Estimation of groundwater storage potential of aquifers in Kathmandu Valley using GIS

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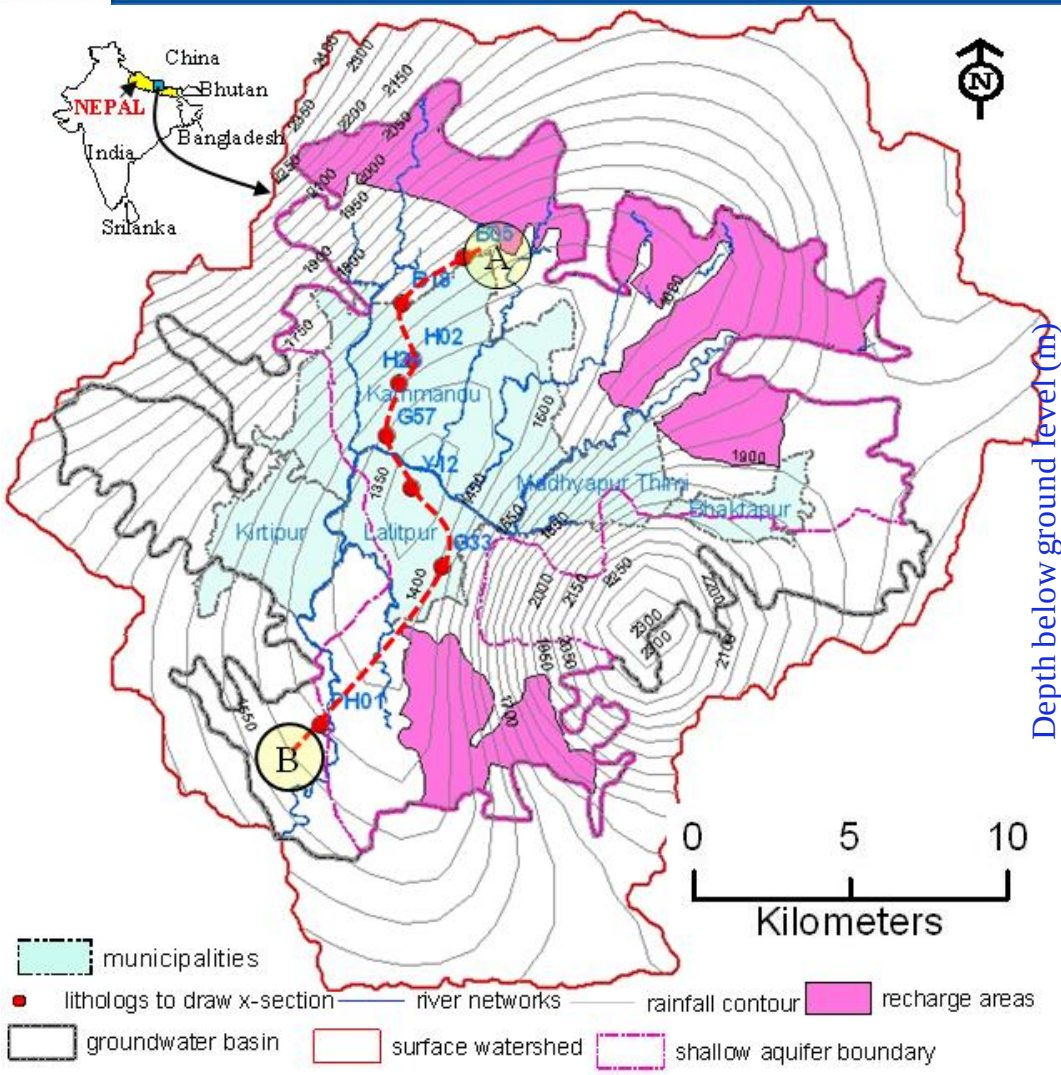
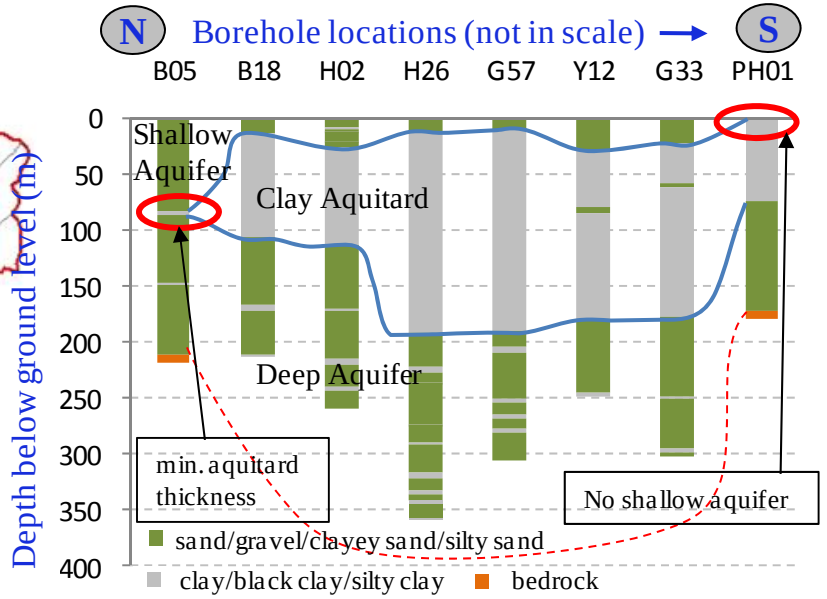
STUDY AREA: KATHMANDU VALLEY





B01, B18: Gongabu; H02: Lazimpat; H26: Durbarmarg;
G57: Tripureshwor; Y12: Patandhoka; G33: Satdobato; PH01: Pharping

- Rainfall: 1,755 mm [range: 1,350 ~ 2,450 mm]
- Many boreholes are drilled
- Rechargeable areas: 154 km^2;

GW DEVELOPMENT TRENDS

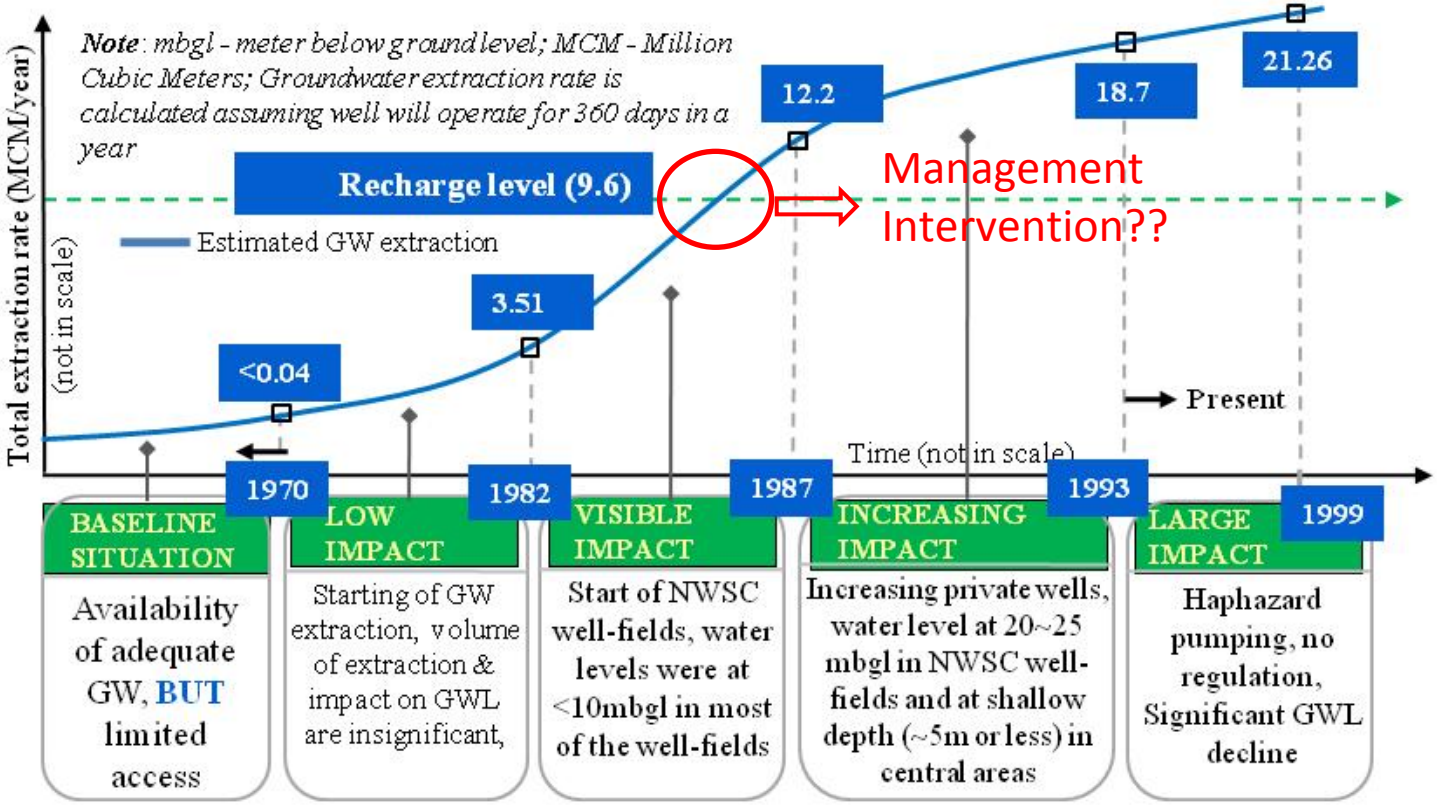


Fig . **Stages of Groundwater development** in Kathmandu valley aquifer and corresponding impacts [Data sources: time trend of extraction from Metcalf & Eddy (2000); & recharge level from Pandey et al (2009), Impact level information from Kharel et al 1998].

Early Studies: Geology, GW quality, Recharge estimate, -etc…

Knowledge Gap: no compilation of highly scattered hydrogeology information; no estimate of GW storage capacity

OBJECTIVES

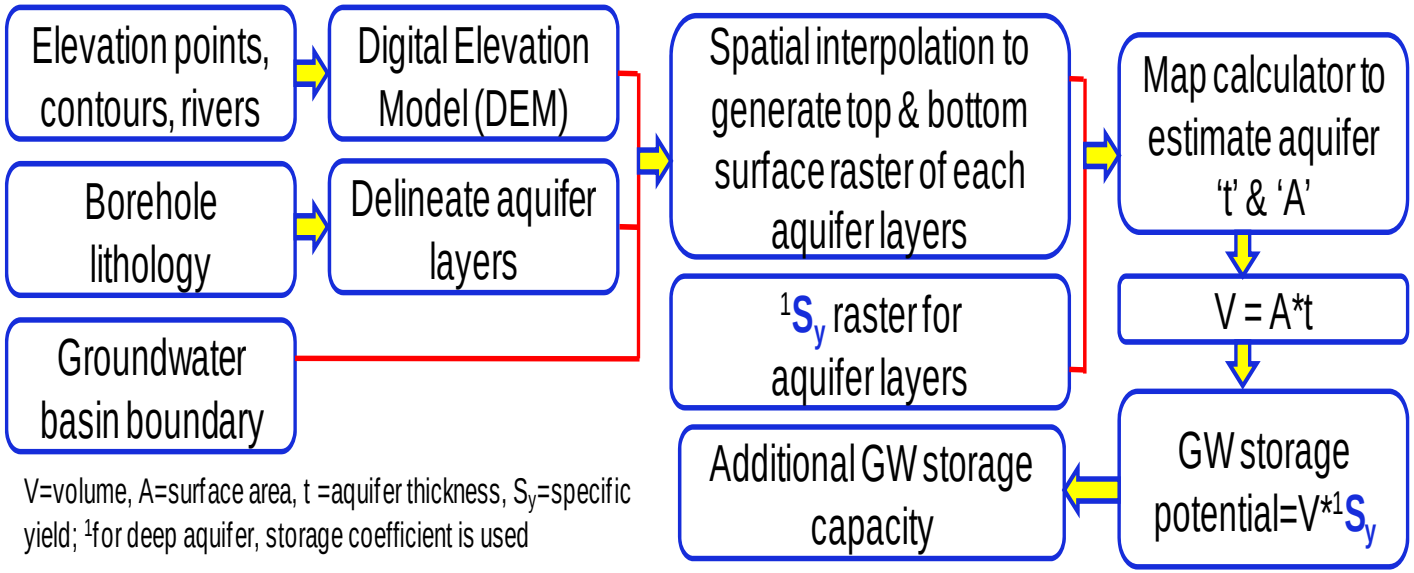
Broad:

Development of GW knowledgebase to assist in GW Mgmt.

Specific:

1. To review, compile and analyze available hydrogeological information
2. To delineate groundwater aquifer layers
3. To estimate total GW storage capacity & its spatial distribution
4. To estimate GW storage within municipal areas within KTM valley
5. To estimate additional GW storage potential

METHODOLOGY



V=volume, A=surface area, t =aquifer thickness, S_y=specific yield; [1]for deep aquifer, storage coefficient is used

Fig.: Flow chart to estimate spatial distribution of groundwater storage potential

RESULTS & DISCUSSION (1)

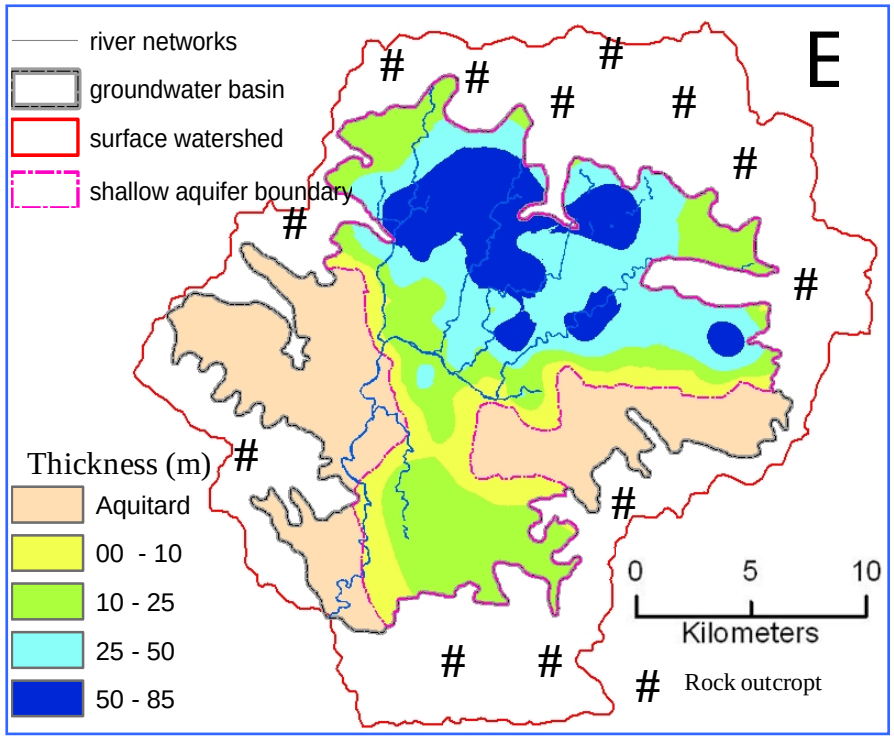


Fig.: Distribution of thickness in shallow aquifer

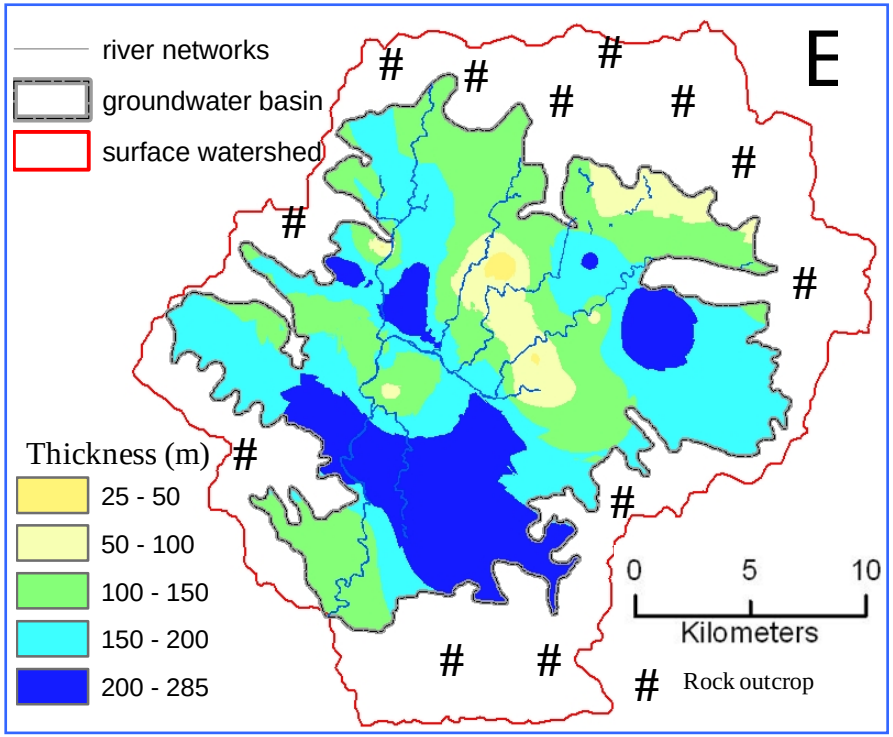


Fig.: Distribution of thickness in deep aquifer

- Aquifer thickness range (m) :SA = 0~85; DA = 25~285, Total = 55 ~ 330
- Aquifer Volume (MCM) : SA = 7,260; DA = 56, 813

RESULTS & DISCUSSION (2)

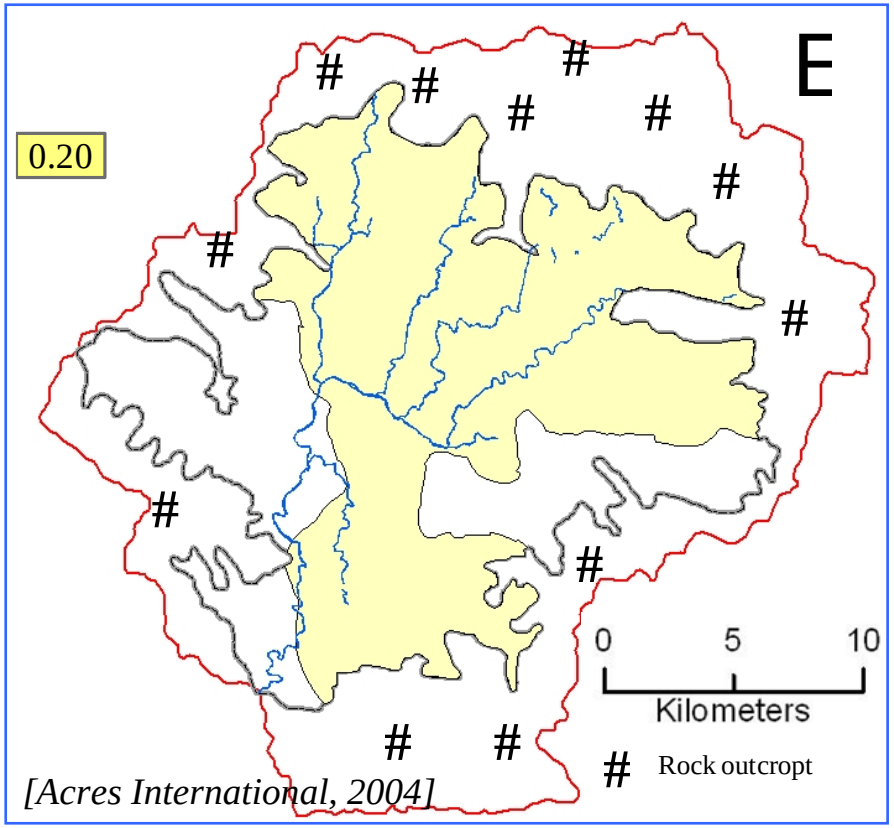


Fig.: Storage coefficient of shallow aquifer

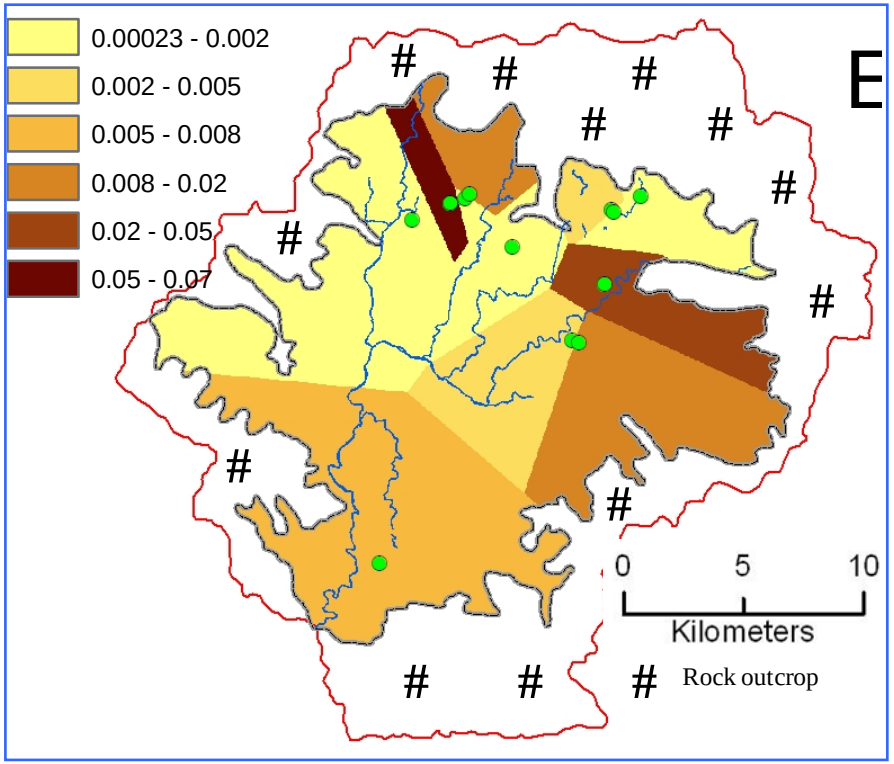


Fig.: Storage Coefficient of deep aquifer

- Storage Coefficient in SA : 0.20 throughout
- Storage Coefficient in DA : 0.00023 ~ 0.07

RESULTS & DISCUSSION (3)

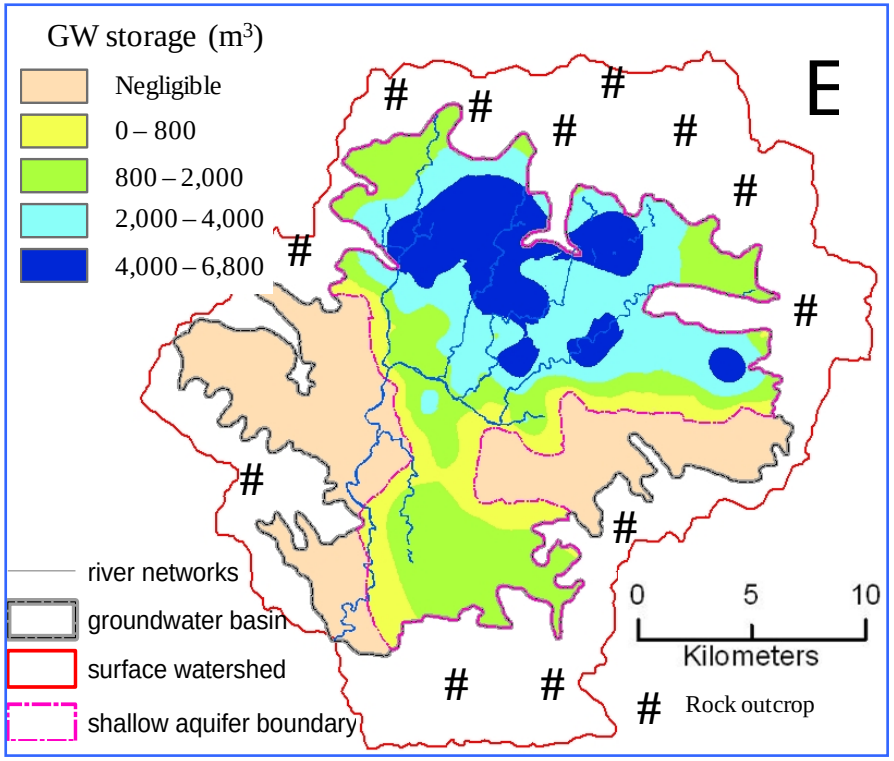


Fig: Potential GW storage in shallow aquifer

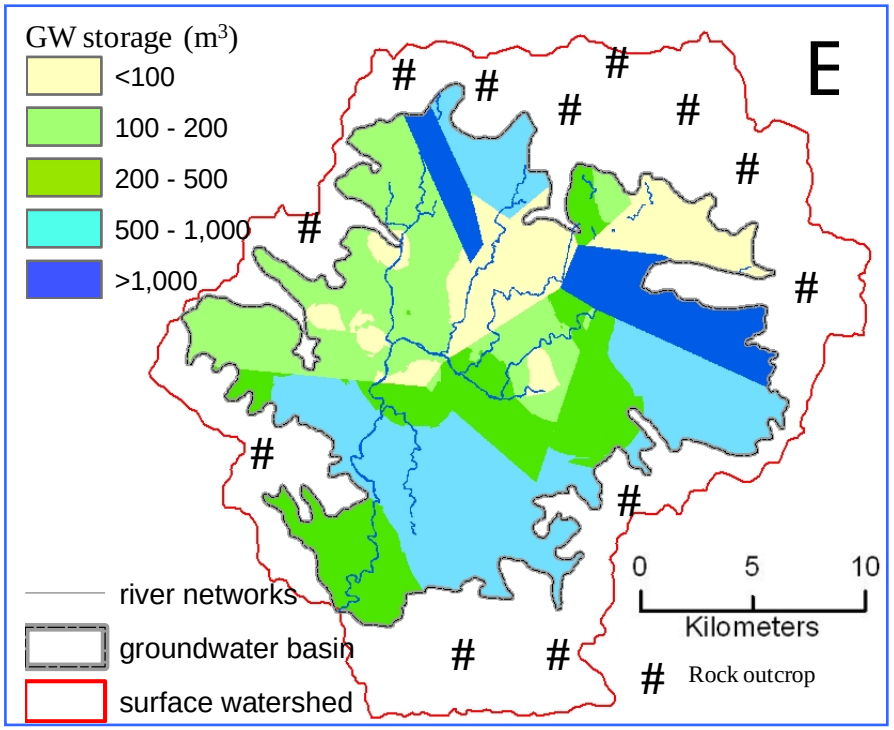
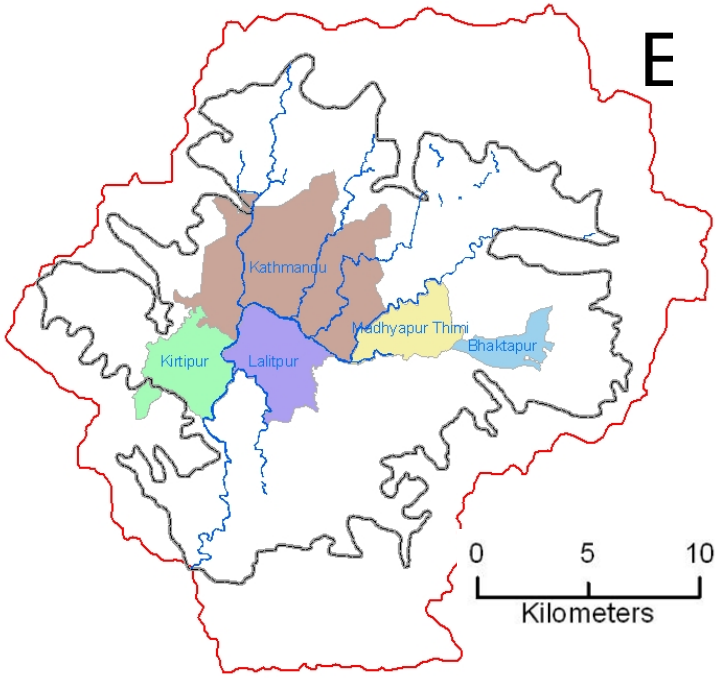


Fig.: Potential GW storage in deep aquifer

- Top of water table : 0.5m below GL
- Potential GW storage (MCM) :SA = 1,452; DA = 572

RESULTS & DISCUSSION (4)



- These scenarios reflect the possible inter-municipality conflict in underground water use in future if the groundwater right is not wisely defined.

Table 4 Groundwater storage potential of municipal areas in the Kathmandu Valley

Municipal name	Area (km^2)	Potential GW storage (MCM)			Pop. (2001)	Pop. density (nos/km^2)	Storage/area (MCM/km^2)	Storage per capita (m^3)
		SA	DA	Total				
Kathmandu	49.9	313.80	31.48	345.28	421,258	8,445.4	6.9	819.6
Lalitpur	15.2	32.27	12.22	44.49	115,865	7,617.7	2.9	384.0
Bhaktapur	6.4	9.44	11.71	21.15	61,405	9,654.9	3.3	344.4
Thimi*	11.2	46.62	6.49	53.11	31,970	2,862.1	4.8	1,661.2
Kirtipur	14.6	0.00	16.71	16.71	31,338	2,145.0	1.1	533.2

** Madhyapur Thimi; Pop. is population, MCM is million cubic meters; GW is groundwater SA and DA are shallow and deep aquifer*

RESULTS & DISCUSSION (5)

Additional GW storage (MCM)

SA = {(GL-0.5) – water level in SA}*S_y*surface area
DA = {(GL-0.5) – water level in DA}*S*surface area
GL is ground level elevation, S is storage coefficient, S_y is specific yield.

Shallow Aquifer

-WL in SA based on WL data in 90 shallow wells ranges from 0.5 to 25.0 mbgl with mean value of 5.2 mbgl (data sources: personal communication with Er. Dhundi R. Pathak)

-Assuming max. possible storage elevation is 0.5 mbgl, mean thickness available for additional storage becomes 4.7 meter

-T = 4.7m, S_y = 0.2, A = 241 km^2; Additional GW storage potential = 226.5 MCM.

Deep Aquifer

-WL in DA based on WL data @ July 2008 in 22 wells range from 5.3 to 98.9 mbgl

-Additional GW storage potential = 8.6 MCM

- Total addition GW storage pot. = 235.1 MCM
- Water demand in KTM = 170 MLD (~ 62 MCM/yr)
- Addition storage can fulfill water demand for 3.8 yrs

RESULTS & DISCUSSION (6)

Parameters	Unit	Shallow aquifer	Deep aquifer
Surface area (A)	km^2	241.0	327.0
Storage coefficient (S)*	-	0.20	0.00023 – 0.07000
Aquifer thickness range	Meter	0.0 – 85.4	25.0 – 284.4
Aquifer volume range	m^3	0.0 – 34,150.0	10,000.0 – 113,773.0
Total aquifer volume	MCM	7,261.27	56,813.70
Potential groundwater storage range	m^3	0.0 – 6,829.8	6.9 – 5,233.5
Total potential groundwater storage	MCM	1,452.25	572.21
Additional groundwater storage potential	MCM	226.5	8.2

** storage coefficient in shallow aquifer is called specific yield (S_y)*

SUMMARY

- This study delineates hydrogeologic units (SA, AT, DA) below the KTM Valley; maps storage coefficient; and calculates GW storage potential
- Thickness of SA range from 0 ~ 85m in SA, AT from 5 ~ 200m, and DA from 25 ~ 200m
- Storage coefficient ranges from 0.00023 ~ 0.070 in DA
- Potential GW storage capacity:
  - SA = 1,452 MCM (range 0 ~ 6,800 MCM)
  - DA = 572.2 MCM (range 0 ~ 5,230 MCM)
- 88.4% of total space is currently filled with GW
- Additional GW storage:
  - SA = 226.5 MCM
  - DA = 8.2 MCM
- If quality of SA can be improved, huge storage capacity of SA may help to buffer the future water demand in the KTM valley

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THANK YOU…

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