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Research Paper

Analysis of changes in snow reservoirs for planning and management of dehydration (Case Study: Sarab Halilroud Area in Kerman Province)

Mahla Shojaei Anari[1]: MSc student of Environmental Hazards, Shahid Bahonar University of Kerman, Kerman, Iran
Mostafa Khabazi: Assistant Professor of Geomorphology, Shahid Bahonar University of Kerman, Kerman, Iran
Sadegh Karimi: Assistant Professor of Climatology, Shahid Bahonar University of Kerman, Kerman, Iran

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Abstract

Today, in the wake of the global water crisis, all countries seek to identify, control, and utilize freshwater resources. Due to the fact that Iran is located in the desert belt of the earth and the reduction of precipitation has caused water scarcity in Iran and Kerman province, therefore identifying water resources and investigating changes in snow cover is necessary. Due to the harsh physical conditions of mountainous environments, it is not possible to permanently measure the terrain to estimate snow sources and to form a database. Therefore, using satellite imagery is very important for identifying snowy surveys and assessing its changes. In this study, we attempted to study the changes in snow cover reservoirs in Halilroud watershed using MOD10A2 satellite imagery. For this purpose, Normalized Difference Snow Index was used. This index has a value greater than 0.4, meaning a pixel with a NDSI greater than 0.4 is referred to as snow and ice. The snow cover specified in the satellite images in ENVI5.1 software was entered into GIS and was classified into 5 classes from 0 to 5000 and the survey of each class was calculated. Then they entered into SPSS and analyzed. Stepwise multivariate regression showed that during the 8-day interval of February (from 18 to 25 February), the most changes of snow survey had a significant and significant relationship with the snow survey trend in these years. In fact, the explanations for the snow changes in this time interval were related to height 3 (2001-3001) and then 4 (3001-4000), respectively. The 2001–3001 height alone accounts for 98.9% of the snowfall trend in the entire study area. Secondly, if the height of 4000-3001 is added, the two class,s justify 99.2 percent of the snowfall change over the past 20 years.

Key words: *Watershed, MOD10A2, NDSI, Snow Cover, Iran.*

Extended Abstract

Introduction:

According to studies, about 60 percent of surface water and 57 percent of groundwater in the country are located in snowy regions and feed on snow melt water (Najafi et al, 2004: 2). Most of the rainfall in the mountainous areas is snow-covered and inaccessible to the mountainous areas, so it is impossible to study them with high-cost, over-the-top terrain methods, and so on, The use of satellite remote sensing technology would be very useful in these studies. The water resources in the mountainous areas are affected by the amount of snowfall and are often fed by snowmelt waters. And the status of the water balance and the discharge regime of the water resources in such areas depend on the extent and speed of snow melting or its persistence on land and their nutritional basin levels. Today, in the wake of the global water crisis, all countries seek to identify and control freshwater

[1] - Corresponding Author's, Email: mahlashojee71@uk.ac.ir, Tel: +989136110872

resources and their optimal use. As one of the most important Islamic countries in the Middle East, Iran is in dire need of full growth and development. Given that the country lies in the desert belt of the earth, the identification of these very important water resources equals about one-third of the water required for agricultural and irrigation activities around the globe (Najafzade et al, 2004). : 3). In our country, these highlands can also be considered as a rich source of fresh water. Therefore, today in the process of efficient water resources management, the use of remote sensing data with the objective of obtaining accurate information from snow cover is operationalized. Given that recent droughts and shortages of rainfall have caused severe water shortages in Kerman province, changes in snow cover and the prevailing climate conditions are necessary and urgent for the public and authorities to reduce water resources. Be warned and find ways to prevent this crisis. Hezar, Laleh Zar and Bahr-e Asman Mountains (in the central areas of Kerman province) are suitable for detecting changes in snow cover due to their location and elevation in the face of various climate systems. Therefore, in this study, the changes of snow cover during the winter of the study years are studied in three mentioned peaks. Therefore, the following question and hypothesis is raised:
Hypothesis: The percentage of snow cover seems to have decreased over the past 20 years.
Q: Has the percentage of snow cover at different altitudes changed over time?

***Methodology**:*

Normalized snow cover differential index greater than 0.4 means that pixels with NDSI greater than 0.4 are introduced as snow and ice and obtained using the 5-2 relationship (Hall et al, 1995: 120).

(1) NDSI = (MODIS4-MODIS6) / (MODIS4 + MODIS6)

Snow and ice are generally determined by having NDSI values larger than other levels. A pixel in a low forest area is called snow or ice when it is 0.4≥ NDSI. While snow and ice cover in forested areas may have NDSI values below 0.4, the combination of NDSI and NDVI (Normalized Vegetation Index) can help to separate snow and ice cover from non-snow and ice in forest areas (Zhang : 2003: 52). The accuracy of the NDSI method is estimated to be 91-95%, which is less accurate in forest areas and in Tondra areas (Hall et al, 1998: 31).

Results and discussion:

The specified snow cover satellite images were entered into GIS environment in ENVI5.1 software and were classified into 5 classes from 0 to 5000 and the area of each class was calculated. Then they entered into SPSS environment and analyzed. Stepwise Weiss multivariate regression showed that during the 8-day interval of February (from 18 to 25 February) the most changes of snow area had a significant and significant relationship with the snow area trend in these years and in fact justified. The changes in snow during this time interval were related to altitudes of 3 (2001–1000) and then 4 (4000–3001), respectively. The 2001–2003 altitude alone accounts for 98.9% of the snowfall trend in the entire study area. Secondly, if the altitude of 3,000-4,000 is added, the two altitudes justify 99.2 percent of the variation in snowfall over the past 19 years.

Conclusion:

The results of the satellite satellite imagery showed that the MOD10A2 Moderator daily snow product is capable of estimating the snow cover area of the study area. In this research, the snow cover maps prepared in ENVI software were entered into ArcGIS software and the snow cover was identified as the study area. The February snow cover maps were classified into five elevation classes in ArcGIS software: the first floor contains 0-1000 height, the second floor contains 2001-1000 height, the third floor contains 2001-2003 height, fourth floor Includes altitude 3,000-4,000 meters and fifth floor contains altitude 4,000-5001 meters. Then, the snow cover area of each of the elevated floors marked with different colors was calculated. The results of this study include the values of snow cover levels in February as outlined in Table 7. According to the Pearson correlation results, the third floor (2001-2003 m) had the highest average snow area (3293.4 sq km) during the study period. Then the fourth floor (4000-1001 m) in the next row had the highest average snow area (1751.6 sq km) during the study period. Stepwise Weiss multivariate regression showed that during the 8-day interval of February (from 18 to 25 February) the most changes of snow area had a significant and significant relationship with the snow area trend in these few years and in fact justified. Snow *variations in this time interval were related to altitude 3 and then 4, respectively. And as the descriptive statistics table observed, the 2001-2003 altitude alone accounted for 98.9% of the snowfall trend in the entire study area. Secondly, if the altitude of 3,000-4,000 is added, the two altitudes justify 99.2 percent of the variation in snowfall over the past 20 years. This means that during this time, snowfall in other elevations has not had much impact on the process of snow changes. In the end, it was determined that the highest snowfall in February (12687.89 sq km) was in 2015. Figure 5 Although the overall snow cover situation in February from 2000 to 2015 showed an upward trend, from 2016 to 2019 this trend declined. Therefore, the crowd has thwarted the whole process.*