Groundwater And Groundwater Depletion in Kathmandu Valley

Sudeep Pokhrel
Institute of Engineering
Department of Water Resource Engineering

Introduction

• Kathmandu nestles capital of Nepal, located in central part of Nepal.
• Upstream of Bagmati River Basin, stressful basin in terms of fresh water.
• Home for about 2.5 million people, with increase rate of 5% per annum (world bank report).
Introduction

• Heavy exploitation of groundwater resources.

• Acute water shortage, about 40% of demand is supplied by KUKL.

• Extraction of Ground water has increased (in dry season (60-70)% of total supply and 50% in wet season)

ICIMOD 2007

Introduction

• No one knows for sure, the current exact figures...

• (how much water is being extracted, how quickly the GW is falling......)
Groundwater Aquifer

• Divided into three districts:
  • Northern Groundwater District (NGD)
  • Central Groundwater District (CGD)
  • Southern Groundwater District (SGD)

Figure 1. Kathmandu Valley in central Nepal (data sources: surface watershed boundary, groundwater basin boundary and recharge areas from JICA (1996); river networks from NGGP (2004); well locations from AIC International (2004) database). Green dots are location of wells shown in Table 2 and Table 3.
Northern Groundwater District

• In northern part of the valley
• Encompassing an area of 156 km² with 59 km² of recharge area
• Contains coarse sediment (thickness 60m), main aquifer that supplies GW
• High GW production potential
Central Groundwater District

- Consists of very thick impermeable (about 200m) black clay

- Unconsolidated coarse sediments of low permeability underlie this black clay and form aquifer unit.

Continued

- Total area of 114 km$^2$
- Presence of methane gas indicates non-recharge or limited recharge, stagnant fossil GW
- Water contains high quantity of ammonia and nitrogen, used only for sanitary proposes (JICA 1990)
Southern Groundwater District

- The aquifer is not well developed
- Characterized by a basal gravel, covered by a thick impermeable clay formation.
- The total area of this district is only 56 km$^2$.

Depletion Of Groundwater

- Causes:
  - Rapid urbanization
  - Mushroomed increment in the build up area,
  - Over-exploitation of surface and groundwater
  - Removal of vegetation cover
continued

• Change in land use pattern
• Formation of impervious surface, lowering of groundwater table

• Huge and haphazard consumption, water has been pumped continuously surpassing natural recharge.

Continued

• Limiting GW abstraction 40.1 MLD but abstraction is nearly 60 MLD (JICA 2010)

• But exact number of the tube wells in Kathmandu is difficult to depict due to poor management and knowledge.
### Table 1. Average static groundwater table depth (m) in Kathmandu valley.

<table>
<thead>
<tr>
<th>Observation site</th>
<th>Groundwater District</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banburi</td>
<td>NGD</td>
<td>74.66</td>
<td>78.38</td>
<td>83.13</td>
<td>85.77</td>
<td>82.50</td>
<td></td>
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<tr>
<td>Ganga</td>
<td>NGD</td>
<td>20.99</td>
<td>24.98</td>
<td>27.44</td>
<td>29.33</td>
<td>30.64</td>
<td>29.27</td>
</tr>
<tr>
<td>Kapan</td>
<td>NGD</td>
<td>-</td>
<td>2.53</td>
<td>2.51</td>
<td>2.64</td>
<td>3.14</td>
<td>3.35</td>
</tr>
<tr>
<td>Phatang</td>
<td>NGD</td>
<td>-</td>
<td>12.70</td>
<td>13.09</td>
<td>13.15</td>
<td>14.11</td>
<td>14.70</td>
</tr>
<tr>
<td>Mahankal</td>
<td>NGD</td>
<td>29.83</td>
<td>30.33</td>
<td>29.42</td>
<td>30.27</td>
<td>31.95</td>
<td>31.85</td>
</tr>
<tr>
<td>Nayapati-6</td>
<td>NGD</td>
<td>13.38</td>
<td>19.30</td>
<td>20.32</td>
<td>22.71</td>
<td>22.43</td>
<td>23.73</td>
</tr>
<tr>
<td>Nayapati-2</td>
<td>NGD</td>
<td>24.95</td>
<td>26.42</td>
<td>27.62</td>
<td>25.82</td>
<td>24.80</td>
<td>20.33</td>
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<tr>
<td>Bhikapur</td>
<td>NGD</td>
<td>38.07</td>
<td>38.90</td>
<td>40.43</td>
<td>41.78</td>
<td>42.68</td>
<td>45.21</td>
</tr>
<tr>
<td>Duskot</td>
<td>NGD</td>
<td>-</td>
<td>92.50</td>
<td>92.01</td>
<td>92.85</td>
<td>93.76</td>
<td>95.23</td>
</tr>
<tr>
<td>Malpa-1</td>
<td>NGD</td>
<td>-</td>
<td>33.30</td>
<td>32.01</td>
<td>32.02</td>
<td>33.54</td>
<td>36.33</td>
</tr>
<tr>
<td>Malpa-2</td>
<td>NGD</td>
<td>-</td>
<td>33.10</td>
<td>31.75</td>
<td>33.79</td>
<td>34.31</td>
<td>35.24</td>
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<tr>
<td>Malpa-3</td>
<td>NGD</td>
<td>-</td>
<td>31.40</td>
<td>30.81</td>
<td>32.01</td>
<td>34.25</td>
<td>34.14</td>
</tr>
<tr>
<td>Bakko-1</td>
<td>CGD</td>
<td>8.98</td>
<td>3.42</td>
<td>4.40</td>
<td>7.04</td>
<td>8.80</td>
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<tr>
<td>Bakko-2</td>
<td>CGD</td>
<td>15.08</td>
<td>13.74</td>
<td>14.87</td>
<td>15.37</td>
<td>18.26</td>
<td>19.11</td>
</tr>
</tbody>
</table>

*Gautam and Prajapati (2014)*

### Table 5. Aquifer depletion at selected locations during the dry season (data source: water level monitoring data from Groundwater Research and Development Project/Department of Irrigation, Kathmandu, Nepal)

<table>
<thead>
<tr>
<th>Location</th>
<th>WID</th>
<th>Previous water level (mbgl)</th>
<th>Current water level (mbgl)</th>
<th>Decline (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Base year SWL</td>
<td>Current year SWL</td>
<td></td>
</tr>
<tr>
<td>Banburi WF</td>
<td>B1-1a</td>
<td>2000 5.27</td>
<td>2008 10.85</td>
<td>5.58</td>
</tr>
<tr>
<td></td>
<td>M8</td>
<td>2003 12.75</td>
<td>2008 14.52</td>
<td>1.77</td>
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<tr>
<td>Gokarna WF</td>
<td>GK3-2a</td>
<td>1999 16.41</td>
<td>2008 23.91</td>
<td>7.50</td>
</tr>
<tr>
<td></td>
<td>GK4</td>
<td>2000 16.60</td>
<td>2008 20.18</td>
<td>3.58</td>
</tr>
<tr>
<td>Dhoi Khola WF</td>
<td>DK1</td>
<td>1999 20.90</td>
<td>2008 30.73</td>
<td>1.83</td>
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<td></td>
<td>DK3</td>
<td>2003 3.89</td>
<td>2008 5.27</td>
<td>1.38</td>
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<tr>
<td>Manohara Bhaktapur/Boke WF</td>
<td>BHEK-1</td>
<td>1999 37.68</td>
<td>2006 42.00</td>
<td>4.22</td>
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<tr>
<td></td>
<td>M5</td>
<td>2003 93.33</td>
<td>2008 98.87</td>
<td>5.54</td>
</tr>
<tr>
<td>Pharping WF</td>
<td>M3</td>
<td>2003 8.48</td>
<td>2008 8.85</td>
<td>0.37</td>
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<tr>
<td>Central area</td>
<td>E26</td>
<td>2000 7.37</td>
<td>2008 13.08</td>
<td>5.71</td>
</tr>
<tr>
<td></td>
<td>G17</td>
<td>2000 10.68</td>
<td>2008 11.68</td>
<td>1.00</td>
</tr>
</tbody>
</table>

SWL: Static water level, WID: well identification number, WF: well-field, mbgl: meter below the ground level
Groundwater Management

- Generate and collect quality information on GW potential, recharge potential
- Carryout necessary recharge and hydrogeology
- Provision of alternative source of water supply
- Prevent pollution at source, monitor and preserve water quality
Recharge tool for GW management

- Valley receives about 1.165 billion cubic meters of rain per year
- 80% of this amount comes in 4 months
- Only about 6.6% of it is retained as GW.
- If additional 6% is retained, demand of drinking water in the valley can be fulfilled (KUKL).

Recharge tool for GW management

- North Zone is potential for GW recharge.
- Other pockets may be potential.
- Such potential areas must be identified through research
Article by journalist Ramesh Bhushal

Putting his hands on his forehead, 70-year-old Sadhu Bhai Maharjan explained how he and his friends used to swim in the Bagmati River, a few minutes walk from his home in Kalimati, at the centre of the Kathmandu valley. The valley has witnessed rapid urbanization in the last few decades and Maharjan is among the few people still engaged in agriculture for their livelihood in the core of Nepal’s capital.

Clipping small bundles of vegetables, he said: “Now people don’t believe us, but we used to swim in the river flowing nearby a few decades back and enjoyed fishing. The water was used for drinking too.” These days, almost all rivers of the valley, including Bagmati – the holiest of them – are as good as dead.