Sustainable Groundwater Management
Lessons from Practice

Case Profile Collection Number 1*

Thailand: Strengthening Capacity in Groundwater Resources Management

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The original input from GW•MATE in 2000-01 on groundwater resource institutional restructuring was part of broader World Bank efforts to facilitate national capacity strengthening in Thailand for natural resources management. It focused upon developing the groundwater resources management function of the (then) Department of Mineral Resources-Groundwater Division (DMR-GWD), through preparing a project with two interrelated components:

- *a long-term strategy to improve staffing and facilities, and to deliver a nationwide groundwater management plan (including better working relations with related organizations and establishment of regional offices)*
- *a pilot-level field groundwater resources management sub-project to evaluate key technical unknowns and to explore mechanisms for user and stakeholder involvement.*

Although this project did not receive government approval, a new Groundwater Resources Department within the Ministry of Natural Resources & Environment was formed in 2004 with a structure similar to that proposed by GW•MATE (and with clearer linkages to other natural resources and environmental departments) and the operation of the new GRD was reviewed with its senior staff during a collaborative initiative in February 2008.

General Background

- Long-term population growth and economic development is placing ever-increasing demands on all natural resources in Thailand. The stress on water in the main development regions is especially heavy, and groundwater has become an important resource for industrial use and urban water-supply. Moreover, as a consequence of recent droughts, it has become more widely exploited for irrigated agriculture to insure dry-season cropping. In the Chao Phraya Basin the typical dry-season shortfall in supply from surface water is some 2440 million m^3, and to offset this groundwater is being heavily developed by more than 10,000 wells capable of producing more than 1120 million m^3/a .

- Thus, Thailand needed a soundly-based and effectively-implemented management system to ensure sustainable and efficient use of its valuable groundwater resources. In general terms it can be said that all of the major alluvial aquifers possess very large reserves of freshwater in storage, but their rates of active replenishment (while very significant) are still subject to a large degree of uncertainty.

Key Issues Identified

- By 2001 the DMR-GWD already had significant experience of attempting to control and reduce groundwater abstraction through its on-going work to mitigate some of the impacts of intensive aquifer development in the Bangkok Metropolitan area. This experience forms the starting point from which to broaden the scope of such work and to extend it geographically to other major aquifers in Thailand. It was noteworthy, however, that there was a lack of practical experience in certain key future concerns:
  - formulating national and regional groundwater resource strategies
  - regulating and guiding groundwater development for agricultural irrigation
  - promoting groundwater quality protection, both at source and resource levels.

- Each agency concerned with groundwater use compiled its own records of development and performance, and no single national agency was responsible for coordinating groundwater resources - and it was not possible to determine the status of development of a given aquifer.

- Shallow wells (even when used for agricultural irrigation) do not require licences, nor do public water-supply (and other) wells constructed by government agencies. At some time in the future this situation needs to be corrected in view of the large numbers and/or large pumping rates involved. Moreover, groundwater pollution incidents were increasingly commonplace and urgently need to be controlled.

Approach Recommended

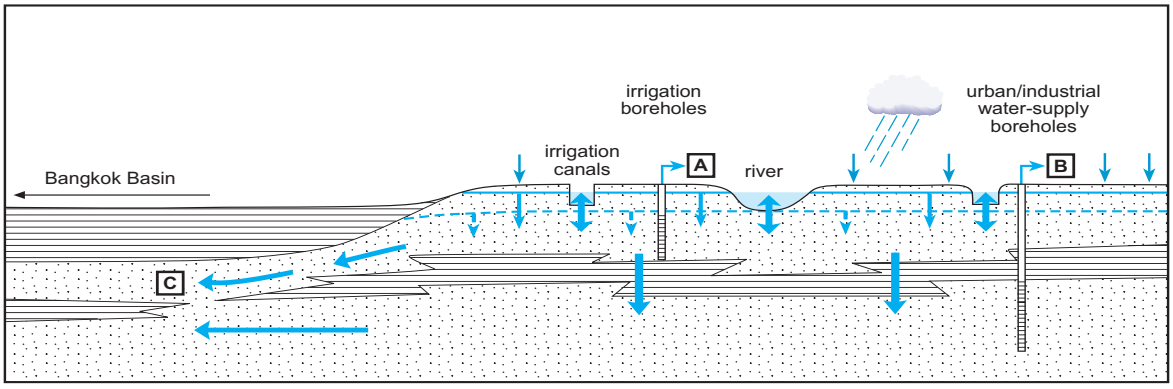
Table 1: Key government functions for groundwater resource management and their incorporation into project components

no.	PROJECT (SUB)COMPONENT Title	IMPLEMENTATION LEVEL National	Pilot
1	**Groundwater Resources Evaluation**		
	• Hydrogeological Surveys & Groundwater Monitoring	X	X
	• Aquifer Numerical Modeling		X
	• Research on Shallow Aquifer Behavior		X
	• Assessment of Conjunctive Use for Irrigation		X
2	**Groundwater Strategic Planning**		
	• Political & Public Awareness of Functions	X	X
	• Groundwater Management Master Plan	X	
	• Groundwater Utilization & Valuation	X	
	• Feasibility of Recharge Augmentation Measures	X	
	• Technical & Economic Appraisal of Impact Mitigation	X	
3	**Groundwater Abstraction Use & Regulation**		
	• Legal Modifications to Abstraction Licensing	X	
	• Stakeholder Engagement & Participation		X
	• Evaluation of Licence Charging, Trading & Policing	X	
4	**Groundwater Quality Assessment & Protection**		
	• Production of Land-Surface Zoning Maps	X	X
	• Groundwater Pollution Hazard Assessment		X
	• Promotion of Water Well Protection Zones		X
	• Groundwater Quality Monitoring Networks	X	X
5	**Groundwater Databasing & Information Provision**		
	• Updating & Linkage of Groundwater Databases	X	
	• Development of GIS for Information Provision	X	
	• Promotion of National Groundwater Data Centre	X	

- The five principal components of groundwater management are listed on page 2 (Table 1). These components are in practice the key functions that government needs to perform or facilitate for comprehensive and effective management of major aquifer systems – the areas for which capability strengthening are specifically required are also listed, and a distinction is made in respect of those which are best developed at pilot sub-project scale.

- The part of the Middle Chao Phraya Basin selected as a pilot field area for strengthening groundwater management practice is underlain by a typical multi-aquifer alluvial system (Figure 1). The uppermost phreatic aquifer has become heavily developed for drought and dry season irrigation of rice and other crops during the 1990s, while the deeper semi-confined aquifer is also under rapidly increasing development for urban and industrial water-supply. The area is also part of the recharge capture zone of the downstream heavily developed Bangkok aquifer.

Figure 1: Generalized groundwater flow regime of area selected for pilot groundwater management project in Middle Chao Phraya Basin – Thailand



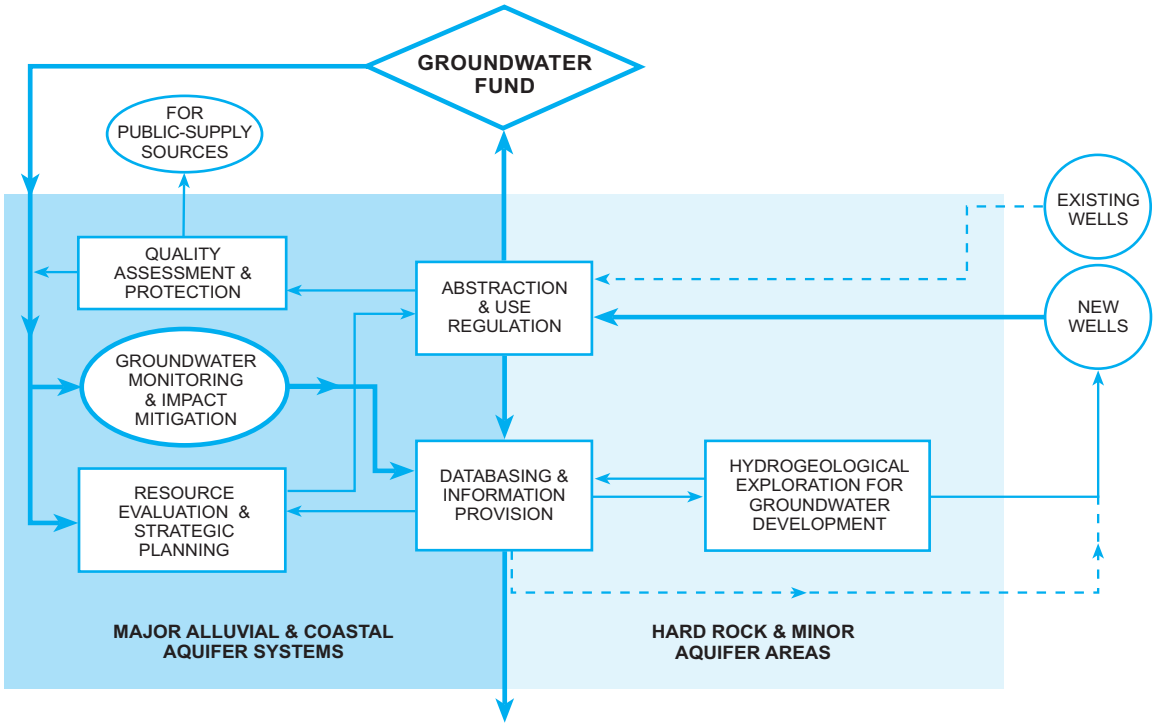
- An adequate level of resource characterization and quantification is needed to provide the scientific foundation for efficient and sustainable groundwater resource management. It has to be recognized, however, that the degree of natural hydrogeological uncertainty and the cost of hydrogeological field investigations are such as to make the precise initial evaluation of resources uneconomic. Careful monitoring of the aquifer response to existing or new pumping, and to already-existent pollution plumes, is the cost-effective way of confirming conceptual models, and calibrating numerical models, used as the basis for groundwater management.

- A particularly important need is to assess shallow aquifer recharge mechanisms and rates, together with evaluation of shallow-deep aquifer interactions, in typical alluvial aquifer situations. This is related to the field assessment of hydrogeological sustainability and socioeconomic benefits of existing informal conjunctive use of groundwater for supplementary agricultural irrigation.

Transforming the DMR-Groundwater Division

- At national level it is important that the key government functions in groundwater resource management are well understood, and that a much clearer distinction is established and maintained between the groundwater regulator and the groundwater users. Moreover, the DMR-GWD as structured was primarily a groundwater development agency, with a licensing of water wells in a separate interlinked section. The organization required restructuring (Figure 2) to focus on what are the primary tasks for government - improving groundwater management - whilst retaining limited groundwater exploration and drilling capacity to continue the search for minor aquifers in the more remote regions of the country.

Figure 2: Proposed groundwater management functions for a national groundwater resource agency



- Because of the very large number of individual abstractors often involved, it can be said that 'groundwater resources management is as much about managing people as it is about managing water'. For this reason it was important that effort be put into mobilizing water-user (and broader stakeholder) participation in the definition and implementation of local groundwater management strategies and into bringing all volumetrically-significant groundwater abstraction (including shallow irrigation wells) inside the regulatory process. These two critical steps involved a large amount of primarily administrative action, and careful technical and political promotion at regional and provincial level.

- While the responsibility for groundwater resource quality protection rested with the DMR-GWD, it was necessary to recognise that this function can only be carried out effectively in close collaboration with other government agencies, which have responsibility for controlling specific sources of potential pollution

and for environmental quality monitoring. In these circumstances, the first priority for the DMR-GWD in its groundwater protection role was to improve communication with sister government agencies (and to land users and developers) on concerns about the vulnerability of groundwater to given types of pollution in certain areas. This can be achieved through the publication of appropriate maps, together where feasible with plans indicating the capture (recharge) areas of important public water-supply sources.

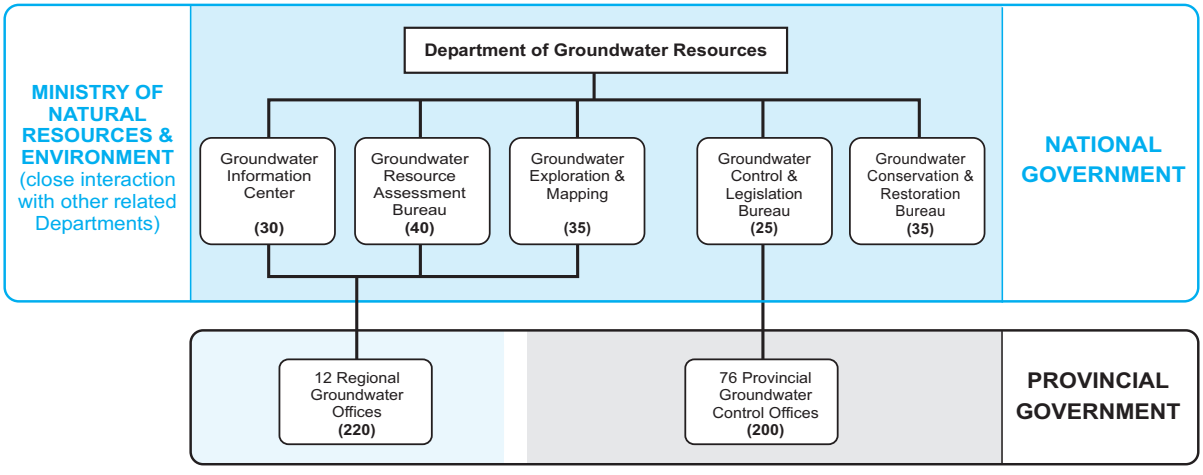
- There was also a need to rationalise databasing, including establishment of a computerised linkage system (with joint numbering and agreed location) between well-based entries in the scientific hydrogeologic database and the abstraction regulation database, and also widening the data-capture up-grading and completion of the computerised regulation database.

- It was considered highly desirable to implement the concept of a 'national groundwater data centre' at the DMR-GWD Bangkok (in a physical as well as virtual sense), with improved conditions for direct public access to groundwater data/information and a provincial level technical enquiry service for water and environmental sector professionals.

The New Groundwater Resources Department

- The DMR-GWD was transferred to the Ministry of Natural Resources & Environment in 2004 to form the new national Groundwater Resources Department (GRD) – in part to make a clearer distinction between government's 'resource management and protection role' and those government agencies concerned with groundwater use (such as the Royal Irrigation Department, PWAs, etc) and to establish closer linkages with other natural resources and environmental departments.

Figure 3: Organizational structure of the Thailand Groundwater Resources Department in 2007



(30) *approximate number of professional and support staff*

- The initial organogram of the new GRD (Figure 3) reflects the key government functions defined in Table 1 and Figure 2. Of particular interest (and relevance to all 'medium-sized countries' grappling with the management of a 'highly-diffuse and locally-variable resource' like groundwater are the following features:
  - the divisional or 'bureau' focus areas which well reflect the various tasks of groundwater resource management and protection
  - the balance between headquarters and regional offices (12 in total with an aggregate of over 200 staff)
  - the existence of a major Groundwater Control & Legislation Bureau (with almost 200 staff), setting national policy and priorities for groundwater resource regulation, but most of whose operational staff are seconded to provincial government in a total of 76 Provincial Groundwater Control Offices (the GRD centrally in effect having a 'professional care and training' function with respect to these provincial staff)
  - a national groundwater data-centre as a semi-autonomous office working directly to the GRD-Director
  - a Groundwater Exploration & Mapping Bureau (including a drilling capacity) is retained to cover work in those more remote parts of the country where groundwater occurrence and availability remains under investigation as a 'public service' to meet potential local demands for improved reliability and quality water-supplies.

- One feature not fully reflected in the organogram (Figure 3) is the creation of a Groundwater Fund generated from a proportion of the charges levied on groundwater abstraction (Groundwater Use Fee of up to a maximum equivalent to US$ 0.21/m^3 & Groundwater Conservation Charge also up to a maximum equivalent to US$ 0.21/m^3) in those parts of the country where groundwater resources are under abstraction stress and/or there is a risk of associated environmental degradation. This Fund has accumulated steadily over recent years, and is now available to meet the costs of approved ground-water monitoring, investigation and research to improve the knowledge base for effective resource management.

Publication Arrangements

The GW•MATE Case Profile Collection is published by the World Bank, Washington D.C., USA. It is also available in electronic form on the World Bank water resources website (www.worldbank.org/gwmate) and the Global Water Partnership website (www.gwpforum.org).

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