding mining activities with intense water uses. These may significantly alter available water resources. In addition, tailings and wastes containing cyanides, heavy metals and fine sediments can pollute surface and ground waters.

Water supply and sanitation: The poor state and performance of current urban wastewater infrastructure and lack of adequate sanitation services are important causes of morbidity and the widespread occurrence of waterborne diseases, particularly in rural areas and the ger settlements on the periphery of towns. Technical solutions adapted to local conditions are needed.

Protection of aquatic ecosystems: Because of the extreme climate, the region's ecosystems are particularly vulnerable, including surface waters. The aquatic ecosystems are nearly virgin in the Kharaa's headwater region but show clear signs of degradation and declining biodiversity in their lower stretches. Via the Orkhon and Selenga, the Kharaa discharges to Lake Baikal which is a natural heritage according to international conventions.

Investigating the fish fauna

9. Deliverables

The project generated information suitable for decision support, including

- a comprehensive assessment of the state of the region's aquatic resources;
- a science-based understanding of the links between climate, land use and hydrology, including future scenarios;
- a geo-database system which is accessible to users via a web-frontend and a freely distributible live DVD;
- pilot wastewater treatment facilities generating design parameters for adapted technologies for urban, informal and rural settlements;
- tools for the identification of leaks in Darkhan's central water supply system, which is a prerequisite for interventions;
- recommendations for water quality standards in Mongolia (requested by the Mongolian Ministry of Nature, Environment and Tourism and the Mongolian Ministry of Roads, Transportation, Construction and Urban Development);
- scientific and policy advice for the Kharaa River Basin Council.

Moreover, the project

- has established an operational hydrological and water quality monitoring network in the Kharaa river basin and set up a geo-database;
- contributes towards improved sanitation in Darkhan's ger districts;
- has built pilot waste water treatment plants that are adapted to the extremely continental climate and assess their practical suitability;
- had conducted extensive capacity development measures addressing various actors, including the local population, schools, universities, water sector professionals and decision makers;
- has disseminated research results in various ways, including peer-reviewed publications, brochures, film spots and participated in a series of events (conferences, workshops, fairs).

Methodologies on the determination of available water resources and their drivers, operative monitoring, capacity development and the institutional strengthening of administrative bodies may provide substantial support for the development and implementation of sustainable mining practices in the country.

10. Scientific Results

With regard to surface and ground waters and their usage, the IWRM MoMo project investigated quantitative and qualitative trends and their determinants. The data sets collected by the project team allow for a much better assessment of the region's water resources than before, identifying both key problems and management options. For the Kharaa River Basin, a rise in temperatures (+2K since the 1940s) coincided with a decline in precipitation which was particularly marked in the 1990s and early 20th century. Consequently, a significant reduction of the mean annual runoff of the Kharaa could be observed.

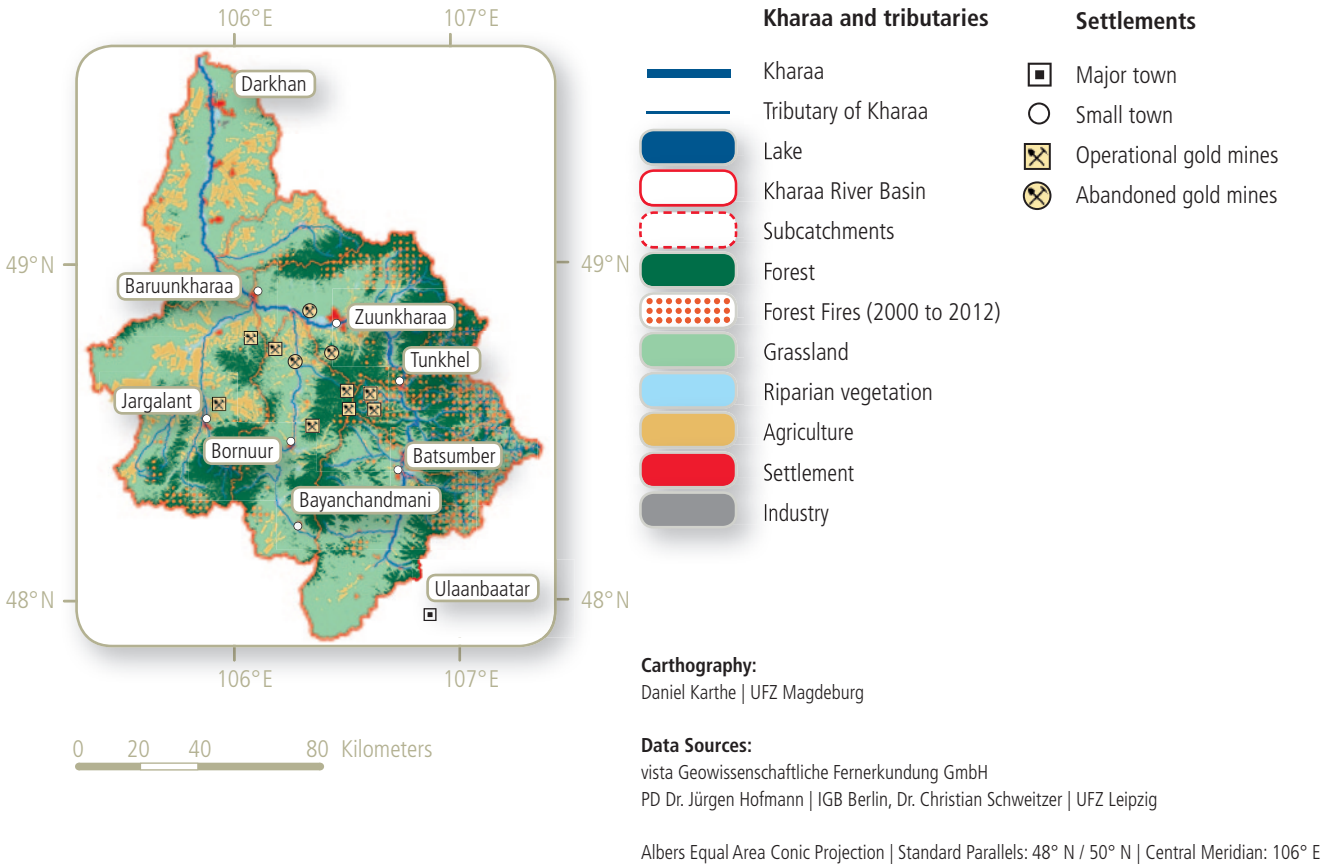
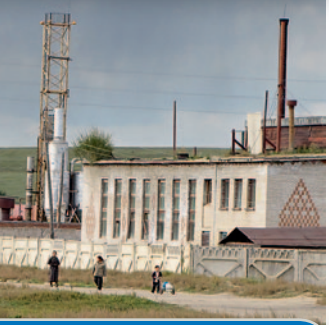


Figure 4: Landuse, mining and forest fires in the Kharaa River Basin

High grazing pressure, an important cause of riverbank erosion



Chemical factory in Khongor, where a major accident in 2007 released arsenic and cyanides

Besides climate trends, land use changes play a significant role for the regional hydrological cycle. Of particular relevance in this context are forest losses in the upper Kharaa River Basin, which are caused both by forest fires and logging (figure 4). This deforestation has negative impacts on both ground and surface water generation, and leads to a reduced water availability further downstream.

With regard to water quality and the state of aquatic ecosystems, the following problem fields were identified:

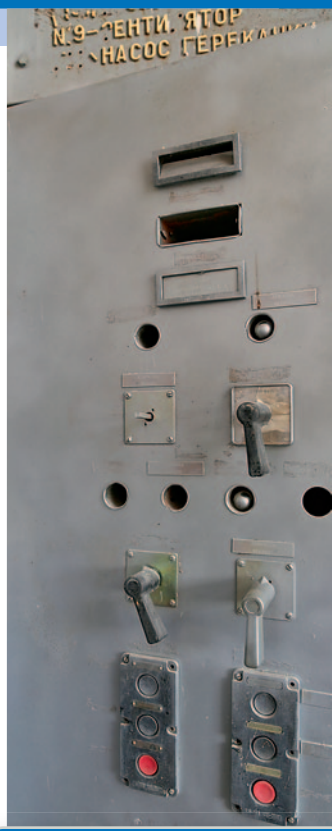
- High fine sediment loads lead to aquatic ecosystem impairments. River bank erosion, which is considerably intensified by high grazing pressures around river banks, is the main source of fine sediment inputs.
- Increased levels of arsenic and mercury have been detected in water, fluvial sediments and aquatic biota. The main sources of these contaminants are mining activities and the combustion of coal containing elevated levels of arsenic.
- With regard to nutrient levels, there is a clear longitudinal gradient along the Kharaa River. Downstream of Darkhan and close to the outlet of the Kharaa River Basin, nutrient concentrations are significantly elevated as compared to natural background conditions. Poor waste water treatment in urban areas is an important reason for this increase. Recreational fishing, both by domestic and international tourists, results in growing pressures.

Poor nutrient elimination, a consequence of dilapidated waste water treatment systems

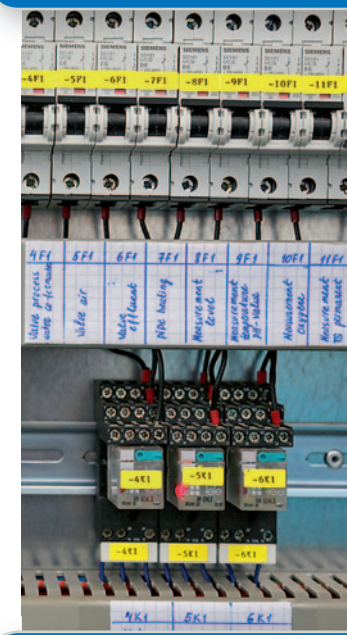
11. Pilot Measures

Based on the project's scientific findings, priority areas for interventions were identied and management solutions analyzed. Finally, selected pilot measures with a high duplication potential were implemented:

- An innovative toilet system was installed in pilot households of Bag 7 , a ger (yurt) district in the city in Darkhan. The core of the system is a new type of a private dry separation toilet, called the iPiT (integrated personal innovative toilet). Urine and feces are collected seperately. While urine was found to be a suitable fertilizer, feces are transported to the city's central wastewater treatment plant (WWTP) and subsequently cofermented with excess sluge from the waste water treatment plant in a biogas reactor. It could be demonstrated that it is feasible to store feces during the winter to allow a more energy-effective operation of the biogas reactor. Moreover, the iPiT has considerable hygienic advantages over conventional latrine systems which frequently contaminate nearby water sources.
- A pilot SBR (sequence batch reactor) unit was installed at Darkhan's central WWTP and officially inaugurated in the presence of a Mongolian government delegation in August 2011. Operational experiences have shown that with appropriate adaptations to the climatic conditions in the region and custom-tailored training for staff, this technology is a reliable and easily scalable solution for a city with a high growth potential. Therefore, the municipal water supply and sewerage company of Darkhan considers the approach a promising technology for a future overhaul of the entire WWTP.
- A second wastewater treatment plant was built at a kindergarden in Orkhon Sum and has been operational without interruption since August 2011. Based on an innovative biofilm carrier technology, it is an ideal solution for decentral to semi-central waste water management, which is of very high relevance in Mongolia. The simple and robust operation has already led to private and government investments using the MoMo-tested technology.
- A constructed wetland was created next to the Mongolian University of Science and Technology in Darkhan and entered the testing phase in 2012. This approach combines waste water treatment with the production of wood which can be used as a fuel or construction material, thereby reducing the pressure on floodplain vegetation which is already critically degraded.
- A combination of multi-parameter probes installed in Darkhan's water supply network and hydraulic modelling has helped to identify and quantify leaks. Based on these priorizations, the city of Darkhan has started a major campaign to replace pipes. Because leakage losses account for roughly half of the water consumed in practically all urban areas with centralized supply systems, Mongolian authorities are interested in similar leak detection campaigns elsewhere.



Old control technology



New control technology

Hydrological and water quality monitoring station at Buren Tolgoi

Copyright: Buren Scharaw, FhAST Ilmenau

Installation of the multiparameter probe for leak detection

- Capacity Development activities were carried out at various levels, ranging from the general public to the educational sector, water professionals and political/administrative decision-makers. Consultation is provided in the context of a nationwide formation of River Basin Councils. Study tours to Germany were conducted for students, experts and stakeholders dealing with environmental education, decentralized waste water treatment and urban water management.

Results of the IWRM MoMo project were showcased at multiple occasions in Mongolia, Germany and internationally. The project organized on site demonstrations for relevant Mongolian stakeholders, including high-ranking government officials. Moreover, the project's status workshops were attended not only by scientists but also by decision makers from ministries, regional authorities and "Mongol Us", the state-owned company for water infrastructures.

In Germany, results of the project were presented at major international conferences and fairs, including IFAT Munich (the leading international trade fair for environment, waste water and waste disposal) and Wasser Berlin. Moreover, representatives of the project participated in and co-organized international conferences, including IWA Water Professional conferences, the EGU General Assembly and the BMBF-supported IWRM conferences.

Introduction of iPiT dry toilet system in Bag 7, Darkhan

Copyright: Jürgen Stauder, Bauhaus-Uni Weimar

Exchange of drinking water pipelines as a result of leak detection

12. From Research to Implementation

One of the R&D project objectives is to support the transfer of the scientific and technical findings to (i) practical full scale application of innovative solutions and (ii) the solving of comparable issues in other regions.

At the end of the second project phase, the MoMo project has

- developed the scientific basis of an IWRM concept for the Kharaa River Basin, made accessible in various forms, including a geodata portal (online and on DVD);
- implemented an operational hydrological and water quality monitoring system;
- piloted and proof-tested innovative solutions for water supply and sanitation in northern Mongolia in rural and urban contexts.

Scientific documentation generated by the project and partially developed in cooperation with senior professionals from several ministries is now available to domestic planners and decision makers for policy enhancement and investment programming in the Kharaa River Basin as well as other comparable regions in Mongolia.

A considerable part of international investments in Mongolia now targets the mining sector. Mongolia is among the world's 10 most resource-rich countries and dynamic development in the mining sector is the key driver for economic growth in Mongolia (12% in 2012). It is expected to remain high throughout the next decade (Asian Development Bank 2013; Germany Trade & Invest 2013).

In October 2011, a cooperation agreement between the Government of Mongolia and the Government of the Federal Republic of Germany on mineral resources, industrialization and technology was signed. Important aspects include scientific and technological cooperation in the efficient use of resources, and the development and implementation of environmental and social standards in the mining sector. The large water demand of the mining sector, limited water availability in many deposit areas and risks of accidental water contamination mean that the results and expertise showcased in the MoMo project are highly relevant in this context. In particular, the generated information on the hydrological system and its determinants, the quantification of available water resources, operative monitoring, water quality and environmental standards, capacity development and the institutional strengthening of administrative bodies are valuable for the development and implementation of sustainable mining practices in the country.

The innovative pilot technologies proof-tested in the field of urban and rural water supply and wastewater management have generated a wealth of design and operational solutions that can be easily used for the planning and viability assessment of full scale systems operating efficiently under the extreme weather conditions prevailing in northern Mongolia.

In order to facilitate the dissemination and application of innovative solutions proof – tested in the R&D project, the project team is collaborating with an initiative carried out by the International Bureau of the German Federal Ministry of Education and Research. Called "Assistance for Implementation" or "AIM", the initiative fosters the dialogue with relevant Mongolian Ministries and Authorities in charge of water resources policy and management and infrastructure development in the country. AIM also assists the development of linkages with potential financing institutions like development banks.

The most prominent example of the successful cooperation between the Mongolian administration, the MoMo project and the AIM initiative lies in the successful application for a prefeasibility study titled "Water Supply and Sanitation Infrastructure Improvement Project (WSSIIP) for the City of Darkhan, Mongolia".

Mongolian delegation visiting the BMBF stall at Wasser Berlin 2013

MoMo scientists informing Massimo Pedrone (Asian Development Bank Manila) about the MoMo project

Three MoMo scientists receive medals of honor at the project's status workshop in 2013

The objectives of the prefeasibility study include:

- a critical review of the results of the IWRM MoMo project with regard to an upscaling of MoMo-tested pilot solutions for large-scale application in Darkhan and similar provincial capitals;
- the preparation of a CDIA feasibility study on the identification of priority measures in the drinking water supply and waste water management sectors for Darkhan city, which have a duplication potential for other provincial capitals;
- the development of modular model solutions for a cost-effective water supply, sanitation and waste water management systems for the ger areas of Darkhan.

Another important field of cooperation between the MoMo project and AIM lies in the development of a River Basin Management Plan for the Kharaa River Basin. In recent years, comprehensive structural reforms of the Mongolian water sector have been carried out, with IWRM now being considered the key concept for water resources management. Consequently, 29 river basins of national importance were identified and river basin administrations and councils are currently being set up. Following a guideline for river basin management planning published by the Mongolian government and based on the results of the MoMo project, the Kharaa River Basin was selected by Mongolian authorities as a model region for the development and implementation of a science-based river basin management plan.

During the past three years, strong signals of interest on the results and findings of the project were received from a number of Mongolian authorities as well as from Russia and Kazakhstan.

Both private and public investors have decided or are considering to use MoMo-tested waste water treatment solutions. Moreover, representatives of the MoMo project are in dialogue with "Mongol Us", the newly-formed state-owned company that will in the future be responsible for water infrastructures and water resources monitoring.
Funded by the International Bureau of the German Federal Ministry of Education and Research and co-financed by Russian and Kazakh partners, projects aiming at the analysis of transfer and duplication potentials and necessary adaptations of MoMo results and solutions have recently started.

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For a full publications list, please refer to www.iwrm-momo.de

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