Integrated Water Resources Management (IWRM) in Karst Areas, Gunung Kidul, Indonesia (2008-2013)

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Karst and water

- Karst is related to the occurrence of **carbonate and gypsum rock**
- Approx. 20% of the world population live on the carbonate rock
- Over a **quarter** of mankind in the world depends on karst aquifer as their source of water
- In many cases, karst regions are suffering from **water scarcity** especially during dry seasons due to the absence of surface water storage possibilities
- In many karst regions exist **underground river networks** with large water potentials even during dry season
Problem of utilization karst water

- **Poor Accessibility**, often deeply underground (in some cases the groundwater level is more than 100 m deep)

- Karst water springs are *rarely* existed, the capacity rate has high variability

- High lifting head cause **high operational cost** for extraction the water using diesel and/or electric pump

- **High vulnerability** to contamination

- **Renewable energy** for 24 hours operation → cave hydroppower plant
- **Application of “appropriate technologies”** (e.g. simple operation, robust, cost-effective & low-maintenance)
- **Cave laboratory** for knowledge transfer, further research and development, capacity development and multiplication

Energy from Hydro Power:
Energy potential approx. 300 kW at design discharge of 2 m³/s

Water supply (24h operation):
75 lpcd for 80,000 people
Vertical shaft drilling technology

Development and implementation of the innovative Vertical Shaft Sinking Machine (VSM 2500)
Vertical shaft drilling technology

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President S. B. Yudhoyono
Vertical shaft drilling technology

Development and implementation of the innovative Vertical Shaft Sinking Machine (VSM 2500)

(VSM 8000 Kuwait)

(VSM 11000 Jeddah, Saudi Arabia)
Water supply technology

“Pump as Turbine (PaT)”

- low investment costs
- easy to maintain
- easy to operate

⇒ “appropriate technology”

Results of optimisation

Test rig at KSB AG

Test rig at TRL (IWG-KIT)
IWRM basic conception – model region Gunung Kidul
(2008 – 2013)

- Exploration of water resources
- Water resources management/Regenerative energies
- Sewage-/waste treatment
- Improvement of living conditions
- Water distribution/Intermediate storage
- Ecological and microeconomic validation

- Estimation of technological development effects
- Socio-economic framework
- Break into new markets/Appropriate Technologies
- 2+2 Concept/Capacity Building
- Sustainability/Participation

- Protection of water resources/Sustainable Use
- Drinking water quality backup
- Ecological and microeconomic validation

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IWRM joint project (German consortium)

- 11 Research Partners
- 6 Industry Partners
- Various counterparts

Industry Partners
KSB AG (Pumpen/Turbinen)
IDS GmbH
COS Systemhaus OHG
GIF GmbH
CIP GmbH
Huber AG
and more partners from construction and water sector
Solutions for sustainable water distribution

- Data management & system analysis
  - Adapted tools and methods
    - for data management
      (e.g. GIS-integrated network register)
    - for hydraulic analysis
      (e.g. numerical model)
  - Capacity building

- Adapted system concept
  - Availability vs. consumption,
    approach: equal distribution of available water
  - Continuously pressurized pipe network
  - Control of consumption

\[ Q(t) = \sum C_i \]
WP 3 Water Quality

Water treatment technology

- Continuous water quality **monitoring** and **implementation** of water treatment **field laboratory** (container system with a.o. slow sand filtration, ceramic membrane filtration, UV-disinfection, etc) as a **research** and **learning object** for German and Indonesian partners (e.g. research centers, universities, planning authority-BAPEDA)

- **Development** of sustainable drinking water treatment and hygienisation concepts

Field laboratory with different water treatment technologies (in container system)

Water quality monitoring activities

Examination of different filter materials (considering local availabilities)
Sanitation and waste management

- Development and implementation of adapted technologies for wastewater and waste treatment → **protection of groundwater resources and health**
- Implementation of **co-fermentation** (in test) and **co-composting** (in planned) pilot-system for septic sludge and bio-waste in semi-centralised plants

Co-fermentation in a two-step process (pilot-plant in container system)

Co-composting system (example)
WP 7 Coordination / Data Management

Data management & decision support system

Development of interdisciplinary web-based information system
- for information exchange within project consortium
- as interface to integrate the application of different models
- as long-term planning instrument for sustainable water resources management

System architecture  COSVega information system
Transferability / multiplication

- Transferability within Indonesia (**actual**: result of multiplication workshop → preparation a proposal for **multiplication concepts**, a.o. establishment of monitoring system at potential locations, pre-feasibility study for possible 3rd “demonstration” project, etc)

- Transferability to world-wide existing (Karst) areas (**actual**: project preparations Thailand & Vietnam)

Karst area in Indonesia (above) and regions which are facing water scarcity problems e.g. Java, Madura, Bali, Sumba, Sulawesi (below)

Karst region in Vietnam
Terima kasih atas perhatian anda

Danke für Ihre Aufmerksamkeit!
Research topics and implementations

- **Identification** of the water resources situation (e.g. geological and hydrological boundary conditions, underground river interconnections, hydrogeology model for karst)
- **Appropriate water supply technology** (second alternative: wood-stave pipeline)
- Optimisation of **water distribution network** (simulation modell / rehabilitation concept / SCADA)
- Adapted **water and wastewater treatment** (container system in laboratory scale)
- **Web-based GIS** technology as water management tools and DSS
- **Sustainability and capacity development** (e.g. technology assessment, social cultural analysis)

Physical model of the wood-stave pipeline

Simulation of bribin water distribution network

Wastewater treatment container – end 2010 will be delivered to Indonesia
Concept for Sustainable Solution

- **Cave hydropower plant** for extraction of underground water (water storage with barrage)
- Implementation of **“appropriate technologies”** (simple operation, robust, cost-effective & low-maintenance)
- Development of **“cave laboratory”** for e.g. knowledge transfer, R&D, capacity development and multiplication

*Energy from Hydro Power:*
*Energy potential approx. 300 kW at design discharge of 2 m³/s*

*Water supply (24h operation):* 75 lpcd for 80,000 people

- New developed vertical drilling machine for karstic area
- Test rig for the implemented technology (IWG) → optimisation
- Implementation of adapted water supply technology and „cave laboratory“
Concept for sustainable solution (Bribin Project 2002 – 2008)

- **Renewable energy** for 24 hours operation → cave hydropower plant
- **Application of “appropriate technologies”** (e.g. simple operation, robust, cost-effective & low-maintenance)
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Energy from Hydro Power: Energy potential approx. 300 kW at design discharge of 2 m³/s
Controlling & monitoring technologies

Electro-technique

Development of real-time data connection to Germany

Control instruments a.o. VAG “Plunger Valve”

Monitoring (e.g. water level, seepage, geology)
Development underground hydropower plant

Variation: Wood stave pipeline

Physical and numerical model at KIT

Example of development wood stave pipeline in Island

Gua Seropan

Preliminary Design (State March 09):
- Approx. 210 m wood stave pipeline
- 3 Modules (ETA 300-340 + 6 phase pump)

Pressure Head \( H = 15 \) m
Design-discharge \( Q = 0.5-1.0 \) m³/s
Pump head \( H_f = 110 \) m
Output \( q = 40 - 96 \) l/s

\[ \rightarrow 24 \text{ h/d} \]
\[ \rightarrow \text{up to 55 lpcd for 150.000 people} \]
WP 3 Water Distribution

Solutions for sustainable water distribution

- Optimized operation and control
  Connecting SCADA & numerical model for real-time data processing

Further models
- GIS
- Demand projection

Numerical model
- Simulation of Q, H
- Optimisation of operation

Control system/SCADA
- Control decisions
- Surveillance

GSM net
- Measured Q, H, WL
- Optimized control set points

Distribution system
- Simulation of Q, H, WL at metering point
- Q, H, WL at any point of the network
- Alarms
- Control strategies

WP 3 Water Distribution
IWRM cooperation partners (3+3 Concept)

**Government**
- BMBF

**Science**
- Karlsruhe Institute of Technology (9 Institutes)
- University of Giessen
- Water Technology Center

**Industry**
- KSB AG
- IDS GmbH
- COS Systemhaus
- GIF GmbH
- CIP GmbH
- Huber AG

**Science**
- BATAN
- UGM – Yogyakarta
- UNS – Yogyakarta
- UII – Yogyakarta
- ITS – Surabaya
- UPN – Yogyakarta

**Industry**
- PT Wijaya Karya
- PT KSB Indonesia
- PT Bestindo
- CV Tatonas
- CV GeoTeknika

**Government**
- Yogyakarta Special Province
- Min. Public Works
- Min. Research & Technology

**Investigation, exploration, analysis**

**Innovation, development of “Appropriate Technology”**

**Technology & knowledge transfer, capacity development**

**Implementation**