Development of an appropriate water treatment for the karst region Gunung Kidul, Southern Java

Dipl.-Ing. Kerstin Matthies
Current Situation in Gunung Kidul

Natural conditions
- Tropical climate
- Karst formation
- Poor retention and filtration capacity
- Water shortages in dry season

Man-made circumstances
- Deficient waste water treatment
- Dilapidated pipelines and reservoirs
- Deficient water treatment
- Lack of monitoring

Results
- Small water amount
- Bad water quality
- Population is forced to boil water
  - Barely sustainable
  - Problematic with high amounts of water
Institute of Functional Interfaces

Motivation

Monitoring

Treatment

Conclusion

Outlook

Distribution of Coliforms in July 2010

TC: 261
R1

TC: 410
R2

TC: 517
R3

TC: 461

R BP3
TC: 970
R BP1
TC: 630
R4

Cave
TC: 275,5

R BP4
TC: 1.350

R BP2
TC: 2.750
R BP1

TC: 860
R5

TC: 980
R6

TC: 970
R8

TC: 461

TC: 410

TC: 275

WHO guideline:
0 CFU/100 mL for
Coliforms and E.coli

CFU= Colony Forming Units

Legende
TC<500
500<TC<1000
1000<TC<10.000

TC=Total Coliforms
Unit: CFU/100 mL

map: http://iwrm.gik.uni-karlsruhe.de/mapguide/iwrm

Motivation Monitoring Treatment Conclusion Outlook

Kerstin Matthies
Development of an appropriate water treatment for the karst region Gunung Kidul

Institute of Functional Interfaces
Coliform Contamination in both Caves

Motivation
Monitoring
Treatment
Conclusion
Outlook

>39,000

Total Coliforms [CFU/100 mL]

Month

July '09
August '09
September '09
October '09
November '09
December '09
January '10
February '10
March '10
April '10
May '10
June '10
July '10
August '10
September '10
October '10
November '10
December '10
January '11
February '11
March '11
April '11
Water Treatment Concept

Cave

Sand filtration

Hygienisation

Ceramic filtration

Central removal of turbidity before distribution system

Central but close to customer (village)

Household (point of use) disinfection

Motivation  Monitoring  Treatment  Conclusion  Outlook
Field Laboratory

- Sand filtration
- UV disinfection
- Chlorination
- Ceramic filtration

Motivation  Monitoring  Treatment  Conclusion  Outlook
Sand Filtration and UV Disinfection

- Sand filtration samples taken after running period of five weeks
- UV disinfection samples taken after running period of 25 h
- UV-C dose at 254 nm: 423.2 J/m²

<table>
<thead>
<tr>
<th></th>
<th>Raw water</th>
<th>After sand filtration</th>
<th>After UV disinfection</th>
<th>Max allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bact. count at 22 °C [CFU/mL]</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>0</td>
<td>20 [CFU/mL]</td>
</tr>
<tr>
<td>Bact. count at 36 °C [CFU/mL]</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>52</td>
<td>100 [CFU/mL]</td>
</tr>
<tr>
<td>Total coliforms [CFU/100 mL]</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0 [CFU/100 mL]</td>
</tr>
<tr>
<td><em>E.coli</em> [CFU/100 mL]</td>
<td>15</td>
<td>40</td>
<td>0</td>
<td>0 [CFU/100 mL]</td>
</tr>
</tbody>
</table>

Development of an appropriate water treatment for the karst region Gunung Kidul

- Sand filtration samples taken after running period of five weeks
- UV disinfection samples taken after running period of 25 h
- UV-C dose at 254 nm: 423.2 J/m²

<table>
<thead>
<tr>
<th></th>
<th>Raw water</th>
<th>After sand filtration</th>
<th>After UV disinfection</th>
<th>Max allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bact. count at 22 °C [CFU/mL]</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>0</td>
<td>20 [CFU/mL]</td>
</tr>
<tr>
<td>Bact. count at 36 °C [CFU/mL]</td>
<td>&gt;100</td>
<td>&gt;100</td>
<td>52</td>
<td>100 [CFU/mL]</td>
</tr>
<tr>
<td>Total coliforms [CFU/100 mL]</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0 [CFU/100 mL]</td>
</tr>
<tr>
<td><em>E.coli</em> [CFU/100 mL]</td>
<td>15</td>
<td>40</td>
<td>0</td>
<td>0 [CFU/100 mL]</td>
</tr>
</tbody>
</table>

Development of an appropriate water treatment for the karst region Gunung Kidul
Chlorination

- Chlorination with Calciumhypochlorite (Indonesian Kaporit)
- Residual Chloride: 0.65 mg/L; 1.02 mg/L; 1.25 mg/L; 3.3 mg/L

<table>
<thead>
<tr>
<th></th>
<th>Raw water</th>
<th>First set</th>
<th>Raw water</th>
<th>Second set</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.65 mg/L</td>
<td>1 mg/L</td>
<td>1.25 mg/L</td>
<td>3.3 mg/L</td>
</tr>
<tr>
<td>Bact. count at 22 °C</td>
<td>&gt;100</td>
<td>23</td>
<td>&gt;100</td>
<td>0</td>
</tr>
<tr>
<td>[CFU/mL]</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Bact. count at 36 °C</td>
<td>&gt;100</td>
<td>fungi</td>
<td>fungus</td>
<td>&gt;100</td>
</tr>
<tr>
<td>[CFU/mL]</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>&gt;200</td>
<td>0</td>
<td>0</td>
<td>&gt;200</td>
</tr>
<tr>
<td>[CFU/100 mL]</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>110</td>
<td>0</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>[CFU/100 mL]</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

**Motivation** | **Monitoring** | **Treatment** | **Conclusion** | **Outlook**
Ceramic Filtration

Cross-Flow-Method
- Pore size 200 nm
- Pore size 50 nm

<table>
<thead>
<tr>
<th></th>
<th>Raw water</th>
<th>50 nm membrane</th>
<th>Raw water</th>
<th>200 nm membrane</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 NTU</td>
<td>20 NTU</td>
<td>0 NTU</td>
<td>20 NTU</td>
</tr>
<tr>
<td>Bact. count at 22 °C</td>
<td>&gt;100</td>
<td>0</td>
<td>&gt;100</td>
<td>4</td>
</tr>
<tr>
<td>[CFU/mL]</td>
<td></td>
<td>21</td>
<td></td>
<td>25</td>
</tr>
<tr>
<td>Bact. count at 36 °C</td>
<td>45</td>
<td>24</td>
<td>fungi</td>
<td>0</td>
</tr>
<tr>
<td>[CFU/mL]</td>
<td></td>
<td>10</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Total coliforms</td>
<td>165</td>
<td>0</td>
<td>&gt;200</td>
<td>0</td>
</tr>
<tr>
<td>[CFU/100 mL]</td>
<td></td>
<td>0</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>E.coli</td>
<td>41</td>
<td>0</td>
<td>&gt;200</td>
<td>0</td>
</tr>
<tr>
<td>[CFU/100 mL]</td>
<td></td>
<td>0</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Reference: atech innovations gmbh
Conclusion

High contamination with hygienically relevant bacteria

**Thorough water treatment is essential**

Water treatment concept:

![Flowchart diagram](image)

- Sand filtration
- Hygienisation
- Ceramic filtration

**Hygienisation**

- Chlorination, UV disinfection & ceramic filtration show good disinfection capacity
- Sand filtration known to have good retention capacity under appropriate conditions (low flow rate etc.)

**Techniques seem appropriate, but have to be repeated under Indonesian conditions**
Future Plans

- Project runs until 2013
- Ongoing monitoring
- Shipping of field laboratory to Indonesia (this year)
- Repetition of experiments under Indonesian conditions
- Capacity Development

Development and introduction of appropriate water treatment technology in project region
Acknowledgements

This project is funded by

Bundesministerium
für Bildung
und Forschung

Thank you for your attention!

? Questions ?

- CIP Chemical Institute Pforzheim GmbH
- Prof. Ursula Obst & department at IFG
- Prof. Franz Nestmann, Dr. Peter Oberle & Dr. Muhammad Ikhwan