QUALITY ASSESSMENT OF DIGITAL ELEVATION MODEL (DEM) IN VIEW OF THE ALTIPLANO HYDROLOGICAL MODELING


HASM : Hydrology of the Altiplano, from Spatial to Modelation
System TDPS
(Titicaca Desaguadero  Poopó Salar)

- Endoreic watershed located between 22 and 14°S / 71 and 66°W (192 390 km²)
- Bolivia (70 %) Peru (26 %) and Chili (4 %)
- Precipitation according to a North-South Gradient (from 750 mm/year to 160 mm/year)
- Elevation range between 3600 m and 6500 m
- Including two lakes (Titicaca and Poopó) connected by the Desaguadero River and two salars (Coipasa and Uyuni)
In remote regions, they are often the only way to characterize topography. Various DEMs are available. Among them, two are commonly used:

- **SRTM** (Shuttle Radar Topographic Mission)
  - Last version: SRTM v4 (released in August 2008)
  - Product of NASA
  - Spatial resolution: 90 m
  - Vertical accuracy: 12.6 meters (South America)

- **GDEM** (Global Digital Elevation Model)
  - Last version: GDEM v2 (released in October 2011)
  - Product of METI and NASA
  - Spatial resolution: 30 m
  - Vertical accuracy: 17 meters (World)

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Need of high accuracy elevation measurement as reference

- GPS differential
  - Data base not always available
  - Low spatial coverage

- Altimetry
  - ICESat/GLAS
    - Freely available
    - High spatial coverage (space of 30 km; 1 mediation each 172 m)
    - Accuracy less than 12 cm
    - 150 000 points available
RESULTS

Global Scale

Negative Bias with SRTM v4

Better performance with GDEM v2

<table>
<thead>
<tr>
<th></th>
<th>AME</th>
<th>STD</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDEM v2</td>
<td>6.6</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>SRTM v4</td>
<td>8.8</td>
<td>8.6</td>
<td>11.1</td>
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</tbody>
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Mean slope classes

Increment of AME, STD and RMSE with the mean slope value

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## RESULTS

### Land occupation classes

<table>
<thead>
<tr>
<th>Classes</th>
<th>AME</th>
<th>STD</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MERGE DEM</strong></td>
<td>5.8</td>
<td>8.5</td>
<td>8.6</td>
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<tr>
<td><strong>GDEM v2</strong></td>
<td>6.6</td>
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</tbody>
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### AME, STD, RMSE

<table>
<thead>
<tr>
<th>Classes</th>
<th>AME</th>
<th>STD</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare areas</td>
<td>5.0</td>
<td>7.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Sparse vegetation</td>
<td>8.1</td>
<td>10.6</td>
<td>10.9</td>
</tr>
<tr>
<td>Closed to open shrubland</td>
<td>7.1</td>
<td>10.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Mosaic Grassland/Forest-Shrubland</td>
<td>6.2</td>
<td>11.6</td>
<td>8.7</td>
</tr>
<tr>
<td>Mosaic Forest-Shrubland/Grassland</td>
<td>8.6</td>
<td>8.7</td>
<td>8.6</td>
</tr>
<tr>
<td>Mosaic Forest-Shrubland</td>
<td>8.7</td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td>Salt hardpans</td>
<td>5.8</td>
<td>4.8</td>
<td>8.0</td>
</tr>
<tr>
<td>Water bodies</td>
<td>8.5</td>
<td>3.7</td>
<td>2.4</td>
</tr>
</tbody>
</table>

- Low STD and RMSE for Salt areas and Water bodies for SRTM v4
- Bias computation and correction for these classes for SRTM v4
- Creation of a new DEM merging GDEM v2 and SRTM v4 corrected
CONCLUSION

- ICESat/GLAS data are useful to assess DEM in remote regions

- SRTM v4 showed an overall negative bias of about 8.8 m

- GDEM is better to reproduce the topography of the Altiplano watershed

- Quality DEM decreases with increasing of mean slope

- Correcting bias on SRTM v4 on specifics area and merge it with GDEM v2 enhance the topographic scheme
GRACIAS