Remote Sensing for Monitoring Physical properties of Hispar Glacier

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Study Objectives

- Snow vs. Dirty snow discrimination
- Snow cloud discrimination
- Debris monitoring
- Glacier mass balance
- Ablation and Accumulation Zone
Hispar Glacier

Hispar Glacier is a 49 km (30 mi) long glacier in the Karakoram Mountains of the Northern Areas.

Landsat 7 ETM+ image of 149-035 Path/Row is selected as the study area.
Material and Methods
Data used

1. Landsat 7 ETM+

2. Google Maps

3. Aster DEM

Software used

• ERDAS
• eCognition
• ArcGIS
• MS Excel, Word
METHODOLOGY

Data Used

- Landsat Multi-date Satellite Image
  - Analyzing Spectral signatures of Snow and cloud
  - Segmentation (Scale 100)
  - Selecting Samples of Snow and cloud
  - Classification
  - Analysis of Snow Characteristics
    - Spatio Temporal Change of Snow Cover

- ASTER DEM
  - Watershed Analysis
    - Delineating Hisper Glacier
    - AOI Subset (Hisper Boundary)
  - Subset according to Boundary
  - Segmentation (Scale 100)
  - Normalized Difference Snow Index (NDSI)
  - Classification
    - Calculating Snow Covered Area

Data

Processing

Results
OBIA (Object Base Image Analysis)
Segmentation Criteria
After Segmentation
Defining Classes
Selecting Samples
Performing Classification
Result of Classification
Results and Conclusions
Snow VS Cloud
Spectral Signature Of Snow and Cloud

Brightness value

Cloud

Snow

Bands
Snow And Cloud Classification

Snow Classification (Landsat Image of 149-035 Path/Row)

Coordinate System: WGS 1984 UTM Zone 43N
Projection: Transverse Mercator
Datum: WGS 1984
False easting: 500,000.0000
False northing: 0.0000
Central meridian: 75.0000
Scale factor: 0.9996
Latitude of origin: 0.0000
Units: Meter

Cloud Classification (Landsat Image of 149-035 Path/Row)

Coordinate System: WGS 1984 UTM Zone 43N
Projection: Transverse Mercator
Datum: WGS 1984
False easting: 500,000.0000
False northing: 0.0000
Central meridian: 75.0000
Scale factor: 0.9996
Latitude of origin: 0.0000
Units: Meter
SNOW AND CLOUD CLASSIFICATION
(LANDSAT IMAGE OF 149-035 PATH/ROW)

RGB
- Red: Layer_6
- Green: Layer_5
- Blue: Layer_3

Coordinate System: WGS 1984 UTM Zone 43N
Projection: Transverse Mercator
Datum: WGS 1984
false easting: 500,000.0000
false northing: 0.0000
central meridian: 75.0000
scale factor: 0.9996
latitude of origin: 0.0000
Units: Meter

Snow
Cloud
Snow VS Dirty Snow
Spectral Signature Of Snow and Dirty Snow

Brightness value

Snow

Dirty snow

Bands
Dirty Snow And Debris
Spectral Signature Of Snow, Dirty Snow and Debris

![Graph showing the spectral signature of snow, dirty snow, and debris]

- **Brightness value**
- **Snow**
- **Dirty snow**
- **Debris**

**Bands**

Dirty Snow and Debris Classification

**Dirty Snow Classification** (Landsat Image of 149-035 Path/Row)

- Red: Layer_6
- Green: Layer_5
- Blue: Layer_3

**Debris Classification** (Landsat Image of 149-035 Path/Row)

- Red: Layer_6
- Green: Layer_5
- Blue: Layer_3
Combined Result

OBIA Classification Result
(Snow, Dirty Snow, and Debris)
Snow Accumulation and Ablation

- The accumulation or ablation zone can be helpful in measuring the mass balance of the glacier.

- For this purpose we chose Hispar Glacier which is one of the major glacier of the Pakistan.

- To analyze the change in glacier I took data of 15 years for two seasons’ spring and autumn.
Snow Accumulation and Ablation in Hispar Glacier
Hispar Glacier Change Detection

![Graph showing area changes over years in Spring (red) and Autumn (black).]
Conclusions

- Determining and differentiating type of snow using remote sensing is an effective, time efficient and less costly technique which give better result only if the sensor has greater spectral resolution (more number of bands) especially in SWIR region and it is the main separator of cloud and snow.

- Understanding of spectral signature is key for this task. Once different type of snow is identified then classification method is used to extract the require information. This also help us in calculating the area of features.

- Mass balance could also be measured using remote sensing technique on a wide range and effectively.

- Time series analysis show us the variation and the glacier due to climatic changes or any other factors. The result of the analysis show that mass balance of Hispar glacier is negative as the amount of recharge is less than the amount of melting.
References

• http://www.polarremotesensing.alaska.edu/case_glacier/about.html.
• http://earthexplorer.usgs.gov/
Thank you