EFFECTS OF CLIMATE CHANGE ON PLANNING AND MANAGING WATER SERVICES IN THE POTOHAR REGION OF PAKISTAN

Lt Col Islam-ul-Haque, TI(M) Retd
Managing Director
Water and Sanitation Agency
Rawalpindi, Pakistan
INTRODUCTION

- Sixty-seven percent of world’s glaciers are retreating at a startling rate in the Himalayas.
- Major causal factor has been identified as climate change (Ageta and Kadota, 1992; Yamada et al., 1996; Fushinmi, 2000).
- Glacial melt will affect freshwater flows with dramatic adverse effects on biodiversity and livelihood, with possible long-term implications on regional food security.
- Over the past 200 years, emissions of greenhouse gases due to human activities have accumulated in the atmosphere.
- As a result, since the Industrial Revolution, concentrations of carbon dioxide have increased by 30 per cent, methane by 145 per cent and nitrous oxide by 15 per cent.
- The Himalayas have the largest concentration of glaciers outside the polar caps. With glaciers coverage of 33,000 km2, the region is aptly called the “Water Tower of Asia” as it provides around 8.6X106 m3 of water annually (Dyurgerov and Maier, 1997).
- These Himalayan glaciers feed seven of Asia’s great rivers: the Ganga, Indus, Bhrhmaputra, Salween, Mekong, Yangtze and Huang Ho which ensure continuous water supply to the millions of people, the snow covered ranges of siachen and Baltoro glaciers;
Sources of Water - Siachen and Baltoro glaciers

The beautiful coincidence point of Siachen and Baltoro glaciers (75 km & 64 km respectively) having 60 peaks (above 7000 meters).
Climate Variation in Pakistan

- Pakistan is a developing country whose economy mainly depends on agriculture which is more susceptible to the effects of climate changes.
- Due to lack of modern technical resources, Pakistan does not have adequate monitoring systems for the prediction of likelihood of occurrence of extreme events.
- Therefore, the assessment of possible changes in weather patterns, thus making the task extremely difficult to develop short term response or disaster mitigation strategies.
- There are several aspects that are circumstantial to the effects of climate change.
- In a country such as Pakistan, the pressures generated as a directly result of climate change impact multiple sectors including water, agriculture, forests, biodiversity, livestock, costal zones, etc.
Potohar Region

Location of Rawalpindi and Islamabad in Potohar Region
Purpose of the study

• The task of a scientifically sound basis for impact assessment and vulnerability assessments becomes all the more daunting due to the problems in the acquisition of scientific knowledge and the problems associated with the availability, accuracy and reliability of data in the country (Pakistan).
• Furthermore, the difficulties of differentiating between impacts caused naturally as a process of climate change from the ones emanating as a result of human induced activities poses additional difficulties in framing the appropriate policy responses.
• Keeping in view the meager technological and scientific resources the objectives of this study are;
  – To assess the affects of climate change on the available water resources in the Potohar Region of Pakistan
  – To assess the climate change variability impacts on the micro management of surface water sources being used by Water and Sanitation Agency Rawalpindi (WASA)-Pakistan
Temperature variation

- There has been a considerable temperature variation all over the country especially in the Northern Punjab and Potohar region, resulting in creating favorable conditions for the extreme weather patterns.
- The increased temperature pattern being experienced can be compared with global temperatures, (from 1860 – 2000) which is showing the same pattern as observed in Pakistan in the recent years.
Temperature variation

The annual Mean Temperature Change in Pakistan
Source: Metrological Department of Pakistan

Global Temperature Variation from 1860 - 2000
Source: Wikipedia, the free encyclopedia
## Change in precipitation pattern

### Annual Rainfall (mm)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>MURREE</th>
<th>ISLAMABAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>1702.9</td>
<td>1615.2</td>
</tr>
<tr>
<td>1996</td>
<td>2192.0</td>
<td>1376.1</td>
</tr>
<tr>
<td>1997</td>
<td>2307.0</td>
<td>1413.8</td>
</tr>
<tr>
<td>1998</td>
<td>1972.5</td>
<td>1411.6</td>
</tr>
<tr>
<td>1999</td>
<td>1897.3</td>
<td>1012.3</td>
</tr>
<tr>
<td>2000</td>
<td>1484.3</td>
<td>999.1</td>
</tr>
<tr>
<td>2001</td>
<td>1317.1</td>
<td>1472.1</td>
</tr>
<tr>
<td>2002</td>
<td>1264.4</td>
<td>885.4</td>
</tr>
<tr>
<td>2003</td>
<td>1520.5</td>
<td>1503.3</td>
</tr>
<tr>
<td>2004</td>
<td>1485.1</td>
<td>1026.3</td>
</tr>
<tr>
<td>2005</td>
<td>1596.2</td>
<td>979.0</td>
</tr>
<tr>
<td>2006</td>
<td>1691.3</td>
<td>1598.0</td>
</tr>
</tbody>
</table>

10 years rain fall in Murree and Islamabad (catchments area of Rawal Lake)
Change in precipitation pattern

%Age change in precipitation variation in Pakistan
Source: Pakistan Meteorological Department, Islamabad

Change in precipitation pattern Murree and Islamabad
Adverse Effects of Climate Change on Planning and Managing Water Services

Rawal Lake
In the process of conversion into oxidation pond
Overall Major Adverse Effects on Water Management System

Following are the major adverse effects envisaged which are directly or indirectly related to water management;

- Increased variability of Monsoon.
- Reduction in capacity of natural reservoirs due to rise in snowline.
- Increased risks of floods and drought and Increased Water Demand
- Severe water-stressed conditions in arid and semi-arid regions- Food insecurity
- Upstream intrusion of saline water in the Indus delta; and risk to mangroves, coral reefs and breeding grounds of fish.
- Increased health risks (heat strokes, malaria and other vector-borne diseases).
Adverse Effects of Climate Change on Rawalpindi Water Utility Specific

- Decreased quantum of Water sources – Surface and ground water
- High levels of Bacterial Contamination - Ground and Surface Water
- Bacteriological Water Quality Of Streams Recharging Rawal Lake
- Increased Turbidity
- Low efficiency of coagulants at sub zero temperatures
- Flash flooding
- Deforestation – Transport of sediments into water sources
- Effects on Glaciers
- Increased water treatment cost
Effect on Water Resources

Ground Water Aquifer Depletion:

Ground Water Depletion

<table>
<thead>
<tr>
<th>Location of Tube well</th>
<th>Water Depth 1960</th>
<th>Water Depth 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liaqat Bagh</td>
<td>250 ft</td>
<td>350 ft</td>
</tr>
<tr>
<td>Gawal Mandi</td>
<td>50 ft</td>
<td>50 ft</td>
</tr>
<tr>
<td>Satelite Town No.1</td>
<td>200 ft</td>
<td>400 ft</td>
</tr>
<tr>
<td>Satelite Town No.2</td>
<td>200 ft</td>
<td>400 ft</td>
</tr>
<tr>
<td>Babu Ali Dhoke</td>
<td>50 ft</td>
<td>50 ft</td>
</tr>
<tr>
<td>Mulpur</td>
<td>100 ft</td>
<td>100 ft</td>
</tr>
</tbody>
</table>
## High levels of Bacterial Contamination - Ground and Surface Water

Latest Ground Water Quality Survey 11 Union Councils

<table>
<thead>
<tr>
<th>Location /UC</th>
<th>Total No. of Samples</th>
<th>Water Quality at Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Fit</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>7</td>
<td>4</td>
</tr>
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<td>6</td>
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<td>9</td>
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<td>0</td>
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<td>13</td>
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<td>10</td>
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<tr>
<td>14</td>
<td>8</td>
<td>6</td>
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<tr>
<td>15</td>
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<td>4</td>
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<tr>
<td>16</td>
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<td>1</td>
</tr>
<tr>
<td>17</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>95</td>
<td>37</td>
</tr>
</tbody>
</table>
# Bacteriological Water Quality Of Streams Recharging Rawal Lake

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>Sample Location</th>
<th>Study Conducted by WASA in 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>aS-4</td>
<td>Stream Coming from Noor Pur Shahan near Bari Imam Village</td>
<td>TNTC (Too numerous to count)</td>
</tr>
<tr>
<td>aS-5</td>
<td>Stream from Quaid-e-Azam University</td>
<td>Purely raw sewage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Detectable</td>
</tr>
<tr>
<td>aS-6</td>
<td>Up Stream of bridge at Bara Kahu</td>
<td>&gt; 5000/ 100 ml</td>
</tr>
<tr>
<td>aRD-3</td>
<td>Korang River before chatter park near Sanam gardens</td>
<td>1320/ 100 ml</td>
</tr>
<tr>
<td>bRD-3</td>
<td>Korang River near chatter park</td>
<td>2200/ 100 ml</td>
</tr>
<tr>
<td>cRD-3</td>
<td>Stream at Chatter Park before entering Korang River</td>
<td>4200 / 100 ml</td>
</tr>
</tbody>
</table>

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Increased Turbidity

- Significant effects of climate change on physical parameters on drinking water.
- Rawal Dam was constructed in 1960 on Korang River to meet the water supply requirement of Rawalpindi.
- At the time of its construction Rawal Lake was one of the cleanest drinking water lakes of the area.
- But due to massive erosion in the catchments area, the turbidity of the lake now ranges up to 2700 NTU.
- The intense rains and human activities (unplanned urbanization) in its catchments area has contributed towards increased turbidity.
Increased Turbidity

Deforestation – Sediment transport

Massive erosion due to intense rains which are causing sediment transport into Rawal Lake – More turbidly with increased levels of contamination
Flooding

Devastating flooding of Murree Road (commercial hub of Rawalpindi city) during intense rains in 2001, which claimed over 100 lives.
Slippage of Sonoghur Glaciers in Chitral, Pakistan

Sonoghur village before disaster

Sonoghur village after disaster

Slippage of Glacier
Issues / Challenges

- Less water availability
- Increased water demand
- Irrational water allocation
- Water distribution conflicts
- High cost of water treatment
- Increased energy requirements
- Financial un-sustainability of water utility
- Environmental degradation – Eutrophication of water bodies (Rawal Lake)
Adaptation Strategies
Mitigation Measures

• **Policy formulation**
  – Legislation on ground water extraction
  – Sound water resource management – defining climate scenarios, vulnerabilities assessments, priority adaptation options for water conservation and judicious use
  – Integration with other sectors – agriculture, irrigation and industry
  – Three dimensional ground water modeling to ascertain ground water potentials

• **Technical solutions**
  – Water demand management
  – Development of water supply and alternative water resources
  – Installation of dry weather wastewater treatment plants on wastewater streams entering into Rawal Lake.
  – Construction of delay action / recharge reservoirs in the upstream
Adaptation Strategies
Mitigation Measures

• **Technical solutions**
  – Rainwater harvesting
  – Reuse of wastewater – Trading for irrigation
  – Water efficiency and conservation – use of water efficient appliances
  – Metered water supply – domestic, commercial and industrial purposes proactive, leak detection and repair program
  – Conservative water allocation

• **Cross-cutting measures**
  – increase awareness
  – Capacity building
  – consultation and involvement of stakeholders
  – Integration with other sectors
Conclusion

• Amongst the possible effects of climate change is the likelihood of increased frequency, and severity of occurrence of extreme events such as floods and droughts.
• Since Pakistan is particularly susceptible to such events, and has experienced large scale destruction on these accounts in the recent past, the analysis of possibility of occurrence of extreme events, and their impacts becomes all the more essential.
• Both macro and micro management of water sources is becoming difficult both qualitatively and quantitatively with high cost.
• Pakistan's vulnerability to the impacts of climate change guides its overall national response in dealing with the issue.
• In view of limited resources, the level of studies and work undertaken has largely been in the area of mitigation, although a few important studies have also been conducted on impacts and adaptation.
Conclusion

Water is going to be a petroleum in 21\textsuperscript{st} Century which is a warning for decision makers and water sector professionals to act on fast track basis for integrating all the resources in water services management.

Otherwise ???
Thanks!