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# *Modeling of Factors Affecting the Anomalies of the Coastal Water Temperature of the Persian Gulf in Hormozgan Province and Its Relevance with Geomorphometric Indices*

Anis Heydari[1], AliAkbar Nazari Samani[2*], Mohsen Farzin[3], Sadat Feiznia[4]

1- Graduated from Master of Watershed Management Science and Engineering, Department of natural resources, University of Tehran, Karaj
2- Associate Professor, Department of natural resources, University of Tehran, Karaj
3- Assistant Professor, Department of natural resources, University of Yasouj
4- Professor, Department of natural resources, University of Tehran, Karaj

## 1-Introduction

Submarine Groundwater Discharge (SGD), any flow or all water flows on the continental banks of the sea bed, is defined regardless of the liquid composition and the driving force of its agent (Barnett et al., 2003). This occurs in a calm and continuous flow of SGD wherever its table has a positive relative hydraulic gradient with the sea level, which is attached to the surface runoff. The outflow of the flow into the sea will cause a temperature anomaly on the surface. The depletion of the underground submarine currents plays a remarkable role in the water cycle, which can be considered as an important part of water balance. Therefore, it is important to identify the range of anomalies caused by the probable depletion of SGD into the sea.

## 2-Methodology

Remote sensing systems are used to determine the site of SGD depletion into the sea or lake, including aerial images with high resolution (Lewandowski et al., 2013). The aerial manual infrared imaging (Duarte et al., 2006) or ground thermal imaging (Schuetz and Weiler, 2011) are highly expensive and are certainly not suitable to assess the regional scale or continuous monitoring of SGD depletion in large blue bodies (Wilson and Rocha, 2016). Hence, free data and images of the Landset 8 satellite for 2017 and 2018 were used to determine sea surface temperature maps. For this purpose, corrections were first applied to thermal bands in the ENVI 5.3 software environment. Then, to investigate the existence of geometrical and non-geometrical errors, the quality of the data was examined on satellite images. Analyses and extraction of sea surface temperature maps were carried out using GIS 10.3.1 software. After preparing a suitable temperature map, the least surface roughness level was determined by applying different classifications in the GIS environment. Then, the distribution of each anomaly was finally prepared to prepare the distribution map of thermal anomalies. In this study, a digital elevation model (DEM) was used in GIS software to provide geomorphometry indices and maps related to environmental variables (slope, Topographic Position Index,

* Corresponding Author; **E-mail**:aknazari@ut.ac.ir

profile curvature, general curvature, plan curvature, and height) and statistical modeling. Finally, the layers were prepared and the required adjustments were made in the software settings. Maxent Version 3.3.3 software was then used to perform statistical modeling.

## 3-Results and discussion

Some anomalies were observed by examining the rainfall of existing pluviometry stations (n = 14) in the study area and investigating the rainfall amount (the same month, the month before, six months before, the same year, and the preceding year). The regression relationship between levels of anomalies and rainfall values determined at different times revealed a strong relationship between the anomaly levels and the amount of rainfall in the previous month. Finally, the seasons studied in 2017 and 2018, the results obtained from the study of SST, STA, and the least common level defined, along with rainfall investigations, all indicated that that the highest temperature anomalies with iterations in two different histories belonged to January 2017 and 2018, which were used for subsequent analyses. The depth studies in the range of anomalies included in January 2017 and 2018, as well as the common level of anomalies from the two dates, show that anomalies obtained in the deep-sea regions are not located and the depth of these anomalies is low within the range, which increases the probable presence of the underground spring. It can be stated that the results obtained are related to the depth of temperature anomalies because they are in the shallow depth of the sea and less than 30 meters, which is the reason to increase the likelihood of the presence of the submarine springs in these areas. According to McBride and Pfannkuch et al. (1975), Shaban et al. (2005), Thomas et al. (2002), Lewandowski et al. (2013), Wilson and Rocha (2016), and Farzin et al. (2017), SGD presence rate decreases with the distance from the shore, and the presence of submarine springs would be expected at a water level close to the shore in the disorders created at the surface of the sea, which corresponds to our results. All temperature anomalies, particularly the repeated anomalies in January 2017 and 2018 are located 3 km away from the coast, which increases the probable presence of SGD. According to the results of the jackknife test, the most important indices are in the presence of temperature anomalies and the presence of SGD (depth) and slope, which indicates that the presence of SGD spring is up to a depth of 4 meters and the appropriate slope for the presence of SGD depletion region is 5%.

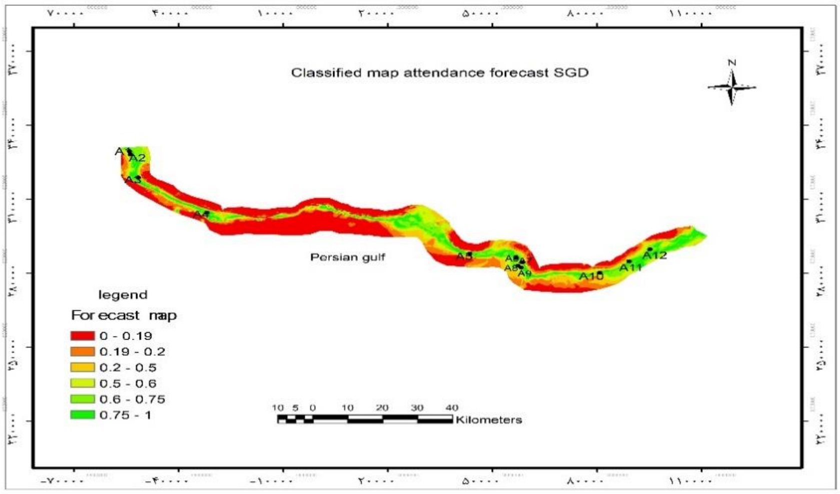


**Figure (1)**: The classification map of the presence of SGD based on temperature level anomalies and environmental variables

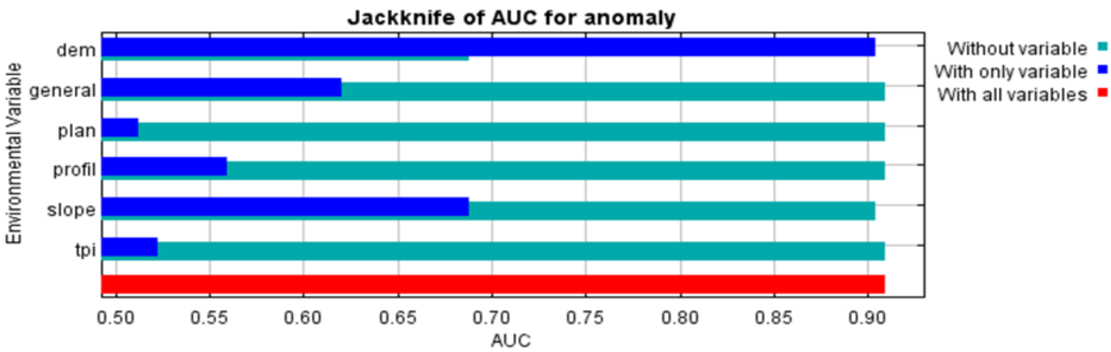


**Figure (2):** The Jackknife test for model sensitivity analysis

## 4-Conclusion

The environmental factors play a role in the creation of temporal and spatial changes of SST and STA. Based on the results obtained from geomorphometry studies and inequalities, as well as those of maxent modeling based on the common level of temperature anomalies in January 2017 and 2018, it can be concluded that anomalies occurred in the Bandar Magham, Bandar Nakhiloo, and coasts of Bandar Divan, Bandar Shenas, Bandar lengeh, and Bandar kong indicate that these areas have a very high probability of underground aquifers. These submarine currents seem to have a substantial amount of evacuation that could have significant effects on the coastal ecosystem and the regional water balance. If the quality of the evacuated water is not intrinsically salty and is desirable to be used, it can be utilized as a water supply source in the area.

**Keywords:** Temperature anomaly, Submarine Groundwater Discharge, Geomorphometry**,** Maxent**,** Persian Gulf

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