



Mekong River Commission
Cambodia • Lao PDR • Thailand • Viet Nam
For sustainable development

Groundwater in the Mekong Region – Transboundary Aquifers

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Mekong River Commission Secretariat

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Food Security in Transboundary Basins under Changing Climate
2 April 2014
Ho Chi Minh City, Viet Nam*

Outline

- **Groundwater Resources in a Global Perspective**
 - Freshwater Resources Globally
 - And Regionally in the Lower Mekong River Basin (LMB)
- **Effect of Groundwater Overexploitation and Possible Influences Across Borders**
 - Quantitative and qualitative examples
- **Transboundary Aquifers in the LMB**
 - Between Cambodia / Lao PDR / Thailand /Viet Nam
- **Example of Groundwater Resources in a LMB**
 - Detailed investigation on 2 Cambodian Border Provinces
- **Arsenic in Deltaic Aquifers**
 - Shallow and now also deeper aquifers are affected

Groundwater in a Global Perspective

■ Global Water Balance

- **World Water Resources** total is **1,388 million km³**
- Only **2.5 %** are **fresh water** with a total of **35 million km³**

■ **Freshwater Resources** (70% frozen, 30 % liquid)

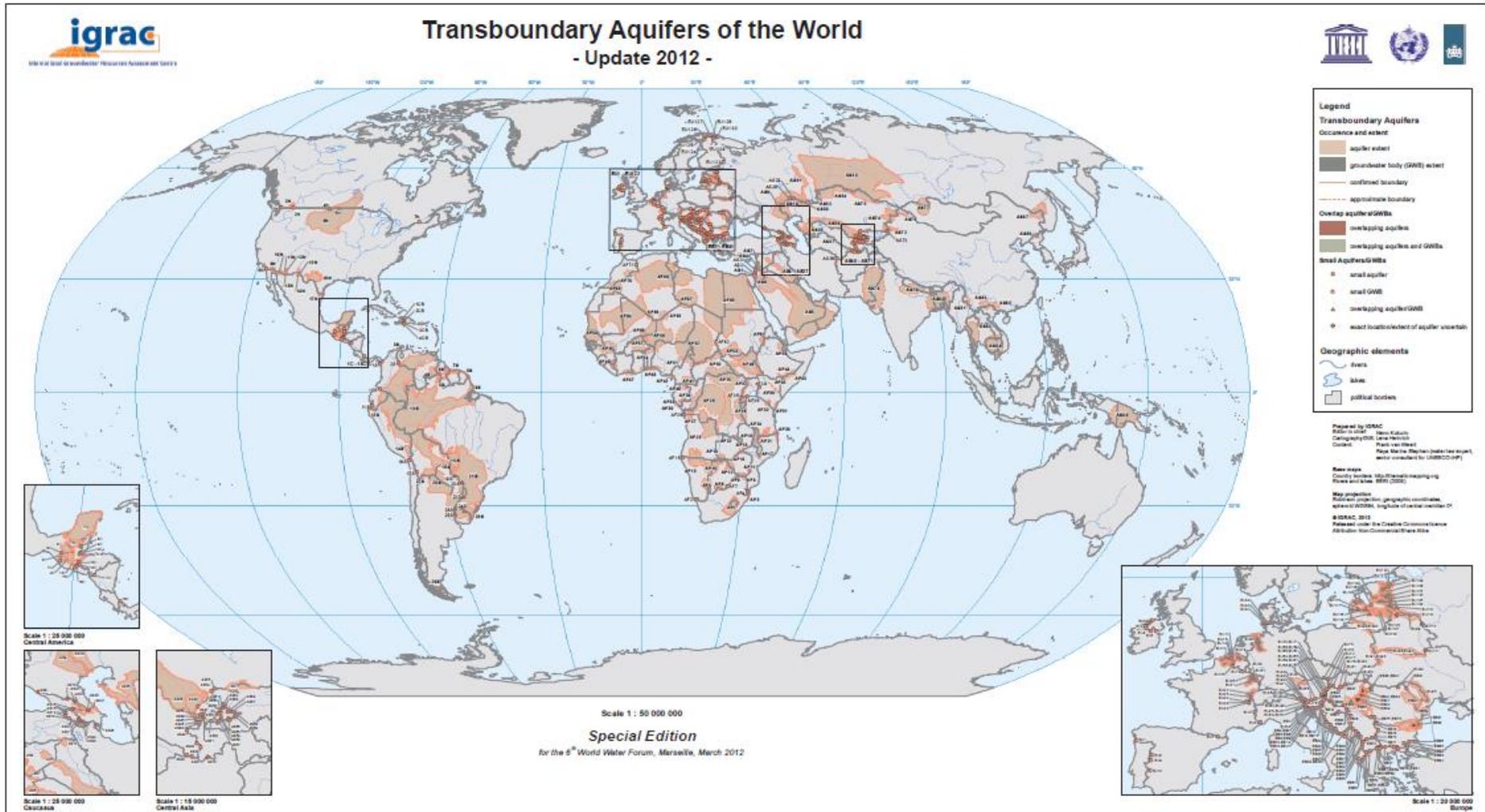
- Ice in form of **Glaciers and Arctic** about: **24 million km³**
- **Fresh groundwater and soil moisture:** **10.5 million km³**
- **Lakes and Reservoirs:** **0.1 million km³**
- **Wetlands and Rivers:** **0.012 million km³**
- **Atmospheric water vapor:** **0.010 million km³**

■ The Mekong River Basin

- Mekong River carries about **450 km³ freshwater** in **1 year**
- **Groundwater reserves** in the Lower Mekong Basin **100 to 300 km³**

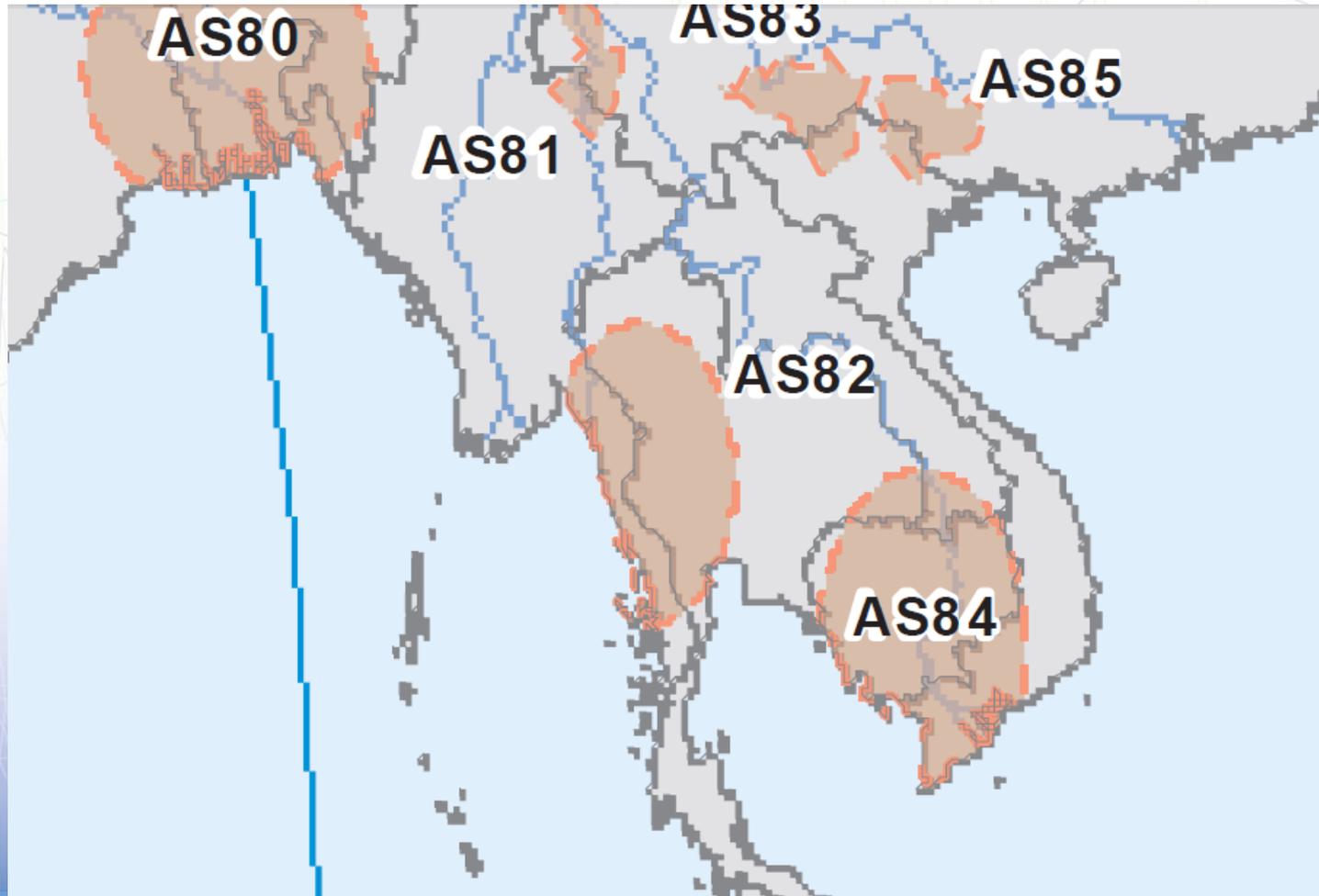
Global Transboundary Aquifers

Map by International Groundwater Resources Assessment Centre (IGRAC)



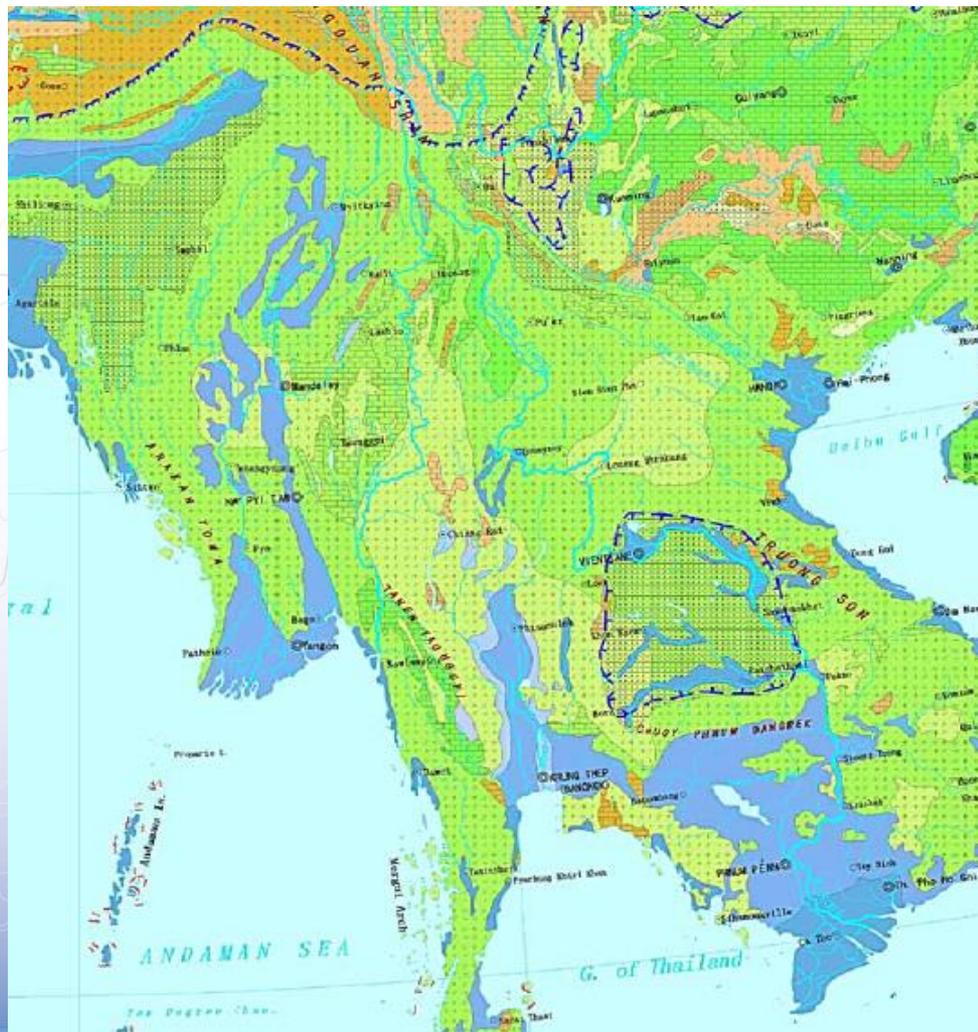
Asian Transboundary Aquifers

88 TB aquifers identified; # 84: Mekong River plain, Cambodia, Lao PDR, Thailand, Viet Nam



Hydrogeological Map Southeast Asian

China Geological Survey, Groundwater Serial Maps of Asia (1: 8,000,000)



Groundwater Resources

Groundwater Resources Zone	Natural Resource Character Modulus (10 ⁶ m ³ / a)
Continuous Aquifer in Plain and Intermediate Basin	10 20 30 50
Discontinuous Aquifer in Hill Area	5 10 20 30
Seasoned Aquifer	5 10 20 30

Groundwater Type

Pore Water Karst Water Fractured Water Fracture-Pore Water

Boundaries

- Area Abundant in Atmospheric Precipitation Recharge
- Area Deficient in Atmospheric Precipitation Recharge
- Area Underlain by Significant Deep Groundwater

Scale 1:8 000 000

Organization and Members of Compilation of Groundwater Resource Maps

Organization: China Geological Survey

Subsidize: International Association of Hydrogeologists

UNESCO

Implement: Institute of Hydrogeology and Environmental Geology, CAGS

Cooperative Foreign Specialists:

RUSSIA V.A.Yevoloshskiy Khaustov Alexandr Wei Lei

IRAN A.Khorsandi

INDIA D.K.Chadha

VIET NAM Nguyen The Tiep Do Huy Cuong

JAPAN Tang Changyuan

KOREA Jeongsang Hahn

MONGOLIA Jadamba Namjil Dejidmaa Dandinorj

IAH Willi Struckmeier (President of IAH)

Shaminder Puri (Secretary-General of IAH)

Shivandra Nath Ra (Vice-President of IAH)

UNESCO R.Jayakumar (Beijing Office of UNESCO)

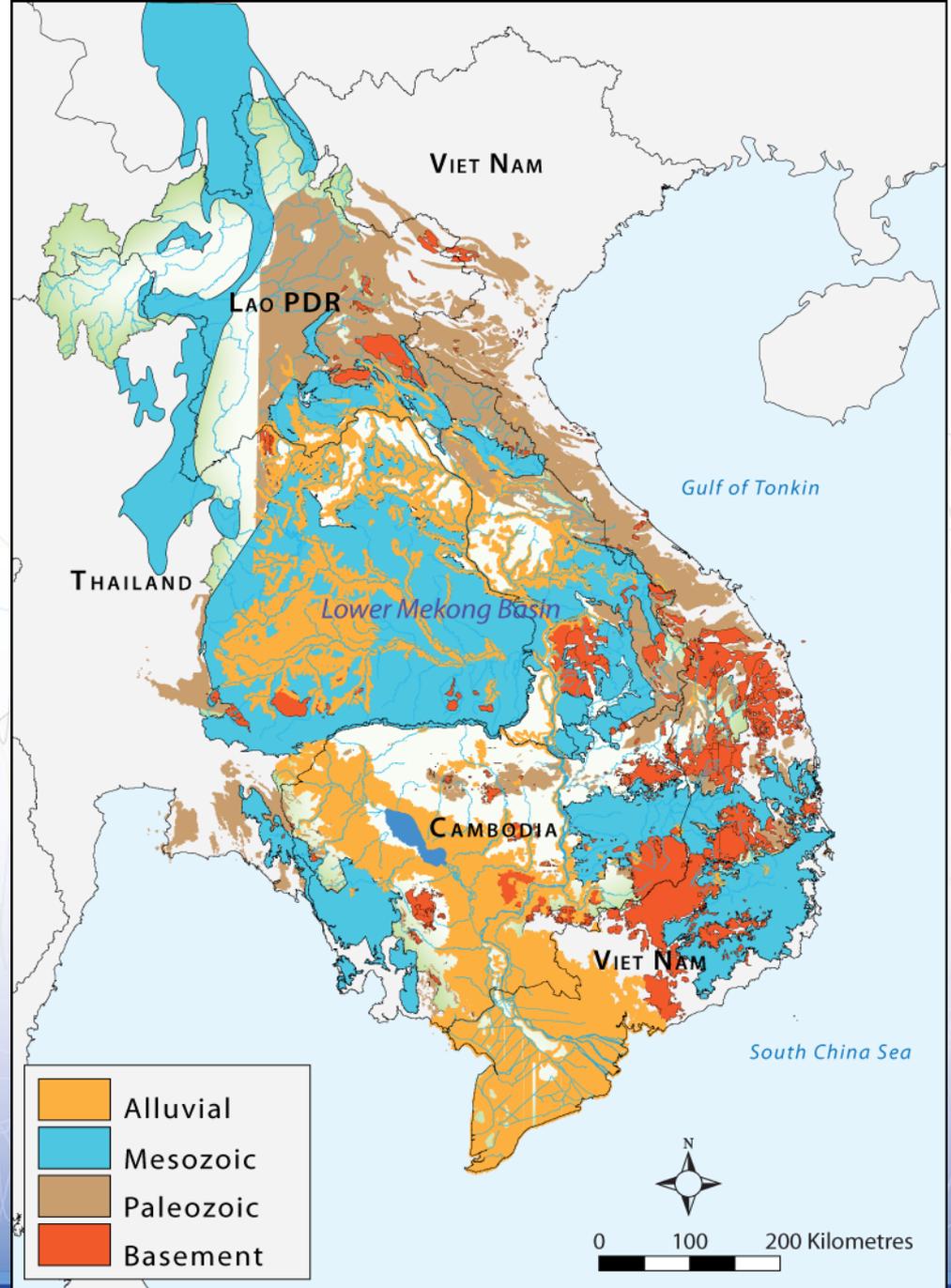
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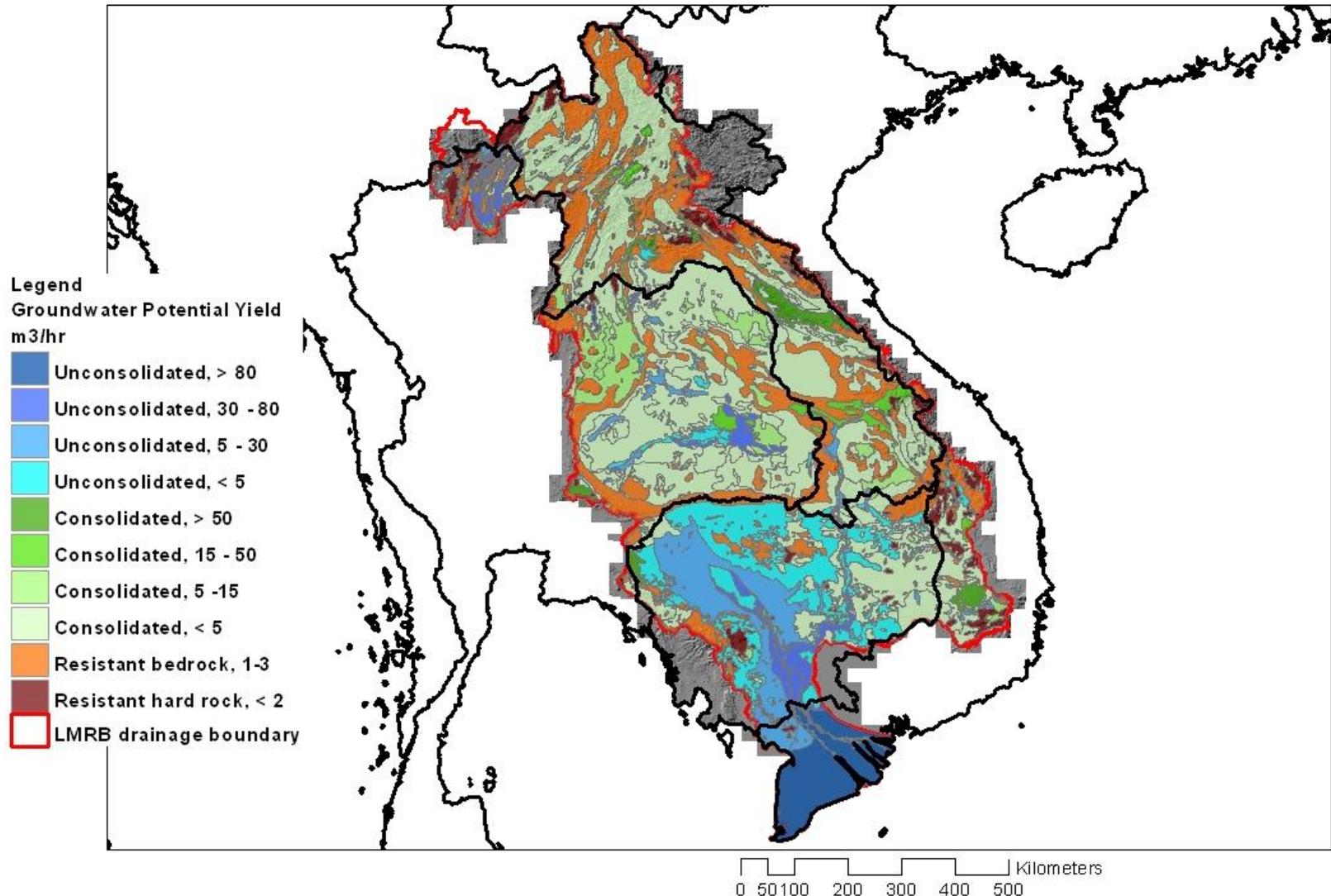
<http://unesdoc.unesco.org/images/0022/002207/220768eo.pdf>

Overview of Hydrogeologic Setting of the LMB

LMRB Aquifer Types/
Hydrogeologic Provinces
(Adapted from Johnson, 1986,
Mekong Secretariat,
Preliminary Hydrogeologic
Assessment of the Lower
Mekong Basin)



Groundwater Yield Map of the LMB



Effect of Groundwater Overexploitation and possible influences across borders

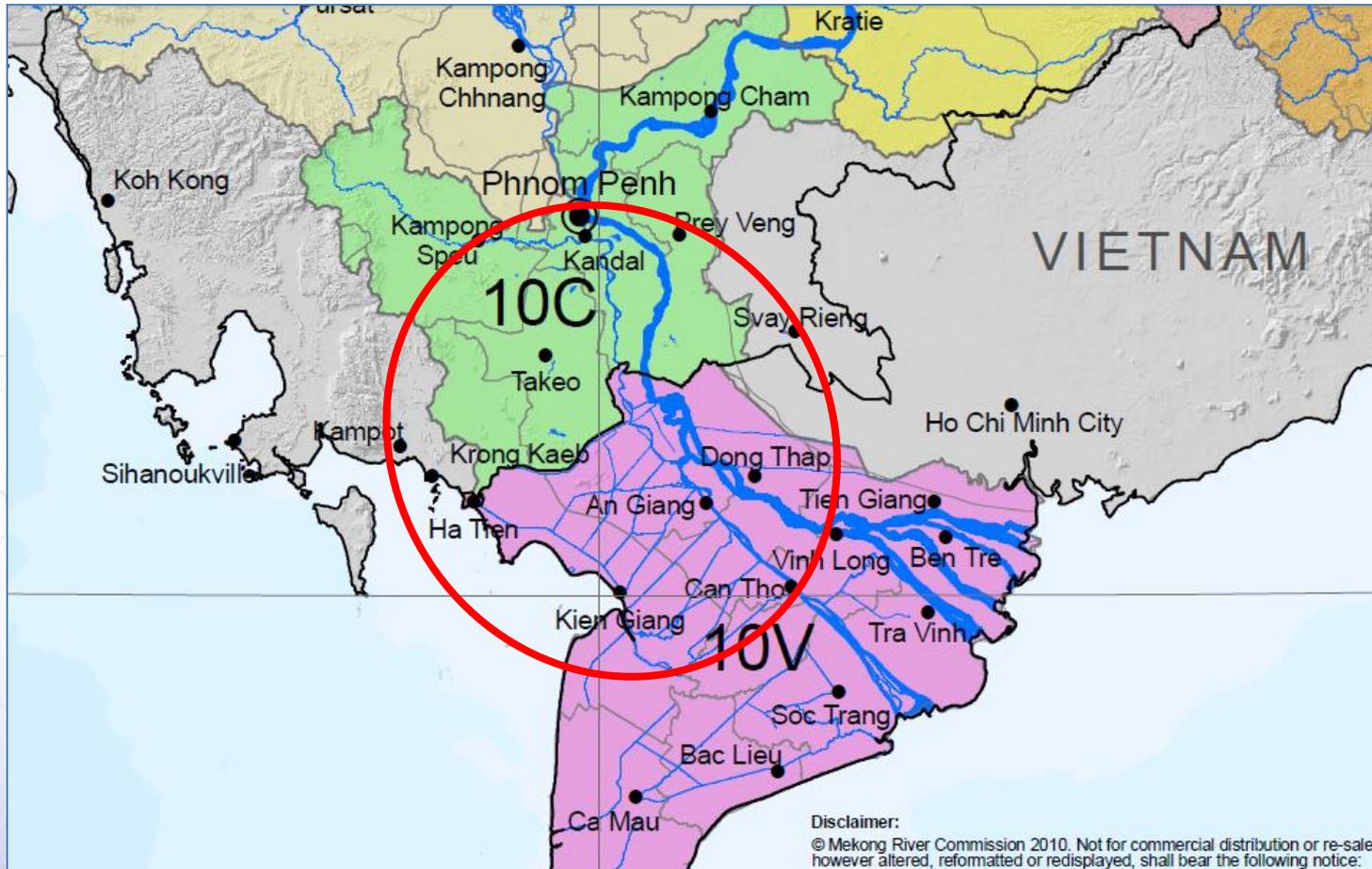
- **Lowering of the GW table;**
- **Reduction of availability of GW;**
 - Hand pumps in Villages don't work anymore / fall dry;
 - Deeper and deeper well development from a few meters to 100 m and deeper;
- **Saltwater intrusion;**
 - Brackish water unsuited for human consumption or irrigation;
 - Reduction in agricultural productivity;
- **Change of water quality;**
 - Man made due to leakages in sewer systems or from industrial sites (e.g. mining retention ponds, tailings and spoils);
 - Naturally occurring arsenic contained in aquifer formations;
- **Land subsidence;**
 - Essentially irreversible and often in combination with saltwater intrusion;
 - Increased risk of flooding (in particular by flash floods);
- **Impact on ecosystems;**
 - drying up of wetlands; creating saline soils;
 - Disappearance of springs, ponds, and lakes

Transboundary Aquifers in the LMB

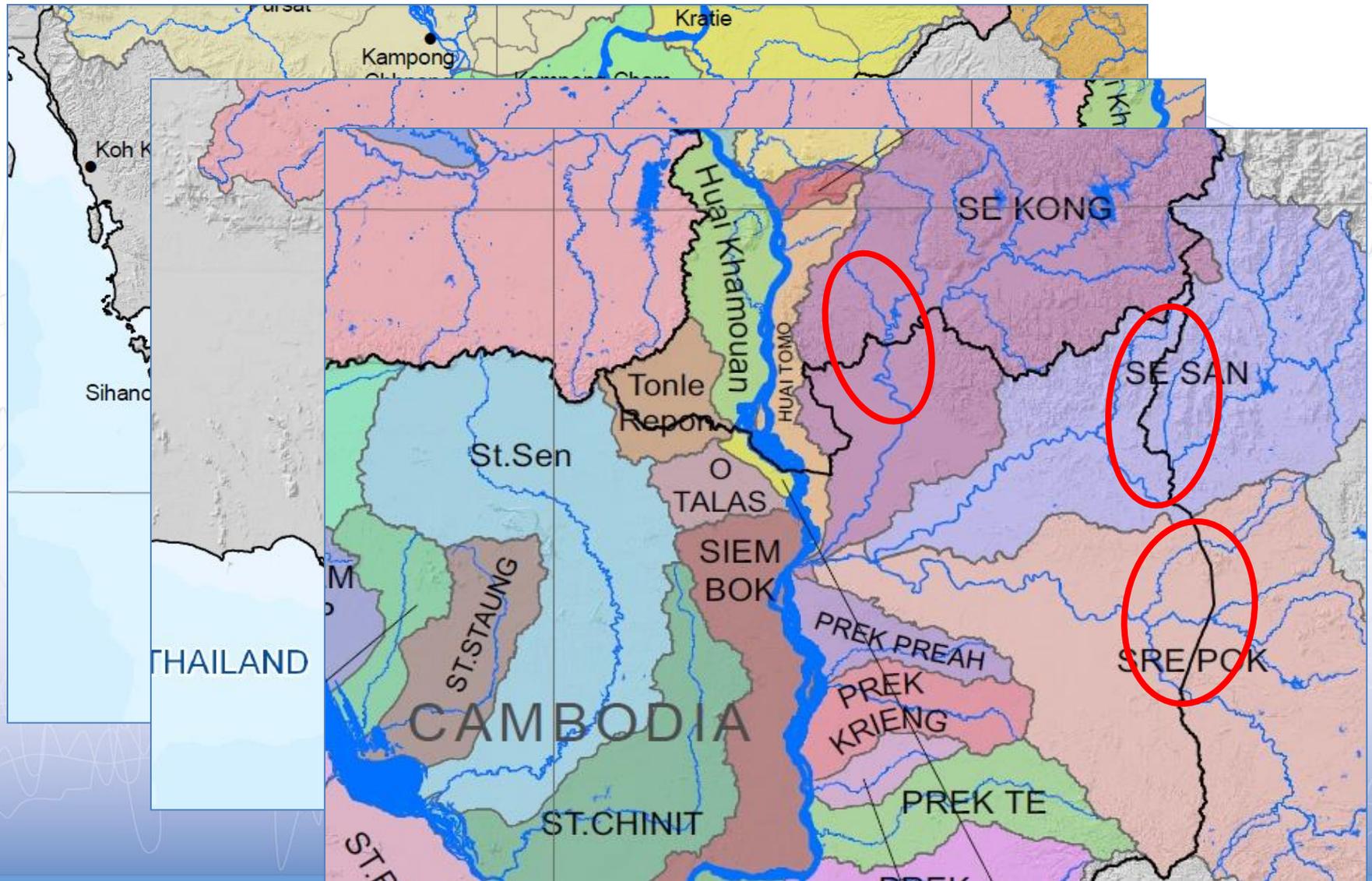
The following transboundary aquifers in the LMB have been identified; however, detailed investigation is necessary to verify the extend of the connectivity across borders

- **Identified main transboundary aquifer systems in the LMB:**
 1. **Mekong Delta** aquifer system of Viet Nam and Cambodia;
 2. **Western Tonle Sap tributary** aquifer system of Thailand and Cambodia;
 3. **Se Kong watershed** of north-central Cambodia and southern Laos;
 4. **Se San watershed** of eastern Cambodia, headwaters in the Central Highlands of Viet Nam;
 5. **Sre Pok watershed** of eastern Cambodia, headwaters in the Central Highlands of Viet Nam;
 6. The **Sakon Nakkon** geologic **subbasin** of the **Khorat Plateau**, including portions of Lao PDR along the Mekong River, the Vientiane plain as well as portions of northeastern Thailand;
 7. **Alluvial deposits located along the Mekong River** along the Thailand – Lao PDR border;
 8. **Mesozoic and Upper Paleozoic** aquifers of along the northern section of the Thailand – Lao PDR border.
- **Primary transboundary aquifer systems:**
 - The primary transboundary aquifers in Cambodia are located in proximity to Viet Nam and the primary transboundary aquifers in Lao PDR are located in proximity to Thailand.
- **Extend of transboundary aquifer systems:**
 - Areas of transboundary aquifers in the LMB are not as extensive as might be expected because many national boundaries are located along high elevation areas underlain by low yield bedrock that are not productive regional aquifers.

Transboundary Aquifers in the LMB



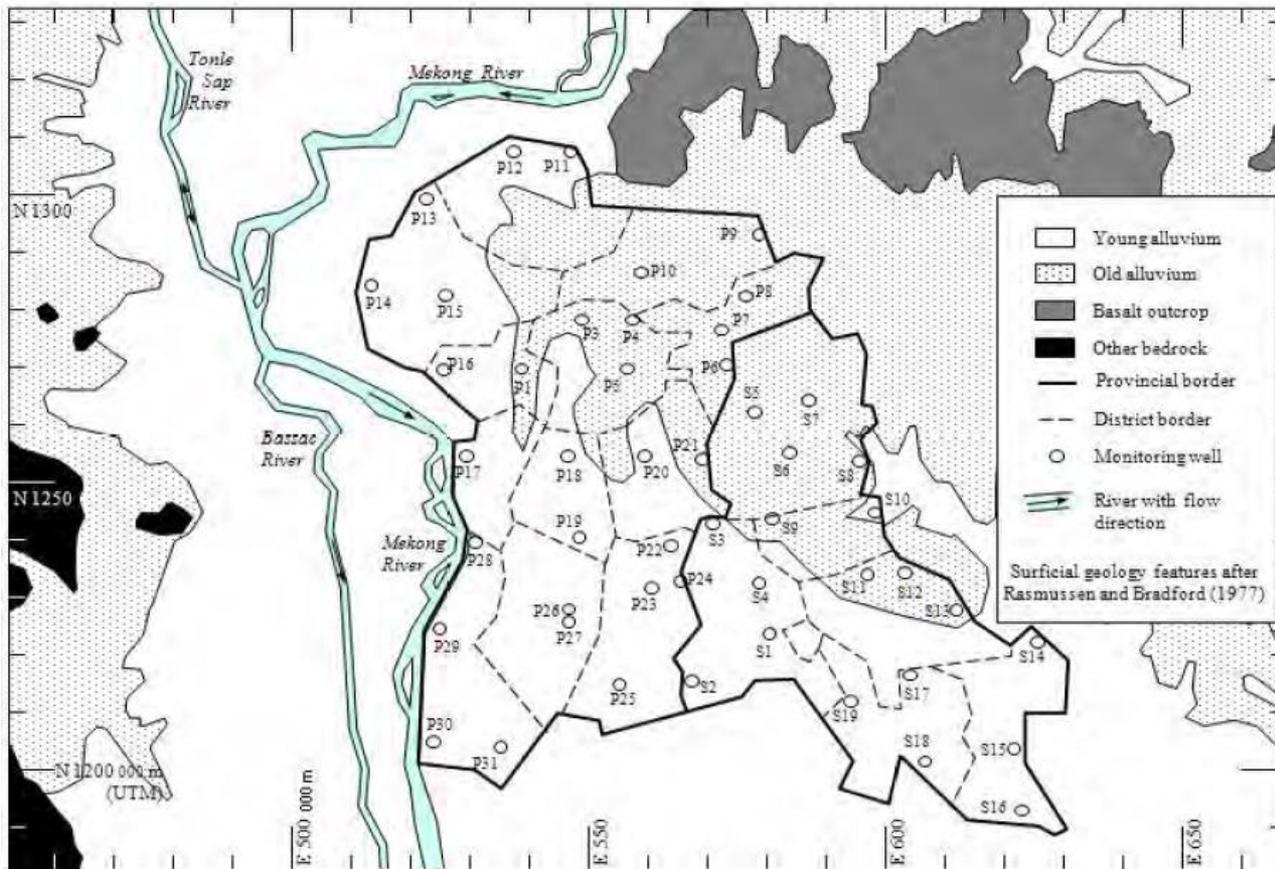
Transboundary Aquifers in the LMB (cont.)



Study Site in Cambodia (IDE, M. Roberts)

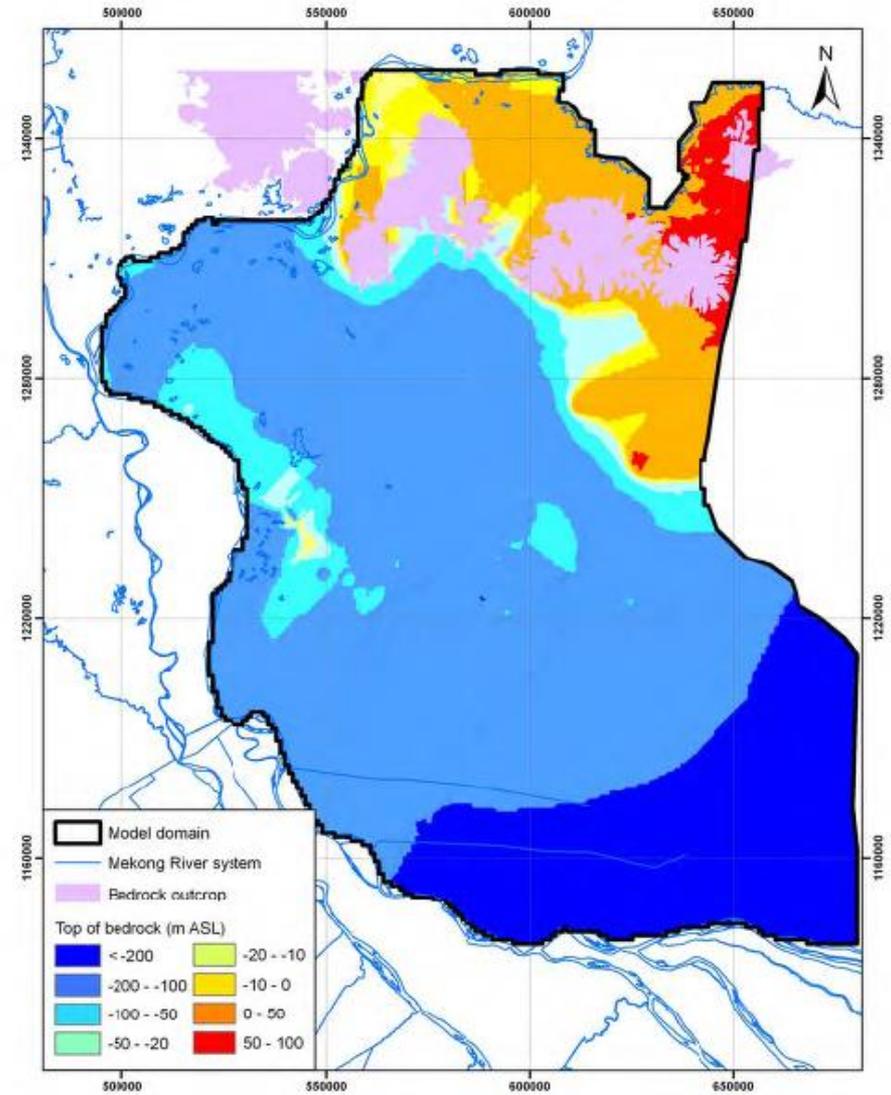
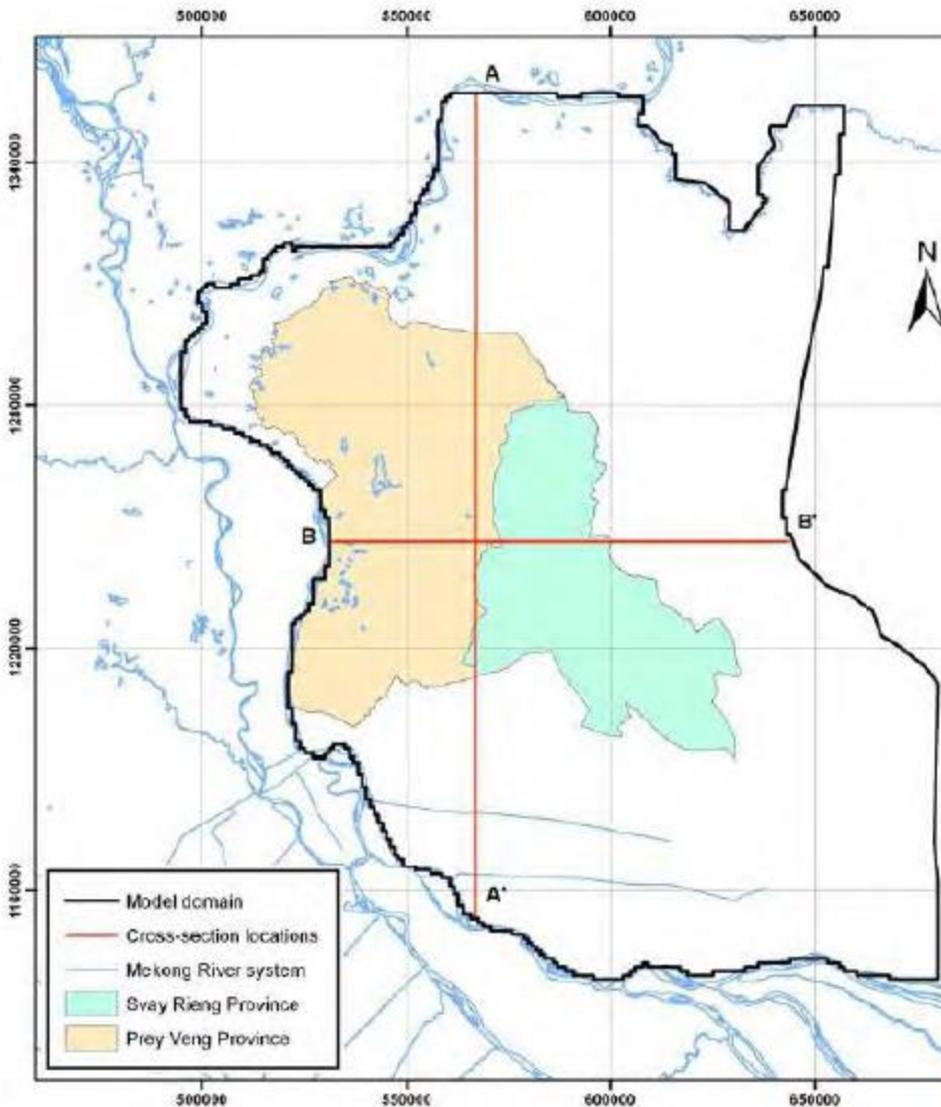
2 provinces on the left banks of the Mekong, multi year study incl. GW model
Data from 1998 to 2008; originally PRASAC III project

Figure 1: Surface Geology of the Study Area and Location of PRASAC Monitoring Wells

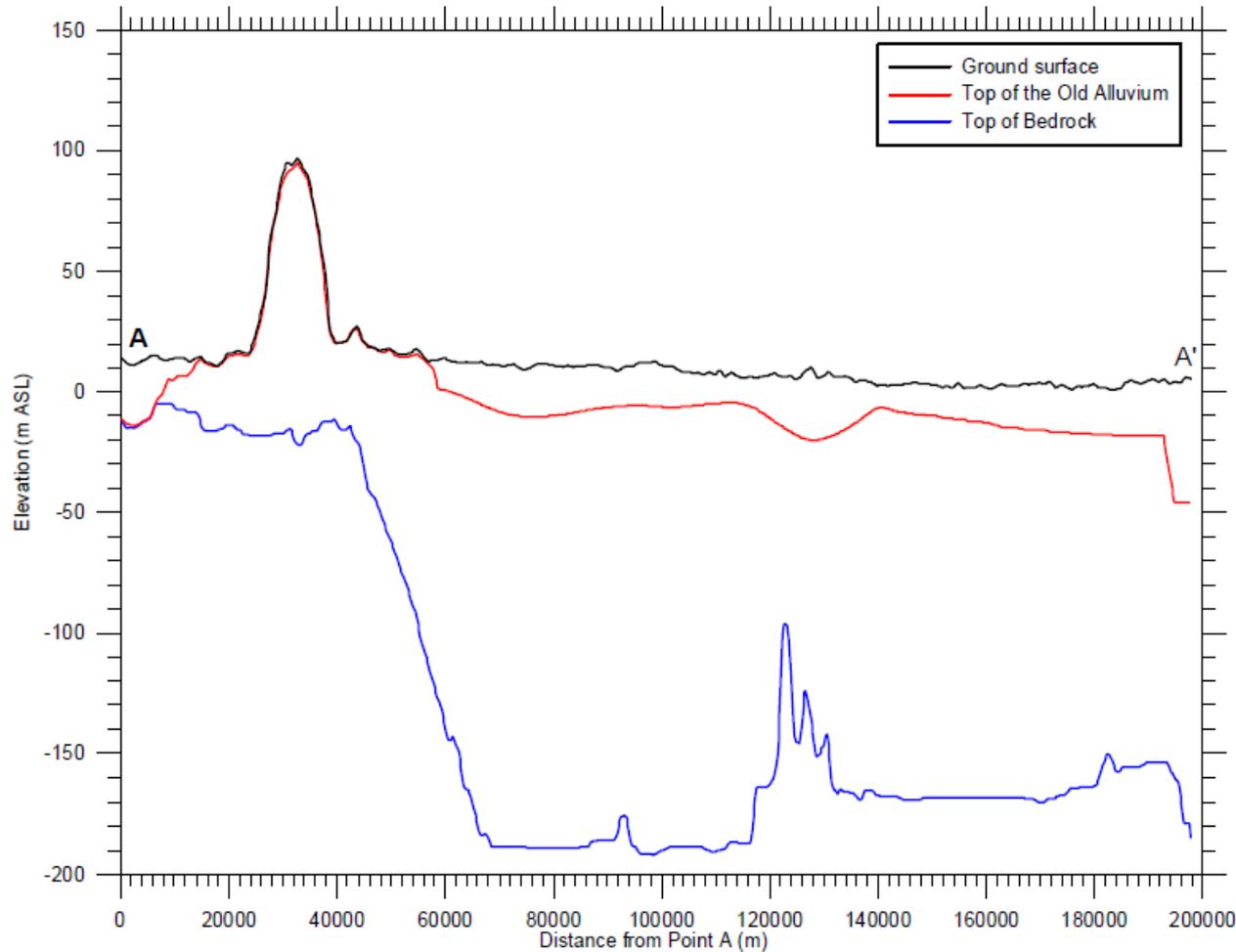


Source: Roberts (1998)

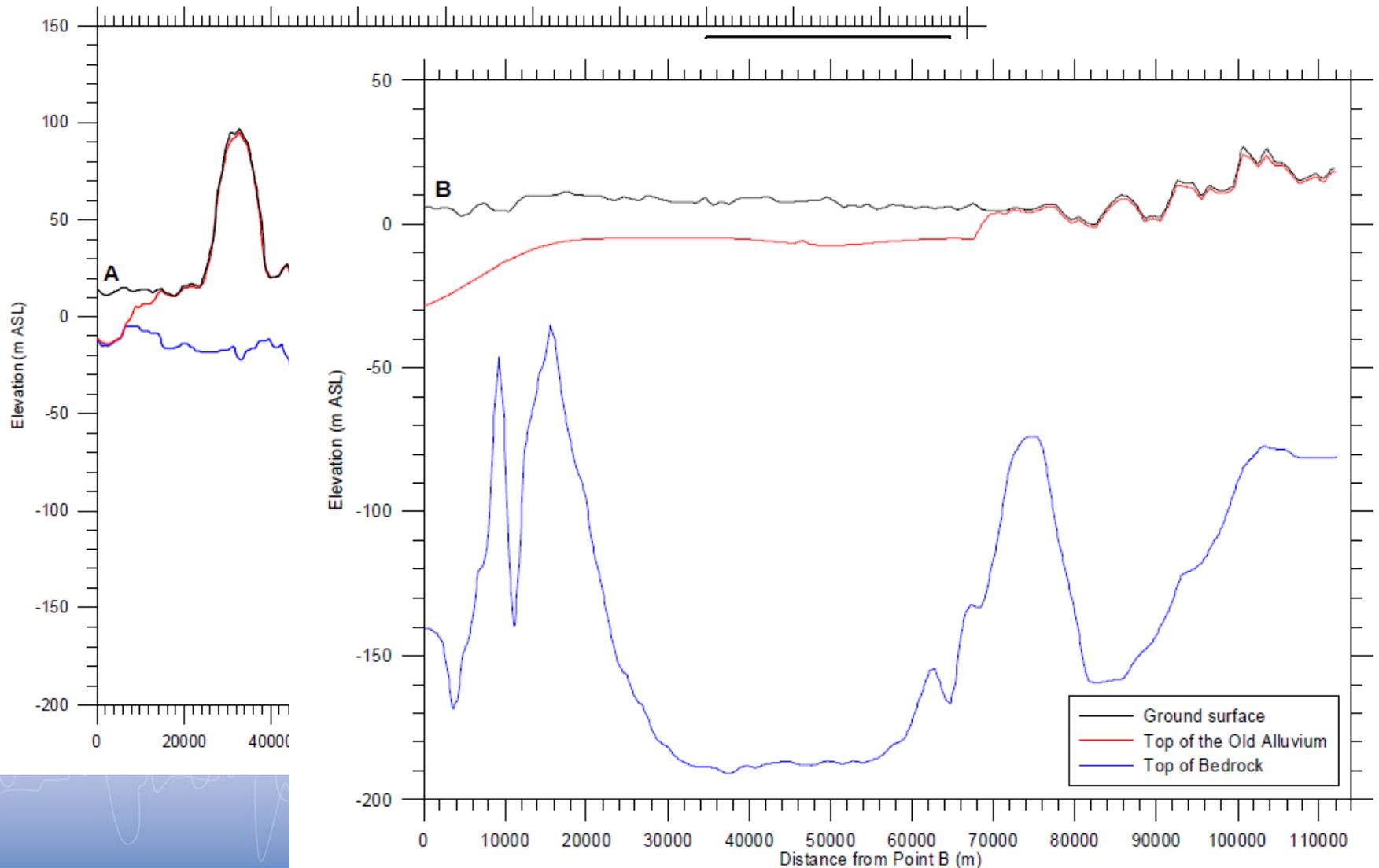
Study Site in Cambodia - Hydrogeology



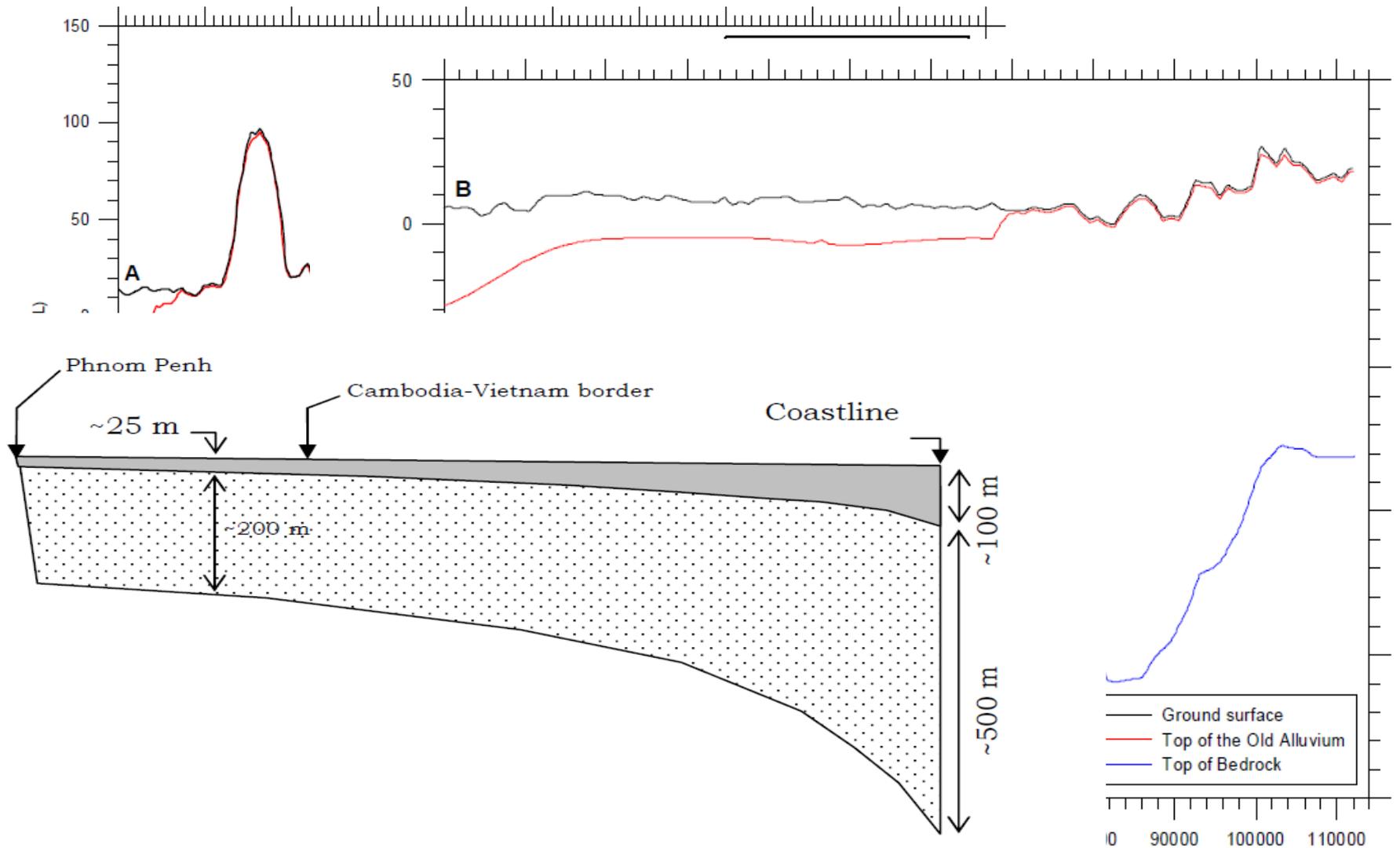
Study Site in Cambodia – Hydrogeology N-S



Study Site in Cambodia – Hydrogeology W-E

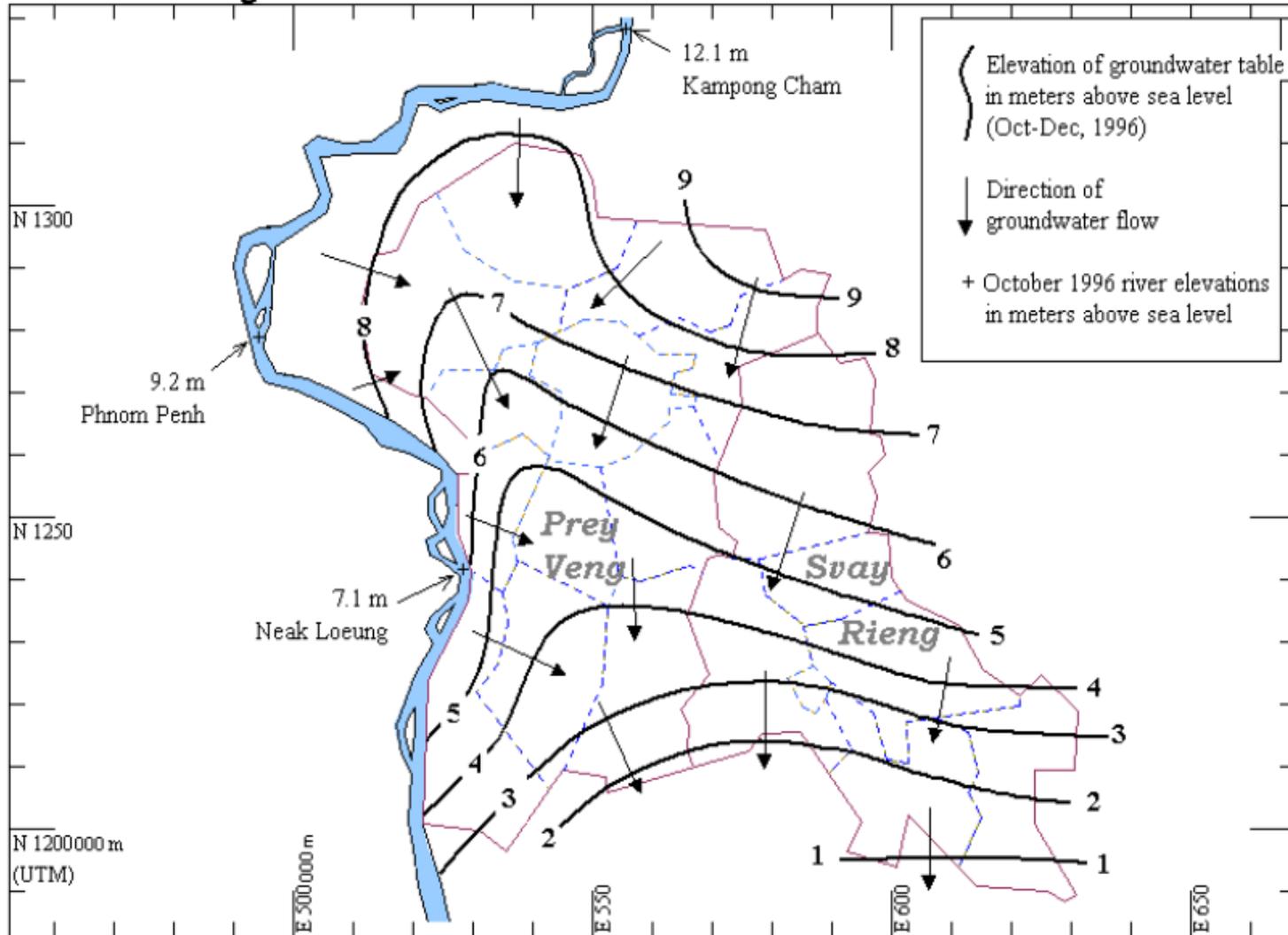


Study Site in Cambodia - Hydrogeology



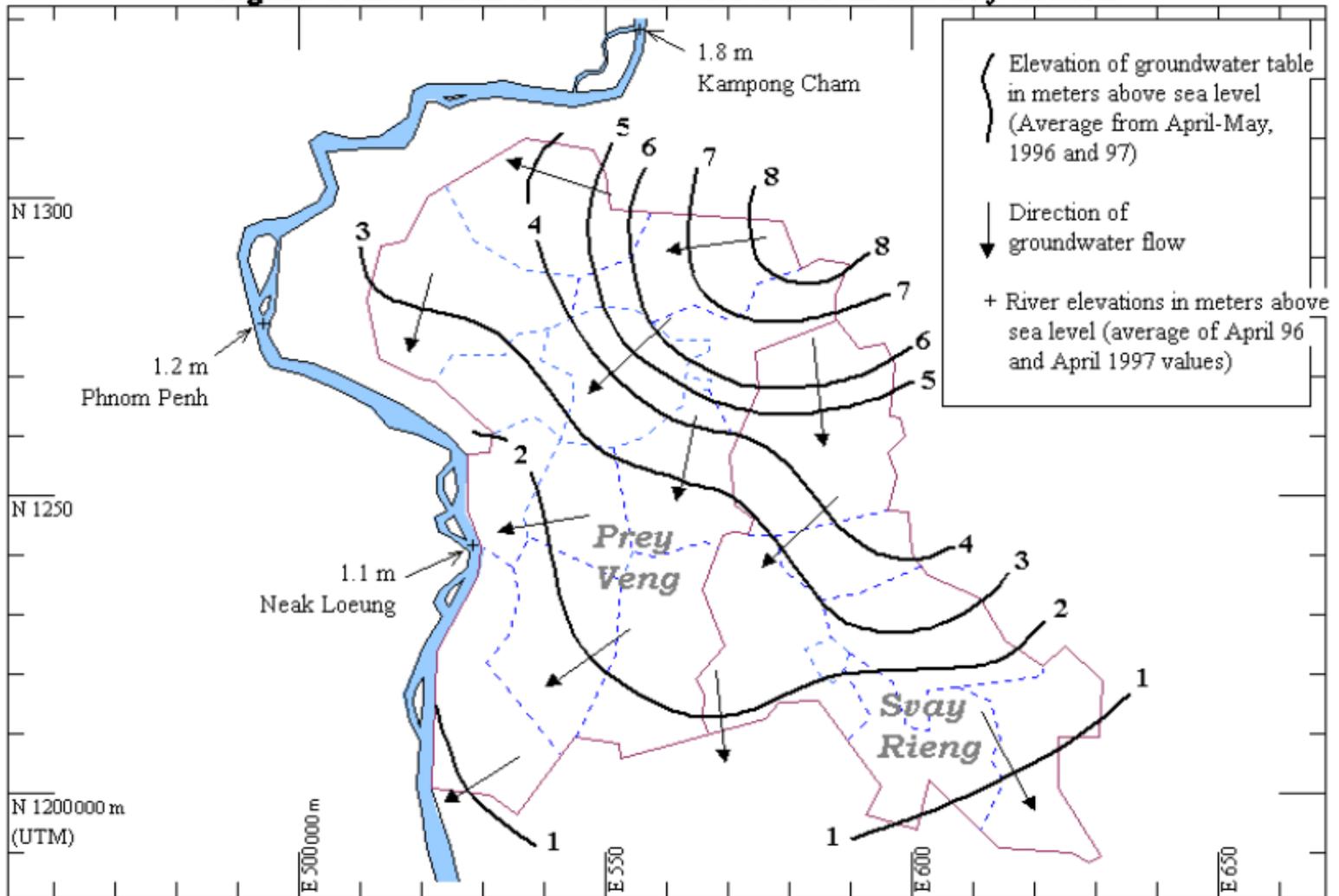
Study Site in Cambodia – Groundwater Level

Figure 5: Elevation of Groundwater Table in the Wet Season



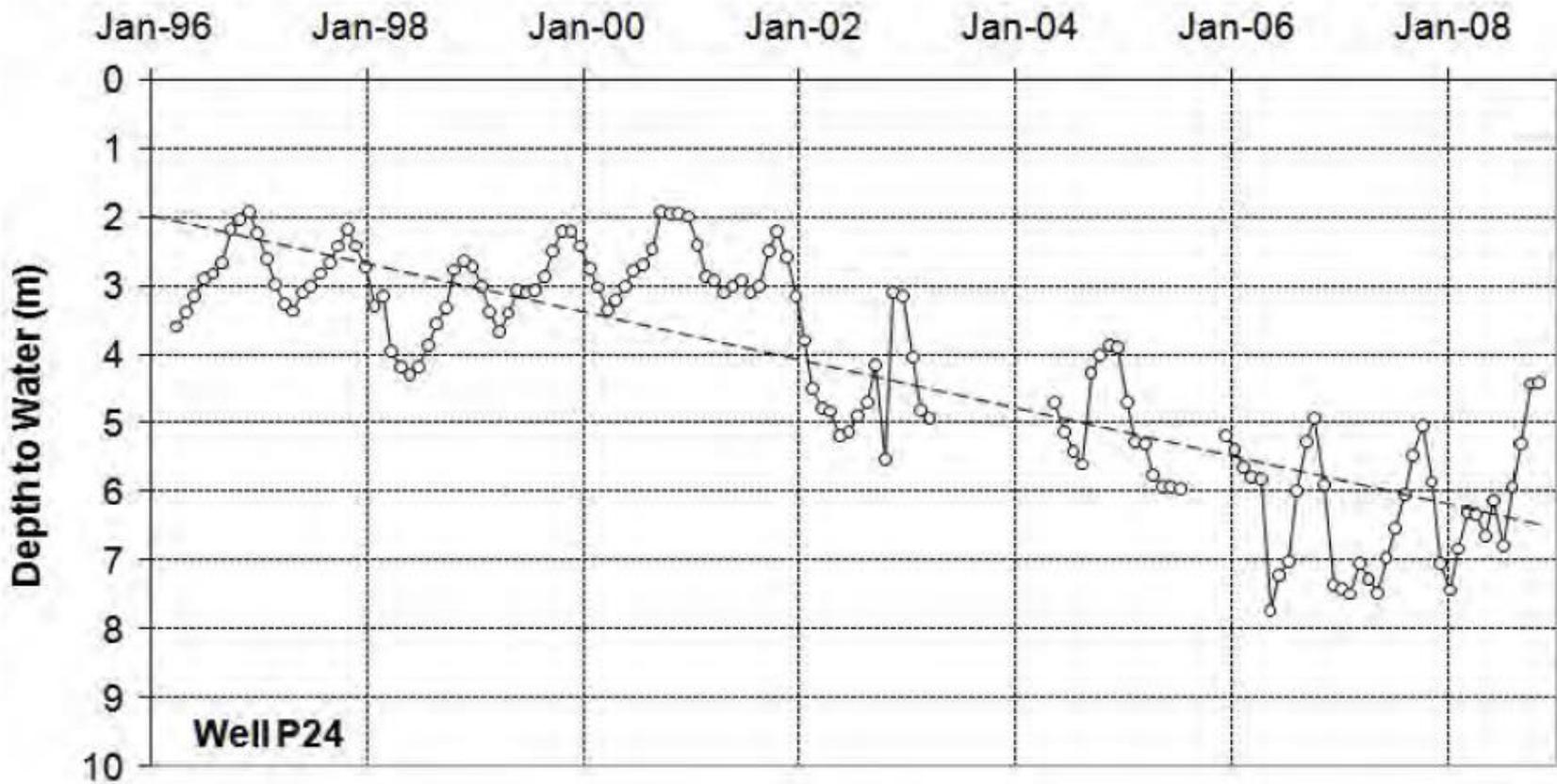
Study Site in Cambodia – Groundwater Level

Figure 6: Elevation of Groundwater Table in the Dry Season



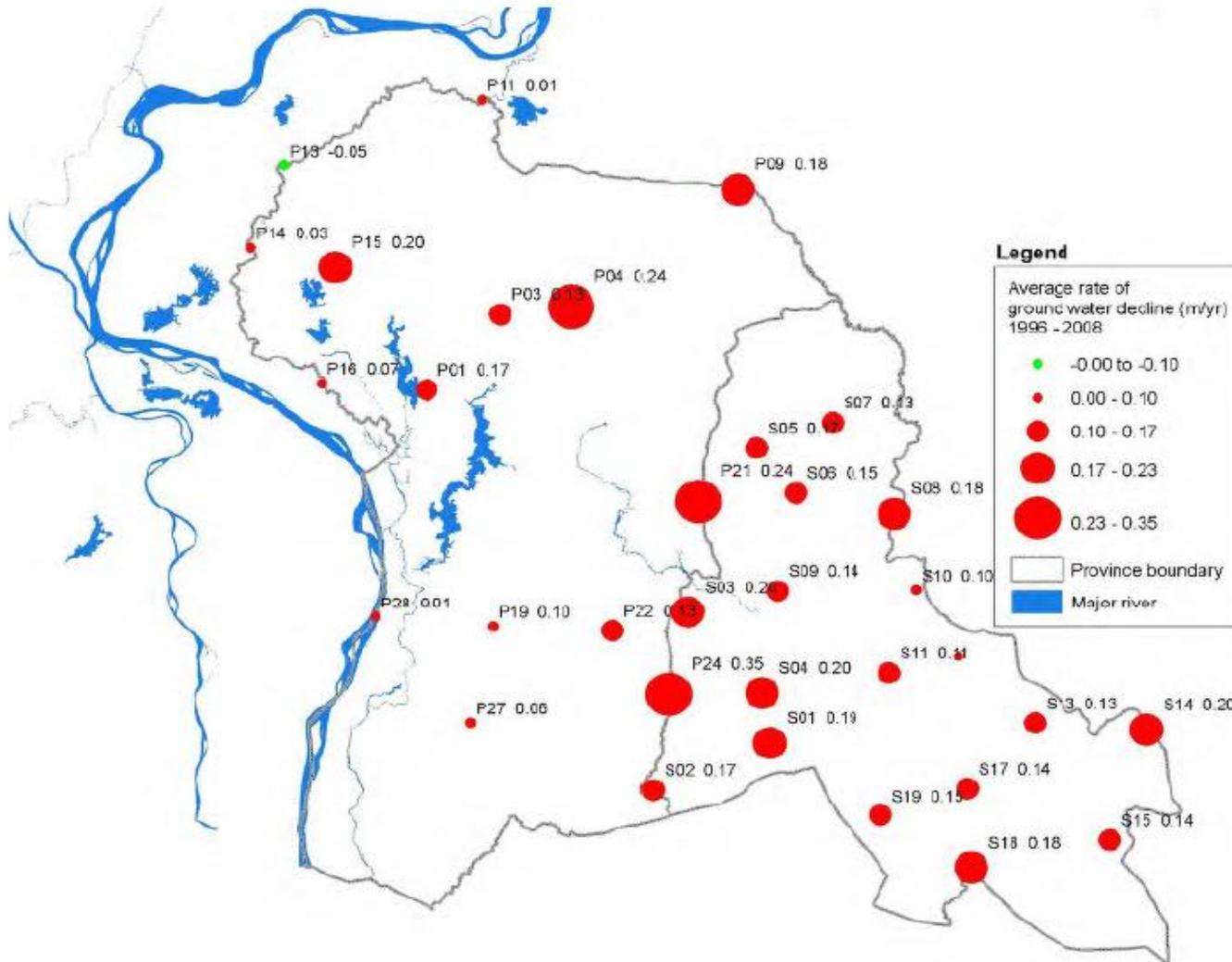
Study Site in Cambodia – Groundwater Decline

Figure 5: Depth to Groundwater Level at Two Representative Monitoring Wells

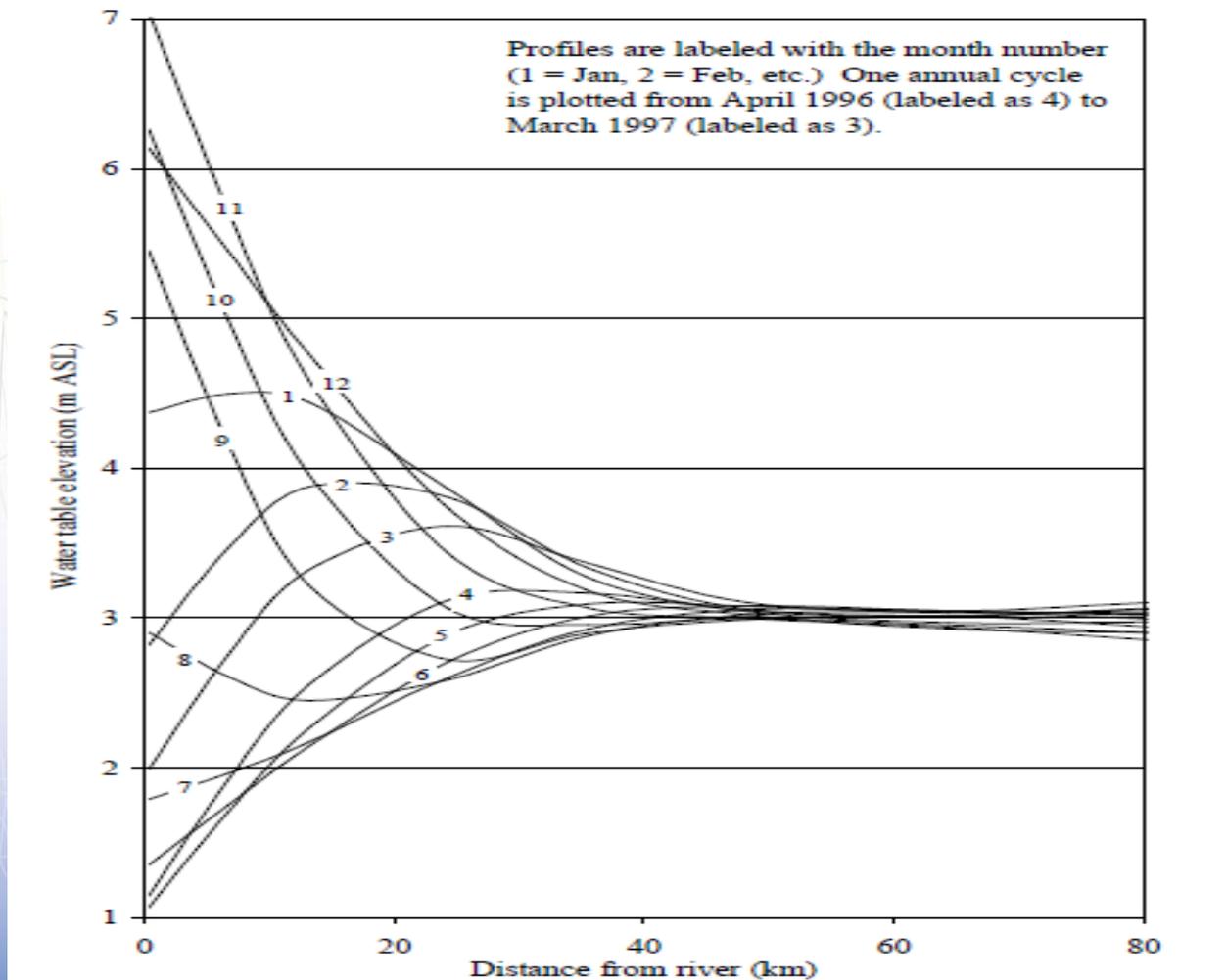


Study Site in Cambodia – Groundwater Decline

Figure 6: Average Rate of Groundwater Decline from Apr 96 to Dec 08



Study Site in Cambodia – Groundwater Level and dependence of Surface water (Mekong)



Study Site in Cambodia (cont.)



Measuring depth to groundwater at PRASAC monitoring well S4



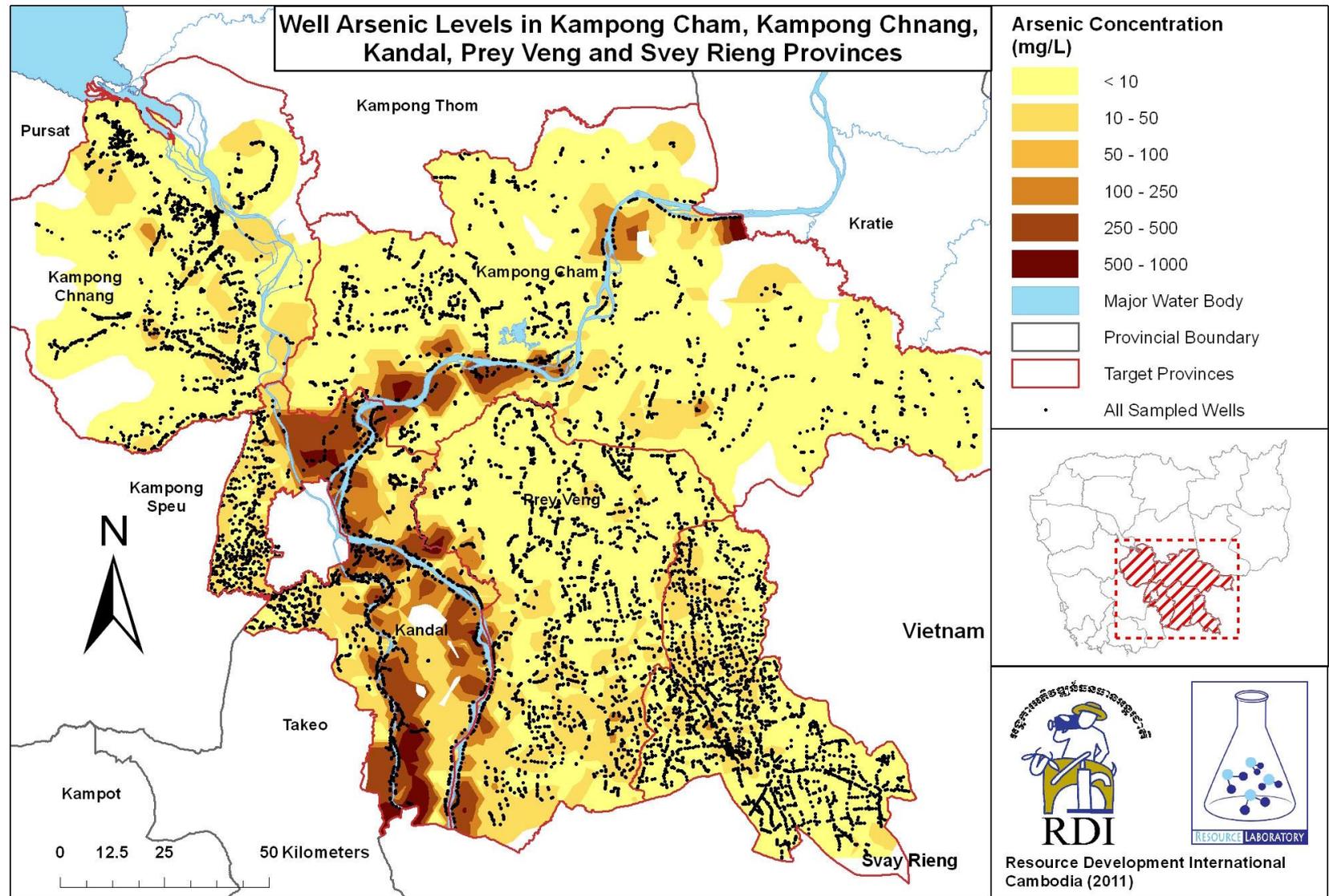
Study Site in Cambodia (cont.)



Suction pumps like this VN6 in Prey Veng will be out of service if the depth-to-groundwater falls below 6 m



Arsenic in Delta Aquifers



Arsenic in Delta Aquifers (L. Erban et al 2013)

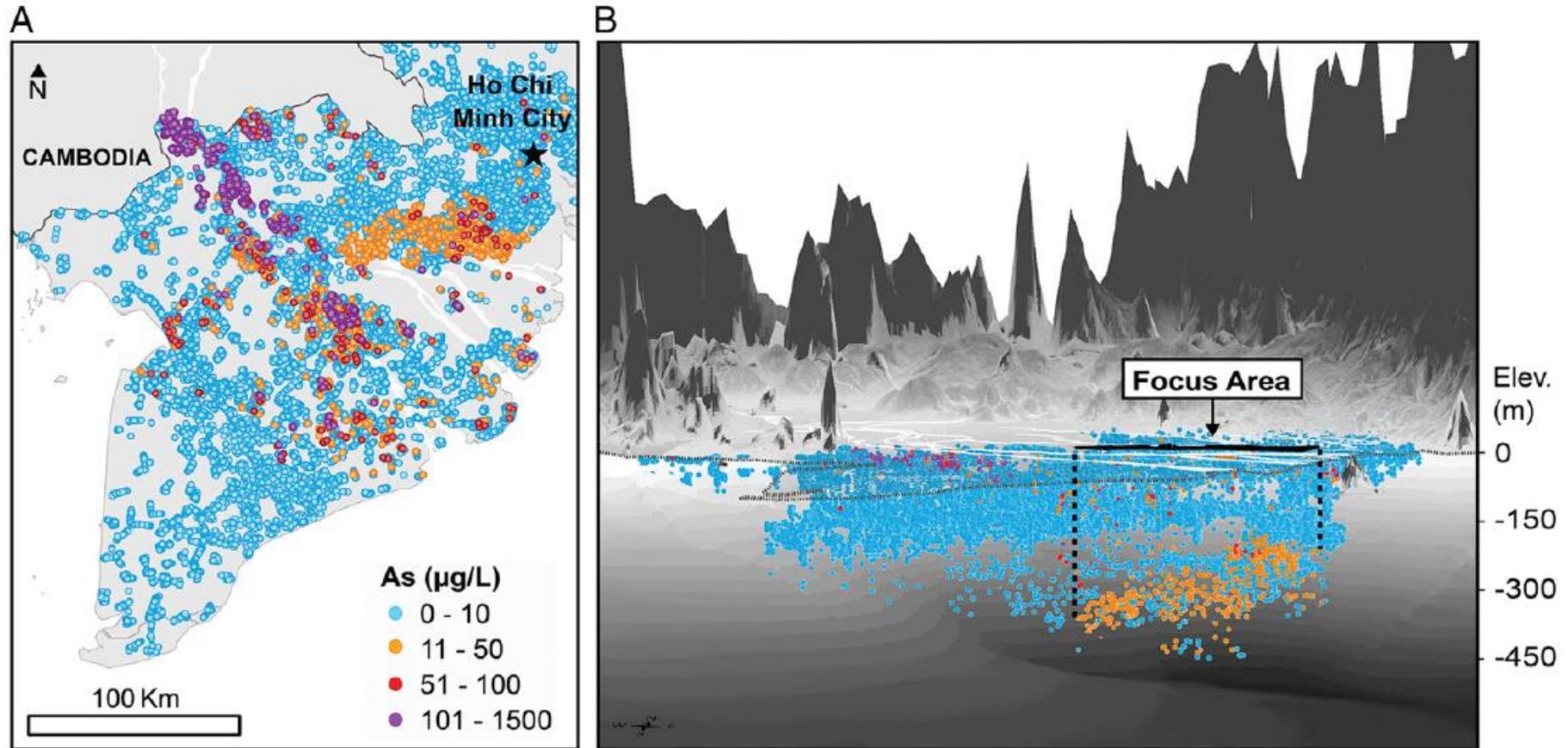


Fig. 1. Groundwater arsenic concentrations in the Mekong Delta, Vietnam. (A) Plan view. (B) North-looking perspective (vertical exaggeration, 150 \times), highlighting the focus area of this work. Topography and bedrock surface shown above and below zero elevation (mean sea level), respectively. Coastline is lightly dashed.

Future work programme with respect to Transboundary Groundwater Systems

- **More detailed geological and hydrogeological investigation on the 8 identified transboundary aquifers:**
 - Finalization of literature research;
- **Developing hydrogeological investigation programmes:**
 - Detailed drilling programme adapted to the specific sites;
 - Team building of riparian hydrogeologists to investigate jointly;
- **Joint Groundwater investigation:**
 - Simultaneous groundwater measurement campaigns across borders;
 - Advanced geophysical borehole methods;
 - Joint pumping tests;
- **Exchange Ground and Surface water:**
 - Establishing groundwater wells close to major rivers (simultaneous recording of water levels along a cross-section);
- **Fostering cooperation:**
 - Exchange experience on hydrogeological investigations;
 - Joint transboundary aquifer investigation/research projects .



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Thank you very much!

Hydrology Team
Information and Knowledge Management Programme
Mekong River Commission Secretariat