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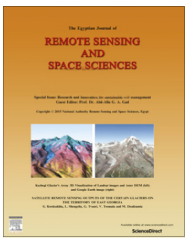

RESEARCH PAPER

Satellite remote sensing outputs of the certain glaciers on the territory of East Georgia

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KEYWORDS

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Abstract The variations in glaciers are the important indicators of regional climate change. The glaciers play an important role in the regulation of water balance. In the conditions of global warming they recede and degrade that is expressed in the related changes in glacier runoff. The research of glacier melting is important for studies of sea/ocean level changes. The Caucasian glacial dimensions (area, volume, length) have been changed over the centuries.

The scientific study of glaciers in the Caucasus was started during the first half of 18th century. In the last century the terrestrial observations on glaciers were carried out. Due to the difficulties of organization and conducting of field works the received observational data sets consists from different series of various temporal duration characteristics of glaciers. The data received contain uncertainties. From another hand carrying out of such field works are expensive.

With the launch of the Earth's satellites it was determined that satellite remote sensing is the best technology allowing to receive data with needed regularity in terms of both time and space resolution. Some uncertainties remain in the data as the observational tool is too far away from the Earth's surface. So, the necessity for the strong quality assessment/quality control (QA/QC) remains. A lot of studies showed that the best method for investigation of glaciers is application of satellite remote sensing combined with terrestrial observations and expert knowledge of separate glaciers.

1. Introduction

It is obvious that variations of glaciers are clear indicators of regional climate change. Recent interest in the study of glaciers is motivated by their clear reaction to climate changes. As glaciers cover so many climate regions worldwide, from the tropics to poles, their study enables a survey of significant aspects of global and regional Climate Change. As many of their features are detectable from the space, such investigations are well adapted for the methods of remote sensing. The glaciers play an important role in the regulation of water balance in certain regions. Under the global warming glaciers recede and degrade, which is reflected in the related changes of glacier

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runoff. These processes result on glacial and hydrological disasters such as ice blocks falls from the glaciers accompanied with the debris, followed by the river bed blockage and natural dam formation, with consequent break and pass of catastrophic flash floods and/or mudflows (Kääb et al., 2006).

The investigation of glacier melting is important for studies of sea/ocean level changes that also may have a significant risk for the residents of coastal areas. That is one of the most negative impacts of modern climate change on mankind. The abovementioned put into agenda the necessity for detailed study of the glaciers.

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With launch of the Earth's satellites it was determined that satellite remote sensing is the best technology allowing to receive data with needed regularity in terms of both time and space resolution. Some uncertainties remain in the data as the observational tool is too far away from the Earth's surface. So, the necessity for the strong quality assessment/quality control (QA/QC) remains. A lot of studies showed that the best method for investigation of glaciers is application of satellite remote sensing combined with terrestrial observations and expert knowledge of separate glaciers.

2. Research area & glaciers survey

Georgia is a transcontinental country, located in the South Caucasus, between the Black Sea to the West and the Caucasus mountains to the North. Georgia is bordered by Russian Federation from the North; it is sided from the South by Turkey and Armenia and it is bordered from the Southeast by Azerbaijan. The territory of the country is divided by Likhi Range into two parts: West Georgia and East Georgia. This division is corroborated by the difference in physical and geographical conditions between them as well. The glaciers are located in North part of the country in the Caucasus Mountains. The main glaciers from the Caucasus Mountains in the territory of East Georgia are researched in the present study. Below are listed the important glaciers to be studied based on the satellite remote sensing. The main objective of the research is the adjustment of characteristics of Mayly, Chachy, Devdoraki, Abano, Gergety, Mna, East Suatisi, Middle Suatisi, West Suatisi, SU4G08011072, SU4G08011061, SU4G08011056, SU4G08011059 and SU4G08011058 glaciers. The last 5 glaciers have no names and they are registered in World data base as mentioned above i.e. SU4G08011072, SU4G08011061, SU4G08011056, SU4G08011059 and SU4G08011058.

In Fig. 1 as an example Aster DEM and Landsat satellite images are presented for Kazbegi glacial mountain array.

In Fig. 2 the 3D visualization of Landsat images and Aster DEM (left) and Google Earth image (right) of Kazbegi glacial mountain array are presented.

The satellite remote sensing gives possibility of universal, systematic and complex research of glaciers properties and changes. This is due to the fact that satellite remote sensing allows to cover efficiently the interesting regions and to study dynamically such important parameters, as the glacier area, terminus positions at the end of its location, firn line elevation, accumulation area, the hypsometry (Pellikka and Gareth, 2010). In turn these parameters allow calculation of glacier mass balance.

In Georgia the glacial parameters (area, volume, length) have been changed over the centuries. It is determined that from the second half of the last century the characteristics of the Georgian glaciers are steadily diminishing. The process is still underway and will likely continue in the future. The elevation of the lower boundary of the glaciers increases.

During the last century the area of the Georgian glaciers decreased by 36% and the volume reduced by 48%. Some glaciers melted away but the glacier melting process causes increase of glacier number due the fragmentation of large glaciers into small ones. Hence, the total number of glaciers increased. The length of glaciers was reduced by 600 m in average. In the lower part of glaciers ice thickness decreased by 50–150 m and in the upper part it was reduced by 20–30 m consequently. During the last decades (1970–2000) glacial conditions in Georgia have changed on the background of rainfall and temperature increase by 10–15% and 1 °C respectively.

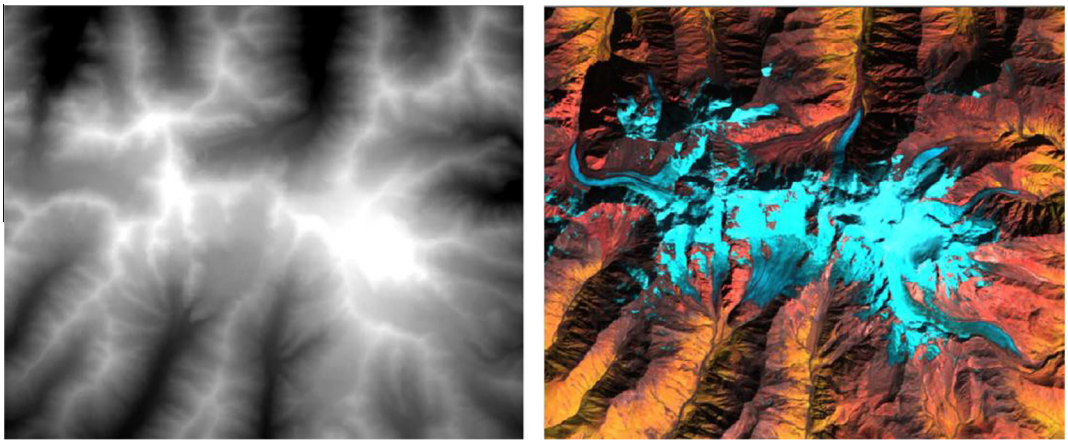

Figure 1 Aster DEM and false colour Landsat images.