Anlage 1
Meilensteine 2009

A. Koordination / Netzwerk

24.11. – 27.11.09	Besuch einer Regierungsdelegation der Sonderregion Yogyakarta beim Karlsruher Institut für Technologie, dem Projektträger, der Firma KSB in Frankenthal und der Firma VAG in Mannheim
10.11. – 13.11.09	Präsentation von Zwischenergebnissen aus Laboruntersuchungen beim „3rd Decentralised Conference on Water and Wastewater International Network“ in Nepal (TP9-IWG/SWW)
10.11. – 12.11.09	Projektvorstellung auf der „Aqua alta – Internationaler Kongress mit begleitender Fachmesse für Klimafolgen und Hochwasserschutz“ in Hamburg (TP1-IWG/WK)
12.10. – 14.10.09	Postervorstellung auf der „Glowa National Konferenz” in Hamburg (TP1-IWG/WK)
02.11.09	Besuch eines Vertreters des „Structural Engineering Dept. – UGM“ beim Karlsruher Institut für Technologie (TP6-VA SHS und TP1-IWG/WK)
12.10.09	Verfassung eines „Letter of Intent“ für die Zusammenarbeit zwischen TP10-ITAS und der Faculty of Geography-UGM.
07.10.09	Abstimmungsgespräch zwischen dem Internationalen Büro des BMBF und u.a. dem Ministry of Public Works und der BAPPENAS (National Planungsbehörde) über zukünftige Multiplikation und einen geplanten Workshop zum Thema selben Thema im März 2010
06.10.09	Workshop des Integrierten Wasserressourcen - Managements (IWRM) in Yogyakarta: „Implementation and construction measures within IWRM in year 2010“
01.10. – 02.10.09	IWRM Themenworkshop „Capacity Development - Nachhaltige Umsetzungsstrategien für Wissenschaft, Verwaltung und Wirtschaft in Entwicklungs- und Schwellenländern“ am UFZ Magdeburg (TP1-IWG/WK und TP11-IfG).
11.09.2009	Verfassung eines „Letter of Intent“ für die Zusammenarbeit zwischen TP3-IMG und der Faculty of Geography-UGM. Vorbereitung eines GIS-Meetings Anfang Oktober in Yogya für die indonesichen Behörden / GIS-Institutionen (TP2-GIK)
11.09.2009	Verfassung eines „Letter of Intent“ für die Zusammenarbeit zwischen TP11-IfG und Faculty of Geography-UGM.
09.09. – 10.09.09	Projektvorstellung auf dem „BMBF Forum: FONA“ in Hamburg zum Thema „Capacity Development“ (TP1-IWG/WK)

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Präsidenten: Prof. Dr. Horst Hippler, Prof. Dr. Eberhard Umbach
Vizepräsidenten: Dr.-Ing. Peter Fritz, Dr. Alexander Kurz, Prof. Dr.-Ing. Detlef Löhe

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09.09.09	Präsentation von TP10-ITAS im Rahmen des Workshops „Sustainable Engineering“ an der TU Berlin
Juli 2009	Sonderausgabe 7-8/2009 der WasserWirtschaft über das Verbundprojekt mit einem Vorwort der Bundesministerin Prof. Dr. A. Schavan, MdB
22.06. – 23.06.09	Besuch eines Vertreters der „Faculty of Geography – UGM“ beim Karlsruher Institut für Technologie (TP3-IMG und TP10-ITAS)
22.06. – 24.06.09	Abstimmungsgespräch zwischen dem International Büro des BMBF und u.a. dem Ministry of Public Works und der BAPPENAS (Nationale Planungsbehörde) über eine zukünftige Multiplikation.
19.06.09	Abstimmungsgespräch mit dem Ministry of Public Works in Jakarta zum Thema: Zentrale Koordination der Umsetzung des IWRM-Konzepts der indonesischen Seite.
10.06.09	Fernsehbeitrag „Wasser aus Karstgebieten“ in der Sendung „Nano“ (3sat) http://www.3sat.de/dynamic/sitegen/bin/sitegen.php?scsrc=2&date=2009-06-10&division=nano&cx=114
18.05. – 19.05.09	IWRM Themenworkshop „Entscheidungsunterstützungssysteme und Datengrundlagen im Kontext von IWRM“ am UFZ Magdeburg (TP1-IWG/WK, TP2-GIK und TP10-ITAS).
28.05.09	Projektvorstellung im Rahmen der Veranstaltung „Globalisierung gestalten – Perspektiven der Entwicklungszusammenarbeit“ der AIESEC (TP1-IWG/WK).
29.04.09	Projektworkshop am IWG mit Beteiligung aller Teilprojekte sowie Vertretern des IB (BMBF) und des Projektträgers FZK, Vorstellung der Projekthomepage www.iwrm-indonesien.de.
30.03. – 03.04.09	Projektvorstellung auf der "Wasser Berlin 2009" mit einem Schaumodell des IWG.
25.03.09	Projektvorstellung beim Secretary General-Ministry of Public Works in Jakarta und Diskussion der Multiplikation in andere indonesische Karstgebiete.
24.03.09	Übergeordnetes Treffen mit indonesischen Behörden zum Thema Umsetzung des IWRM in Yogyakarta.
20.03. – 21.03.09	Projektvorstellung auf der „International Conference on Rehabilitation and Maintenance in Civil Engineering”, Solo – Indonesien (TP1-IWG/WK und TP5-IfMB).
18.03.09	Projektvorstellung beim „Fachgespräch Wissenschaftskooperation mit Entwicklungs- und Schwellenländern der CDU/CSU-Bundestagsfraktion (TP1-IWG/WK, TP12-KSB und Stellvertreter des indonesischen Bildungsministeriums).
12.03. – 13.03.09	Projektvorstellung im Rahmen des Wasserbaukolloquiums Dresden (TP1-IWG/WK).

B. Erkundung der Wasserressourcen, Wasserförderung und Bewirtschaftungsstrategien (WP1/2)

13.10.09	Übergabe des Maßnahmenplans für die Gua Seropan in 2010 „Advanced Geotechnical Investigations and Storage Possibilities in Gua Seropan as Prerequisite for the Pre-design of the Seropan Hydropower Plant" an das DPU (TP1-IWG/WK, TP2-GIK, TP3-IMG, TP4-IBF, TP5-IfMB, TP6-VASHS).
06.10.09	Workshop und Fachdiskussion mit indonesischen Partnern über die für 2010 geplanten Maßnahmen in Seropan.
Sept. 2009	Felduntersuchung durch TP3-IMG, u.a.: • Geologische Kartierung der Höhle Seropan vom Wehr bis zum 2. Wasserfall (Lithologie, Strukturwerte, Gesteinsprobenahme). • Wasserprobennahme in Seropan (Fließgewässer, Tropfwasser). • Beprobung von Quellen, Brunnen, Oberflächengewässern und unterirdischen Karstfließgewässern in Semanu, Semin, Karangmojo, Ponjong mit Unterstützung von KRG. • Aufnahme von Strukturwerten an der Oberfläche über der Höhle Seropan.
Sept. 2009	Einrichtung + Verteilung der Zugangsdaten für den Internetzugang zum GIS (http://iwrm.gik.uni-karlsruhe.de/mapguide/iwrm) an alle deutschen Teilprojektpartner und an ausgewählte indonesische Partner
Aug. 2009	Felduntersuchung durch TP1-IWG/WK, TP2-GIK, TP3-IMG, TP4-IBF, TP5-IfMB, TP6-VASHS, u.a.: • Erkundung und Bemessung der oberstromigen Verzweigung in Seropan durch deutsche Berufstaucher. • 3D-Aufnahme in Gua Seropan (Wehr bis 2. Wasserfall) mit TLS (Leica HDS6000) • Absteckung der geplanten Position der Förderanlage Seropan an der Erdoberfläche mit der funktionierenden Leica GPS-Ausrüstung 900 (RTK) • Bestimmung der Höhe des Zugangs zur Schlammhöhle vor dem 2. Wasserfall in Seropan (dh mit Disto von PP39 aus übertragen) • Geophysikalische Messungen (Very Low Frequency) an der Oberfläche über Seropan zur Lokalisierung weiterer unterirdischer Fließgewässer im Nahbereich, durchgeführt von ITS. • Geophysikalische Messungen (Ground Penetrating Radar) in Seropan zur Erkundung von angrenzenden Hohlräumen zur Einschätzung der Stabilität der Höhle, durchgeführt von ITS. • Installation einer Leitfähigkeits- und Temperatursonde in Seropan. • Probenahme von Stalagmiten, sowie deren Tropfwasser in Bribin, in Zusammenarbeit mit KRG. • Geologische und geotechnische Beurteilung, zusammen mit Geo-technical Department – UPN.

	• Photographische Aufnahme der Höhle vom Wehr bis zum 2. Wasserfall. • Detaillierte Aufnahme der Wehrgeometrie • Begutachtung der Felsqualität und -klüftigkeit
Juli 2009	Felduntersuchung durch TP1-IWG/WK, TP6-VA-SHS, u.a.: • Erkundung der neuen Höhlenstrecke im Bereich des 2. Wasserfalls in Seropan. • Installation Traverse und Sicherungsseil im Bereich des 1. Wasserfalls Seropan.
Juni 2009	Installation des COSVega-Auskunftssystems auf dem Web-Server am TP2-GIK
Mai 2009	Installationen von Planen und Netzen im Bereich des 1.Wasserfalls Seropan für die Beobachtung möglicher Felsabbrüche von der Höhlendecke.
März – April 2009	Felduntersuchung in Gua Seropan durch TP1-IWG/WK, TP2-GIK, TP4-IBF, TP5-IfMB, TP6-VASHS, u.a.: • Untersuchung der Stabilität der Höhlendecke Seropan. • Untersuchung und Abstimmung des geplanten Trassierungsplans der Holzrohleitung. • Absteckung der geplanten Rohrachse in Gua Seropan mit TCR1205. • Installation von drei Messsonden des Abflussmonitoringsystem. • Geologische und geotechnische Beurteilungen im Bereich des zukünftigen Fundaments und Verankerung der Holzrohrleitung.
11.03.09	Einführung / Präsentation des GIS am TP2-GIK (zusammen mit COS) für alle deutschen Projektpartner
01.02.09	Verfassung des Schriftstückes: „Preliminary German-Indonesian Cooperation within Work Package 1 (WP1) Exploration of Water Resources“ als Grundlage für die Zusammenarbeit zwischen TP3-IMG, TP1-IWG/WK, KRG, ITS, BATAN.

C. Wasserverteilung und -gütesicherung sowie Abwasserbehandlung (WP3/4)

November 2009	Modifikationen am Anaerobreaktor der TP18-Hans Huber AG (TP9-IWG/SWW).
Oktober 2009	Felduntersuchung im Wasserverteilungssystem Bribin durch TP1-IWG/WK, TP7/8-IFG u.a.: • Vergleichsmessungen (Drücke und Durchflüsse) in allen Netzabschnitten des Verteilungssystems zur Kalibrierung des hydraulischen Modells und zur Bestimmung der realen Wasserverluste. • Probenahme Gua Bribrin, Gua Seropan, Krankenhaus Wonosari und im Verteilungssystem Bribin durch TP7/8
06.10. + 27.10.09	• Präsentation der Entwurfsplanung zur Umstrukturierung des Zubringernetzes Bribin und Übergabe des Dokuments „Restructuring of the main line system Bribin – comparison of scenarios“ durch TP1-IWG/WK. • Diskussion und Entscheidung für die finale Variante des Netzkonzepts mit den indonesischen Partnern (u.a. DPU-Cipta Karya) durch TP1-IWG/WK.
05.08.2009	• Diskussion über Standort der Pilotanlagen (von TP7/8 und TP9) für die Wasseraufbereitung mit indonesischen Partnern (BAPPEDA, DPU, Health Office GK, PDAM GK). • Einigung über Krankenhaus Wonosari als Standort.
Ab Juli 2009	• Monatliche Beprobung und Untersuchung der Wasserqualität der Gua Bribin, Gua Seropan und Krankenhaus Wonosari durch Projektpartner UII von TP7/8-IFG. • Ausarbeitung und Verfeinerung eines Konzepts für die Wasseraufbereitung als eine Zusammenarbeit von TP7/8-IFG, TP9-IWG/SWW und TP17-CIP.
April – Oktober 2009	• Entwurfsplanung (Variantenstudium) für die Umstrukturierung des Zubringernetzes Bribin durch TP1-IWG/WK. • Aufbau und Inbetriebnahme des Anaerobreaktors der Hans Huber AG auf dem Kläranlagengelände in Neureut durch TP9-IWG/SWW und TP18-Huber AG • Untersuchung der Wasserqualität durch TP7/8: Generell hohe Belastung des Wassers durch Coliforme Bakterien. Belastung des Wassers in Behältern an Enden des Leitungsnetzwerkes (R 6, R8, R9) am höchsten.
März – April 2009	Felduntersuchung im Wasserverteilungssystem Bribin durch TP1-IWG/WK, TP2-GIK, TP13-IDS, TP17-CIP, u.a.: • Untersuchung der GSM-Abdeckung und der Stromversorgung für die Planung des Leitsystems. • Aufnahme und Vermessung der Installationen der Speicherbehälter und Pumpstationen. • Beurteilung des Zustands der Systemelemente (Leitungen, Armaturen, Pumpen, Speicherbehälter).

	• Beprobung des in den Behältern gespeicherten Wassers hinsichtlich Qualität. • Standortuntersuchungen für die geplante Wasseraufbereitungsanlage.
März 2009	• Diskussion und Konzipierung der notwendigen Umstrukturierungsmaßnahmen sowie der Versorgungsphilosophie und der Steuerung (Leitsystem) im zukünftigen Zubringersystem Bribin durch TP1-IWG/WK, TP13-IDS und indonesische Partner. Abstimmung eines Zeitplans. • Aufbau und Betrieb von aerob und anaerob Versuchsanlagen im halbtechnischen Maßstab und Labormaßstab durch TP9-IWG/SWW.
Januar – März 2009	• Vorplanung der Verbesserungs- und Umstrukturierungsmaßnahmen des Wasserverteilungssystems Bribin und Konzipierung des Leitsystems durch TP1-IWG/WK und TP13-IDS. • Bestandsaufnahme zu den regionalen Verhältnissen im ländlichen Einzugsgebiet des Wasserversorgungsnetzes der Gua Bribin in Petir, Indonesien durch TP9-IWG/SWW.

D. Sozioökonomische Analyse / Technikfolgenabschätzung und Capacity Development (WP5/6)

Oktober – November 2009	Felduntersuchungen in Ponjong (Bribin-Einzugsgebiet) durch TP10-ITAS, u.a.: • Ist-Analyse der Abwassersituation im ländlichen Raum • Untersuchung der Akzeptanz der Bevölkerung zur Nutzung von Grau-, Braun- und/oder Gelbwasser • Untersuchung des Bewusstseins der Bevölkerung hinsichtlich des Zusammenhangs zwischen Abwasserbehandlung(-entsorgung) und Schutz der Wasserressourcen. Treffen mit WP 1 + WP 2 zur Abstimmung der Datenerhebung für LCA (TP10-ITAS)
August	Übersiedlung der Doktorandin nach Yogyakarta zum Ständigen Aufenthalt, Kontaktaufnahme zu verschiedenen Institutionen, Datensammlung zu Nachhaltigkeitsindikatoren, Unterstützung von Feldarbeiten vor Ort (TP10-ITAS)
Juli – September 2009	Gastdozentur mit Feldarbeiten im Untersuchungsgebiet (Norden des Seropannetzes) und Teilnahme an Haushaltsuntersuchungen der Geogr. Fakultät der UGM (TP11-IfG).
Juli 2009	Beginn der Datenerfassung zur Sachbilanz des Bribin-Systems im Rahmen der LCA/LCC (TP10-ITAS) in Abstimmung mit WP 1/2 und WP3/4
April 2009	Felduntersuchung durch TP10-ITAS, u.a.: • Interviews mit Institutionen aus dem Wasserversorgungs- Abwasser- und Abfallbehandlungssektor in Yogyakarta • Übersicht über die relevanten Stakeholder und zuständigen Institutionen im Wassersektor • Analyse der Finanzpläne für Wasserversorgung, Abwasser- und Abfallbehandlung und ihre Optimierungsmöglichkeiten (Subventionen, PPP)

E. Bribin Unterirdische Wasserkraftanlage

Oktober 2009	• Fertigstellung der E-Technik-Installation und Überprüfung über manuellen Betrieb durch TP1-IWG/WK und Fa. Walcher. • Ausrichtung der KSB-Fördermodule durch KSB-Indonesien. • Überprüfung der Installation des Rohrsystems (u.a. Dichtigkeit) durch TP1-IWG/WK. • Staumauerüberwachungsmessungen (1. Epoche nach der Nullmessung) mit Leica TCR1205 durch TP2-GIK.
September 2009	• Installation der zweiten Förderleitung.. • Sanierung Reservoir Kaligoro.
August 2009	• Nachbohren der Drainagebohrungen sowie Einstauen zum Testen des Injektions-schleiers (bzw. Sickerwassermonitoring), begleitet durch TP4-IBF, TP5-IfMB und TP1-IWG/WK. • Sicherung der „Big-Packs“ im ehemaligen Felssturzbereich nach dem Siphon durch deutsche Berufstaucher.
Juli 2009	Installation der Module und des Rohrleitungssystems, begleitet durch das IWG.
März - April 2009	• Realisierung des Injektionsschleiers, begleitet durch das IBF und das IfMB. • Fertigstellung und Lieferung von vier KSB-Fördermodulen nach Indonesien.
Februar 2009	Maßnahmen zum Test des Injektionsschleiers, begleitet durch TP4-IBF.

Abkürzungen:

DPW (Department / Ministry of Public Work)
UGM (Gadjah Mada University, Yogyakarta)
KRG (Karst Research Group, Faculty of Geography, Gadjah Mada University, Yogyakarta)
ITS (Institute of Technology Surabaya)
BATAN (National Atom Energy Board)
UPN (Pembangunan Nasional University, Yogyakarta)

Anlage 2

Bisherige Terminplanung 2010

(stand: 14.12.09)

Voraussichtlich Termin		Thema	Beteiligte
Monat	Datum		
Januar	Ab 24.01.	Fertigstellung Elektrotechnik Bribin Wasserkraftanlage	TP1-IWG/WK, Fa. Walcher
	*	Aufbau des Wasseraufbereitungsbehälters für die Pilotanlage – wird zwischen Februar und Juli 2010 an der Schwarzwald- Jagesquelle getestet	TP7/8-IFG, TP17-CIP
	*	• Sanierung und Optimierung der Wasseraufbereitungsanlagen Sewon and Sedayu • Implementierung der „leakage control strategy“ (Training/Einführungskurs und Systeminspektion im Pilotgebiet Bantul)	TZW
Februar	04.02. – 05.02.	IWRM-Themenworkshop "Governance und Partizipationsprozesse im Integrierten Wasserressourcen-Management", organisiert durch das BMBF IWRM-Vernetzungsprojekt	Noch nicht festgelegt
	08.02.	Vortrag über Projekt bei der Geographische Gesellschaft Karlsruhe	TP3-IMG
	*	Nachinjektionen Maßnahme Bribin Wasserkraftanlage	TP4-IBF, TP5-IfMB, TP3-IMG
Februar - März	*	• Kurzes Seminar über Geologische Untersuchungen in der Karstregion Surabaya – Indonesien • Felduntersuchungen (u.a. Tracerversuch, Wasserprobenahme nach der Regenzeit, Untersuchungen zur Vulnerabilität in Zusammenarbeit mit UGM & TP10-ITAS)	TP3-IMG
März	**09.03.**	**IWRM Multiplikationsworkshop in Jakarta / Yogyakarta mit Beteiligung des Internationalen Büros des BMBF**	(Voraussichtlich) TP1-IWG/WK, TP3-IMG, TP11-IfG
	10.03. – 11.03.	**IWRM Workshop in Yogyakarta und Übergabe der Bribin Wasserkraftanlage mit Stellvertretern des BMBF, KIT Präsident Prof. Horst Hippler und Presse.**	Alle TPs

	*	Messkampagne durch TP2-GIK, u.a.: • TLS-Messungen Gua Bribin: Staumauer, Plattform, Förderanlage (in Zusammenarbeit mit TP1-IWG/WK) • GPS-Netzmessungen Seropan (in Zusammenarbeit mit TP1-IWG/WK) • Tachymetermessungen Gua Bribin (in Zusammenarbeit mit TP4-IBF)	TP2-GIK, TP1-IWG/WK, TP4-IBF
	*	Übergabe und Diskussion der Spezifikationen für die Umstrukturierung des Zubringersystems Bribin mit indonesischen Partnern	TP1-IWG/WK
April	**28.04.**	**IWRM Status Workshop in Karlsruhe mit Sachstandspräsentationen aller TP's**	Alle TPs
	*	Bau der temporären Wehrerhöhung in Seropan, um zusätzlichen Speicher für Probeeinstau in Gua Seropan bereitzustellen	TP5-IfMB, TP1-IWG/WK, TP6-VA-SHS
Mai	*	• Probeeinstau Gua Seropan • Beginn der weiterführenden geotechnischen Untersuchungsmessungen	TP1-IWG/WK, TP4-IBF, TP5-IfMB, TP6-VA-SHS
Juni	*	IWRM-Themenworkshop „IWRM Konzepte", organisiert durch das BMBF IWRM-Vernetzungsprojekt	Noch nicht festgelegt
Juli	*	Fertigstellung des Konzepts des Leitsystems des Bribin Wasserverteilungsnetzes	TP1-IWG/WK, TP13-IDS
	*	Doktoranden-Sommer, organisiert durch das BMBF IWRM-Vernetzungsprojekt	(Voraussichtlich) TP7/8 IFG, TP9-IWG/SWW, TP10-ITAS
August	*	Übergabe und Diskussion des Vorentwurfs der Seropan Wasserkraftanlage mit indonesischen Partnen	TP1-IWG/WK, TP4-IBF, TP5-IfMB, TP6-VA-SHS
	*	Übergabe und Diskussion des Konzepts des Leitsystems des Bribin Wasserverteilungsnetzes mit indonesischen Partnern	TP1-IWG/WK, TP13-IDS
	*	Transport der Abwasserbehandlungs- und Wasseraufbereitungsanlagen nach Indonesien, entprechend durch TP 7/8-IFG und TP9-IWG/SWW	TP7/8-IFG, TP9-IWG/SWW, TP17-CIP, TP18-HUBER
Oktober	*	Messkampagne durch TP2-GIK, u.a.: • GPS-Ergänzungsmessungen Verteilungssystem Bribin in Zusammenarbeit mit TP1-IWG/WK) • GPS-Aufnahme Wasserverteilungssystem Seropan in Zusammenarbeit mit TP1-IWG/WK) • Weitere GIS-Workshops mit UGM und indonesischen Behörden	TP2-GIK, TP1-IWG/WK

	*	IWRM Themenworkshop „Implementierung von IWRM Konzepten“ organisiert durch das BMBF IWRM Vernetzungsprojekt	Noch nicht festgelegt
November	24.11 – 25.11	IWRM Karlsruhe 2010, Kongress und Messe	u.a. TP1-IWG/WK

* Geplantes Datum ist noch nicht bekannt

Anlage 3
Bilderdokumentation / Impressionen 2009

1. Work-Package 1 und 2: Erkundung der Wasserressourcen / Wasserdargeboten und Wasserbewirtschaftung / Wasserförderung

1.1 Geologische Erkundung der Höhle und ihrer Wasserressourcen


Wasserprobennahme in Seropan


Probenahme von Stalagmiten



Beprobung von Quellen, Brunnen, Oberflächengewässern

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Präsidenten: Prof. Dr. Horst Hippler, Prof. Dr. Eberhard Umbach
Vizepräsidenten: Dr.-Ing. Peter Fritz, Dr. Alexander Kurz,
Prof. Dr.-Ing. Detlef Löhe

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1.2 Installationen weiterer Abfluss Monitorringsysteme in Gua Seropan

1.3 Felduntersuchungen und Messungen an Gua Seropan für die Entwicklung eines Entwurfs für die Wasserförderanlage

Zugangstollen

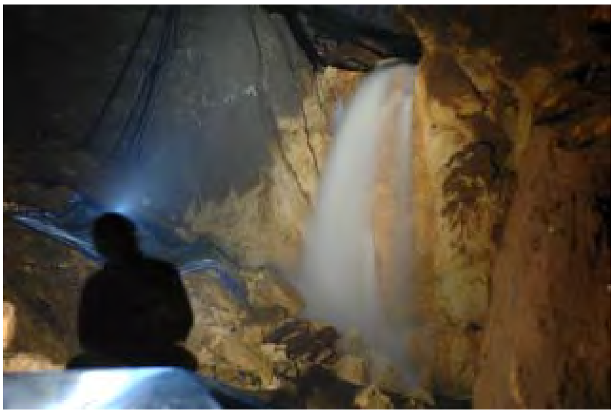
Wehrbereich – Planung für zukünftige Lage der Holzdruck-rohrleitung

Anfang des Höhlenverlaufes nach dem Wehr

Eingang des großen Hallenbereichs

Kurz vor dem 1. Wasserfall – Felsen in der Trasse

Kurz vor dem 1. Wasserfall



Abstieg über 1. Wasserfall

Zukünftige Position der Wasserförderanlage

Geologische und geotechnische Beurteilung

1.4 Erkundung der Schlammhöhle vor dem 2. Wasserfall Gua Seropan

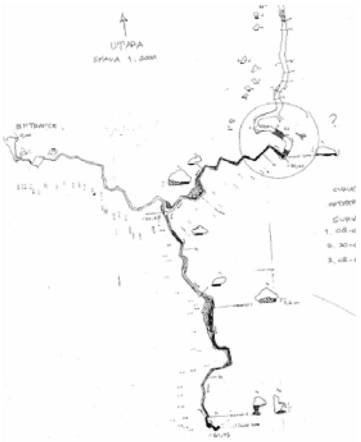
Eingang Schlammhöhle

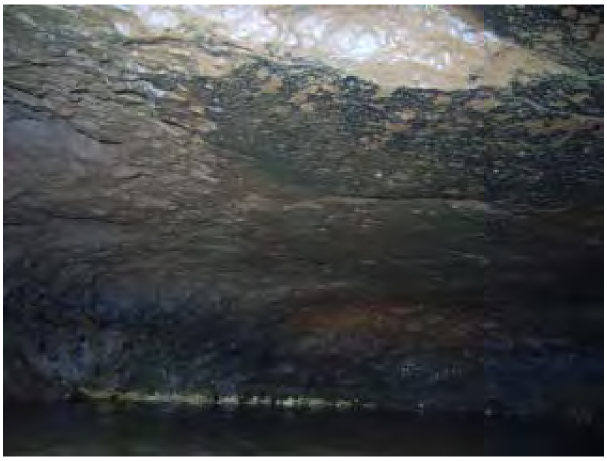
ca. 10 m hohe, vertikale Wand

Höhleverlauf

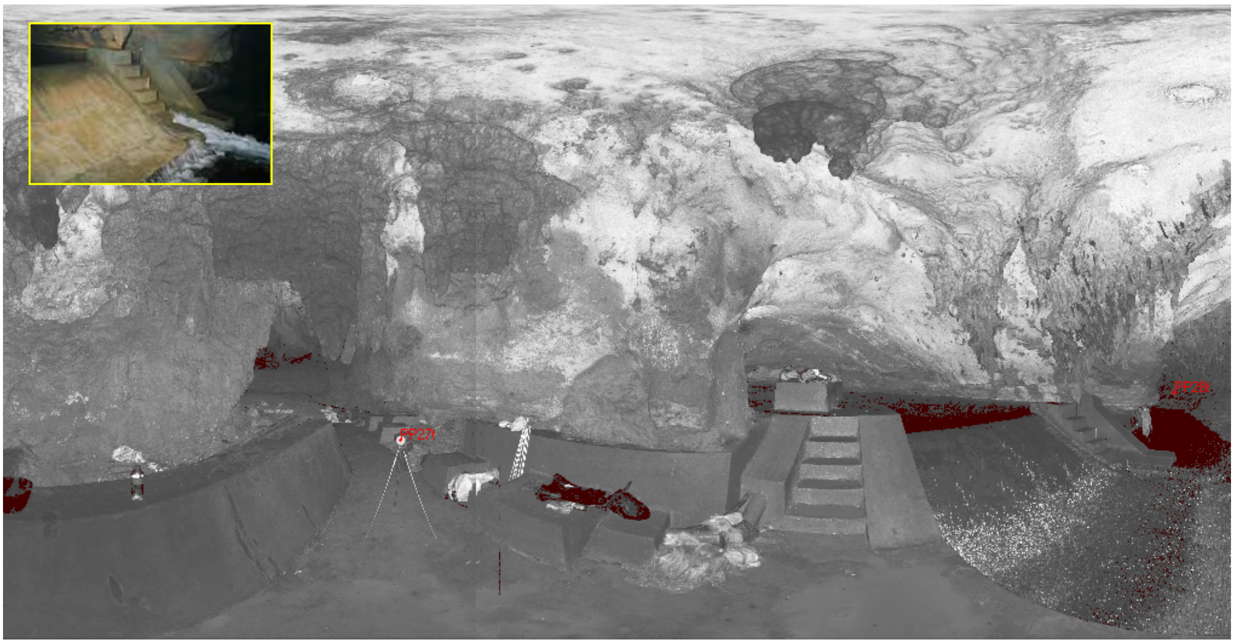
Nach ca. 25 m

1.5 Erkundung der Verzweigung im Oberwasser Gua Seropan





1.6 3D- Terrestrische Laserscanner Messungen



Grauwertbild Darstellung – Wehrbereich Seropan

2. Work-Package 3 und 4: Wasserverteilung / -aufbereitung / -gütesicherung und Abwasser- / Abfallbehandlung

2.1 Bestandsaufnahme und Messungen für die Optimierung, das Sanierungskonzept und die Entwicklung des Leitsystems





2.2 Wasserprobenahme im Einzuggebiet


2.3 Entwicklung des Abwasserbehandlungskonzeptes für das ländliche Gebiet in Gunung Kidul


Felduntersuchungen

Aerob Versuchsanlagen (Labormaßstab)

2.4 Probelauf der Pilotanlage (Anaerobreaktors) zur Abwasserbehandlung auf dem Gelände der Kläranlage in Neureut (wird voraussichtlich Mitte 2010 nach Indonesien geliefert)




3. Work-Package 5 und 6: Sozioökonomische- / Technikfolgeabschätzung und Capacity Development

3.1 Datenerhebung zur Sozioökonomischen Analyse und den Nachhaltigkeitsindikatoren

4. Fertigstellung zur unterirdischen Wasserförderanlage Gua Bribin

4.1 Realisierung des Injektionsschleiers inkl. Nachbohren der Drainagebohrungen

4.2 Lieferung und Installation weiterer KSB-Fördermodule (inkl. Ausrichtung durch KSB-Indonesien) und des Rohrleitungssystems

4.3 Reservoir Kaligoro

4.4 Fertigstellung der E-Technik inkl. Datenübertragung für Wasserspiegelüberwachung des Reservoir Kaligoro zur Baustelle Bribin

SPS Panel an Aufzughaus

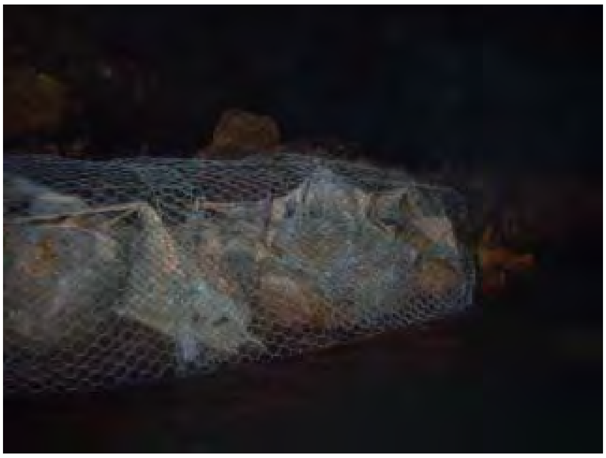
Schaltschrank im Schacht

Installation der Antenne für die Datenkommunikation

Installationen des Wasserspiegelmonitoring inkl. Datenübertagung zum Reservoir Kaligoro

4.5 Sicherung der Abbrüche („Big-Packs“) hinten dem Siphon Bribin durch dtsch. Beruftaucher

Vorher



Nachher

Bilderquelle: Teilprojekte IWRM-Indonesien

Universität Karlsruhe (TH)
Forschungsuniversität • gegründet 1825

Geodätisches Institut

GADJAH MADA UNIVERSITY
Yogyakarta, INDONESIA

Faculty of Geography

16 October 2008

LETTER OF INTENT

Based on the membership in the project "Integrated Water Resources Management (IWRM) in Karst Area, Gunung Kidul, Yogyakarta Special Region" and to promote friendly ties, the representatives of the

Faculty of Geography, Gadjah Mada University Yogyakarta, Indonesia
and
the Geodetic Institute, University of Karlsruhe, Germany (GIK),

Prof. Dr. Suratman, M.Sc. and Prof. Dr. G. Schmitt decided to collaborate within the IWRM project, including the following items:

- data sharing and data acquisition to develop and increase the IWRM-project GIS, provided by the GIK.
- Intensification of the contact of staff members and knowledge exchange in GIS.
- mutual support in field studies and measurement campaigns.

Dean of the Faculty of Geography
Gadjah Mada University Yogyakarta
Indonesia

UNIVERSITAS GADJAH MADA FAKULTAS GEOGRAFI

Prof. Dr. Suratman, M.Sc.

Geodetic Institute University of Karlsruhe
Karlsruhe / Germany

UNIVERSITÄT KARLSRUHE (TH)
GEODÄTISCHES INSTITUT
Englerstraße 7
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Justus-Liebig- Universitat Giessen
Institut fur Geographie
Senckenbergstr, 1, D-34390 - Giessen

University of Gadjah Mada
Faculty of Geography
Bulaksumur – Yogyakarta 55284

Letter of Intent

On Scientific Cooperation and Academic Exchange
between
Institute of Geography (IfG) Giessen University
and
Faculty of Geography (FAGEO), Gadjah Mada University - Yogyakarta

---

Both partners agree to cooperate with regard to the following research field:

WATER MANAGEMENT AND SOCIO-ECONOMIC CONDITIONS OF KARST AREAS IN INDONESIA

The cooperation is based on an official partnership between the Gadjah Mada University Yogyakarta and the Justus-Liebig-University Giessen, which exists since 2001, and on the 'Integrated Water Resource Management' (IWRM) -Project.

IfG has successfully applied for funds from the BMBF in Germany and will support FAGEO-efforts to apply for funds from UGM or other institutions.

FAGEO will support IfG-members with regard to visa-applications and visa-extensions.

Field surveys will be performed and documented jointly.

Results will be shared among all partners who have participated.

Depending on the success of the joint research activities FAGEO and IfG will discuss about subsequent corresponding research and other possibilities of scientific cooperation.

Yogyakarta, 11 September, 2009

Prof. Dr. Suratman, M.Sc.
Dean of Faculty of Geography
Gadjah Mada University

Prof. Dr. Andreas Dittmann
Institute of Geography
University Giessen

Universität Karlsruhe (TH)
Institut für Mineralogie und Geochemie
Forschungsuniversität · gegründet 1825

University of Gadjah Mada
Faculty of Geography
Bulaksumur – Yogyakarta 55284

LETTER OF INTENT
ON SCIENTIFIC COOPERATION AND ACADEMIC EXCHANGE

between
Institute of Mineralogy and Geochemistry (IMG), Universität Karlsruhe
and
Faculty of Geography (FAGEO), Gadjah Mada University

Both partners agree to collaborate in respect of the following avenue of research:

KARST HYDROGEOLOGY AND SPELEOGENESIS IN GUNUNG KIDUL

The COLLABORATION is based on the IWRM project. Both parties contribute to the field trips and to preliminary investigations in the frame of their possibilities. IMG will apply for funding to the BMBF and will support FAGEO with regard to applying for UGM or other funds. Both parties agree that third parties can be involved in the above mentioned research field only upon mutual agreement.

SAMPLES will be shared among IMG and FAGEO and mutual agreement upon treatment has to be found. FAGEO is responsible that IMG will be able to export samples from Indonesia.

INVESTIGATIONS: Field observations will be documented and samples will be shared for analysis. Laboratory work on the samples will be conducted within the frame of possibilities of both parties (see technical attachments).

RESULTS will be shared among all partners who have contributed and shall be published jointly. On mutual agreement results can be used in a different way. It is intended, that two PhD theses will be completed with the following objectives: (i) Vulnerability study of Seropan karst system (Supervised by FAGEO), (ii) Geological and hydrochemical characterisation of the Seropan karst system (supervised by IMG).

PERSPECTIVE: Depending on the success of the field trips and the preliminary results IMG and FAGEO will discuss a roadmap of subsequent corresponding research and jointly develop a concept for sustainable research activities.

Yogyakarta, the 11 September 2009

Institut für Mineralogie u. Geochemie
der Universität
76128 Karlsruhe · Kaiserstraße 12
Tel. 0721/608 33 22/33 16
Fax 49-721/608 72 47

Prof. Dr. Suratman, M.Sc.
Dean of Faculty of Geography
Gadjah Mada University

Prof. Dr. Thomas Neumann
Head of Institute for Mineralogy and Geochemistry

Faculty of Geography
Gadjah Mada University
Yogyakarta

ITAS Institut für Technikfolgenabschätzung und Systemanalyse

LETTER OF INTENT

on Scientific Cooperation and Academic Exchange
between
Institute of Technology Assessment and Systems Analysis (ITAS),
Karlsruhe Institute of Technology
Hermann-von-Helmholtzplatz 1, D-76344 Eggenstein-Leopoldshafen
and
Faculty of Geography (FAGEO), Gadjah Mada University
Bulaksumur, Yogyakarta 55281, Indonesia

Both partners agree to collaborate in respect of the following avenue of research:

MANAGING CATCHMENT AREA OF BRIBIN SYSTEM WITH MAIN FOCUS ON WATER, WASTE WATER AND SOLID WASTE

The COLLABORATION is based on the project "Integrated Water Resources Management in Gunung Kidul, Java, Indonesia. Both parties contribute field surveys and analysis on the attitude of people how to use water and to manage waste water and solid waste in different parts of the Bribin catchments area (Gunung Kidul regency). ITAS has applied for funding to the BMBF (German Ministry for Science and Research) and will support FAGEO as far as field surveys are carried out on which both sides have agreed on before and with regard to applying for UGM or other funds. Both parties agree to develop collaboration with other parties in this research field only upon mutual agreement.

SCOPE of collaboration will be on joined research, education, publication and dissemination to the local people. DATA will be shared among ITAS and FAGEO and mutual agreement upon treatment has to be found.

SURVEY: Field observations and questionnaire will be documented and raw data will be shared for analysis. Analysis will be conducted within the frame of possibilities of both parties. In case that a survey is financed by one side this side has the ownership on the data. Independent from this the data can be used for academic theses.

RESULTS will be shared among all partners who have contributed and shall be published jointly. On mutual agreement results can be used in a different way.

PERSPECTIVE: Depending on the success of the field surveys and the preliminary results, ITAS and FAGEO will discuss a roadmap of subsequent corresponding research and jointly develop a concept for sustainable research activities.

Yogyakarta, October 5th, 2009

Prof. Dr. Suratman, M.Sc.
Dean of Faculty of Geography
Gadjah Mada University

Karlsruhe, October 12th, 2009

A. Grunwald

Prof. Dr. Armin Grunwald
Head of Institute of Technology Assessment and Systems Analysis (ITAS)

JOINT PROJECT:
INTEGRATED WATER RESOURCES MANAGEMENT (IWRM) IN GUNUNG KIDUL, INDONESIA

Advanced Geotechnical Investigations and Storage Possibilities in Gua Seropan as Prerequisite for the Pre-design of the Seropan Hydropower Plant

Status: 10/09

Note:
This advanced geotechnical investigations and storage possibilities document should be used as a basis for the cost determination of the Indonesian project partners and for further planning and discussions.

In cooperation with the German project partners the detailed designs for the advanced geotechnical investigation and for the construction of heightening of the weir should be done based on this document. The below mentioned quantities are approximate values calculated on basis of the current document and the knowledge of the boundary conditions at Gua Seropan. The construction company and/or subcontractors are fully responsible for the detailed planning and exact design of all load-bearing members based on assumptions verified by themselves.

Especially for the difficult construction work for the advanced geotechnical investigation a constant supervision by an expert in the field of geology and rock mechanics is absolutely mandatory. The construction workers need to be familiar with working on soil and rock material. They must be experienced in working on tunnelling or mining projects, related to drilling, placing anchors etc. It is necessary to train and educate all staff on site, especially the construction workers, in safety standards.

- Content -

1. Advanced geotechnical investigation

The required advanced geotechnical investigation is developed on the data basis of several analyses in 2009. Belonging to it Terrestrial Laser Scanning (TLS), intensive geological mapping and georadar measurements. The results of this advanced geotechnical investigation serve as a decision support of the extend and intensity of the future geotechnical stabilisation measures.

The detailed requirements for the advanced geotechnical, the kind of measurement the objective and region of them in the Gua Seropan are explained in the following. To accentuate the importance of the supervision by an expert in the field of geology and rock mechanics the point d) is listed below.

Definition of the sections:

Section 1: from weir to the entrance of the Big Hall

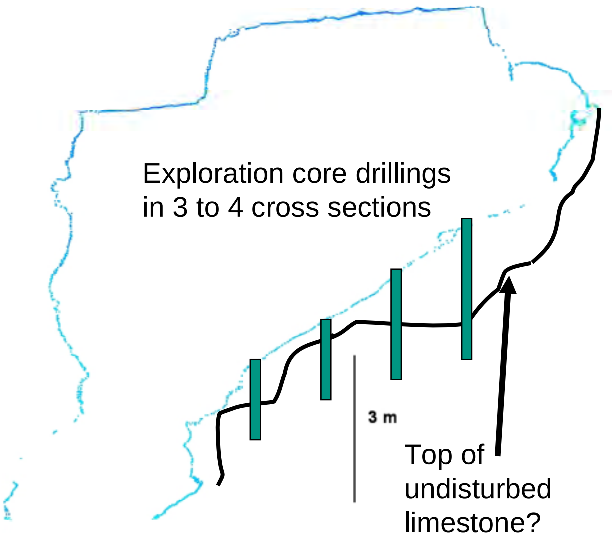
Section 2: from the entrance of the Big Hall to the 1st waterfall

Section 3: decent over the 1st waterfall

Section 4: until the location of the machinery platform

a) Exploration drillings in the rock slopes and endoscopic inspection in section 2

- approx.. 12 core drillings, approx.. 60 m total length
- Thickness and properties of rock debris
- Determination of top of undisturbed solid limestone

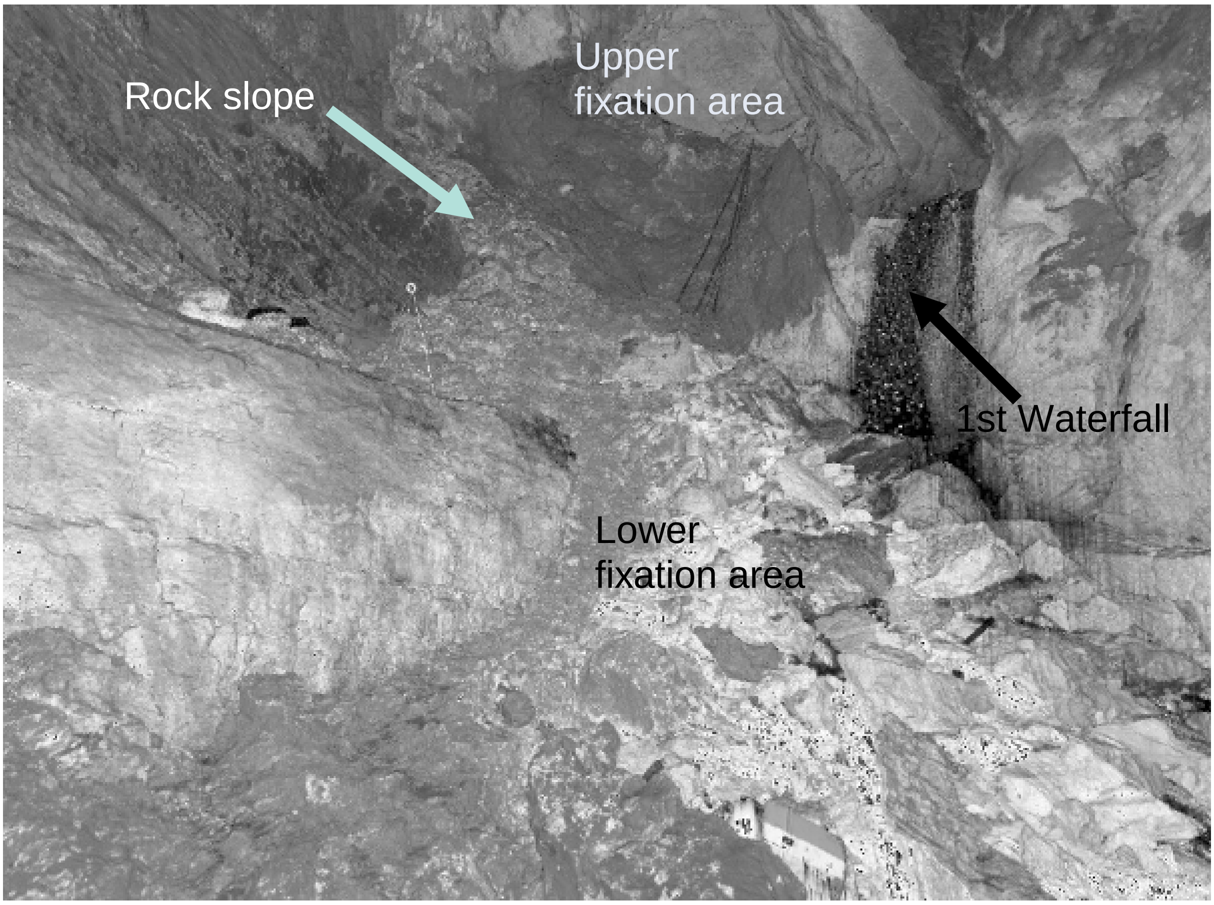


Rock slope in downstream view in section 2 and measured cross-section

Rock slope with the visualized pipeline in downstream view in section 2

b) Exploration drillings at the bottom area of 1st waterfall

- approx. 8 core drillings, approx. 60 m total length
- Thickness and properties of rock debris
- Determination of top of undisturbed solid limestone



Upstream view of the bottom area at the 1st waterfall in section 3

c) Test anchoring in section 1 (thread steel bars d = 28 mm)

- Testing of drilling technique
- Endoscopic examination of boreholes
- Pull-out test to determine


Downstream view at the weir (left) and at the entrance to the Big Hall (right) with the visualized pipeline in section 1

d) Checking of mining capacities in Indonesia

- Excursion to gold mine
- Collaboration with UPN, Yogyakarta

General Note:

For the season in which the drillings should be done, it is important that no risk for high water exists. Beside that all the measures can be executed during the entire year.

Notes to a) and b):

The exploration drillings must be done as core drillings with a drill-diameter of 66 mm and a core-diameter of 50 mm. Larger diameters are also possible, but it is more difficult for the execution. The drillings in the rock slopes have to be realized as smooth coring so that no significant vibrations occur. The risk of an after-rupture of the ridge is not raised by the exploration drillings in the rock slopes. Because of the ongoing evaluation of the TLS measurements, the exact location of the cross sections and the drillings as well as the drilling positions at the bottom area of the first waterfall will be set at a later date. Generally in section 2 (total length about 50 m) at three to four cross sections in each three to four drillings should be investigated. It is very important that the extracted drill cores placed meter by meter in core boxes.

Note to c):

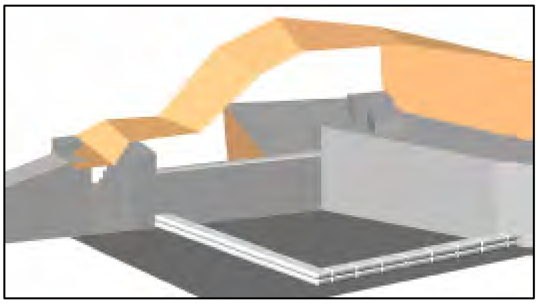
Pull-out test should be done as double test with two anchors installed vis-à-vis. In total three pull-out tests should be done. The suspension of the wood stave pipeline is designed account to the earthquake forces. These forces are much bigger than any influence from vibrations that can occur during proper operation of the hydropower plant so, that these effects can be neglected.

2. Temporary heightening of the weir for test storage

In the course of Seropan construction activities, the permanent heightening of the existing weir is planned. Thus, an additional water storage level of 1,30 m could be obtained to guarantee a bigger permanent hydraulic head during the subsequent operation of the hydro power plant. Furthermore, this certainly results in optimised cost effectiveness of the whole hydro power plant.

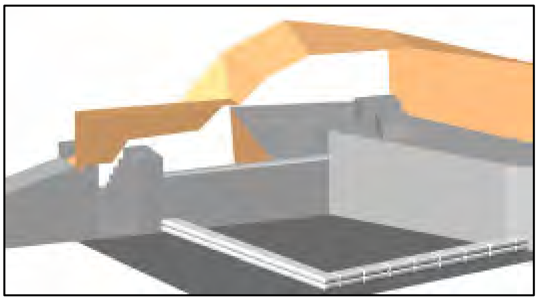
Previous to the permanent heightening of the weir, it is essential to know, if the additional storage height can be reached or if the upstream junctions in the karst rock serve as natural flood reliefs. Therefore, a temporary test storage should be performed to estimate to what extent a heightening of the weir could be useful.

The detailed requirements for the temporary heightening of the weir are given in the material requirement list below. The principle of the suggested heightening method is explained in detail and illustrated in the following.



Step 1.1: Opening of the sliding valve of the weir to lower the upstream water storage level. After that, the area upstream of the weir (e.g. 4 x 4 m²) can be drained with a sandbag dam which directs the flow through the open sliding valve at the left side of the weir.

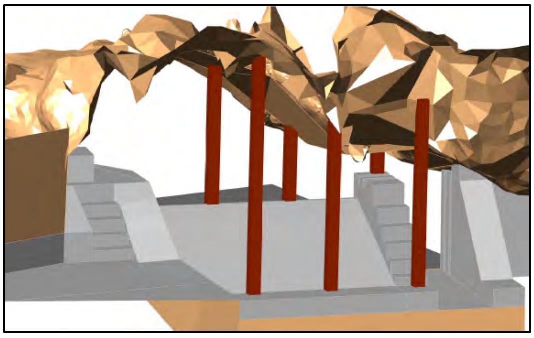
Step 1.2: Removing of the mud layers in the upstream area with suction to excavate the base of the weir. The material can be used to build the sandbag dam mentioned in Step 1.1.



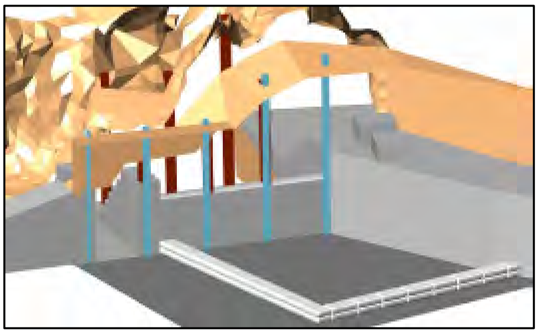
Step 2: Excavation of the low parts of the cave roof above the sliding valve to create working space and to be able to install the stop-log frame more easily. This measure is already useful with regard to the subsequent permanent heightening of the weir.

Step 3.1: Excavation of the bearings for the steel frames and for the weir-supporting construction at the weir roof and on the backplate of the weir.

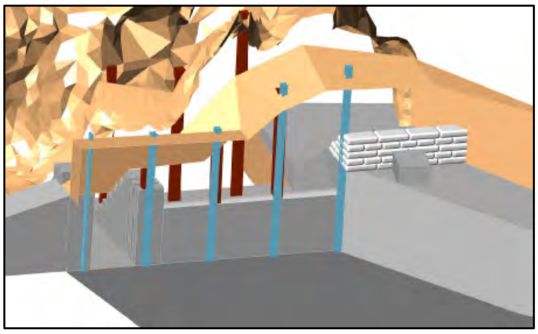
Step 3.2: Building of the weir-supporting construction (e.g. pillars of wood or steel). The construction should support the weir head and the weir ramp against buoyancy. The pillars have to be dimensioned according to the static requirements. Proof against buoyancy has to be verified.



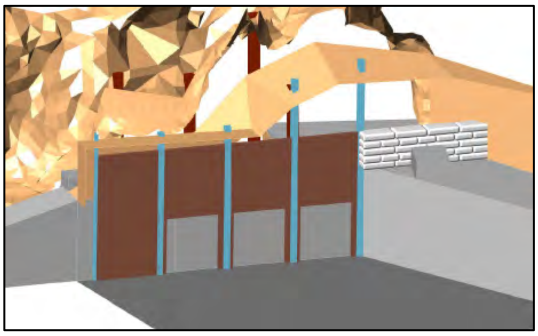
Step 4: Installation of the steel frames for the stop-logs. The length of the steel frames has to be chosen according to the conditions on site. The cross section of the steel frames has to be dimensioned according to the static requirements. If the existing weir has been built according to the old Indonesian construction drawings, there should be a plate at the base of the weir on which the steel frames could be installed. The proofs against sliding and tilting of the weir have to be verified.



Step 5: Construction of a sand bag dam (h ~ 80 cm) on the lateral platform.

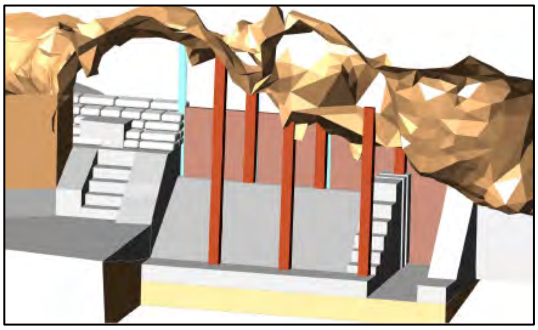


Step 6: Installation of the stop-logs. The stop-logs have to be dimensioned according to the static requirements. The proofs of bearing and shear have to be verified. In order to save timber, the stop-logs could start shortly under the weir head. The



tightness of the construction has to be assured.

Step 7: Monitoring of the test storage together with German experts



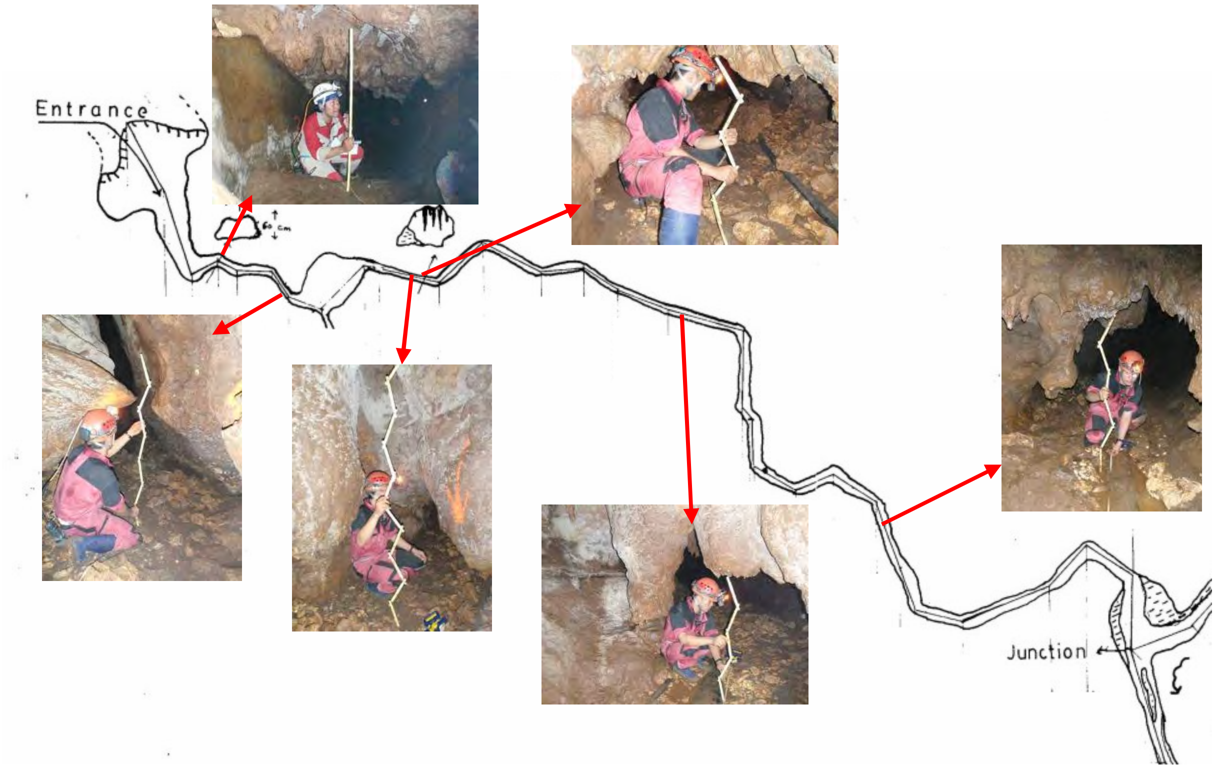
Work and material requirements / Quantities

Nr.	Requirements / Construction works	Unit	Quantity
2.1	excavation of mud layer at the base of the weir	m³	~ 10
2.2	supply of electricity on site	pc.	1
2.3	sandbag dam first use: to drain the area upstream of the weir (h ~ 1,0 m) second use: to build the dam on the lateral platform	 m³ m³	 ~ 10 ~ 5
2.4	dewatering pump (2 kW), head: 3 m, flow: 10 l/s to drain the area upstream of the weir	pc.	3
2.5	temporary work platform (e.g. bamboo construction) for excavation work at the cave roof above the sliding valve	-	-
2.6	excavation work excavation of the cave roof above the sliding valve and chiselling of the bearings for the weir-supporting construction (see 2.7) and for the steel frames (see 2.8)	m³	~ 8
2.7	supporting construction against buoyancy of the weir e.g. pillars made of wood or steel cross section according to load assumptions proof against buoyancy has to be verified	m	~ 14

2.8	steel bars (e.g. I and U-profiles) to create the stop-log frame cross section according to load assumptions (min. h = 100 mm) length according to the conditions on site	m	~ 18
2.9	welding equipment e.g. to cut or connect the steel frames	pc.	1
2.10	stop-logs made of timber proof of bending and shear has to be verified cross section according load assumptions (min. b = 100 mm) length according the conditions on site	m	~ 75

3. Measures for the entrance tunnel

For the realization of the geotechnical measures (see Chapter 1) and the heightening of the weir for test storage (see Chapter 2) a good accessibility of the cave Gua Seropan is required. Currently, the dimensions of the cave entrance are in several passages too small (see Figure). Due to the needed equipments (e.g. drilling machine), materials (e.g. concrete, steel frames) and for escape in case of emergency the minimal dimension of the entrance is a height of 2 m and a width of 1 m. The volume of the entire excavation is about 50 – 60 m³.



Location of the most problematic passages

Work and material requirements / Quantities

Nr.	Requirements	Unit	Quantity
3.1	Excavation Height: 2 m Width: 1 m	m³	50 - 60
3.2	Equipment for excavation (to be defined by Indonesian side)	pc.	1

4. Time Plan (Bribin and Seropan)

The results of these advanced investigations will be used as a basis for the finalisation of the pre-design Seropan hydropower plant. **The pre-design can be delivered approximately 3 months after the acquirement of the investigation results**.

Therefore, it is important to carry out these measures together by German and Indonesian experts as soon as possible. The latest should be before mid 2010 in order to finish the pre-design and to start the construction measures of Seropan hydropower plant in 2011.

As addition to the activities in Seropan, an appointment is planned for the commissioning of Bribin hydropower plant in March 2010. As discussed, several measures have to be carried out before Bribin can be in full operation.

Based on the conditions above, the proposed time plan for the activities in Indonesia is:

Time (2010)	Activities	Responsible institutions from Indonesian side	Accompanied by German Side*
Activities in Bribin			
Jan. – Feb.	Preparation of additional curtain grouting	DPW / DPW Consultant	IBF
Mid. February (15.02.)	Start the additional curtain grouting	DPW / DPW Consultant	IBF
March	Commissioning of Bribin hydropower plant	DPW, PDAM	IWG, IfMB, IBF, IMG, GIK, VA-SHS
Activities in Seropan			
March – April	Mobilization of construction facilities and excavation of the entrance tunnel	DPW / DPW Consultant	IWG, VA-SHS
April	Construction of the temporary weir heightening	DPW / DPW Consultant, Civil Eng. UGM	IfMB, VA-SHS
May	Test storage	DPW / DPW Consultant, Civil Eng. UGM	IWG, IfMB, VA-SHS
May	Mobilization of equipment for geotechnical investigation (among others: drilling machine)	DPW / DPW Consultant Mining Eng. UPN	IBF, IMG, VA-SHS
End of May	Start of advanced geotechnical investigation measures	DPW / DPW Consultant, Mining Eng. UPN	IBF, IMG

* See the acronym in the contact section

Contact:

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KIT – Karlsruhe Institute of Technology
Testing Institute of Steel, Timber and Stones (VA-SHS)
Chair of Timber Engineering and Building Constructions
Prof. Dr.-Ing. H.J. Blaß

KIT – Karlsruhe Institute of Technology
Institute of Concrete Structures and Building Materials (IfMB)
Prof. Dr.-Ing. H. S. Müller

KIT – Karlsruhe Institute of Technology
Institute of Soil and Rock Mechanics (IBF)
Prof. Dr.-Ing. Triantafyllidis

KIT – Karlsruhe Institute of Technology
Institute of Mineralogy and Geology (IMG)
Prof. Dr.-Ing. T. Neumann

KIT – Karlsruhe Institute of Technology
Geodetic Institute of Karlsruhe (GIK)
Prof. Dr.-Ing, Dr.-Ing. E.h. G. Schmitt

Innovative Water Resources Mobilisation in Karst Area

- Indonesian Experience and Transferability Potential -

University of Karlsruhe (TH)
Institute for Water and River Basin Management
Prof. Dr.-Ing. Franz Nestmann, Dr.-Ing. Peter Oberle, Dr.-Ing. Muhammad Ikhwan

Institute of Mineralogy and Geochemistry
Prof. Dr. Thomas Neumann, Dr. Elisabeth Eiche

Justus Liebig University Giessen
Department of Geography
Prof. Dr. Andreas Dittmann, Prof. Dr. Ulrich Scholz, Dipl.-Geogr. Tobias Tkaczick

1. Abstract

Mobilising water resources in karst areas is always a difficult endeavor. Water resources tend to infiltrate rapidly in a multiplicity of underground cracks, caves and rivers making a practical capture for local use extraordinary tricky and difficult to implement.

In two research and development projects (R&D) sponsored by the Federal Ministry for Education and Research (BMBF), the Institute for Water and River Basin Management (IWG) of the University of Karlsruhe under the supervision of Prof. Franz Nestmann, is testing since 2002, the viability of capturing underground water in karst zones using renewable micro-hydropower that boost underground water to the surface without the need of external energy. Solutions tested in the district of Gunung Kidul which is particularly water stressed during the dry season, included micro-hydro turbines with the water-head provided by either a mini dam or a wood-stave pressure line. The mini-dam solution was successfully completed in 2009 in the cave “Gua Bribin”. The proof of concept of the wood-stave pressure line was tested in Germany since 2005 and is now being field-tested in the cave “Seropan” in the same district.

Indonesia is the seat of a number of karst areas in which so far, no practical solution for sustainable underground water capture could be realized. The purpose of this report is to provide outline guidance how the successful experience of the BMBF R&D project in Gunung Kidul could be duplicated in other regions in the country. The innovative character of the German projects means a particularly low cost for operation, allowing maximized socio-economic benefits for rural populations which have so far been deprived of any safe and reliable water supply solution.

The report introduces briefly the solutions tested in the German project. It follows with a recommended methodology to help identify where duplication would be best suited in Indonesia with maximum economic benefits for concerned population. Decision support criteria considered included (1) extensiveness of karst areas where (2) water shortages occur and (3) many people are affected. Geographically this means essentially the regions of central and eastern Java, the adjacent string of islands with Bali and the Lesser Sunda Islands as well as some parts of southern Sulawesi.

It is concluded with a list of areas where the solutions could be tested as well as an indication of the investment costs that would be required and service delivery cost that would be resulting.

2. Innovative Solutions for Sustainable Underground River Exploitation in Karst Areas

Lack of natural surface water storage capabilities are typical features of karst areas which cause acute water scarcity problems during dry seasons. The rain water rapidly infiltrates and eventually reaches underground caves and rivers that often interconnect. These river networks can wander from several meters to several hundred meters below ground level. This results often with high pumping head and cost which renders groundwater exploitation in karst areas with traditional energy sources often prohibitive.

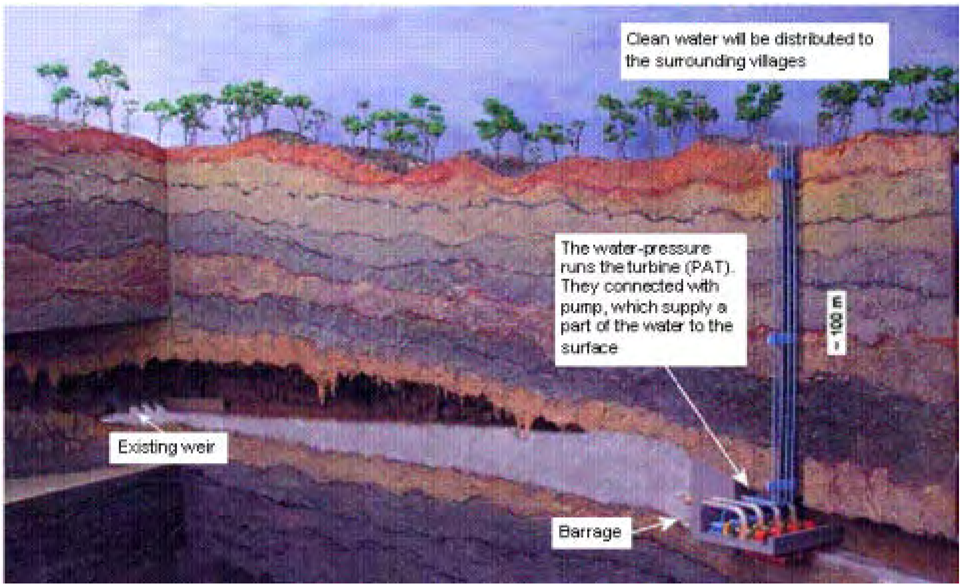
The innovative idea of the German R&D project was to create an artificial water head that can provide the pressure required to run a turbine coupled to a water pump to bring the water above ground. The challenge laid in the unpredictable fissured character of many karst underground geology which can impact on the capacity to create a necessary water head.

To overcome the problem while providing solutions that could found application in a wide range of karst underground geology, two complementary options of "water storage" techniques were explored: a mini dam or a wood-stave pressure line.

2.1 Option 1: Mini-dam Water Storage

In this option, successfully implemented and tested in the Bribin cave, a dam closed the whole cross-section of the cavern, blocking completely the water discharge until a necessary pressure head has been achieved (15 m in the case of the Bribin cave). The pressured water flows through discharge pipes to operate turbines that pump water to the surface using directly coupled pumps [FIGURE 1]. This option is especially suitable for shallow gradient river system with compact and dense geological formation.

FIGURE 1: Outline of Underground Hydro Power Plant Concept for Water Supply (not-to-scale)



Source: IWG/WK – BATAN

Efforts were dedicated to finding an "Appropriate Technology" solution adapted to the local socio-economic conditions and needs. Instead of using conventional turbine, a "Pump as Turbine" (PaT) concept was applied. In such solution a "reverse pump" creates mechanical power directly coupled to a pump through a gear-box. The key advantages of a PaT technology solution include (1) pumps and spare-parts are relatively easily available worldwide with, (2) much lower investment cost compared to conventional turbine. They are (3) robust and (4) easy to maintain.

The strengths and drawbacks of this opti on are:

Strengths:

- The construction activities are concentrated in specific location, although it requires appropriate access, natural or man-made (shaft).
- The underground water storage can be exploited (not relevant when there is a continuous water discharge even during dry periods).

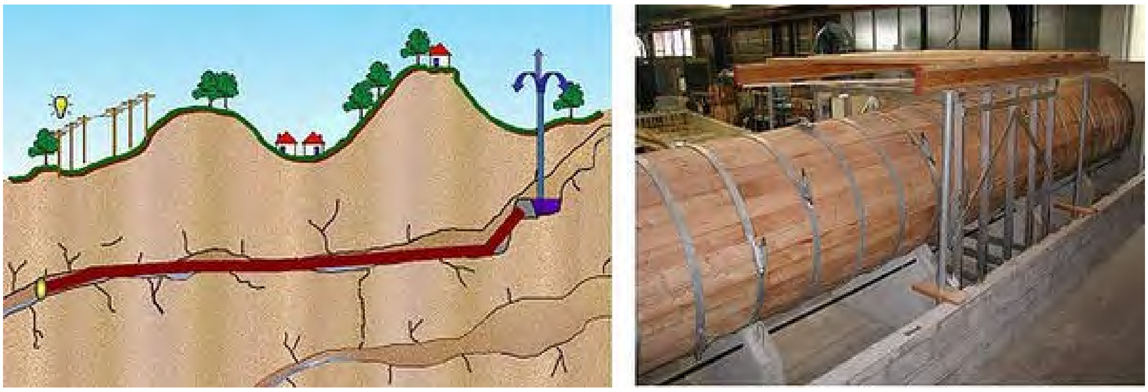
Drawbacks:

- In the absence of a natural access, a man-made entrance need to be developed which can increase the construction cost.
- Depending on local geology, the option bears some risk of water storage losses due to gaps and porosity of the karst formation.

2.2 Option 2: Wood-stave Pipeline

In this second option, a wood-stave pipeline (i.e. wood-pressure pipeline) is used to convey the water to produce a geodetic head in order to operate the turbine [FIGURE 2]. This option is suitable for a river with relative short path and relatively high geodetic head gradient. As in the previous option, a PaT technology can also be applied.

FIGURE 2: Outline of Underground Hydro Power Plant Concept for Water Supply using Wood-stave Pipeline (left) and Physical Model of the Wood-stave Pipeline at University of Karlsruhe (right)



Source: IWG/WK – VA SHS

Strengths:

- Independence from the surrounding geological condition, which eliminates the risk of storage water losses.
- Wood-staves are easy to handle (low dead weight) and to construct. It can be applied in caves with limited accessibility. Furthermore, friction losses decrease with increasing operating time.
- No man-made access required, which can lower the construction cost.

Drawbacks:

- Construction activities have to be spread over an entire cave pathway.
- There is no large water storage capacity (not relevant when there is continuous water discharge even during dry periods).

3. Methodology for Identification of Suitable Sites for Techniques Duplication

Indonesia is the seat of a large number of karst areas in which so far no practical solution for sustainable underground water capture could be realized. The successful experience of the German R&D project in Gunung Kidul, combined with the two different solutions tested, enables the possibility to explore a dissemination strategy to other karst zones in Indonesia. The innovative character of the German projects means a particularly low cost for operation, allowing maximized socio-economic benefits for rural populations which have so far been deprived of any safe and reliable water supply solution.

To define other karst areas in the country where benefits can be maximized, an extensive hydrological, hydro-geological as well as geo-technological assessment will have to be conducted based on reliable hydrological data in time and space covering preferably periods over 10 to 20 years. Furthermore underground river networks of most promising sites need to be investigated with the help of tracer tests to document possible interaction with adjacent cavern systems or the impact of surrounding springs.

Such assessment goes well beyond the scope of this report. To support a preliminary identification of potential sites for duplication, this report relies on a simplified methodology that considers the assessment of three key decision-support criteria. These include (1) extensiveness of the karst zone in explored areas, (2) occurrence of water shortages in these areas and (3) large size of the population potentially benefiting. As shown in figures and graphs provided in annexes to this report, geographically the inclusion of these criteria means in first approximation, a concentration of the zones to be contemplated to essentially the following regions: Central and Eastern Java, the adjacent string of islands with Bali and the Lesser Sunda Islands as well as some parts of Southern Sulawesi.

The following paragraphs summarize key aspects considered.

3.1 Geological Aspects

Limestone deposits can be found in Indonesia from Sumatra to Papua nearly in all parts of the country and cover approx. 10% of the surface [SGES RESEARCH 2009, APPENDIX 1]. They were mainly formed during the tertiary (2-65 million years) and are predominantly of bioclastic origin (coral reefs etc.). WILSON [2002] gives a detailed overview of the distribution of carbonates in Indonesia. Due to high precipitation rates, as well as strong tectonic stress which led to the genesis of well developed fissure and fault systems, limestone in Indonesia is generally well karstified.

From a geologic point of view, important criteria favouring the water storage approach (German option 1 and 2) are (1) strongly karstified limestone, (2) the occurrence of sufficiently spacious caves, (3) integrity of the cave walls, and (4) underground water courses with sufficient discharge. In each case, detailed studies of sites and monitoring of hydrological parameters are necessary in order to exactly estimate and confirm the suitability of specific karst areas for the technical utilisation of underground water resources with the water storage techniques.

Nevertheless the following preliminary assessment is possible regarding specific regions of the country.

JAVA: Beside the IWRM project area of Gunung Sewu, there are other comparable limestone deposits on Java itself, especially along the southern coastline and along the northern coast of East Java [FIGURE 3].

FIGURE 3: Karst Areas on Java and Bali

The karst areas of Garang Bolong and South Gombong, Kebumen, Central Java [FIGURE 3, (1)], situated about 120 km west of Gunung Sewu, are relatively small but known for their ability to store water and the existence of caves. Gunung Sewu itself stretches further to the east beyond the project area up until the bay of Pacitan and, interrupted by volcanic intrusions and sedimentary rocks, further eastwards for several tens of kilometres [FIGURE 3, (2)]. These karst areas all belong to the Wonosari formation and, therefore, comparable characteristics with regard to karstification and hydrogeology can be expected. Underground water courses are also known to occur on the peninsula of Blambangan, South-East Java [FIGURE 3, (3)], which is nearly completely made up of limestone. In the northern part of East Java, the limestone deposits around Tuban (known as the "city of thousand caves", FIGURE 3, (4)) is well karstified [WILSON 2002] and possess a high water storage capacity [UIS BULLETIN 1994]. In the catchment area of the Citarum river smaller areas with limestone deposits are present [WILSON 2002; FIGURE 3, (5)]. However, the suitability of these areas for the utilisation of underground water would have to be thoroughly checked mainly with regard to water quality as some parts of the catchment area are known to be heavily polluted [HERMAWAN/KIJIMA 2009].

MADURA: From a geologic point of view, the island of Madura, North-East Java [FIGURE 3, (6)], is a continuation of the northern tertiary limestone belt of Java. Considerable parts of the island are covered by 50 - 300 m thick limestone deposits which are mainly strongly karstified and classified as an aquifer by FLATHE/PFEIFFER [1963]. They estimate that moderate to large quantities of groundwater could be gained from these aquifers. In some parts, however, sea water intrusion into the aquifer might be a problem.

BALI: The peninsula Bukit (South Bali) and the island Nusa Penida (to the East of the peninsula Bukit) are geologically a continuation of the southern tertiary limestone belt of Java [FIGURE 3, (7)] and show, therefore, similar characteristic features [UHLIG 1980]. Caves are assumed to have been built during a similar time span compared to the ones in Gunung Sewu [BAWONO 2008]. Underground rivers are well known in this area as well.

LESSER SUNDA ISLANDS: Karst areas on the southern archipelago of the Lesser Sunda Islands (e.g. Sumba, Timor) might be of further interest for the implementation of the water storage techniques tested in the German R&D project. Especially on Sumba Island the limestone deposits are widespread and occasionally more than 1,000 m thick [WILSON 2002]. Caves are abundant and sufficient underground discharge should be available throughout the year. Some springs with a discharge of 1 l/s up to 100 l/s are known [AKIRA/MITUSA 1993]. But also from Timor, the existence of caves and perennial water flow was described [UHLIG 1980].

OTHER AREAS: Other regions in Indonesia from which the occurrence of subsurface water courses is known are karst areas in Maros (South Sulawesi), the Lorentz National Park (West Papua) as well as some smaller islands like Hoga (Southeast of Sulawesi) and Seram (Molucca Islands).

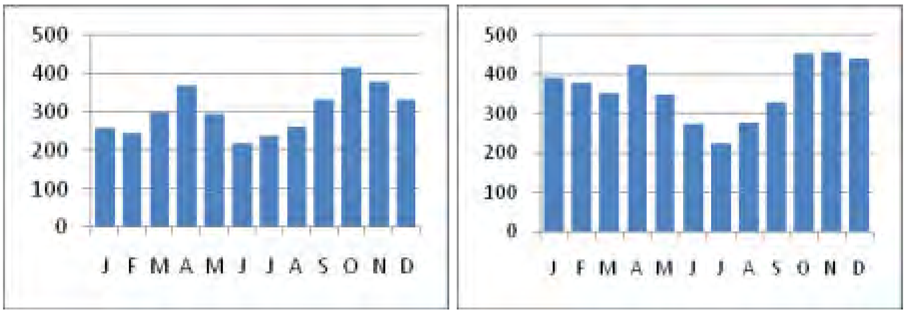
3.2 Climatic Aspects

Groundwater systems need several hundred till thousands of years to develop. The utilisation of alternative replenishable water sources should be considered before using valuable unsustainable groundwater resources [KAPPAS 2009]. Due to Indonesia's location in the tropics, rainwater catchment can for example be a possibility to obtain access to freshwater sources.

Tropic climate with high mean annual temperatures (around 27 °C) and high annual precipitation rates is typical for whole Indonesia [WEISCHET/ENDLICHER 2000; APPENDIX 2]. However, Indonesia can still be distinguished into two different zones:

Firstly the northern regions Sumatra, Kalimantan, Sulawesi, the Moluccas and Papua which are situated in the permanent humid tropical belt near the equator. High annual precipitation rates (more than 2,500 mm per year) with two maxima of rainfall in April and October characterise these regions [FIGURE 4]. Even in karst areas where surface water bodies might be missing, the monthly rainfall is enough to cover the daily use for drinking water throughout the whole year.

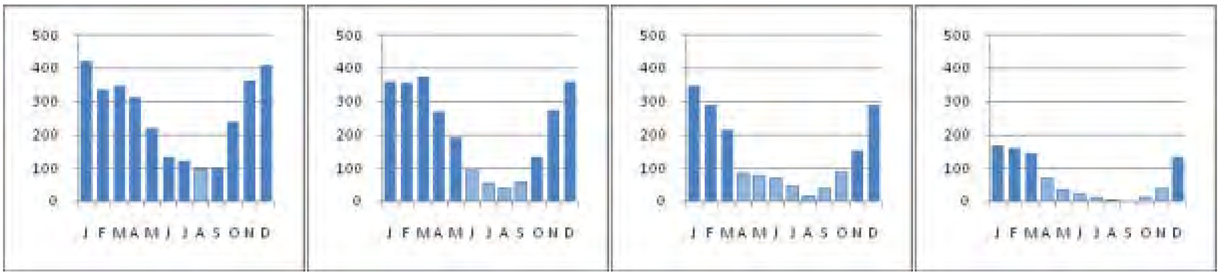
FIGURE 4: Mean Annual Precipitation Rates in Meulaboh (North Sumatra – left) and Putusiban (Central Kalimantan – right) between 1895 and 2004



Source: Global Historical Climatology Network (2005).

Secondly the southern parts of Indonesia (Java, Bali, the Lesser Sunda Islands and small regions in the south of Sulawesi) which are located in the seasonally humid tropics. Less rainfall with a decrease towards the East (partly below 1,000 mm) is specific for these areas [Figure 5], which are significantly influenced by the monsoon cycle. The monsoon causes an unequal annual distribution of rainfall: during the wet season, lasting from October until April, the amount of monthly rainfall is almost the same like in the equatorial regions in Indonesia. The people can easily receive their whole drinking water by storing the rainfall in appropriate cisterns. The problem in these areas is the distinctive dry season which normally lasts from May until September [FIGURE 5].

FIGURE 5: Mean Annual Precipitation Rates in Malingping (West Java), Magelang (Central Java), Denpasar (Bali) and Waingapu (Sumba) between 1907 and 2004 (from left to right)



approx. same latitude from west to east of Indonesia →

The decline of the total amount of rainfall as well as the increasing number of arid months (light blue) towards the eastern parts of southern Indonesia can be easily recognized.

Source: Global Historical Climatology Network (2005).

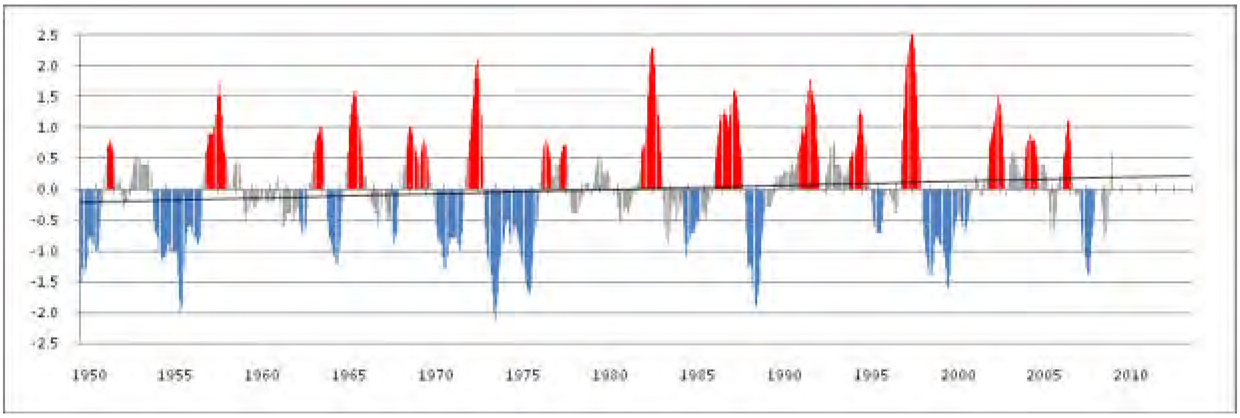
The monthly precipitation rates decrease below 100 mm during the dry season, which is an indicator for aridity in tropic regions. In most of the eastern parts of Indonesia, hardly any rain falls for several consecutive months. The dry season in northern and eastern Java, Bali, the Lesser Sunda Islands and southern Sulawesi lasts for a minimum of three months [APPENDIX 3]. The drought changes the landscape significantly [FIGURE 6] and may lead to many problems: unsafe drinking water supply, delay of new cultivation period leading to crop failures and food shortages, increase of draught-related diseases, uncertain income in areas where agriculture determines the primary revenue etc. These unfavourable living conditions force many people to migrate towards urban centres. Especially young people seek to find a better life in the big cities. The most productive workers emigrate away of hard-up rural areas leaving behind the even more disfavoured.

Another natural phenomenon intensifies the situation during the dry season, namely the El-Niño phenomenon, which recurs every three to seven years. Whereas little is known about the direct causes of the El-Niño, the process and the effects are empirically well observed [KAPPAS 2009]. Normally the sea surface temperature in the western Pacific is up to 10 °C higher than the eastern Pacific which leads to a typical wind circulation pattern called Walker circulation. During El-Niño years, the water in the eastern Pacific Ocean heats up, becomes almost as warm as the western Pacific and disturbs the typical Walker circulation. One of many indicators is the Oceanic Niño Index (ONI), which was developed by the National Oceanic and Atmospheric Administration (NOAA). The ONI chart indicates that during the last 30 years eight El-Niño phenomena occurred [FIGURE 7]. While the El-Niño phenomena affects the rainfall during the wet season only marginal, the effects on Indonesia are tremendous during the dry season [KIRONO/KHAKHIM 1998]: the El-Niño events are associated with an increased risk of dry conditions that are more pronounced and longer lasting than in 'normal years' [AUSTRALIAN GOVERNMENT – BUREAU OF METEOROLOGY 2009]. The dry season can extend up to six till eight months; extreme water shortages (precipitation rates decline by more than 50%), drought, forest fires and reduced rice harvests are common results [WHITTEN ET AL. 2000].

FIGURE 6: Comparison between the Karst Landscape near Yogyakarta during the Wet Season (left) and the Dry Season (right)

Source: Lux, Department of Geography, JLU Giessen (2003/04).

FIGURE 7: Oceanic Niño Index (ONI) with El-Niño (red), El-Niña (blue) and 'Normal' Periods (grey) between 1950 and 2009



Description of ONI by Climate Prediction Center of NOAA: 'Warm (red) and cold (blue) episodes based on a threshold of +/- 0.5°C for the Oceanic Niño Index (ONI) ... , based on the 1971-2000 base period. For historical purposes cold and warm episodes (blue and red coloured bars) are defined when the threshold is met for a minimum of five consecutive over-lapping seasons.'

Source: Climate Prediction Center of NOAA (2009).

Climate change is expected to alter the global water balance that will acerbate weather anomalies and singularities. However, to what extent observed climate change is affecting the occurrence and impact of the El-Niño periods is still not evident. KAPPAS [2009] is describing the cause-and-effect chain tends to see the impact in an adverse manner: the intensification/persistence of the El-Niño phenomenon is one of the climate's 'tipping elements' with direct and immense consequences for humanity.

3.3. Socio-economic Aspects

At present, around 240 million people are living in the Indonesian archipelago. This makes Indonesia the country with the world's fourth largest population [CIA FACTBOOK 2009]. However, the population within Indonesia is extremely unequally distributed (Gini coefficient for distribution of land area per capita: 0.6) [APPENDIX 4] as can be seen in the following explanations:

With a population density of more than 1,000 inhabitants per square kilometre, the island Java is one of the most densely populated greater areas in the world. On less than 10% of the Indonesian territory are living almost 60% of the total population [STATISTIK INDONESIA 2007]. Even the so-called 'rural areas' of Java are more densely populated (> 300 inh./km^2) than most of the Western countries (e.g. Germany: 230 inh./km^2). The high population pressure bears several problems including the sustainable management of scarce resources like water. Hence Java is even considered to be one of the regions in the world with severest problems regarding the access to safe drinking water [KFW 2008].

Other densely populated regions in Indonesia are the islands of Bali and Lombok as well as smaller coastal areas in the provinces of North Sumatra (around Medan, Tanjungbalai/Kisaran), West Sumatra (around Padang, Bukittinggi), Lampung at the southern tip of Sumatra and South Sulawesi (all along the coastline). Additionally, every urban centre in Indonesia is highly populated (e.g. Palembang on Sumatra, Banjarmasin in Kalimantan or Manado on Sulawesi). However, these areas are exceptional cases outside of Java. Most of the rural areas in remaining Indonesia (e.g. swathes of

Kalimantan, the Moluccas and Papua) are difficult to access and therefore sparsely populated (less than 10 inh./km^2) or not even populated at all [GLOBAL RURAL-URBAN MAPPING PROJECT 2005; APPENDIX 4].

Beside the domestic need of the local population, there are other indicators that need to be considered when assessing the freshwater demand of a specific area. Water is mainly used for agricultural and in industrial purposes as well [UNDP 2006]. UHLIG [1980] points out that with regard to land use potentials, amazingly strong differences exist between karst areas in Indonesia. While people in some regions are barely able to obtain water for their daily needs (e.g. Gunung Sewu), people in some karst areas in Sulawesi are even able to irrigate floors of the karst basin and cultivate rice twice a year. The potentials to use water for industrial purposes (e.g. small-scale home industries, wood processing industries, limestone processing industries etc.) differ as well. Some regions do not only have to supply the local population, but must also support increasing numbers of tourists with freshwater. Problems of excessive water consumption in tourist complexes in water-scarce areas can occur [UNESCO 2006]. One of these tourist 'hot spots' is the Blambangan peninsula in West Java: high water demand in this area is increasingly driven by thousands of tourists who are visiting the Alas Purwo National Park or the Bay of Grajagan (G-Land, 'surfer paradise'). Other tourist areas with water supply problems are the southern peninsula of Bali, Nusa Penida and the vicinity around Kuta in southern Lombok.

The major objective of the Millennium Development Goals (MDGs) is fighting poverty, which includes the satisfaction of absolute basic needs like water, food and an irreducible health standard [UN 2000]. Target group of the MDGs are people whose income is considered to be below the poverty line. According to STATISTIK INDONESIA [2007], the poverty line is determined at 130,000 Indonesian Rupiah, which is monthly needed by every individual in order to fulfil his basic minimum requirements including food and non-food such as for living, clothing, schooling, transportation, household necessities etc. Appliance of this definition means that more than one-fifths of the total Indonesian citizens who live in rural areas are considered to be poor. Especially the south-eastern provinces of Indonesia (e.g. East Java, Lesser Sunda and Molucca Islands as well as Papua) are characterised by a high percentage of poor people [APPENDIX 5]. Due to natural constraints, karst areas are often described as poorhouses [NIBBERING 1991]. Main income of the local population is mostly farming, which is hardly enough to sustain their self-subsistence. Additional earnings are necessary to satisfy the demand for goods like mobile phones, motor-cycles or modern houses. However, working opportunities outside the agrarian sector are rare and the people, especially young people, emigrate towards urban centres to seek additional incomes.

4. Multi-criteria Assessment of Suitable Project Areas

From a technological, geological and socio-economic point of view the criteria for a successful duplication of the water storage technology can, in first approximation be defined as follows:

(1) A project region must be situated in karst areas where appropriate technology can be sustainably installed (cf. '3.1 Geological Aspects'),

(2) the mean annual precipitation rate should be below 2.500 mm and the monthly variability be high enough with at least three arid months per year so that rainwater catchment cannot be a sustainable alternative for water supply (cf. '3.2 Climatic Aspects') and

(3) the population density should be higher than 100 inhabitants per square kilometre so that enough people can gain from the contemplated investment (cf. '3.3 Socio-economic Aspects').

To meet certain Millennium Development Goals it will be necessary that the existing water supply system has not been improved yet and that the implementation would be geared to serve especially the poor. Finally, a feasibility assessment through on site survey is absolutely needed to determine whether the selected karst regions really suit all technical, geological as well as socio-economical requirements for a sustainable implementation of the technologies developed under the German R&D project.

The first three requirements can be combined in a GIS-based multi-criteria analysis to preselect possible project regions [APPENDIX 6]. According to this analysis a list of regions can be identified as potentially suitable for the transferability of the water storage techniques applied in the German R&D project. A first such list is presented in TABLE 1:

TABLE 1: Preliminary Group of Potential Sites

Karst Area	Island	District*	Province	Population**
(1) Western Gunung Sewu	Java	Wonogiri Pacitan	Central Java East Java	980,000 554,000 **1,534,000**
(2) Madura	Madura	Bangkalan Sampang Pamekasan Sumenep	East Java	966,000 914,000 796,000 1,077,000 **3,753,000**
(3) Tuban Area	Java	Tuban Lamongan Bojonegoro Pati Rembang	East Java Central Java	1,108,000 1,281,000 1,263,000 1,168,000 573,000 **5,393,000**
(4) Blitar Area	Java	Tulungagung Blitar Kab. Malang	East Java	992,000 1,145,000 2,442,000 **4,579,000**
(5) Tourism Area	Java Bali Lombok	Banyuwangi Badung Klungkung Lombok Tengah	East Java Bali Nusa Tenggara Barat	1,580,000 377,000 175,000 831,000 **2,963,000**
(6) Southern Sulawesi	Sulawesi	Takalar Jeneponto Bulukumba Muna Buton Kota Baubau	South Sulawesi** South-East Sulawesi	250,000 329,000 384,000 243,000 276,000 125,000

				1,607,000
(7) Sumba	Sumba	Sumba Barat Sumba Timur	Nusa Tenggara Timur**	107,000 228,000 **335,000**
(8) Western Timur	Timur	Kupang Rote Ndao	Nusa Tenggara Timur**	384,000 114,000 **498,000**

* The assumed premises of the multi-criteria analysis will apply on the karst area, but it must be checked on site if the assumed premises completely apply to each single district. The listing of the districts (Kabupaten) shall only be a help to find possible contact persons.

** Population figures are dated from 2007 (except South Sulawesi from 2006 and Nusa Tenggara Timur from 2008). Data presents the total amount of people who are living in the whole district, not in the karst area.

5. Costs Aspects

To enable a duplication of the "storage techniques" applied under the German R&D project, the costs of the solution in terms of investment and more importantly operation (cost per m^3 of water produced) should be competitive versus other water supply technology that can considered. In addition operation and maintenance and possibly re-investment should be affordable to the beneficiary population.

5.1 Investment Costs

The German R&D projects being a research project, the investment costs applied there may not be fully representative of the investment expected to be necessary for duplication. The R&D projects have to deal with numerous cases of uncertainty to be tested by trial and errors and to face unforeseen events or conditions that impact on implementation time and cost. Several of them (but not all considering the fundamental variability and unpredictability of karst zones) could be eliminated in a duplication strategy, geared specifically to optimize construction methods, material input and implementation time.

The TABLE 2 reflects a very preliminary assessment of the final investment cost of the two German projects and the population benefiting together with a cost reduction factor expected to be achievable in a case of a duplication strategy geared to minimize/optimize investment costs.

TABLE 2: Investment Cost of 'Water Storage' Techniques

German Project Solution	System Capacity (l/s)	Population Benefiting	R&D Project Investment Value (1.000 EUR)	Cost Reduction Potential Factor	Investment Cost / Benefiting Population
Mini-Dam Storage	65	80,000 (@70 lpcd)	3.057	35 %	32 EUR p.P.
Wood-stave Pipeline	60 to 90	80,000 (@70 lpcd)	1.800	20 %	23 EUR p.P.

5.2 Operation Costs

The report already highlighted that the operation costs of the innovative systems are particularly efficient because it (1) relies on the water pressure accumulated in the constructed underground systems as energy to transfer the water to the surface for storage and distribution to beneficiary population and (2) use simple PaT Technology systems as turbine-pump aggregates which have particularly low maintenance costs. Real O&M costs of the system are therefore expected to be essentially marginal.

The Table 3 summarizes a preliminary assessment of the O&M costs including depreciation of investment of the installed systems on the basis of a 30 years life expectancy and 6,132 10^7 m^3 of water delivered to beneficiary population.

TABLE 3: O&M Cost of 'Water Storage' Techniques

German Project Solution	Mechanical Equipment Value (1.000 EUR)	O&M Cost (5% mech. Inv. Value / Year	Reinvestment Costs (Depre-ciation of In-vestment)	Overall O&M Cost (EUR/m^3)	Overall O&M Cost (IDR/m^3)
Mini-Dam Storage	290	14.500	0.042 EUR/m^3	0.049 EUR/m^3	686 (IDR/m^3)
Wood-stave Pipeline	290	14.500	0.026 EUR/m^3	0.033 EUR/m^3	462 (IDR/m^3)

The figures compare well with the 1000 IDR/ m^3 used as benchmark by BAPPENAS the national planning agency in Indonesia, to determine the competitiveness of a rural water supply system, although of course an add-on cost would have to be compiled for the distribution system cost.

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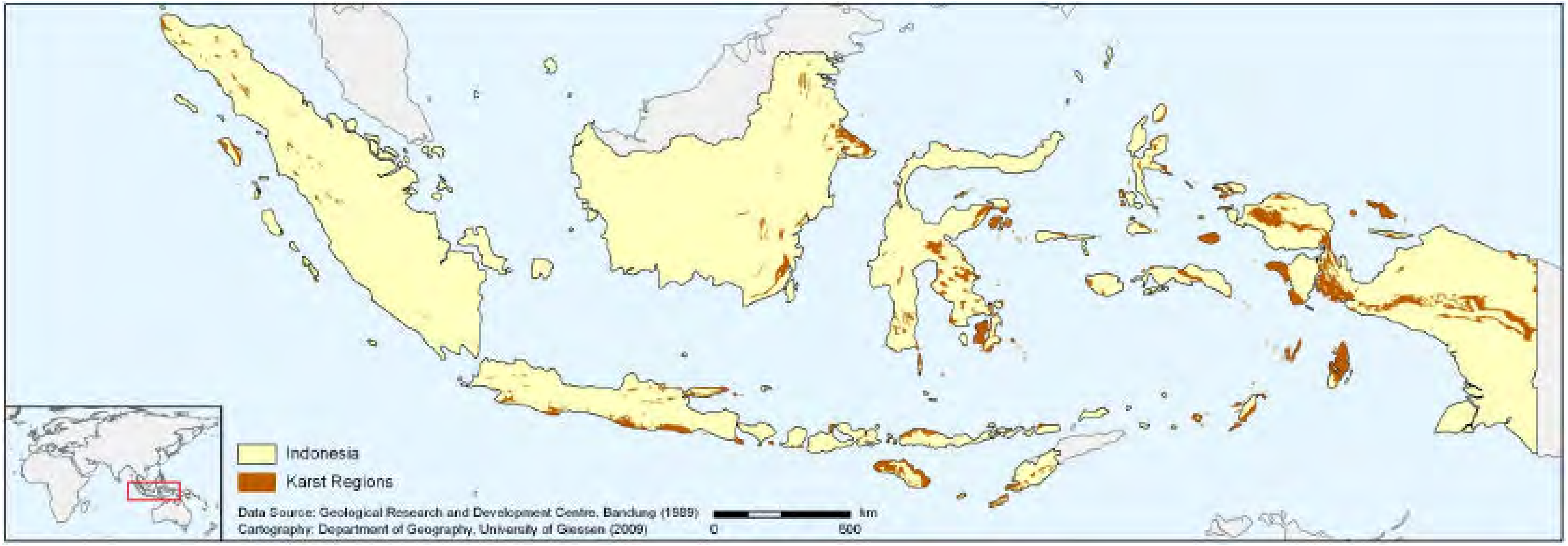
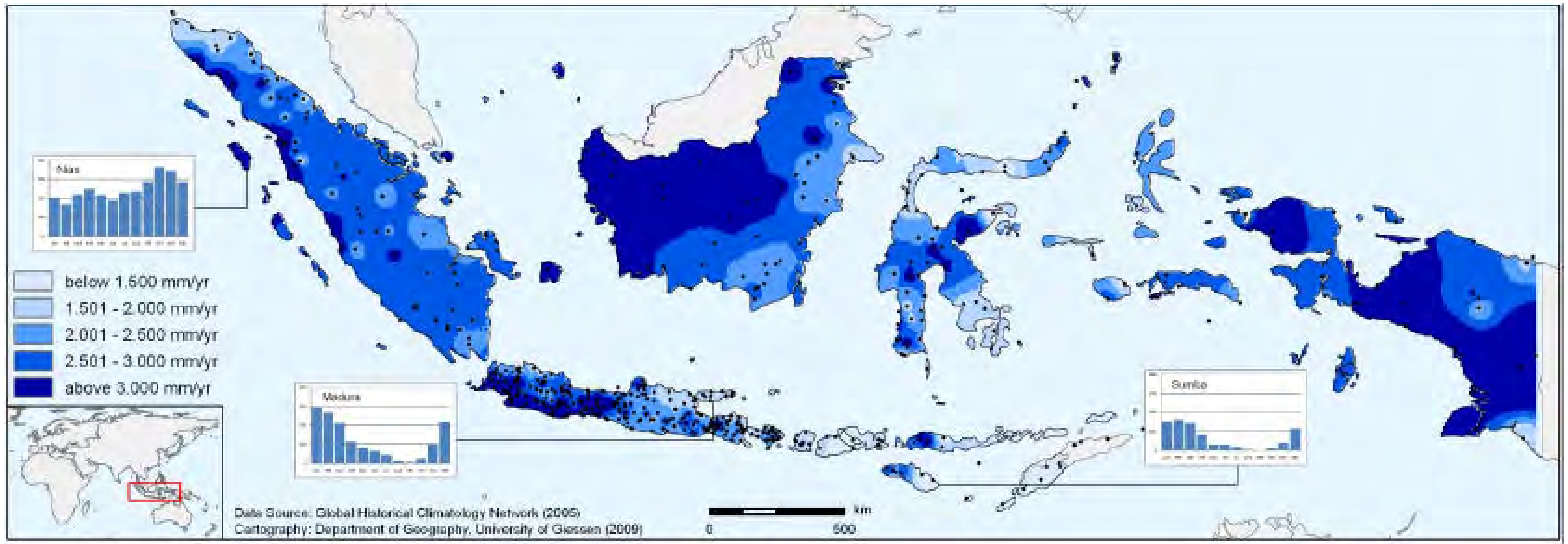
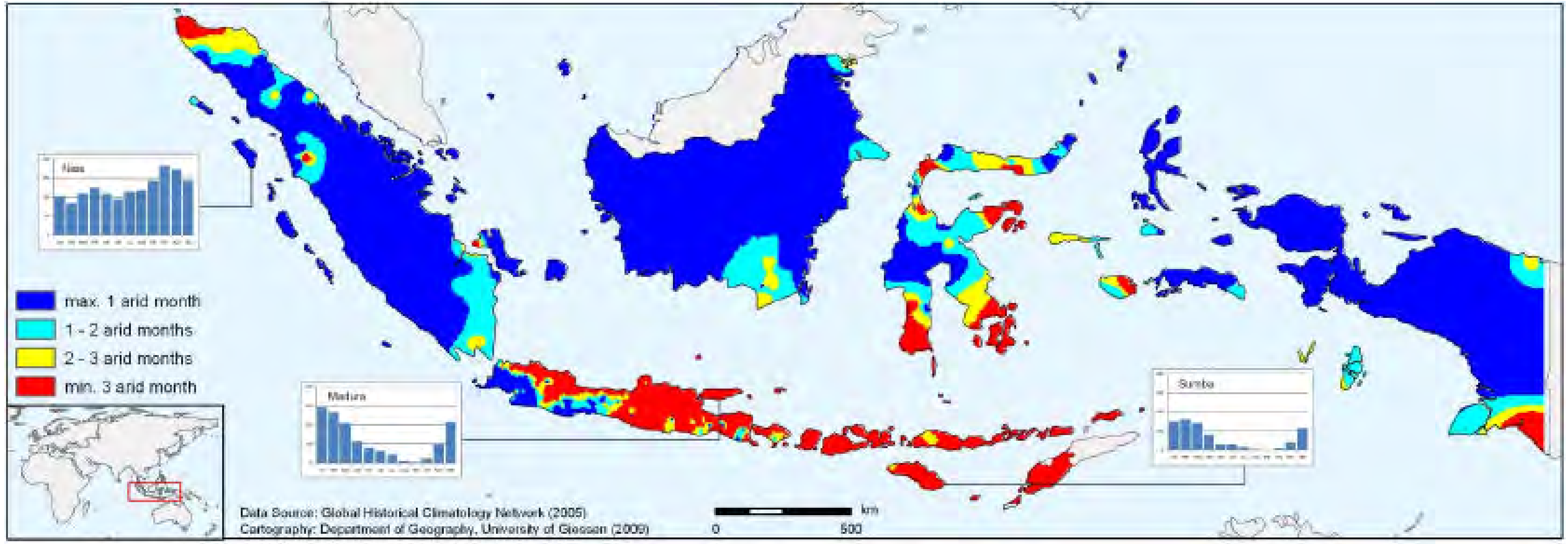
APPENDIX 1: Karst Regions in Indonesia



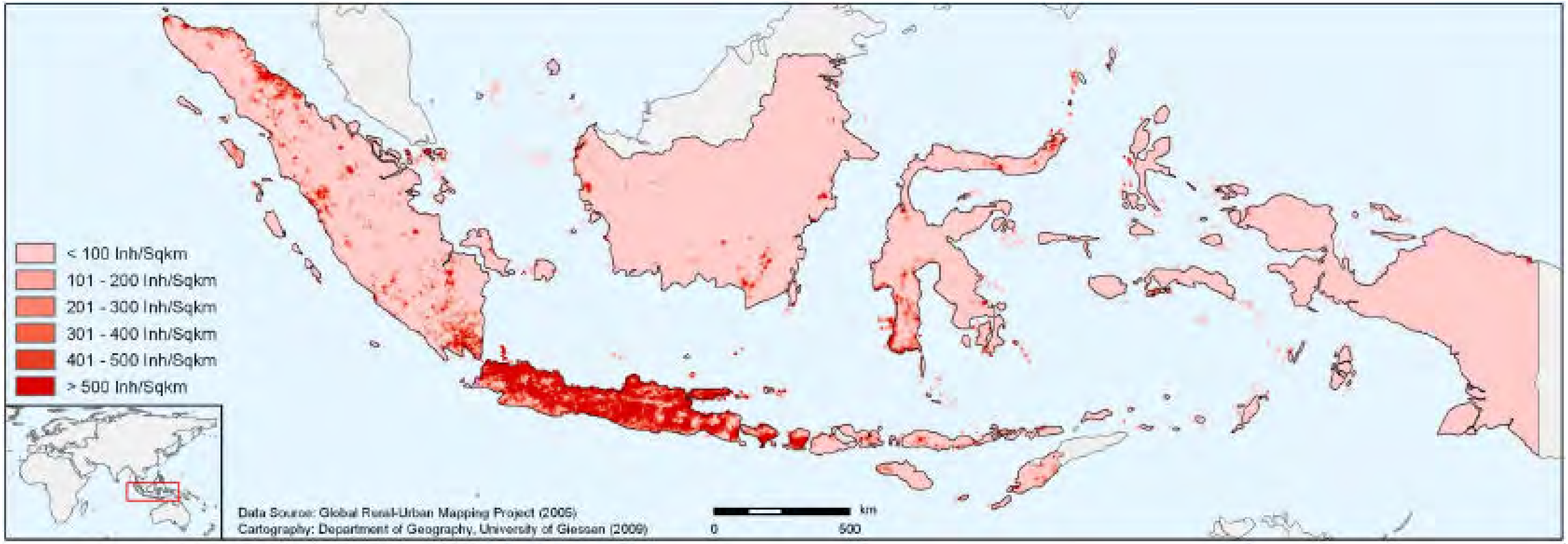
APPENDIX 2: Precipitation Rates in Indonesia



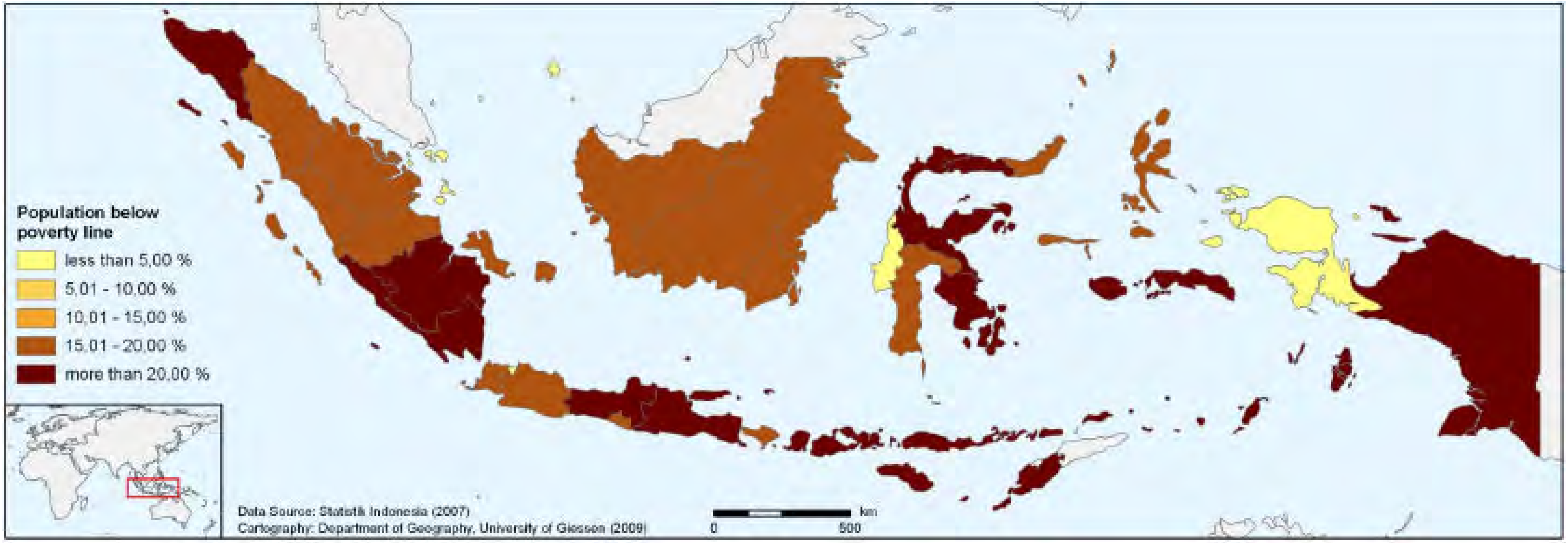
APPENDIX 3: Regions which suffer from distinctive Dry Season in Indonesia



APPENDIX 4: Distribution of Population in Indonesia



APPENDIX 5: Percentage of Poor People per Province



APPENDIX 6: Suitable Regions for the Transferability of the IWRM Project Approach