Solid Waste Management Research in SNPBZ and its Outcomes

Sanjay N. Khanal

Kathmandu University
Dhulikhel
Location:
27°45′19″-28°07′41″N
86°28′19″-87°07′41″E

Area covered:
SNP-1148km²
BZ – 287.04 km²

Elevation ranges-2800m – 8848m

Park declared: 1979
UNESCO World Heritage Site: 1981
Background

• Solid Waste Management (SWM) is considered as the most prominent environmental concern and key management issue

• The HKKH Partnership Project through EV-K2-CNR has entrusted KU to conduct a baseline solid waste research in SNPBZ to develop a model within a Decision Support System that allows to evaluate different solid waste management options and scenarios so that an appropriate decision could be made
Present scenario of Solid Waste Management in SNPBZ

- **SPCC**
  - Door to door collection in Lukla and Namche
  - Pit construction and management
  - Rubbish bin installation
  - Garbage collection from the NMA permit peaks

- **Personally managed**
  - Cattle feeding
  - Collection of waste up to pit
  - Reuse of glass bottle
  - Recycle of Aluminum can
Objectives

To improve the current Solid Waste Management System to achieve sustainable mountain ecosystem management
Simile model
Methodology

Questionnaire Sampling Methods
- Simple random stratified sampling
- The samples were divided into four groups:
  (1) Business that includes: lodges/hotels and business (Bakery, Restaurant, Shop)
  (2) Institutions: Bank, School, Post office
  (3) Residential
  (4) Hospital was kept separately because it contains hazardous and infectious waste
7-days Waste Quantification

Sites: Lodge, house, school, office

Lodges were classified into three categories:
1) Large  2) Medium  3) Small

Waste types:
1) Plastic  2) Glass  3) Metal
4) Other (Kitchen Waste, paper, Dust, Others)

1-Day Waste Quantification

- During the questionnaire survey of lodges and houses
<table>
<thead>
<tr>
<th>S.N.</th>
<th>Location</th>
<th>Quantification</th>
<th>Questionnaire</th>
<th>Water</th>
<th>Air</th>
<th>Soil</th>
<th>Dumping pits No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 days</td>
<td>1 day</td>
<td>2007</td>
<td>2008</td>
<td>Open</td>
<td>Closed</td>
</tr>
<tr>
<td>1</td>
<td>Lukla</td>
<td>35</td>
<td></td>
<td>16</td>
<td>16</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Phakding</td>
<td>16</td>
<td></td>
<td>9</td>
<td>9</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Chaumoa</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Monju</td>
<td>5</td>
<td></td>
<td>5</td>
<td>5</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Jorsalle</td>
<td>1</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Tok Tok</td>
<td>2</td>
<td></td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Namche Bazar</td>
<td>35</td>
<td>26</td>
<td>18</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

**Total 35 Settlements**
Water/Soil/Air samples from different sites were collected and analyzed

Collection of information on dumping sites
Kathmandu University’s Activities

**September 2007 Field Visit**
- Questionnaire
  Lukla – Chhukung
  (25 settlements)
- 7 days waste quantification at Namche
- Air, water and soil sampling in Namche Bazar
- Collection of dumping sites information

**May 2008 Field Visit**
- Questionnaire
  Lukla – Everest Base Camp and Gokyo (32 settlements)
- 7 days waste quantification at Lukla and Phakding
- Air, water and soil sampling at Lukla and Namche Bazar
- Collection of dumping sites information
Results

* Waste generated in SNPBZ: 787 kg/day
* Waste generated in SNPBZ: 0.43 kg/day/person
* Waste composition:
  Plastic: 7%
  Glass: 2%
  Metal: 2%
  Other: 89% (Kitchen: 79%, Paper 9%, Other: 1%)
Results

* All kitchen wastes are used for cattle feeding or composting

* Plastic, glass and metal are of major concern in SWM

* Reasonably good waste collection system in SNPBZ
  
  However, additional technical inputs are needed for effective handling, proper segregation and treatment of the waste
### Results of soil quality test

<table>
<thead>
<tr>
<th>Location</th>
<th>Cu (ppm)</th>
<th>Zn (ppm)</th>
<th>Cd (ppm)</th>
<th>Ni (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lukla Dumping Pit</td>
<td>0.7948</td>
<td>18.144</td>
<td>0.073</td>
<td>9.058</td>
</tr>
<tr>
<td>Lukla Dumping Pit down</td>
<td>0.36</td>
<td>3.42</td>
<td>0.036</td>
<td>0.317</td>
</tr>
<tr>
<td>Lukla Incinerator</td>
<td>1.5416</td>
<td>262.703</td>
<td>0.085</td>
<td>0.555</td>
</tr>
<tr>
<td>Lukla near river bank</td>
<td>0.0674</td>
<td>63.063</td>
<td>0.128</td>
<td>0.313</td>
</tr>
<tr>
<td>Namche burning place</td>
<td>5.4378</td>
<td>153.784</td>
<td>1.268</td>
<td>0.549</td>
</tr>
<tr>
<td>Mislung</td>
<td>0.127</td>
<td>39.573</td>
<td>0.086</td>
<td>0.508</td>
</tr>
<tr>
<td>Monju</td>
<td>0.2886</td>
<td>68.813</td>
<td>0.097</td>
<td>0.994</td>
</tr>
<tr>
<td>Gorakhshep</td>
<td>0.0476</td>
<td>0.614</td>
<td>0.023</td>
<td>0.155</td>
</tr>
<tr>
<td>Gorakhshep pit local</td>
<td>0.0756</td>
<td>0.319</td>
<td>0.012</td>
<td>0.098</td>
</tr>
<tr>
<td>Tyangboche</td>
<td>0.007</td>
<td>0.719</td>
<td>0.006</td>
<td>0.271</td>
</tr>
</tbody>
</table>

0.1-2.5  0.2-2.0  20.0  3-1000
### Results of soil quality test

<table>
<thead>
<tr>
<th>Settlement</th>
<th>Cu (ppm)</th>
<th>Zn (ppm)</th>
<th>Cd (ppm)</th>
<th>Ni (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dingboche (lower pit)</td>
<td>0.064</td>
<td>1.151</td>
<td>0.024</td>
<td>0.351</td>
</tr>
<tr>
<td>Dingboche (Upper pit)</td>
<td>0.033</td>
<td>1.358</td>
<td>0.016</td>
<td>0.193</td>
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<tr>
<td>Lobuche</td>
<td>0.0502</td>
<td>4.491</td>
<td>0.025</td>
<td>0.438</td>
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<tr>
<td>Pangboche</td>
<td>0.058</td>
<td>2.867</td>
<td>0.023</td>
<td>0.233</td>
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<tr>
<td>Pheriche 1</td>
<td>0.0176</td>
<td>1.837</td>
<td>&lt;0.003</td>
<td>0.123</td>
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<td>Pheriche 2</td>
<td>0.0038</td>
<td>0.716</td>
<td>0.008</td>
<td>0.336</td>
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<tr>
<td>Thame dumping pit</td>
<td>0.0128</td>
<td>0.648</td>
<td>&lt;0.003</td>
<td>0.202</td>
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<tr>
<td>Khumjung dumping pit</td>
<td>0.0694</td>
<td>1.231</td>
<td>&lt;0.003</td>
<td>0.137</td>
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<tr>
<td>Mochharmo</td>
<td>0.0548</td>
<td>0.412</td>
<td>&lt;0.003</td>
<td>&lt;0.02</td>
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<tr>
<td>Pangboche upper</td>
<td>0.0716</td>
<td>1.164</td>
<td>0.004</td>
<td>0.342</td>
</tr>
<tr>
<td>Phortse</td>
<td>0.0794</td>
<td>4.049</td>
<td>0.008</td>
<td>0.255</td>
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<tr>
<td>Gokyo dumping pit</td>
<td>0.0224</td>
<td>3.267</td>
<td>0.014</td>
<td>&lt;0.02</td>
</tr>
</tbody>
</table>

**Range:**  0.1-2.5  0.2-2.0  20.0  3-1000
## Result of water quality analysis during field visit 2008

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Settlement</th>
<th>Location</th>
<th>Lead mg/l</th>
<th>Nickel mg/L</th>
<th>Iron mg/L</th>
<th>Zink mg/L</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Lukla</td>
<td>Dumping pit near Hospital (Ghatte Khola)</td>
<td>0.251</td>
<td>0.016</td>
<td>0.605</td>
<td>0.105</td>
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<tr>
<td>2</td>
<td>Lukla</td>
<td>10 m below dumping pit</td>
<td>0.344</td>
<td>0.028</td>
<td>0.327</td>
<td>0.12</td>
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<tr>
<td>3</td>
<td>Namche</td>
<td>Mislung</td>
<td>0.151</td>
<td>0.014</td>
<td>0.339</td>
<td>0.06</td>
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<td>4</td>
<td>Dole</td>
<td></td>
<td>0.098</td>
<td>0.01</td>
<td>0.216</td>
<td>0.031</td>
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<td>5</td>
<td>Machherma</td>
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<td>0.074</td>
<td>0.016</td>
<td>0.409</td>
<td>0.014</td>
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<td>6</td>
<td>EBC</td>
<td></td>
<td>0.068</td>
<td>0.022</td>
<td>5.075</td>
<td>0.054</td>
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<td>7</td>
<td>Dingboche</td>
<td></td>
<td>0.177</td>
<td>0.013</td>
<td>6.043</td>
<td>0.044</td>
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<tr>
<td>8</td>
<td>Pheriche</td>
<td></td>
<td>0.065</td>
<td>0.01</td>
<td>1.647</td>
<td>0.055</td>
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<tr>
<td>9</td>
<td>Lobuche</td>
<td></td>
<td>0.092</td>
<td>0.018</td>
<td>5.15</td>
<td>0.037</td>
</tr>
<tr>
<td>10</td>
<td>EBC</td>
<td></td>
<td>0.091</td>
<td>0.016</td>
<td>8.922</td>
<td>0.046</td>
</tr>
<tr>
<td>11</td>
<td>Gorakshep lake</td>
<td></td>
<td>0.128</td>
<td>0.016</td>
<td>14.431</td>
<td>0.046</td>
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<tr>
<td></td>
<td>NDWQS</td>
<td></td>
<td>0.01</td>
<td>0.3-3.0</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**NDWQS**: National Drinking Water Quality Standard (2062)
Concentration of PM10 at selected point at Lukla and Namche
Some recommendations of Management Levers

1. Reduction of waste production
   - ban on plastic bag and beer bottles
   - imposition of heavy taxation on plastic, glass, metal
   - Provision of improved water quality in SNPBZ

2. Capacity building: training
   - Training to waste handlers, NGO and other related groups
   - Awareness Workshops for different Stakeholders

3. Capacity building: equipment for collection and transportation
   - Support on equipment; Human Resource
Management Levers

4. New technologies: Installation and operation of incinerators
   - The incinerator with capacity 100 kg/hr should be installed at Namche
   - Lukla incinerator should be replaced with capacity 100 kg/hr

5. New technologies: Sanitary lands fills
   - Sanitary land fills should be use for dumping waste
Management Levers

6. Increase waste export (transported outside)
   - Should increase exporting metals
   - Plastic should also be exported outside

7. Recycling plant for plastic bottles
   - Reuse of bottles
   - Export outside after crushing/compacting

8. Efficiency of waste segregation
   - proper awareness and demonstrations to locals about the waste segregation
   - Subsidies to households
Management Levers

9. Effectiveness of solid waste collection
   - Adequate human resource and equipment are necessary to SPCC and local groups could be trained and facilitated

10. Solid waste monitoring system
    - Monitoring of composition and quantities
    - Environmental qualities (emission and leachate)
    - Different treatment proportion and quantities
Summary

Solid waste collection system in SNPBZ is good

Additional technical inputs are needed for effective handling and, proper segregation and treatment of the waste

Recommended management lever options for betterment of the system designed to reduce production of solid waste, recycling waste, enhance capacity of waste handlers, installation of incinerator and sanitary landfill sites must be implemented