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Snow Cover Status and Trends in the Indus Basin

Snow Cover

Snow constitutes an important component of the cryosphere, characterized by high temporal and spatial variability. Because of the contribution of snow melt to water availability, snow is an important focus for research on climate change and adaptation. The implementation plan of the Global Climate Observation System (GCOS) recognizes the global areal extent of snow as one of the essential climate variables (ECVs) for monitoring climate change. Snow cover information is important for a number of reasons, such as validation of Global Climate Model (GCM) climate simulations, climate change detection, and greater understanding of climate–cryosphere interactions.

In the context of high mountain regions, in particular the Hindu Kush Himalayas (HKH), snow is a vital component of the water cycle. A study quantifying the contribution of meltwater from upstream areas to overall basin hydrology (Immerzeel et al. 2010) shows that meltwater is especially important in the Indus basin in comparison with other basins in the region.

Therefore detailed information on snow pack parameters such as snow cover area in both space and time has an important role for climate change and adaptation research.

Snow Cover Mapping

Data and source

Mapping and monitoring were based on satellite remote sensing allowing observation of the changes in geophysical parameters including snow on an extended spatial and temporal scale. The snow cover area for the entire HKH was mapped using 8-day L3 global products – Aqua (MYD10A2) and Terra (MOD10A2) – generated using Moderate Resolution Imaging Spectro-radiometer (MODIS) and made available by the United States National Snow and Ice Data Center (NSIDC). The 8-day snow cover products give the maximum snow cover extent over the 8 days at 500 m spatial resolution. These products have been available from 2000 (Aqua) and 2002 (Terra). The 8-day snow cover area was analysed for the years 2002 to 2010.

Reference
Immerzeel, WW; van Beek, LPH; Bierkens, MFP (2010) 'Climate change will affect the Asian water towers.' *Science*, 328(5984): 1382–1385

Data acquisition

NSIDC

ICIMOD

Research

Algorithm refinement

Processing

MOD10A/MYD10A (8-day composite snow data)

Mosaicking

Re-projection

Subset/clipping (HKH context)

Dissemination

Cryosphere portal

Status report
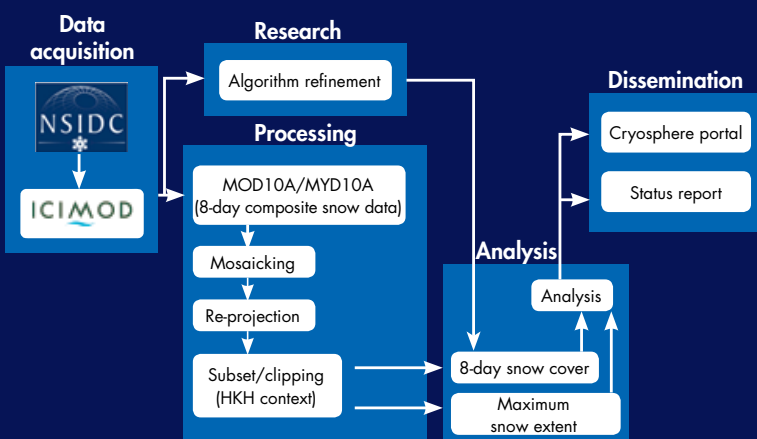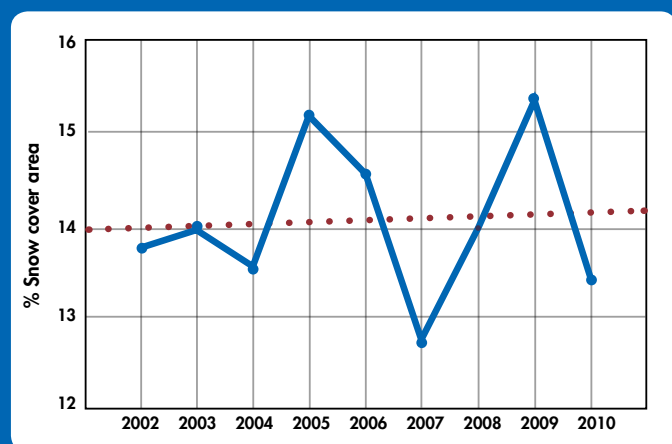
Analysis

Analysis

8-day snow cover

Maximum snow extent

Figure 2: **Decadal trend of snow cover for the Indus basin**

The broken line indicates the trend based on a linear regression equation.

Methodology

The 8-day snow cover products contain cloud pixels, particularly during the monsoon season when conditions are often overcast. Since cloud pixels hinder the mapping application, several cloud filtering steps were implemented to generate an enhanced 8-day MODIS snow product (Figure 1).

Results

From 2002 to 2010, the average snow cover area was 167,992 km^2, 16.7% of the total area. The trend, although not significant, was slightly positive overall (Figure 2), with a negative trend observed during winter and autumn and a positive trend in summer and spring (Table 1). Snow cover change over the decade (Figure 3) varied spatially. While snow cover area decreased in most cases, it increased in certain pockets. There was a strong correlation between snow cover area and elevation (R = 0.96).

Snow cover portal

A dedicated portal provides access to snow cover data and information for the entire HKH region (Figure 4).

Disaggregated and decadal seasonal snow cover trend for the Indus basin

Period	Snow cover (%)
Spring	0.07 ± 1.27
Summer	0.15 ± 0.48
Autumn	-0.04 ± 1.93
Winter	-0.12 ± 0.81
Decadal	0.02 ± 0.79

Figure 3: **Changes in snow cover area over the decade**
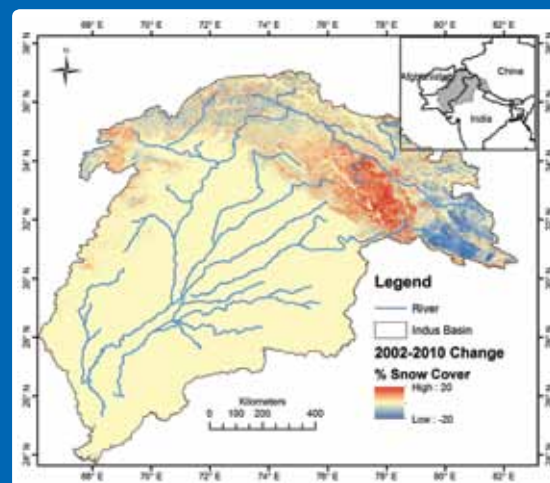

Figure 4: **Snow cover portal facilitating access to data and information**

For further information contact

Deo Raj Gurung   drgurung@icimod.org
Khun Sang Aung   kaung@icimod.org

Photo: Andrew Scanlon