IWRM-Indonesia Fact Sheet

An Innovative Underground Water Supply Plant to Face Water Scarcity in Rural Karst Area of Gunung Kidul, Indonesia

General Data

Plant type:	Underground hydropowered water supply plant
Location:	Semanu, Kabupaten Gunung Kidul, Province of Yogyakarta Special Region, Indonesia (110,673563° E / -8,038273° S)
Operated since:	June 2011
Operator:	Balai Besar Wilayah Sungai Serayu Opak – BBWS SO / Indonesian Ministry of Public Works (status October 2015)

Technical Data

Supply system:	5 conveying modules as coupled unit of volute casing pump used as turbine (“Pump as Turbine”, PAT) and multistage pump for water delivery
Module manufacturer:	KSB AG, Germany
Hydropower flow rate:	~400 l/s per module
Hydraulic head:	15 m
Pumping head:	220 m
Supply discharge at full capacity:	max. 62 l/s (all 5 modules in operation)

Current Status (October 2015)

Four years of continuous operation with an average supply rate of 800 million liters of water per year applying a renewable-energy-based supply concept to enhance the water supply situation for approx. 75.000 people living within the distribution area.

1 Objective

Karst is related to the occurrence of carbonate and gypsum rock which covers approx. 20 % of the earth's surface. More than 25 % of the world's population depends on karst aquifers for fresh water supply. However, due to the karstified underground with high infiltration rates and lacking storage possibilities at the surface, karst areas are very often characterized by severe water shortage. At the same time there are underground water resources available throughout the whole year which could be used for an improvement of the water supply situation in the affected areas.

The objective of this work package was to develop a sustainable and innovative concept to extract the underground karst water resources in an efficient way. In this context the world's first underground water supply plant was implemented in the cave *Gua Bribin* (later referred to as '*Bribin'*). Besides securing the water supply for the people living in the distribution area, the plant is also used as a reference facility for technology dissemination especially for sub- and tropical regions resp. for emerging and developing countries.

2 Concept and Technology

Fig. 1. Concept of Bribin's underground water supply system

Bribin's water supply system is located 100 m below the surface and can be accesses by a vertical shaft which was developed in cooperation with German tunneling experts from Herrenknecht AG. The water supply system is equipped with a hydropower drive utilizing a hydropower potential with a pressure head of 15 m by damming the underground *Bribin* River with a multiangular low-reinforced concrete barrage. Hereby, the river water can partially be conveyed to the surface.

To utilize the hydropower potential resp. to drive the water supply system reverse driven centrifugal pumps, a technology known as "*Pumps as Turbines*" (PAT), are applied instead of common turbines. The PAT are mechanically linked via spur-gears (for speed transmission) to high-pressure feed-pumps which convey the river water partially to a distribution reservoir elevated by approx. 220 m. Five modules are set up in parallel to utilize a discharge range from approx. 400 to 2,000 liters per second. From the reservoir the water will be distributed to the communities mainly by the impact of gravity. The selection and adaption of proper machines was conducted in close cooperation of KIT with the German pump manufacturer KSB AG.

A Pump becomes a Turbine

Simple hydraulic designs of PAT compared to conventional turbines leads to

- ✓ Lower maintenance effort and costs
- ✓ Lower investment costs
- ✓ Higher robustness

3 Implementation and Results

After intensive investigations *Gua Bribin* was found to be suitable for natural or anthropogenic water storage due to its geological and mineralogical features. The implementation of the *Bribin* Plant was finalized in 2010 in close cooperation between various institutions from both countries including scientific and governmental institutions as well as industry partners ("*3+3 concept*").

SPONSORED BY THE
Federal Ministry of Education and Research
IWRM Indonesia

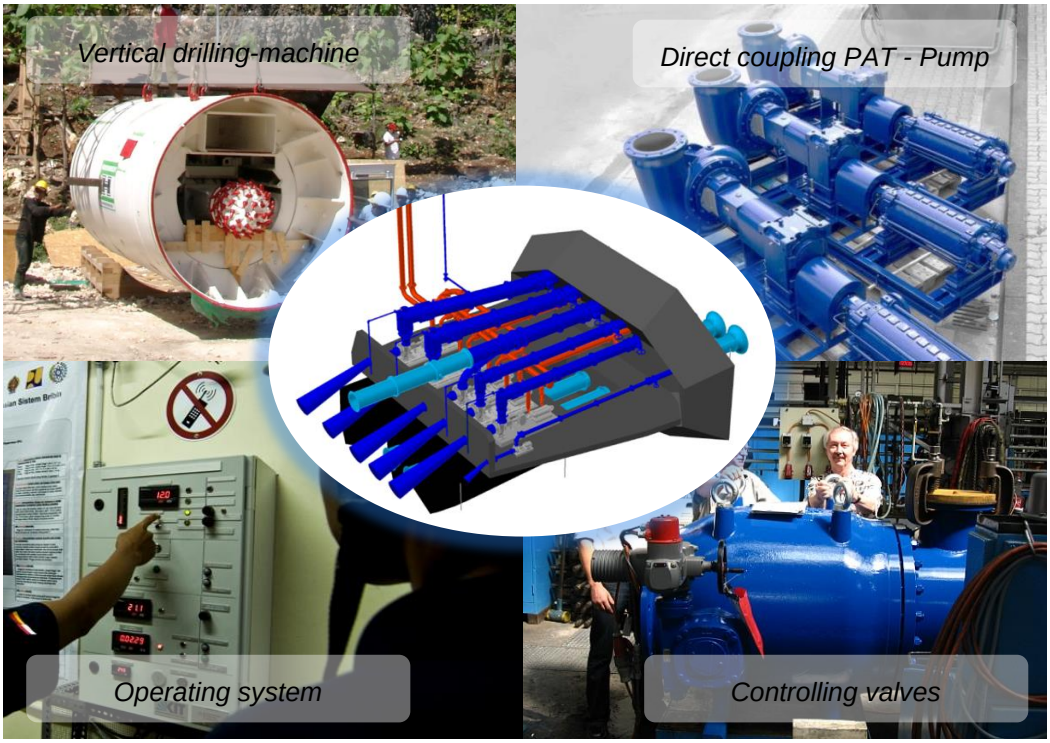

Fig. 2. Application of adapted technologies in Bribin water supply system

With the utilization of adapted technologies (among others the PAT-technology, an innovative monitoring and alert system etc.) associated with a comprehensive knowhow transfer, the plant has been successfully and continuously operated since the year 2011 under the autonomous assignment of local Indonesian authorities. Because the operation of the plant does not require expensive external energy carriers (diesel or electrical energy) this facility can cost-efficiently be operated 24/7.

Fig. 3. Pictures impression of the implementation

4 Hydraulic Machinery

Parameter		Description of the Module		
Function	[-]	PAT	Gearbox	Feed Pump
Manufacturer	[-]	KSB AG	Walther Flender GmbH	KSB AG
Type	[-]	Volute Casing Pump: ETANORM R-300-340	Spur Gear: RXP1/ 808/ A/ 1.8/ ECE/ N/ M4	Multistage Pump: MTC D 65/ 9 6.1
Nominal hydraulic head	[m]	15	-	-
Operating range	[m]	10 – 15		
Pressure head*	[m]	-	-	220
Inflow/discharge*	[l/s]	375	-	13.5
Rotation speed*	[min^{-1}]	1,200	-	2,200
Max. efficiency*	[%]	81	95	70
Transmission	[-]	-	1:1.83	-
System efficiency*	[%]	55		

* At nominal conditions which refer to a hydraulic head of 15 m

5 Project Partners

Institute for Water and River Basin Management
Institute of Concrete Structure and Building Materials
Institute of Soil and Rock Mechanics
Geodetic Institute
Applied Geosciences Karlsruhe - Aquatic Geochemistry

Ministry of Public Works and Public Housing

Ministry of Research and Technology

Province of Yogyakarta Special Region

National Nuclear Energy Agency

Gadjah Mada University

Sebelas Maret University

Indonesian Speleologist Club

Wijaya Karya Ltd.

Bestindo Putra Mandiri Ltd

6 Contact

IWRM-Indonesia Project Coordinator:
Institute for Water and River Basin Management, KIT
Prof. Dr.-Ing. Franz Nestmann, franz.nestmann@kit.edu

Sub-Project and Technical Contact
Institute for Water and River Basin Management, KIT
Dr.-Ing. Peter Oberle, peter.oberle@kit.edu
Dr.-Ing. Muhammad Ikhwan, ikhwan@kit.edu
Dipl.-Ing. Daniel Stoffel, daniel.stoffel@kit.edu

Hydraulics and Structural Mechanics, KSB AG
Dr. Jochen Fritz, jochen.fritz@ksb.com