Assessment of Spatio-Temporal Variation in Water Resources Availability in Karnali-Mohana River Basin, Nepal

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Context

• Huge untapped potential for WR development in Nepal
  – More in Western Nepal

Data source: DoE website + Planning documents

• Total Hydropower Projects (> 0.5 MW): 150 nos; 21,006.8 MW
• Storage: 19 projects (67 – 6,720 MW); All are planned/proposed

• Huge untapped potential for WR development in Nepal
  – More in Western Nepal

• A sound knowledgebase on spatio-temporal variability of WR may help informed decision-making
  – Hydrological models are useful for that purpose

• Well calibrated/validated hydrological models can
  – Characterize spatio-temporal variation in WR availability under current & future conditions
  – Be used for CC impact assessment on WR availability

• However, such studies are lacking in Western Nepal
Context – DJB Project

- **Project**: Digo Jal Bikas (DJB)
- **Goal**: Promote sustainable WRD&M in western Nepal
- **Duration**: 2016-2019
- **Funding**: USAID
- **Scale**: Basin (3 basins) & Local (3 pilot sites)

**OBJECTIVES**
- Generate knowledgebase
- Develop & apply tools/models/approaches
- Develop integrated WRD & M guidelines for policy & practice

Study Area: Karnali-Moahan (A=49,889 km²)

- **Topography**: 69-7726 masl
- **Soil**: 21 types (SOTER)
- **LULC**: 9 generic types
- **Rainfall variation**
- **Temperature variation**

We Expect Spatial Variability on WR availability within the basin

Methodology: Framework & Data

<table>
<thead>
<tr>
<th>Data type</th>
<th>Description/Properties</th>
<th>Resolution/Period</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEM</td>
<td>DEM</td>
<td>30m</td>
<td>ASTER-GDEM</td>
</tr>
<tr>
<td>Soil [Soil class &amp; physical properties]</td>
<td>Vector data</td>
<td>ICIMOD (2010)</td>
<td></td>
</tr>
<tr>
<td>Rainfall [mm]</td>
<td>Observed</td>
<td>36 stations; daily, 1995-2013</td>
<td>DHM, Nepal; IMD, India</td>
</tr>
<tr>
<td>Temperature [°C]</td>
<td>Observed</td>
<td>22 stations; daily, 1995-2013</td>
<td>DHM, Nepal; IMD, India</td>
</tr>
<tr>
<td>Sunshine [hrs]</td>
<td>Observed</td>
<td>22 stations; daily, 1995-2013</td>
<td>DHM, Nepal</td>
</tr>
<tr>
<td>Wind speed [m/s]</td>
<td>Observed</td>
<td>5 stations; daily, 1995-2013</td>
<td>DHM, Nepal</td>
</tr>
<tr>
<td>Q [m³/s]</td>
<td>Observed</td>
<td>10 stations; daily, 1995-2013</td>
<td>DHM, Nepal</td>
</tr>
</tbody>
</table>

Methodology: SWAT set-up

- 111 sub-basins & 2,122 HRUs
- 36 P stations
- 22 T & RH stations
- 5 sunshine hours stations
- 7 stations for wind speed
Results/Discussion: Model Performance

10 Q Stations
- 3 in Seti
- 2 in Bheri
- 1 in Tila
- 1 in Mohana
- 3 in Karnali Main

Results/Discussion: Model Performance

Q360 – Outlet, Seti

Results/Discussion: Model Performance

Q270 – Outlet, Bheri
Results/Discussion: Model Performance

KARNAL-MAIN RIVER

Results/Discussion: Spatial distribution of WR

- P varies from 365 to 2,585 mm, with basin average of 1,335 mm
- Northern part receives less precipitation

Results/Discussion: Spatial distribution of WR

- AET varies from 17 to 835 mm (basin average = 489 mm)
• Higher % P is lost as AET in middle part of the basin; & less in the northern part;

• Sub-basin average Q (net water yield) varies from 7.3 m³/s to 2,292.2 m³/s
  • The cumulative flow increases when we move towards D/S

• Surface runoff - major contributor in net water yield
  • Lateral flow - 2nd major contributor in most sub-basins.
Results/Discussion: Temporal distribution of WR

- P & net water yield are high during rainy months (Jun-Sep) & AET also follows the same trend

Summary

- Performance of SWAT model for KarMo basin
  - Can reproduce reasonably the hydrological patterns, incl. spatio-temporal variability

- Spatial variation in water balance
  - P varies from 365 to 2,585 mm
  - AET varies from 17 to 835 mm
  - Runoff (net water yield) varies from 7.3 to 2,292.2 m³/s

- Temporal variation of water balance
  - P & runoff are high during rainy months (Jun-Sep) & AET also follows the same trend

Next Steps (Ongoing)

- Impact of Water Infrastructures
  - Hydropower Projects?
  - Irrigation Projects?

Impact of Climate Change

- Rainfall Change?
- Temperature Change?

Impacts

- Simulated results will be used for hydro-economic modelling (Ongoing)
  - Trade-off evaluation of WR Development pathways (likely)

- The model results are used by DoI
  - Irrigation Master Plan development

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THANK YOU!
Results/Discussion: Spatial distribution of WR

- AET varies from 17 to 835 mm (basin average = 489 mm)
- Q260 (Seti)
  - AET = 28.9%
  - PER = 24.6%
- Q270 (Bheri)
  - AET = 35.7%
  - PER = 13.4%
- Q280 (Karnali Outlet, Chisapani)
  - AET = 35.8%
  - PER = 10.3%