Dam-Break Flood Inundation Modelling Using Coupled 1-D and 2-D Hydrodynamic Model

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Study area = 26,453 km²
Length of Narmada in study area = 504 km

Bargi dam
Gross storage = 3,920 MCM
Live storage = 3,180 MCM

Legend
- GD Sites
- River
- Bargi Reservoir

Upper Narmada basin
Study area = 26,453 km²
Length of Narmada in study area = 504 km
Synthetic Unit Hydrographs

<table>
<thead>
<tr>
<th>SubBasin</th>
<th>A (km²)</th>
<th>S (m/km)</th>
<th>L (km)</th>
<th>Lₙ (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manot</td>
<td>4971.95</td>
<td>1.94</td>
<td>272.25</td>
<td>161.84</td>
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<tr>
<td>Manot to Bargi</td>
<td>3681.10</td>
<td>2.43</td>
<td>176.24</td>
<td>73.02</td>
</tr>
<tr>
<td>Burahnar</td>
<td>4012.50</td>
<td>2.56</td>
<td>174.02</td>
<td>88.18</td>
</tr>
<tr>
<td>Banjar</td>
<td>2522.14</td>
<td>1.46</td>
<td>171.20</td>
<td>91.27</td>
</tr>
</tbody>
</table>
## Rainfall Frequency Analysis

### 1-day maximum rainfall

<table>
<thead>
<tr>
<th>Rain gauge</th>
<th>Freq. Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malanjkhand</td>
<td>GPA</td>
</tr>
<tr>
<td>Mandla</td>
<td>GNO</td>
</tr>
<tr>
<td>Dindori</td>
<td>PE3</td>
</tr>
<tr>
<td>Hirdyanagar</td>
<td>GNO</td>
</tr>
<tr>
<td>Manot</td>
<td>GNO</td>
</tr>
<tr>
<td>Mawai</td>
<td>GNO</td>
</tr>
<tr>
<td>Mohgaon</td>
<td>GEV</td>
</tr>
<tr>
<td>Mukki</td>
<td>GNO</td>
</tr>
<tr>
<td>Jabalpur</td>
<td>GPA</td>
</tr>
<tr>
<td>Regional</td>
<td>PE3</td>
</tr>
</tbody>
</table>

- **Extreme value (EV1)**
  - Logistic (LOS)
  - Generalized logistic (GLO)
  - Normal (NOR)
  - Generalized normal (GNO)
  - Uniform (UNF)
  - Pearson Type-III (PE3)
  - Exponential (EXP)
  - Generalized Pareto (GPA)
  - Kappa (KAP)
  - Five parameter Wakeby (WAK)

GLO, GEV, GNO, GPA, PE3 are three-parameter distributions, and are shown as lines.

WAK is a five-parameter distribution, and is shown as a line.

UNF, NOR, LOS, EV1 and EXP are two-parameter distributions shown as points, and are mentioned in italics.

12 Frequency Distributions
## Rainfall Frequency Analysis

### 1-Day Rainfall (cm) for various return periods

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Catchment</th>
<th>SPS</th>
<th>PMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manot</td>
<td>25.21</td>
<td>35.78</td>
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<td>2</td>
<td>Manot to Bargi</td>
<td>22.35</td>
<td>33.41</td>
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<td>3</td>
<td>Burahnar</td>
<td>23.09</td>
<td>31.61</td>
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<tr>
<td>4</td>
<td>Banjar</td>
<td>22.86</td>
<td>29.00</td>
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</table>

### 2-Day Rainfall (cm) for various return periods

<table>
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<th>Sl.No.</th>
<th>Catchment</th>
<th>SPS</th>
<th>PMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manot</td>
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<td>2</td>
<td>Manot to Bargi</td>
<td>31.18</td>
<td>45.62</td>
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<tr>
<td>3</td>
<td>Burahnar</td>
<td>29.04</td>
<td>36.66</td>
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<tr>
<td>4</td>
<td>Banjar</td>
<td>32.40</td>
<td>43.86</td>
</tr>
</tbody>
</table>
Design Flood Hydrographs

- 1-Day
  - 25 Year
  - 100 Year
  - 1000 Year
  - PMF

- 2-Day
  - 25 Year
  - 100 Year
  - 1000 Year
  - PMF

Discharge (m³/s)

Time (h)
Schematic diagram of river and reservoir modelled for dam break analysis in MIKE 11.
∴ Bargi dam is a composite earth and masonry dam

➢ Length of earthen portion is 4540 m long while the masonry is 827 m long including spillway length of 385.7 m.

∴ Breach time of 2 h
∴ Breach width of 250 m
∴ Trapezoidal shape (1H:1V)
Flood Discharge at various locations

- NARMADA 128961.92 53.7 km
- NARMADA 140140.81 75.0 km
- NARMADA 161744.61 92.7 km
- NARMADA 180869.75 114.4 km

Time Series Discharge

Discharge
Water levels at various locations

Water Level
- NARMADA 175190.00
- NARMADA 142460.08
- NARMADA 160398.27
- NARMADA 170391.91
- NARMADA 200311.77
- NARMADA 222000.00
- NARMADA 239340.09
- NARMADA 260327.20
- NARMADA 262893.59

Time Series Water Level

[Graph showing water levels at various locations with distances marked in kilometers.]
Maximum Flood Depth

25 Year

PMF

100 Year

1000 Year

Legend:

- 1
- 1-2
- 2-3
- 3-4
- 4-5
- 5-7
- 7-10
- 10-15
- 15-20
- 20-25
- 25-30
- >30
Flood Inundated Area Contd...

Legend
- River_Main
- 25 Year
- 100 Year
- PMF
- 1000 Year

Flooded area (km²)

- 25 Year: 334
- 100 Year: 407
- PMF: 545
- 1000 Year: 715
Sensitivity Analysis (Breach Parameters)

Time Series Water Level (m) vs. Time (days)

Water Level:
- NARMADA 127190.00
- NARMADA 142460.08
- NARMADA 160398.27
- NARMADA 179391.91
- NARMADA 200311.77
- NARMADA 222000.00
- NARMADA 238340.09
- NARMADA 260127.20

0 km
15.3 km
33.2 km
52.2 km
73.1 km
94.8 km
112.2 km
132.9 km

Initial WL 426.9 m
Final WL 357 m
250 m
The inflow hydrographs at Bargi dam for 25 year, 100 year, 1000 year return periods and PMF for 1 day and 2 day duration are simulated using HEC-HMS employing corresponding design rainfall and SUH.

About 14 h time is required for peak flow to reach downstream located at 135 km.

The simulated discharge is very high just below the dam and it reduces towards downstream, which may occur due to storage of flood water in the river channel as well as in the flood plain.

The simulated flood inundated area due to dam break with 25 year, 100 year, PMF and 1000 year return period floods are 334 km$^2$, 407 km$^2$, 554 km$^2$ and 715 km$^2$ respectively.

The simulated water levels in the river and time to peak are quite sensitive to Manning’s roughness coefficient.

The effect of dam breach parameters is not much significant on the depth and discharge of flows in lower reaches.