

# **WATER MANAGEMENT IN KARST AREA IN THE PROVINCE OF YOGYAKARTA SPECIAL REGION**

**Presented by**

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**in**

**Scientific Forum**

**“Opportunity of Nuclear Technology for Sustainable Human  
Development in Asia and the Pacific”**

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# INTRODUCTION

## Vision and mission of BATAN (National Nuclear Energy Agency of Indonesia)

- ❑ Nuclear Science and Technology with reliable safety to actuate and to accelerate people's welfare (vision)
- ❑ R & D of Nuclear Science and Technology with reliable safety for energy and non-energy industry (mission)
- ❑ Dissemination of proven result of R & D in Nuclear Science and Technology (mission)
- ❑ Total Quality Management for user/customer satisfaction (mission)

# SCOPE OF ACTIVITIES

Started 2000

## R & D ACTIVITIES

- Increasing of agricultural productivities in marginal land
  - Sandy soil (coastal area)
  - Karst area (Gunungkidul area)
- Increasing of cattle production and reproduction
- Product and process improvement of small scale industry
- Water resources management
- Energy :
  - ✓ Sandy soil (coastal area)
  - ✓ Microhydro power plant for water supply
  - ✓ Windmill water pump
  - ✓ Biodiesel energy

**Since 2001**

**INTERNATIONAL SUPPORT**

**IAEA TC Project**



- **Agricultural production**
- **Cattle production**
- Water resources management

**University of Karlsruhe Project**



Exploitation of water system in Bribin

**OTHER SUPPORT**

- **FNCA-JSPS (International)**
- **PT Bogasari Flour Mills Industry (Indonesian company)**





## TC-IAEA

**1. INS/05/030 Sustainable Agriculture Development in Yogyakarta: sorghum in dry area (Pajangan, Semanu) + sandy soil (Pandansimo)**

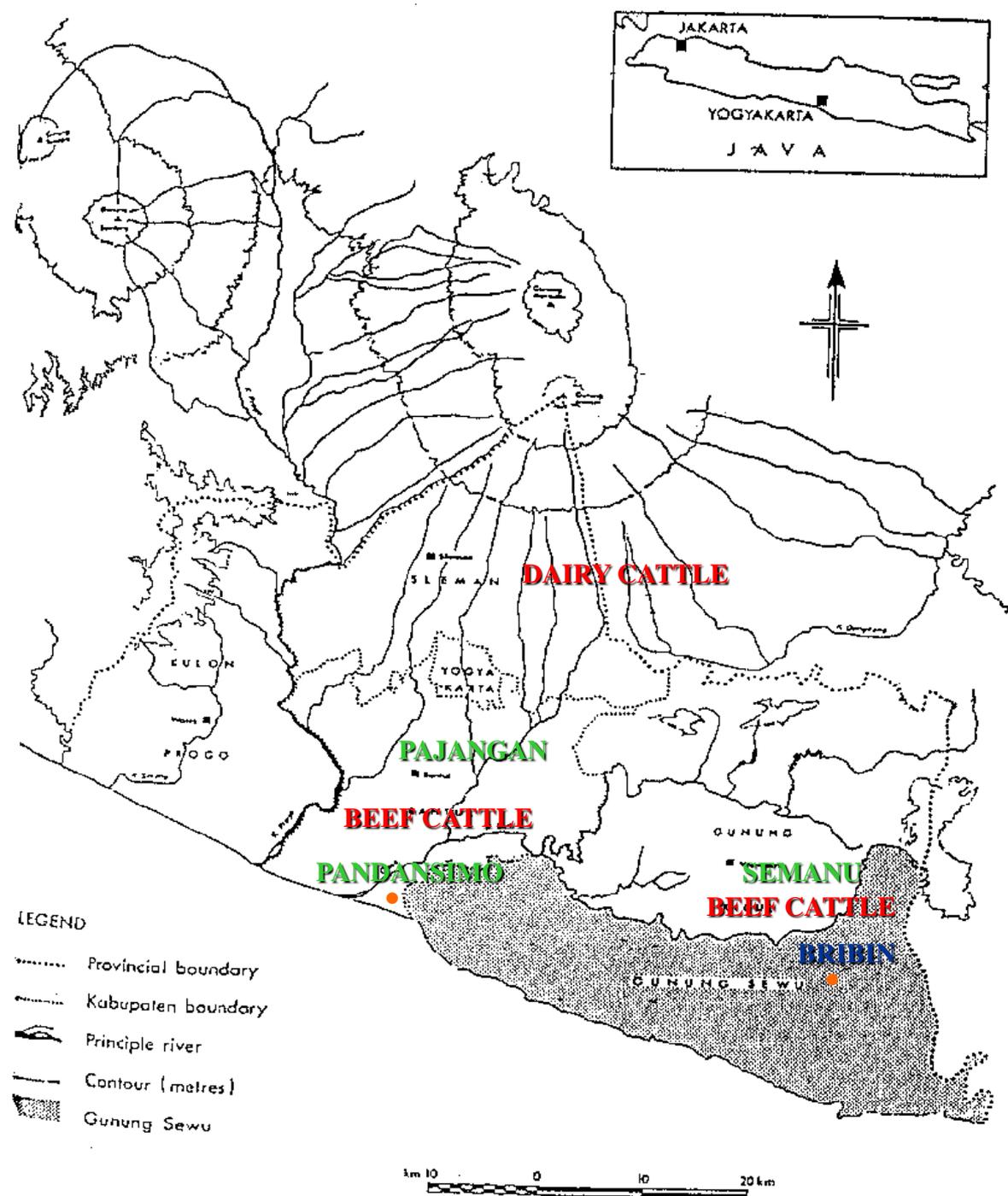
**2.INS/05/032 Improving Beef and Dairy Cattle Production in Yogyakarta**

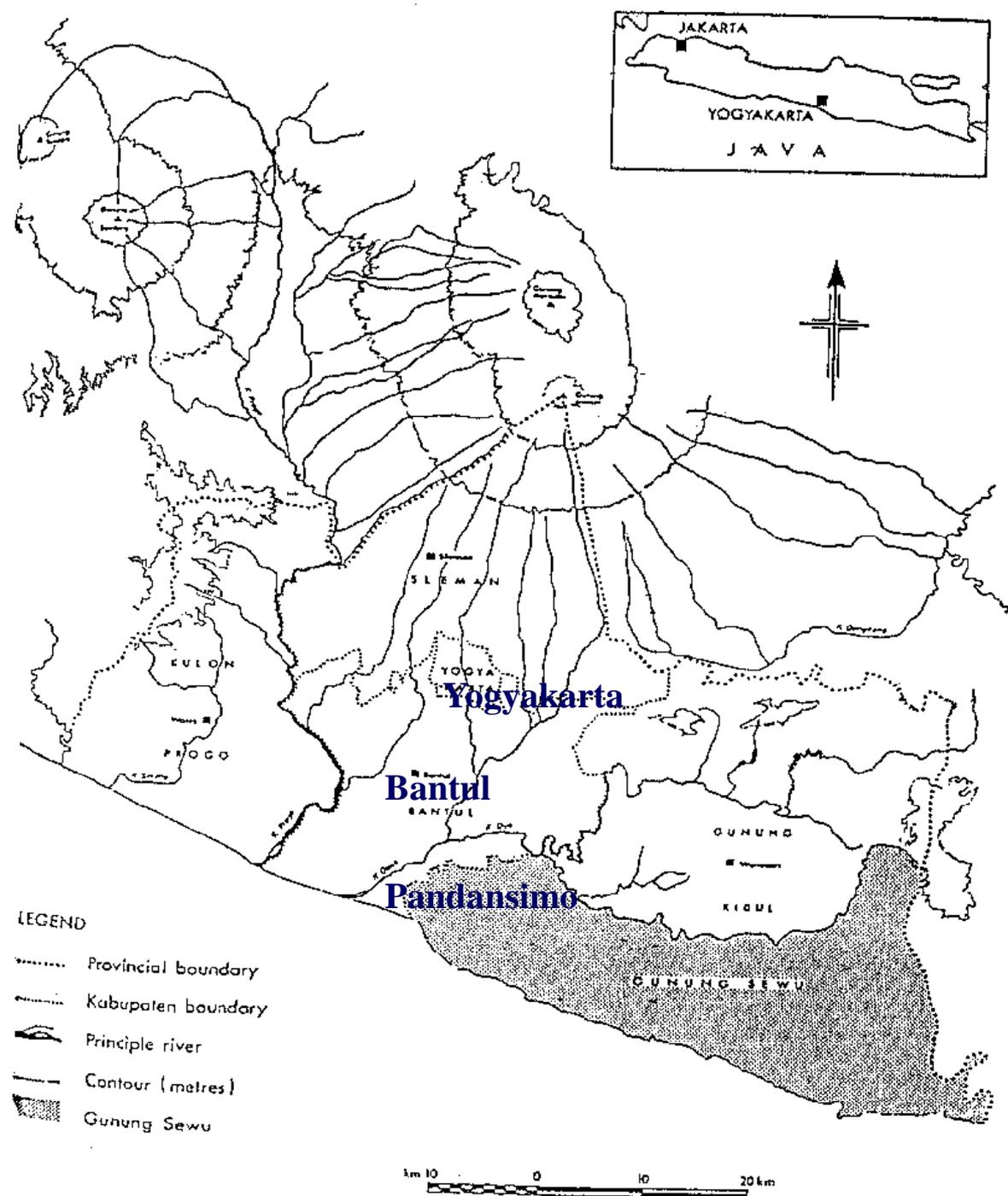
**3.INS/08/023 Groundwater Resources Exploitation in the Gunungkidul Area (Bribin)**

## GERMANY COOPERATION (Kalsruhe)

**1. Windmill water pump at Pandansimo (LAPAN)**

**2. Underground stream exploitation Bribin, Gunungkidul (UI, UNS, UGM)**





## S & T for Regional Development

1. Study of surface water potential in Bantul area using natural isotopes (STRD + research)
2. Study of sea water intrusion in Pandansimo (PU + CDNMMG)

## Health Cooperation

1. Gamma camera maintenance at Prof. Dr. Sardjito Hospital, Yogyakarta
2. Renograph and X-ray Units at Muhammadiyah Hospital, Bantul

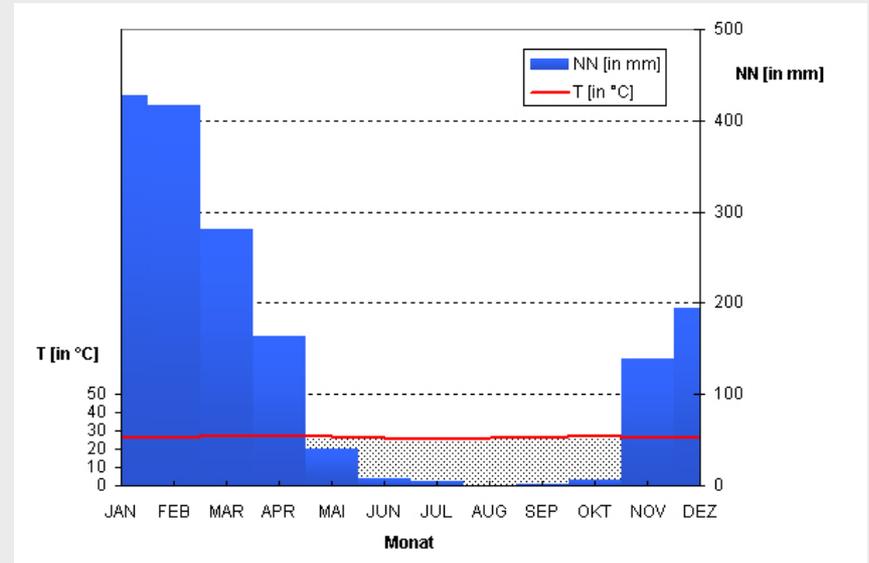
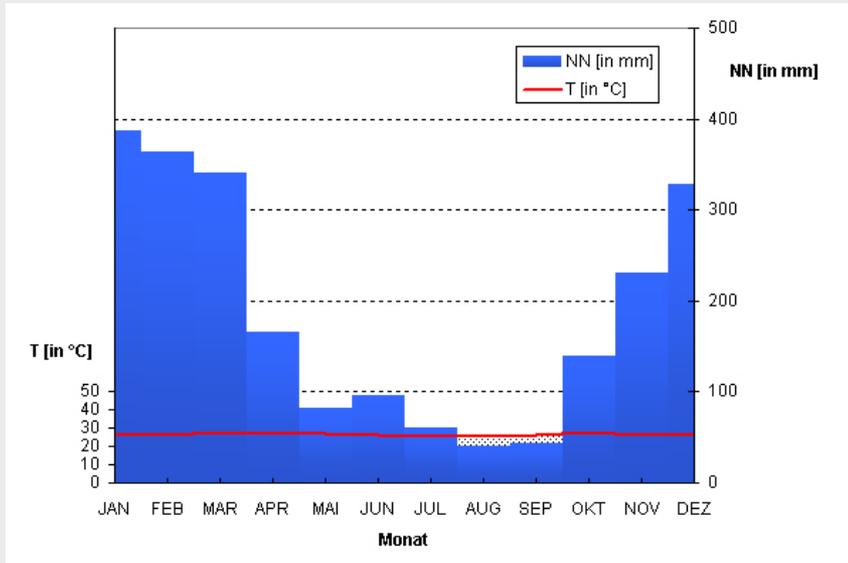
## Gunung Sewu („A thousand hills“) during Rainy Season



## Gunung Sewu („A thousand hills“) during Dry Season



# Water Shortage during Dry Season



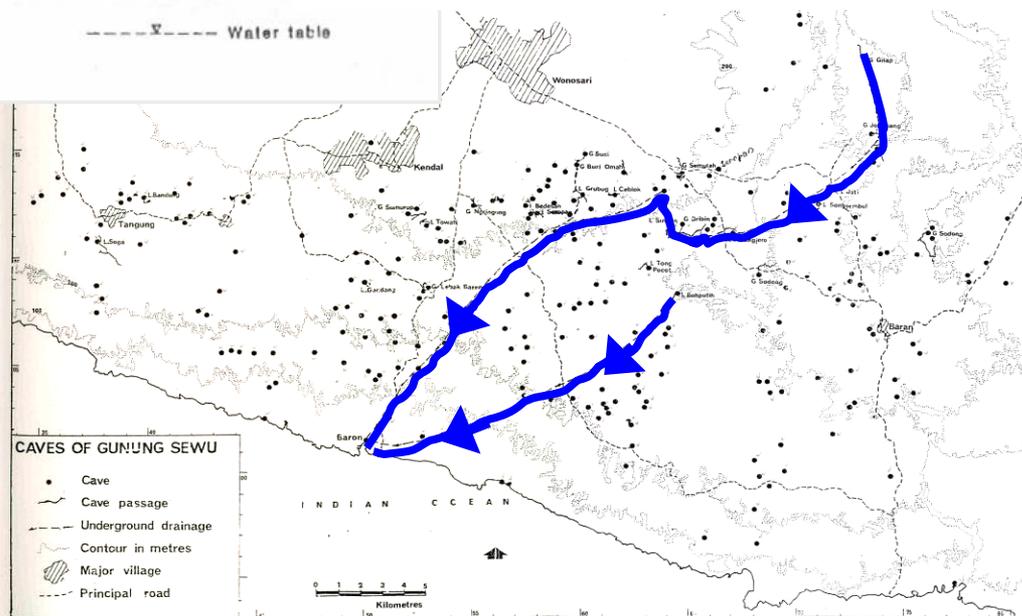
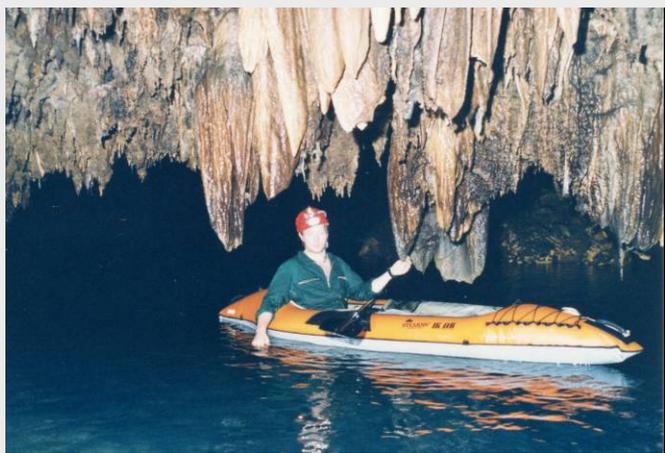
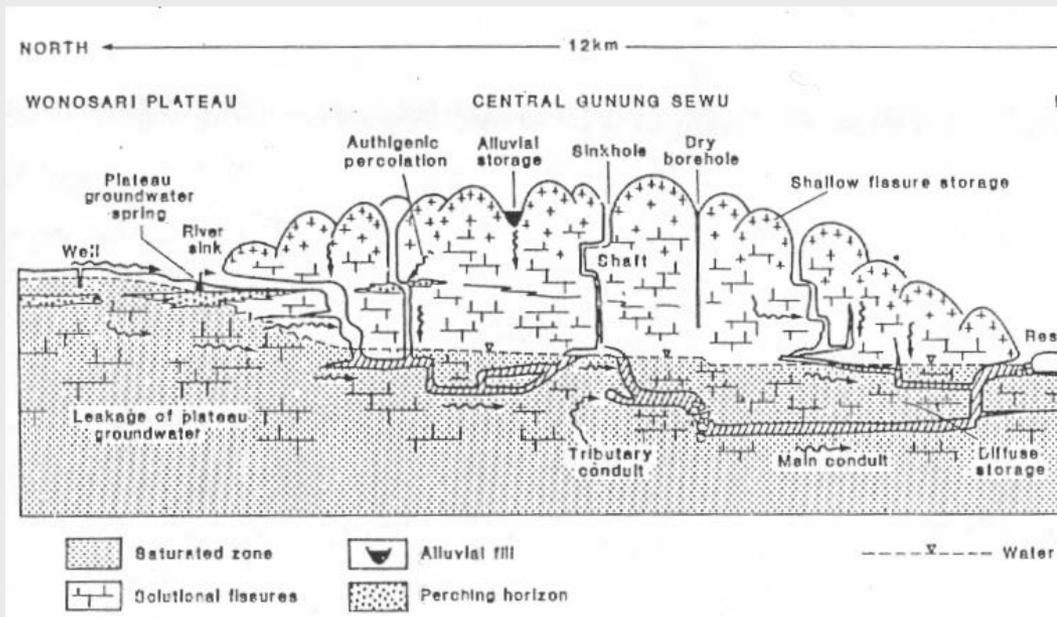
Mean annually rainfall distribution in Gunung Kidul from 1971 to 2000 (fig. left) and during ENSO-years 1991, 1993, 1994, 1997 (fig. right)(ENSO = El Nino Southern Oscillation)



Dry Telaga



Bribin Cave



Underground river KALI BRIBIN

# WATER RESOURCES

## Coastal Area

Windmill Engineering :  
Water supply for agriculture

Potential of groundwater for  
industry

Surface water potential

Sea water intrusion



BANTUL : Samas

## Karst Area

Optimal Groundwater  
Exploitation

Groundwater system  
assessment

Drilling point

Microhydro power plant

To be inaugurated end of  
May 2006 by the  
President of Indonesia

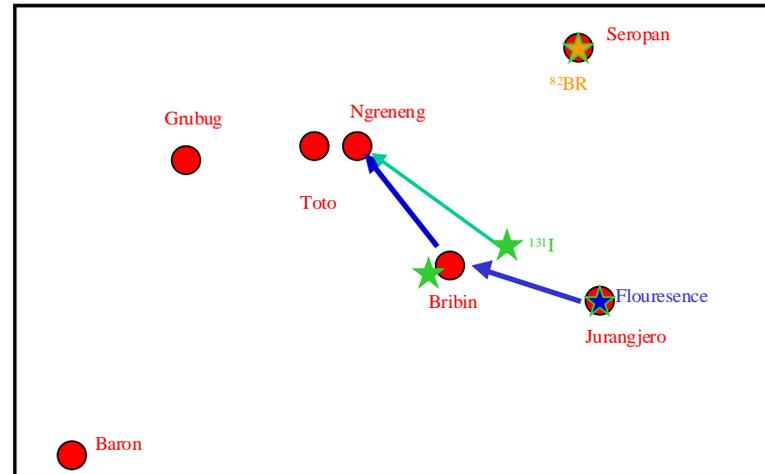


GUNUNGKIDUL

# TC-IAEA INS/08/023

## Optimal Groundwater Exploitation

Determination of Underground Stream Interconnections Using Radioisotope and Fluorescence Tracer ( Bribin, Seropan, Ngreneng, Jurangjero, etc. ) - Gunungkidul

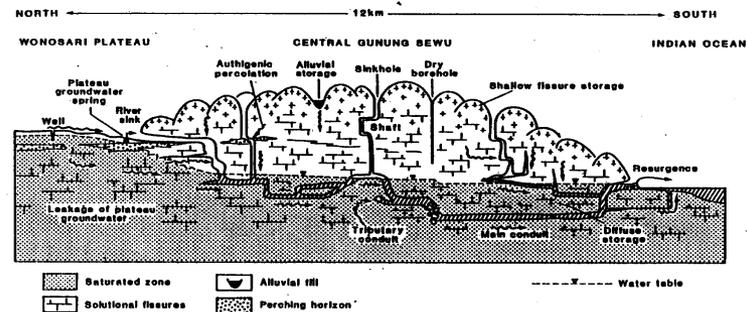


Schematic of tracing test

## Groundwater System Assessment

Formulating data of :

- environmental isotope
- hydrochemical
- physical parameter
- flow hydrograph



Schematic section through Gunung Sewu showing features of karst hydrology

<b>Time</b>	<b>Tracers</b>	<b>Injection point</b>	<b>Monitoring point</b>	<b>Conclusion</b>
<b>April 1999</b>	<b>Br-82</b>	<b>Seropan</b>	<b>Bribin</b>	<b>Not connected</b>
			<b>Toto</b>	<b>Not connected</b>
			<b>Grubug</b>	<b>Not connected</b>
			<b>Ngreneng</b>	<b>Not connected</b>
<b>July 2000</b>	<b>Fluorescence</b>	<b>Jurang Jero</b>	<b>Bribin</b>	<b>Connected</b>
			<b>Seropan</b>	<b>Not connected</b>
			<b>Toto</b>	<b>Not connected</b>
			<b>Ngreneng</b>	<b>Connected</b>
<b>June 2002</b>	<b>I-131</b>	<b>Bribin junction</b>	<b>Ngreneng</b>	<b>Connected</b>
<b>June 2002</b>	<b>I-131</b>	<b>Bribin mainstream</b>	<b>Ngreneng</b>	<b>Not connected</b>

# PREVIOUS RELATED IAEA PROJECT

## GROUNDWATER HYDROLOGY

### IAEA-TC PROJECT

#### TITLE

1. Groundwater resources exploitation in the Gunungkidul area (INS/8/023; 2001 – 1 yrs)

#### OBJECTIVE

To optimally exploit groundwater resources in the Gunungkidul area → for agriculture development and enhancement of sosio-economic status of farmers

# PREVIOUS RELATED IAEA PROJECT

## RCA PROJECT

### TITLE

2. Isotope use in managing and protecting drinking water (RAS/8/084; 1995 - 4 yrs)
3. Use of isotopes in dam safety and dam sustainability (RAS/8/093; 2001 - 2 yrs)
4. Isotope techniques for groundwater contamination studies in urbanized and industrial area (RAS/8/097; 2003 - 1 yrs)

### OBJECTIVE

To promote the routine use of isotope techniques in addressing the problem of supply of fresh drinking water

To promote the use of environmental safe isotopes techniques in the operation and management of dams and reservoirs

To assess, manage, and prevent further degradation of groundwater quality in selected urbanized and industrial areas

# SHORT TERM PROGRAM

## PROGRAM & ACTIVITIES

## GOALS

### GROUNDWATER HYDROLOGY

1. To obtain data and informations required for optimal exploitation of underground stream in the Gunungkidul area.
2. Assessment of the potential groundwater resources in the Gunungkidul sub province.
3. To install and operate microhydro power plant in the underground stream of Bribin.

To optimally exploit groundwater resources at in the Gunungkidul area for agricultural production and enhancement of socio-economic status of farmers.

Increase the capacity and reduce the cost of fresh water supply, pumped from the underground stream.

# COOPERATION PROGRAM

## Exploration of Underground Water Resources at Bribin Cave

**GUNUNGKIDUL**

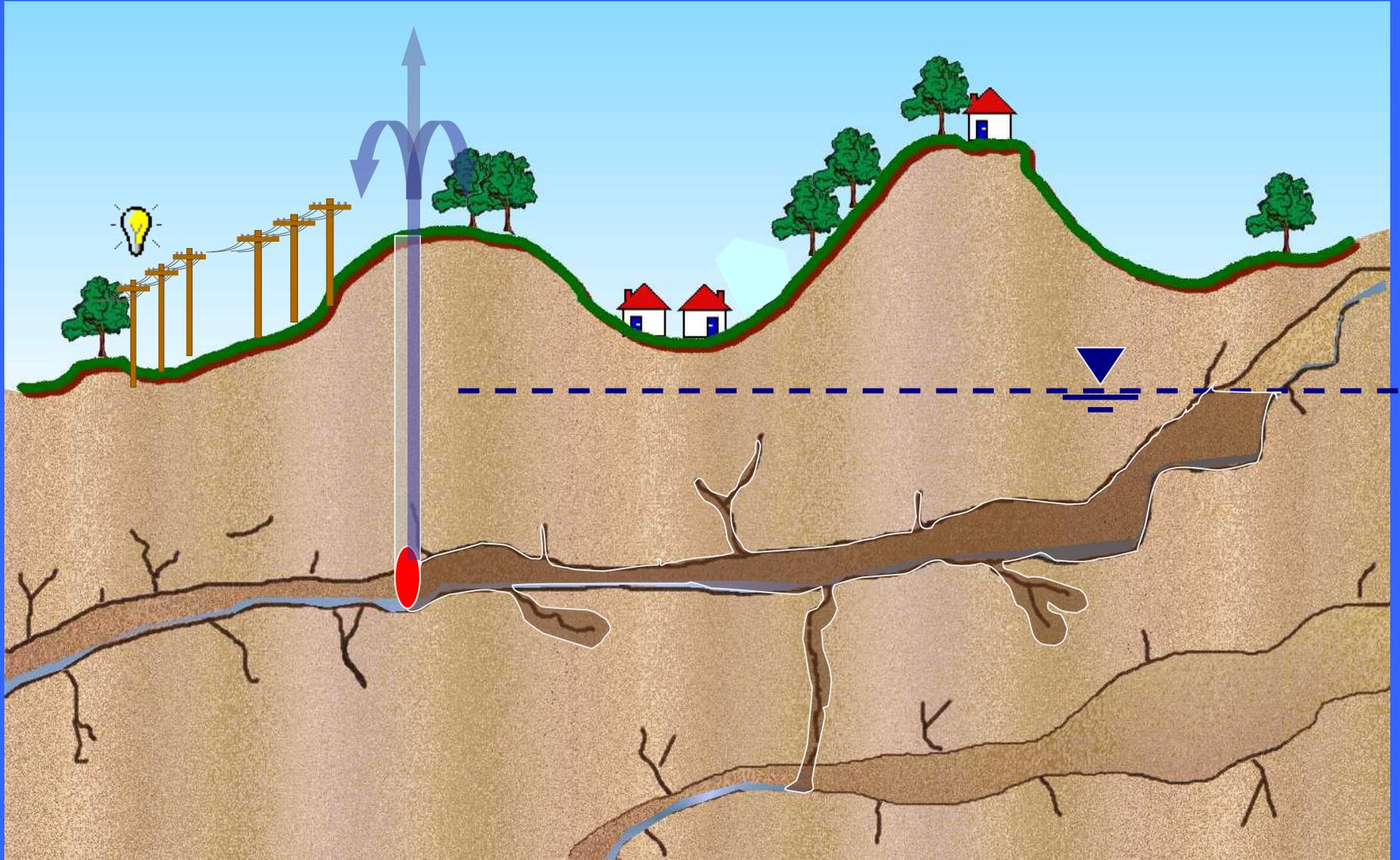
Preliminary drilling (7.5 inches diameter) to determine the drilling point accuracy



- Participating institutes :**
- Related offices of the provincial and district government
  - BATAN
  - Univ. of Karlsruhe, Germany

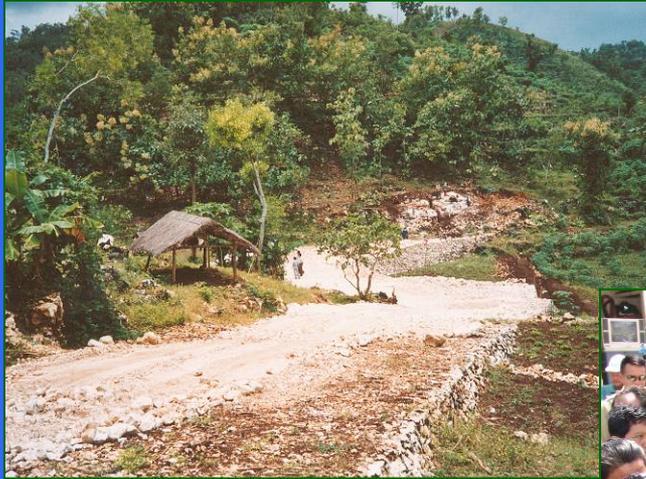
# Water Resources Management

Alternative: Complete storage (schematically)



# Contribution of German Industry Partners

German fund **approx. 1 million €** equity investment until now **> 1 million €**  
Indonesian fund approx. **6,5 billion Rp (= 700,000 €)**



Drilling location (April 2004)



Drilling location (August 2004)



Visit of Indonesian President at the construction site (December 2004)



Turbine on KSB test rig (April 2005)



Shaft break-through (9 December 2004)





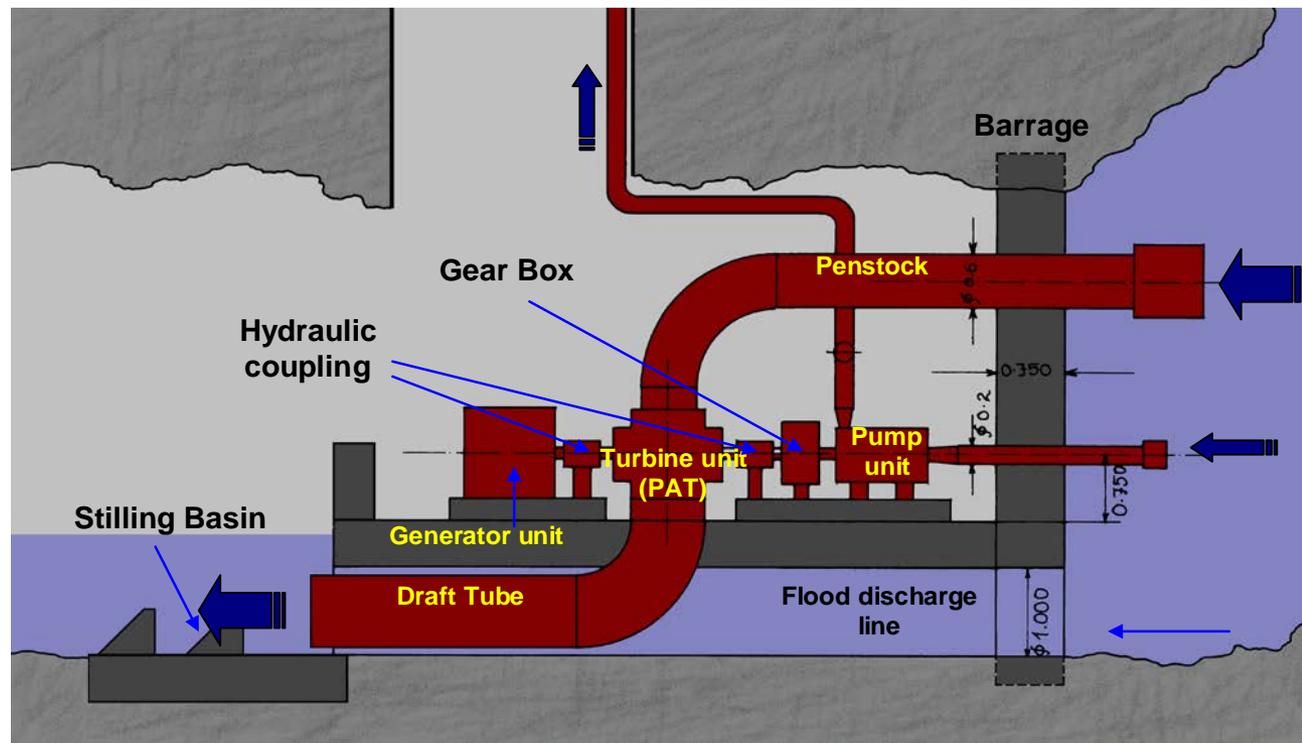
Joint Project

# „Water Resources Management of an Underground River in a Karst Area in Gunung Kidul, Yogyakarta Special Province, Indonesia“



Federal Ministry  
of Education  
and Research

# Hydro power system



UNIT	Turbine			Pump			Generator
	Head (m)	Discharge (m <sup>3</sup> /s)	Mech. Power output (kW)	Head (m)	Discharge (l/s)	Mech. Power input (kW)	Elec. Power Output (kW)
Unit I	15	1	125	250	35	120	106
Unit II	15	1	125	250	35	120	106
Unit III	15	1,5	185	250	55	180	160
Unit IV	15	0,5	63	250	18	60	54
Total mech.output Power			<b>498 kW</b>	Total Electrical Output Power			<b>426 kW</b>
→ water supply during dry season (Q = 2 m <sup>3</sup> /s) : 80 l pcd (75.000 people)							

# Comparison of Present and Future Pumping System

## PRESENT SITUATION

electr. driven pumps  
water delivery to R4 (320 m asl)

Fuel and  
electrical power  
input

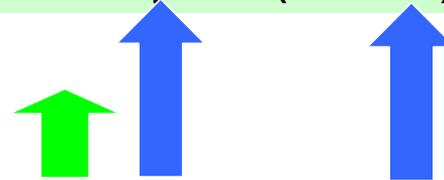


<b>Energy input (electr. Power)</b>	<b>150 kW</b>
<b>Energy costs per month</b>	<b>50 Mio Rp (5000 €)</b>
<b>Water supply</b>	<b>1900 m<sup>3</sup>/d (60 l/s, 9h)</b>
<b>Water supply (75.000 people)</b>	<b>26 lpcd</b>

## FUTURE SITUATION

pumping with hydro power (12m\* pressure height)  
water delivery to R5 (325 m asl)

Electrical  
power  
output

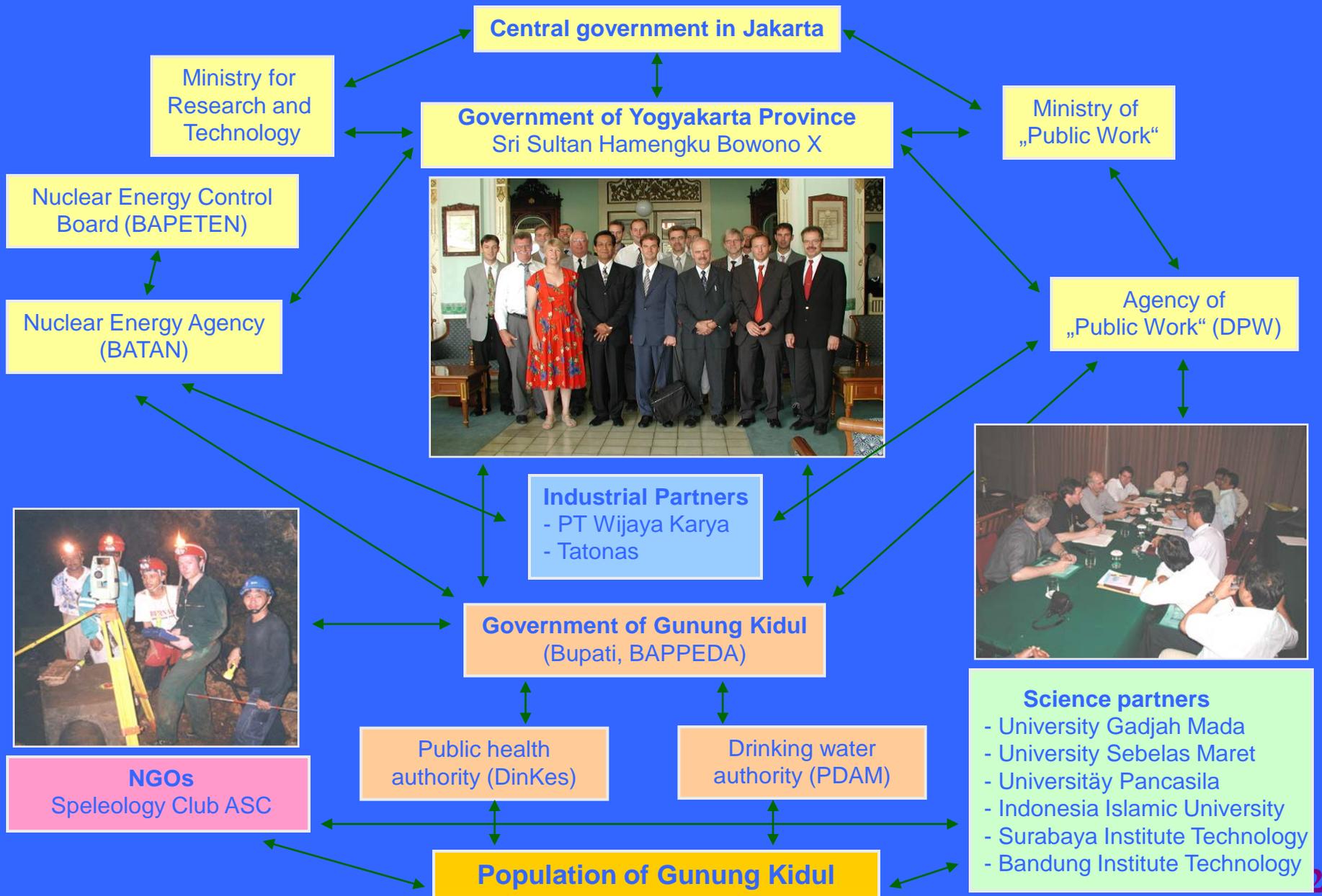


	Rain season	Dry season
<b>Discharge</b>	<b>2,7 m<sup>3</sup>/s</b>	<b>1,9 m<sup>3</sup>/s**</b>
<b>Energy output</b>	<b>250 kW</b>	<b>180 kW</b>
<b>Possible power output</b>	<b>70 kW</b>	<b>-</b>
<b>Water supply</b>	<b>5200 m<sup>3</sup>/d (60 l/s, 24h)</b>	<b>5200 m<sup>3</sup>/d (60 l/s, 24h)</b>
<b>Water supply (75.000 people)</b>	<b>70 lpcd</b>	<b>70 lpcd</b>

\* The calculations are based on the assumption of a pressure height of 12 m. The topography in Gua Bribin allows a storage height of more than 15 m, if no leakages occur! The modules and barrage are designed to work efficient also with a pressure height of 15 m and more! The exact storage level will be fixed after finishing the barrage construction!

\*\* Based on discharge records from DPW, Mac Donald's & Partners, PDAM from 1980 to 1999 and own measurements in the years 1999-2002. **lpcd = litre per consument day.**

# Network of Indonesian Partners



A photograph of a hydroelectric power station located inside a cave. The scene is dimly lit with warm, yellowish light. In the foreground, there is a large, rough rock formation. In the middle ground, water is flowing through a series of turbines or spillways. The background shows the dark, textured walls of the cave. The text "Integrated Water Resources Management (IWRM), in Gunung Kidul, Indonesia" is overlaid in white, bold font across the center of the image.

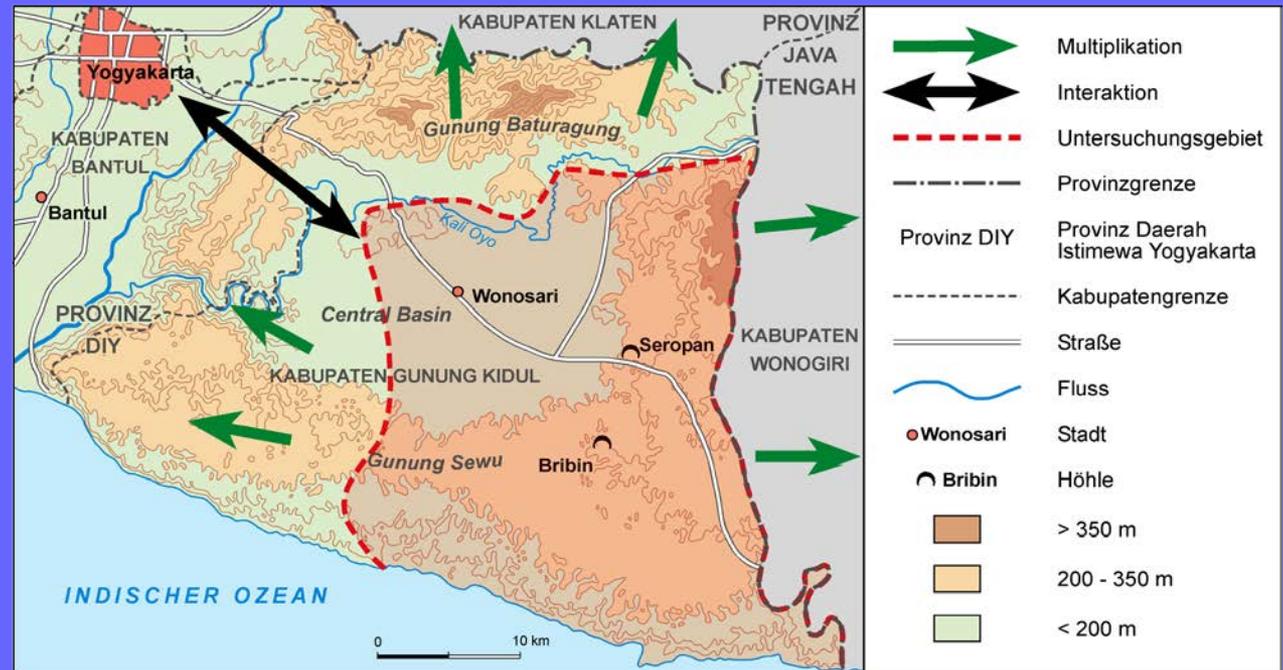
**Integrated  
Water Resources Management (IWRM),  
in Gunung Kidul, Indonesia**

# Integrated Water Resource Management (IWRM) Project Area

Area: ca. 2000 km<sup>2</sup> , Population: 280.000

## Qualification for exemplary realisation of an IWRM:

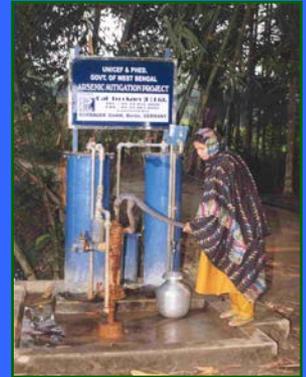
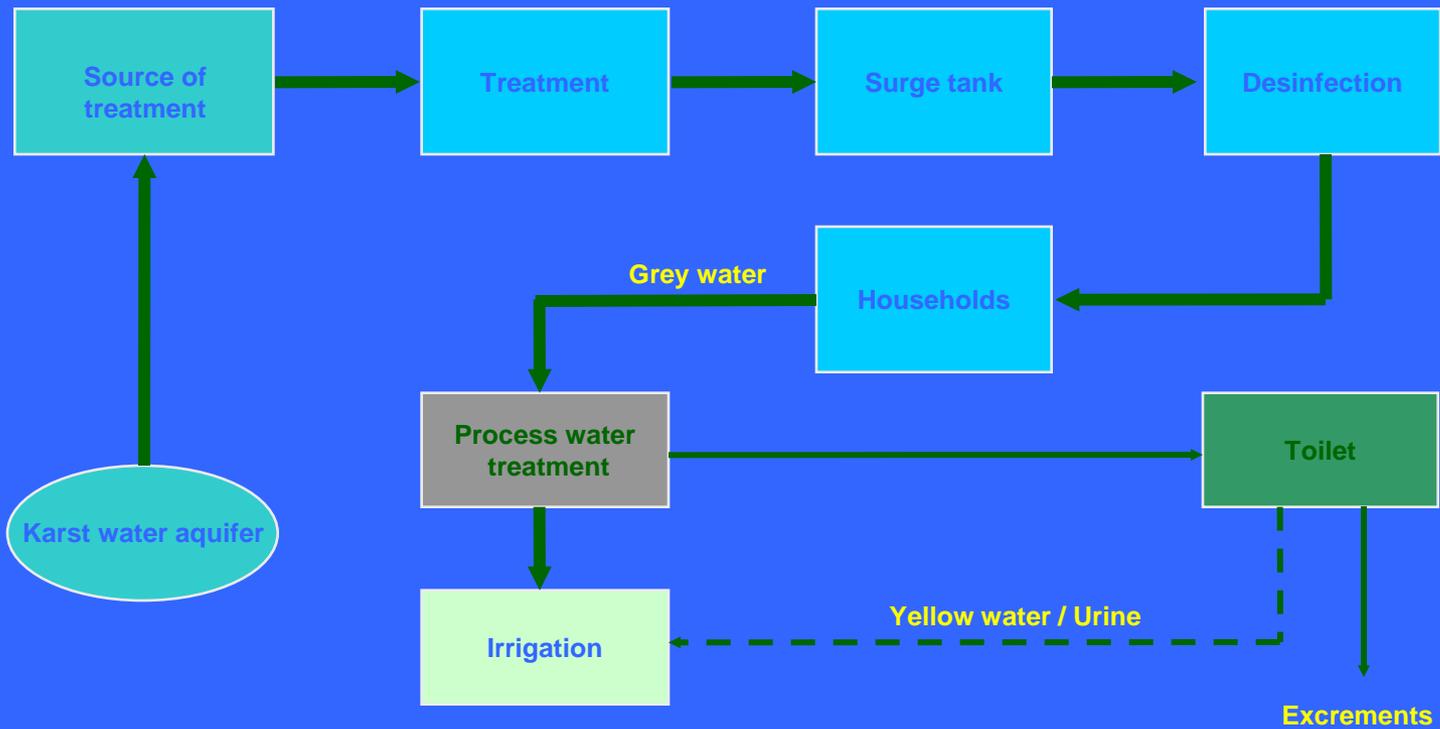
- Urgent call for action (Gunung Kidul: Java's "poor house")
- Availability of major underground freshwater resources in the karst area
- Acquisition of rural and urban structures
- Existing extensive German-Indonesian network
- "Highlighted projects" with various multiplication possibilities



Project area Gunung Kidul  
[Source: IfG/IWG]

# Water treatment / water quality

- Semi-centralised / decentralised treatment steps
- Appropriate Technologies using locally available materials
- ...



# Sewage- / Waste treatment

- Quantitative analysis of water demand and resulting sewage (Current / target state)
- Sewage and waste concept for local trade/industry and urban areas
- Upgrading of sanitary systems in the rural areas (separation technology)
- Energetic use of sewage and biological waste

Community toilet with septic tank



Drinking water well right next to the toilets



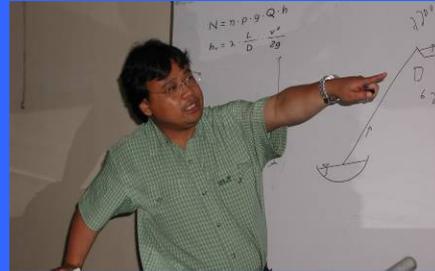
Open sewage drain



Tempe-Production (50l/kg)

# Technology- and Know-how-Transfer (Capacity-Building)

Transfer of science and Education in the field of “Energy and Natural Resources“



Project workshop at BATAN Yogyakarta with participation of Indonesian and German project partners (15-16 March 2004)



Seminar “Water Resources Management in Karst Area“ at Sebelas Maret University, Surakarta (1-5 December 2003)

Training for realisation of tachymetric measurements within the scope of geodetic measurements in Gua Bribin



**Joint project → 2+2 Project / 3+3 Project:  
acad. + gov. / acad. + gov. + bus.  
of each country**

**“AGB concept” of the Indonesian Ministry of Research:  
involvement of Academy, Government, Business**

**Budget planning on Indonesian side:**

- **Universities and scientific work (Academy)**
- **Implementation of infrastructural measures (Government, Business)**
- **External funding e.g. by “World Bank” (Business)**

**Thank you  
very much  
for your attention**

