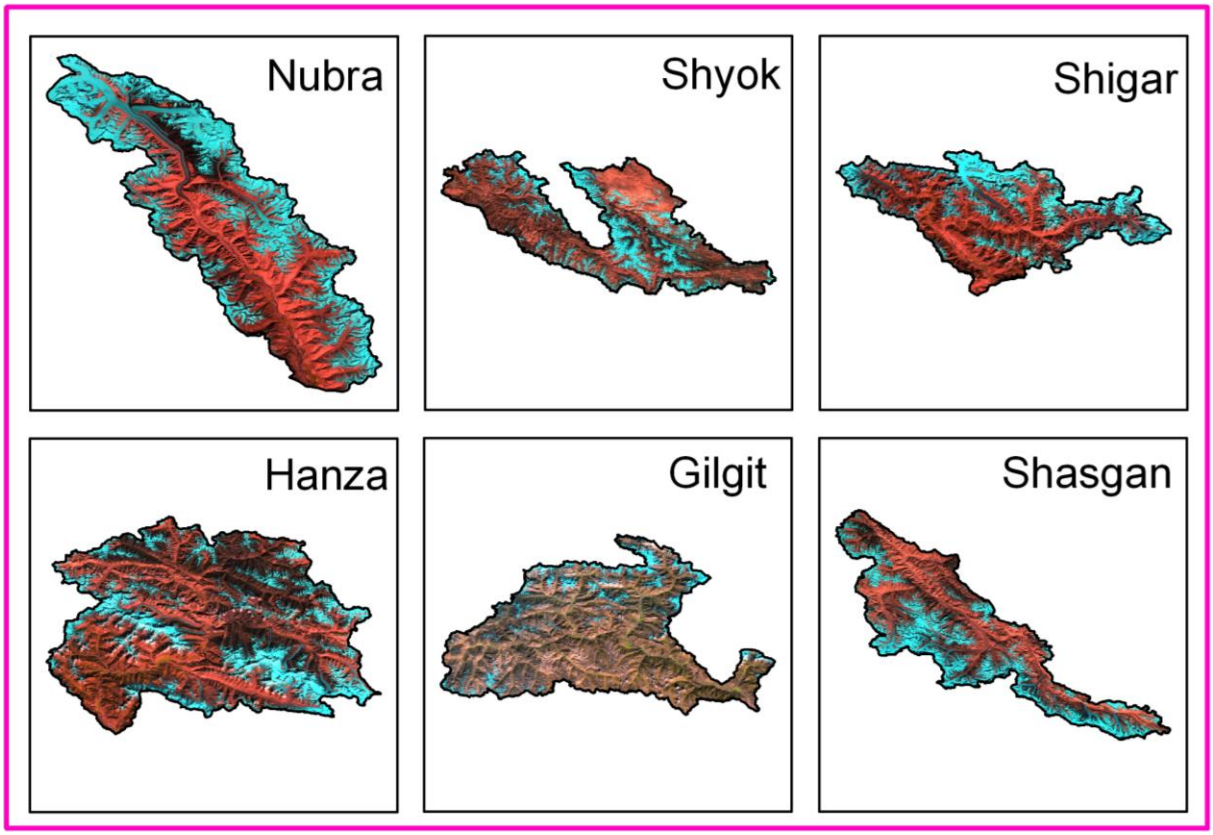
# SNOW COVER ATLAS OF INDUS BASIN

## Sub basins: Nubra, Shyok, Shigar, Hanza, Gilgit and Shasgan

(Integrated *Studies of Himalayan Cryosphere*

A Project of Indian Space Research Organisation)

Year 2015 - 2016




**Volume II**

**Prepared by**
**Space Applications Centre (ISRO)**
**Ahmedabad-380015**

**October 2018**

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**DOCUMENT CONTROL AND DATA SHEET**

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| Month and year of publication | October 2018 |
| Title | Snow cover Atlas of the Indus basin |
| Type of Report | Scientific Report |
| No. of pages | 140 |
| No. of figures, Charts & Tables | 110, 18 & 12 |
| Authors | B. P. Rathore, S. K. Singh, I. M. Bahuguna and A. S. Rajawat |
| No. of References | 9 |
| Originating Unit | Cryosphere Sciences Division, Geo-Sciences, Hydrology, Cryosphere Sciences and Applications Group, Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area, Space Applications Centre (ISRO), Ahmedabad-15 |
| Abstract | This atlas gives subbasin-wise distribution of snow cover in the Indus basin from October 2015 to June 2016. The subbasins included in this report are Nubra, Shyok, Shigar, Hanza, Gilgit and Shasgan. The areal extent of snow cover was estimated in fully automatic mode using Normalized Difference Snow Index (NDSI) based algorithm. For this purpose AWiFS sensor of Resourcesat satellite was used. This atlas gives snow cover products, statistics and seasonal snow depletion curve. It is expected that this data will be useful for hydrological and climatological applications. |
| Key words | Snow cover, NDSI, AWiFS, depletion curve, Nubra, Shyok, Shigar, Hanza, Gilgit and Shasgan basins. |
| Security Classification | Unrestricted |
| Distribution | Among concerned |

**CONTENTS**

## 1. **Introduction**

Snow covers almost 40 per cent of the Earth's land surface during Northern Hemisphere winter. This makes albedo and areal extent of snow as important component of the Earth's radiation balance (Foster and Chang, 1993). In addition, large areas in the Himalayas are also covered by snow during winter. Area of snow can change significantly during winter and spring. This can affect stream flow for rivers originating in the higher Himalayas. All the rivers originating from higher Himalayas receive almost 30-50 % of annual flow from snow and glacier melt run off (Agarwal et al., 1983). In addition, snow pack ablation is highly sensitive to climatic variation. Increase in atmospheric temperature can influence snowmelt and stream runoff pattern (Kulkarni et al., 2002). Therefore, mapping of the areal extent and reflectance of snow are important parameter for various climatological and hydrological applications. In addition, extent of snow cover can also be used as input for numerous other applications.

Mapping and monitoring of seasonal snow cover using field methods are normally very difficult in a mountainous terrain, like the Himalayas. Therefore, remote sensing techniques have been extensively used for snow cover monitoring. Snow cover monitoring using satellite images were started by using the TIROS-1 satellite from April 1960 (Singer and Popham 1963). Since then, the potential for operational satellite-based mapping has been enhanced by the development of higher temporal frequency and satellite sensors with higher spatial resolution. In addition, satellites with better radiometric resolutions, such as NOAA have been used successfully for snow mapping (Hall et al., 1995). This is possibly due to the distinct spectral reflectance characteristics of snow in visible and near infrared regions. India has launched series of Indian Remote Sensing satellite (IRS) to study the different earth resources. Previously launched satellites have flown with many sensors having different spatial, temporal and spectral resolutions. Recently launched RESOURCESAT-1 satellite has three different sensors namely LISS III, LISS IV & AWiFS with different spatial, temporal and spectral resolutions as desired for different applications. AWiFS (Advanced Wide Field Sensor) is an advanced version of earlier Indian satellite sensor WiFS (Wide Field Sensor) with improved spectral and spatial resolutions maintaining the same repetivity. There are a series of other polar orbiting satellites, like Landsat, NOAA and MODIS etc., which have provided information on different aspects of

snow. Geo-stationary satellites also proved their utility in mapping/monitoring the snow-covered regions. Information generated from satellite observations has been extensively used for snowmelt runoff modeling (Kulkarni et al., 1997).

## 2. Study Area:

This Atlas gives distribution of snow cover in six subbasins of the Indus basin. These are Nubra, Shyok, Shigar, Hanza, Gilgit and Shasgan sub basins. Locations of these basins are shown in Figure 1.

## 3. Data used:

AWiFS data from October 2015 to June 2016 were used in this study.

## 4. Normalised Difference Snow Index (NDSI):

In general, the reflectance of snow is high at the red end of the visible spectrum. It tends to decline in the near-infrared region until 1090 nm, where slight gain in reflectance occurs and gives a minor peak at approximately 1090 to 1100 nm. One of the important difficulties in snow cover monitoring is the presence of cloud cover. Cloud has strong reflectivity in visible, NIR and SWIR regions while snow absorbs in SWIR, and this difference can be utilized for snow/cloud discrimination. Normalized Difference Snow Index (NDSI) utilize the normalized ratio of green and SWIR and is used as an automated approach for snow mapping addressing the shadow and cloud problems in snow bound areas.

Normalized Difference Snow Index was calculated using the ratio of green wavelength (band 2) and SWIR (band 5) of AWiFS sensor:

$$Normalized\,Difference\,Snow\,Index(NDSI) = (band2 - band5)/(band2 + band5) \quad ..(1)$$

To estimate NDSI, DN numbers were converted into reflectance. This involves conversion of digital numbers into the radiance values, known as sensor calibration, and then estimation of reflectance from these radiance values. Various parameters needed for estimating spectral reflectance are maximum and minimum radiances and mean solar exo-atmospheric spectral irradiances in the satellite sensor bands, satellite data acquisition time, solar declination, solar zenith and solar azimuth angles, mean Earth-Sun distance etc. (Markham and Barker, 1987; Srinivasulu and Kulkarni, 2004).

**5. Snow cover monitoring algorithm**

An algorithm is developed to provide changes in the areal extent of snow (Kulkarni et. al., 2006). Snow extent is estimated at an interval of 5-days and 10-days, depending upon availabilities of AWiFS data. In 5-daily product, snow extent is generated scene-wise. In this product, snow and cloud extents are given. Estimate of cloud is important because, at times, snow is covered by cloud and this may be classified as non-snow area, leading to erroneous conclusions. In 10-daily product, three scenes are analyzed, if available. For example, 10 March product data of 5, 10 and 15 March was used. If any pixel is identified as snow on any one date then this pixel will be classified as snow on final product. This provides snow cover at an interval of 10 days, an important requirement in hydrological applications. Therefore, this product is generated basin-wise. Since this product is using three scenes, probability becomes high that at least in one scene, pixel may be cloud-free and this helps in overcoming problem associated with snow under cloud cover. If three consecutive scenes are not available, then all available scenes in 10 days window was used in the analysis. Differentiation between water and snow is difficult using NDSI image. In addition, separation of snow and water pixels is also difficult based on reflectance due to mountain shadow. Therefore, in the present algorithm, water bodies are marked in pre-winter

season and are masked in the final products during winter. Flow diagram of the algorithm is given in Figure 2.

## 6. Results and discussions

In this atlas, basin-wise snow cover statistics, maps, and seasonal depletion curves have been provided from October 2015 to June 2016. Snow ablation pattern varies from basin to basin, depending on area altitude distribution in the basins. Many of these sub-basins like Nubra, Shigar and Hanza are highly glacierized, therefore large area under snow and glacier cover was observed even at the beginning and end of accumulation season. In case of Gilgit sub-basin, it is at lower altitude and is less Glacierized so lot of variation in areal extent of snow was observed accumulation starts during mid of October and ablation starts from April onwards. In Shasgan and Shyok sub-basins accumulation and ablation were observed through the year.

## Acknowledgements

This investigation was carried out under Integrated studies of Himalayan Cryosphere, at Space Applications Centre (ISRO), Ahmedabad. The authors are grateful to Shri D. K. Das, Director, Space Applications Centre, Ahmedabad for continuous guidance and encouragement during the investigation. Authors would like to thank Dr. Rajkumar Deputy Director, EPSA, SAC for their suggestions and comments on the manuscript.

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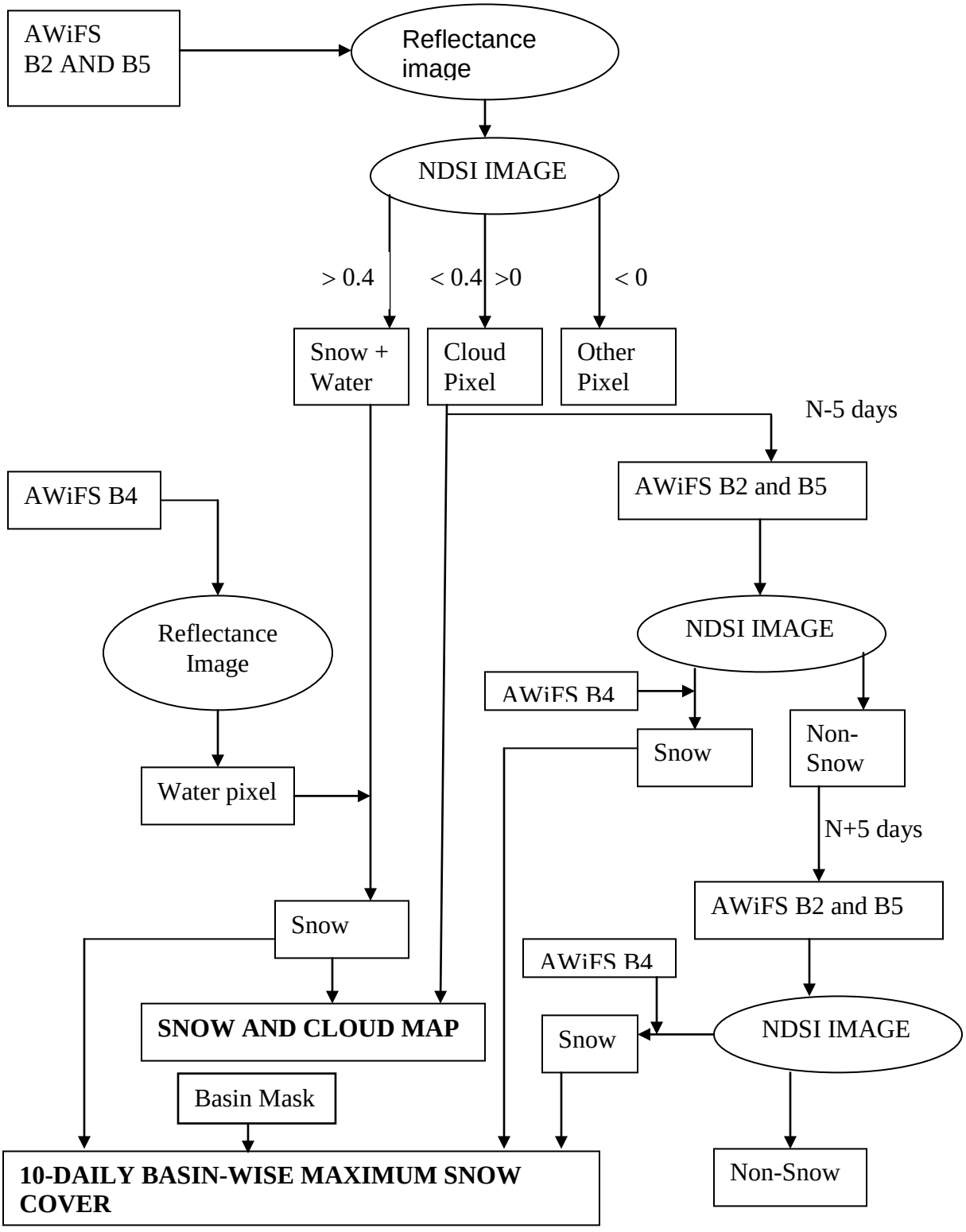



**Figure 2: Algorithm for snow cover mapping using AWiFS data**

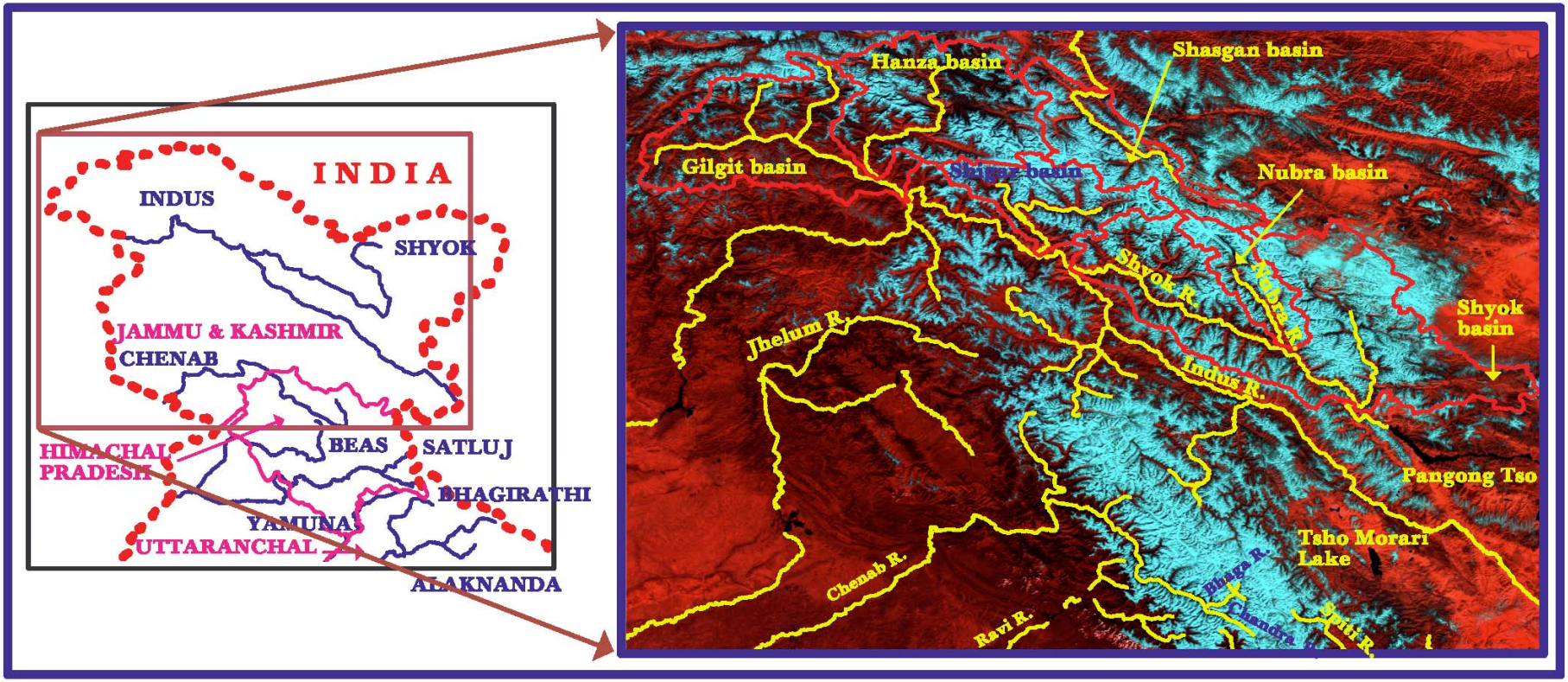



**Figure 1: Location map of Nubra, Shyok, Shigar, Hanza, Gilgit and Shasgan sub-basins (Part of Indus basin)**

# *NUBRA SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: NUBRA** **BASIN AREA: 4258 sq km**

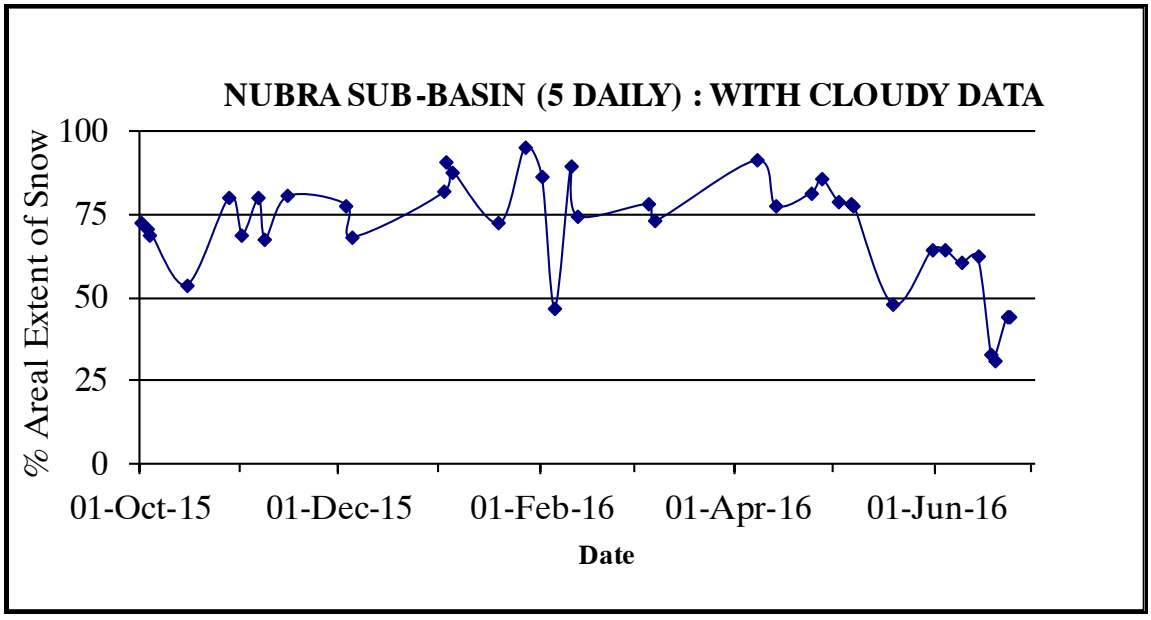
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 01-Oct-15 | 3100 | 73 | **4** | 15-Oct-15 | 2290 | 54 |
| **2** | 03-Oct-15 | 2999 | 70 | **5** | 28-Oct-15 | 3414 | 80 |
| **3** | 04-Oct-15 | 2941 | 69 | | | | |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 2941 | 69 | **7** | 08-Nov-15 | 2882 | 68 |
| **6** | 06-Nov-15 | 3403 | 80 | **8** | 15-Nov-15 | 3426 | 80 |
| **December 2015** | | | | | | | |
| **9** | 03-Dec-15 | 3317 | 78 | **10** | 05-Dec-15 | 2901 | 68 |
| **January 2016** | | | | | | | |
| **11** | 02-Jan-16 | 3483 | 82 | **13** | 19-Jan-16 | 3077 | 72 |
| **12** | 03-Jan-16 | 3857 | 91 | | 27-Jan-16 | 4062 | 95 |
| | 03-Jan-16 | 3730 | 88 | | | | |
| **February 2016** | | | | | | | |
| **14** | 01-Feb-16 | 3684 | 87 | **17** | 10-Feb-16 | 3819 | 90 |
| **15** | 05-Feb-16 | 1994 | 47 | **18** | 12-Feb-16 | 3171 | 74 |
| **March 2016** | | | | | | | |
| **20** | 05-Mar-16 | 3325 | 78 | **22** | 07-Mar-16 | 3109 | 73 |
| | | | | | | | |
| **April 2016** | | | | | | | |
| **24** | 07-Apr-16 | 3882 | 91 | **26** | 24-Apr-16 | 3475 | 82 |
| **25** | 13-Apr-16 | 3303 | 78 | | 27-Apr-16 | 3655 | 86 |
| **May 2016** | | | | | | | |
| **27** | 02-May-16 | 3367 | 79 | **28** | 19-May-16 | 2038 | 48 |
| | 06-May-16 | 3321 | 78 | | 31-May-16 | 2741 | 64 |
| | 07-May-16 | 3303 | 78 | | | | |
| **June 2016** | | | | | | | |
| **29** | 04-Jun-16 | 2739 | 64 | **33** | 19-Jun-16 | 1326 | 31 |
| **30** | 09-Jun-16 | 2566 | 60 | **34** | 23-Jun-16 | 1887 | 44 |
| **31** | 14-Jun-16 | 2652 | 62 | **35** | 24-Jun-16 | 1892 | 44 |
| **32** | 18-Jun-16 | 1411 | 33 | | | | |
| | | | | | | | |

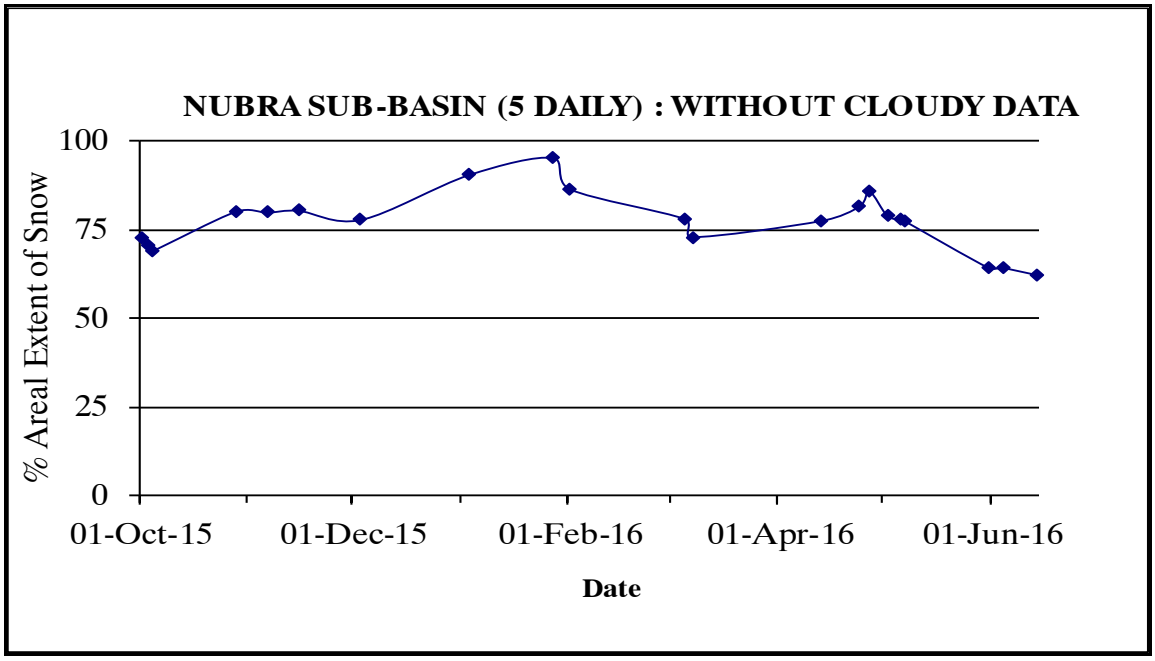
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: NUBRA** **BASIN AREA: 4258sq km**

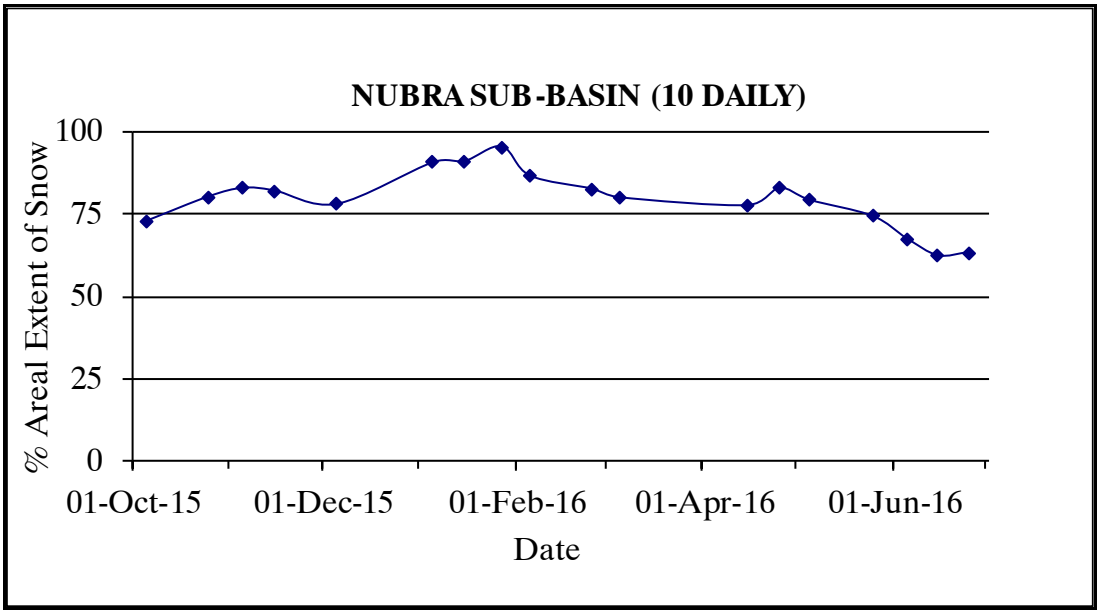
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 3099 | 73 | **3** | 05-Nov-15 | 3525 | 83 |
| **2** | 25-Oct-15 | 3415 | 80 | | 15-Nov-15 | 3491 | 82 |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **4** | 05-Dec-15 | 3317 | 78 | **5** | 05-Jan-16 | 3857 | 91 |
| | | | | **6** | 15-Jan-16 | 3869 | 91 |
| | | | | **7** | 25-Jan-16 | 4062 | 91 |
| **February 2016** | | | | **March 2016** | | | |
| **8** | 05-Feb-16 | 3684 | 87 | **11** | 05-Mar-16 | 3402 | 80 |
| **9** | 25-Feb-16 | 3513 | 83 | | | | |
| | | | | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **13** | 15-Apr-16 | 3302 | 78 | **15** | 05-May-16 | 3368 | 79 |
| **14** | 25-Apr-16 | 3527 | 83 | **16** | 25-May-16 | 3163 | 74 |
| | | | | | | | |
| **June 2016** | | | | | | | |
| **17** | 05-Jun-2016 | 2872 | 67 | | | | |
| **18** | 15-Jun-2016 | 2653 | 62 | | | | |
| | 25-Jun-2016 | 2695 | 63 | | | | |

## SNOW COVER DEPLETION CURVE

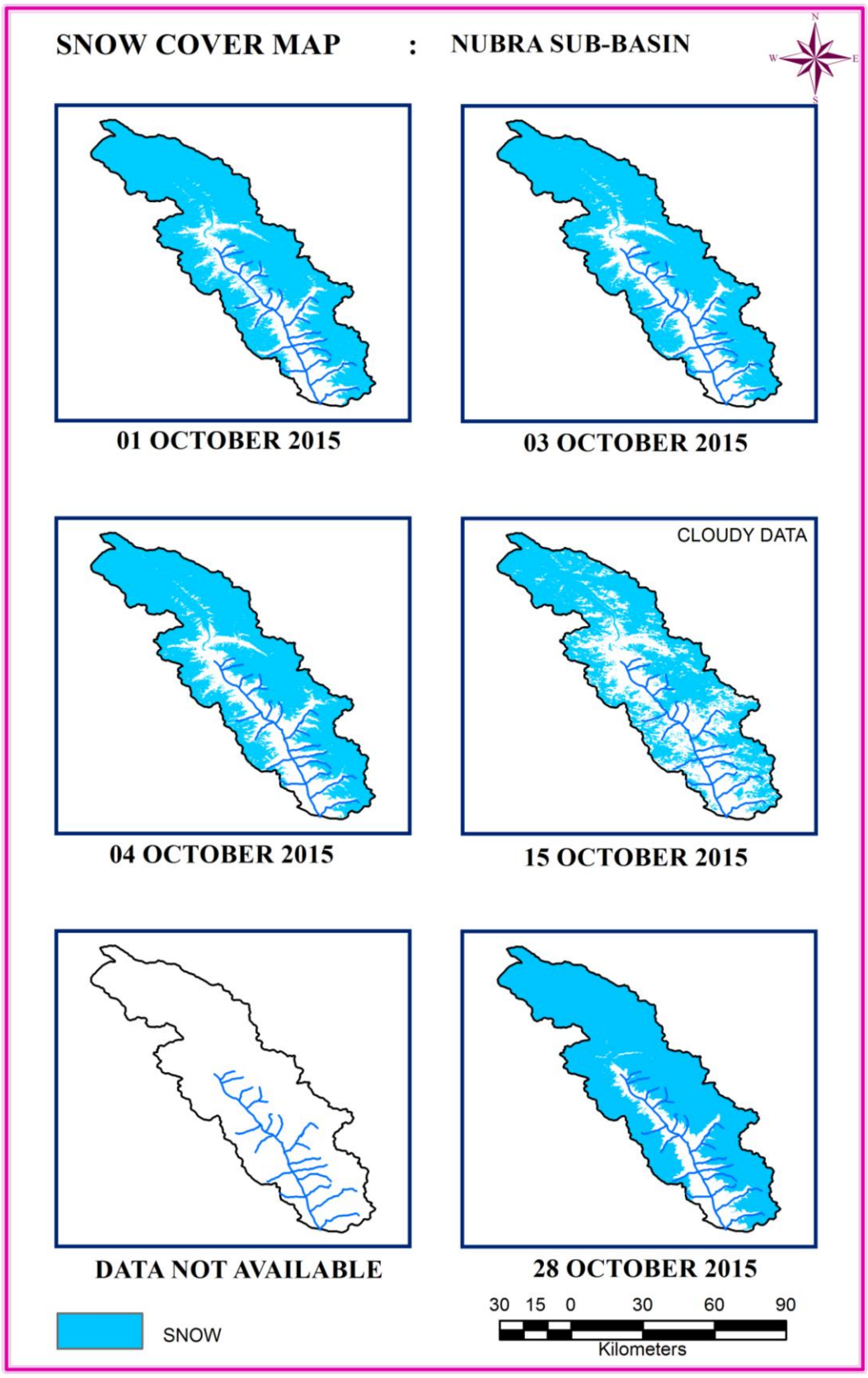


**SNOW COVER DEPLETION CURVE**



# *SNOW COVER MAP*


SNOW COVER MAP : NUBRA SUB-BASIN
N
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01 OCTOBER 2015
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04 OCTOBER 2015
CLOUDY DATA
15 OCTOBER 2015
DATA NOT AVAILABLE
28 OCTOBER 2015
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

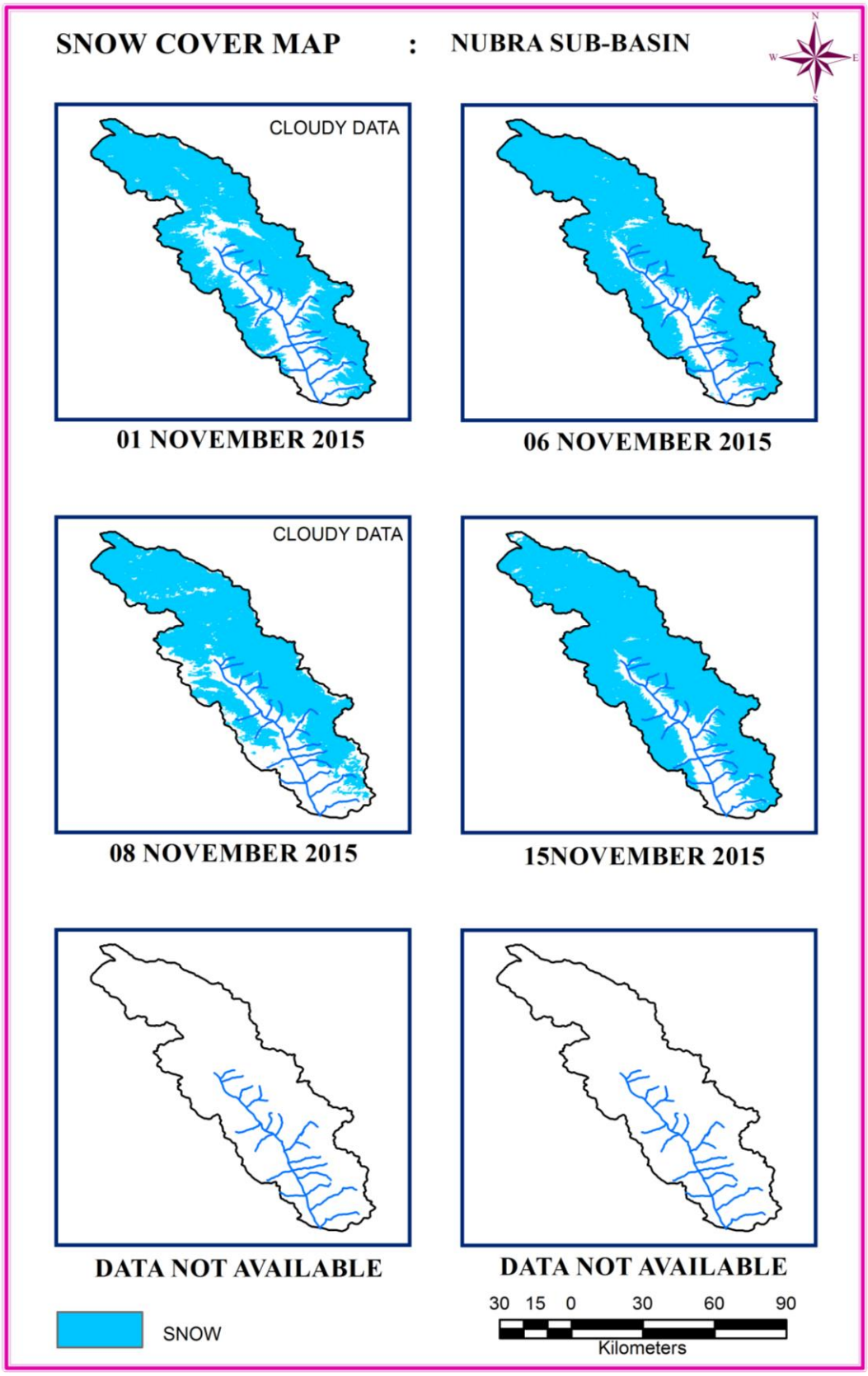
DATA USED
**01 OCTOBER 2015**
**03 OCTOBER 2015**
**04 OCTOBER 2015**

**DATA NOT AVAILABLE**

DATA USED
**25 OCTOBER 2015**

SNOW

30 15 0 30 60 90
Kilometers


SNOW COVER MAP : NUBRA SUB-BASIN
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CLOUDY DATA
01 NOVEMBER 2015
06 NOVEMBER 2015
CLOUDY DATA
08 NOVEMBER 2015
15NOVEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

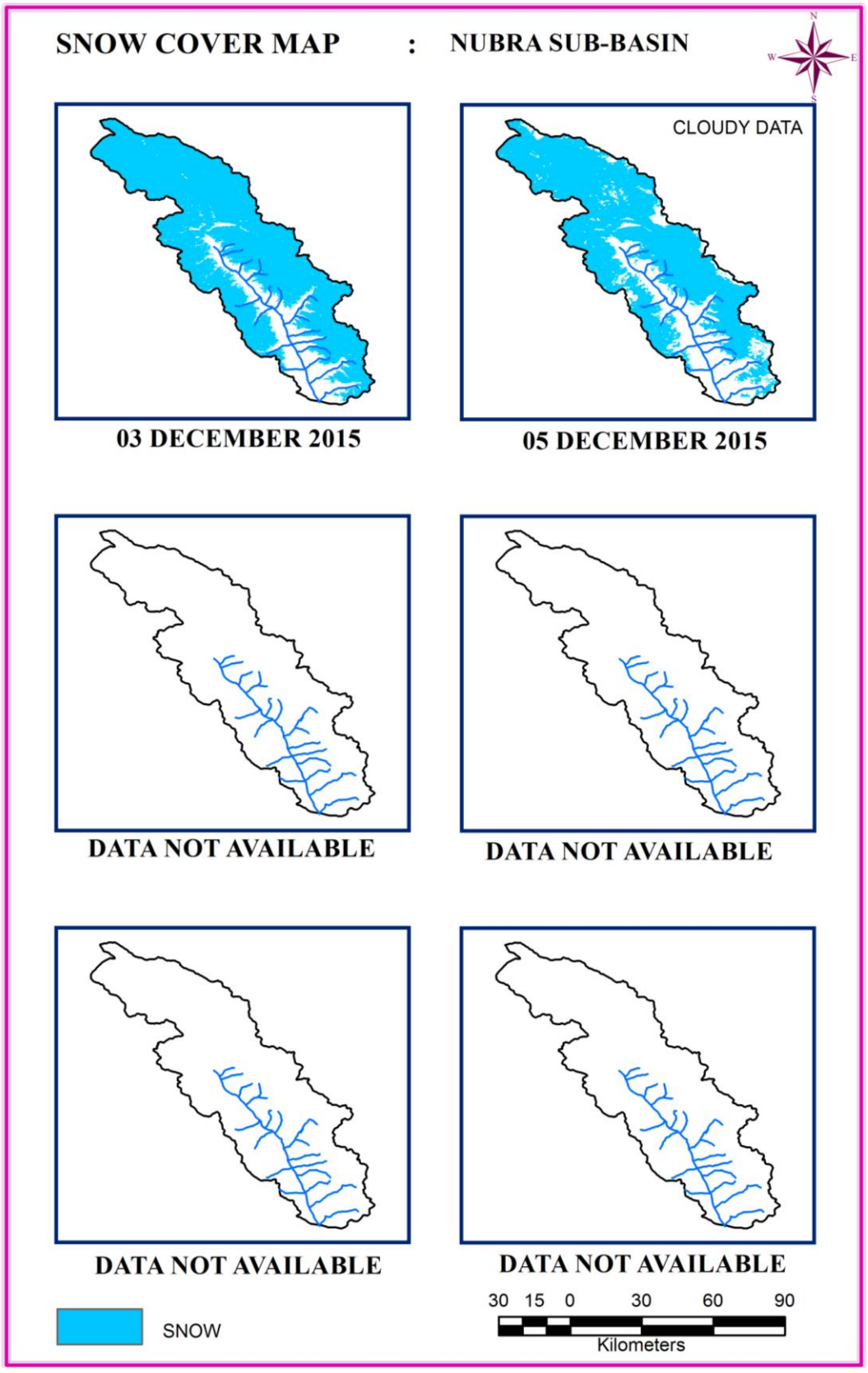
DATA USED
**01 NOVEMBER 2015**
**06 NOVEMBER 2015**
**08 NOVEMBER 2015**

DATA USED
**15 NOVEMBER 2015**

**DATA NOT AVAILABLE**

SNOW

30 15 0 30 60 90
Kilometers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DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

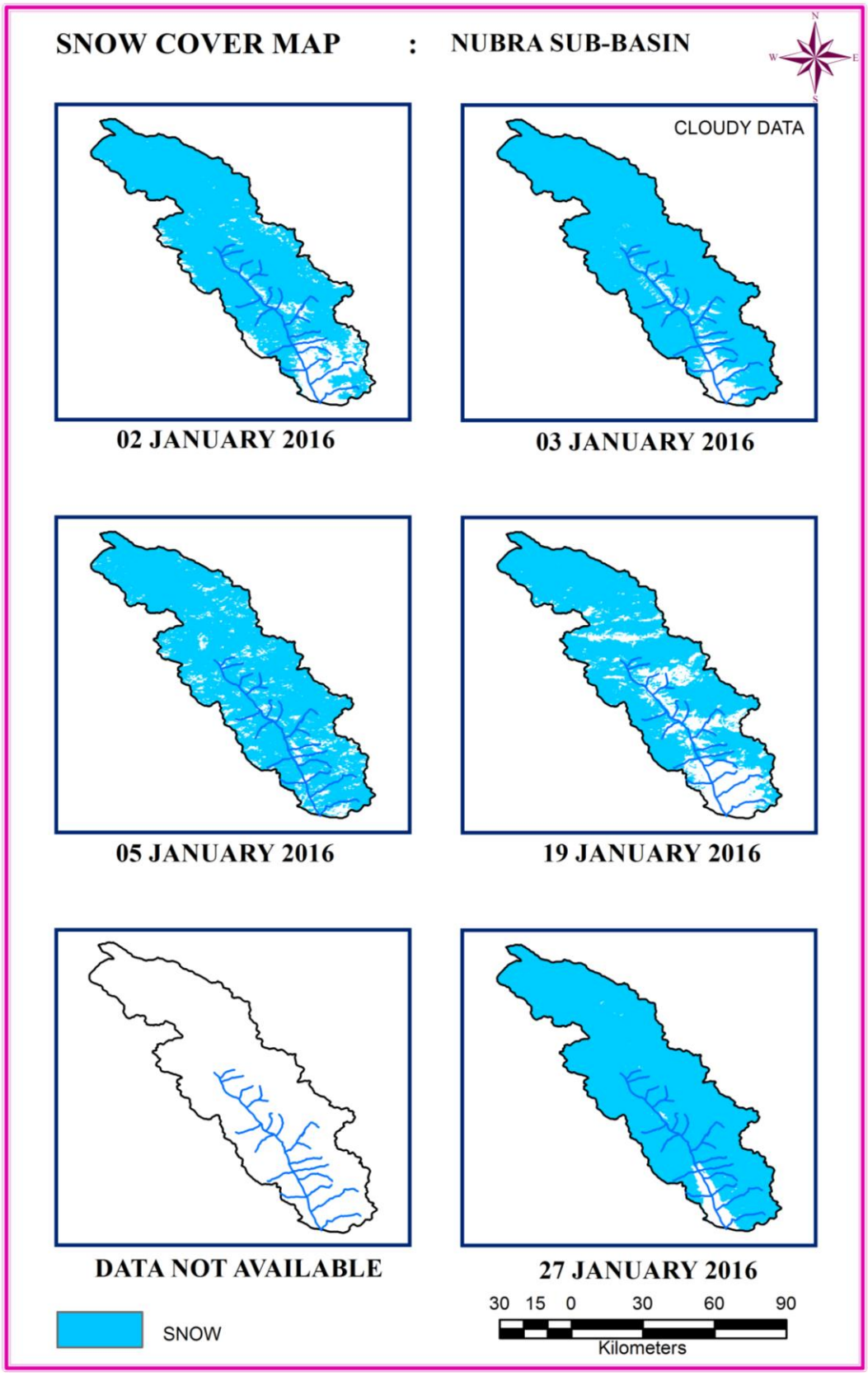
DATA USED
**03 DECEMBER 2015**
**05 DECEMBER 2015**

**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

30 15 0 30 60 90
Kilometers


SNOW COVER MAP : NUBRA SUB-BASIN
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CLOUDY DATA
02 JANUARY 2016
03 JANUARY 2016
05 JANUARY 2016
19 JANUARY 2016
DATA NOT AVAILABLE
27 JANUARY 2016
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

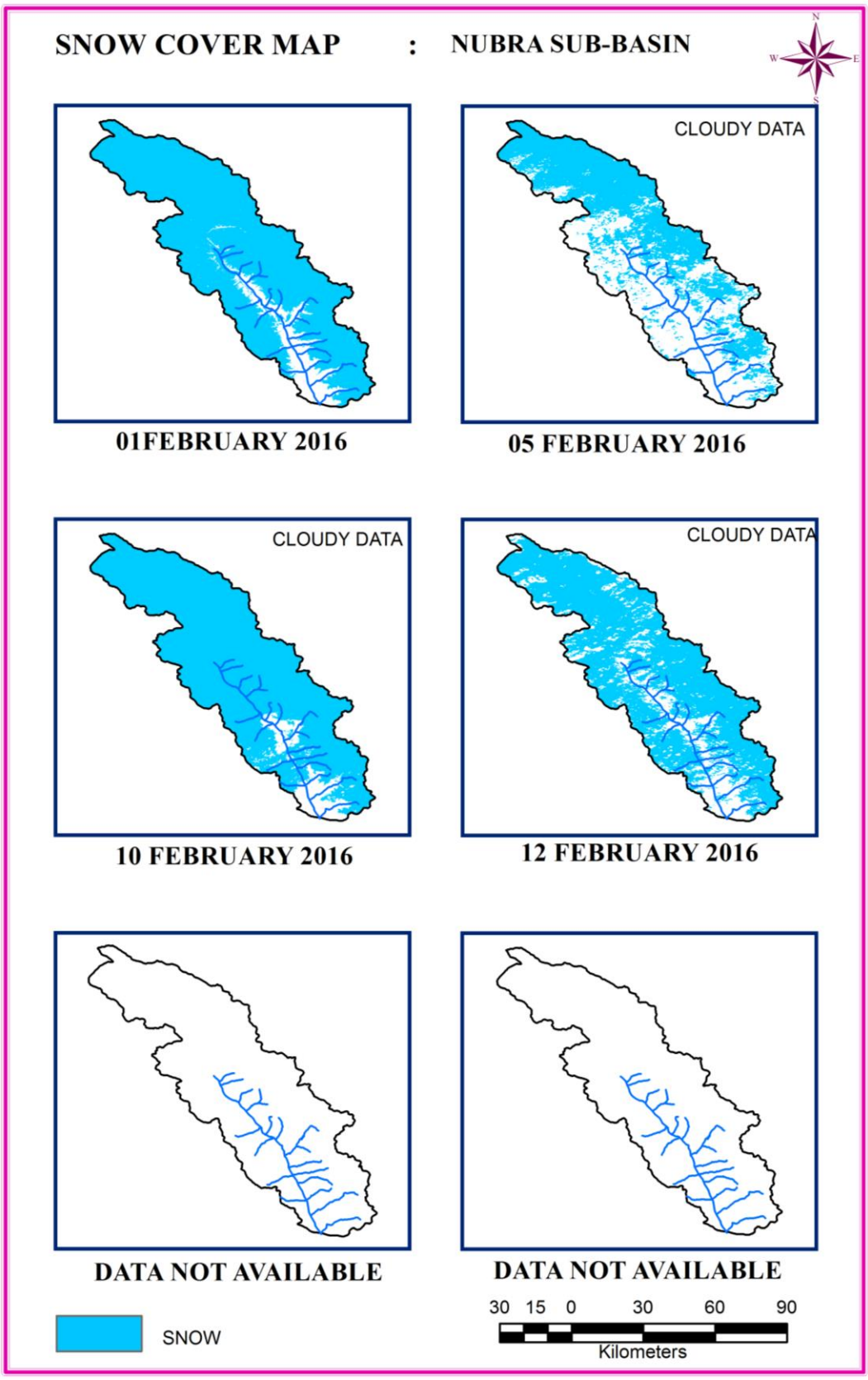
DATA USED
**02 JANUARY 2016**
**03 JANUARY 2016**
**05 JANUARY 2016**

DATA USED
**15 JANUARY 2016**

DATA USED
**25 JANUARY 2016**

SNOW

30 15 0 30 60 90
Kilometers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12 FEBRUARY 2016
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DATA NOT AVAILABLE
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

DATA USED

**01FEBRUARY 2016**

**05 FEBRUARY 2016**

**10 FEBRUARY 2016**

DATA USED

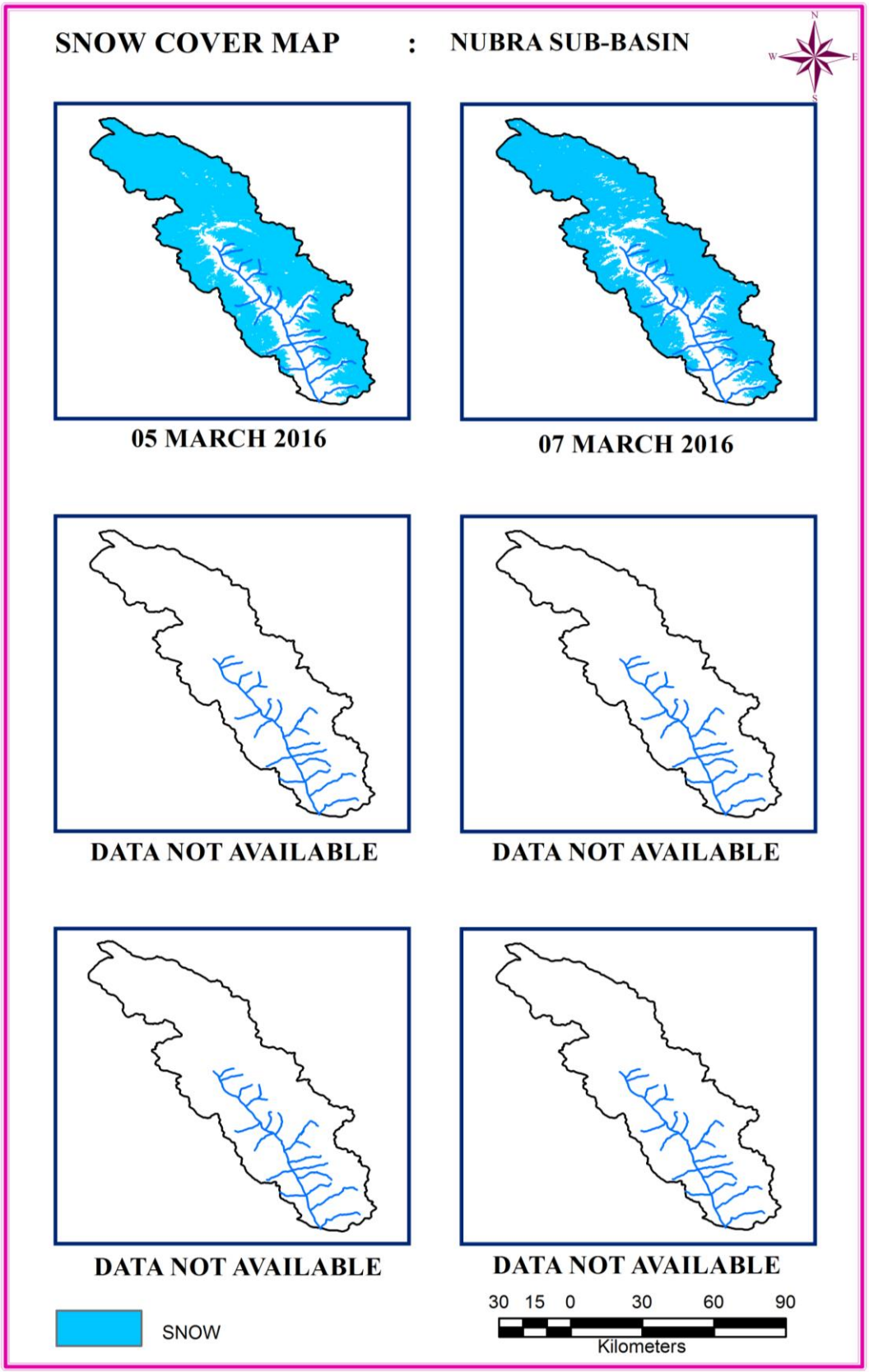
**15 FEBRUARY 2016**

**DATA NOT AVAILABLE**

SNOW

30 15 0 30 60 90

Kilometers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05 MARCH 2016
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DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

DATA USED
**05 MARCH 2016**
**07 MARCH 2016**

**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

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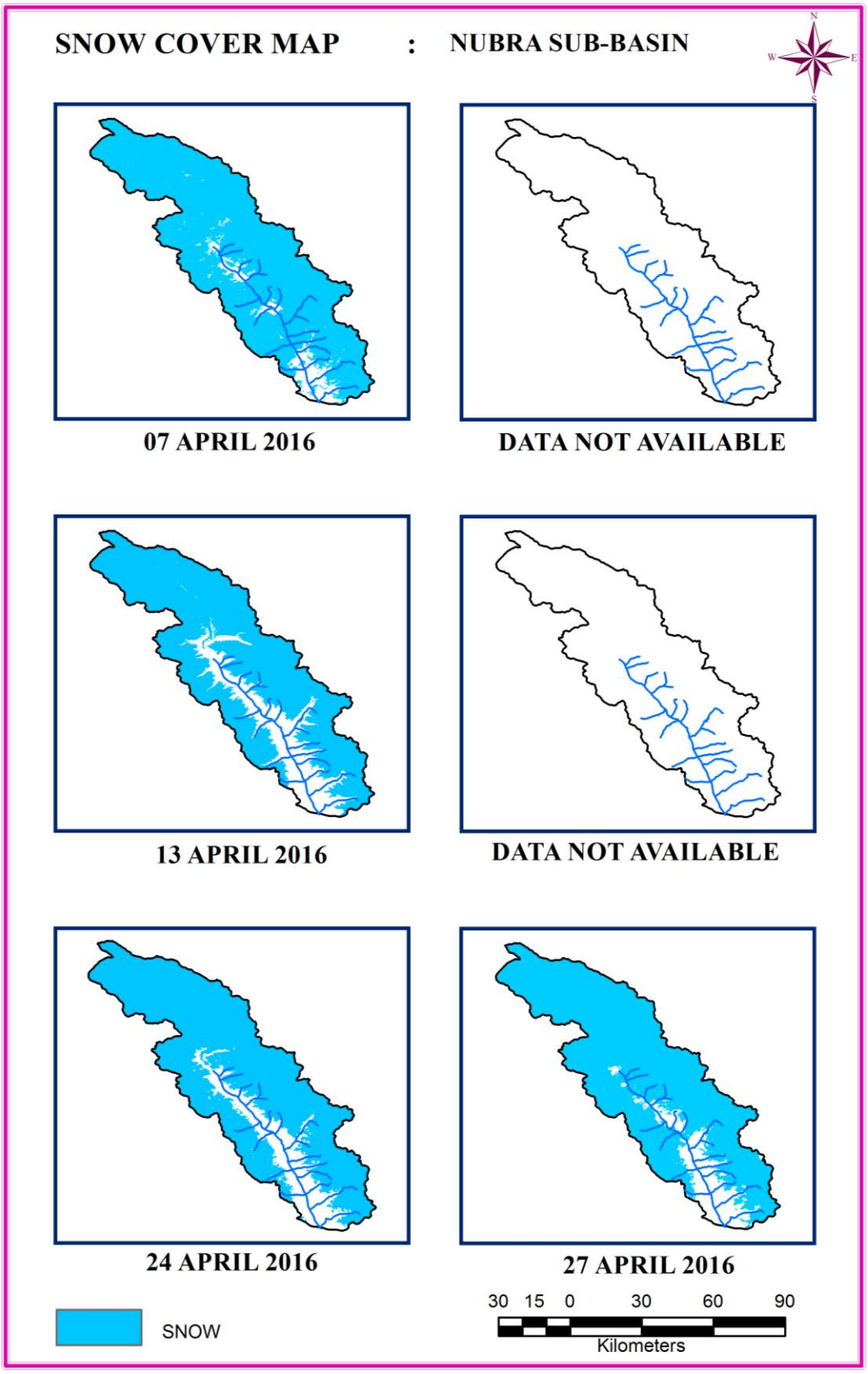
Kilometers


SNOW COVER MAP : NUBRA SUB-BASIN
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27 APRIL 2016
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Kilometers
SNOW

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

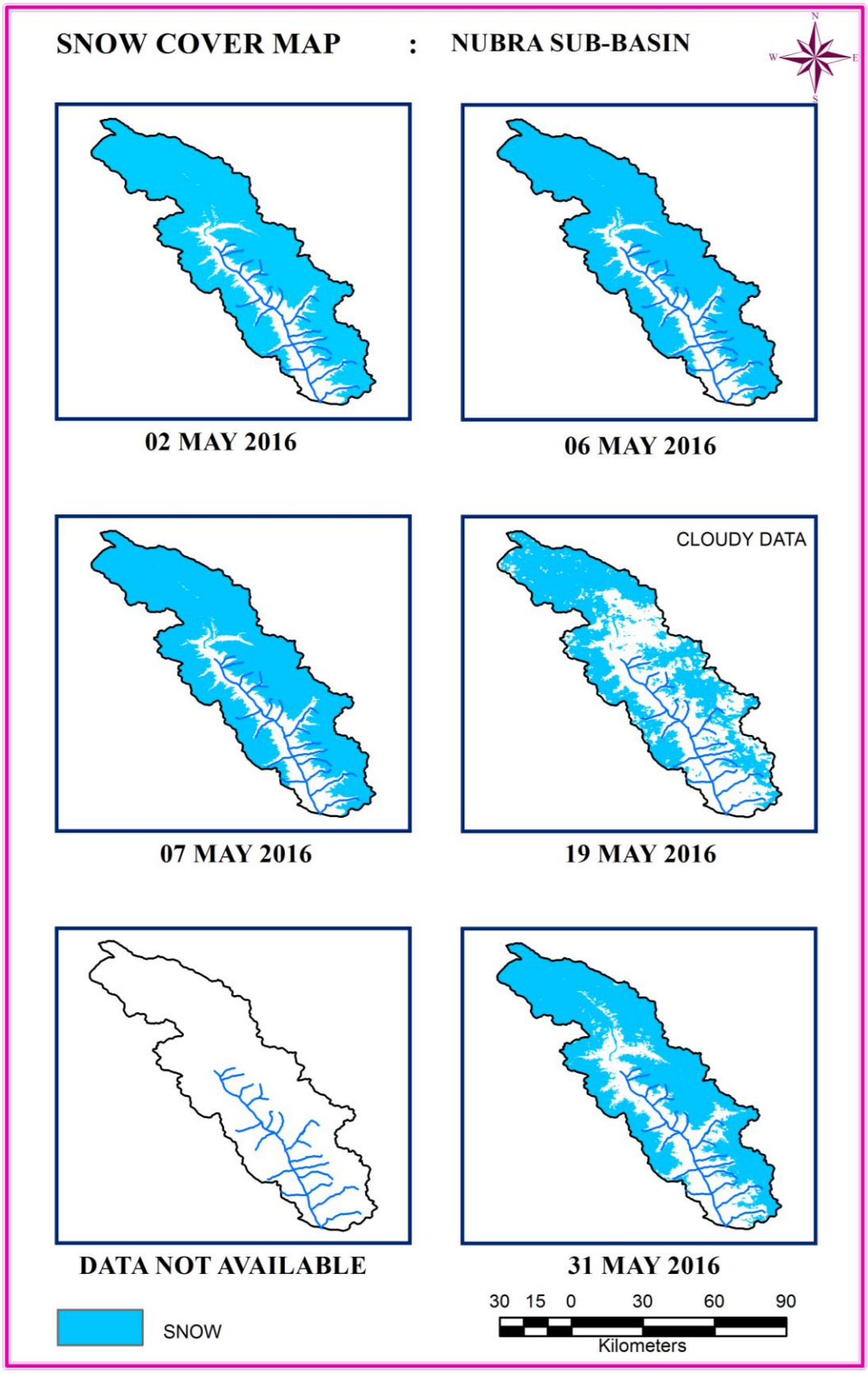
DATA NOT AVAILABLE

DATA USED
**15 APRIL 2016**

DATA USED
**24 APRIL 2016**
**27 APRIL 2016**

SNOW

30 15 0 30 60 90
Kilometers


SNOW COVER MAP : NUBRA SUB-BASIN
N
W
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02 MAY 2016
06 MAY 2016
07 MAY 2016
CLOUDY DATA
19 MAY 2016
DATA NOT AVAILABLE
31 MAY 2016
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

DATA USED
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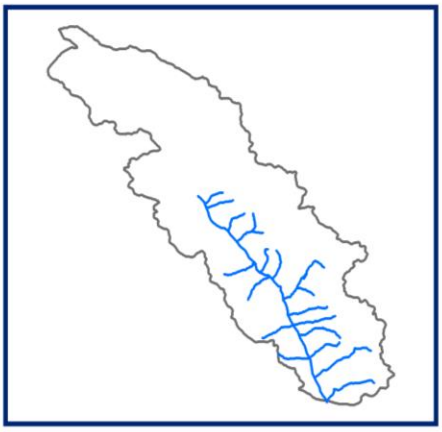
**06 MAY 2016**
**07 MAY 2016**



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DATA USED
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SNOW

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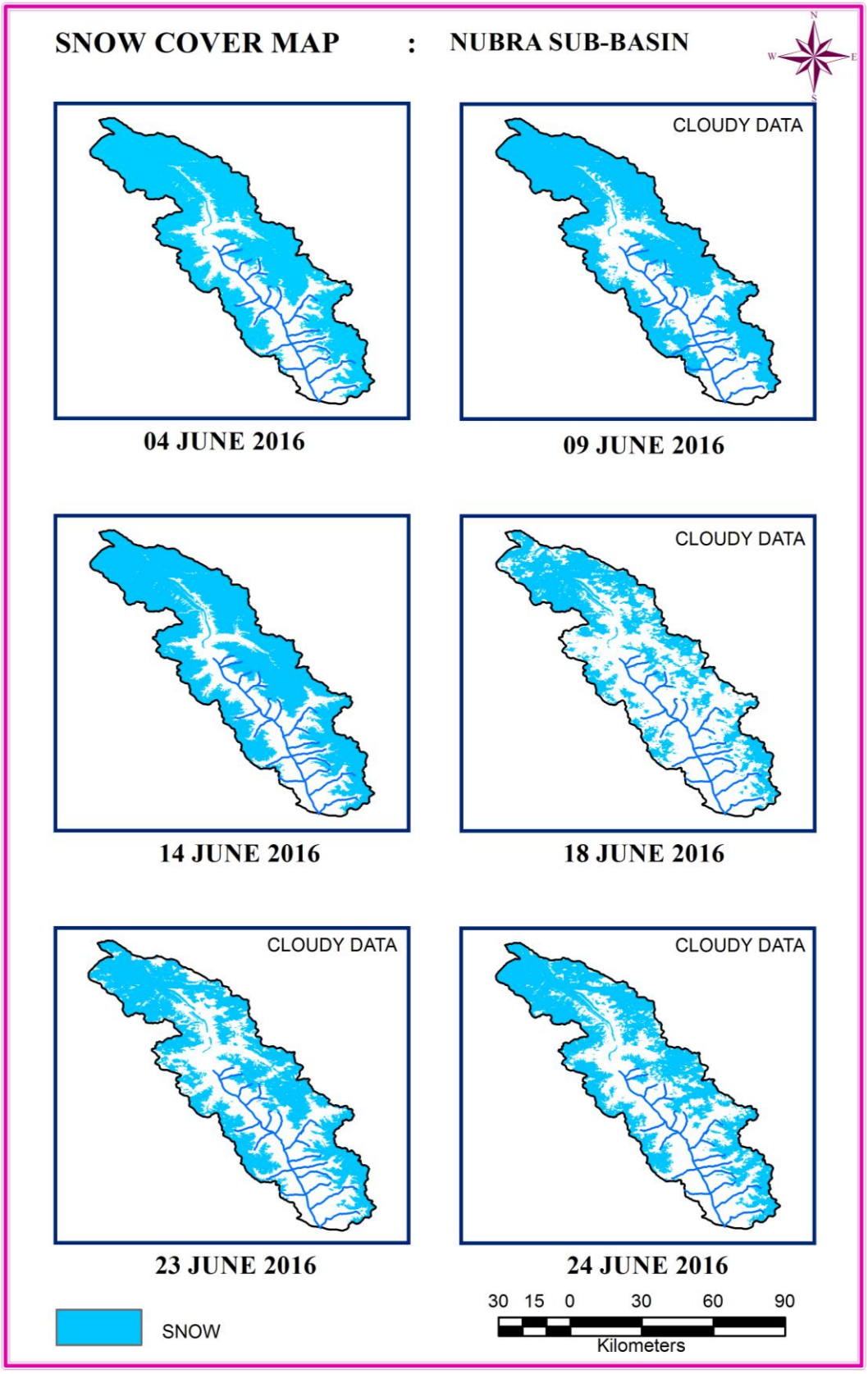
Kilometers


SNOW COVER MAP : NUBRA SUB-BASIN
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CLOUDY DATA
04 JUNE 2016
09 JUNE 2016
CLOUDY DATA
14 JUNE 2016
18 JUNE 2016
CLOUDY DATA
CLOUDY DATA
23 JUNE 2016
24 JUNE 2016
SNOW
30 15 0 30 60 90
Kilometers

## 10 DAILY SNOW COVER MAP : NUBRA SUB-BASIN

DATA USED
**04 JUNE 2016**
**09 JUNE 2016**

DATA USED
**14 JUNE 2016**
**18 JUNE 2016**

DATA USED
**23 JUNE 2016**
**24 JUNE 2016**

SNOW

30 15 0 30 60 90
Kilometers

# *SHYOK SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: SHYOK** **BASIN AREA: 27120sq km**

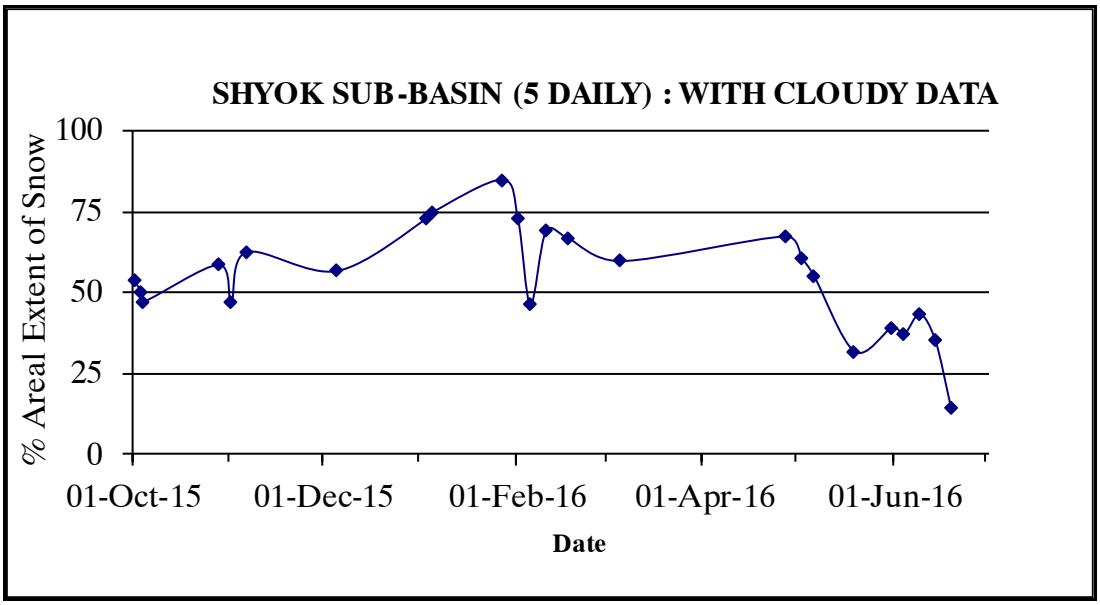
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 01-Oct-15 | 14524 | 54 | **3** | 05-Oct-15 | 12810 | 47 |
| **2** | 03-Oct-15 | 13653 | 50 | **4** | 15-Oct-15 | 15879 | 59 |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 12756 | 47 | **6** | 06-Nov-15 | 16949 | 62 |
| | | | | | | | |
| **December 2015** | | | | | | | |
| **7** | 05-Dec-15 | 15366 | 57 | | | | |
| | | | | | | | |
| **January 2016** | | | | | | | |
| **8** | 03-Jan-16 | 19790 | 73 | **10** | 27-Jan-16 | 23004 | 85 |
| **9** | 05-Jan-16 | 20343 | 75 | | | | |
| **February 2016** | | | | | | | |
| **11** | 01-Feb-16 | 19873 | 73 | **13** | 10-Feb-16 | 18680 | 69 |
| **12** | 05-Feb-16 | 12542 | 46 | **14** | 17-Feb-16 | 18124 | 67 |
| | | | | | | | |
| **March 2016** | | | | | | | |
| **15** | 05-Mar-16 | 16196 | 60 | | | | |
| | | | | | | | |
| **April 2016** | | | | | | | |
| **16** | 27-Apr-16 | 18256 | 67 | | | | |
| | | | | | | | |
| **May 2016** | | | | | | | |
| **17** | 02-May-16 | 16485 | 61 | **19** | 19-May-16 | 8639 | 32 |
| **18** | 06-May-16 | 14970 | 55 | | 31-May-16 | 10611 | 39 |
| **June 2016** | | | | | | | |
| **20** | 04-Jun-16 | 10096 | 37 | **22** | 14-Jun-16 | 9519 | 35 |
| **21** | 09-Jun-16 | 11769 | 43 | **23** | 19-Jun-16 | 3920 | 14 |

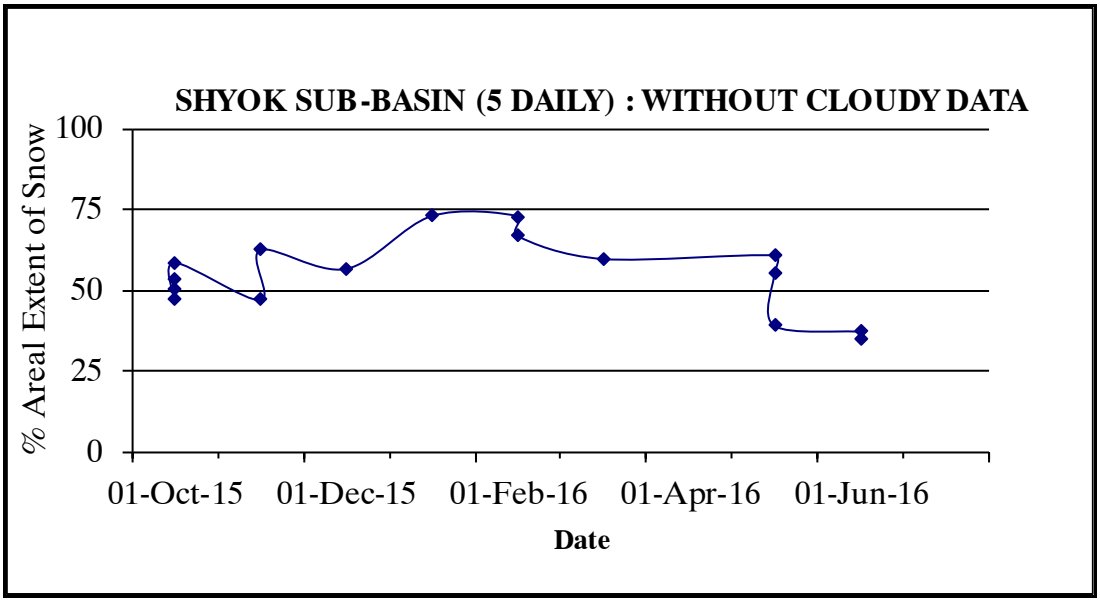
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: SHYOK** **BASIN AREA: 27120 sq km**

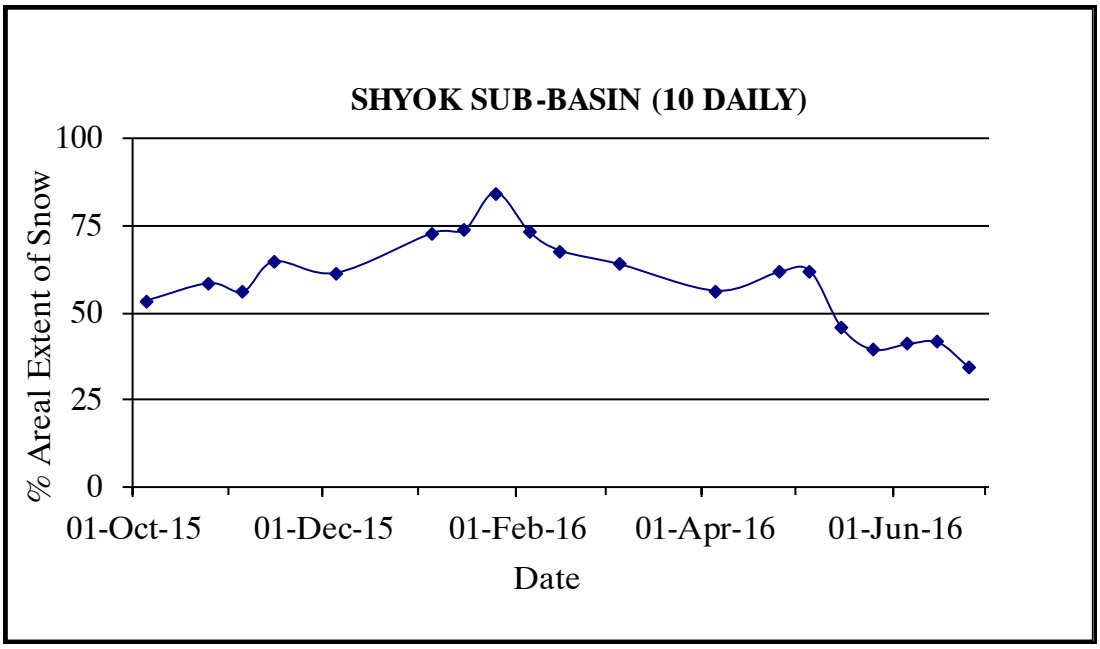
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 14526 | 54 | **3** | 05-Nov-15 | 15220 | 56 |
| **2** | 25-Oct-15 | 15870 | 59 | **4** | 15-Nov-15 | 17556 | 65 |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **5** | 05-Dec-15 | 16679 | 62 | **6** | 05-Jan-16 | 19788 | 73 |
| | | | | **7** | 15-Jan-16 | 19972 | 74 |
| | | | | **8** | 25-Jan-16 | 22907 | 84 |
| **February 2016** | | | | **March 2016** | | | |
| **9** | 05-Feb-16 | 19825 | 73 | **11** | 05-Mar-16 | 17331 | 64 |
| **10** | 15-Feb-16 | 18374 | 68 | | | | |
| | | | | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **12** | 05-Apr-16 | 15282 | 56 | **14** | 05-May-16 | 16799 | 62 |
| **13** | 25-Apr-16 | 16737 | 62 | **15** | 25-May-16 | 12443 | 46 |
| | | | | | | | |
| **June 2016** | | | | | | | |
| **16** | 05-Jun-2016 | 11128 | 41 | | | | |
| **17** | 15-Jun-2016 | 11275 | 42 | | | | |
| **18** | 15-Jun-2016 | 9331 | 34 | | | | |

## SNOW COVER DEPLETION CURVE

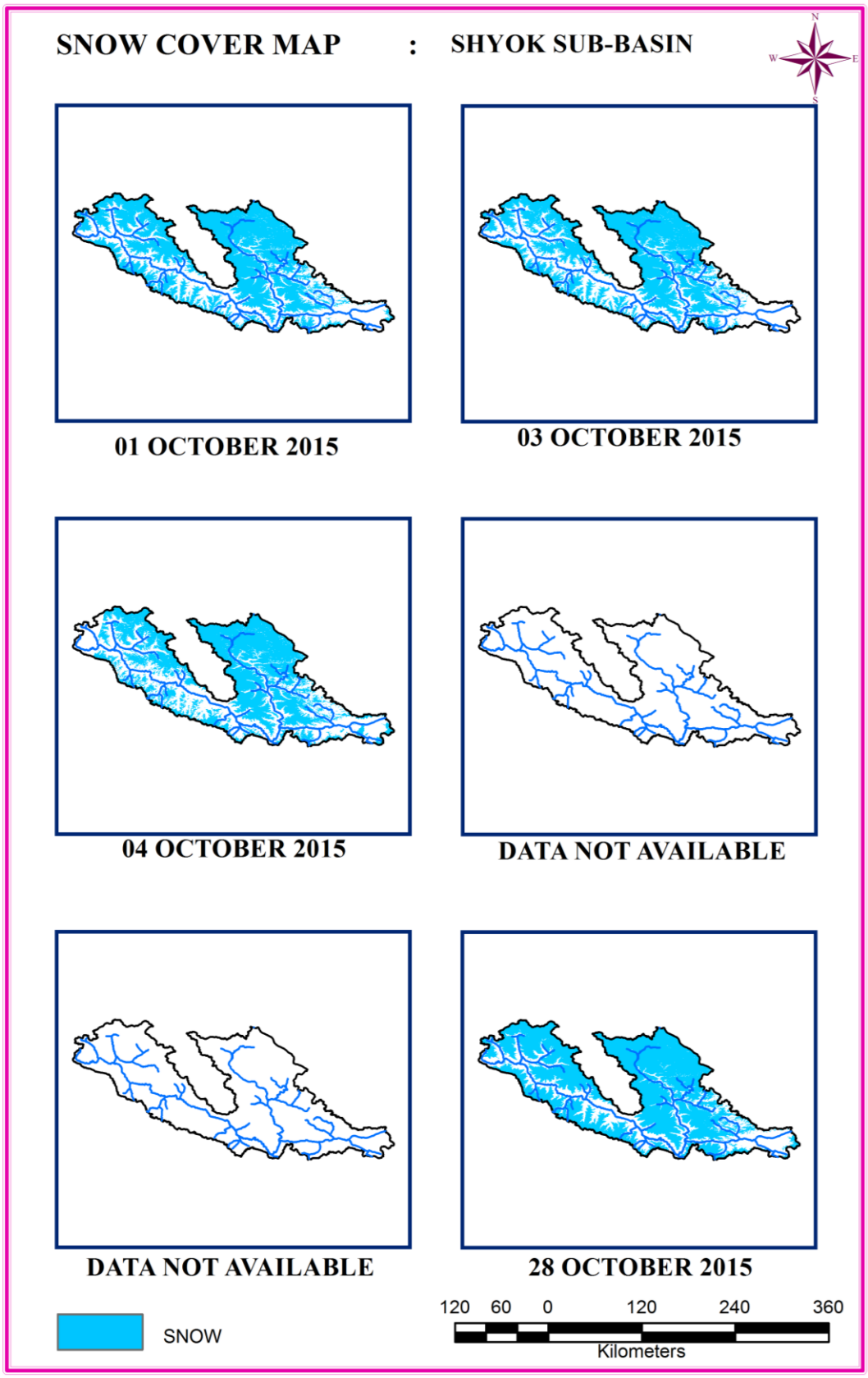


## SNOW COVER DEPLETION CURVE



# *SNOW COVER MAP*


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
01 OCTOBER 2015
03 OCTOBER 2015
04 OCTOBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
28 OCTOBER 2015
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

DATA USED

**01 OCTOBER 2015**

**03 OCTOBER 2015**

**04 OCTOBER 2015**

**DATA NOT AVAILABLE**

DATA USED

**25 OCTOBER 2015**

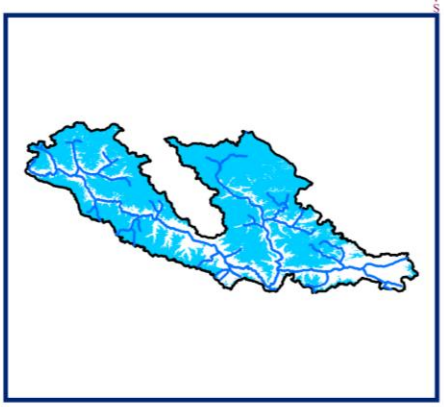
SNOW

110 55 0 110 220 330

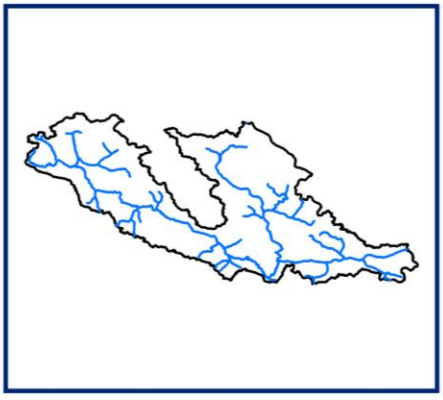
Kilometers

**SNOW COVER MAP : SHYOK SUB-BASIN**

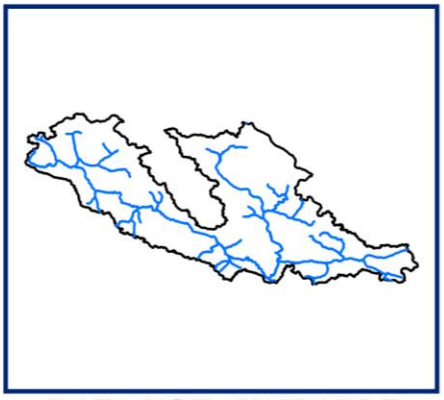
01 NOVEMBER 2015



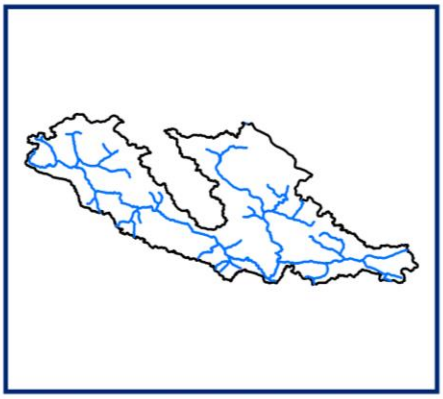
06NOVEMBER 2015



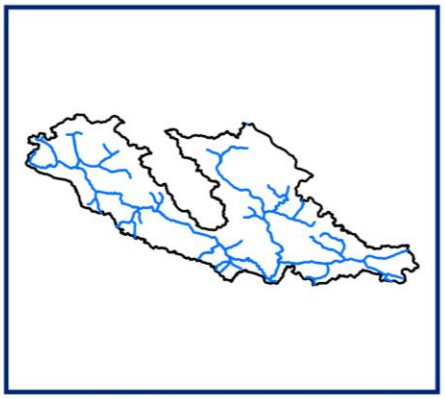
DATA NOT AVAILABLE



DATA NOT AVAILABLE



DATA NOT AVAILABLE



DATA NOT AVAILABLE

SNOW

120 60 0 120 240 360

Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

DATA USED
**01 NOVEMBER 2015**
**06 NOVEMBER 2015**

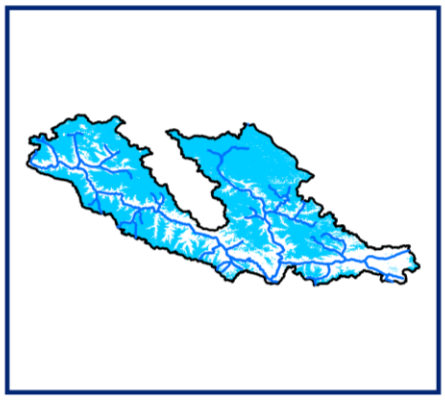
DATA USED
**15 NOVEMBER 2015**

**DATA NOT AVAILABLE**

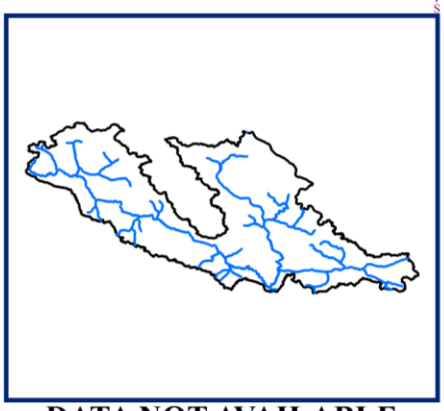
SNOW

110 55 0 110 220 330
Kilometers

**SNOW COVER MAP : SHYOK SUB-BASIN**



05 DECEMBER 2015

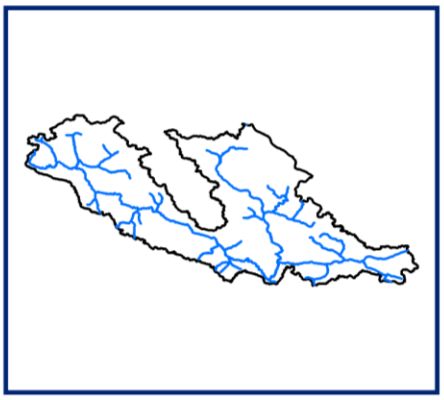


DATA NOT AVAILABLE

DATA NOT AVAILABLE

DATA NOT AVAILABLE

DATA NOT AVAILABLE



DATA NOT AVAILABLE

SNOW

120 60 0 120 240 360

Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

DATA USED

**05 DECEMBER 2015**

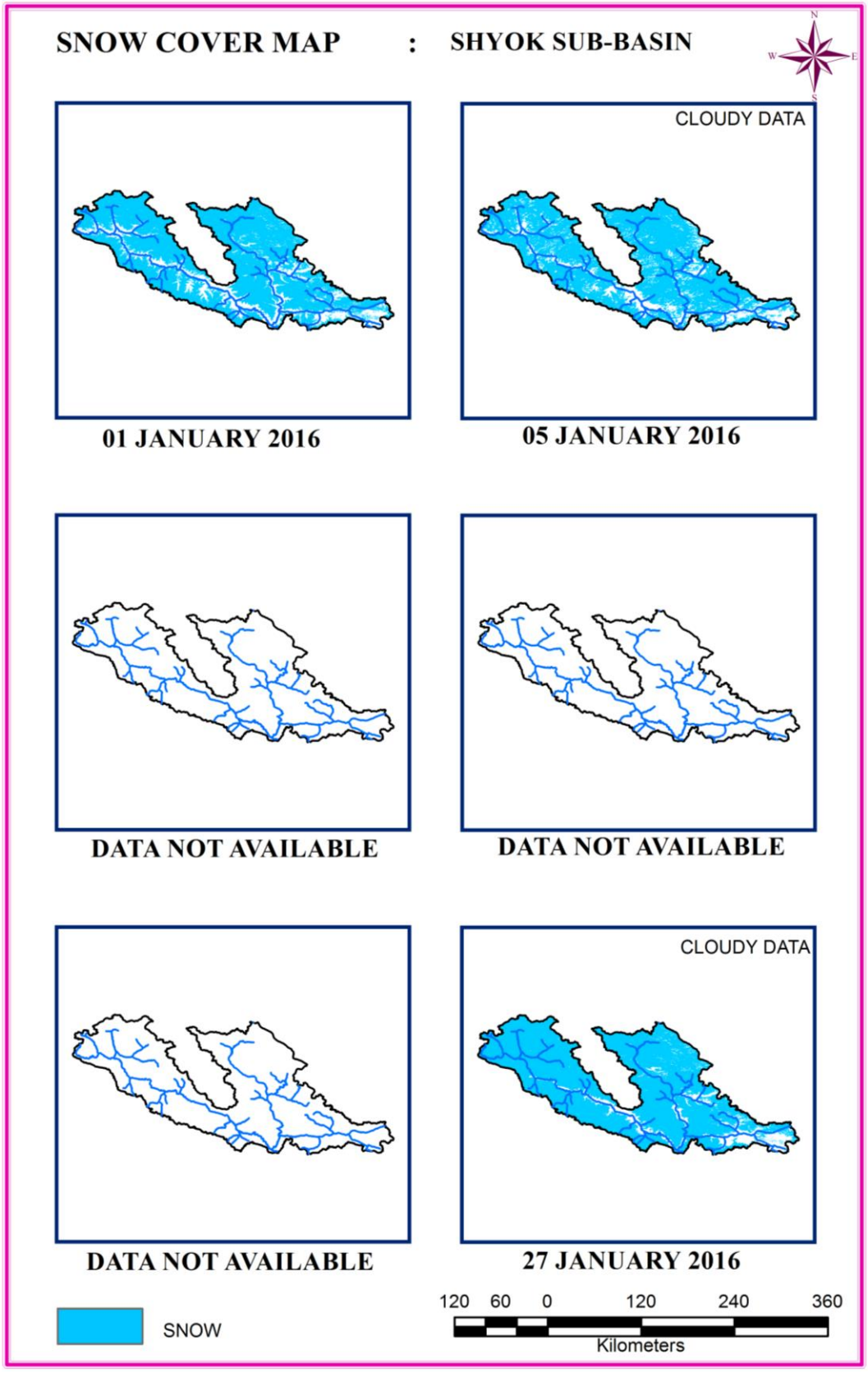
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

110 55 0 110 220 330

Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
CLOUDY DATA
01 JANUARY 2016
05 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
CLOUDY DATA
27 JANUARY 2016
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

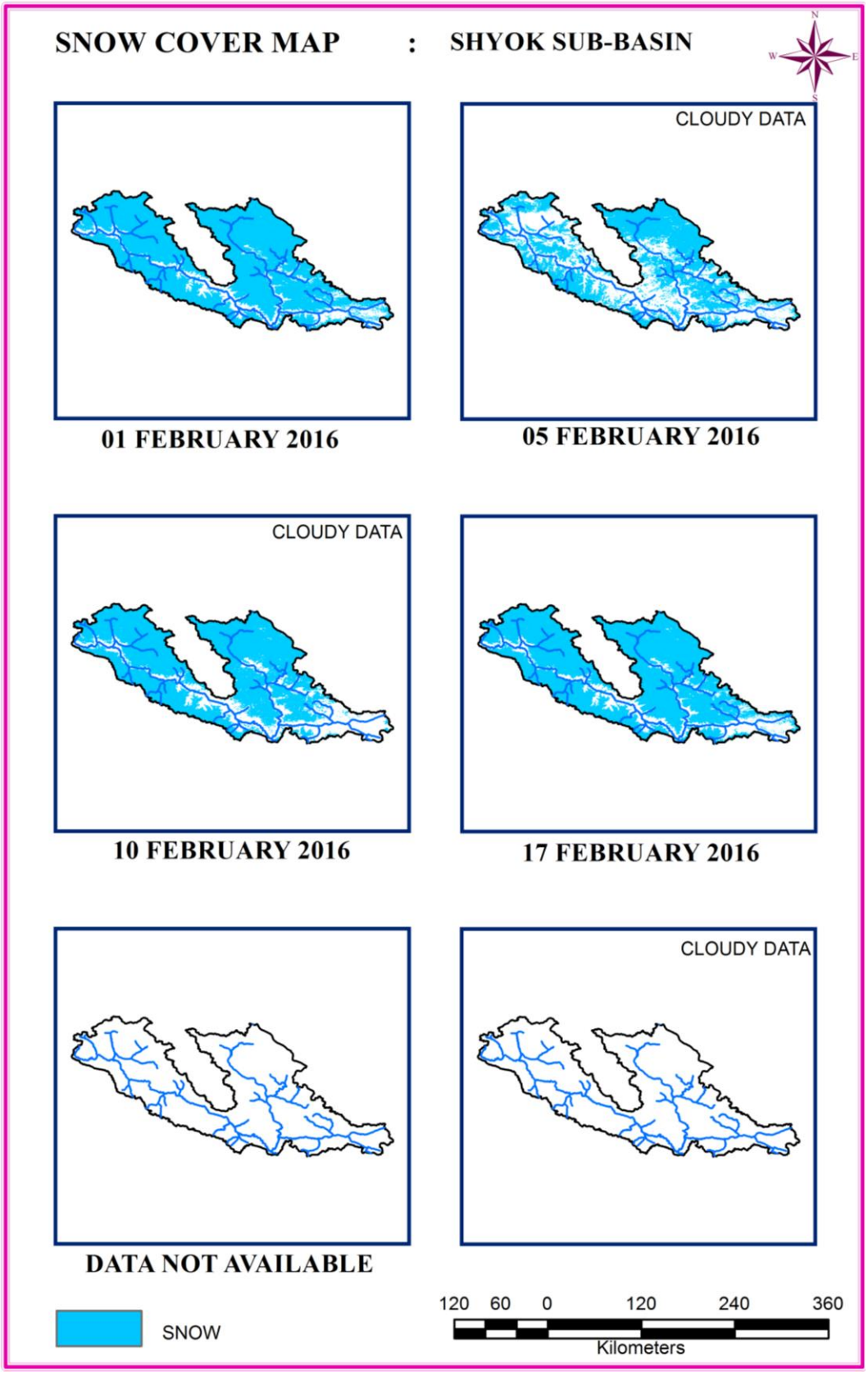
DATA USED
**03 JANUARY 2016**
**05 JANUARY 2016**

DATA USED
**15 JANUARY 2016**

DATA USED
**25 JANUARY 2016**

SNOW

110 55 0 110 220 330
Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
CLOUDY DATA
01 FEBRUARY 2016
CLOUDY DATA
05 FEBRUARY 2016
CLOUDY DATA
10 FEBRUARY 2016
17 FEBRUARY 2016
DATA NOT AVAILABLE
CLOUDY DATA
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

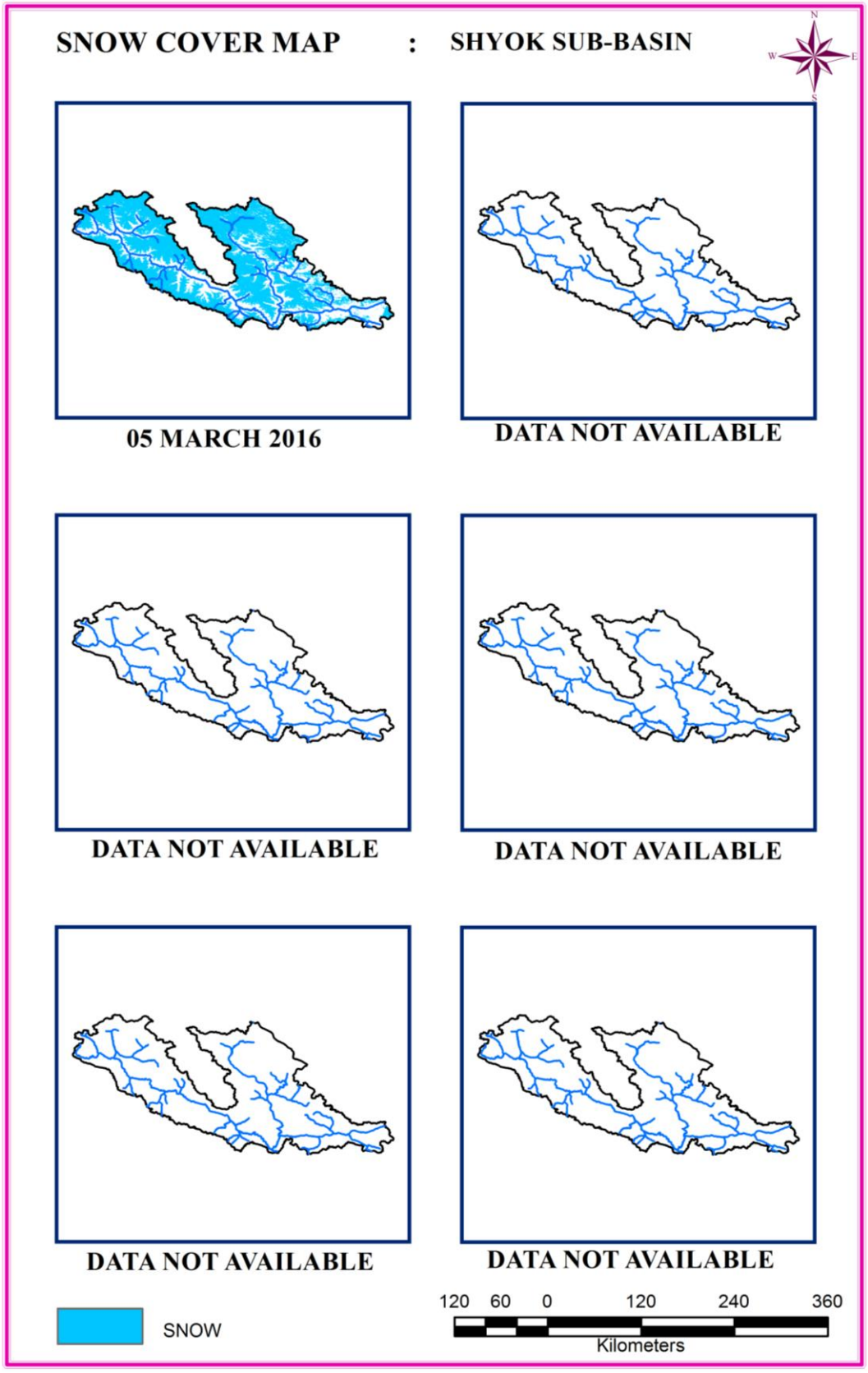
DATA USED
**01 FEBRUARY 2016**
**05 FEBRUARY 2016**

DATA USED
**15 FEBRUARY 2016**

**DATA NOT AVAILABLE**

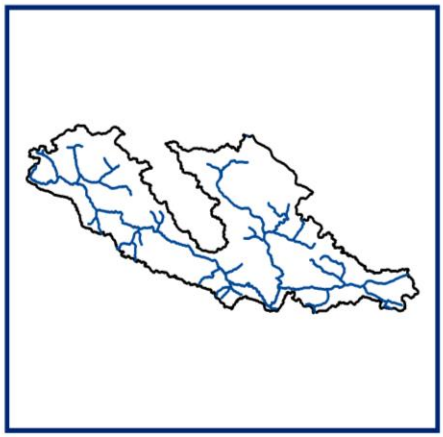
SNOW

110 55 0 110 220 330
Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
05 MARCH 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

DATA USED
**05 MARCH 2016**

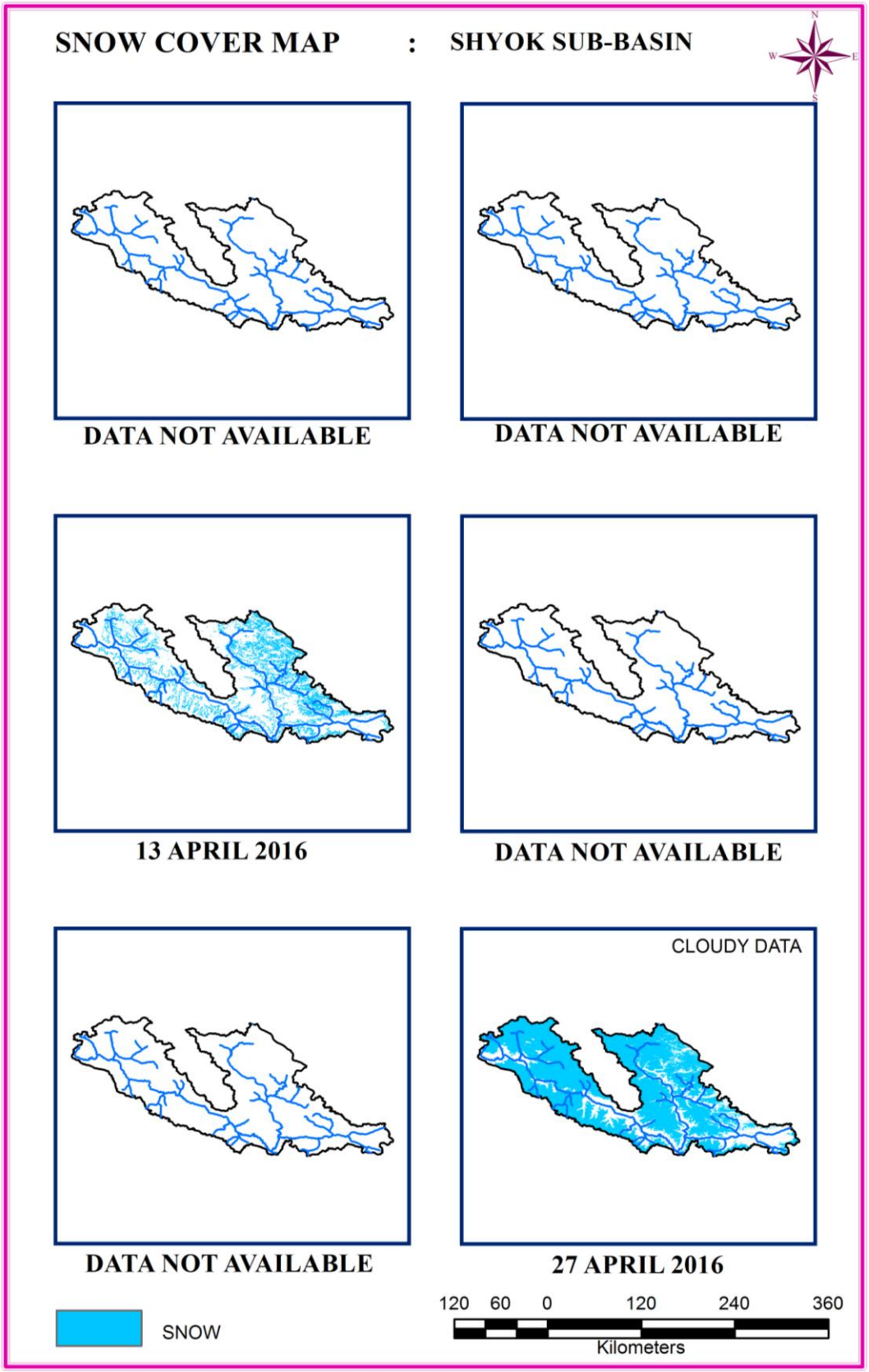


**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

110 55 0 110 220 330
Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
DATA NOT AVAILABLE
DATA NOT AVAILABLE
13 APRIL 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
CLOUDY DATA
27 APRIL 2016
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

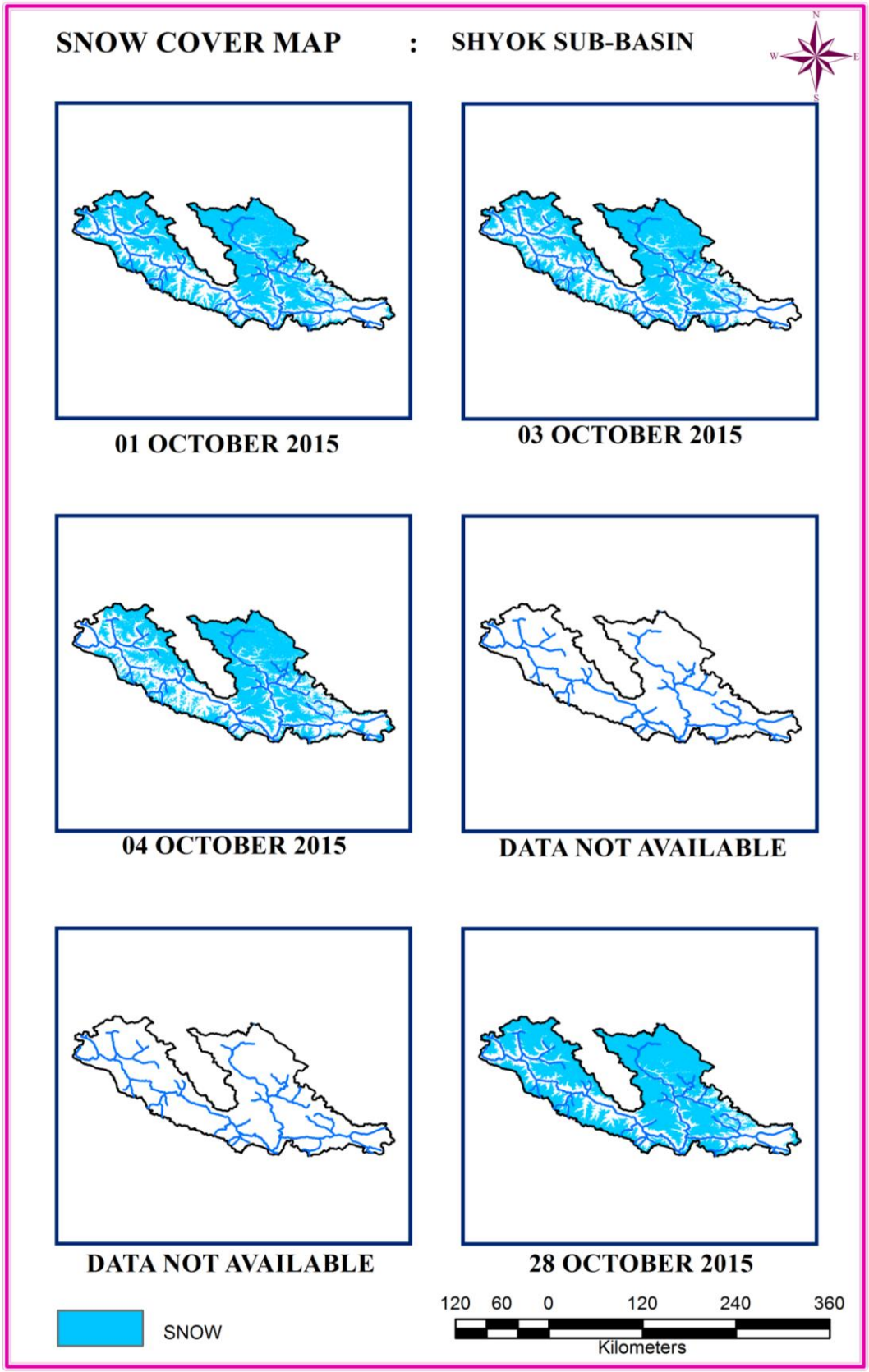
**DATA NOT AVAILABLE**

DATA USED
**15 APRIL 2016**

DATA USED
**25 APRIL 2016**

SNOW

110 55 0 110 220 330
Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
01 OCTOBER 2015
03 OCTOBER 2015
04 OCTOBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
28 OCTOBER 2015
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

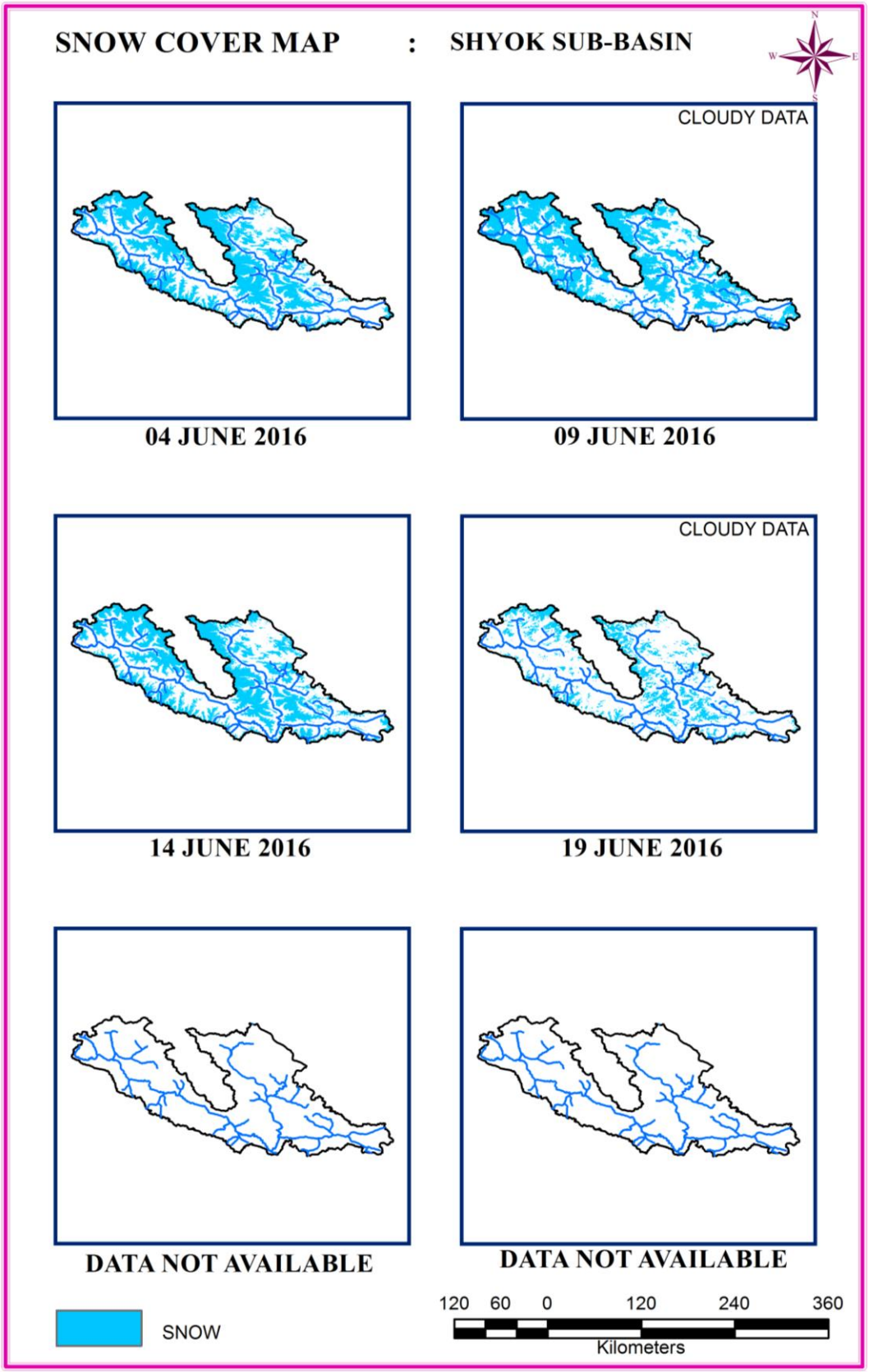
DATA USED
**02 MAY 2016**
**06 MAY 2016**

DATA USED
**15 MAY 2016**

DATA USED
**25 MAY 2016**

SNOW

110 55 0 110 220 330
Kilometers


SNOW COVER MAP : SHYOK SUB-BASIN
N
W
E
S
CLOUDY DATA
04 JUNE 2016
09 JUNE 2016
CLOUDY DATA
14 JUNE 2016
19 JUNE 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
120 60 0 120 240 360
Kilometers

## 10 DAILY SNOW COVER MAP : SHYOK SUB-BASIN

DATA USED
**04 JUNE 2016**
**09 JUNE 2016**

DATA USED
**14 JUNE 2016**
**19 JUNE 2016**

DATA USED
**25 JUNE 2016**

SNOW

110 55 0 110 220 330
Kilometers

# *SHIGAR SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: SHIGAR** **BASIN AREA: 7050 sq km**

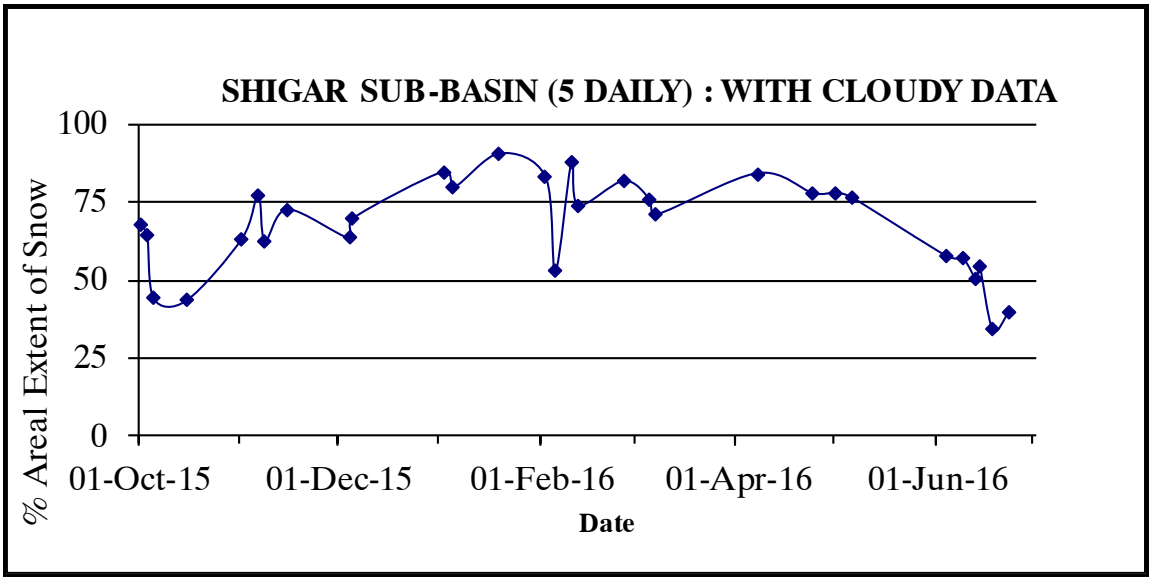
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 01-Oct-15 | 4782 | 68 | **3** | 05-Oct-15 | 3113 | 44 |
| **2** | 03-Oct-15 | 4529 | 64 | **4** | 15-Oct-15 | 3074 | 63 |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 4463 | 63 | **7** | 08-Nov-15 | 4413 | 63 |
| **6** | 06-Nov-15 | 5453 | 77 | **8** | 15-Nov-15 | 5122 | 73 |
| **December 2015** | | | | | | | |
| **9** | 04-Dec-15 | 4473 | 63 | **10** | 05-Dec-15 | 4920 | 70 |
| | | | | | | | |
| **January 2016** | | | | | | | |
| **11** | 02-Jan-16 | 5981 | 85 | **13** | 19-Jan-16 | 6379 | 90 |
| **12** | 05-Jan-16 | 5622 | 80 | | | | |
| **February 2016** | | | | | | | |
| **14** | 02-Feb-16 | 5849 | 83 | **17** | 10-Feb-16 | 5214 | 74 |
| **15** | 05-Feb-16 | 3728 | 53 | **18** | 12-Feb-16 | 5762 | 82 |
| **16** | 09-Feb-16 | 6211 | 88 | **19** | 26-Feb-16 | 5341 | 76 |
| **March 2016** | | | | | | | |
| **20** | 05-Mar-16 | 5341 | 76 | **22** | 07-Mar-16 | 5007 | 71 |
| | | | | | | | |
| **April 2016** | | | | | | | |
| **24** | 07-Apr-16 | 5935 | 84 | **26** | 24-Apr-16 | 5484 | 78 |
| | | | | | | | |
| **May 2016** | | | | | | | |
| **27** | 01-May-16 | 5499 | 78 | **28** | 06-May-16 | 5382 | 76 |
| **June 2016** | | | | | | | |
| **29** | 04-Jun-16 | 4068 | 58 | **33** | 14-Jun-16 | 3849 | 55 |
| **30** | 09-Jun-16 | 4006 | 57 | **34** | 18-Jun-16 | 2420 | 34 |
| **31** | 13-Jun-16 | 3549 | 50 | **35** | 23-Jun-16 | 2820 | 40 |

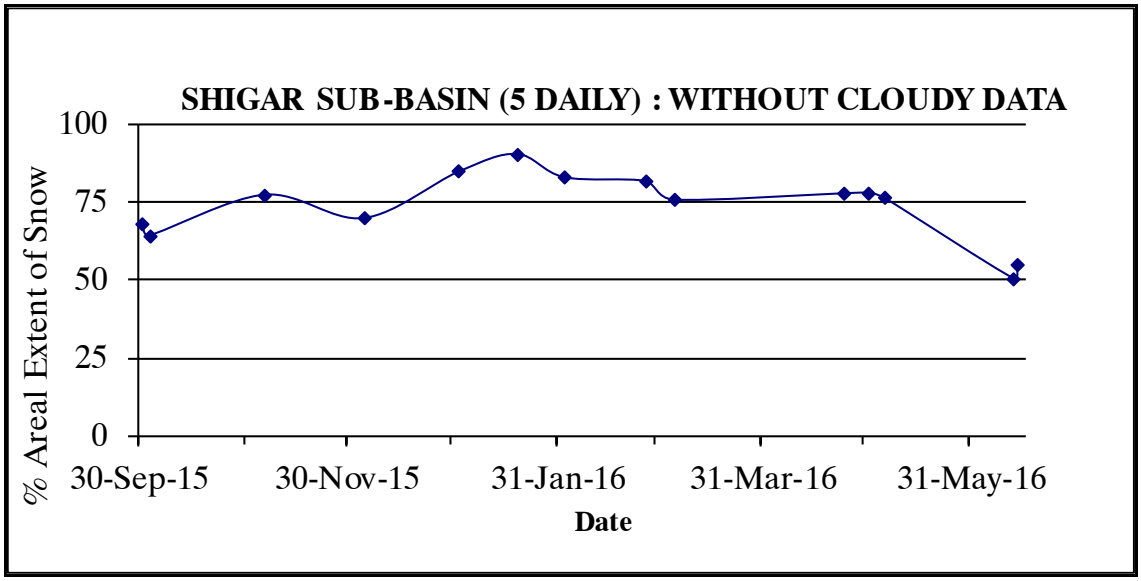
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: SHIGAR** **BASIN AREA: 7050sq km**

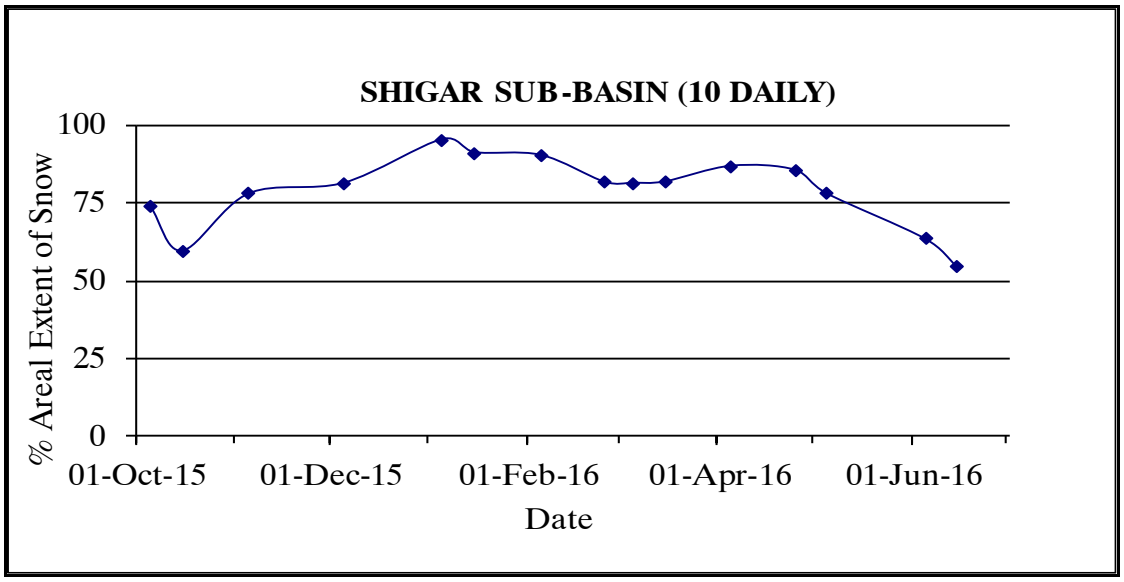
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 5205 | 74 | **3** | 05-Nov-15 | 5398 | 78 |
| **2** | 15-Oct-15 | 4209 | 60 | | | | |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **4** | 05-Dec-15 | 5739 | 81 | **5** | 05-Jan-16 | 6724 | 95 |
| | | | | **6** | 15-Jan-16 | 6428 | 91 |
| | | | | **7** | 25-Jan-16 | | |
| **February 2016** | | | | **March 2016** | | | |
| **8** | 05-Feb-16 | 6365 | 90 | **11** | 05-Mar-16 | 5739 | 81 |
| **9** | 25-Feb-16 | 5761 | 82 | **12** | 15-Mar-16 | 5768 | 82 |
| | | | | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **13** | 05-Apr-16 | 6123 | 87 | **15** | 05-May-16 | 5382 | 78 |
| **14** | 25-Apr-16 | 6031 | 86 | | | | |
| | | | | | | | |
| **June 2016** | | | | | | | |
| **17** | 05-Jun-2016 | 4478 | 64 | | | | |
| **18** | 15-Jun-2016 | 3850 | 55 | | | | |

## SNOW COVER DEPLETION CURVE

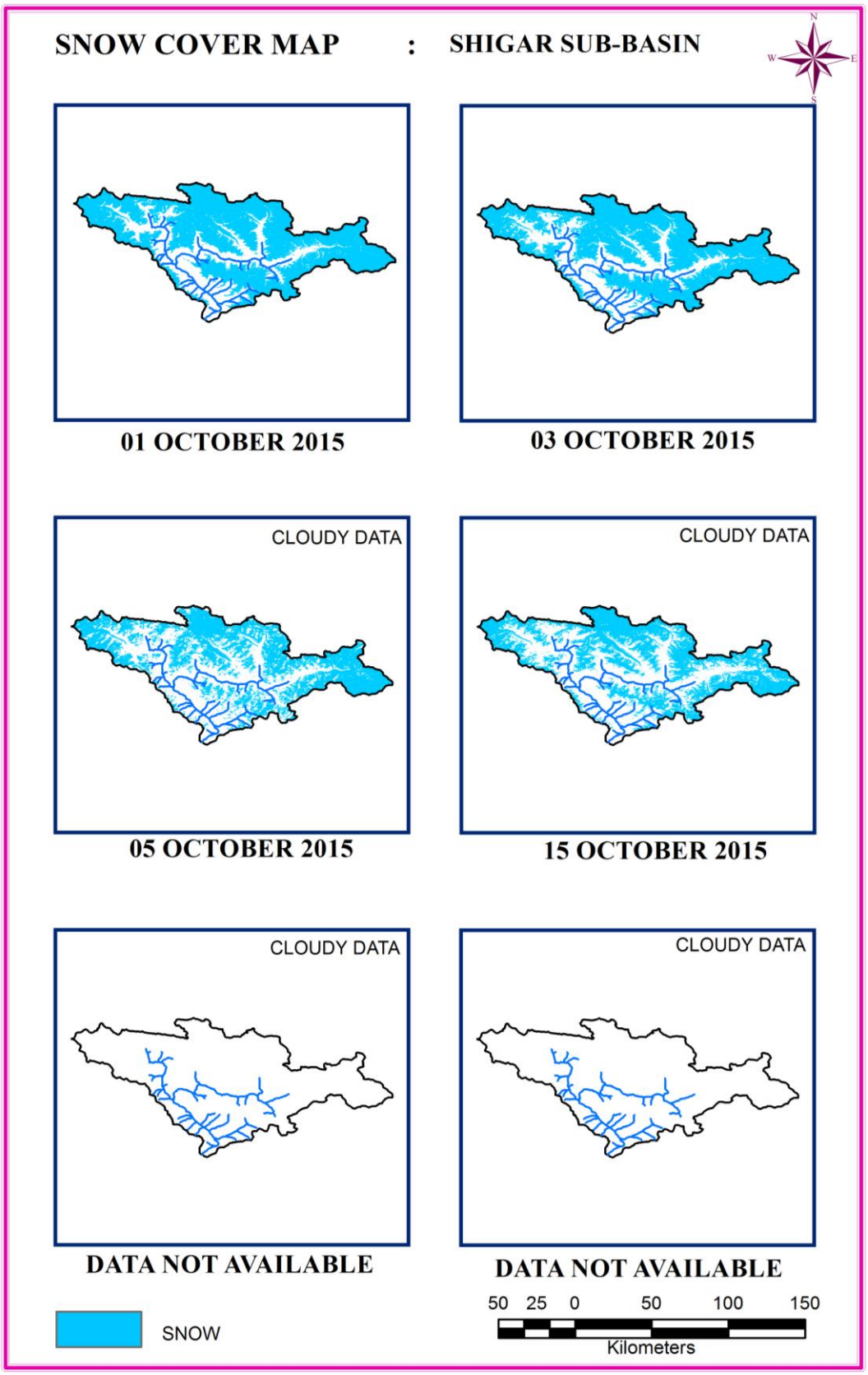


## SNOW COVER DEPLETION CURVE



# *SNOW COVER MAP*


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
01 OCTOBER 2015
03 OCTOBER 2015
CLOUDY DATA
05 OCTOBER 2015
CLOUDY DATA
15 OCTOBER 2015
CLOUDY DATA
DATA NOT AVAILABLE
CLOUDY DATA
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

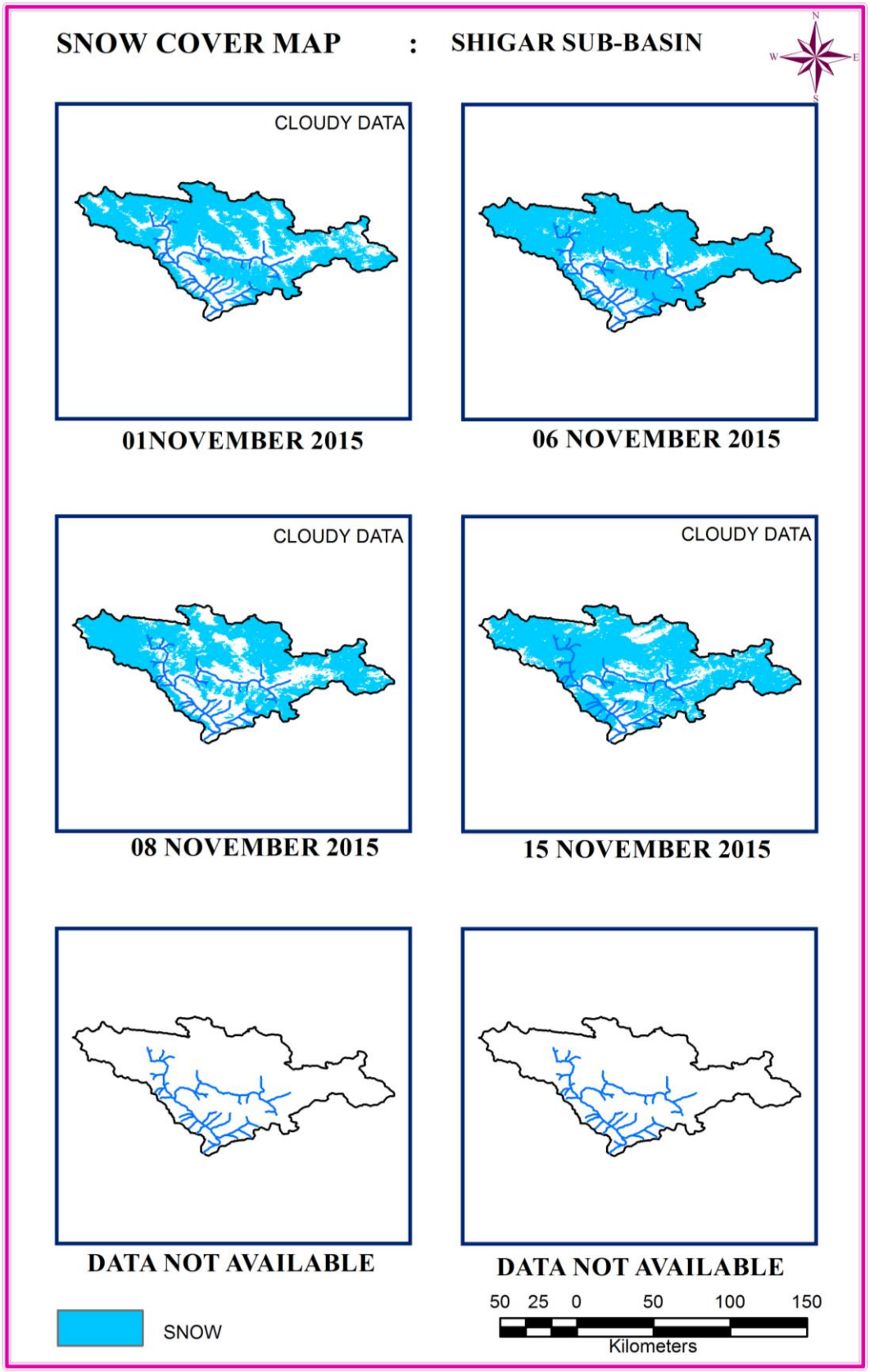
DATA USED
**01 OCTOBER 2015**
**03 OCTOBER 2015**
**05 OCTOBER 2015**

DATA USED
**15 OCTOBER 2015**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120
Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
01NOVEMBER 2015
06 NOVEMBER 2015
CLOUDY DATA
08 NOVEMBER 2015
CLOUDY DATA
15 NOVEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

DATA USED

**01 NOVEMBER 2015**

**06 NOVEMBER 2015**

**08 NOVEMBER 2015**

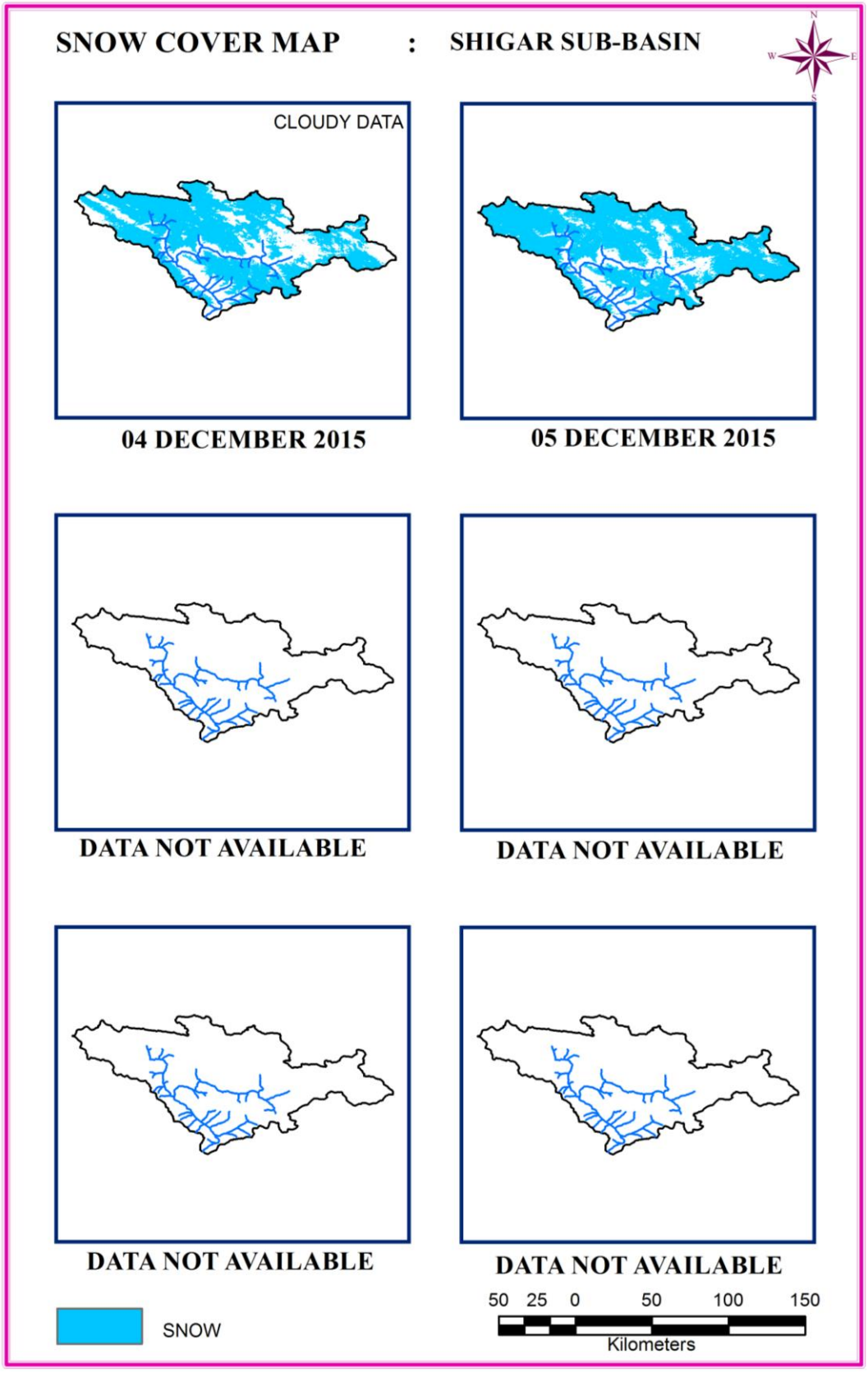
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120

Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
04 DECEMBER 2015
05 DECEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

DATA USED

**04 DECEMBER 2015**

**05 DECEMBER 2015**

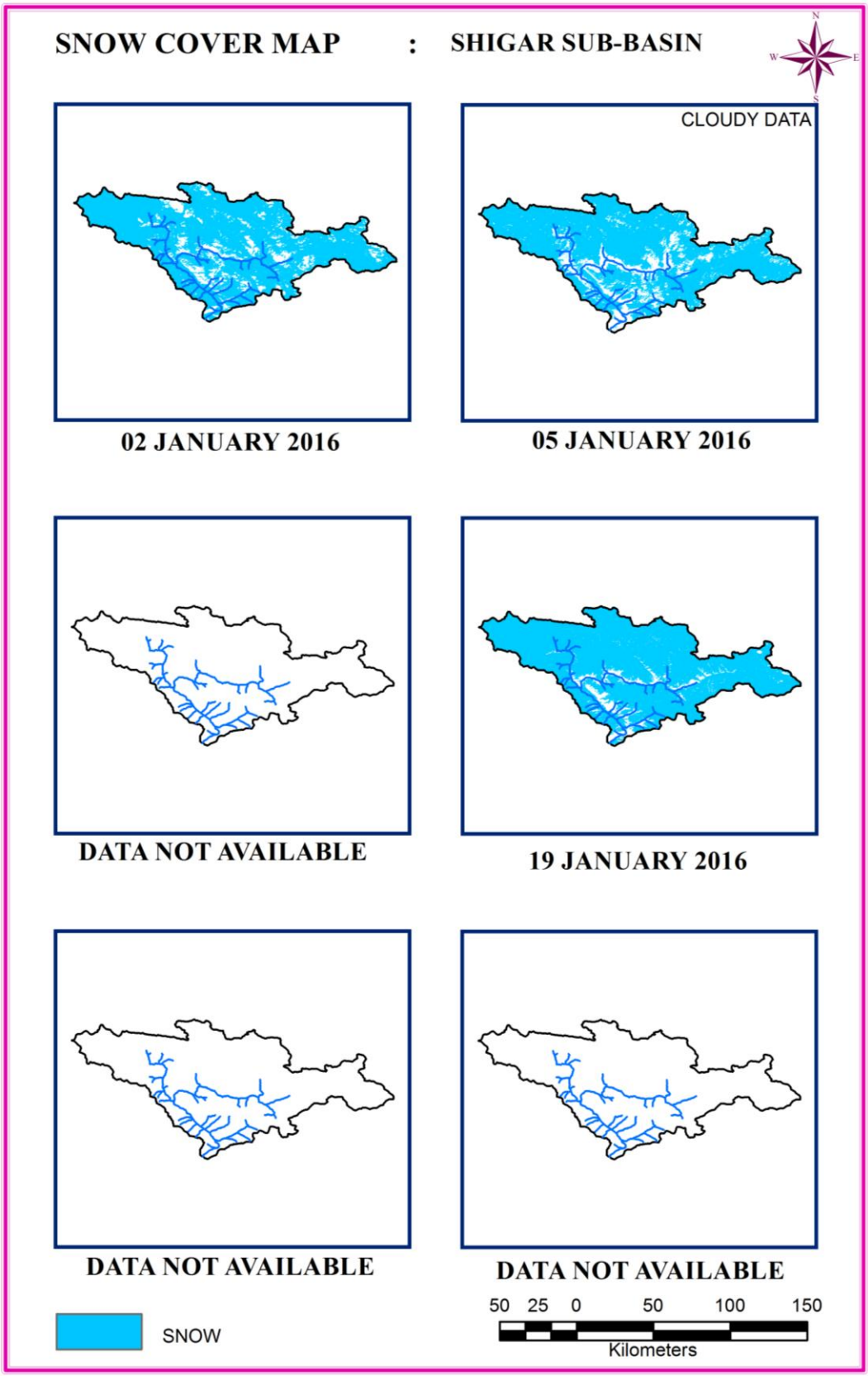
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120

Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
02 JANUARY 2016
05 JANUARY 2016
DATA NOT AVAILABLE
19 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

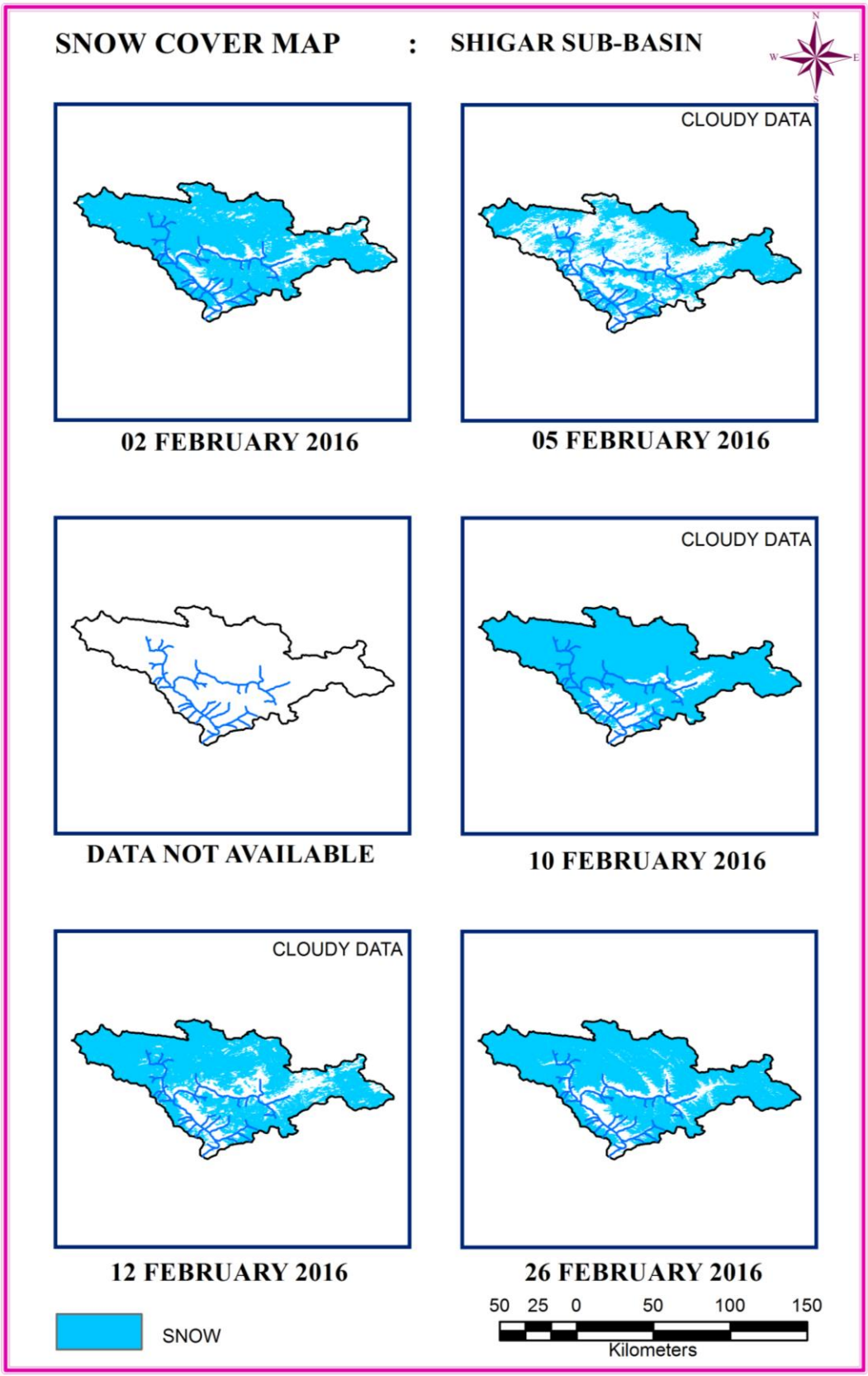
DATA USED
**02 JANUARY 2016**
**05 JANUARY 2016**

DATA USED
**15 JANUARY 2016**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120
Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
02 FEBRUARY 2016
05 FEBRUARY 2016
DATA NOT AVAILABLE
CLOUDY DATA
10 FEBRUARY 2016
CLOUDY DATA
12 FEBRUARY 2016
26 FEBRUARY 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

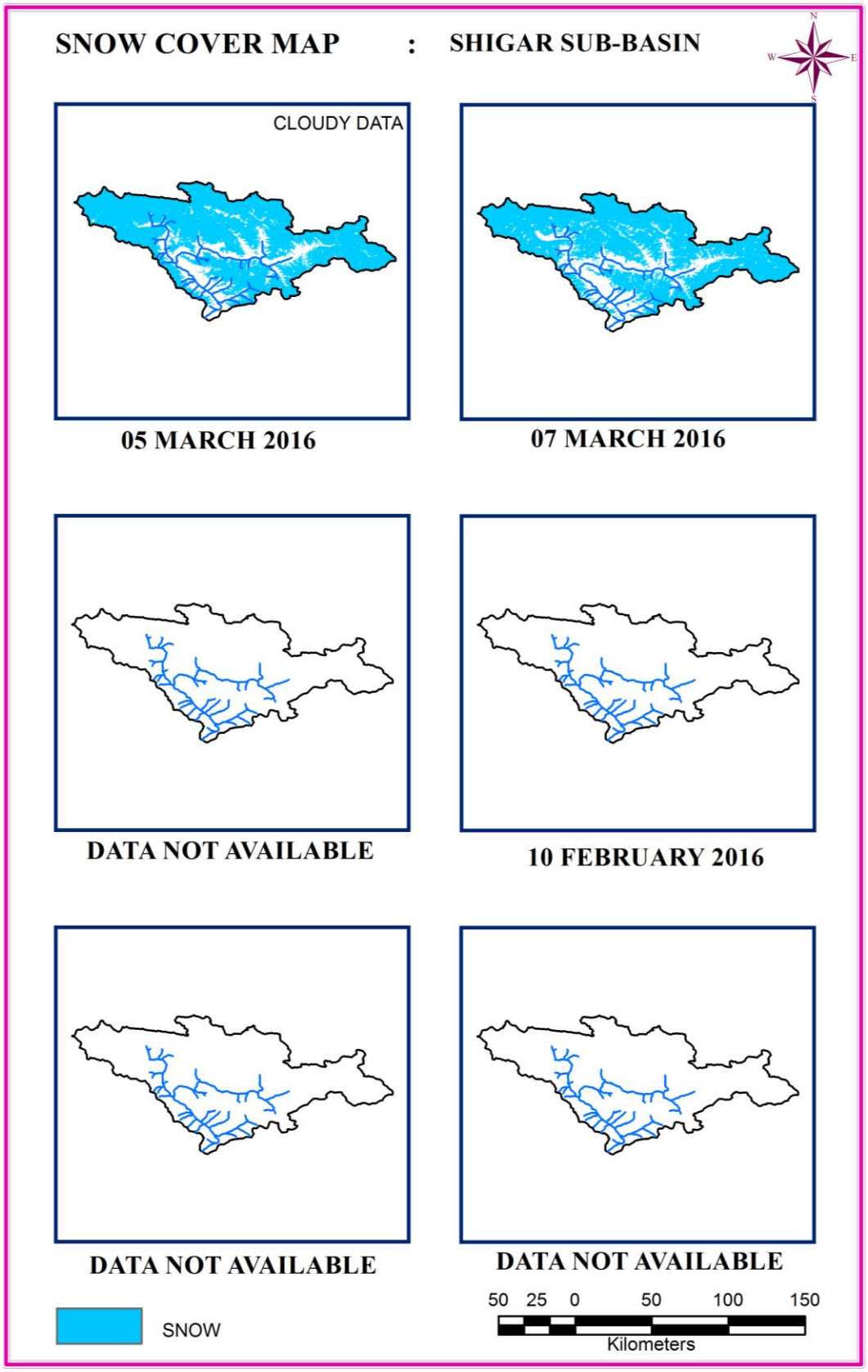
DATA USED
**02 FEBRUARY 2016**
**05 FEBRUARY 2016**
**10 FEBRUARY 2016**

**DATA NOT AVAILABLE**

DATA USED
**25 FEBRUARY 2016**

SNOW

40 20 0 40 80 120
Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
05 MARCH 2016
07 MARCH 2016
DATA NOT AVAILABLE
10 FEBRUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

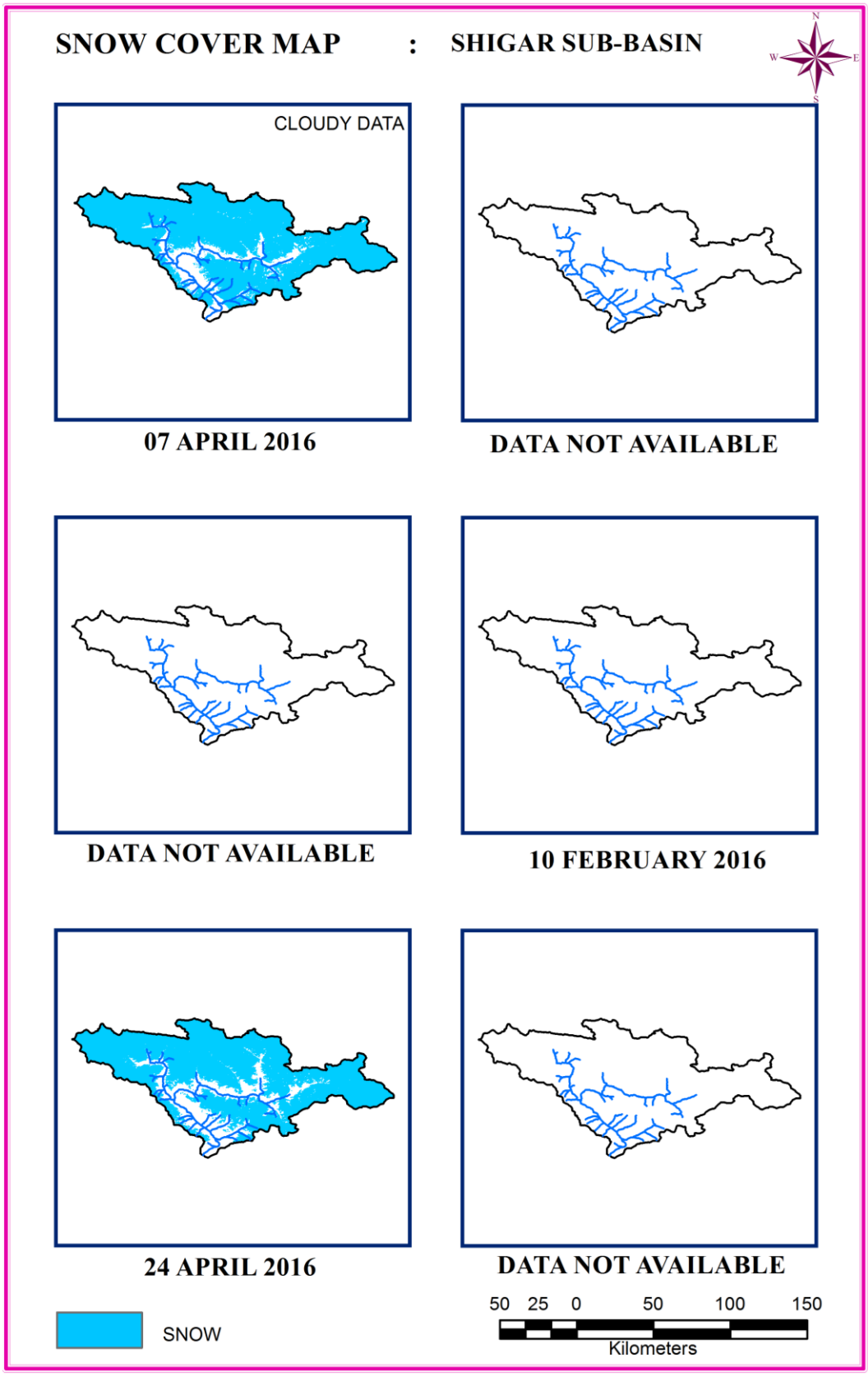
DATA USED
**05 MARCH 2016**
**07 MARCH 2016**

DATA USED
**15 MARCH 2016**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120
Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
CLOUDY DATA
07 APRIL 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
10 FEBRUARY 2016
24 APRIL 2016
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

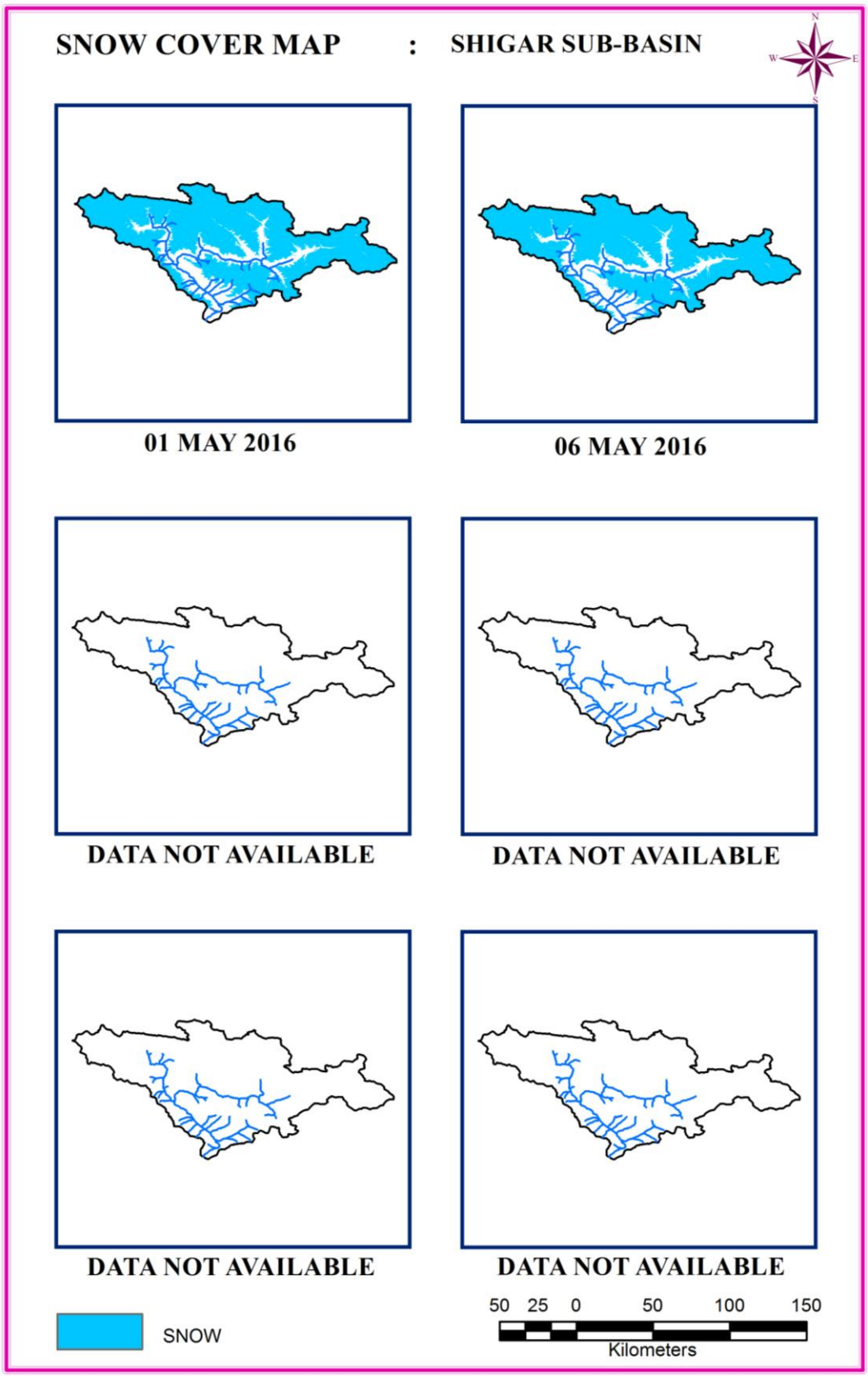
DATA USED
**05 APRIL 2016**

**DATA NOT AVAILABLE**

DATA USED
**25 APRIL 2016**

SNOW

40 20 0 40 80 120
Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
N
W
E
S
01 MAY 2016
06 MAY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

DATA USED

**01 MAY 2016**

**06 MAY 2016**

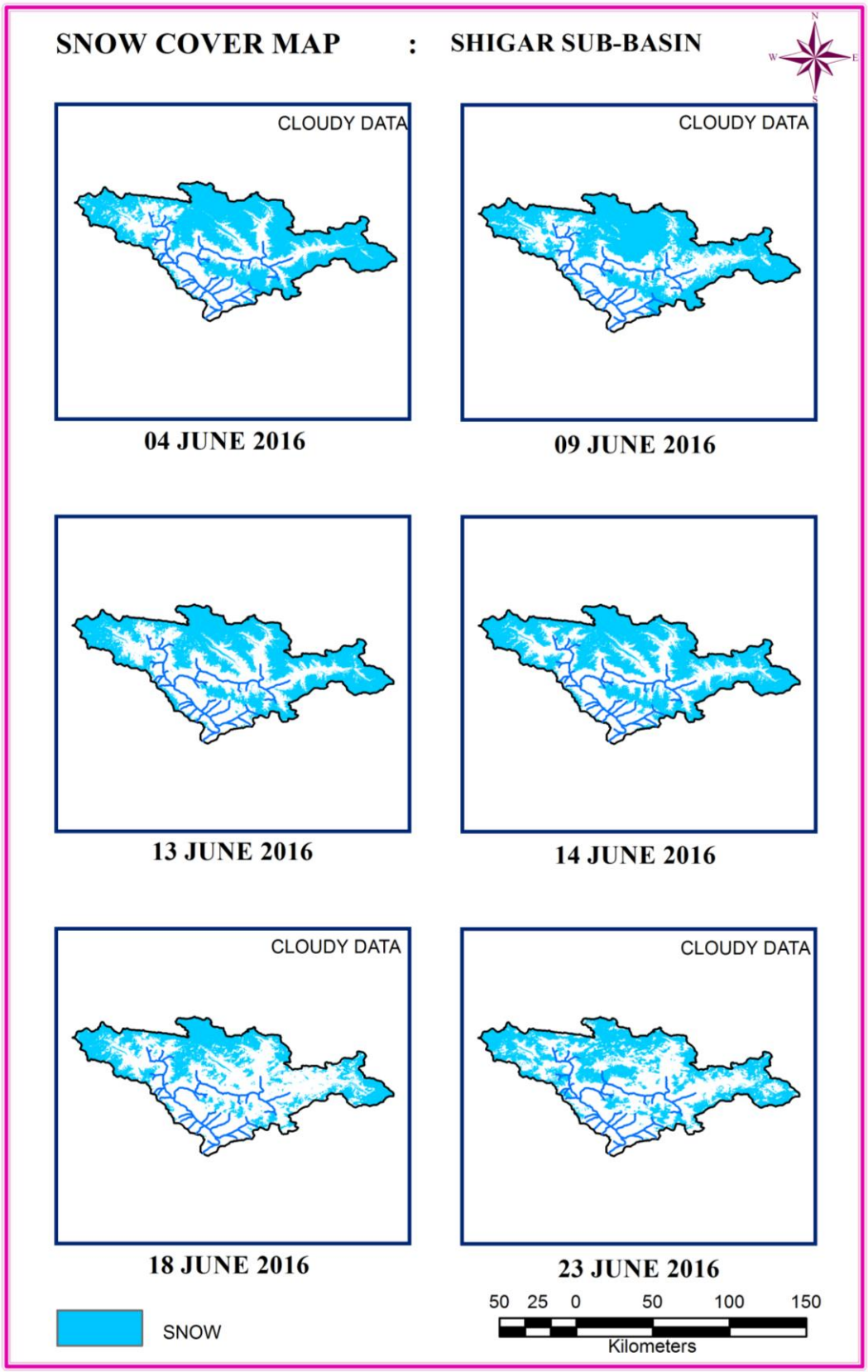
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120

Kilometers


SNOW COVER MAP : SHIGAR SUB-BASIN
CLOUDY DATA
04 JUNE 2016
CLOUDY DATA
09 JUNE 2016
13 JUNE 2016
14 JUNE 2016
CLOUDY DATA
18 JUNE 2016
CLOUDY DATA
23 JUNE 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHIGAR SUB-BASIN

DATA USED
**04 JUNE 2016**
**09 JUNE 2016**

DATA USED
**13 JUNE 2016**
**14 JUNE 2016**
**18 JUNE 2016**

**DATA NOT AVAILABLE**

SNOW

40 20 0 40 80 120
Kilometers

# *HANZA SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: HANZA** **BASIN AREA: 13711sq km**

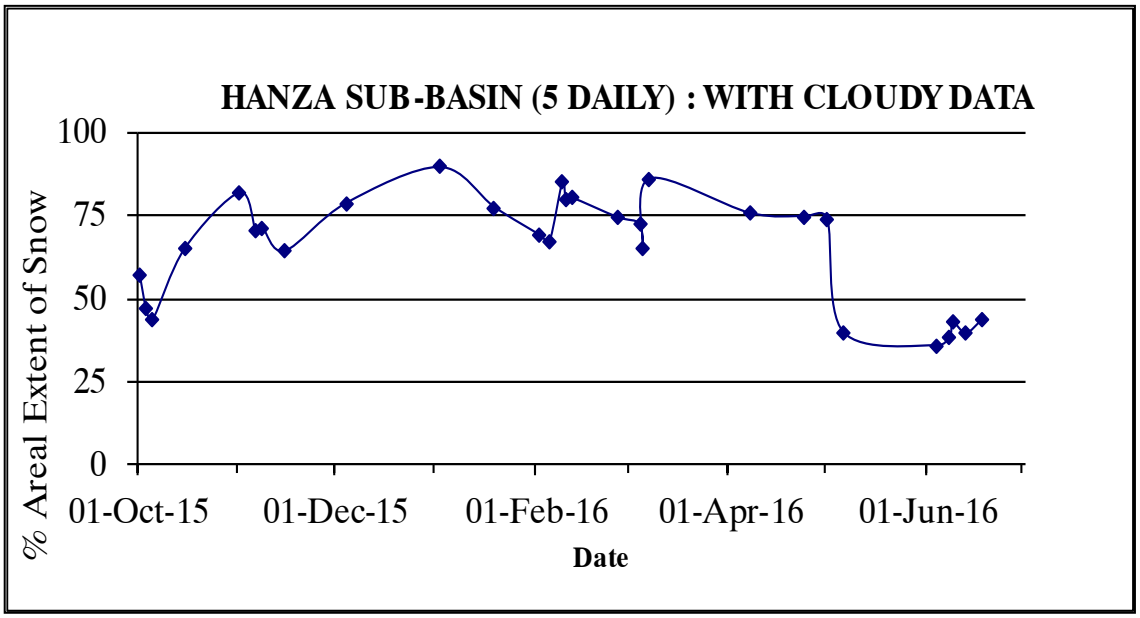
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 01-Oct-15 | 7841 | 57 | **3** | 05-Oct-15 | 5965 | 65 |
| **2** | 03-Oct-15 | 6426 | 47 | **4** | 15-Oct-15 | 8922 | 82 |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 8922 | 65 | **7** | 08-Nov-15 | 9633 | 70 |
| **6** | 06-Nov-15 | 11226 | 82 | **8** | 15-Nov-15 | 9785 | 71 |
| **December 2015** | | | | | | | |
| **9** | 04-Dec-15 | 8819 | 64 | | | | |
| | | | | | | | |
| **January 2016** | | | | | | | |
| **11** | 02-Jan-16 | 10796 | 79 | **13** | 19-Jan-16 | 12280 | 90 |
| | | | | | | | |
| **February 2016** | | | | | | | |
| **14** | 02-Feb-16 | 10616 | 77 | **17** | 10-Feb-16 | 11690 | 85 |
| **15** | 05-Feb-16 | 9472 | 69 | **18** | 12-Feb-16 | 10964 | 80 |
| **16** | 09-Feb-16 | 9213 | 67 | **19** | 26-Feb-16 | 11010 | 80 |
| **March 2016** | | | | | | | |
| **20** | 04-Mar-16 | 10212 | 74 | **22** | 07-Mar-16 | 8891 | 65 |
| **21** | 05-Mar-16 | 9928 | 72 | | | | |
| **April 2016** | | | | | | | |
| **24** | 07-Apr-16 | 11807 | 86 | **26** | 24-Apr-16 | 10386 | 76 |
| | | | | | | | |
| **May 2016** | | | | | | | |
| **27** | 01-May-16 | 10246 | 75 | **28** | 06-May-16 | 10142 | 74 |
| **June 2016** | | | | | | | |
| **29** | 04-Jun-16 | 5462 | 40 | **33** | 13-Jun-16 | 5857 | 43 |
| **30** | 08-Jun-16 | 4904 | 36 | **34** | 18-Jun-16 | 5420 | 40 |
| **31** | 09-Jun-16 | 5242 | 38 | **35** | 23-Jun-16 | 5970 | 44 |

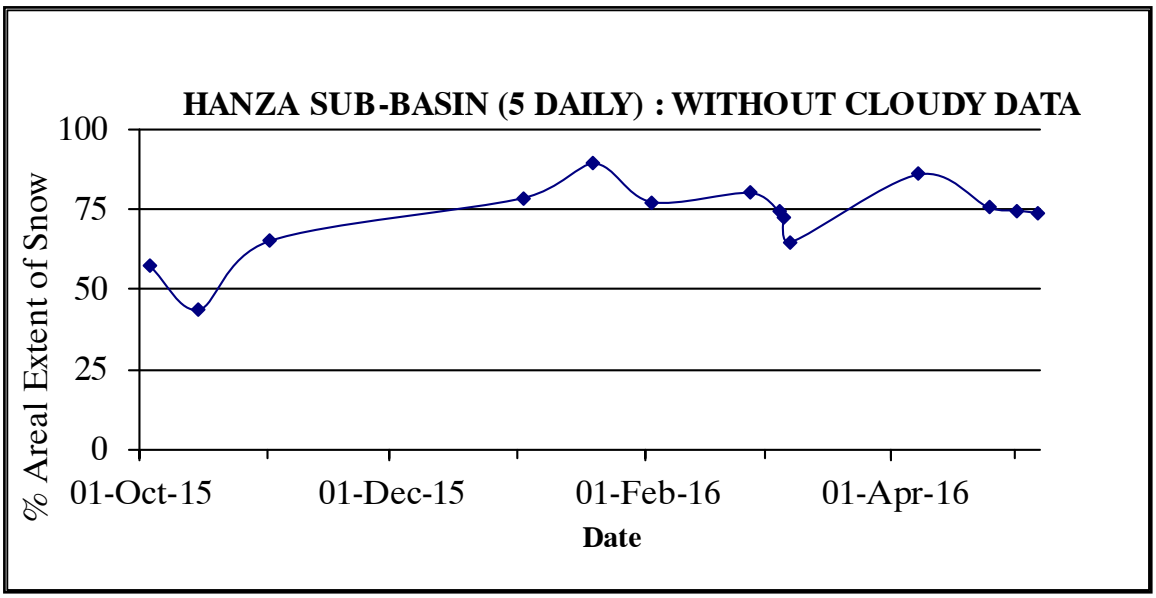
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: HANZA** **BASIN AREA: 13711sq km**

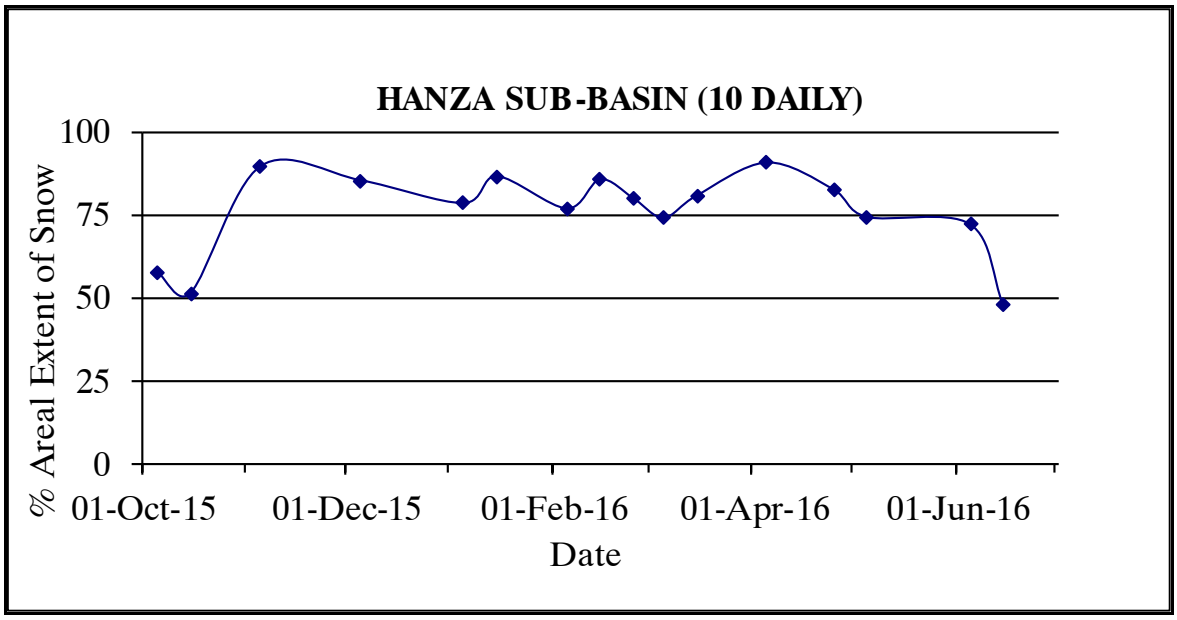
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 7963 | 58 | **3** | 05-Nov-15 | 12348 | 90 |
| **2** | 15-Oct-15 | 7097 | 52 | | | | |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **4** | 05-Dec-15 | 11766 | 86 | **5** | 05-Jan-16 | 10818 | 79 |
| | | | | **6** | 15-Jan-16 | 11931 | 87 |
| | | | | | | | |
| **February 2016** | | | | **March 2016** | | | |
| **8** | 05-Feb-16 | 10595 | 77 | **11** | 05-Mar-16 | 10212 | 74 |
| **9** | 15-Feb-16 | 11800 | 86 | **12** | 15-Mar-16 | 11130 | 81 |
| **10** | 25-Feb-16 | 11012 | 80 | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **13** | 05-Apr-16 | 12498 | 91 | **15** | 05-May-16 | 10245 | 75 |
| **14** | 25-Apr-16 | 11386 | 83 | | | | |
| | | | | | | | |
| **June 2016** | | | | | | | |
| **17** | 05-Jun-2016 | 9942 | 73 | | | | |
| **18** | 15-Jun-2016 | 6580 | 48 | | | | |

## SNOW COVER DEPLETION CURVE

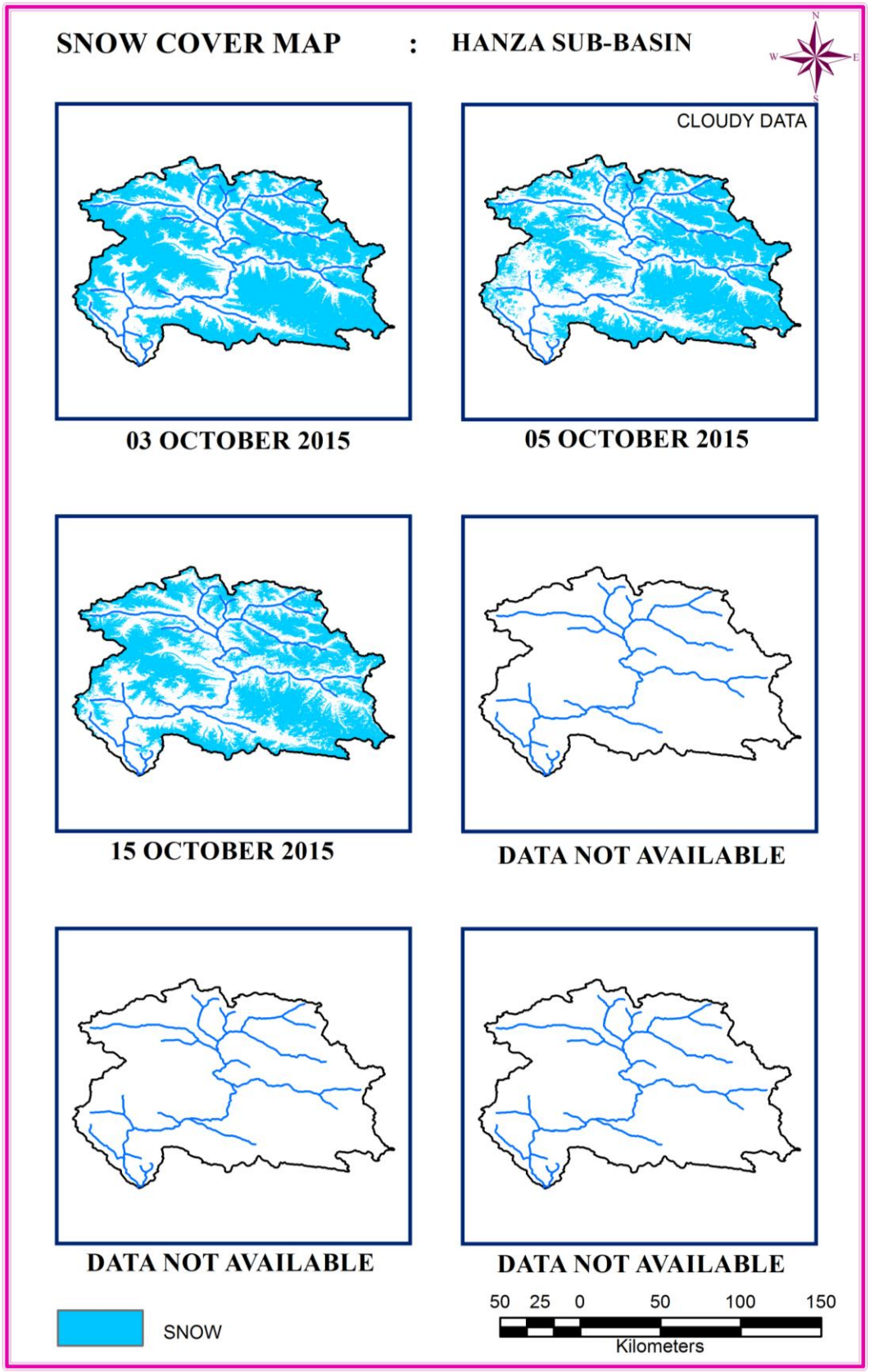


**SNOW COVER DEPLETION CURVE**



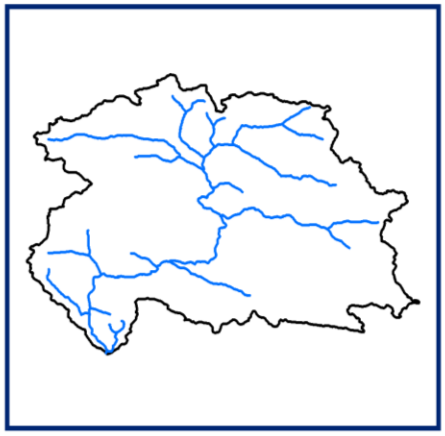
# *SNOW COVER MAP*


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
CLOUDY DATA
03 OCTOBER 2015
05 OCTOBER 2015
15 OCTOBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN

DATA USED
**03 OCTOMBER 2015**
**05 OCTOMBER 2015**

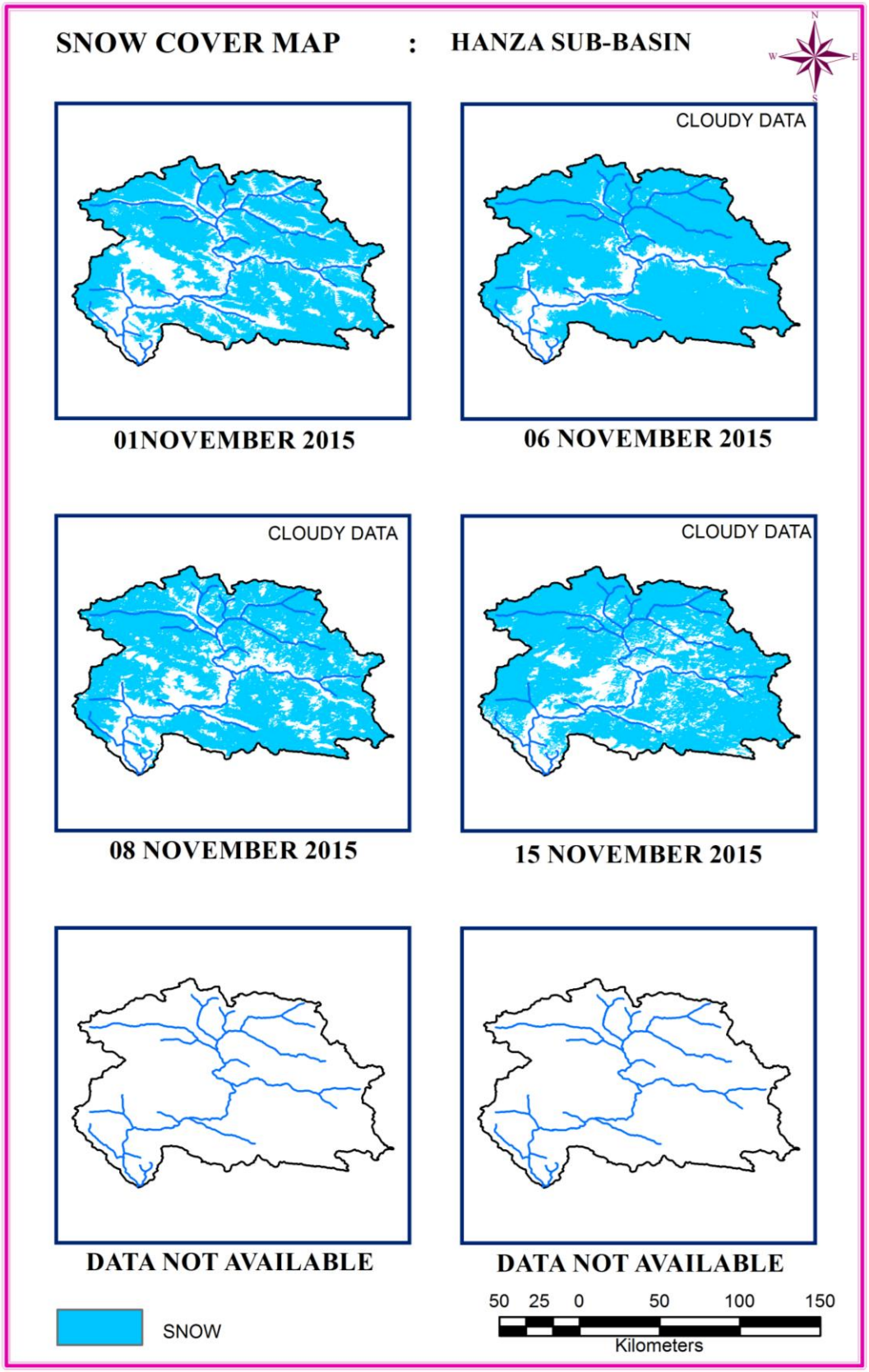
DATA USED
**15 OCTOMBER 2015**



**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
CLOUDY DATA
01NOVEMBER 2015
CLOUDY DATA
06 NOVEMBER 2015
CLOUDY DATA
08 NOVEMBER 2015
CLOUDY DATA
15 NOVEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN

DATA USED

**01 NOVEMBER 2015**

**08 NOVEMBER 2015**

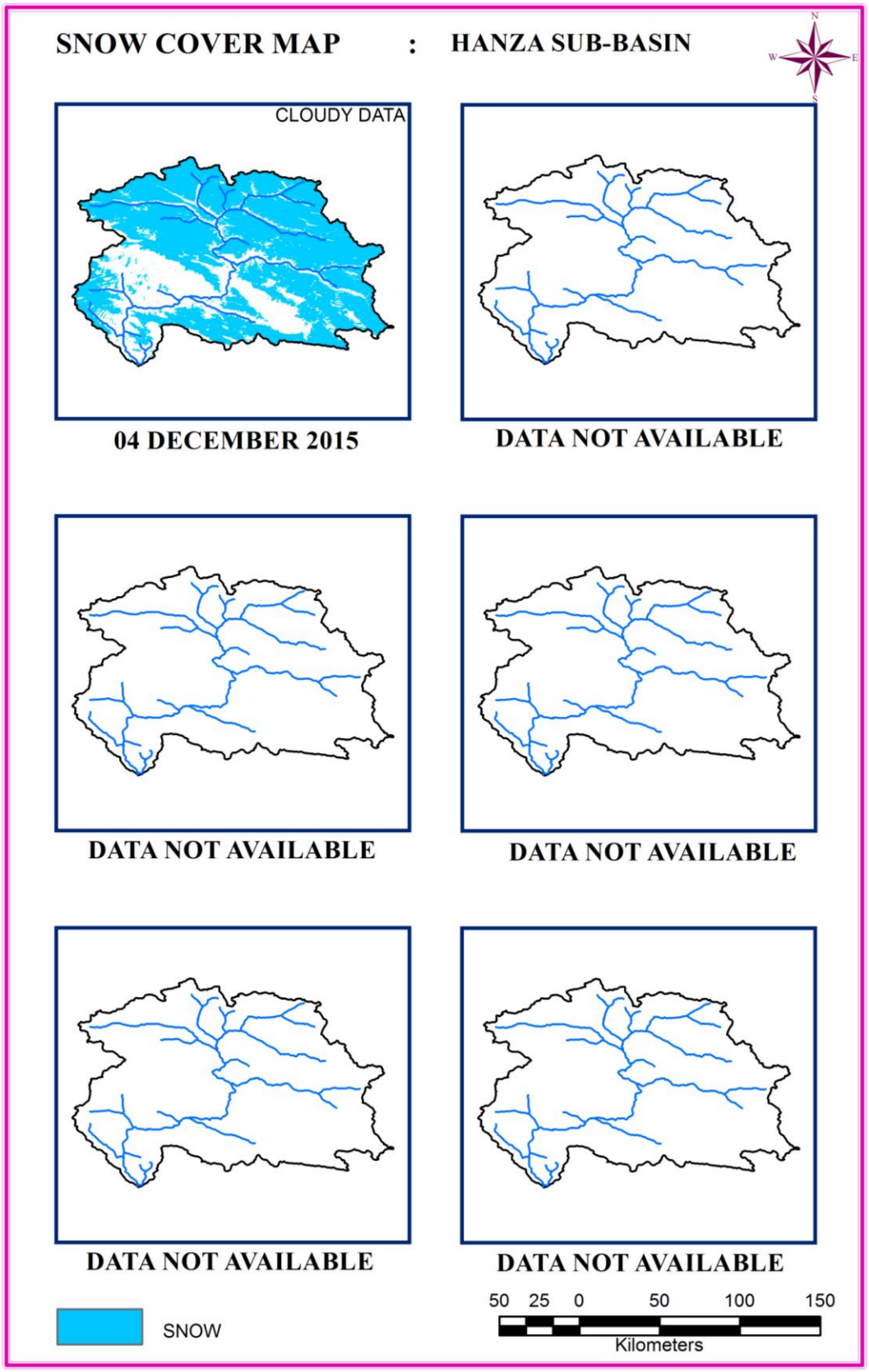
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150

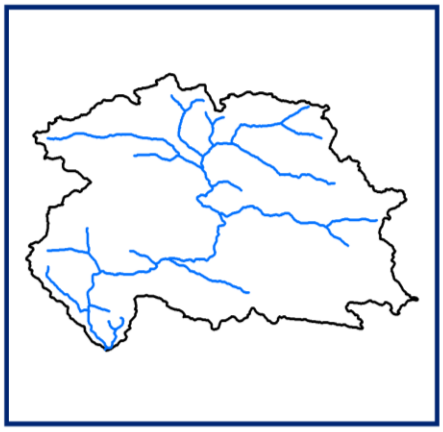
Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
CLOUDY DATA
04 DECEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

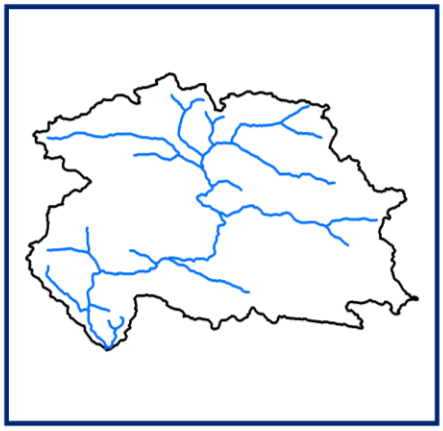
## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN

DATA USED

**05 DECEMBER 2015**



**DATA NOT AVAILABLE**

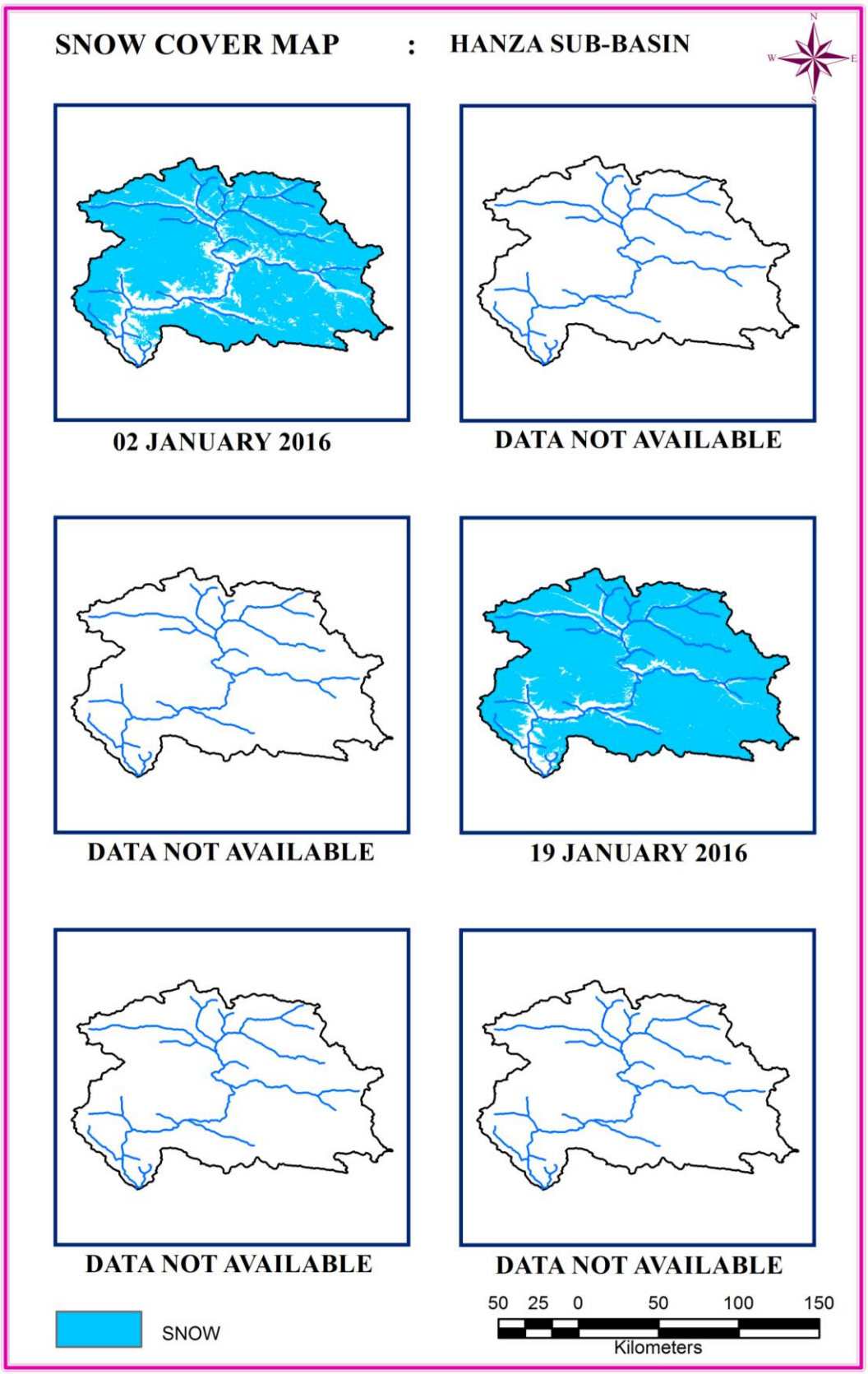


**DATA NOT AVAILABLE**

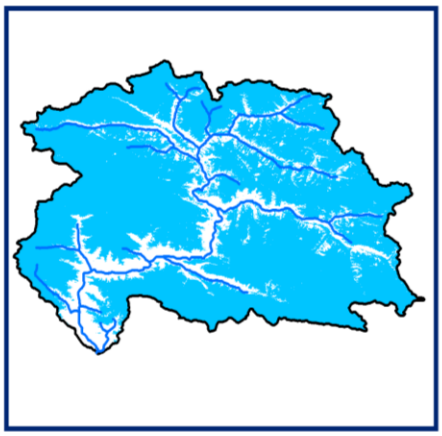
SNOW

50 25 0 50 100 150

Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
02 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
19 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN



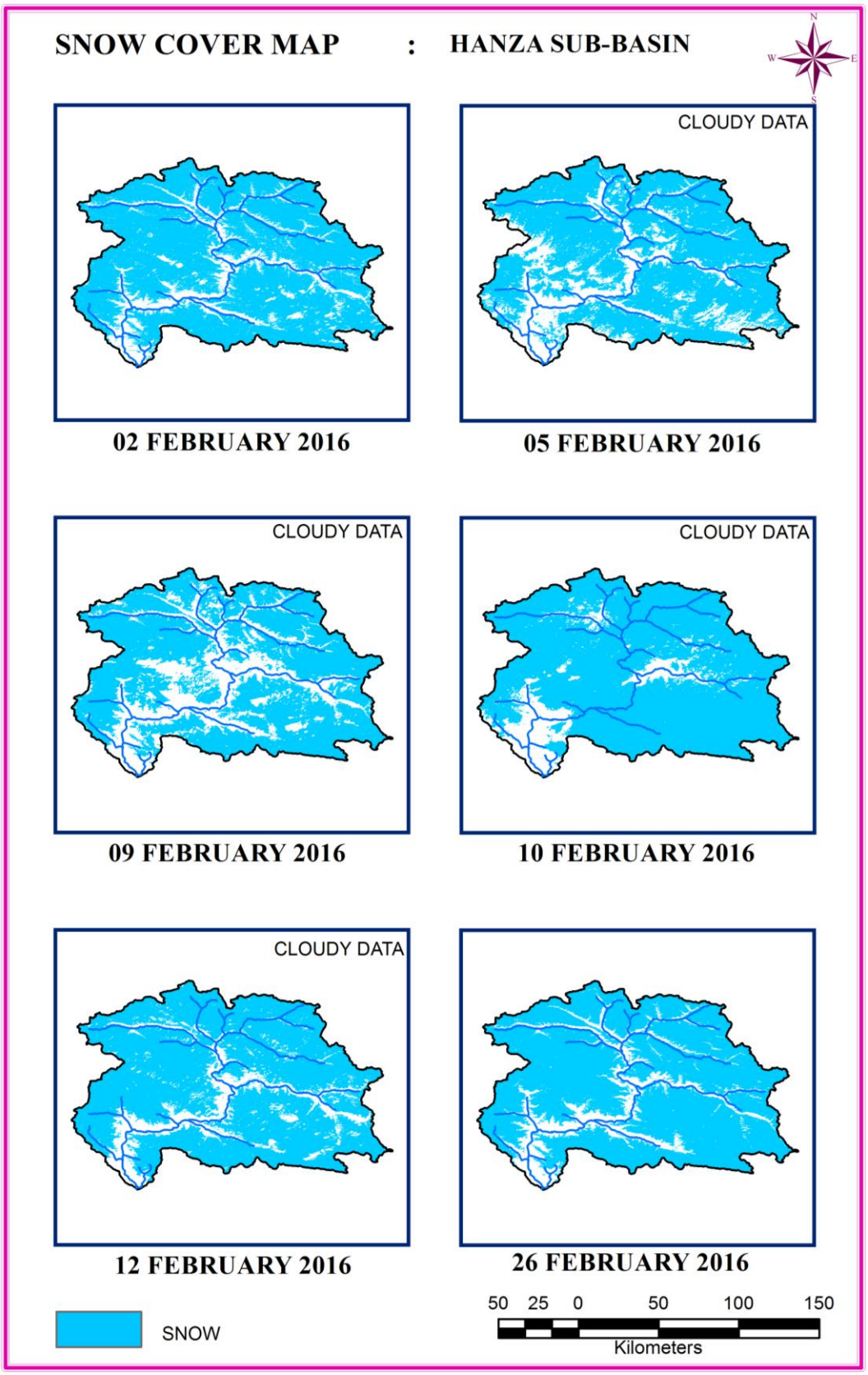
DATA USED
**05 JANUARY 2016**

DATA USED
**15 JANUARY 2016**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
CLOUDY DATA
02 FEBRUARY 2016
05 FEBRUARY 2016
CLOUDY DATA
CLOUDY DATA
09 FEBRUARY 2016
10 FEBRUARY 2016
CLOUDY DATA
12 FEBRUARY 2016
26 FEBRUARY 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN

DATA USED

**02 FEBRUARY 2016**

**05 FEBRUARY 2016**

**09 FEBRUARY 2016**

DATA USED

**15 FEBRUARY 2016**

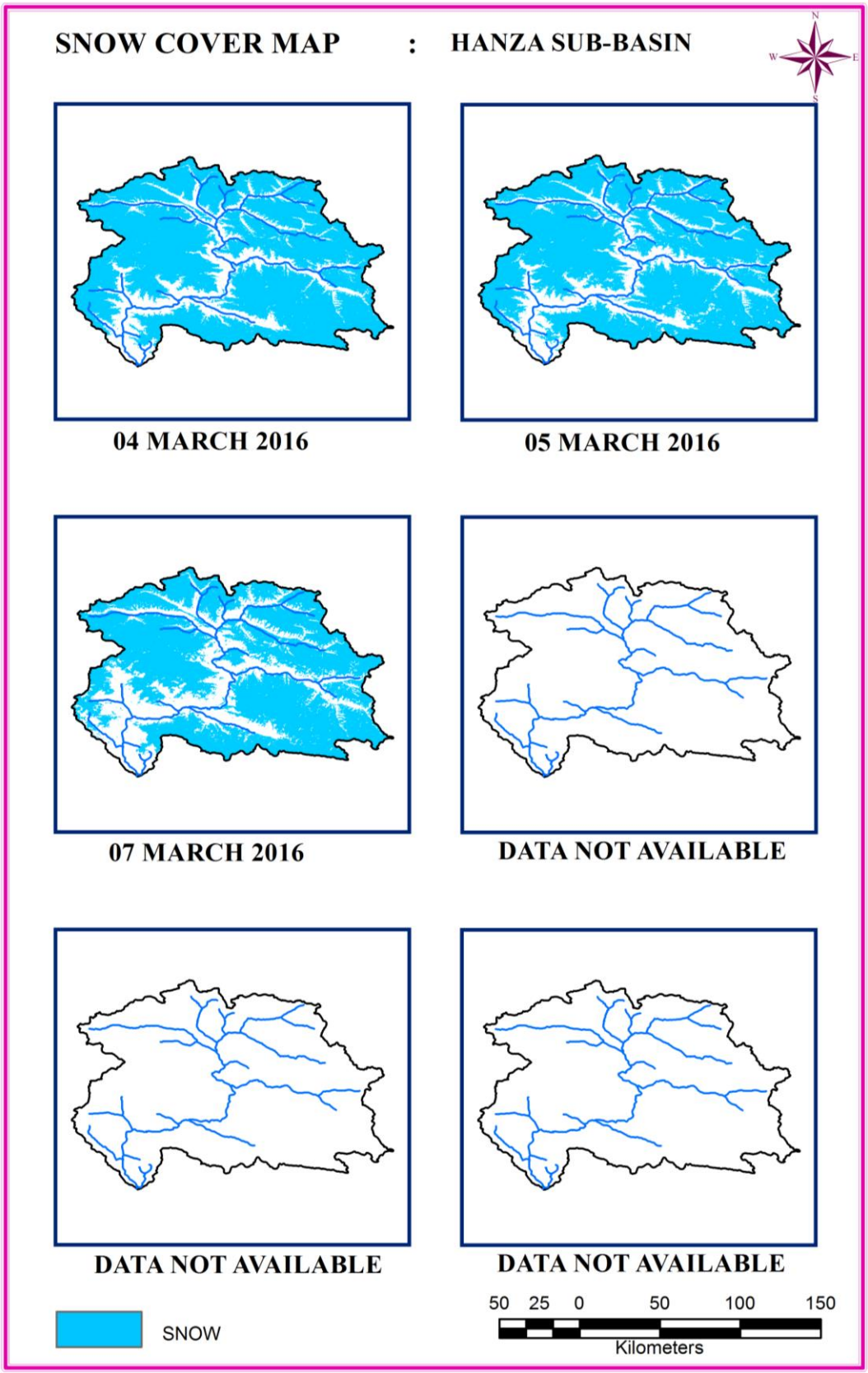
DATA USED

**25 FEBRUARY 2016**

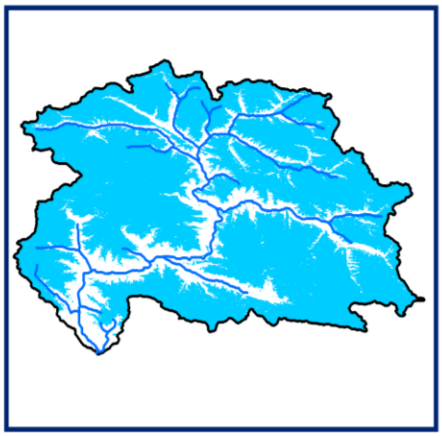
SNOW

50 25 0 50 100 150

Kilometers

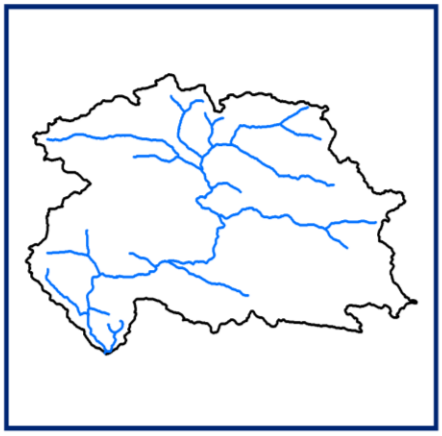

SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
04 MARCH 2016
05 MARCH 2016
07 MARCH 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN



DATA USED
**04 MARCH 2016**
**05 MARCH 2016**

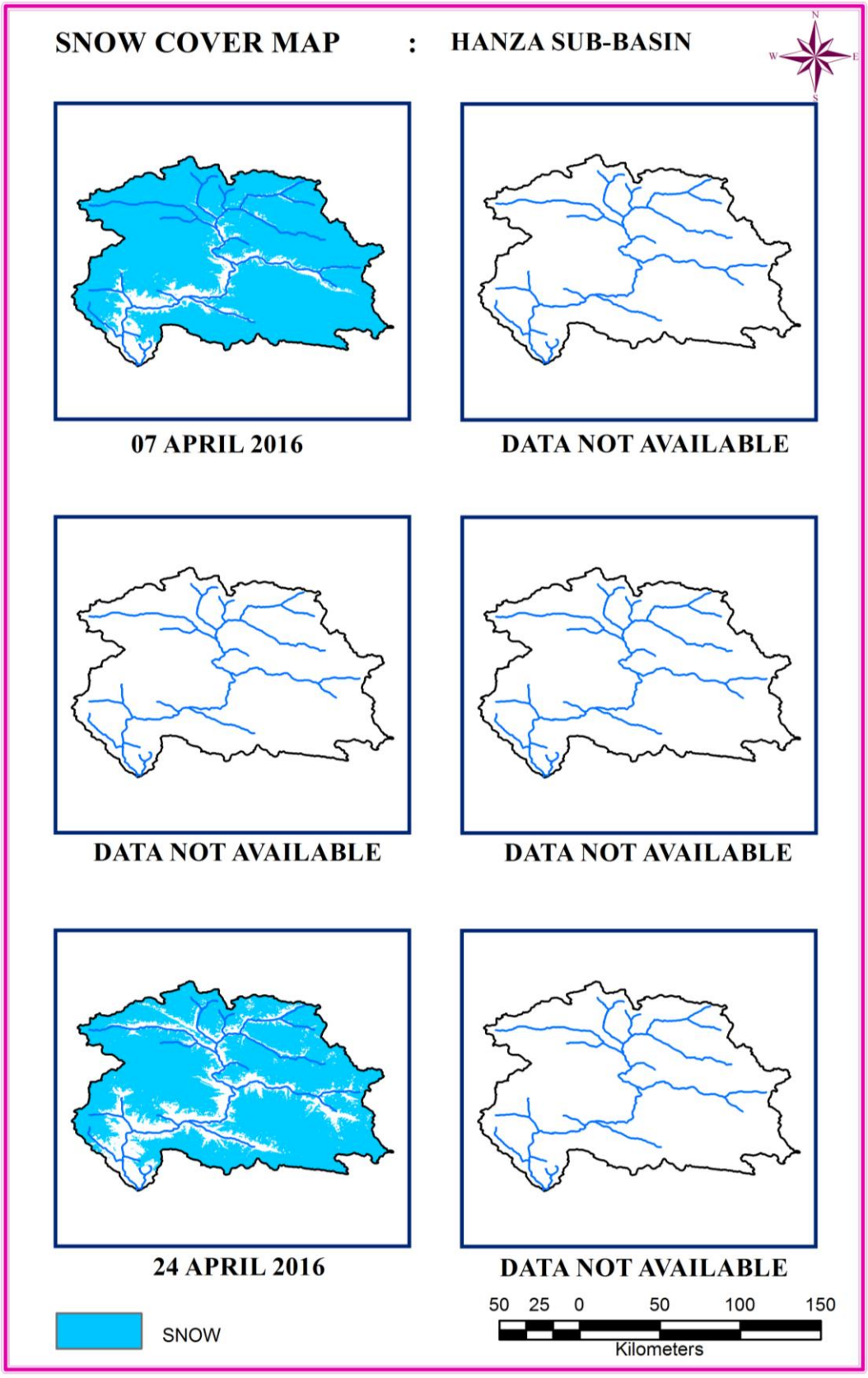
DATA USED
**15 MARCH 2016**



**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
07 APRIL 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
24 APRIL 2016
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN

DATA USED

**05 APRIL 2016**

**DATA NOT AVAILABLE**

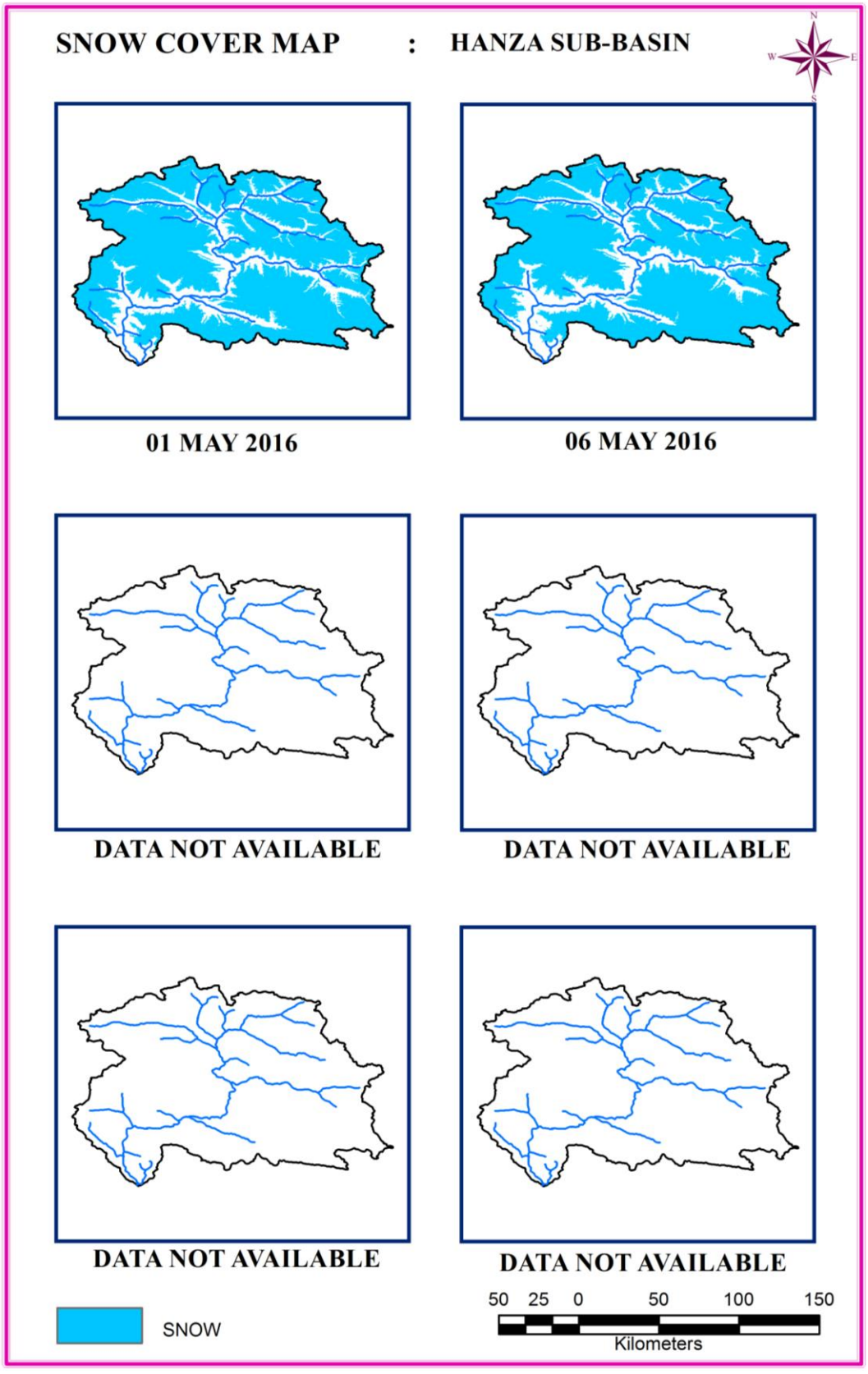
DATA USED

**25 APRIL 2016**

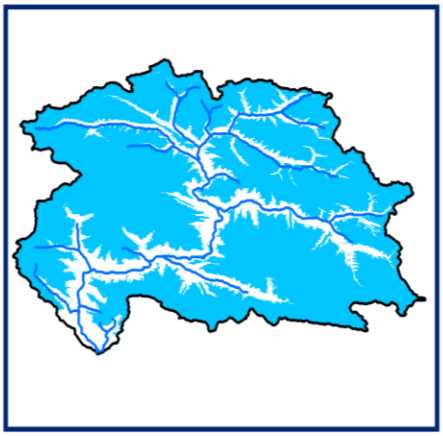
SNOW

50 25 0 50 100 150

Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
01 MAY 2016
06 MAY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

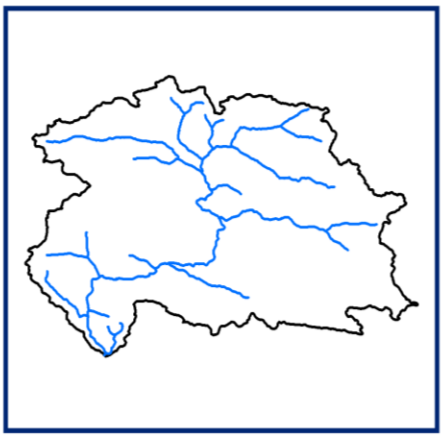
## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN



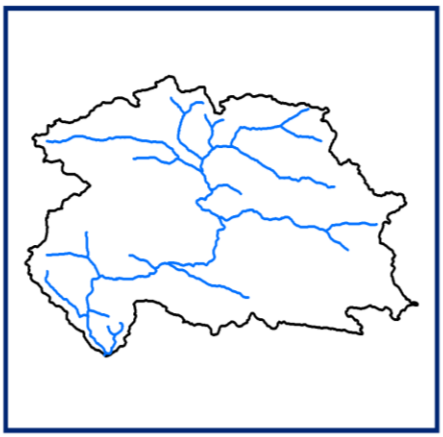
DATA USED

**01 MAY 2016**

**06 MAY 2016**



**DATA NOT AVAILABLE**

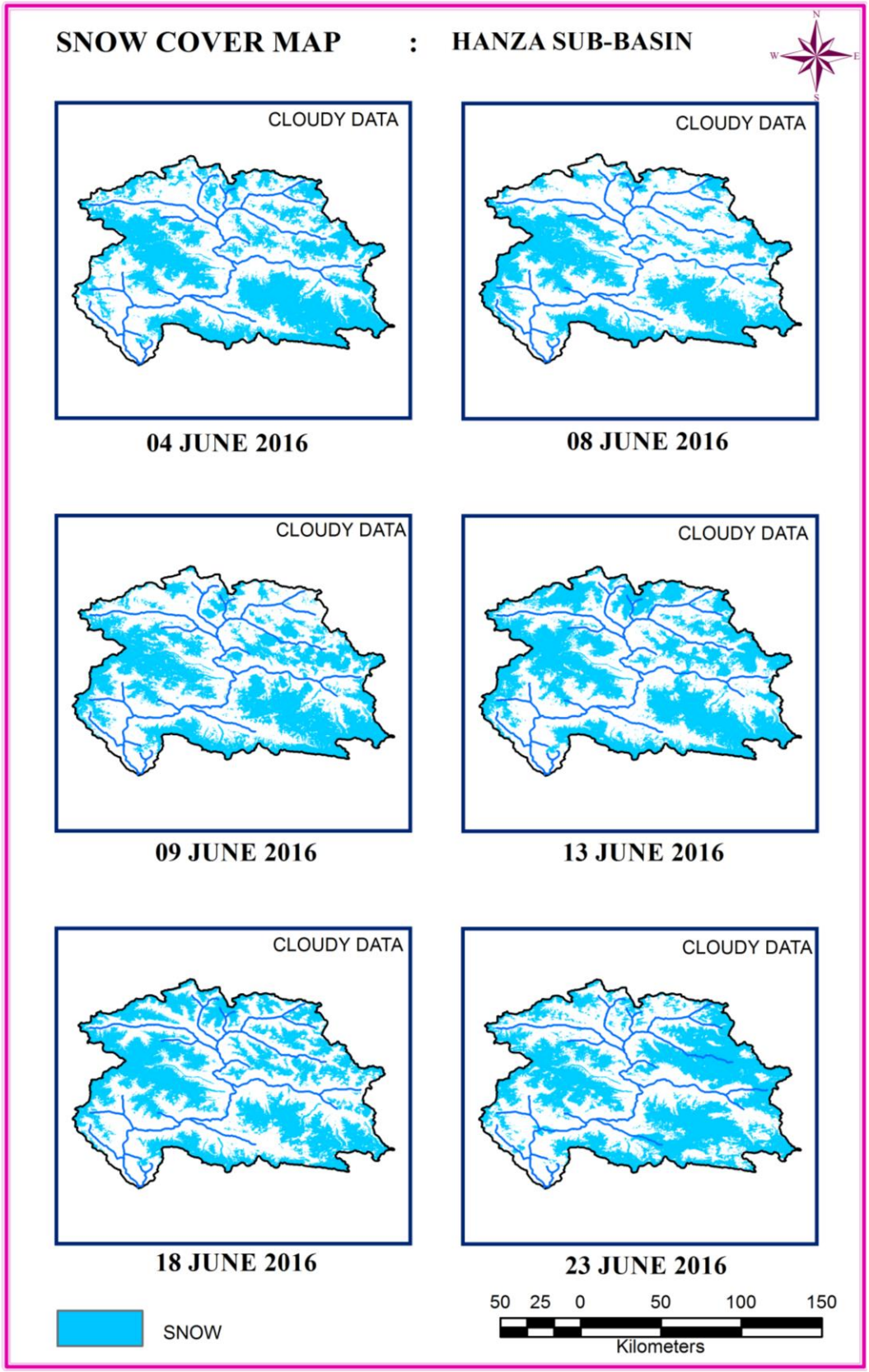


**DATA NOT AVAILABLE**

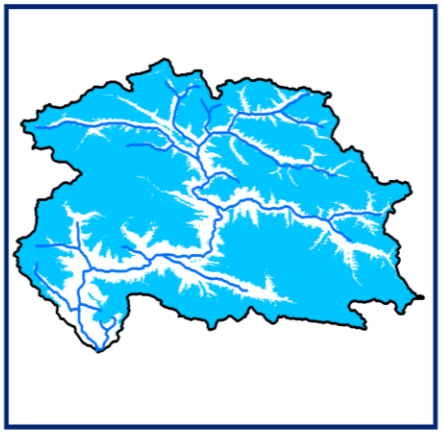
SNOW

50 25 0 50 100 150

Kilometers


SNOW COVER MAP : HANZA SUB-BASIN
N
W
E
S
CLOUDY DATA
04 JUNE 2016
CLOUDY DATA
08 JUNE 2016
CLOUDY DATA
09 JUNE 2016
CLOUDY DATA
13 JUNE 2016
CLOUDY DATA
18 JUNE 2016
CLOUDY DATA
23 JUNE 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : HANZA SUB-BASIN



DATA USED

**04 JUNE 2016**

**08 JUNE 2016**

DATA USED

**13 JUNE 2016**

**18 JUNE 2016**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150

Kilometers

# *GILGIT SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: GILGIT** **BASIN AREA: 13615 sq km**

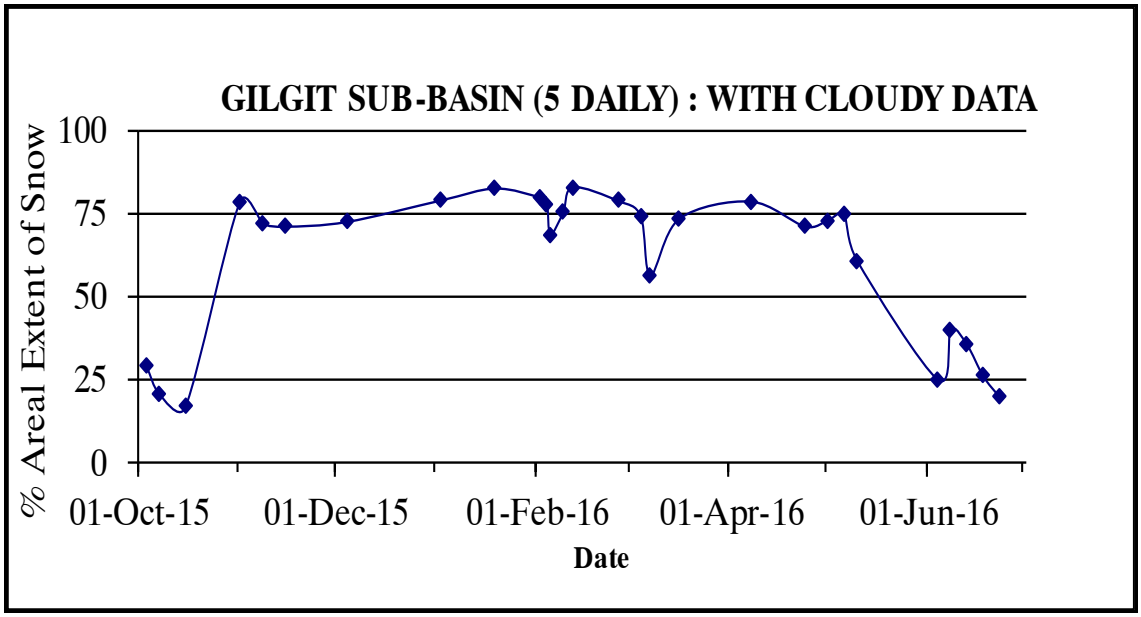
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 03-Oct-15 | 4034 | 30 | **3** | 15-Oct-15 | 2334 | 17 |
| **2** | 07-Oct-15 | 2891 | 21 | | | | |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 10775 | 79 | **7** | 15-Nov-15 | 9738 | 72 |
| **6** | 08-Nov-15 | 9872 | 73 | | | | |
| **December 2015** | | | | | | | |
| **9** | 04-Dec-15 | 9929 | 73 | | | | |
| | | | | | | | |
| **January 2016** | | | | | | | |
| **11** | 02-Jan-16 | 10805 | 79 | **13** | 19-Jan-16 | 11299 | 83 |
| | | | | | | | |
| **February 2016** | | | | | | | |
| **14** | 02-Feb-16 | 10918 | | **17** | 09-Feb-16 | 10319 | |
| **15** | 04-Feb-16 | 10679 | | **18** | 12-Feb-16 | 11351 | |
| **16** | 05-Feb-16 | 9421 | | **19** | 26-Feb-16 | 10793 | |
| **March 2016** | | | | | | | |
| **20** | 04-Mar-16 | 10164 | 75 | **23** | 16-Mar-16 | 10067 | 74 |
| **22** | 07-Mar-16 | 7750 | 57 | | | | |
| **April 2016** | | | | | | | |
| **24** | 07-Apr-16 | 10767 | 79 | **26** | 24-Apr-16 | 9739 | 72 |
| | | | | | | | |
| **May 2016** | | | | | | | |
| **27** | 01-May-16 | 10004 | 73 | **28** | 10-May-16 | 8340 | 61 |
| | 06-May-16 | 10205 | 75 | | | | |
| **June 2016** | | | | | | | |
| **29** | 04-Jun-16 | 3474 | 26 | **33** | 18-Jun-16 | 3618 | 27 |
| **30** | 08-Jun-16 | 5509 | 40 | **34** | 23-Jun-16 | 2770 | 20 |
| **31** | 13-Jun-16 | 4900 | 36 | | | | |

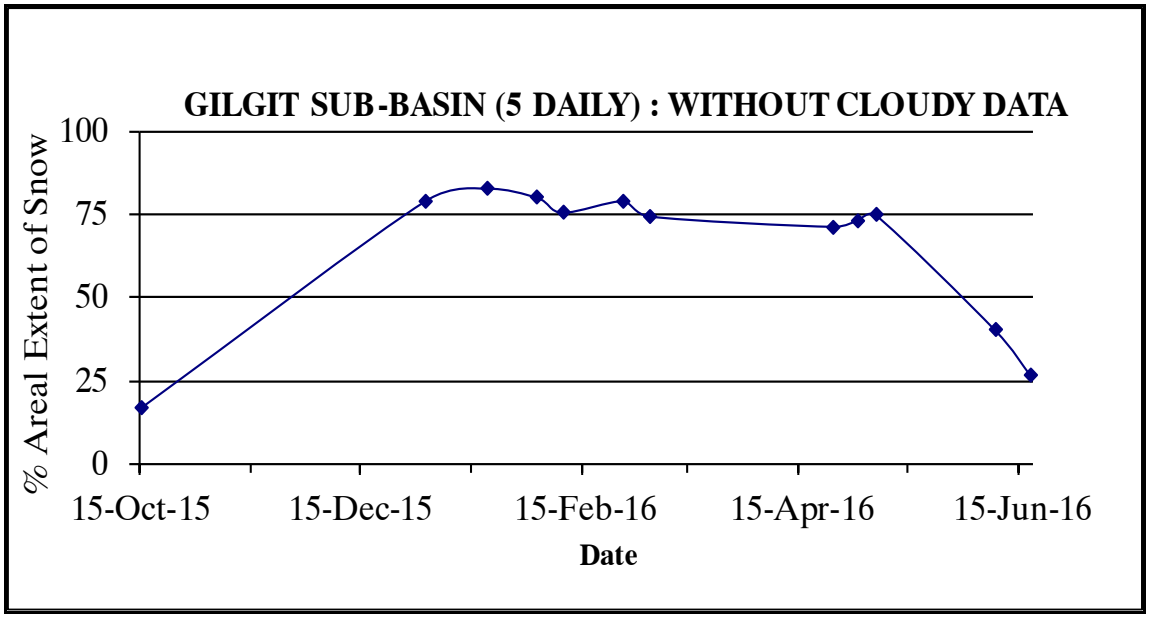
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: GILGIT** **BASIN AREA: 13615sq km**

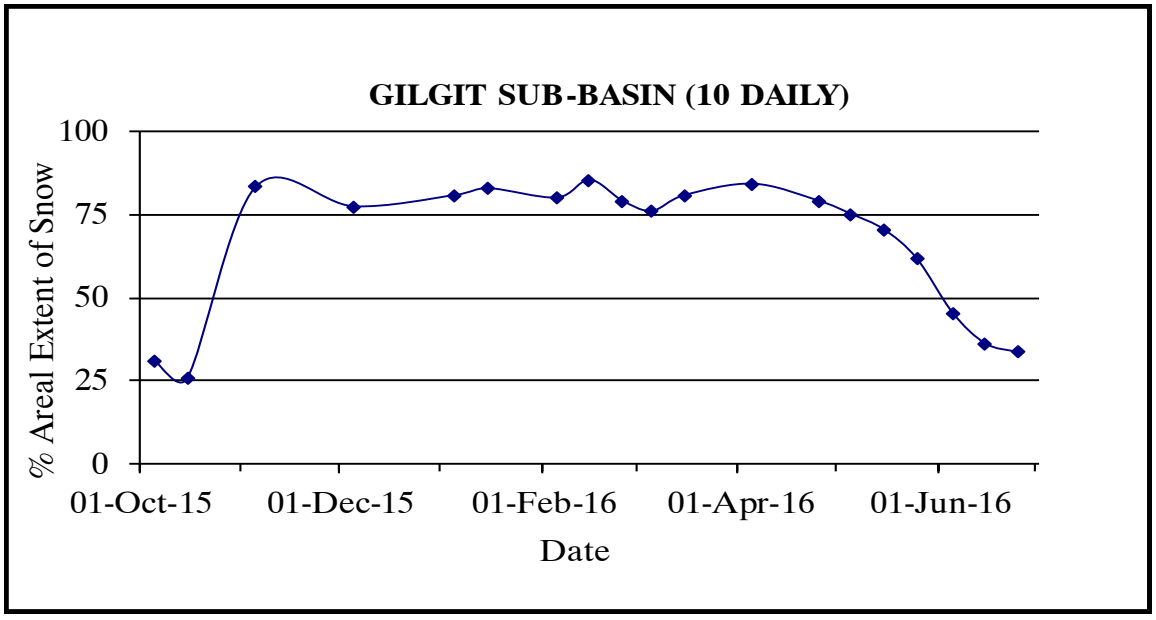
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 4239 | 31 | **3** | 05-Nov-15 | 11361 | 83 |
| **2** | 15-Oct-15 | 3519 | 26 | | | | |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **4** | 05-Dec-15 | 10554 | 78 | **5** | 05-Jan-16 | 11021 | 81 |
| | | | | **6** | 15-Jan-16 | 11299 | 83 |
| | | | | | | | |
| **February 2016** | | | | **March 2016** | | | |
| **8** | 05-Feb-16 | 10917 | 80 | **11** | 05-Mar-16 | 10371 | 76 |
| **9** | 15-Feb-16 | 11646 | 86 | **12** | 15-Mar-16 | 11013 | 81 |
| **10** | 25-Feb-16 | 10792 | 79 | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **13** | 05-Apr-16 | 11483 | 84 | **15** | 05-May-16 | 10242 | 75 |
| **14** | 25-Apr-16 | 10786 | 79 | **16** | 15-May-16 | 9610 | 71 |
| | | | | | 25-May-16 | 8427 | 62 |
| **June 2016** | | | | | | | |
| **17** | 05-Jun-2016 | 6199 | 46 | | | | |
| **18** | 15-Jun-2016 | 4943 | 36 | | | | |
| | 25-Jun-2016 | 4583 | 34 | | | | |

**SNOW COVER DEPLETION CURVE**

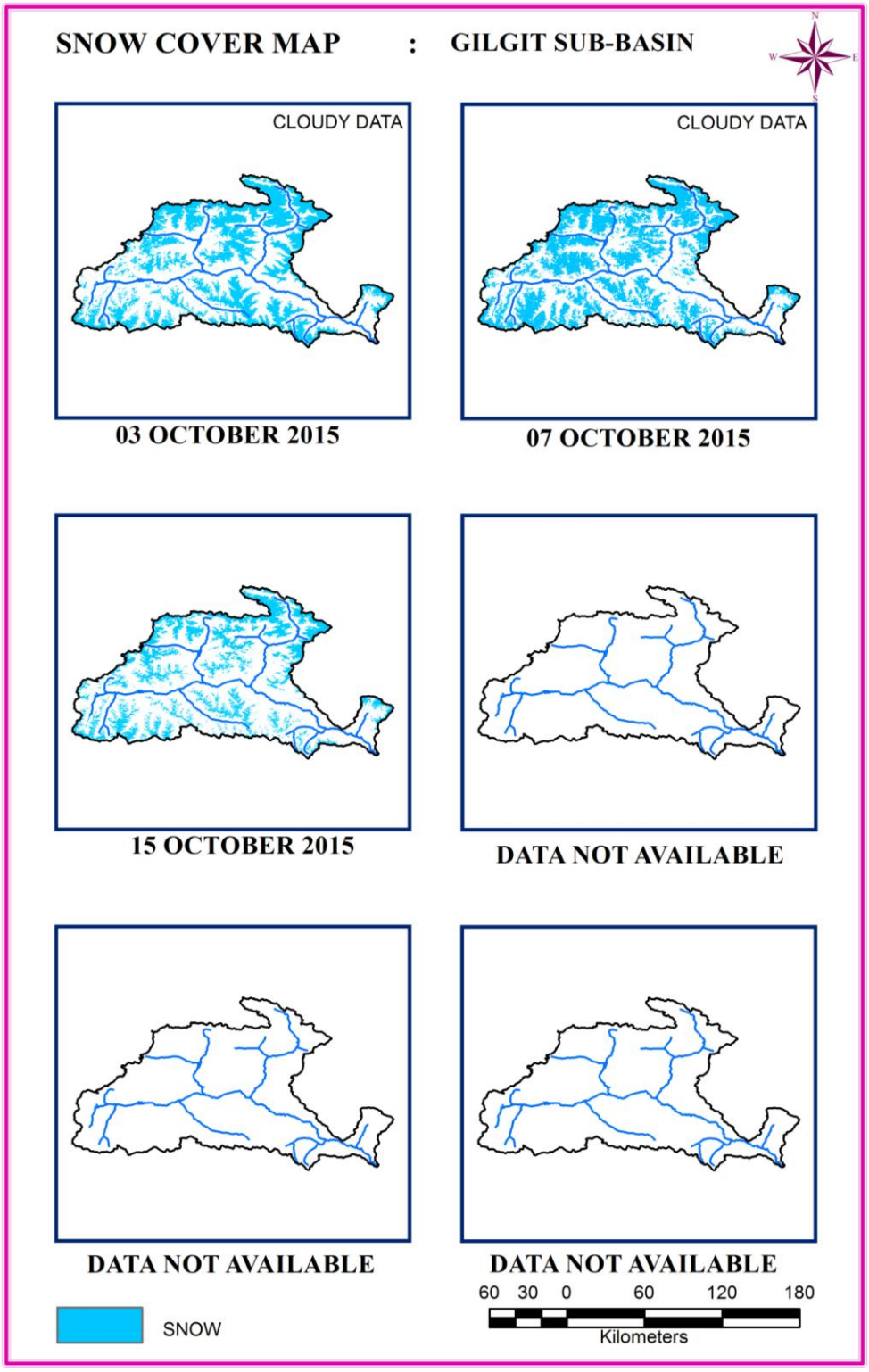


## SNOW COVER DEPLETION CURVE



# *SNOW COVER MAP*


SNOW COVER MAP : GILGIT SUB-BASIN
CLOUDY DATA
03 OCTOBER 2015
CLOUDY DATA
07 OCTOBER 2015
15 OCTOBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN

DATA USED

**03 OCTOBER 2015**
**07 OCTOBER 2015**

DATA USED

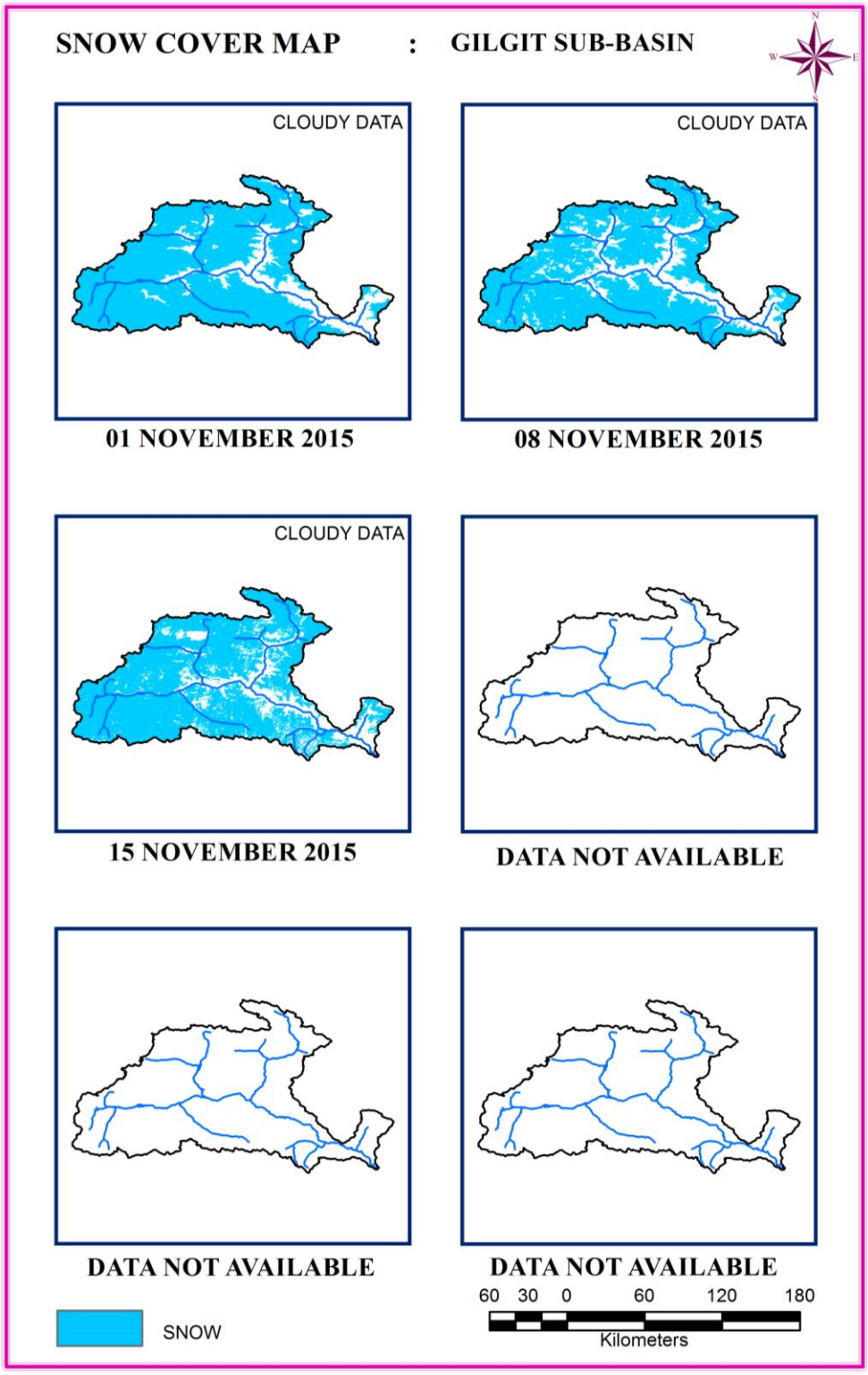
**15 OCTOBER 2015**

**DATA NOT AVAILABLE**

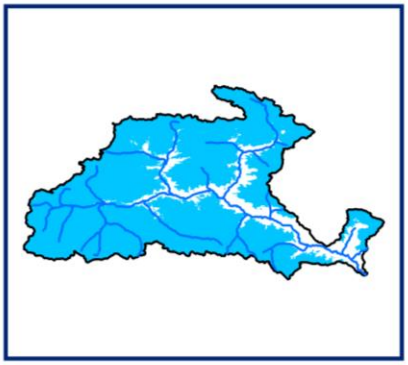
SNOW

60 30 0 60 120 180

Kilometers

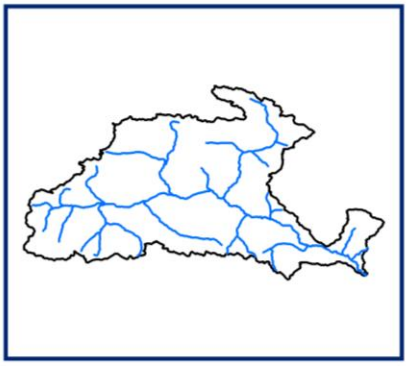

SNOW COVER MAP : GILGIT SUB-BASIN
CLOUDY DATA
01 NOVEMBER 2015
CLOUDY DATA
08 NOVEMBER 2015
CLOUDY DATA
15 NOVEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN

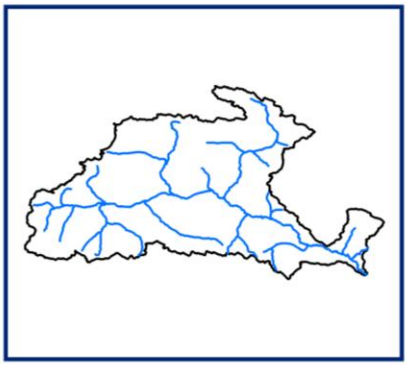


DATA USED

**01 NOVEMBER 2015**
**07 NOVEMBER 2015**



**DATA NOT AVAILABLE**

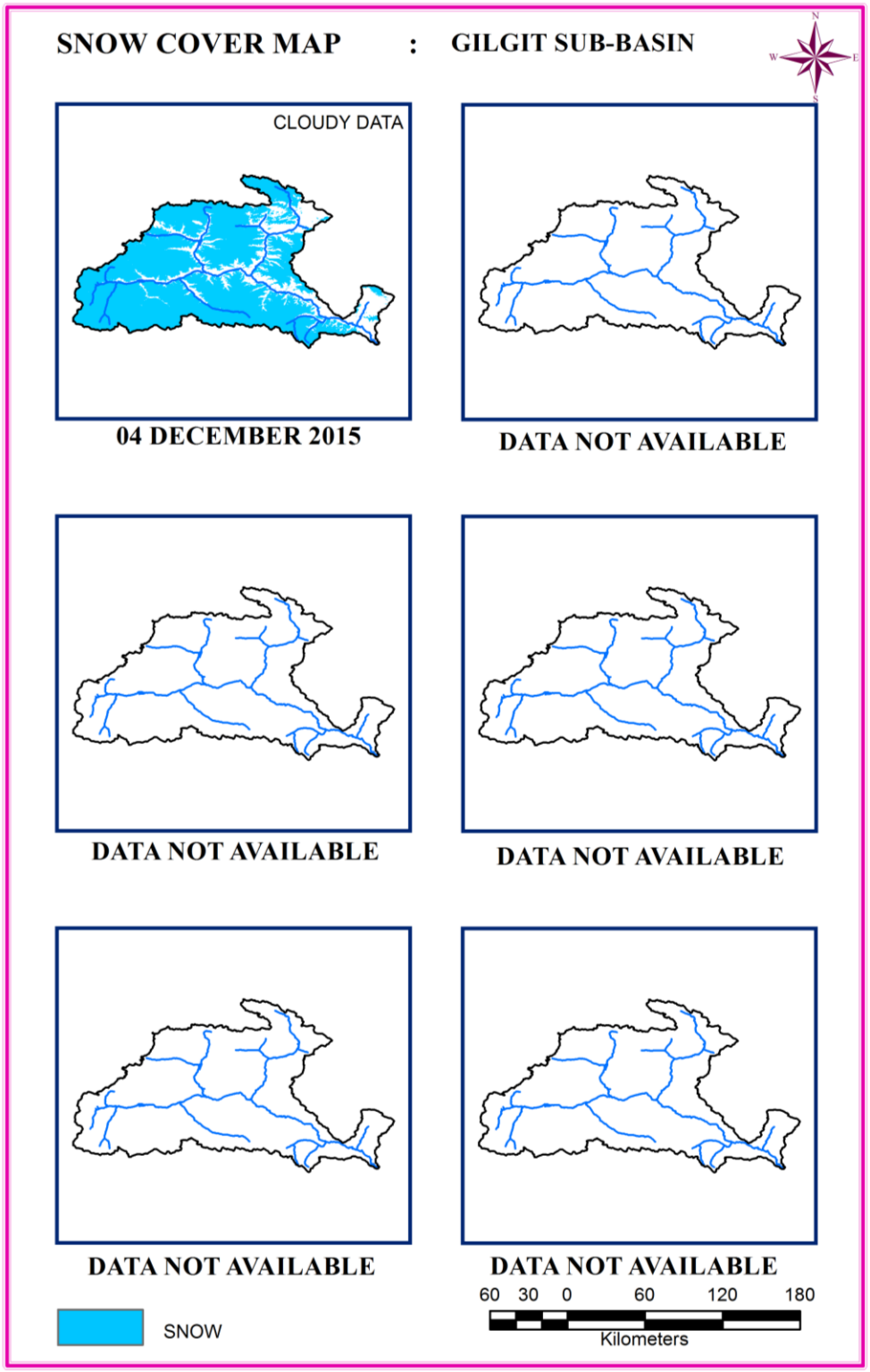


**DATA NOT AVAILABLE**

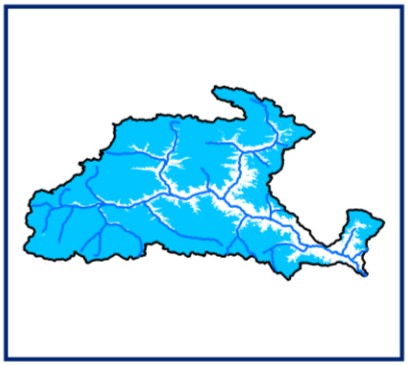
SNOW

60 30 0 60 120 180

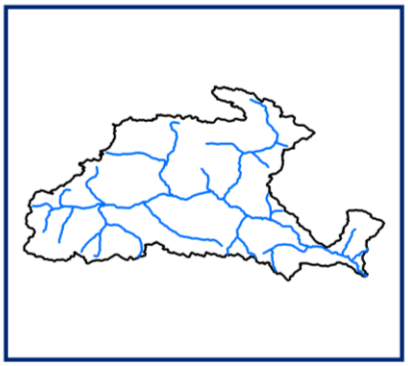
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
CLOUDY DATA
04 DECEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

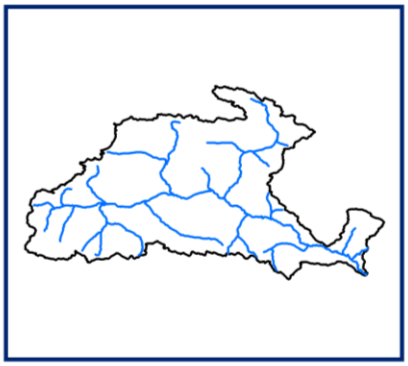
## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN



DATA USED
**05 DECEMBER 2015**



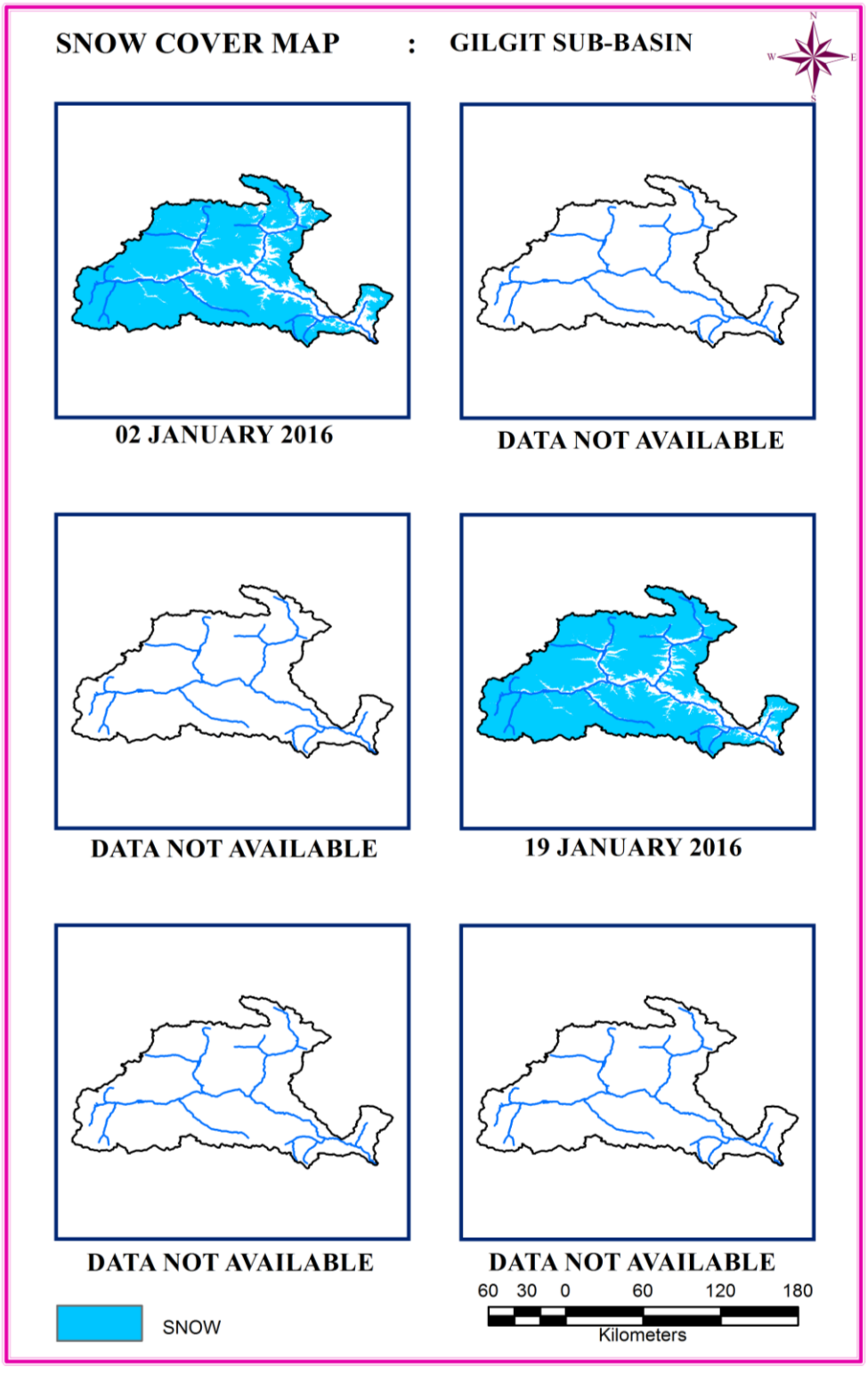
**DATA NOT AVAILABLE**



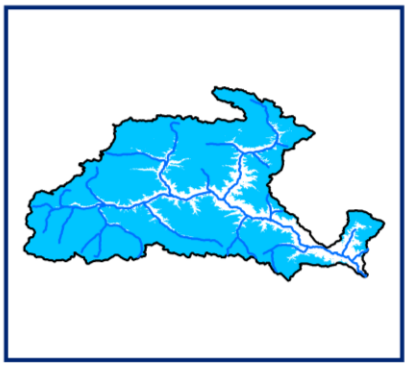
**DATA NOT AVAILABLE**

SNOW

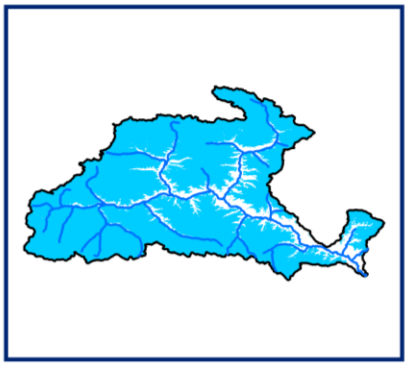
60 30 0 60 120 180
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
02 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
19 JANUARY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

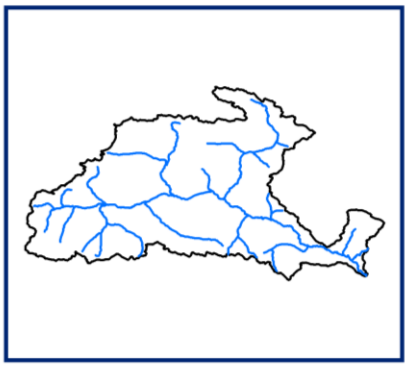
## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN



DATA USED
**05 JANUARY 2016**



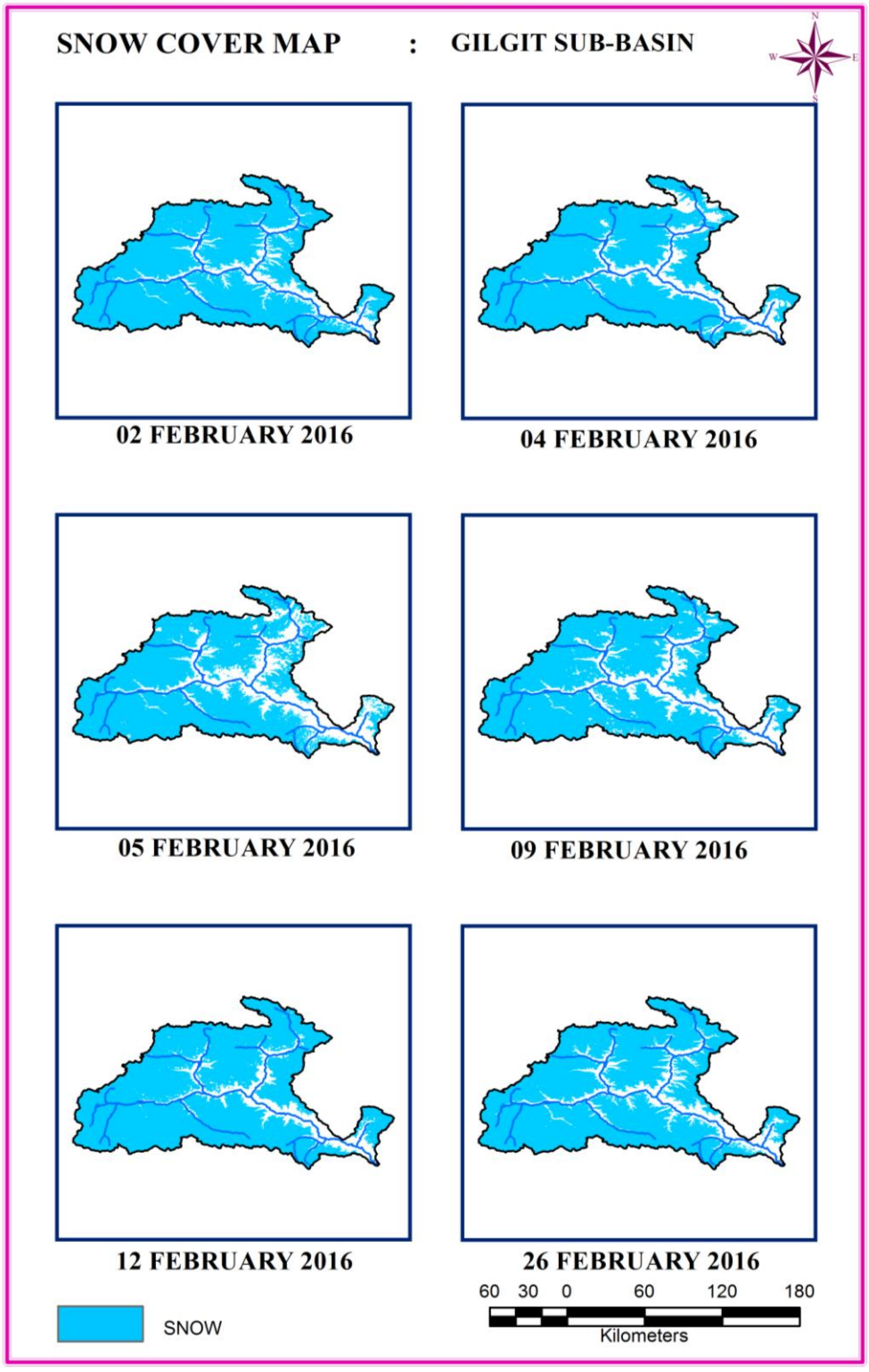
DATA USED
**15 JANUARY 2016**



**DATA NOT AVAILABLE**

SNOW

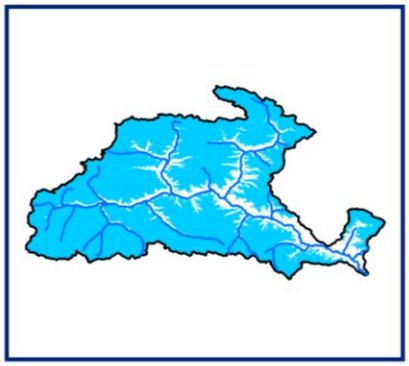
60 30 0 60 120 180
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
02 FEBRUARY 2016
04 FEBRUARY 2016
05 FEBRUARY 2016
09 FEBRUARY 2016
12 FEBRUARY 2016
26 FEBRUARY 2016
SNOW
60 30 0 60 120 180
Kilometers

## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN

DATA USED
**02 FEBRUARY 2016**
**04 FEBRUARY 2016**
**09 FEBRUARY 2016**

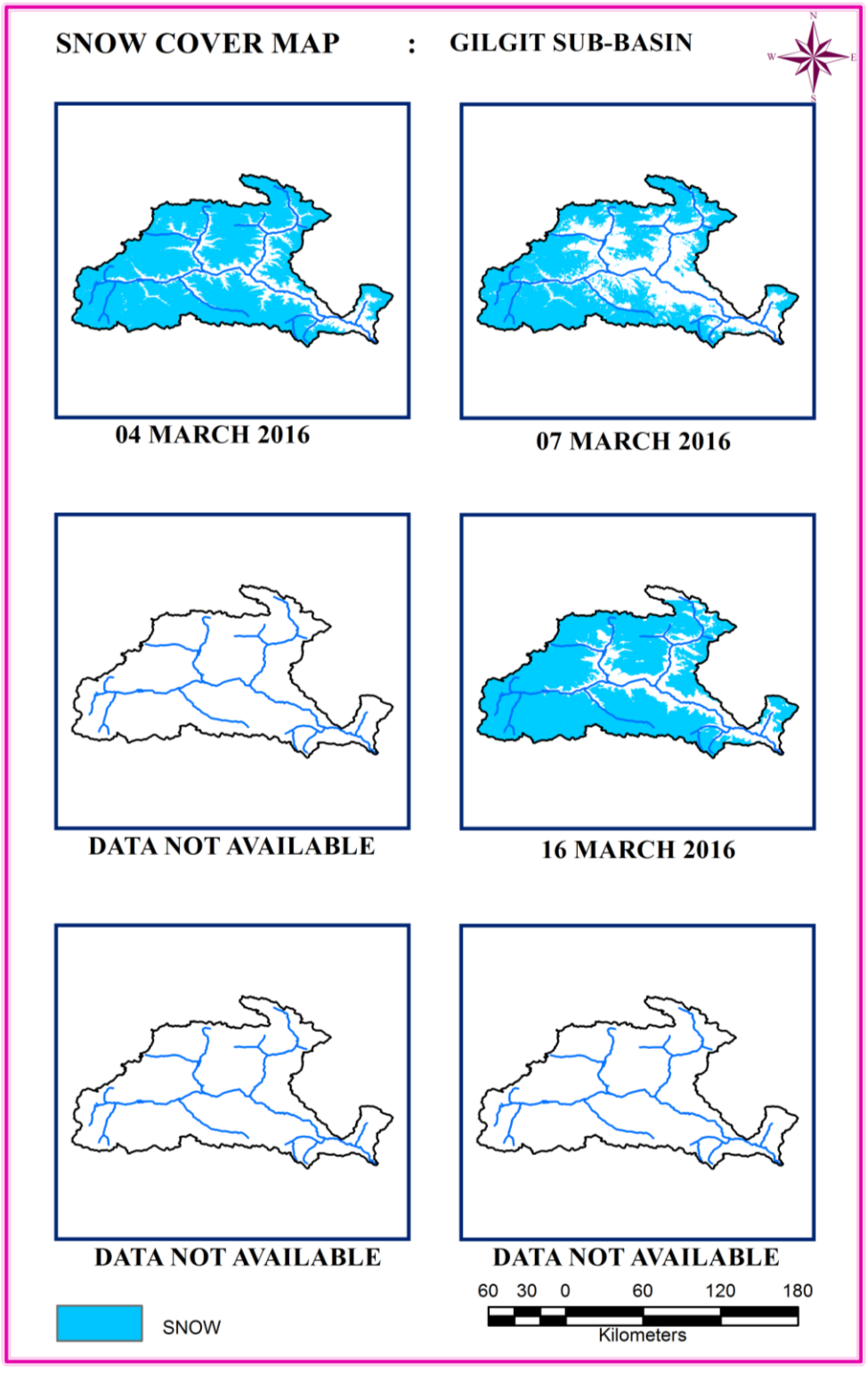
DATA USED
**15 FEBRUARY 2016**



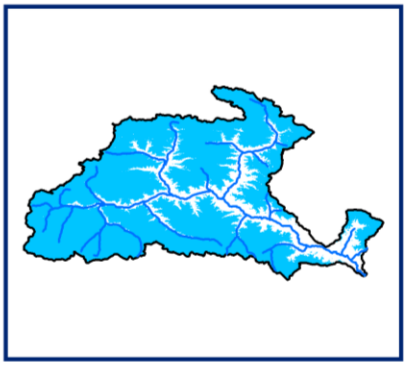
DATA USED
**25 FEBRUARY 2016**

SNOW

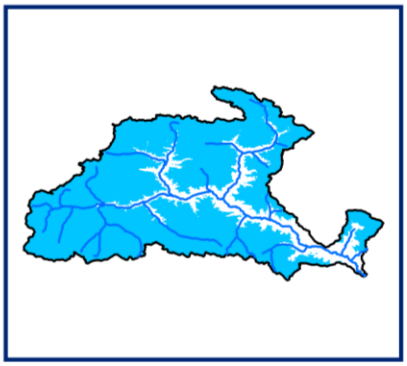
60 30 0 60 120 180
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
04 MARCH 2016
07 MARCH 2016
DATA NOT AVAILABLE
16 MARCH 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

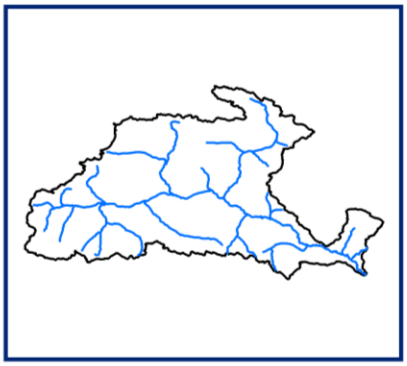
**10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN**



DATA USED
**04 MARCH 2016**
**07 MARCH 2016**



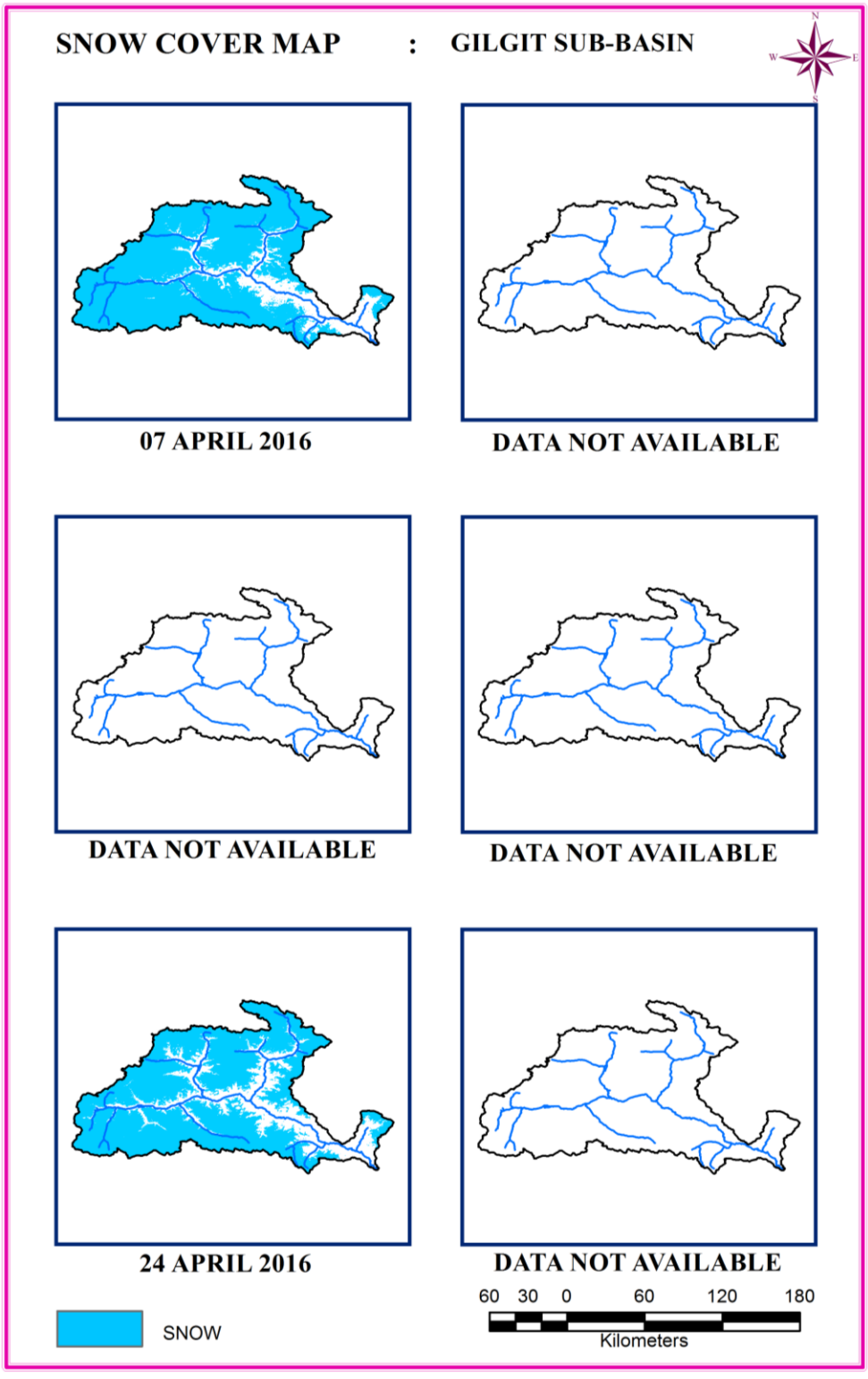
DATA USED
**15 MARCH 2016**



**DATA NOT AVAILABLE**

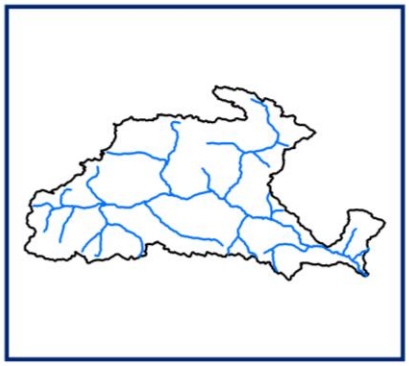
SNOW

60 30 0 60 120 180
Kilometers

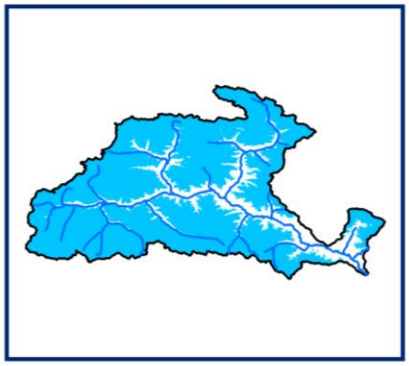

SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
07 APRIL 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
24 APRIL 2016
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN

DATA USED
**05 APRIL 2016**



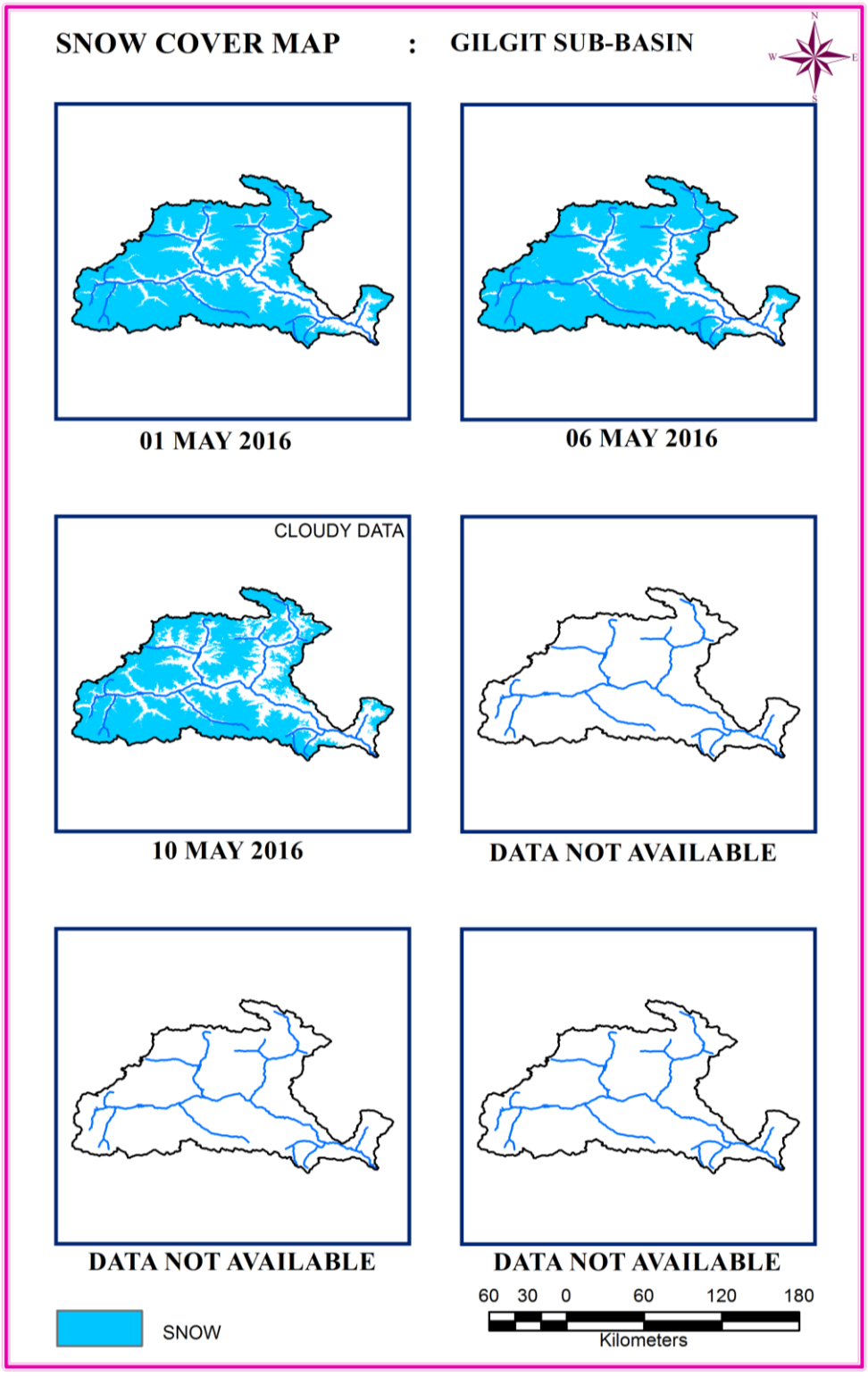
**DATA NOT AVAILABLE**



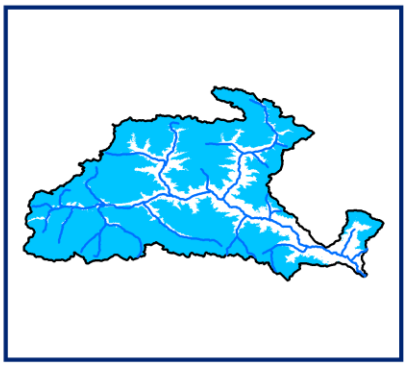
DATA USED
**25 APRIL 2016**

SNOW

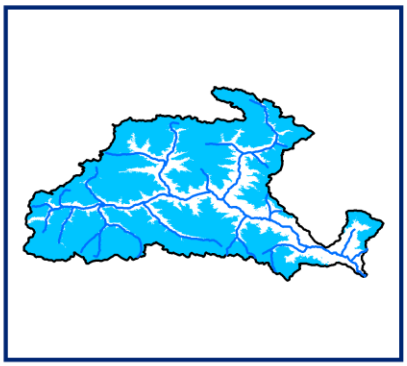
60 30 0 60 120 180
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
N
W
E
S
01 MAY 2016
06 MAY 2016
CLOUDY DATA
10 MAY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

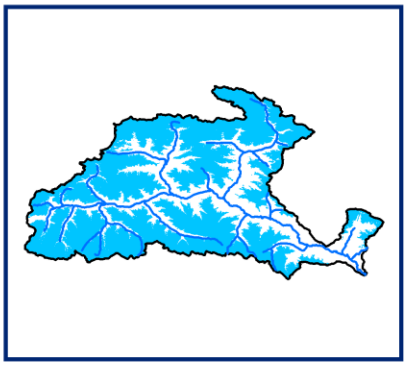
**10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN**



DATA USED
**05 MAY 2016**



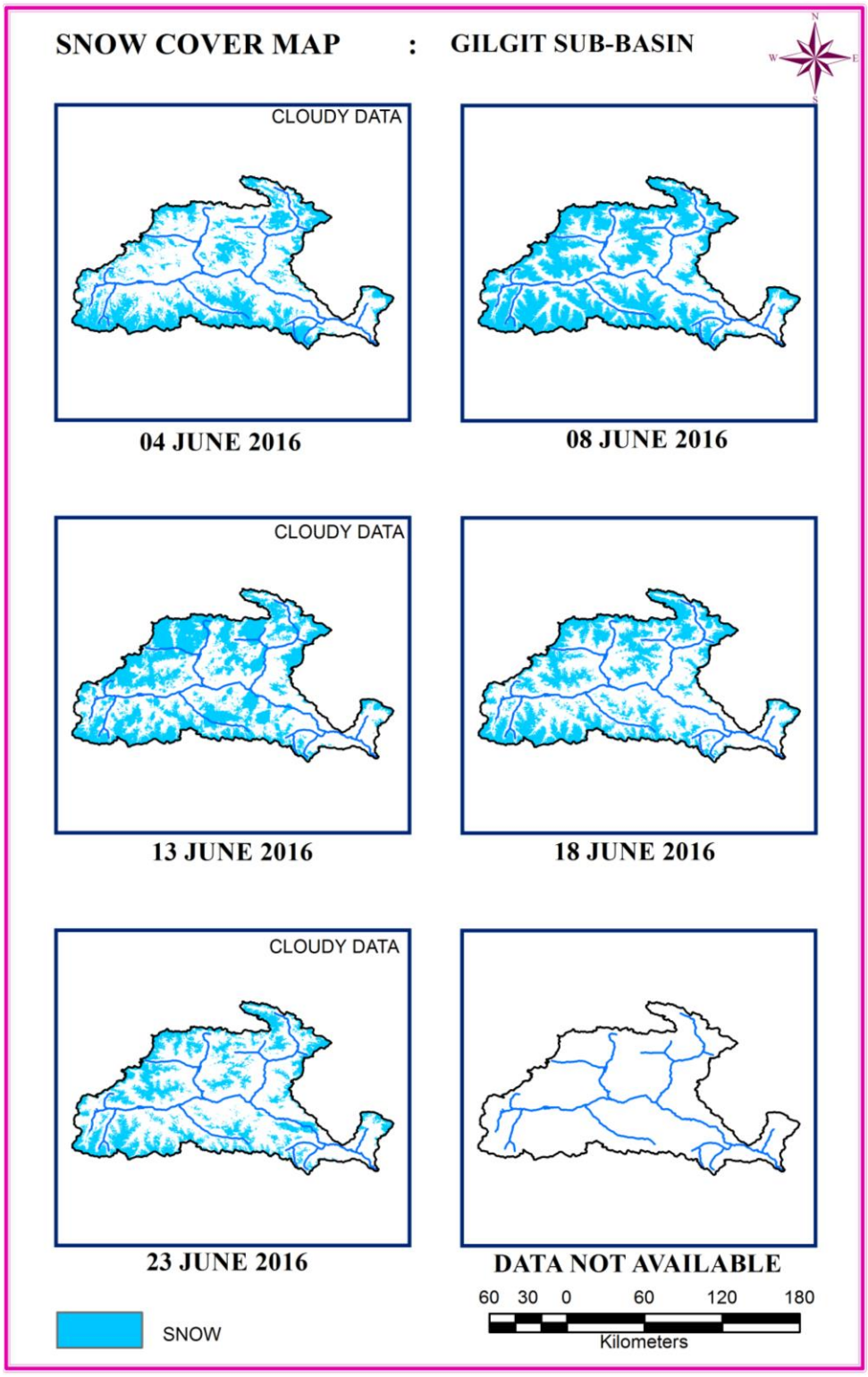
DATA USED
**15 MAY 2016**



DATA USED
**25 MAY 2016**

SNOW

60 30 0 60 120 180
Kilometers


SNOW COVER MAP : GILGIT SUB-BASIN
CLOUDY DATA
04 JUNE 2016
08 JUNE 2016
CLOUDY DATA
13 JUNE 2016
18 JUNE 2016
CLOUDY DATA
23 JUNE 2016
DATA NOT AVAILABLE
SNOW
60 30 0 60 120 180
Kilometers

## 10 DAILY SNOW COVER MAP : GILGIT SUB-BASIN

DATA USED
**04 JUNE 2016**
**08 JUNE 2016**

DATA USED
**13 JUNE 2016**
**18 JUNE 2016**

DATA USED
**25 JUNE 2016**

SNOW

60 30 0 60 120 180
Kilometers

# *SHASGAN SUB-BASIN*

## AREAL EXTENT OF SNOW (5 DAILY)

**BASIN NAME: SHASGAN** **BASIN AREA: 7613sq km**

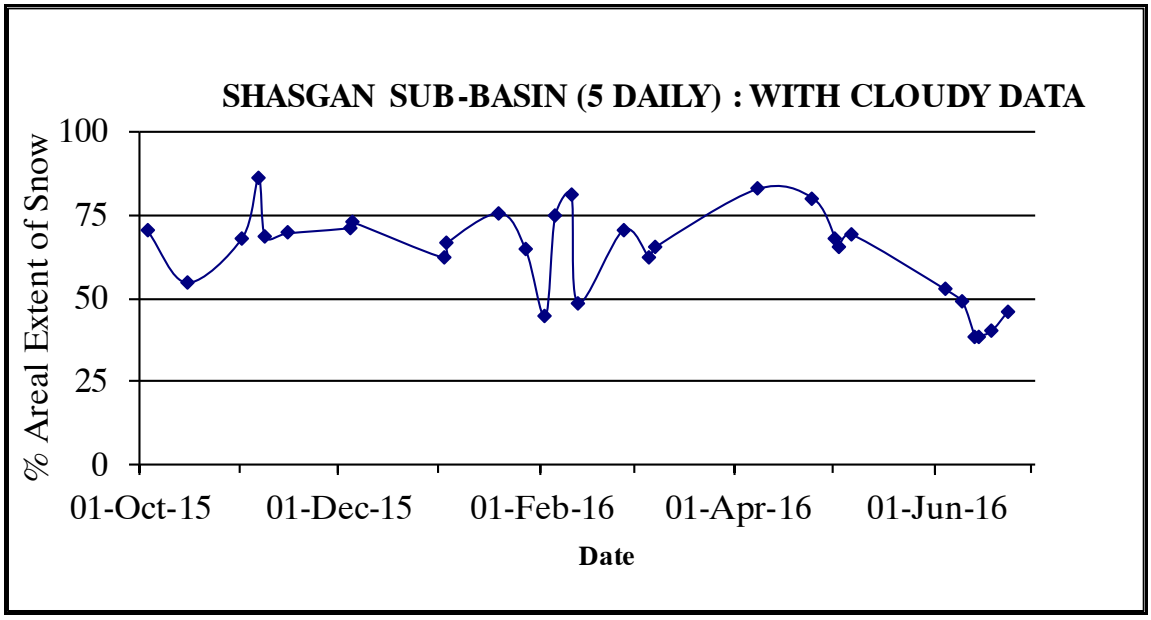
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | | | | |
| **1** | 03-Oct-15 | 5361 | 70 | **3** | 15-Oct-15 | 4180 | 55 |
| | | | | | | | |
| **November 2015** | | | | | | | |
| **5** | 01-Nov-15 | 5207 | 68 | **7** | 08-Nov-15 | 5233 | 69 |
| **6** | 06-Nov-15 | 6579 | 86 | **8** | 15-Nov-15 | 5312 | 70 |
| **December 2015** | | | | | | | |
| **9** | 04-Dec-15 | 5434 | 71 | **10** | 05-Dec-15 | 5559 | 73 |
| | | | | | | | |
| **January 2016** | | | | | | | |
| **11** | 02-Jan-16 | 4749 | 62 | **13** | 19-Jan-16 | 5777 | 76 |
| **12** | 03-Jan-16 | 5093 | 67 | | 27-Jan-16 | 4932 | 65 |
| **February 2016** | | | | | | | |
| **14** | 02-Feb-16 | 3392 | 45 | **17** | 12-Feb-16 | 3718 | 49 |
| **15** | 05-Feb-16 | 5698 | 75 | **18** | 26-Feb-16 | 5387 | 71 |
| **16** | 10-Feb-16 | 6204 | 81 | | | | |
| **March 2016** | | | | | | | |
| **20** | 05-Mar-16 | 4754 | 62 | **22** | 07-Mar-16 | 5004 | 66 |
| | | | | | | | |
| **April 2016** | | | | | | | |
| **24** | 07-Apr-16 | 6325 | 83 | **26** | 24-Apr-16 | 6121 | 80 |
| | | | | | | | |
| **May 2016** | | | | | | | |
| **27** | 01-May-16 | 5206 | 68 | **28** | 06-May-16 | 5282 | 69 |
| | 02-May-16 | 5010 | 66 | | | | |
| **June 2016** | | | | | | | |
| **29** | 04-Jun-16 | 4015 | 53 | **33** | 14-Jun-16 | 2950 | 39 |
| **30** | 09-Jun-16 | 3746 | 49 | **34** | 18-Jun-16 | 3074 | 40 |
| **31** | 13-Jun-16 | 2926 | 38 | **35** | 23-Jun-16 | 3524 | 46 |

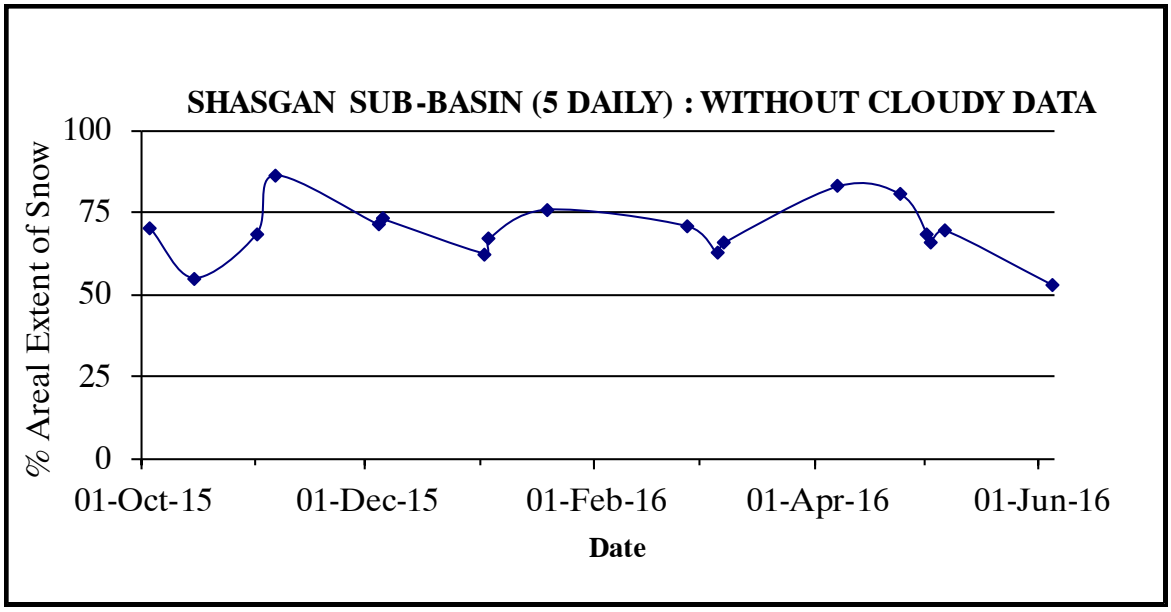
## AREAL EXTENT OF SNOW (10 DAILY)

**BASIN NAME: SHASGAN** **BASIN AREA: 7613sq km**

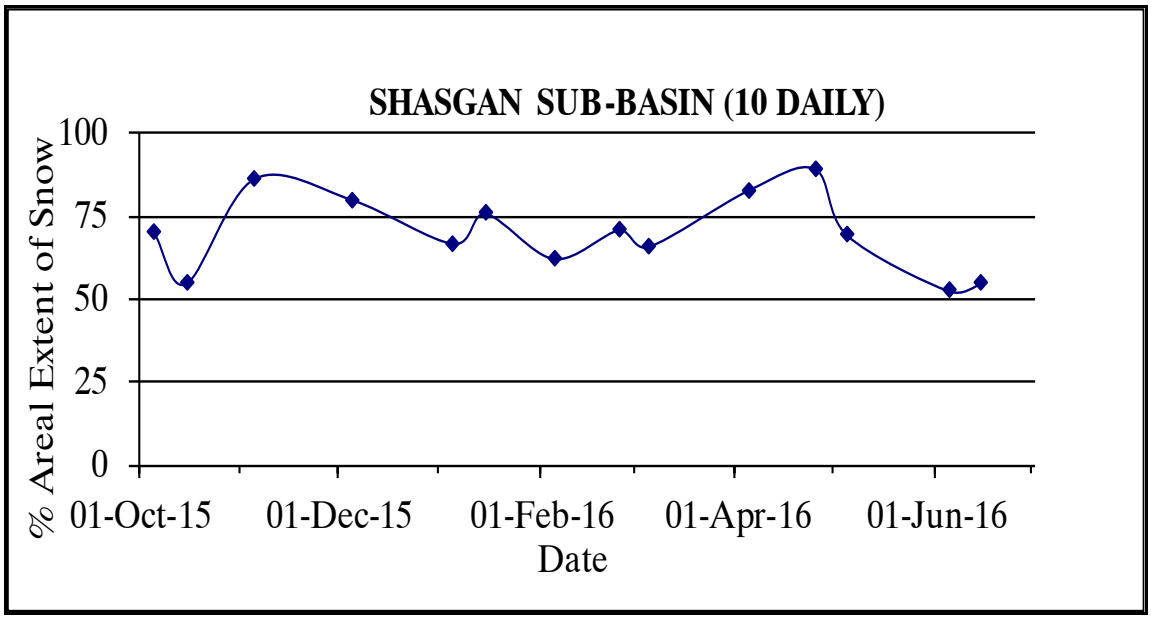
| S No | Date | Snow cover (sq km) | Snow cover (%) | S No | Date | Snow cover (sq km) | Snow cover (%) |
|---|---|---|---|---|---|---|---|
| **October 2015** | | | | **November 2015** | | | |
| **1** | 05-Oct-15 | 5360 | 70 | **3** | 05-Nov-15 | 6581 | 86 |
| **2** | 15-Oct-15 | 4182 | 55 | | | | |
| | | | | | | | |
| **December 2015** | | | | **January 2016** | | | |
| **4** | 05-Dec-15 | 6091 | 80 | **5** | 05-Jan-16 | 5094 | 67 |
| | | | | **6** | 15-Jan-16 | 5775 | 76 |
| | | | | | | | |
| **February 2016** | | | | **March 2016** | | | |
| **8** | 05-Feb-16 | 4746 | 62 | **11** | 05-Mar-16 | 4755 | 66 |
| **9** | 25-Feb-16 | 5318 | 71 | | | | |
| | | | | | | | |
| **April 2016** | | | | **May 2016** | | | |
| **13** | 05-Apr-16 | 6324 | 83 | **15** | 05-May-16 | 5283 | 69 |
| **14** | 25-Apr-16 | 6803 | 89 | | | | |
| | | | | | | | |
| **June 2016** | | | | | | | |
| **17** | 05-Jun-2016 | 4015 | 53 | | | | |
| **18** | 15-Jun-2016 | 4166 | 55 | | | | |

## SNOW COVER DEPLETION CURVE

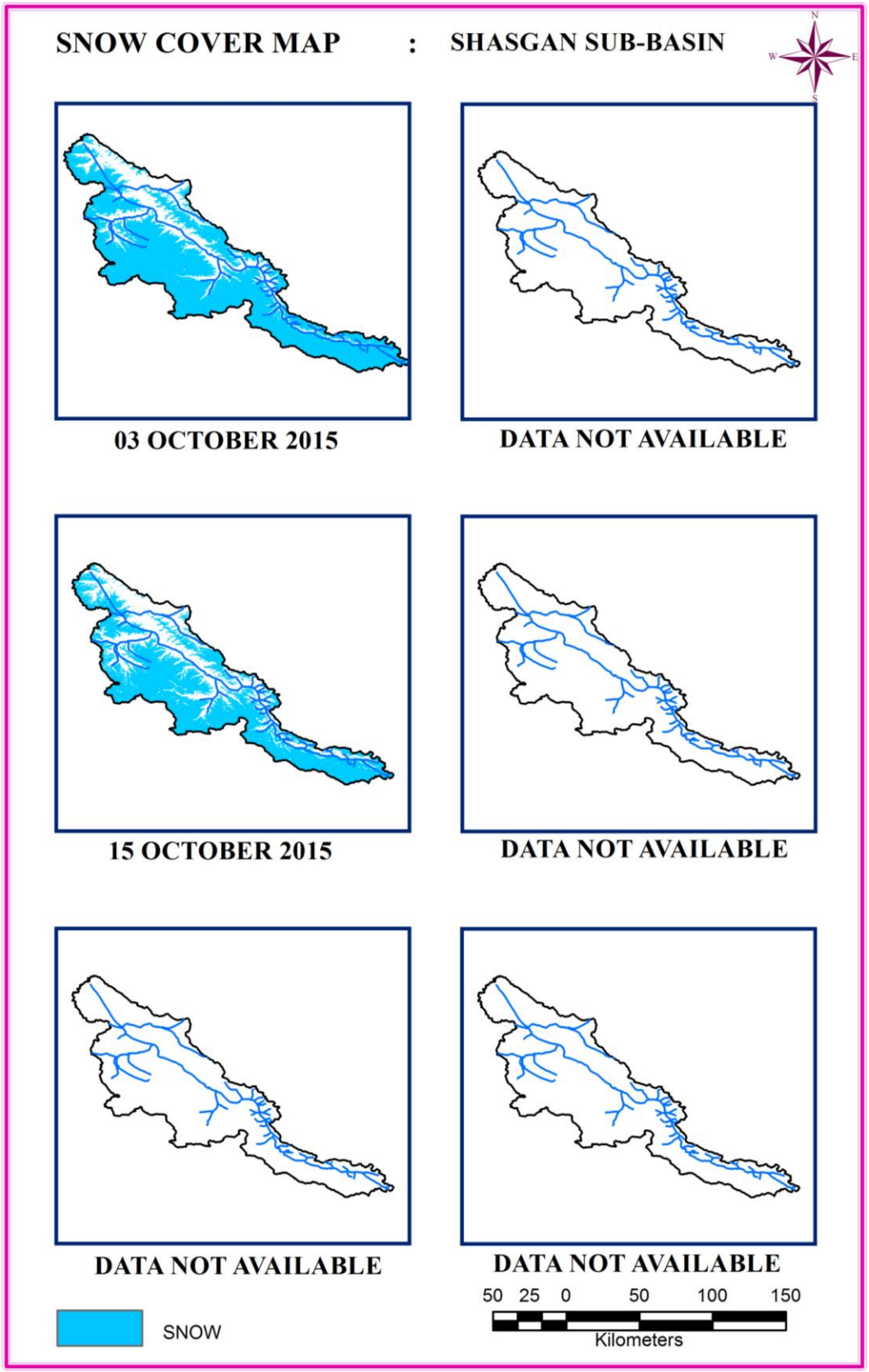


**SNOW COVER DEPLETION CURVE**

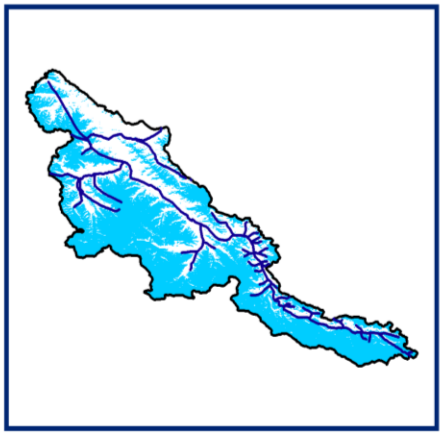


# *SNOW COVER MAP*


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
03 OCTOBER 2015
DATA NOT AVAILABLE
15 OCTOBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
50 25 0 50 100 150
Kilometers
SNOW

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

DATA USED
**05 OCTOBER 2015**

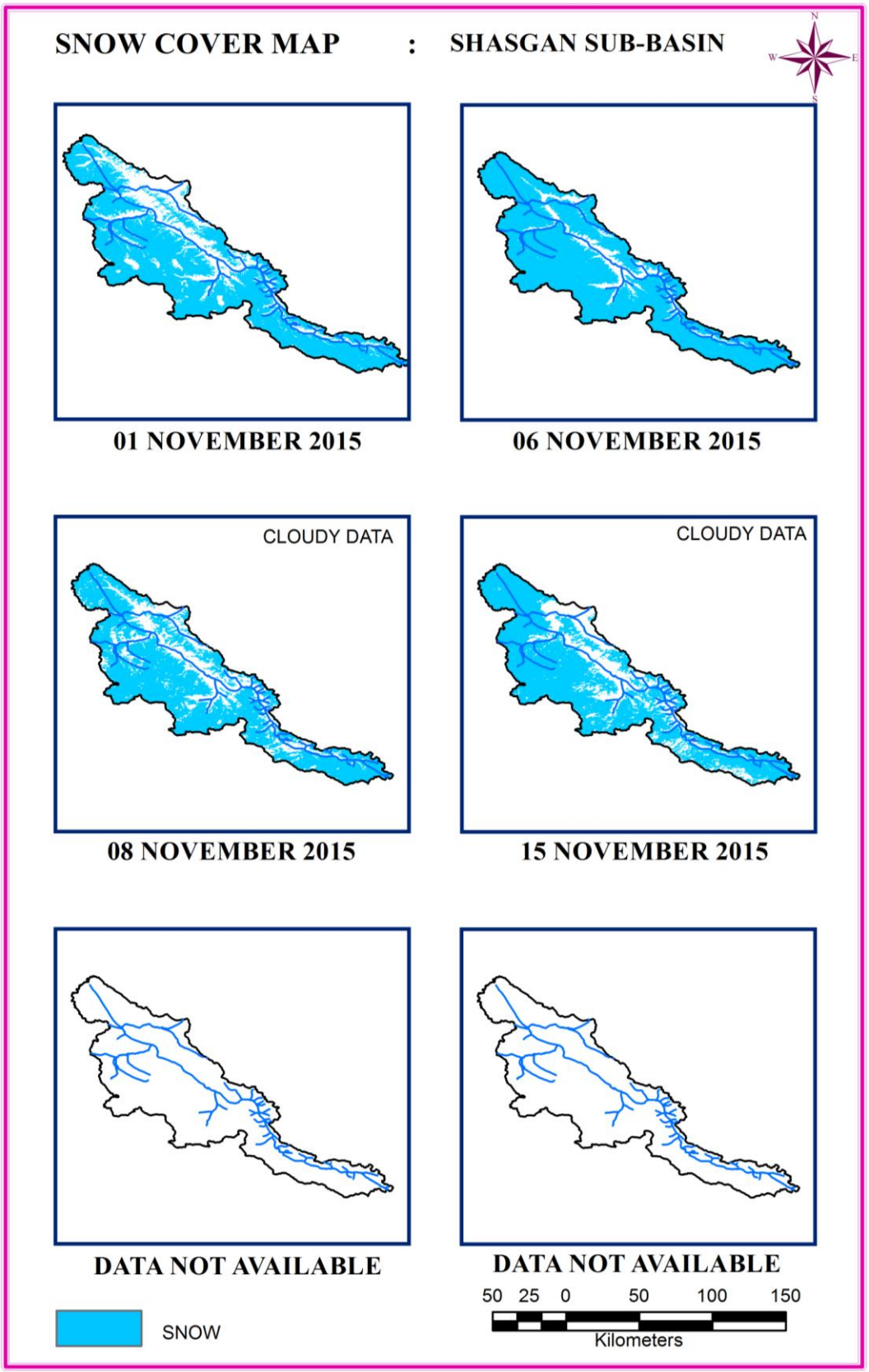


DATA USED
**15 OCTOBER 2015**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
01 NOVEMBER 2015
06 NOVEMBER 2015
CLOUDY DATA
08 NOVEMBER 2015
CLOUDY DATA
15 NOVEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
50 25 0 50 100 150
Kilometers
SNOW

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

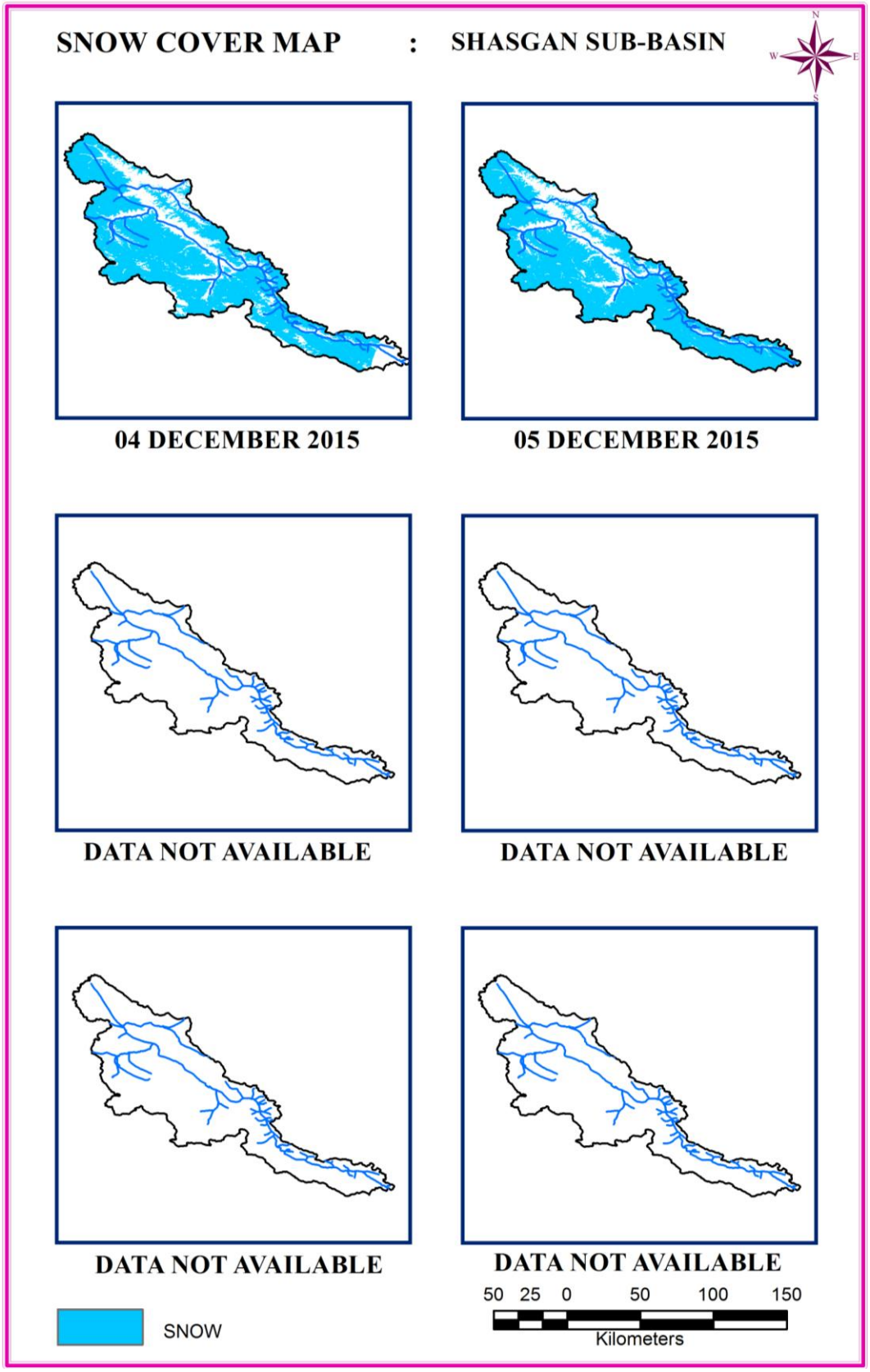
DATA USED
**01 NOVEMBER 2015**
**06 NOVEMBER 2015**
**08 NOVEMBER 2015**

**DATA NOT AVAILABLE**

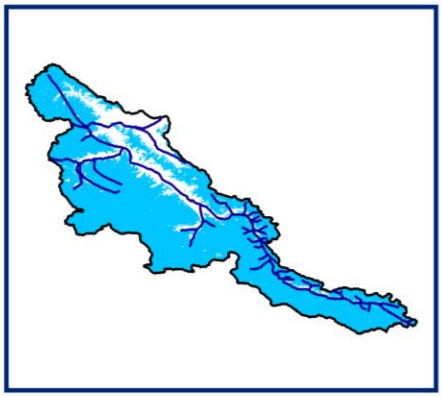
**DATA NOT AVAILABLE**

SNOW

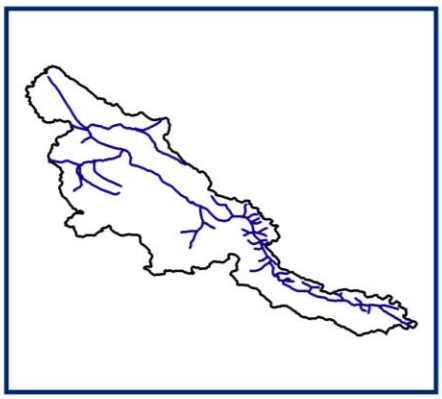
50 25 0 50 100 150
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
04 DECEMBER 2015
05 DECEMBER 2015
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
50 25 0 50 100 150
Kilometers
SNOW

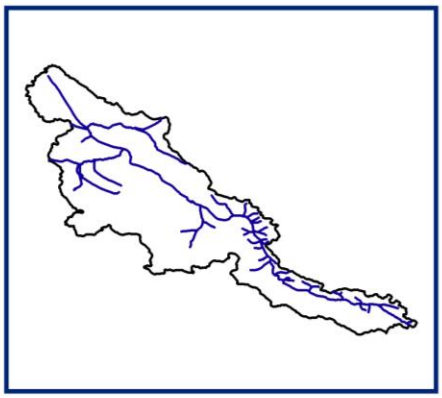
## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN



DATA USED
**04 DECEMBER 2015**
**05 DECEMBER 2015**



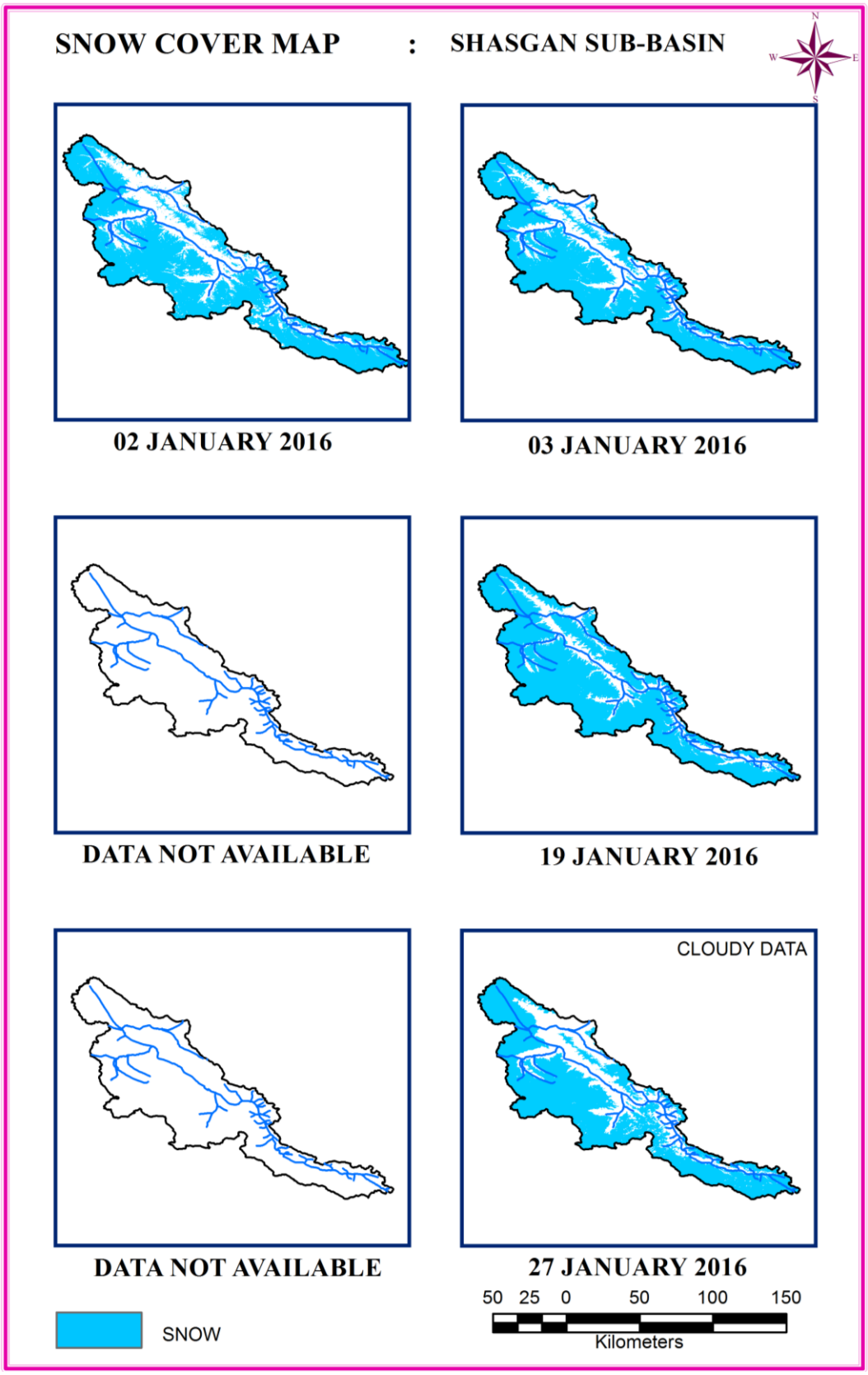
**DATA NOT AVAILABLE**



**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
02 JANUARY 2016
03 JANUARY 2016
DATA NOT AVAILABLE
19 JANUARY 2016
DATA NOT AVAILABLE
CLOUDY DATA
27 JANUARY 2016
50 25 0 50 100 150
Kilometers
SNOW

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

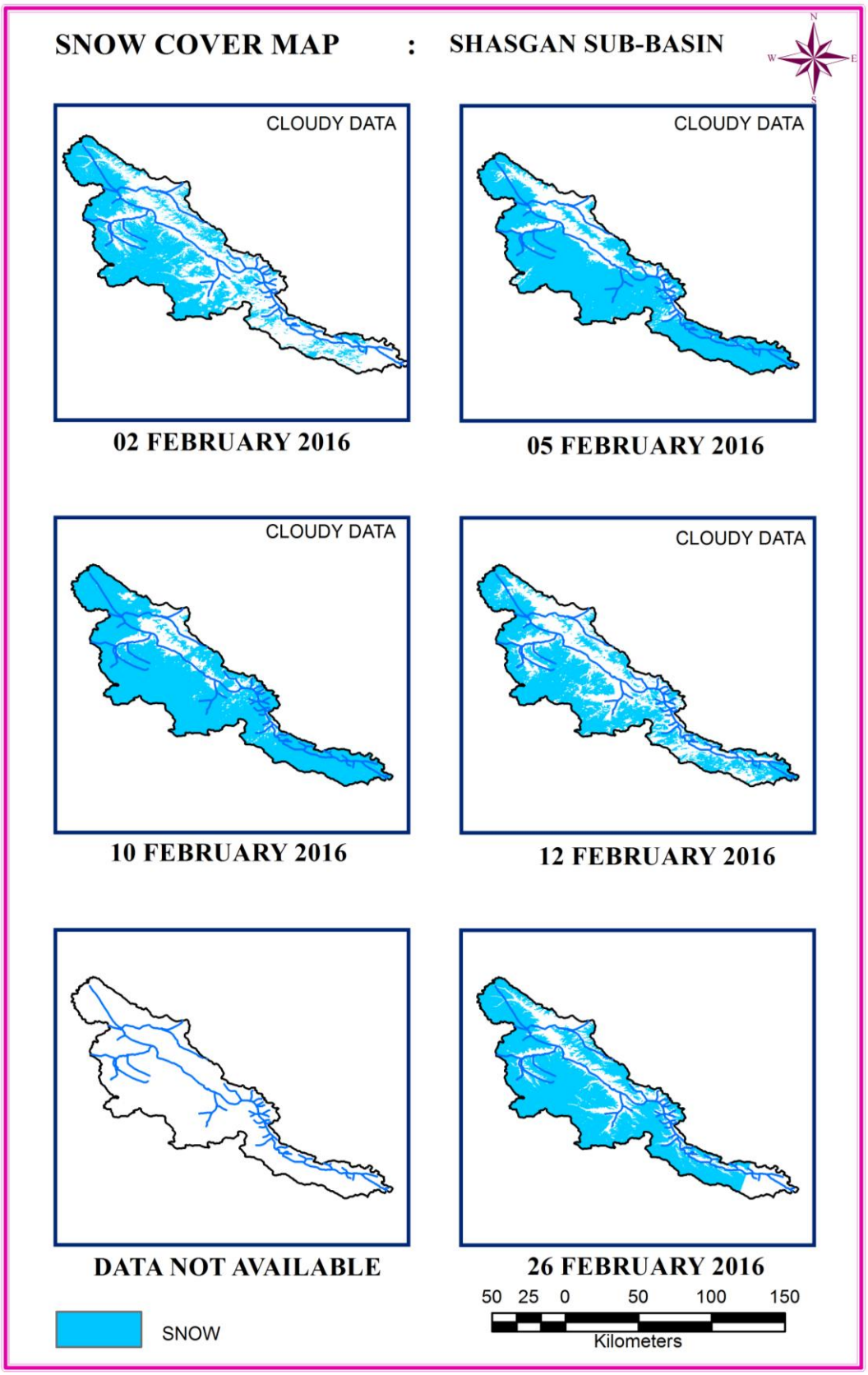
DATA USED
**02 JANUARY 2016**
**03 JANUARY 2016**

DATA USED
**15 JANUARY 2016**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
CLOUDY DATA
02 FEBRUARY 2016
CLOUDY DATA
05 FEBRUARY 2016
CLOUDY DATA
10 FEBRUARY 2016
CLOUDY DATA
12 FEBRUARY 2016
DATA NOT AVAILABLE
26 FEBRUARY 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

DATA USED

**02 FEBRUARY 2016**
**05 FEBRUARY 2016**
**10 FEBRUARY 2016**

**DATA NOT AVAILABLE**

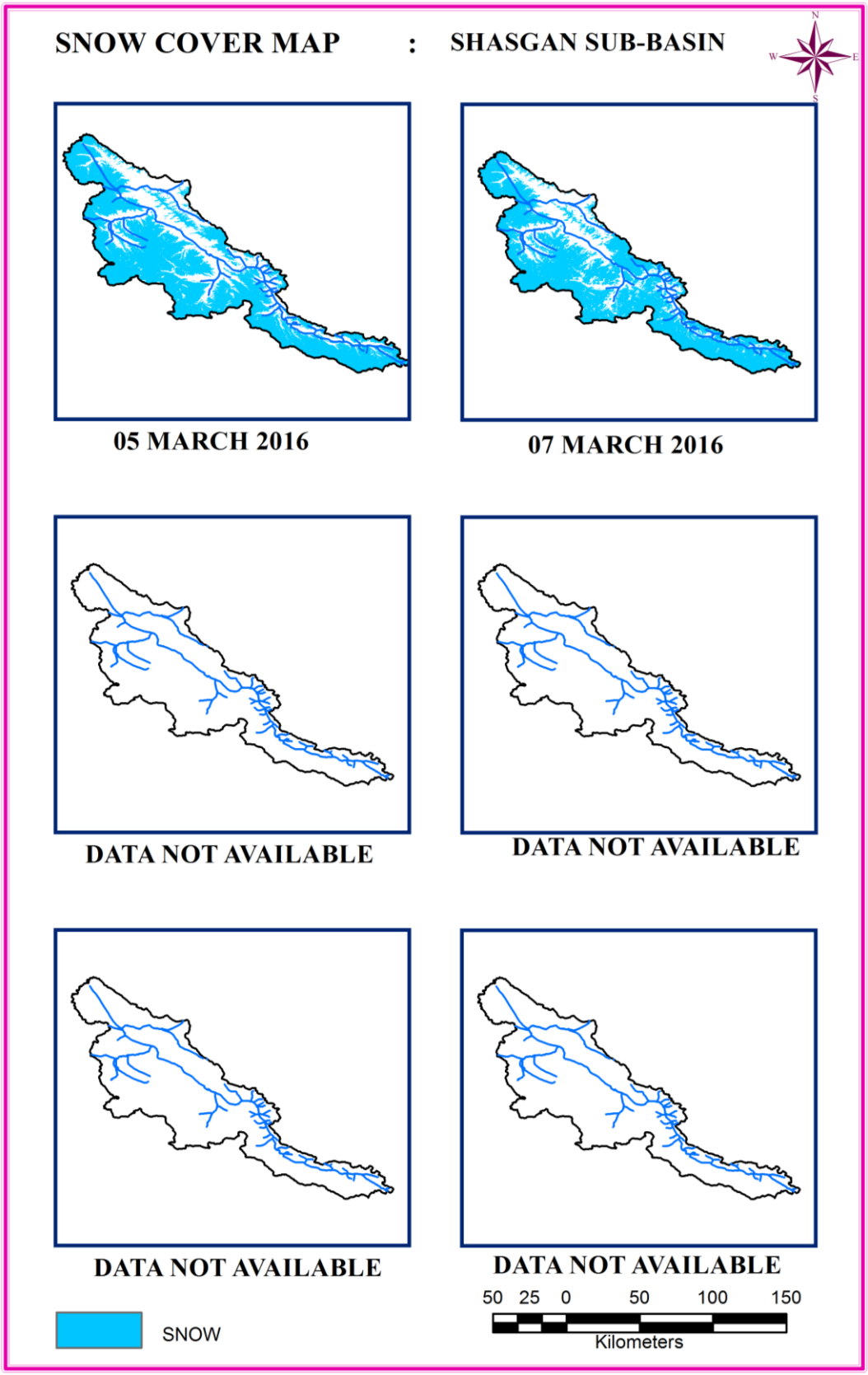
DATA USED

**25 FEBRUARY 2016**

SNOW

50 25 0 50 100 150

Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
05 MARCH 2016
07 MARCH 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

DATA USED

**05 MARCH 2016**
**07 MARCH 2016**

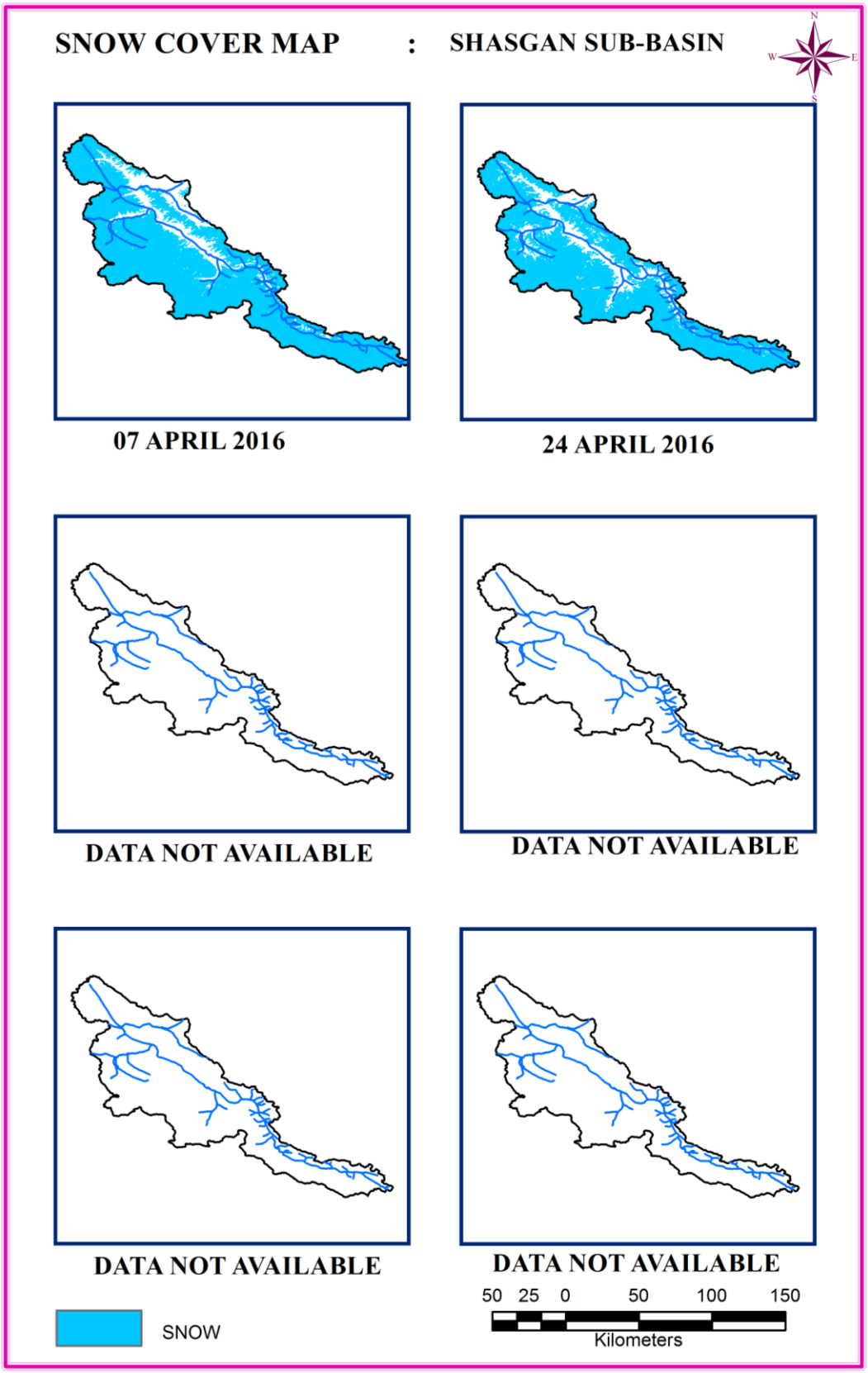
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150

Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
07 APRIL 2016
24 APRIL 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

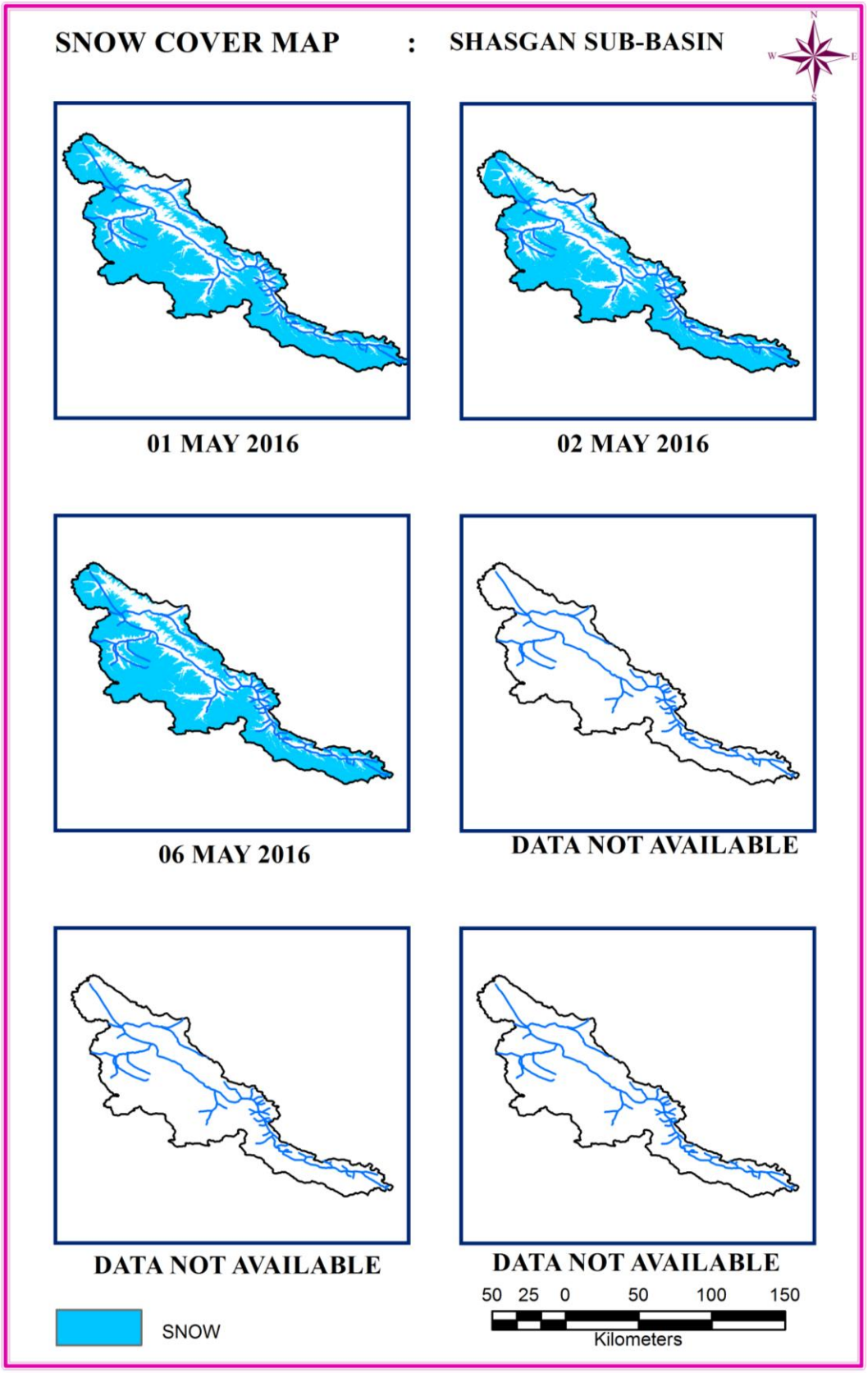
DATA USED
**05 APRIL 2016**

**DATA NOT AVAILABLE**

DATA USED
**25 APRIL 2016**

SNOW

50 25 0 50 100 150
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
01 MAY 2016
02 MAY 2016
06 MAY 2016
DATA NOT AVAILABLE
DATA NOT AVAILABLE
DATA NOT AVAILABLE
50 25 0 50 100 150
Kilometers
SNOW

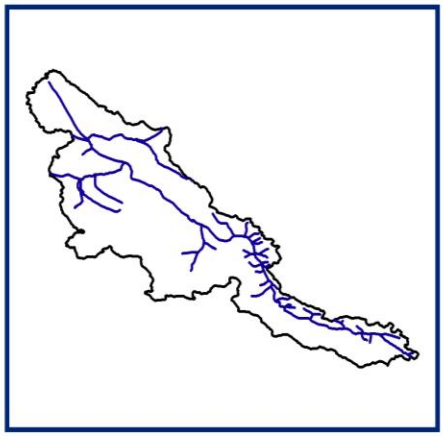
## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN

DATA USED

**01 MAY 2016**

**02 MAY 2016**

**06 MAY 2016**



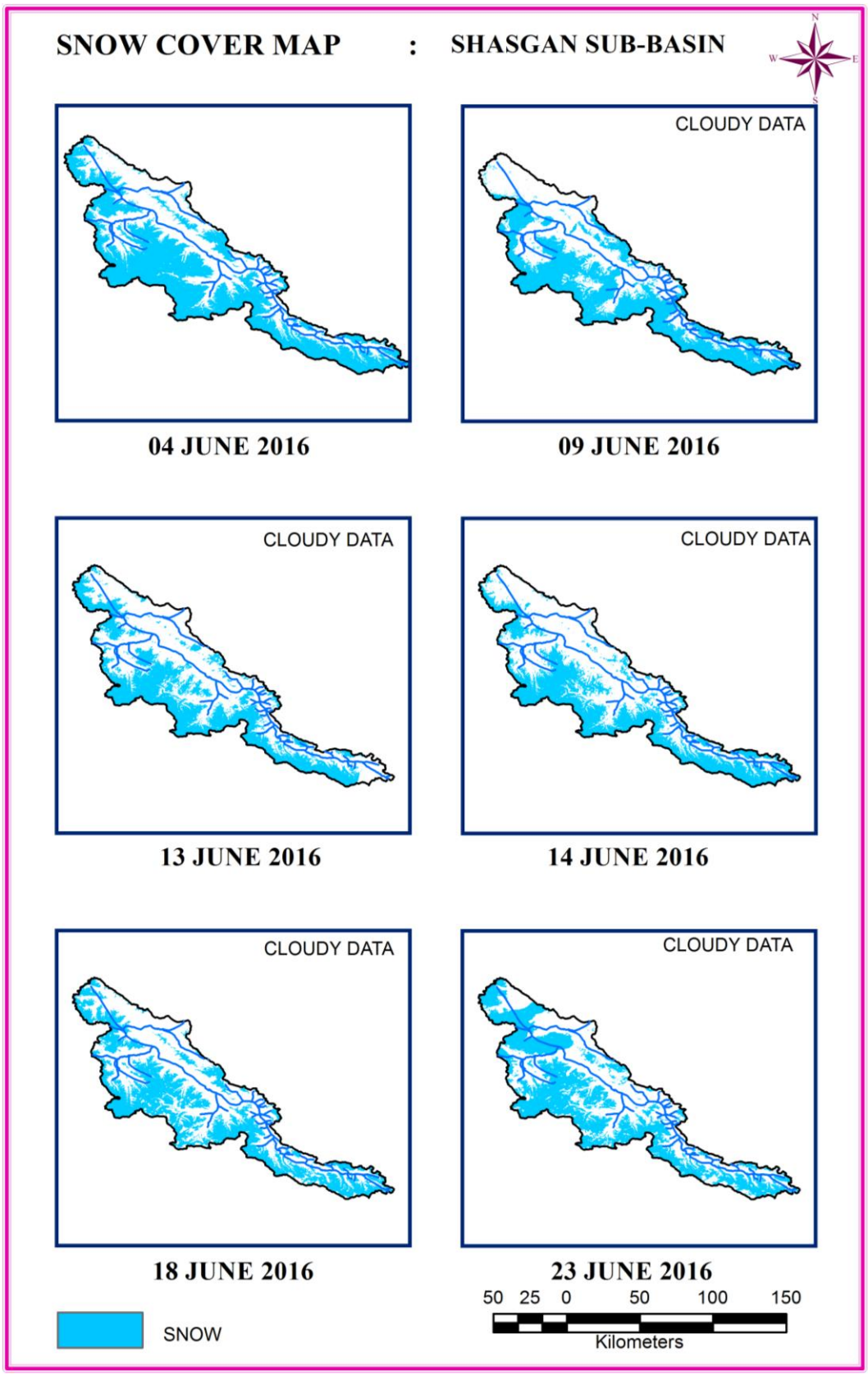
**DATA NOT AVAILABLE**

**DATA NOT AVAILABLE**

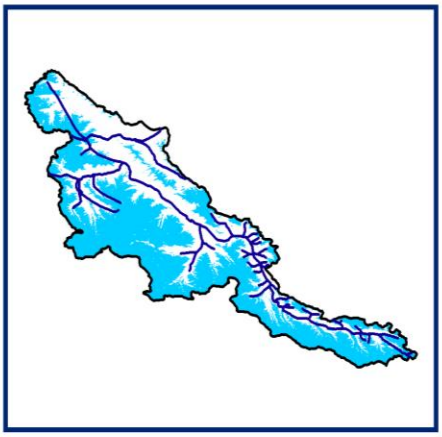
SNOW

50 25 0 50 100 150

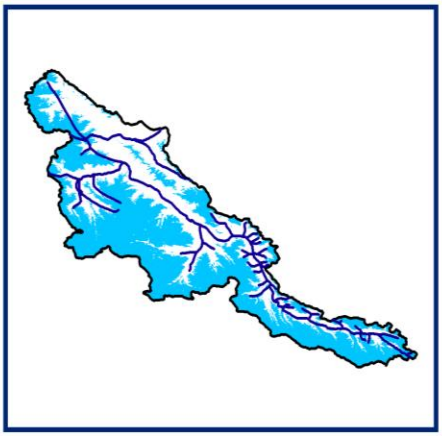
Kilometers


SNOW COVER MAP : SHASGAN SUB-BASIN
N
W
E
S
CLOUDY DATA
04 JUNE 2016
CLOUDY DATA
09 JUNE 2016
CLOUDY DATA
13 JUNE 2016
CLOUDY DATA
14 JUNE 2016
CLOUDY DATA
18 JUNE 2016
CLOUDY DATA
23 JUNE 2016
SNOW
50 25 0 50 100 150
Kilometers

## 10 DAILY SNOW COVER MAP : SHASGAN SUB-BASIN



DATA USED
**04 JUNE 2016**
**09 JUNE 2016**



DATA USED
**14 JUNE 2016**
**18 JUNE 2016**

**DATA NOT AVAILABLE**

SNOW

50 25 0 50 100 150
Kilometers