



Assessment of Snowmelt Runoff Contribution to Senqu River

The 2019 MOXXI, CandHy, WMO HydroHub, and
CUAHSI Joint Conference "Innovation in
Hydrometry: Overbarriers to operationalization"

(11-13 March 2019, New York, USA)



Mr. Neo Makhalemele

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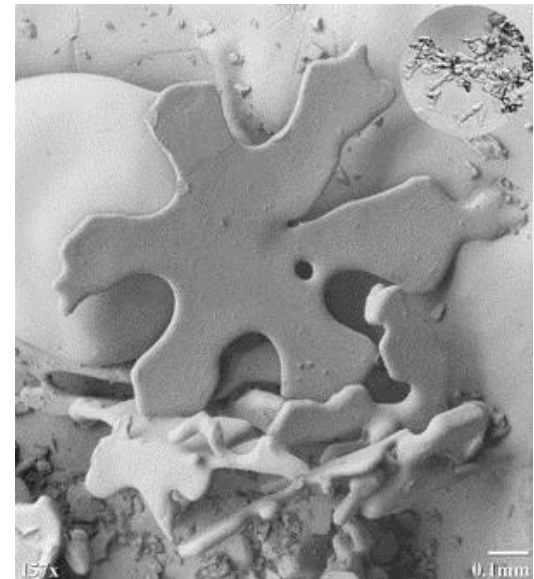
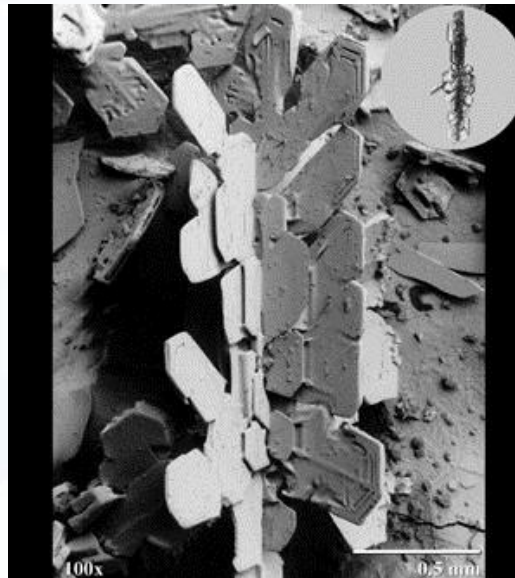
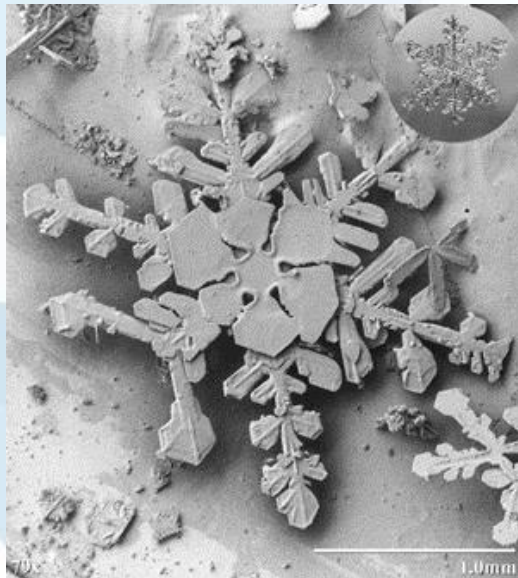
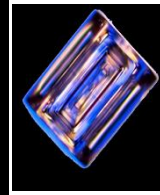
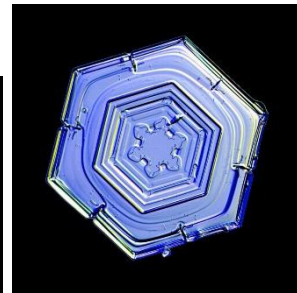
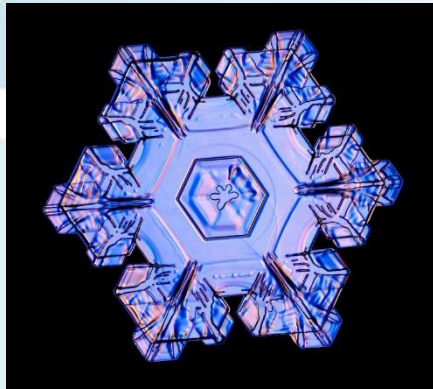
Mr. Webster GUMINDOGA



MOXXI Measurements &
Observations in the
21st Century
Working Group - International Association of Hydrological Sciences



Who is Snow?



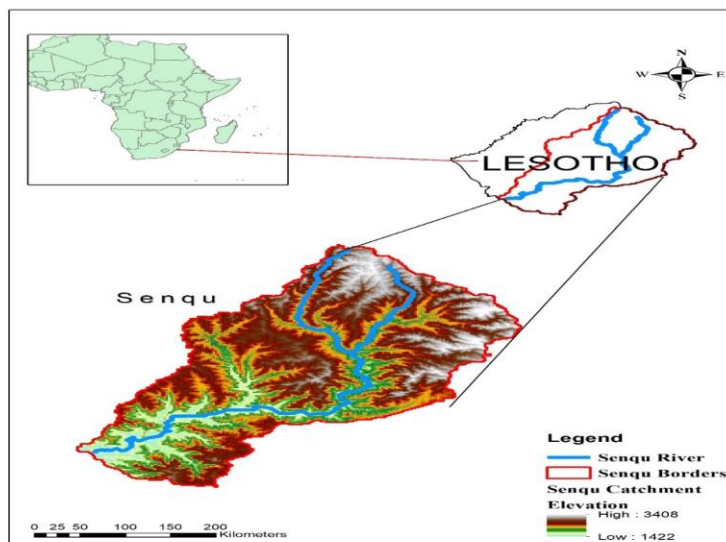
Images from <http://www.anri.barc.usda.gov/emusnow/default.htm>

Why This Study?

- The spatial and temporal variation of snow cover in Lesotho is not comprehensively known.
- Contribution of snowmelt to runoff is not adequately quantified.
- Assessment of how much snowmelt water equivalence is contributing to the country's water resources will help improve integrated water resources management..

Lesotho

Study Area

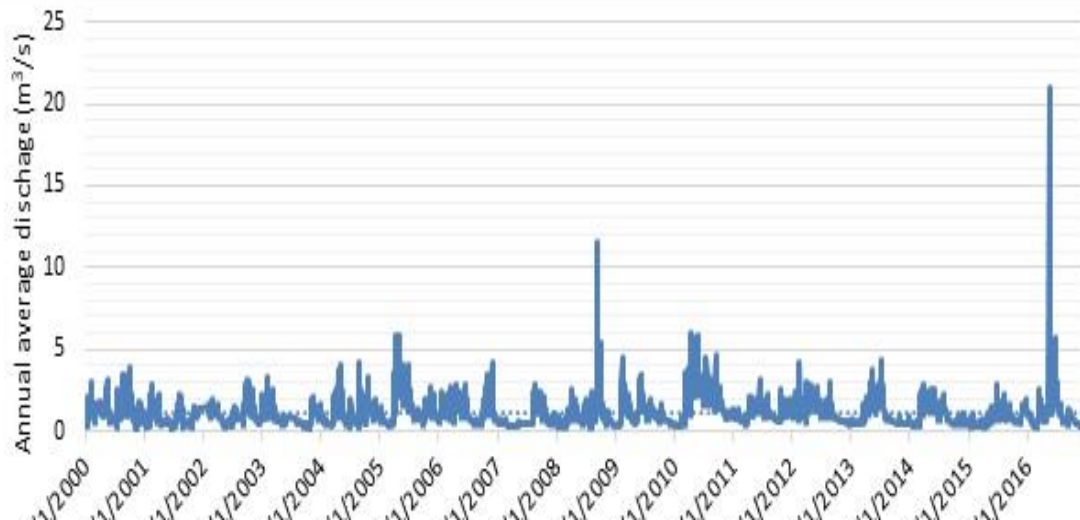
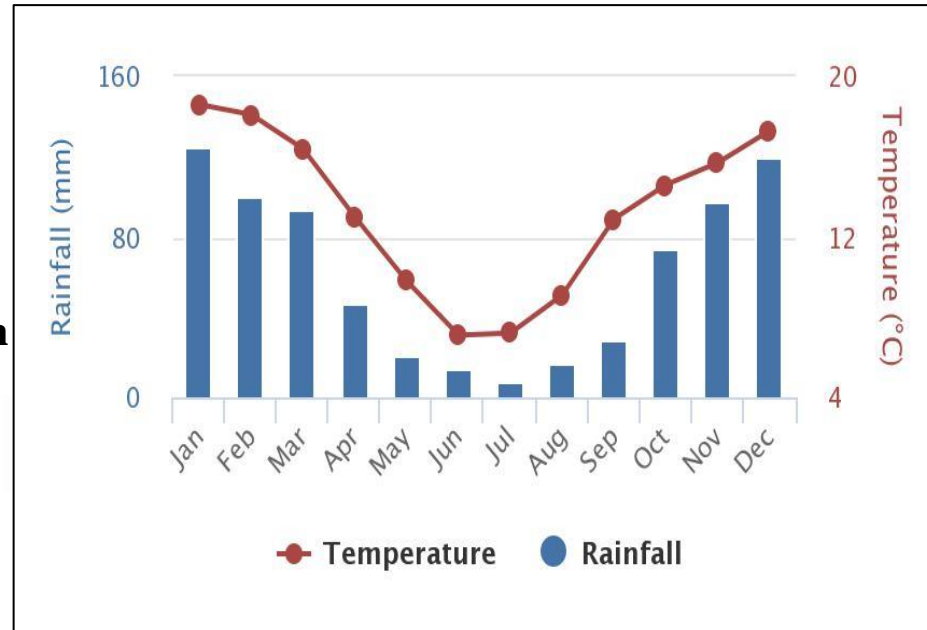


Metro-Hydrological Conditions of Lesotho

Climate and Hydrology

The annual estimates of about 1200 mm in the highlands and about 800mm at the lowlands mean annual air temperature (MAAT) above 2800 m is assumed to be 3°C to 7°C (Nel et al.,2008)

Annual average daily discharge at Seaka (SG03)

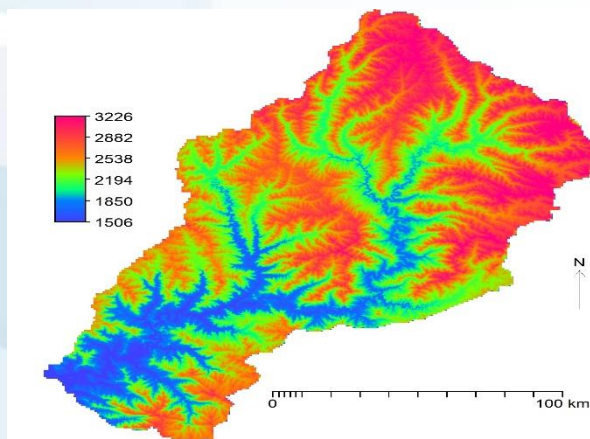


Datasets Used

a) Shuttle Radar Topography Mission (SRTM)

Digital Elevation Model	DEM (30m) (SRTM)
Provider	NASA & NGA
Horizontal Datum	WGS84
Spatial Resolution	1 arc-second for global coverage (~30 meters)
Raster Size	1 degree tiles

c) SRTM 30m digital elevation model



b) MODIS SIN Grid V006 L3 Images

Surface Reflectance	MOD09A1
Provider	NASA-LAADS/DAAC
Spatial coverage	Globally
Period tested	2013-2017
Band Wave Length	250m-500m
Temporal Resolution	8-Day

d) MODIS



Equipment Used

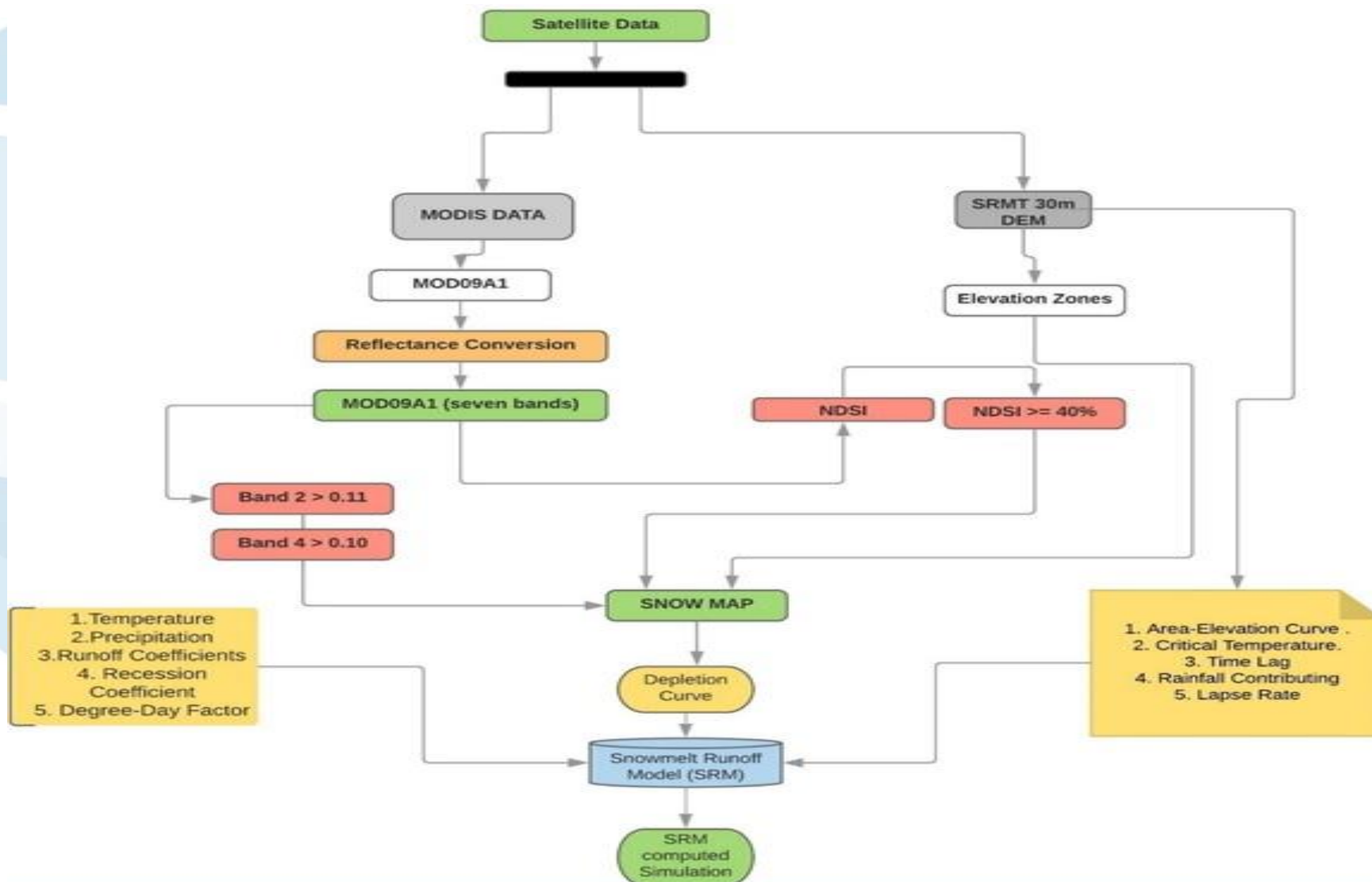
e) Meteorological Station @ Semonkong

(International Meteorological Consultant Inc., 2016)

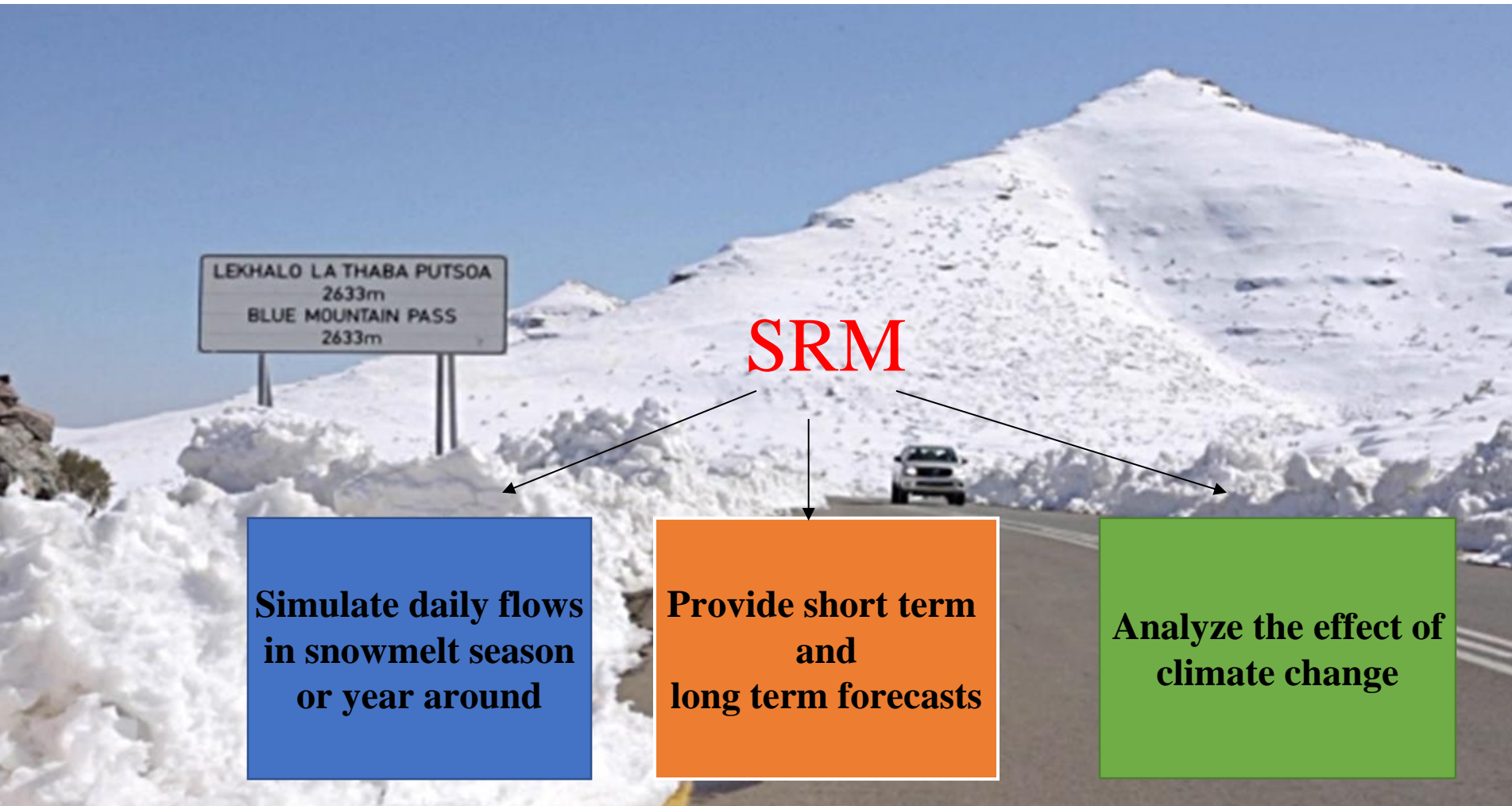


f) Streamflow Gauging Station @ Sani

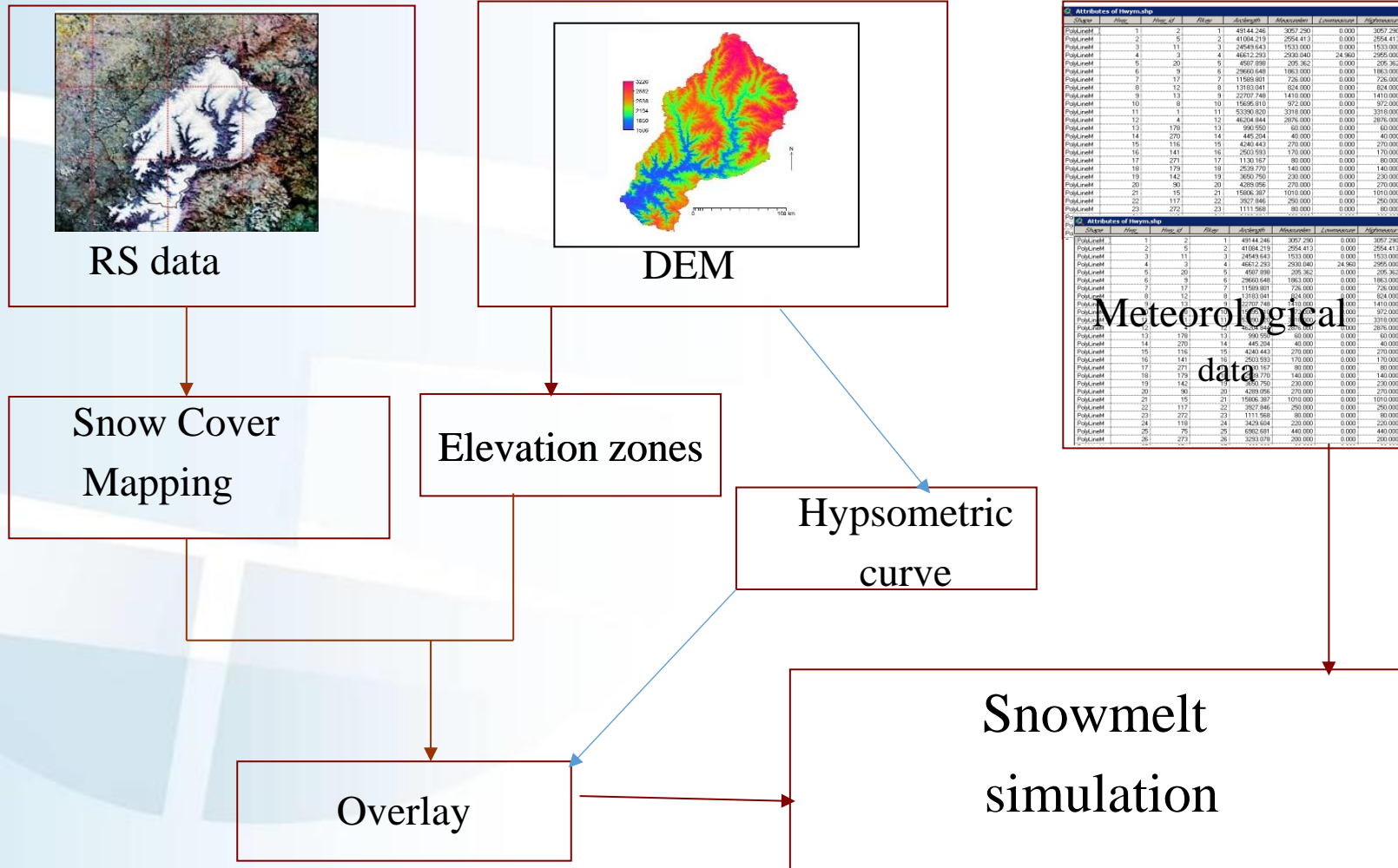
Study Conceptual Approach



Snowmelt runoff model (SRM)



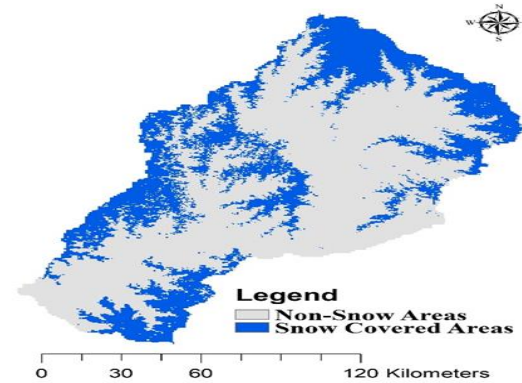
Methods – SRM Cont.....



Results: Snow Cover Areas



○ MOD09A1.A2016209.tif



○ MOD09GA.A2006217.HDF



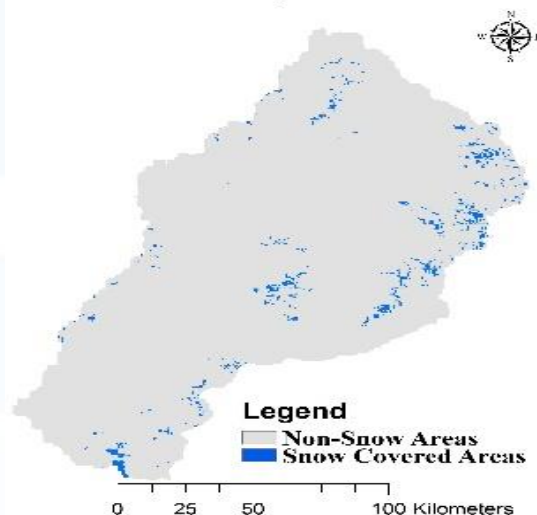
Snow cover 27 July 2016



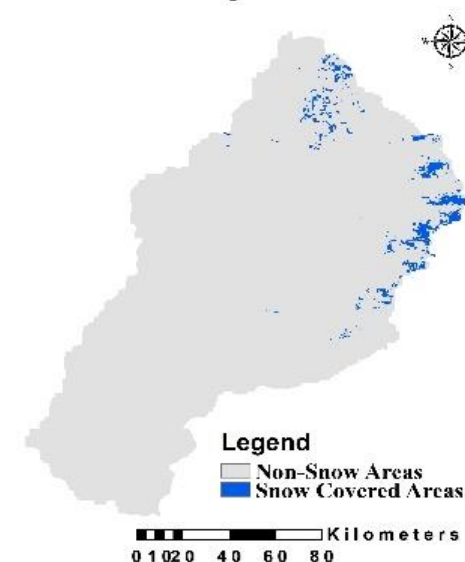
Results: Snow Cover Areas Cont....

17 May 2013	0.25%
28 July 2015	2.17%
27 July 2016	34%
17 May 2017	2.04%

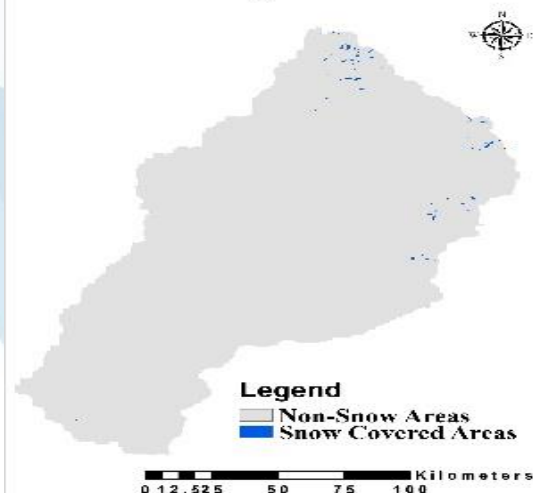
28 July 2015



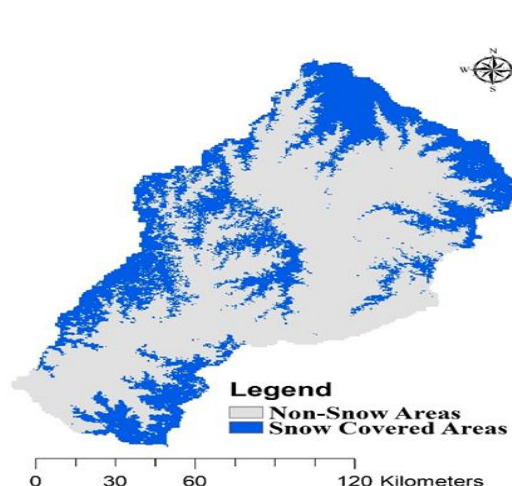
17 May 2017



17 May 2013



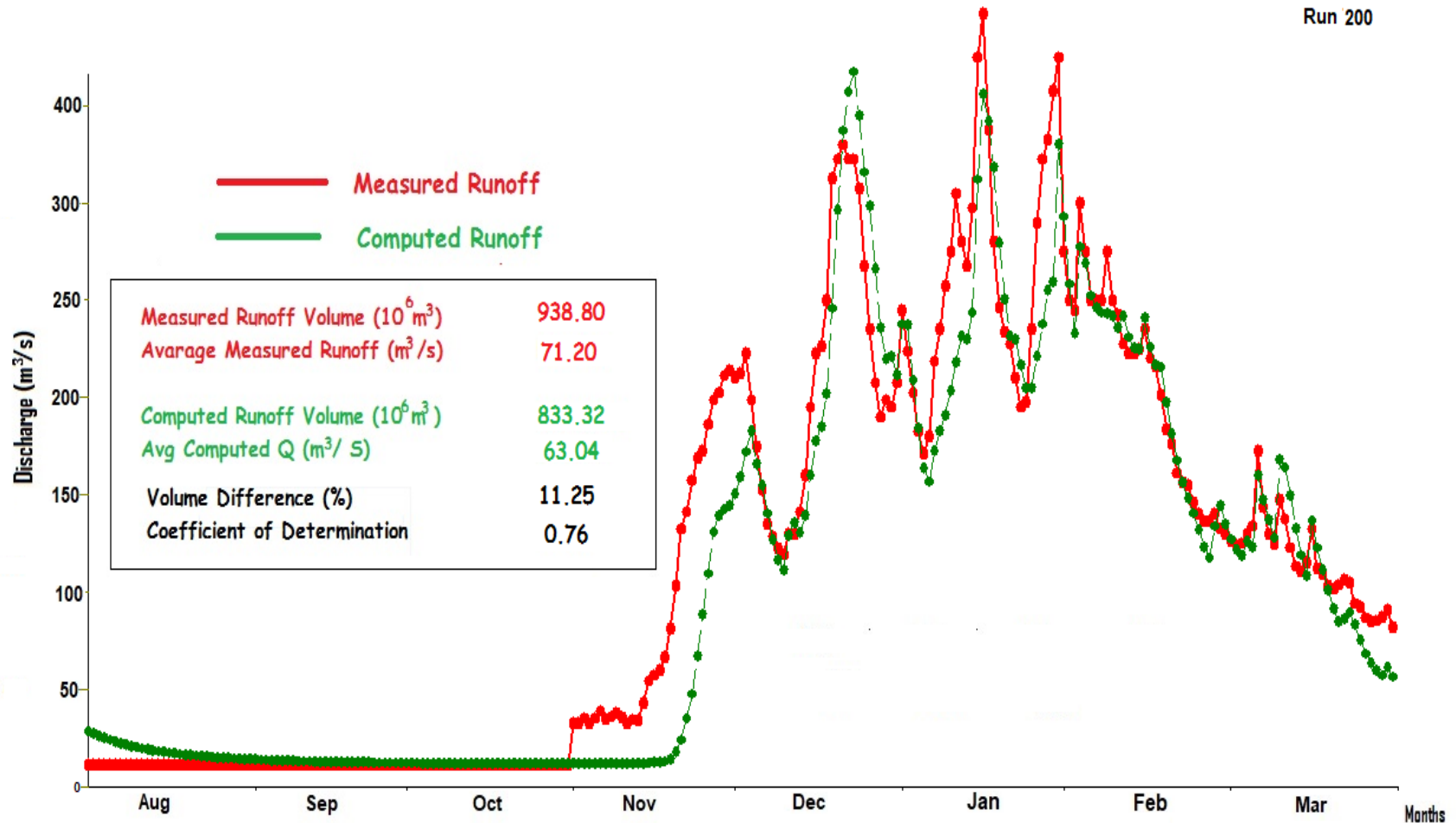
27 July 2016



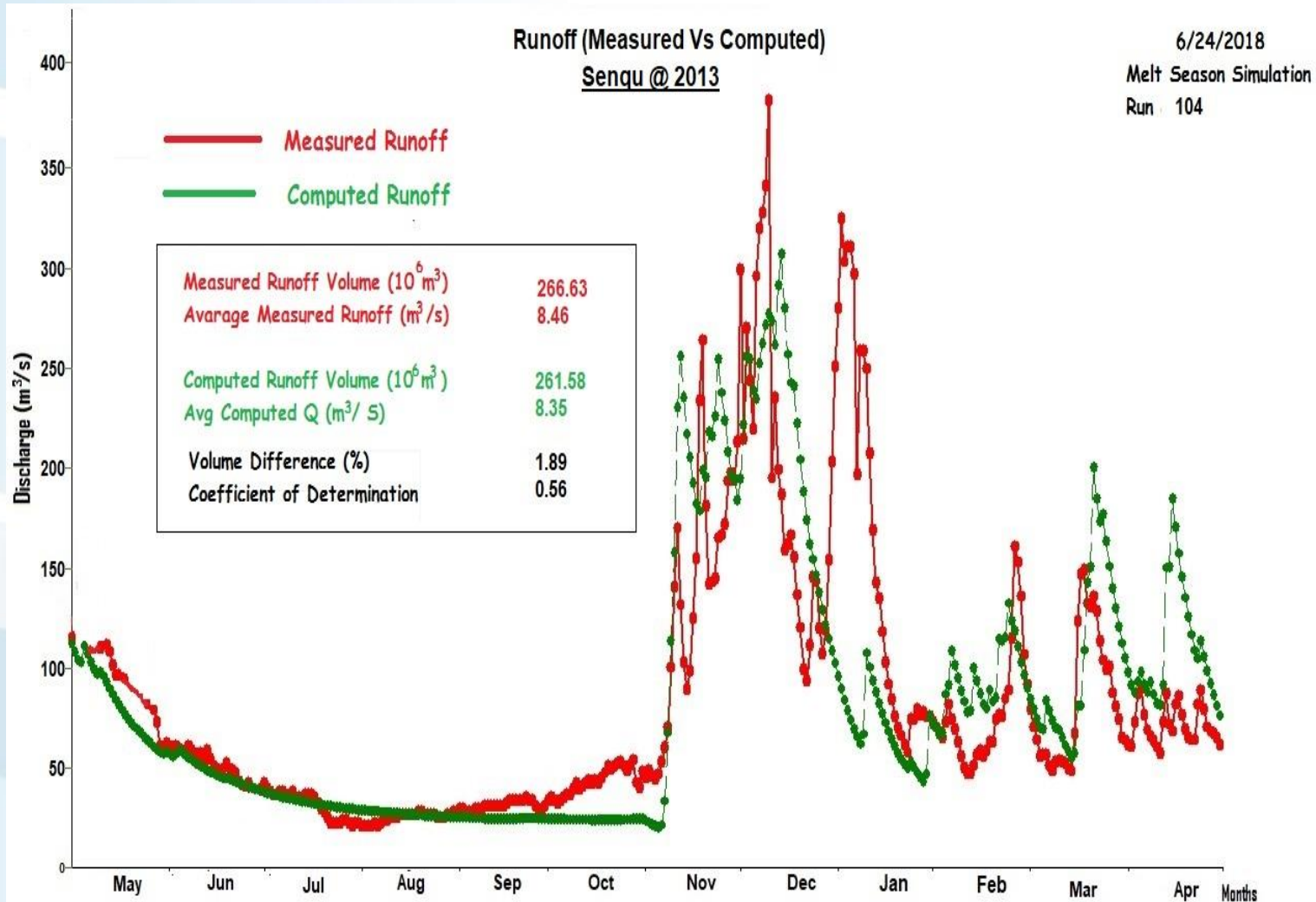
SRM Calibration and Validation

Results: SRM Calibration Simulation

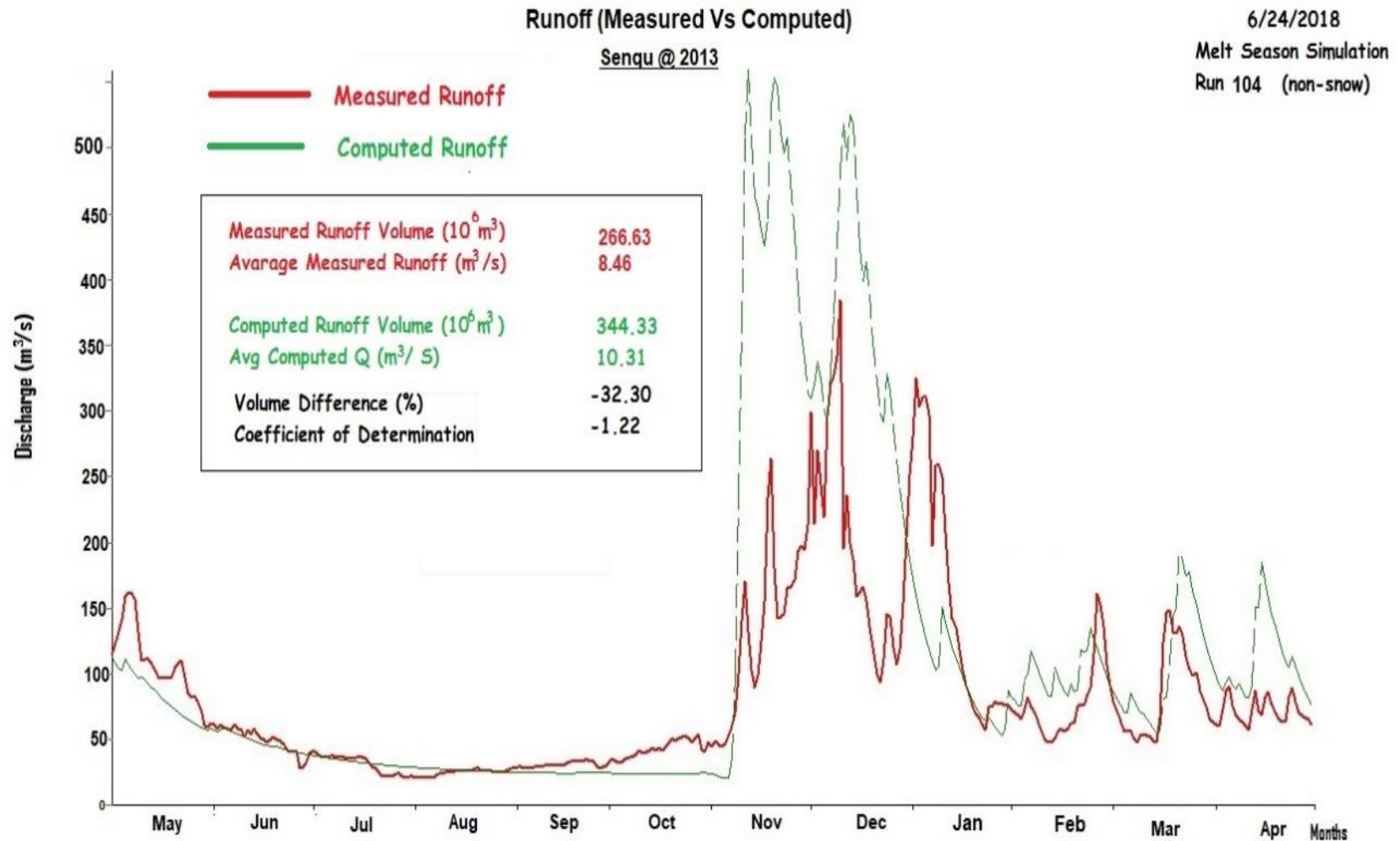
7/14/2018
Melt Season Simulation
Run 200



Results: SRM Validation Simulation



Results: SRM Validation Simulation



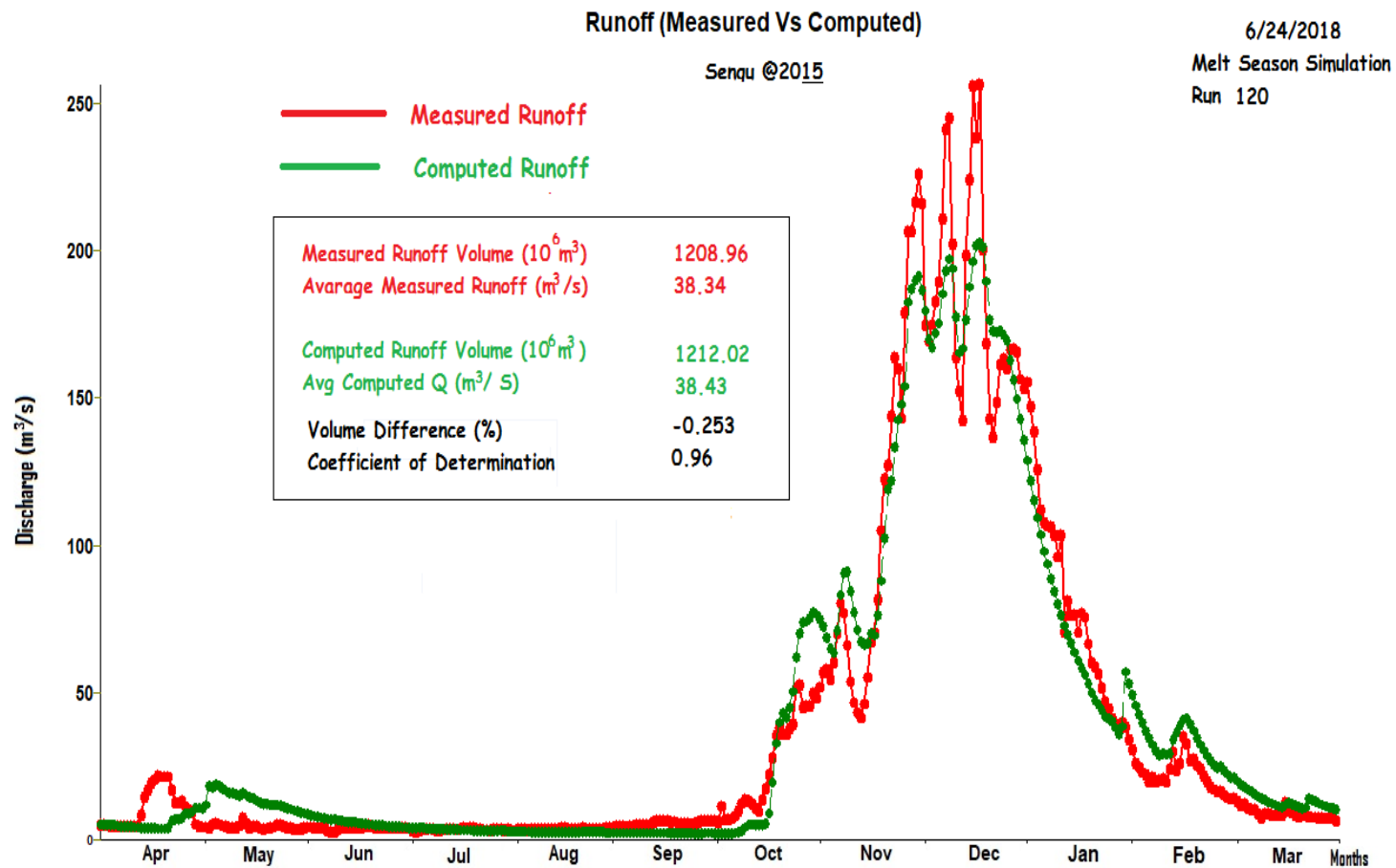
Summary of Model Performance



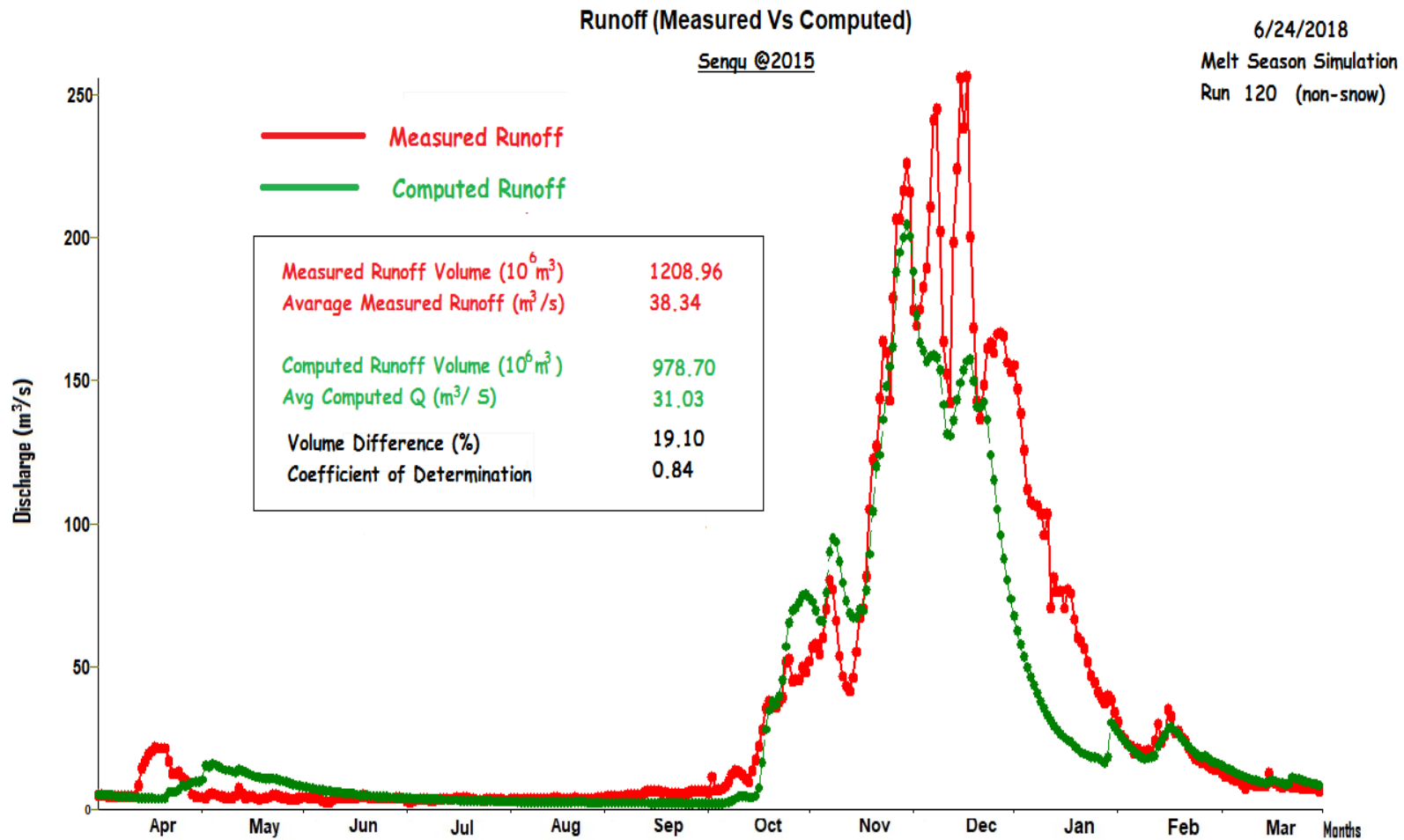
	Calibration	Validation
R^2	76%	56 %
D_v	11.25%	1.89

Application of model to assess Snowmelt Contribution Assessments

Results: Snowmelt Runoff Contribution



Results: Snowmelt Runoff Contribution



Snowmelt Contribution Results

Snowmelt Contribution Results

Contribution @ 2015

$$1212.02 \times 10^6 \text{m}^3 - 978.70 \times 10^6 \text{m}^3 \\ = \underline{233.32 \times 10^6 \text{m}^3}$$

Contribution @ 2016

$$1674.093 \times 10^6 \text{m}^3 - 1664.846 \times 10^6 \text{m}^3 \\ = \underline{9.247 \times 10^6 \text{m}^3}$$

Contribution @ 2017

$$843.08 \times 10^6 \text{m}^3 - 709.75 \times 10^6 \text{m}^3 \\ = \underline{133.33 \times 10^6 \text{m}^3}$$

Conclusion and Recommendation

Conclusion:

- i. The study shows that snow cover can vary temporary from 0.25 -35% in Senqu Catchment.
- ii. It is concluded that snowmelt contribution from Senqu Catchment can range from $9.247 \times 10^6 \text{m}^3$ to $233.32 \times 10^6 \text{m}^3$

“Follow a drop of water from where it falls on land, to the streams, and all the way to the ocean.”



R.M. Hirsch, USGS

Kea leboha, Likhomo!!!
Thank you

