Disaster Management and On-Site Urban Sanitation in South Africa

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Sanitation as a disaster risk

- Disasters accompanied by disruption of sanitation services
- Disasters can be:
  - acute (e.g. flood) or
  - chronic (e.g. dysfunctional sanitation services)
No. 57 of 2002: The Disaster Management Act of 2002 [South Africa]

- Guidelines for establishing disaster management structures
- Covers occurrences which cause or threaten disease
- Power to respond in invested in local governance
- **National disaster management information system required**
- Prevention and mitigation strategies required
Disaster management plans for municipalities
[Act No. 57, 2002: 53(2)]

• Anticipate types of disaster likely to occur

• **Identify areas of risk**

• Reduce vulnerability of disaster-prone areas

• Promote disaster management research

• Provide prevention and mitigation strategies
Sanitation as a disaster risk

- Outbreaks of faecal-oral diseases linked to sanitation
- Due to unsafe water, poor sanitation and hygiene
- In SA, 3.8% of all mortalities due to intestinal infectious diseases (IID) – 6th leading cause of death in 2011
- Children bear the greatest burden of IID
- 13.6% of 0 – 14 years deaths in SA in 2011 due to IID
- 17.6% of 1 – 4 years succumbed in 2011 to IID
## Natural causes of death Eastern Cape, 2011

<table>
<thead>
<tr>
<th>Eastern Cape, both sexes, 0-14</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Intestinal infectious diseases (A00-A09)</td>
<td>587</td>
<td>11.8</td>
</tr>
<tr>
<td>2 Influenza and pneumonia (J09-J18)</td>
<td>443</td>
<td>8.9</td>
</tr>
<tr>
<td>3 Respiratory &amp; cardiovascular disorders (perinatal period (P20-P29)</td>
<td>238</td>
<td>4.8</td>
</tr>
<tr>
<td>4 Tuberculosis (A15-A19)</td>
<td>177</td>
<td>3.6</td>
</tr>
<tr>
<td>5 Malnutrition (E40-E46)</td>
<td>155</td>
<td>3.1</td>
</tr>
<tr>
<td>6 Disorders related to length of gestation and foetal growth (P05-P08)</td>
<td>129</td>
<td>2.6</td>
</tr>
<tr>
<td>7 Other viral diseases (B25-B34)</td>
<td>97</td>
<td>2.0</td>
</tr>
<tr>
<td>8 Disorders related to length of gestation and foetal growth (P05-P08)</td>
<td>80</td>
<td>1.6</td>
</tr>
<tr>
<td>9 Other acute lower respiratory infections (J20-J22)</td>
<td>77</td>
<td>1.5</td>
</tr>
<tr>
<td>10 Infections specific to the perinatal period (P35-P39)</td>
<td>75</td>
<td>1.5</td>
</tr>
<tr>
<td>Other natural causes</td>
<td>34 130</td>
<td>46.7</td>
</tr>
<tr>
<td>Non natural causes</td>
<td>640</td>
<td>12.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4968</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Eastern Cape Province

• Two different types of human settlements
  
  – Western half: commercial farms interspersed by nodal towns
  
  – Eastern half: subsistence farming and densely scattered settlements
Population density in the Eastern Cape

- Buffalo City Metropole
- Nelson Mandela Bay Metropole
Water-borne sanitation in the Eastern Cape

Sewered and unsewered communities (black is sewered)

http://en.wikipedia.org/wiki/List_of_municipalities_in_the_Eastern_Cape
Sanitation disaster model

- Model factors that contribute influence the risk of sanitation disaster:

\[ \text{Risk} = \frac{\text{Haz} \times \text{Exp}}{\text{Res}} \]
Hazard \((Haz)\)

\[
Risk = \frac{Haz \times Exp}{Res}
\]

• *Haz* is the hazard linked to sanitation disaster i.e. IIDs

• Use mortality due to **intestinal infectious diseases (IIDs)**

• Age cohort used is 0 – 14 as it is the most vulnerable

• Caveat: not all deaths are attributed to a known cause
Relationship between IIDs and prevalence of non-waterborne sanitation

- Prevalence of on-site sanitation
  - Western sector of the province
  - Eastern sector of the province

- Intestinal infectious disease (mortality)
  - 0%
  - 1%
  - 2%
  - 3%
  - 4%
  - 5%
  - 6%

- IID categories:
  - NMBMM
  - BCMM
  - CDM
  - CHDM
  - JGDM
  - ORTDM
  - ADM
  - ANDM
Expectancy (of disaster event) \((Exp)\)

\[
Risk = \frac{Haz \times Exp}{Res}
\]

- Acute disasters depend frequency of occurrence of disaster
  - e.g. 0.05 in a 20 year flood cycle

- Chronic disasters score 1.00
  - e.g. dysfunctional sanitation service
Resilience ($Res$)

\[ Risk = \frac{Haz \times Exp}{Res} \]

- Two factors are used to formulate resilience
  - Availability of potable water ($PW$)
  - Availability of water-borne sanitation ($WBS$)
- Census 2011 data used for $PW$ and $WBS$
Defining Res

- Each factor moderated by audit tool
  - Blue Drop (BD) score (quality of water)
  - Green Drop (GD) score (quality of sanitation service)

\[ Resilience = \% PW \times BD + \% WBS \times GD \]

- Lack of water-borne sanitation lowers Res

- Indicates increased risk to community to IIDs

- Draws attention to hazard potential of on-site sanitation
Calculating **Risk** \((Risk = \frac{Haz \times Exp}{Res})\)

<table>
<thead>
<tr>
<th>District Municipality/Metro</th>
<th>Haz</th>
<th>Exp*</th>
<th>Res</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfred Nzo DM</td>
<td>0.057</td>
<td>1</td>
<td>0.33</td>
<td>0.175</td>
</tr>
<tr>
<td>O.R. Tambo DM</td>
<td>0.038</td>
<td>1</td>
<td>0.27</td>
<td>0.140</td>
</tr>
<tr>
<td>Chris Hani DM</td>
<td>0.051</td>
<td>1</td>
<td>0.66</td>
<td>0.077</td>
</tr>
<tr>
<td>Amathole DM</td>
<td>0.043</td>
<td>1</td>
<td>0.56</td>
<td>0.077</td>
</tr>
<tr>
<td>Cacadu DM</td>
<td>0.025</td>
<td>1</td>
<td>0.44</td>
<td>0.057</td>
</tr>
<tr>
<td>Joe Gcabi DM</td>
<td>0.042</td>
<td>1</td>
<td>0.85</td>
<td>0.049</td>
</tr>
<tr>
<td>Buffalo City Metro</td>
<td>0.032</td>
<td>1</td>
<td>1.50</td>
<td>0.021</td>
</tr>
<tr>
<td>Nelson Mandela Bay Metro</td>
<td>0.028</td>
<td>1</td>
<td>1.60</td>
<td>0.017</td>
</tr>
</tbody>
</table>

* Default value: Risk normalised to \(Exp = 1\) for all DMs and Metros
Conclusions

- Sanitation disasters can be acute or chronic
- On-site or water-borne sanitation have disaster potential
- Model highlights the threat posed by on-site sanitation
- Info regarding IID mortality required at Local Municipality level and ultimately Ward level
End

Thank-you
Blue Drop scoring criteria

• Performance Area
• Water Safety Planning Process & Incident Response Management
• Process Control, Maintenance & Management Skills
• Monitoring Programme
• Credibility of Sample Analyses
• Submission of Results
• Drinking Water Quality Compliance
• Performance Publication
• Asset Management
• Bonus Scores and Penalties
Green Drop scoring criteria

- Performance Area
- Process Control, Maintenance & Management skills
- Monitoring Programme
- Credibility of Sample Analyses
- Submission of Results
- Wastewater Quality Compliance
- Failure Response Management
- Bylaws
- Treatment & Collector Capacity
- Asset Management
- **Bonus Scores and Penalties**
Disaster Management Information System
[Act No. 57, 2002: 17(1-2)]

• Covers collecting, processing, analysing and disseminating knowledge

• This knowledge is comprised of information of factors causing disasters, risk factors, prevention and mitigation, areas and communities particularly vulnerable to disasters
Prevention and mitigation

[Act No. 57. 2002: 20(1)]

Prevention and mitigation requires:

- Determining levels of risk
- Assessing vulnerability
- Increasing resilience of communities
- Monitoring the likelihood of disaster and state of readiness
- Implementing prevention and mitigation methodologies
- Management of high risk developments
Auditing water and sanitation services

• Audits of water treatment and wastewater treatment plants are carried out in SA
• These treatment works receive a score based on risk assessment of management systems and water/effluent quality (Blue Drop and Green Drop scores)
• No such system is in place for on-site sanitation units and their management
Relationship between IID prevalence and unsafe water supply

Intestinal infectious disease (mortality)

Unsafe water supply
Sanitation in disaster management

- On-site sanitation that meets basic requirements should safely isolate and contain faecal pathogens
- Water-borne sanitation and end-of-line treatment should result in pathogen destruction
- Both solutions have an element of risk associated with them
A case in point

New warning over sewage health threat
(source: Grocott's Mail Fri, 27 Jun, 2014)

“[A] Grahamstown health professional has warned that the city could be on the brink of a health catastrophe, unless large sewage spills affecting several areas of the city are brought under control”

“.........an inspection by Water Affairs this week of the sewage entering Belmont Valley revealed that 90% of sewage bypasses the [WWTP] and goes into rivers”

“Hundreds others had diarrhoea as a result of contact with contaminated water”
## Mortalities due to IIDs (A00-A09) in South Africa 2011

<table>
<thead>
<tr>
<th>Causes of death (based on ICD-10)</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholera (A00)</td>
<td>6</td>
<td>0.0</td>
</tr>
<tr>
<td>Typhoid and paratyphoid fevers (A01)</td>
<td>9</td>
<td>0.0</td>
</tr>
<tr>
<td>Other salmonella infections (A02)</td>
<td>19</td>
<td>0.1</td>
</tr>
<tr>
<td>Shigellosis (A03)</td>
<td>10</td>
<td>0.0</td>
</tr>
<tr>
<td>Other bacterial intestinal infections(A04)</td>
<td>13</td>
<td>0.1</td>
</tr>
<tr>
<td>Other bacterial food-borne (A05)</td>
<td>2</td>
<td>0.0</td>
</tr>
<tr>
<td>Amoebiasis (A06)</td>
<td>30</td>
<td>0.1</td>
</tr>
<tr>
<td>Other protozoan intestinal diseases (A07)</td>
<td>19</td>
<td>0.1</td>
</tr>
<tr>
<td>Viral and other specified intestinal infections (A08)</td>
<td>49</td>
<td>0.2</td>
</tr>
<tr>
<td>Diarrhoea and gastroenteritis of presumed infectious origin (A09)</td>
<td>19 211</td>
<td>99.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19 368</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
Sanitation as a disaster risk

• The hazard is the exposure to faecal pathogens

• Source of pathogens is human (sometimes animal) faeces

• Pathogens includes bacteria, viruses, protozoa and helminths

• Spread by faecal contaminated water (not the only route)

• Poor hygiene is also important

• Children most vulnerable – indicate presence of faecal pathogens
Eastern Cape Province

- Water-borne sanitation in west and on-site sanitation in east
- Metros and towns moving towards water-borne sanitation
- On-site sanitation the norm in smaller settlements
- Migration from rural to urban puts increases sanitation demand
Mortalities due to IIDs in the Eastern Cape 2011 (all ages)

<table>
<thead>
<tr>
<th>District Municipalities and Metros</th>
<th>Number of deaths</th>
<th>% of mortalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amathole</td>
<td>434</td>
<td>2.9%</td>
</tr>
<tr>
<td>Chris Hani</td>
<td>374</td>
<td>4.0%</td>
</tr>
<tr>
<td>O.R. Tambo</td>
<td>371</td>
<td>2.6%</td>
</tr>
<tr>
<td>Alfred Nzo</td>
<td>167</td>
<td>2.7%</td>
</tr>
<tr>
<td>Joe Gcabi</td>
<td>141</td>
<td>3.1%</td>
</tr>
<tr>
<td>Buffalo City Metro</td>
<td>&lt;245</td>
<td>&lt;2.3%</td>
</tr>
<tr>
<td>Nelson Mandela Bay Metro</td>
<td>&lt;201</td>
<td>&lt;3.2%</td>
</tr>
<tr>
<td>Cacadu</td>
<td>&lt;115</td>
<td>&lt;2.5%</td>
</tr>
</tbody>
</table>