What would be the fate of snow in the western Himalaya: A climate change perspective?

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What would be the fate of snow in the western Himalaya: A climate change perspective?
Strong dependency of meltwater

In Indus basin, up to 60% of the total irrigation withdrawals originate from mountain snow and glacier melt in the Spring season.

What would be the impact of climate change on snow dynamics?
Area: 2210 km$^2$
Methodological approach

1. Global model selection and downscaling
   a) Model selected based on historical performance
   b) RCP4.5 and RCP8.5
   c) Cold-wet models (2) and warm-dry models (2)
   d) Statistical empirical downscaling (9 x 9 km)

2. Cryospheric-hydrological J2000 model
   a) ERA5 reference data (1981-2010)
   b) Validation with MODIS snow cover data
   c) 8-days and monthly comparison
   d) Snow storage and snowmelt

3. Future snow dynamics
   a) Decadal snow cover change
   b) Annual snow cover change
   c) Changes in snow storage and snowmelt
Future climate change in Panjshir

<table>
<thead>
<tr>
<th>RCPs</th>
<th>Model characteristics</th>
<th>Model runs</th>
<th>Mid Century</th>
<th>End Century</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Precip (%)</td>
<td>Temp (°C)</td>
</tr>
<tr>
<td>RCP45</td>
<td>Cold and Wet</td>
<td>MRI-CGCM3_r1i1p1</td>
<td>4%</td>
<td>1.86</td>
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<tr>
<td></td>
<td>Warm and dry</td>
<td>IPSL-CM5A-LR_r2i1p1</td>
<td>-17%</td>
<td>3.1</td>
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<td>RCP85</td>
<td>Cold and Wet</td>
<td>MRI-CGCM3_r1i1p1</td>
<td>23.3%</td>
<td>2.2</td>
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<tr>
<td></td>
<td>Warm and dry</td>
<td>IPSL-CM5A-LR_r4i1p1</td>
<td>-34%</td>
<td>4.4</td>
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</tbody>
</table>
Modelling snow cover using the J2000 model (2003-2018)

\[ CoD (r^2) = 0.94 \]
\[ Nash-Sutcliff (e^2) = 0.92 \]
Changes in decadal snow cover
Change in annual snow cover

**Cold and wet 4.5**
- Change: $-10\%$
- Equation: $y = -1.6452x + 1365.4$
- $R^2 = 0.3051$

**Cold and wet 8.5**
- Change: $-18\%$
- Equation: $y = -3.4108x + 1427.9$
- $R^2 = 0.5845$

**Warm and dry 4.5**
- Change: $-22\%$
- Equation: $y = -4.0884x + 1385.9$
- $R^2 = 0.6227$

**Warm and dry 8.5**
- Change: $-36\%$
- Equation: $y = -6.6043x + 1441.1$
- $R^2 = 0.8351$
Changes in snow storage and snowmelt

Decreasing snow storage in summer

- Increase in cold-wet RCP4.5 scenarios (except summer)

Increasing snowmelt in winter and spring and decrease in summer

- Higher decrease in RCP8.5 than 4.5

Reference: 1981-2010
Mid century: 2036-2065
End century: 2071-2100
Summary

Panjshir basins’ snow storage capacity will be reduced in the future

Even during the optimistic scenario (cold-wet), the snow cover is likely to decrease

Increasing snowmelt in winter and spring could be an opportunity for downstream agriculture

Adaptation strategy is required to better cope with decreasing snowmelt scenarios in summer
The pulse of the planet.