

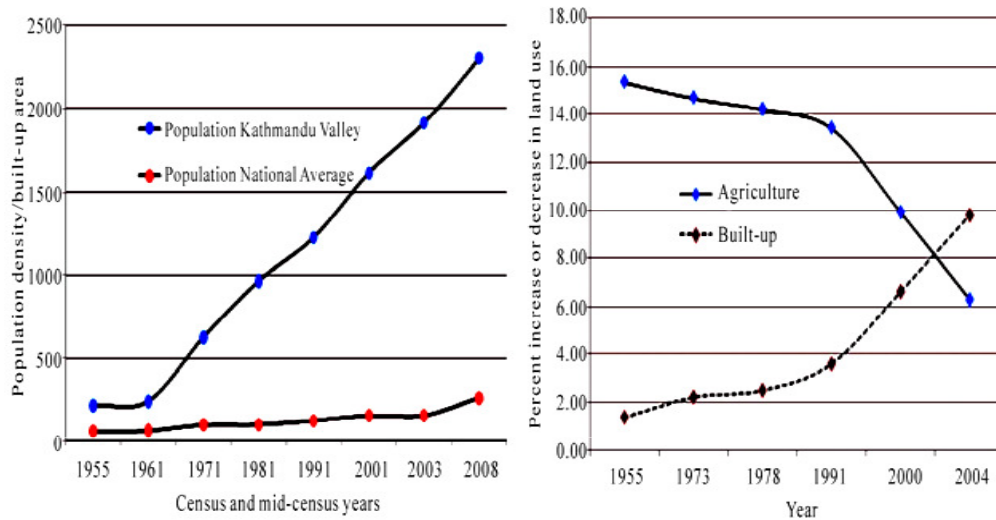
Groundwater Extraction: Implications on Local Water Security of Peri-urban Kathmandu

Anushiya Shrestha¹, Rajesh Sada¹, Kanchan Karki² and Ashutosh Shukla¹

1. Peri-urban Water Security Project, Nepal Engineering College-Center for Postgraduate Studies, Balkhu, Kathmandu, Nepal
2. Southern Illinois University Edwardsville, Illinois, USA

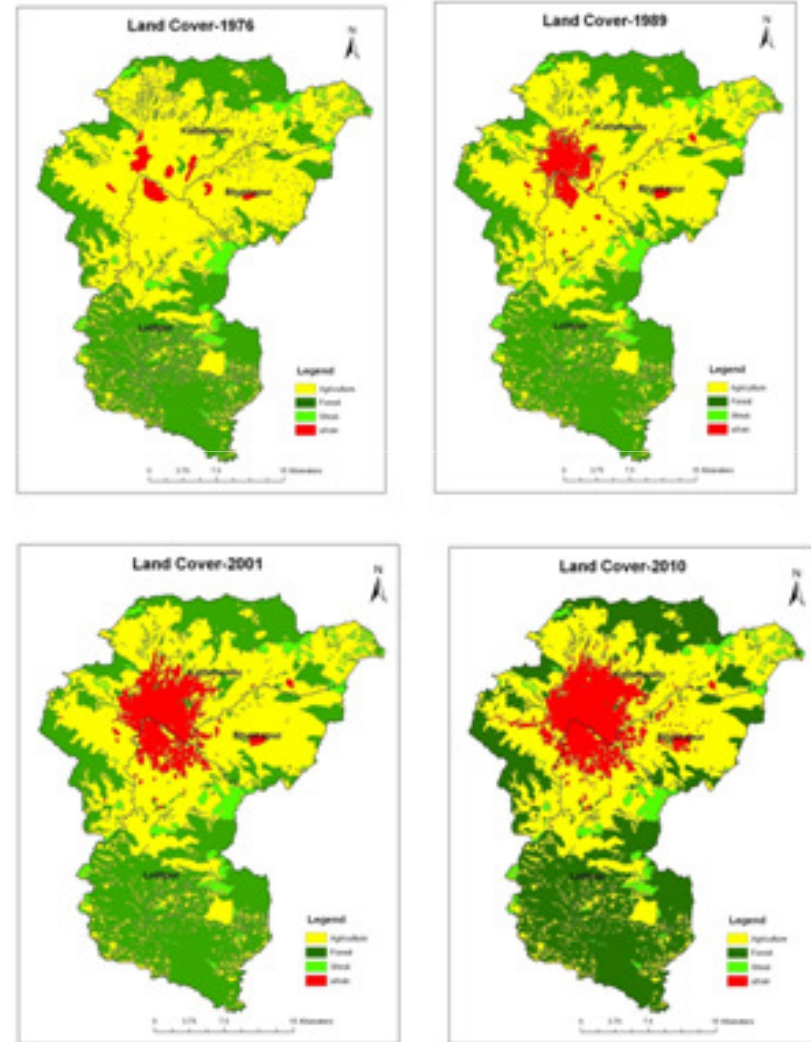


Urbanization in Kathmandu and Emergence of Peri-urban areas



(Source: Bhattarai and Conway 2010)

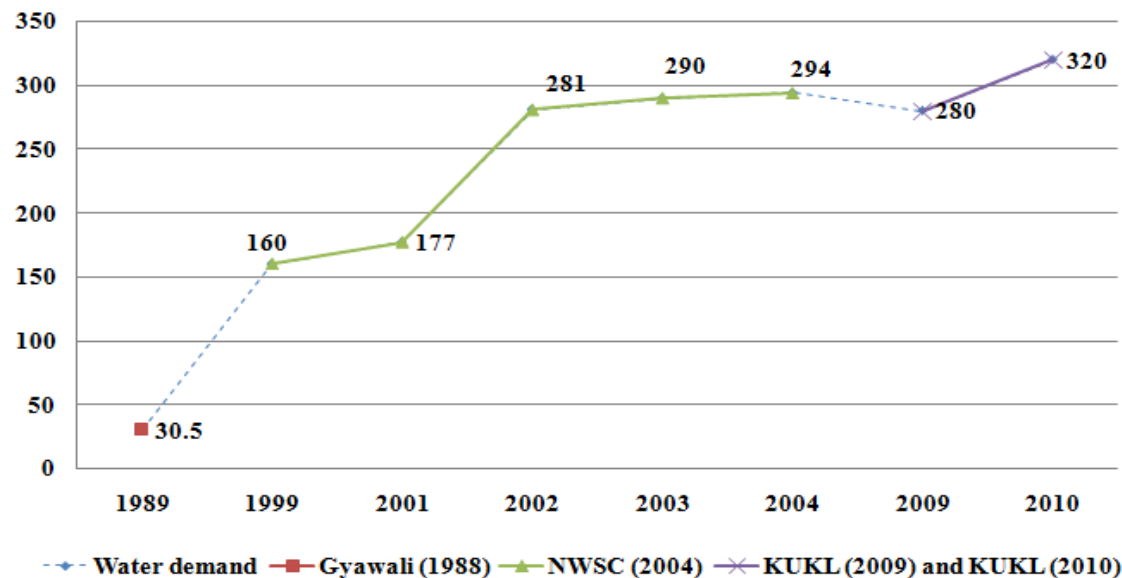
- Increased from 1.6 Million in 2001 to 2.51 Million in 2010 (CBS, 2012)
- Built-up area expanded from 3,330 ha in 1955 to 16,472 ha in 2000 (Pradhan and Parera, 2005)



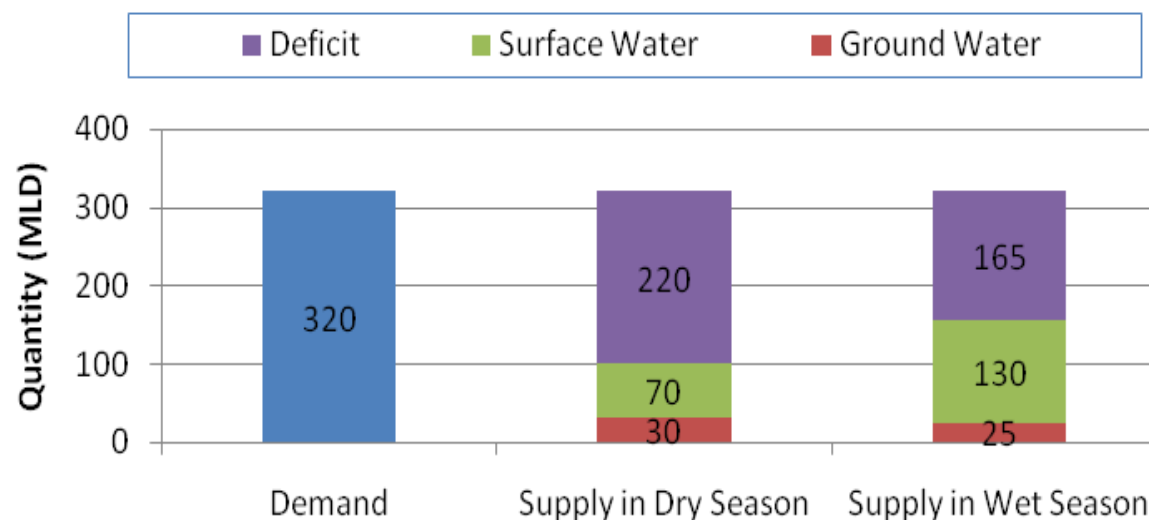
Water Demand & Supply in Kathmandu Valley

- Increasing demand supply gap
- Emergence of different modes of water transfer
- Rural and peri-urban to urban water transfer
- More than 90% of the water supplied by tankers is extracted from groundwater resources mostly from the peri-urban areas (Shrestha, 2011)

Water demand of Kathmandu Valley



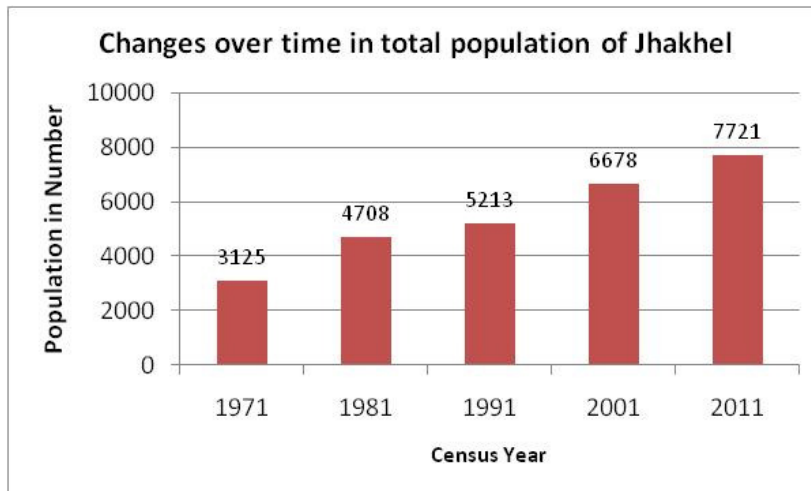
(Shrestha, 2011)



Source: (modified from KUKL, 2010)

Study Area- Jhaukhel VDC

- At the northern flange of Bhaktapur Municipality
- Area- 5.41 sq. km
- Lies in the northern groundwater recharge zone (JICA ,1990).
- Decadal population growth : 1.56%
- Increasing built up area: 435
 - (3.68%) households added



Methods of Study

Qualitative research design

- Direct field observation
- Semi-structured interviews-
 - local residents, government and non-governmental officials, commercial water entrepreneurs and brick kiln operators
- Focus group discussions-
 - understanding the perceptions on positive and negative implications of the increasing competition over the extraction of groundwater resources in terms of local water security
- Review of Secondary sources of data

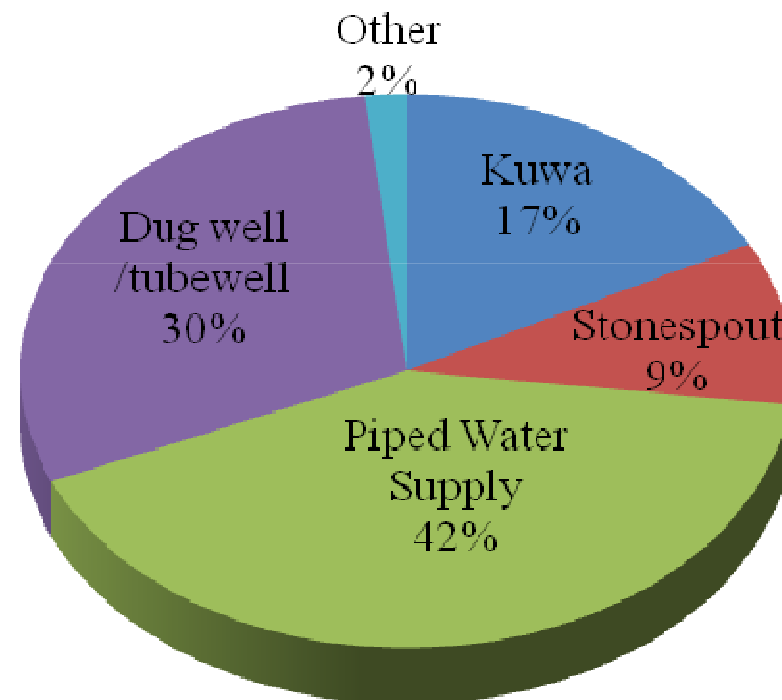
Findings

Groundwater Extraction Modes

Groundwater extraction for local water use

- Majority of the households dependent upon piped water supply connection followed by dugwell/ tubewell, stone spouts and other sources
- Tap water supply **inadequate** to meet the domestic water requirements
- **Alternative water source:** existing community groundwater and private groundwater source

Percentage of Households using Different Sources of Water



(Source: VDC profile, 2006)

S.N	Name of Drinking water users committee	Name of place	Source	Ward No.	Year of construction(B.S.)
1	Changu-Duwakot-Jhaukhel Drinking water users committee	-	Tube well	1-8	2056/57 (1998)
2	Chundevi Drinking water users committee	Kolpakot	Tube well	6	2057/58
3	Aganja Drinking water users committee	Aganja Tol	Tube well	8	2058/59
4	Lakila Drinking water users committee	Lakila	Tube well	9	
5	Dunde Kanla water users committee		Tube well	6	2057/58
6	Dunde Kanla Second water users committee		Tube well	6	2058/59
7	Lamsal Tole water users committee	Lamsal Tole	Tube well	8	2058/59
8	Amar jyoti water users committee		Tube well	7	2063/64
9	Amar jyoti second water users committee	Khatri tole	Tube well	7	2063/64
10	Parighar water users committee	Parighar	Dug well	1	2065/66
11	Dahalgau water users committee	Dahal gau	Tube well	1	2065/66



Community Groundwater Sources

- 70 community groundwater sources
 - 29 springs,
 - 11 stone spouts,
 - 26 dugwells and
 - 4 tubewells.

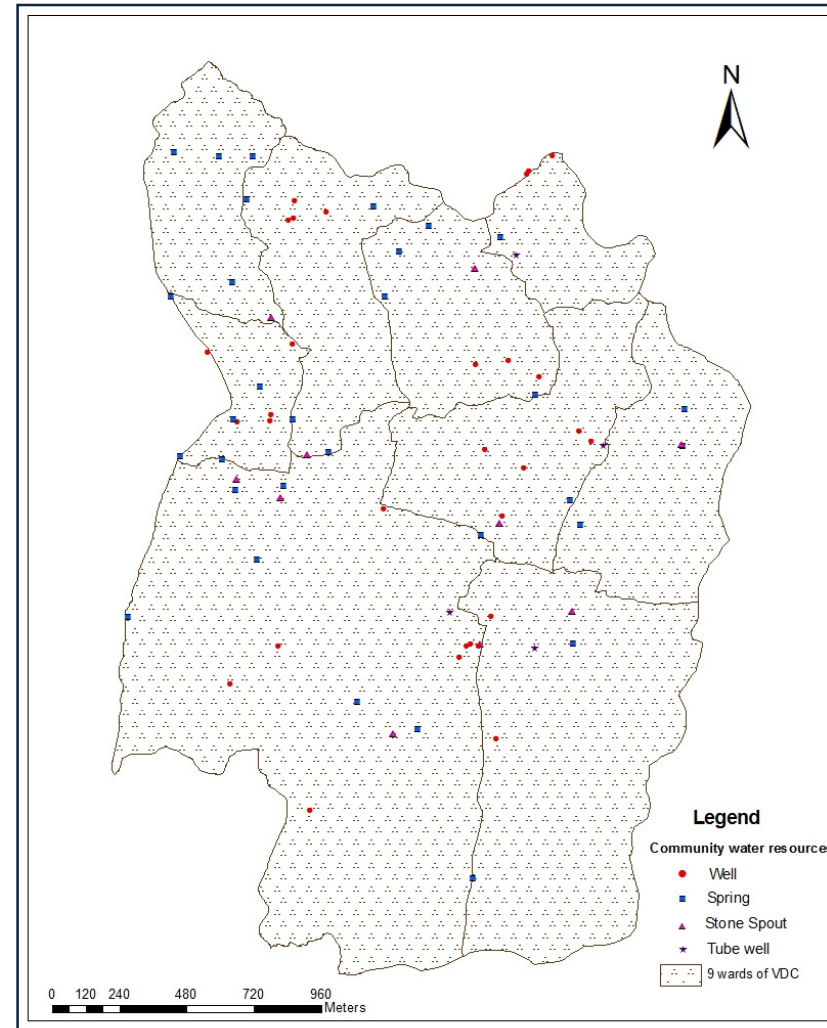


Figure: Spatial distribution of community groundwater sources in Jhaukhel

Source: ENPHO, 2011

Household water source- **Groundwater**

- Piped water supply, Community/ Private groundwater sources
- Increasing private dug wells and tube wells uses for both domestic and irrigation.
- Increasing dependency on groundwater extraction



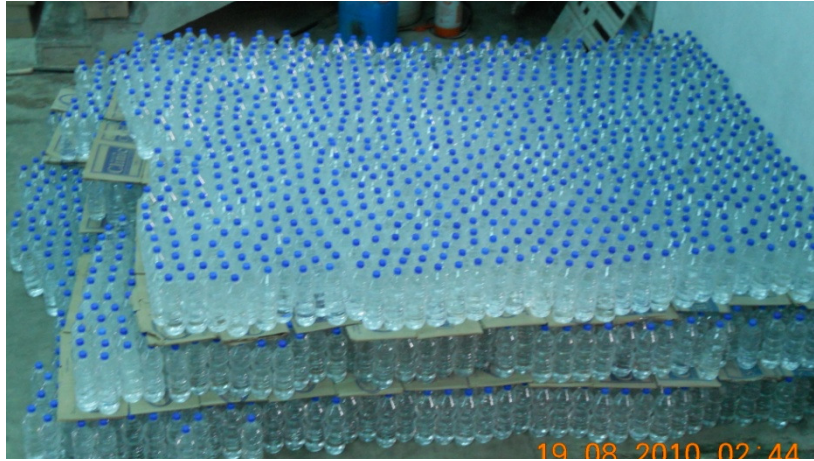
Groundwater Extraction for Brick Production

- **Brick industries** in operation in Jhaukhel **since 1990**
- At present (2012) **12 brick industries**
- **Total Annual** brick production- **31.8 million** (DCSI record)
- Annual average brick production per industry- 7 million (Field study)
- **Total Annual** brick production- (7x12) = **84 million**
- Water requirement per brick production- **0.75 litres**
- Estimated volume of annual groundwater extraction- **23.85 million** litres (DCSI record)
- Estimated volume of annual groundwater extraction - **63 million** litres
- **Total employees engaged in brick industries- 2890** (DCSI record)
- Involvement of employees in brick industries in a year around **7 months**
- Annual average water consumption by the labors- (45x2890x7x30)= **27.3 million litres**

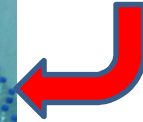
Total annual groundwater extraction for Brick industries- (63+27)= **90 million litres**



Groundwater Extraction for Commercial Purpose



2002

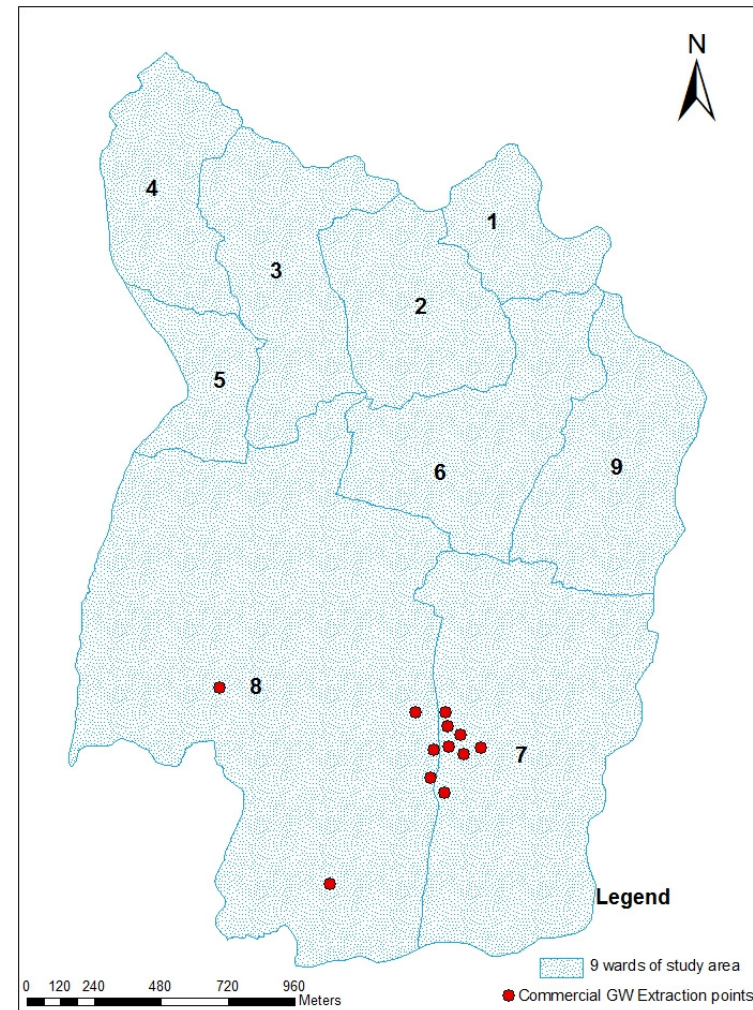


2008



Groundwater Extraction for Commercial Purpose Contd....

- **12 privately owned commercial water extraction points**
- **7** Supply water bottling industries (4 local + 3 outsiders)
- **2** new bottling industries in process of initiation
- Tankers (**5**) and Tractors water vendors
- Tanker operators of 3 different sizes (**1000, 5000 and 7000 litres**)
- Tractor owners- individual owners, transfer water from varying areas based on the convenience of hauling distance



Source: ENPHO, 2011

Groundwater Extraction for Commercial Purpose Contd....

- Groundwater withdrawal for commercial supply from **shallow tube wells** (60 to 120 feet deep).

Water volume	Charge at water extraction points	Charge at Urban water consumers
1000 litres	NPR. 50	NPR. 400
5000 litres	NPR. 150	NPR. 1000
7000 litres	NPR. 200	NPR. 1200

Water market

- Tanker/Tractor water supply- Bhaktapur city
- Bottles or jars- Kathmandu, Bhaktapur and Lalitpur
- **Expanding Water Market areas>> Increasing groundwater extraction**



Groundwater Extraction for Commercial Purpose Contd....

S.N.	Water Product Type	Volume of Groundwater Extracted (litres/day)		
		Monsoon (Asar - Asoj)	Winter (Kartik-Magh)	Summer (Falgun-Jestha)
1	J+B	12,000	12,000	15,000
2	J+B	10,000	10,000	15,000
3	J+B +T	10,000	10,000	70,000
4	J+B +T	20,000	20,000	40,000
5	J+B +T	10,000	10,000	35,000
6	J+B +T	10,000	10,000	50,000
7	J+T	30,000	30,000	60,000
8	T	45,000	45,000	85,000
9	T	10,000	10,000	20,000
10	T	0	0	15,000
11	T	500	500	15,000
12	T	0	0	21,000

Note: J-Jar, B-Bottle, T- Tanker/Tractor

More than **90 million litres** of groundwater extracted at the 12 commercial wells during fiscal year 2010/11.

Terrace Sand mining and Declining Groundwater

- **Terrace sand mining** in Jhaukhel started since 1978

(from ward no 8 for Araniko Highway)

- **Three sand mines** in operation from hillocks in

- Tajale approximately area 26000 sq.m since 2011

- Sundarthali 1400 sq.m from 2012

- Devdole : sand mining in Sarkigaun, a part of mine site in Devdole prohibited by District Development Committee (DDC) since 2009.



Terrace Sand Mining and Declining Groundwater Contd....

- **Sand layers** serves as spongy layer and **helps in recharge of groundwater** through percolation of water through different layers of sand (Nagaraj, 1968).
- **Sand when quarried** check vertical and lateral water movements- **affect groundwater recharge** (Hemalatha *et al.*, 2005).
- **Sand mining adversely impact groundwater recharge** (Rao, 2006; Chandrakanth *et al.*, n.d and Rodrigo n.d).
- Jhaukhel- **Northern groundwater district** of Kathmandu Valley- the most potential groundwater recharge zone.
- **Continued sand mining in the area likely to produce negative consequence on groundwater reserve**
- **Sand demand of Kathmandu valley-** 3100 cu.m per day (Sayami and Tamrakar 2007).
- **Increasing urbanization-** increasing sand demand- **resulting adverse impacts on groundwater of the area.**

Growing Groundwater Extraction: Implications on Local Water Security

S. N	Type of water business	Year of Construction	Initial Depth of Pump (ft bgl)*	Current Depth of Pump (ft bgl)*	Increase in Depth of Pumping (ft)**	Annual Drawdown (ft)**	Average Annual Drawdown (ft)**
1.	Bottling Plant I	2003/04	40	60	20	2.22	3.38
2.	Bottling Plant II	2007/ 08	50	60	10	1.67	
3.	Tanker	2008/09	50	75	25	6.25	

Note: * Feet below ground level ** Feet

- 3 commercial wells **lowered down submersible pumps by 10 to 25 ft**
- Lowering of the water table, an increasing concern for Jhaukhel residents

Growing Groundwater Extraction: Implications on Local Water Security Contd....

- "**Khujocha Hiti**, a traditional stone spout in ward no. 8 was a reliable source for domestic and irrigation purposes
- Served large number of households from Bhaktapur Municipality
- Disappeared in late 1980s due to mining the sand required for construction of Araniko Highway
- Stone spout in **Nabala** area- reliable source of irrigation for the farms located at Lukhondole area.
- Progressive decrease in yield of Nabala spring.
- 95% decline during dry season since 2010.



Monsoon Season



Dry Season

Growing Groundwater Extraction: Implications on Local Water Security Contd.....

- A spring in ward no. 7
- Located between the commercial extraction points in the upland area and number of brick kilns in the low land
- Serving domestic water needs of 20 households
- Dried 3-4 years ago



A dead spring in ward no. 7.

- Local community previously dependent on the spring source; compelled to depend upon a groundwater source of neighbors water supply.
- **Unsatisfied with the quality of water but have no option for their daily water requirements.**

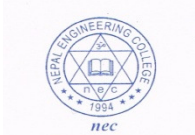
Growing Groundwater Extraction: Implications on Local Water Security contd....

- Local people anticipate acute water shortage in Jhaukhel
- Limited influential groups relish the advantage of massive groundwater extraction
- Declining groundwater- **Increasing needs of deepening of the wells and bores and drying of sources.**
- **Those capable adopt by deepening** the wells and bores in commercial wells.

BUT

Major victims become the poor; not capable to afford deepening of their wells, unsatisfied water quality but no alternative

- Additional threat of **land subsidence**
- **Excessive groundwater extraction,** causes drawdown of water table in the aquifer, the **most important mechanism causing land subsidence** (Chai *et al.*, 2004).



Regulatory Attempts

- **Local opposition against massive groundwater extraction increasing**
- Jhaukhel VDC office stepped forward to regulate the commercial water extraction.
- **Licensing-** legalization mechanism for the bottling industries
- Water bottling industries in Jhaukhel registered
 - under the **Department of Cottage and Small Industries** under Industrial Enterprises Act, 1992 A.D
 - in the **Company Registration Office** under the Company Act, 2006 A.D, Department of Food Research Laboratories, Internal Revenue Department and Chamber of Commerce and Industries.
- **Fee charged by local VDC office-**
 - Initial registration NPR. 6,500
 - Annual Renewal fee: 33% of the initial registration cost (**VDC not being able to collect**)
- **No restriction upon the volume of groundwater extraction**



- No regulatory norms for tractor and tanker water supply in Jhaukhel.
- Charged only the road tax upon plying along the road, ranges from NPR. 25 to NPR. 80/trip.

Taxation mechanism:

VDC annually calls tender; tax collection contract awarded to the highest bidder.

Regulatory Interventions

limited as a source of revenue for the VDC



NO CONCERN ON THE VOLUME OF GROUNDWATER EXPORTED AND POSSIBLE CONSEQUENCE ON THE LOCAL ENVIRONMENT

- Local people demanding immediate regulation of the commercial water extraction,
- VDC issued a public notice on prohibiting private water tankers declaring it as an illegal activity, **poor implementation**

Regulatory Gaps

- **Brick industries-** registered in the **Department of Cottage and Small Industries**
- **No regulatory authority with VDC office**
- **Sand mining** monitored by **Bhaktapur DDC**
- **Limited Institutional capacity**
- Involvement of influential groups- **Extraction activities expanding rampantly**
- Local opposition against the unregulated extraction of natural resources growing
- **No any concrete monitoring and regulatory mechanisms** by local government
- Existing regulatory mechanism and its implementation- weak
- Doubt on the efforts and hence effectiveness of regulatory actions.

Conclusion

- Water security at Jhaukhel closely associated with groundwater
- Limited influential groups relishing the advantage from resource extraction
- Lowering of the groundwater table and drying of water sources
- Groundwater extraction beyond the sustainable withdrawal rate
- Stresses on local hydrology and local water insecurity increasing
- Local peoples' awareness and opposition increasing
- Weak regulatory mechanism
- Need of redefining the legal and institutional framework addressing the groundwater management in the area.



Acknowledgement

Water Security in Peri-urban South Asia: Adapting to Climate Change and Urbanization

Action research implemented in peri-urban areas of Kathmandu Valley by **Nepal Engineering College**

in coordination with

South Asia Consortium for Interdisciplinary Water Resource Studies (SaciWATERs)

with financial support of

International Development Research Centre (IDRC), Canada.



THANK YOU