The Urban-Rural Nexus and its role for solving the global water quality challenge
Prof. Dr. Dietrich Borchardt (UFZ and TU Dresden)
My institutional background

Two forces in a cutting-edge cluster on water

CAWR
Center for Advanced Water Research

HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH – UFZ

TECHNISCHE UNIVERSITÄT DRESDEN

22 professorships, ca. 280 scientists

25 professorships, ca. 250 scientists

5 joint appointments

Joint postgraduate education & training (HIGRADE, CIPSEM)
CAWR approach: integrated regional water resources management in the global context

The Center for Advanced Water Research focuses its work on the fields of research, education & training and transfer.

CONTRIBUTIONS TO AN „INTEGRATED WATER RESOURCES MANAGEMENT IN THE CONTEXT OF GLOBAL CHANGE“ THROUGH JOINT ACTIVITIES & PROJECTS

- **Education & Training**: „classical“ & „open access“
  - Master- & PhD-Programs, E-learning, UNU etc.

- **Research**: Theoretical & applied, national & international
  - Infrastructure: TERENO, ICOS, Data-Infrastructure

- **Transfer**: Research & Praxis (national & international)
  - GIZ, CIPSEM-UNEP GWP, KfW etc.
Pre-study for a World Water Quality Assessment

UN-Water Analytical Brief (in review)
Water quality challenge

• Wastewater production at least doubling by 2050 → Sewerage connections increasing
• But not wastewater treatment → More untreated wastewater to rivers and lakes

Health:
Health risk of contaminated rivers & lakes → contact with surface waters → washing, cleaning, drinking

Food Security:
95% inland fishery production from developing world
200 million Africans consume fish regularly
• The **generic concept** behind the assessment:

- **Drivers (D)**: Population growth
- **Pressures (P)**: Waste water load
- **State (S)**: Conc. BOD, NH$_4^+$, ...
- **Impacts (I)**: Food security
- **Response (R)**: SDGs eg. connec. x% of pop. to sanit.

Efficiency of WWTPs
Data driven analysis – example oxygen

Actual status
- Oxygen concentration <7mg/l
- Oxygen concentration >7mg/l

Trend (2000’s vs. 1990’s)
- Decreasing trend
- No or increasing trend
**Water quality and food security: intake from inland fishery**

**Description** :- Estimation of the level of consumption of inland fisheries per person per country.

**Method** :- Reported inland fisheries catch (t) divided by the official national population.

**Categorisation** :- Higher risk: ≥ 1,86 kg/capita/2010 and Lower risk: < 1,86 kg/capita/2010 (75th percentile of countries reporting inland fisheries yields)
**Water quality and food security: “BOD hot spots”**

**Description**: Percentage of river stretches in each country with “increasing trend of BOD of particular concern” meaning that in these stretches the pollution level increased into the severe pollution category in 2008-10, or that they were already in the severe pollution category in 1990-1992 and further increased in concentration by 2008-2010.
Model driven analysis – example fecal coliforms

Description :- Estimated in-stream concentrations of faecal coliform bacteria (FC) for Latin America, Africa and Asia for February 2008-2010. Bar charts show minimum and maximum monthly estimates of river stretches in the severe pollution class per continent in the 36-month period from 2008-2010.
Main messages of the WWQA Phase 1

• **Water pollution has worsened since the 1990s** in almost all rivers in Latin America, Africa and Asia.

• **Severe pathogen pollution already affects around one-third of all river stretches** in Latin America, Africa and Asia.

• **The number of people at risk to health** by coming into contact with polluted surface waters **may range into the tens of millions** on these continents.

• **Severe organic pollution already affects around one-seventh of all river stretches** in Latin America, Africa and Asia.

• **The food security from inland fisheries is threatened** in a number of countries in Africa and Asia.
Main messages of the WWQA Phase 1

• There is a substantial data and information gap

• Very low density of monitoring stations in the only global data bank (GEMStat)
  
  • typical minimum density of around 1.5 to 4 stations per 10,000 km² of river basin area in the USA and Europe.
  
  • The average density for the Latin American continent is 0.3 stations per 10,000 km², for Africa 0.02 stations per 10,000 km², and for Asia, 0.08 stations per 10,000 km²

• Significant inconsistencies between global assessment and regional knowledge/information needs

• Efforts and priorities on data-deficient rivers/catchment needed => crucial for management
Regional water management in the nexus context
Kharaa River and Darkhan City (Mongolia)
Quantitative and qualitative Monitoring of water resources in the Kharaa River and in Darkhan City

Monitoring concept of the MoMo-project

Three levels

- **Surveillance monitoring**
  (giving an overview at catchment scales)

- **Operational monitoring**
  (at higher resolution for the identification of pressures and impacts and operation of infrastructures; e.g. drinking water)

- **Investigative monitoring**
  (at regional scales related to specific problems, e.g. source identification of heavy metal contamination)
Quantitative and qualitative Monitoring of water resources in the Kharaa River and in Darkhan City

Kharaa River Basin with monitoring stations established in the MoMo-Project

Cartography: Philipp Theuring, Daniel Karthe / UFZ Magdeburg

Data Sources:
USGS/NASA SRTM Version 4.0
MoMo Consortium

Albers Equal Area Conic Projection
Standard Parallels: 48° N / 50° N
Central Meridian: 106° E

Kharaa catchment
Kharaa subbasins
Meteorological Stations
Waterlevel monitoring
WQM Stations

Symbols represent only stations installed by the IWRM MoMo project.
- Hydrological monitoring stations set up in the up-, mid- and downstream sections of the Kharaa with automated data transfer
Groundwater resources monitoring and modelling in Darkhan City in MoMo III

- Online-Monitoring of groundwater (Quality and Quantity)
- Training and transfer of monitoring infrastructure and assessment tools to local authorities
- Contribution to the strategic master plan for the Kharaa River Basin until 2030

Ressources and use intensities

Risk analysis
Drinking water supply and risks to human health

- particular challenges in periurban ger districts

- underconsumption: about 8L / P per day

- two main distribution systems:
  - water kiosks (piped water, delivery by truck, tubewell)
  - private wells, which are shallow in the floodplains → high risk of contamination due to latrines and animal excreta

- no reliable data on water-borne diseases available, but: indications of massive rise in hepatitis A

- facilities for virological testing exist only centrally (Ulaanbaatar)
A new rapid detection system for pathogens in water (EDIT)

- Mobile Cross flow filtration device
- Pathogens to be detected
- Microchip in Lab-on-chip system
- Automated Lab-on-chip system
- Positioning of sampling sites and data transfer

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Viruses</th>
<th>Phages</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Escherichia coli</em></td>
<td><em>Norovirus GGI-I</em></td>
<td><em>MS2</em></td>
</tr>
<tr>
<td><em>Enterococcus faecalis</em></td>
<td><em>Adenovirus 40,41,52</em></td>
<td><em>PhiX174</em></td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td><em>Enteroviruses</em></td>
<td></td>
</tr>
<tr>
<td><em>Campylobacter jejuni</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Klebsiella pneumoniae</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Klebsiella oxytoca</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
From monitoring data to consistent information: the MoMo-Geoportal

Geodata structure based on open software platform

- Free and open software for web based analysis and visualisation of data and information
- Geodata from MoMo I and MoMo II in one consistent data environment
Summary and conclusions

- **A wide range of technical options are available** for water pollution control and for short-cutting the negative trends of the water quality challenge. These include:
  -Pollution prevention and source control
  -Wastewater treatment
  -Safe reuse
  -Protecting and restoring aquatic ecosystems

- **Multiple entry points for management linked** with society’s priorities such as health, food security and water security => **nexus approach**

- **Information/data base ↔ technological approaches/solutions** crucial, but innovative/effective approaches available
Thank you very much for your attention

Prof. Dr. Dietrich Borchardt
Helmholtz-Centre for Environmental Research – UFZ
TU Dresden

dietrich.borchardt@ufz.de