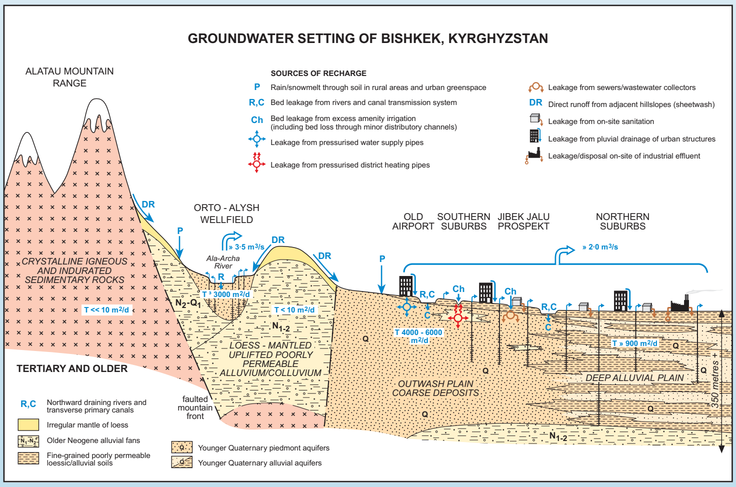
# CASE STUDIES



## Rationale for selection

The cities of Narayanganj in Bangladesh and Bishkek in Kyrghyzstan were selected for the case-studies because they represent two of the most common urban groundwater development environments (Table 1 and socio-economic situations where water quality deterioration could have serious economic consequences (Morris *et al,* 1994). The hydrogeological setting of Narayanganj (deep fluvio-deltaic multi-aquifer) and of Bishkek (on a piedmont/alluvial outwash plain aquifer adjacent to a high mountain region) are both frequently encountered, especially in the South, Central and East Asian regions.

**Figure 1 Narayanganj**

**Figure 2 Bishkek**

The results of the study can therefore be generalised to numerous other cities of similar type. The cities contrast with each other socio-economically, as Bangladesh is an industrialising developing world economy, while Kyrghyzstan is an ex-command economy in transition. There are thus opportunities for lessons to be learnt in the evolution of practical sustainable development policies in different socio-economic settings.

The cities were both in their own ways representative of typical developing city situations in that the amount of available data and the financial, institutional and professional resources to hand to collect, analyse, supplement and interpret the results were limited.

Figures 3 and 4 summarise the groundwater setting in each city.

**Table 1 Summary of characteristics of principle hydrogeological environments**

| Type | Hydrogeological Environment | Lithology | Description/Genesis | Extent/Dimension |
|---|---|---|---|---|
| Unconsolidated Aquifers | Major Alluvial & Coastal Plain Sediments* | Gravels, sands, silts and clays | Unconsolidated detritus deposited by major rivers, deltas and shallow seas; primary porosity and permeability usually high. | Usually both areally extensive and of significant thickness |
| | Intermontane Colluvial & Volcanic Systems** | Pebbles, gravels, sands, clays, ± interbedded lavas & pyroclastics | Rapid infilling of faulted troughs and basins in mountain regions; deposits are unconsolidated, primary porosity and/or permeability usually high for colluvium and coarse alluvium, modern basaltic/andesitic lavas and andesitic/rhyolitic pyroclasts, but older volcanics are often poor aquifers. | Much less extensive than alluvial and coastal plain sediments but can be very thick. |
| | Glacial and Minor Alluvial Formations | Boulders, pebbles, gravels, sands, silts, clays | Ice-transported sediments are commonly unsorted and of low permeability, but water-sorted sediments such as meltwater and outwash deposits often have high porosity and permeability. Alluvial sands and gravels can also be very productive but storage is limited and resource is sensitive to recharge regime. | Can comprise relatively narrow channel fills or coalesce to form thick patchy multi-aquifer along piedmont zone. |
| | Loessic Plateau Deposits | Silts, fine-sands and sandy clays | Usually well-sorted windblown deposits of silt and fine sand, with some sandy clay deposits of secondary fluvial origin; low permeability generally makes sub-surface more suitable as receptor than aquifer. | Very extensive although deposits may form isolated systems cut by deep gullies |
| Consolidated Aquifers | Consolidated Sedimentary Aquifers | Sandstones | Marine or continental sediments compacted and cemented to form consolidated rocks; degree of consolidation generally increases with depth/age of deposition. Primary porosity moderate to poor but secondary porosity from fractures of tectonic origin can be significant. | Difficult to generalise but can form extensive aquifers and be of substantial thickness |
| | | Limestones | Deposited from skeletal material (shell fragments, reefs, reef detritus) in shallow seas and compacted to form consolidated rocks. Solution enlargement of fractures can form well-developed cavities/conduit systems (karst features). | |
| | Recent Coastal Calcareous Formations | Limestones and calcareous sands | Composed of coral limestones, shellbanks, chemically precipitated oolites and calcareous oozes; often loosely cemented; porosity and permeability can be exceptionally high, especially if features solution-enhanced. | Limited area, often forming narrow aquifers that fringe coastline/form oceanic islands |
| | Extensive Volcanic Terrains | Lavas, tuffs ± ash intercalations | Flows from quiet effusion of mainly basaltic lavas or, more rarely, large explosive eruptions of incandescent ash. Primary (interconnected) porosity of thick flows often neglible but flow junctions and chilled margins can be very permeable if rubbly or degassed. Extremely variable potential | Flood basalts and some ignimbrites areally extensive and thick. |
| | Weathered Basement Complex | Crystalline rocks | Decomposition of ancient igneous or metamorphic rocks produces a weathered mantle of variable thickness, moderate porosity but generally low permeability, underlain by fresher rock which may be fractured. The combination result in a low-potential, but regionally important, aquifer system | Very extensive, but aquifers are often restricted to upper 30 m or less. |

Case-study examples: ***** Narayanganj, Bangladesh
****** Bishkek, Kyrghyzstan

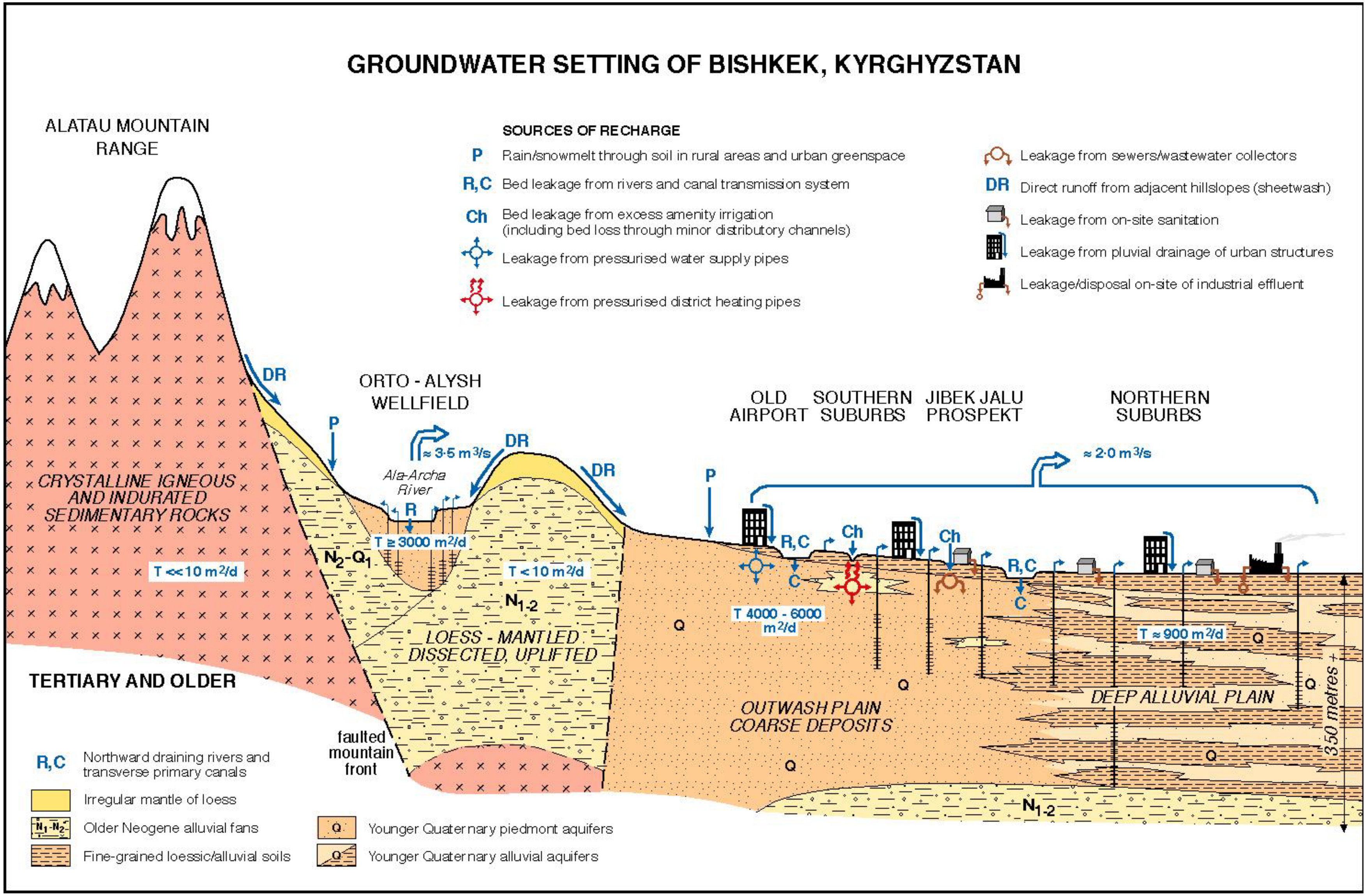



**Figure 3** Groundwater setting of Bishkek. Kyrghyzstan

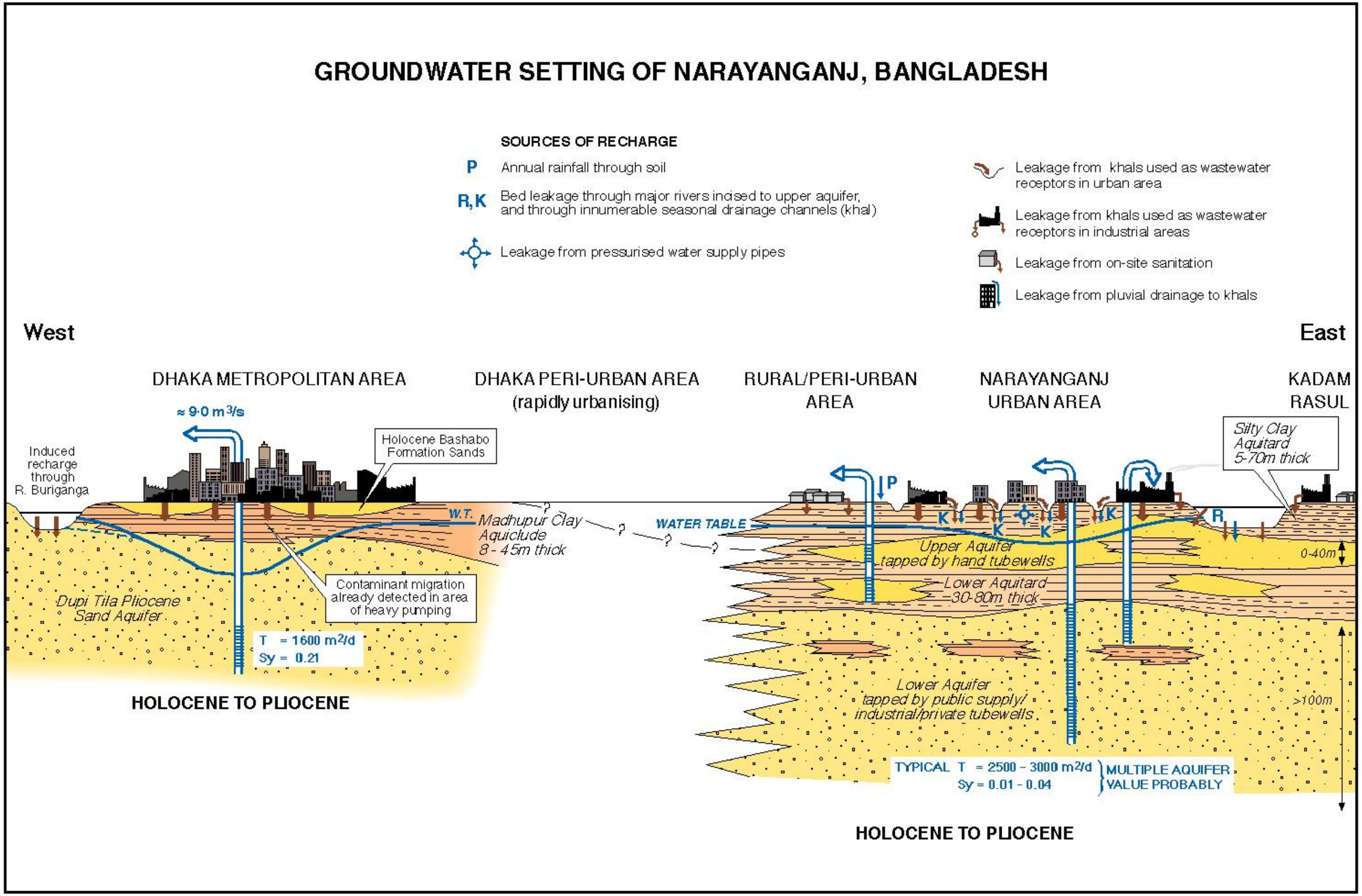



**Figure 4** Groundwater setting of Narayanganj, Bangladesh