The Journal of the Georgian Geophysical Society,
Issue (B), Physics of Atmosphere, Ocean, and Space Plasma, v. 17, 2014, pp. 107-111

Application of Remote sensing and GIS technologies for study of seasonal snow cover in Georgia

Lomidze N.,[1] Janjalia T., [2] Koridze K., [2] Tvauri G.,[2] Zilpimiani D.[2]

[1] Iv. Javakhishvili Tbilisi State University, V. Batonishvili Institute of Geography, 6. Tamarashvili st. Tbilisi, Georgia
[2] Iv. Javakhishvili Tbilisi State University, M. Nodia Institute of Geophysics, 1, Alexidze st. Tbilisi, Georgia

Abstract

Terra MODIS Snow product were used for seasonal snow cover study in Georgia. Spatial and temporal distribution data of snow covered areas in 2012 January-December period were obtained for 12 regions of Georgia. Preliminary results of snow cover dynamics were obtained. Investigation of seasonal snow cover dynamics for 2000-2014 time periods is underway.

Seasonal snow cover is an important component of climate system significant part – cryosphere. It effects on climate, relief, hydrographic and soil formation processes, plant and animal living ecosystem. The practical significance of snow cover is determined by the hydrographic network formation, development of mountain tourism, transport functioning in winter period.

Snow cover influence on climate is determined by interaction with atmosphere. Duration of seasonal snow cover duration is conditioned by winter temperatures, which in its turn, during the last decades, experiences changes with the tendency of warming and is expressed by the significant decrease of seasonal snow cover in north hemisphere. Together with natural factors, this process is emphasized also by anthropogenic factors. Snow cover area change impacts on climate, ecosystems and population welfare both in global and regional scale.

Besides responding on climate change and being climate change indicator, snow cover also have an great influence on climate. Snow is distinguished by high reflectivity; Fresh snow has the highest albedo. Large amount of sun light reaching the earth surface is reflected back to the atmosphere. Presence-absence of snow cover impacts on cooling-warming of earth surface, on energy balance of the Earth.

Current climate change can dramatically alter the areas of steady snow cover on the earth surface and effects to its duration. Unlike to other substances snow cover exists near to the melting point (0°C) and can be changed from solid condition to liquid with a little change of air temperature. Prolonged warming trend can cause significant change of landscape, if snow mass will decrease during the distinct period of time.

This problem is very important for mountainous countries, particularly for Georgia with its strategical location in Caucasus region. Methodic monitoring of snow cover is very significant from economical and geo-ecological points of view. The rational management of hydro-

energetic resources, safe transportation in winter period, development of mountain touristic centers and eco-tourism, their future perspectives, water-supply for population, natural hazards (flooding landslides, avalanches, mudflows) is impossible without snow cover current condition assessment and change trend determination.

Generally, different snow parameters are obtained during the snow cover observation at meteorological stations. Unfortunately nowadays in Georgia only 16 meteorological stations are operational and snow observations are conducted only in few of them. These data does not cover the whole picture of snow dynamics for complex orography of Georgia. For solving this problem, we decide to use satellite remote sensing data.

Satellite remote sensing provides the opportunity to evaluate snow cover parameters. Remote sensing and GIS technologies give possibility to analyze and visualize snow cover changes. Since the mid 1960 different remote sensing instruments were used for snow cover mapping. Moderate Resolution Imaging Spectroradiometer (MODIS) installed on Terra and Aqua satellites is widely used for snow cover monitoring. These satellites began to orbit in February 2000 and July 2002 respectively. MODIS uses 36 spectral bands to estimate 44 globally available data products with spatial resolution of 250, 500 and 1000 km. Among other datasets MODIS provides also snow cover data at 500 m spatial and daily temporal resolution.

This study presents preliminary results of MODIS snow data application for snow cover analysis in Georgia for January-December of 2012. The 8 day composite MODIS snow products from Terra (MOD10A2) were used (Hall at all, 2006). The snow products were generated by the NASA Godard Space Flight Center and made available by the National Snow and Ice Data Center (NSIDC), Colorado, USA. The 8 day cover in MODIS snow product is mapped as maximum snow extent and as a chronology of snow observations in two scientific data sets _ Maximum Snow Extent and Eight Day Snow Cover.

As an example, Fig 1 presents Terra MODIS 8 day composite snow product visualization for 2012, 1-8 January. For this image Maximum Snow Extent data set was used. After determination of region of interest (500 m A.S.L.) for each of 12 regions of Georgia (Apkazeti, Samegrelo-Upper Svaneti, Racha-Lechkhumi-Lower Svaneti, Imereti, Guria, Samtskhe-Javakheti, Inner Kartli, Lower Kartli, Mtskheta-Mtianeti, Kakheti and Tbilisi), areas of snow covered, cloud covered and snow free areals may be easily delivered. The Aster DEM digital Elevation model was used to study distribution of snow cover over the 500 m elevation.

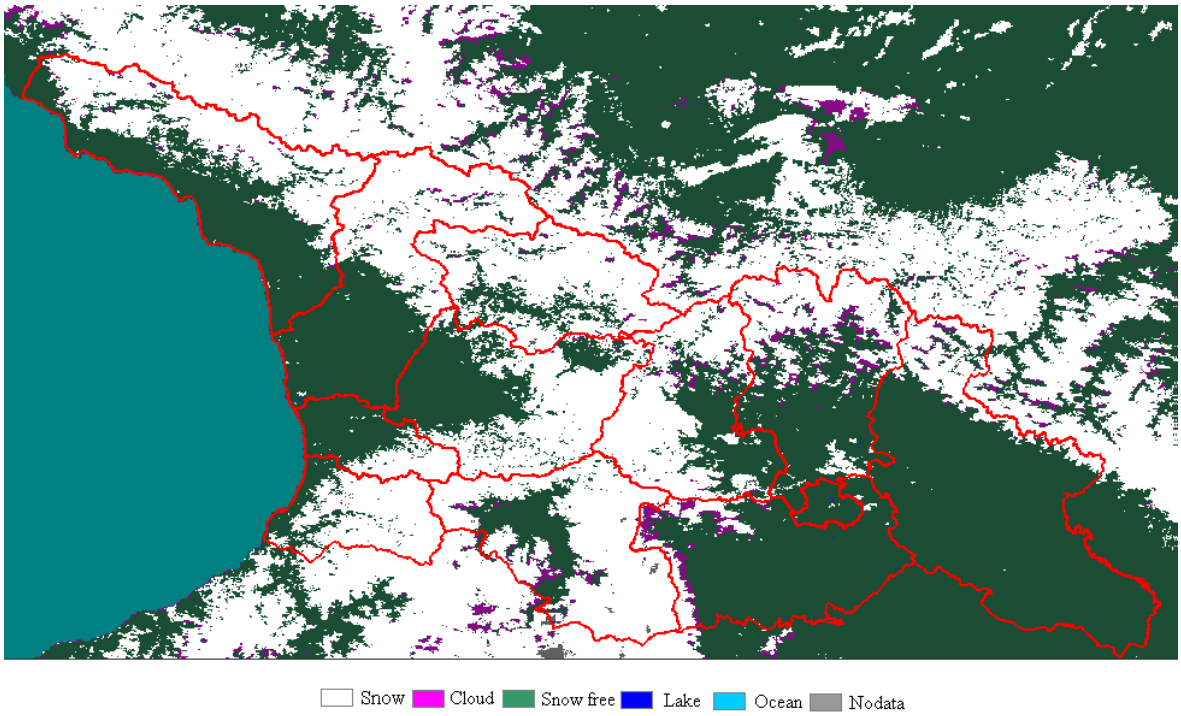

Fig. 1. Terra MODIS 8 day composite snow product visualization for 2012, 1-8 January

Fig. 2 shows seasonal snow cover dynamics of Aphkhazeti region of Georgia for 2012, Jan-Dec, derived from 8 day composite MODIS snow products. Axis of ordinates shows amount of snow or cloud covered pixels. The nominal area of pixel for 500 m spatial resolution MODIS Images is 0.2146587 km^2 (Riggs at all, 2006).

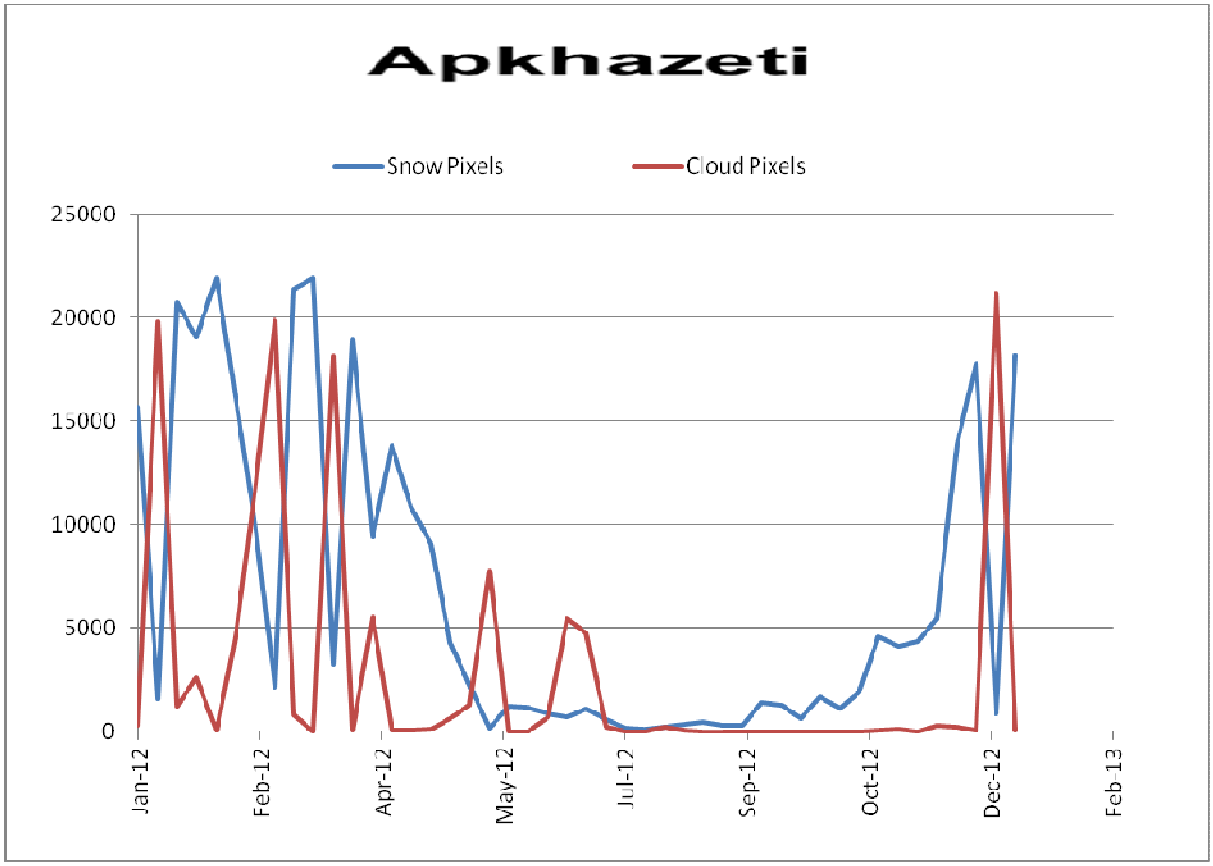

Fig. 2. Seasonal snow cover dynamics of Aphkhazeti region of Georgia, 2012, Jan-Dec

On the next picture the image Seasonal snow cover for January of 2012 year is given. This image is the result of compilation of four 8 day datasets for the same period (1, 9, 17 and 25 January)

It should be noted that MODIS 8 day composite snow products must be handled carefully and comparison with meteorological station data is necessary. Fig. 4 shows that in the image of snow cover for August there are some "contaminated" pixels, corresponding to the snow covered areas in Kolkheti region in the August. Second dataset of MOD10A2 files, Eight Day Snow Cover gives possibility to make some corrections. Snow cover duration in Summer is more than one day and therefore, pixels marked as "snowy" with duration of one day may be mark as "cloudy" pixels. Application of this "one day snow" pixel filter to snow cover data gives much better result represented on the next figure.

Additional correction can be performed with application of ground measurement data, snow observations and especially air temperature distribution. This kind of correction gives possibility to filter contaminated pixels and get more correct results.

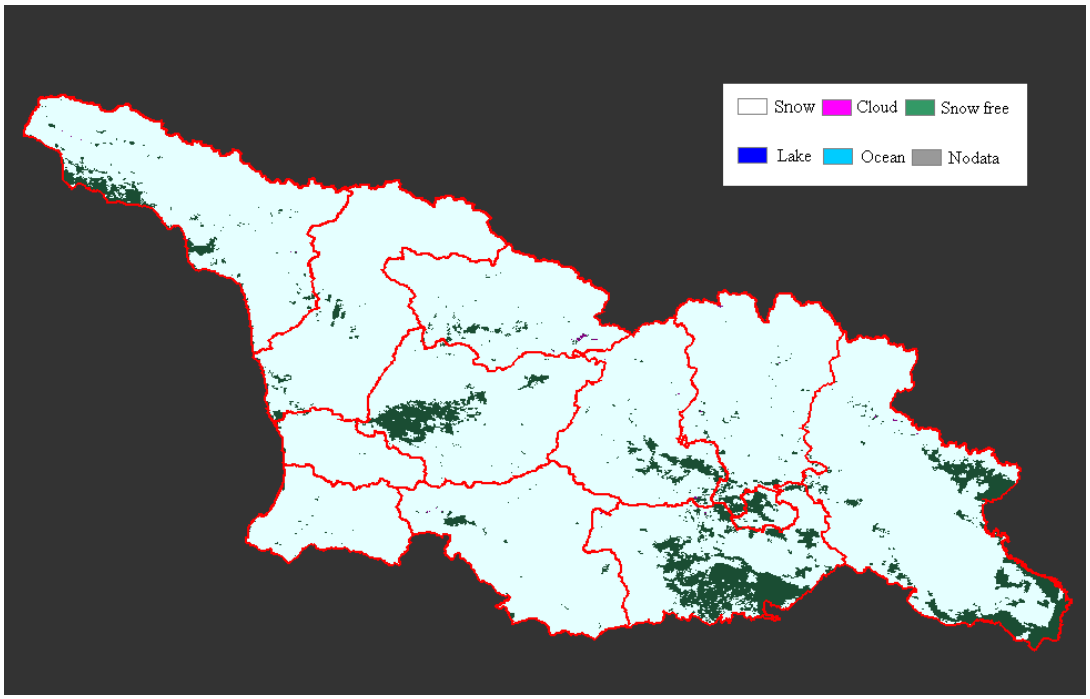

Fig. 3. Seasonal snow cover for January, 2012

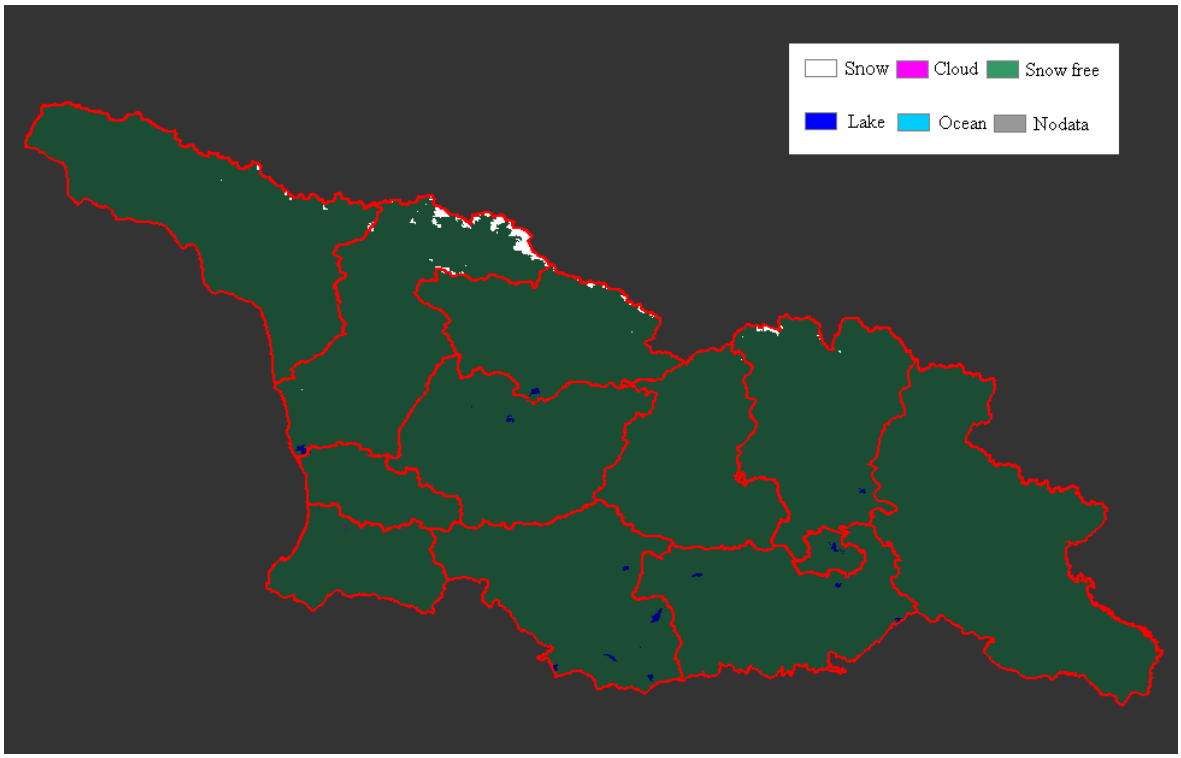

Fig. 4. Snow Cover images for August, 2012 before and after correction.

This study is a result of cooperation between Vakhushti Bagrationi Institute of Geography and Space Research Center of M. Nodia Institute of geophysics. The topic of research is a part of

dissertation thesis of PhD student Nino Lomidze from Vakhushti Bagrationi Institute of geography.

References

[1]. Hall, D. K., V. V. Salomonson, and G. A. Riggs. 2006. *MODIS/Terra Snow Cover Daily L3 Global 500m Grid.* Version 5. January to December 2012. Boulder, Colorado USA: National Snow and Ice Data Center.

[2]. Riggs G.A. Hall D.K. and V. V. Salomonson, 2006, MODIS Snow product User Guide v5, (http://modis-snow-ice.gsfc.nasa.gov/uploads/sug_c5.pdf). Last accessed - 2014, October 31

დისტანციური ზონდირების და გის ტექნოლოგიების გამოყენება საქართველოს თოვლის საფარის კვლევისათვის

ლომიძე ნ., ჯანჯალია ტ., ქორიძე ქ., თვაური გ., ზილფიმიანი დ.

რეზიუმე

საქართველოს თოვლის საფარის კვლევის მიზნით გამოყენებულია Terra MODIS სენსორის დისტანციური ზონდირების მონაცემები. საქართველოს 12 სხვადასხვა რეგიონისათვის მიღებულია თოვლის საფარის სივრცითი და დროითი განაწილების წინასწარი შედეგები 2012 წლის იანვარი-დეკემბრის პერიოდში. ამჟამად მიმდინარეობს თოვლის დინამიკის კვლევები 2000-2014 წწ. პერიოდისათვის.

Применение дистанционного зондирования и ГИС для исследовании снежного покрова Грузии

Ломидзе Н., Джанджалия Т., Коридзе К., Тваури Г,. Зилпимиани Д.

Резюме

Данные дистанционного зондирования Terra MODIS сенсора были ииспользованы для исследования снежного покрова Грузии. Получены данные пространственного и времменного распределения снежного покрова в период Январь-Декабрь 2012 года для 12 регионов Грузии. Получены предварительные результаты динамики снежного покрова. Проводятся исследования динамики снежного покрова для 2000-2014 периода.