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Original Paper

Evaluating the satellite images for identifying the geomorphological forms – Case study: Abadan district

Reza Qaedtahari [1], Mehdi Mumipour✉[1], Javad Darvishi Khatouni [2]

1- Marine Geology Department, Khorramshahr University of Marine Science and Technology, Khorramshahr, Iran

2- Geological Survey and Mineral Exploration of Iran, Tehran, Iran

✉mumipur@kmsu.ac.ir

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Abstract

Nowadays, more than ever before, satellite images are used for investigating of the earth's surface, by means of different sensors. The studied area is the coastal areas of Khuzestan province from Abadan to Khourmusa district. The aim of this study is evaluating the ability of satellite images to identify geomorphological forms, features and landforms. In this research, two set of satellite images (Landsat 8 and Sentinel 2) was used for applying in principal components analysis, false color combination and visual interpretation using ArcMAP 10.5, ENVI 4.7 and Google Earth Pro softwares. The images obtained from two satellites were first divided into some band combinations and some RGB color combinations in the ENVI software environment, in order to identifying the features and landforms of the region such as evaporate deposits, tidal zones, Annual tidal flat, sand mud flats, monthly tidal flats, sand flats, mud flats, coastal marsh, coastal sedge, saline mud flats, puffed lands, freshwater wetland and vegetation. Then a general geomorphological map of the area was composed.

Keywords: Satellite Images, Principal Component Method (PCA), Coastal Landform, Geomorphology, Abadan District.

1- Introduction

Identification of earth surface phenomena is of great importance. By using satellite images, these forms and complications on the ground can be identified well and accurately (Maleki, 2017). In the processing of satellite images, it is possible to collect and check the information of the earth's surface features without direct physical contact (Sofianian & Falahatkar, 2009). Satellite images can obtain information in multiple scales, multiple spectral, and multiple dimensions (Alavi-Panah, 2013). Satellite images are captured in the visible and infrared spectrum (Yang et al., 2018). Satellite images are important in earth science research because of their spectral resolution, accuracy in observation, speed in imaging, and their digital nature (Najafzadeh et al., 2017). Satellite images play an important role in recognizing geomorphological forms, due to the difficulty, high cost and time-consuming field work (Hashemi, 2016). satellite images provides a single and unified view of a larger area and the ability to record data in the infrared and thermal infrared bands make them more valuable (Farajzadeh et al., 2015).

Remote sensing is an art that obtains information from a phenomenon without direct contact (Rostami et al., 2015). The art of remote sensing is related to geomorphology, soil science, geology, spectroscopy, paysical and urban geography, agriculture and other applied fields and specialties.

Another feature of using satellite images and remote sensing is that the geomorphological forms and phenomena in areas out of reach or deserts, etc., which have a large area, can be evaluated easily and in a short period of time (MollaMehrAlizadeh et al., 2013). In general, the use of satellite images and remote sensing with low cost and time saving can help many researches to raise their levels (Goltapeh et al., 2016).

(Alharbi et al., 2011) used Landsat satellite images, data analysis software, false color images and field visits to investigate the coastal landforms of Al-Shaqiq region along the Red Sea coast in Saudi Arabia. With the help of Landsat satellite images, seven geomorphological units were identified in the coastal area of Khaq al-Shaqiq, including: sand dunes, salt flats, sandy beaches, wetlands, wadis, organic carbon, and plant areas. Quashigh (2013) assessed the coasts of the eastern region of Ghana using Landsat 8 satellite images, manual and semi-automatic coastline extraction in a period of 25 years. The results showed that this beach has landforms that are changing due to various factors. They were also able to identify and analyze the changes that have occurred in this beach. (Jia et al., 2019) used Landsat satellite images to investigate the coastlines and their changes in the coastal area of Lingshai, China. The results showed that due to excessive and unnecessary human activities such as aquaculture ponds (fish and shrimp), the shorelines have decreased. (Zou et al., 2019) with the aim of investigating the coastal landforms in the Shisha area of China from satellite images and AHP model, was able to obtain the information about coral reefs, sand dunes, swamps and sandy beaches. (Nadaf, 2019) used satellite images, Google Earth, GIS and false color combinations with the aim of investigating and evaluating the landforms of Canacona beach in Goa, a city in India, using satellite images, they were able to identify phenomena such as dykes, sandy beaches and sand dunes. (Negaresh et al., 2020) used Landsat satellite images, GIS and field visits to investigate the coastal geomorphology of Khor Teng and identify the landforms of this region such as sand dunes, sand tongue and beach sand. (Yamani et al., 2013) used satellite images of 2010 and 2007, classification method and field visits to investigate the changes of the coastline and identify coastal landforms in the coastal area east of the Strait of Hormuz. They were able to divide the coastal area of this region into three types of wetland morphology, smooth sand and rough rocky coast. (Saif et al., 2013) investigated the changes of the northern coasts

of the Persian Gulf from the coast of Bandar Abadan to Bandar Bushehr using satellite images, false color images and field activities, they were able to identify landforms such as estuaries, deltas, marine terraces of the Persian Gulf. (Sharifi, 2014) used Landsat satellite images and GIS for morphological investigation of the coastline and classification of landforms from Nowshahr to Babolsar coasts and were able to identify 5 classes of sand banks, sandy banks with residential use, sandy banks, classify the mouth of the river and the results indicate that among the landforms, the largest and most extensive landforms in this region are sandbanks. (Sharifi, 2014) studied the coastal geomorphology of Khuzestan province in the coastal city of Abadan, using satellite images, he was able to find complications and landforms such as old sand dunes, vast swollen lands, old and abandoned canals. So, in this study the goal is to combine a geomorphologic map of Abadan to Khourmusa district, SW Iran, using Landsat 8 and sentinel 2 satellite images.

2- Materials and Methods

1-2 Location of the study area

The study area is the coastal areas of Khuzestan from Abadan to Khourmusa district. The geographic location of the studied area is between 48º 9′ 58″ to 48º 58′ 30″ and between 29º 51′ 34″ to 30º 33′ 22″ (Fig. 1). The studied area is located 35 km from the Persian Gulf located near the two countries of Iraq and Kuwait. Bahmanshir, Karun and Arvand rivers are among the most important rivers in this region.

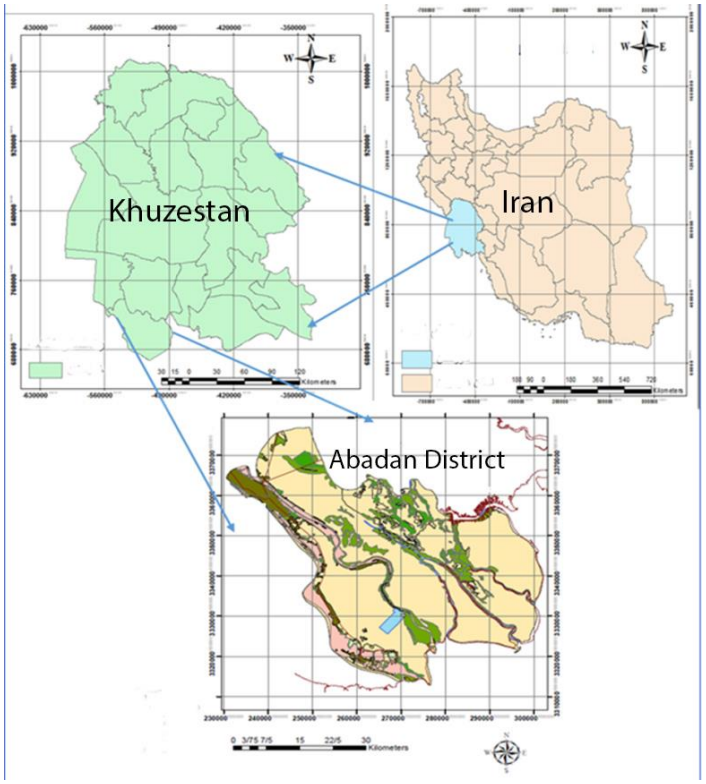

Figure 1- Location of the studied area

2-2 Materials and Methods

In this research, carried out by using satellite images (Landsat 8 and Sentinel 2), Meteorological reports, geological maps, visual interpretation and field visits and ArcMAP 10.5, ENVI 4.7 and Google earth.

Principal components analysis (PCA), false color composition (FCC) and visual interpretation were used to identify and examine the shapes and landforms obtained from satellite images in the study area. Principal component analysis (PCA) is a statistical method introduced by Carl Pearson in 1901. This model is a processing technique on band composition images that compresses the information of several bands by reducing the data volume to fewer bands, the main components can be used to reduce the dimensions of the data and so on. It preserves the components of the data set that have the greatest effect on the variance (Sharifi, 2014). In this research, compression was done by ENVI 4.7 software, and the RGB color image was applied to satellite images. Landsat 8 band compositions are 246, 364, 456 and 641 and Sentinel-2 band compositions are 741, 321, 432 and 345.

False color combination is a method to identify and recognize phenomena in satellite images. In this method, 3 different bands are combined in the RGB environment to create color images. In this research, by using false color combination, the bands were first combined using ENVI 4.7 software, with RGB color combination (Landsat 8 including band composition 234, 542, 567 and 642) and (Sentinel-2 including band composition 834, 234, 824 and 843). In this method, the information of the less important bands was removed with the aim of selecting the appropriate bands for making color images of the study area, and then useful information was used to identify the important landforms of the study area, leading to generation of geomorphological map of the area. Using visual interpretation in the GIS software environment, geomorphological features and landforms in the study area were identified and investigated.

4- Results and Discussion

The study area was divided into several different regions according to RGB band combinations using PCA, FCC and visual interpretations of Landsat 8 and Sentinel 2 satellite images. The results are as follows:

The color combination of 641 principal components of Landsat 8 is suitable for separating water and land areas, type of sediments, evaporative sediments and vegetation. In this image, landforms such as evaporative deposits are in orange color, puffy lands in orange and white, mud flats in purple color, sandy mud flats in deep purple color, flood plain in deep purple color (Fig. 2).

The color combination of 364 principal components of Landsat 8 is suitable for separating water and land areas, type of sediments, evaporative sediments and vegetation. Evaporative deposits are light green, mud flats are yellow, sandy mud flats are orange, sand flats are purple and puffy fields are yellow. Also, the yellow to brown color indicates the size of the sediments (Fig. 3).

The color combination of 246 principal components of Landsat 8 is suitable for distinguishing water and land areas, type of sediments, evaporative sediments and vegetation. Vegetation with a red color and also with a color change to orange indicates a decrease in the density of vegetation, blue mud areas, purple evaporate deposits and yellow sand areas can be seen in this image (Fig. 4).

The 456 principal components color combination of Landsat 8 is suitable for distinguishing water and land areas and vegetation. Landforms such as evaporite deposits are assigned a light blue color. Also, fine-grained sediments are lighter with a blue-

green tone and coarse-grained sediments are visible with a darker tone (Fig. 5).

The false color combination of 234 Landsat 8 is suitable for the identification of water and land areas, areas with evaporative deposits and identification of old channels. Landforms such as puffy lands are mostly gray and white, areas with evaporative deposits are visible in white, sandy areas are visible in gray to gray color (Fig. 6).

The false color combination of 542 Landsat 8 is suitable for the separation of water and land areas, type of sediments, evaporative sediments and vegetation. Landforms such as white evaporate deposits, dark green freshwater wetlands, cream colored mud flats, brown sandy mud flats, light brown sandy mud flats, coastal sand in The combined colors of white and brown, bushy vegetation with a light purple to pink colors, the active delta of Arvand in brown color, as well as the puffy lands with a relatively white color and the floodplain in the red color can be seen. The yellow to brown tone indicates the size of the sediments (Figure 7).

The false color combination of 567 Landsat 8 is suitable for the separation of water and land areas, types of sediments, evaporative sediments and vegetation. Landforms such as red to crimson coastal marshes, white evaporate deposits, pale blue to white puffy lands, gray sandy areas, and pale blue mud areas can be seen (Figure 8).

The false color composition of 642 Landsat 8 is suitable for the separation of water zones, types of sediments, evaporative sediments and vegetation. Landforms such as evaporate deposits in white color, coastal marsh in dark green color, muddy areas in light cream color, sand area in brown color and bush vegetation in light purple to pink spectrum can be seen (Figure 9).

The 321 principal components color combination of Sentinel 2 has been suitable for separating water and land areas, sediments and vegetation. In this image, coastal marsh in purple and blue spectrum, evaporate deposits in the east and southeast of Abadan city and Bahmanshir River in light green color, sand areas in purple color, sandy mud areas in colors between pink and green. The mud flats are attributed to light pink color. Also, in this image, the water of Arvand and Bahmanshir rivers can be seen somewhat pink due to the muddy water (Figure 10).

The 345 principal components color combination of Sentinel has been suitable for the separation of water and land areas, evaporative sediments and vegetation. Mud areas are often visible in blue color, evaporate deposits are visible in colors between blue and purple, and high volumes of evaporate deposits are identified with blue color and small parts with purple color. Also, the green color in this combination indicates the presence of sand deposits (Figure 11).

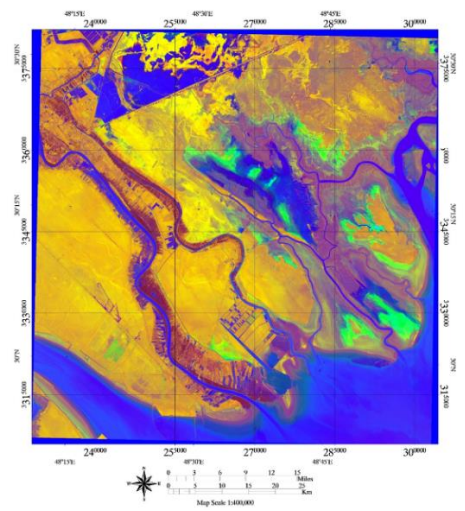

Figure 3- 634 PCA FCC landsat 8

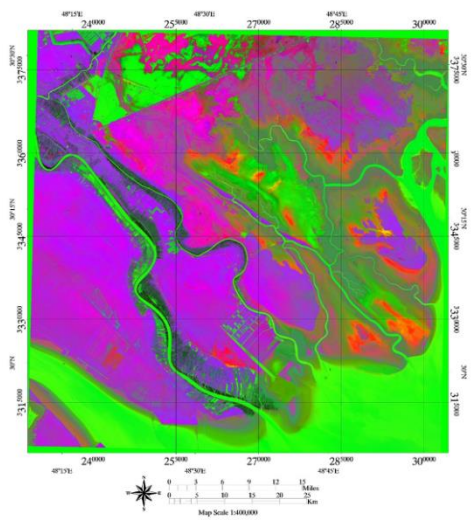

Figure 2- 641 PCA FCC landsat 8

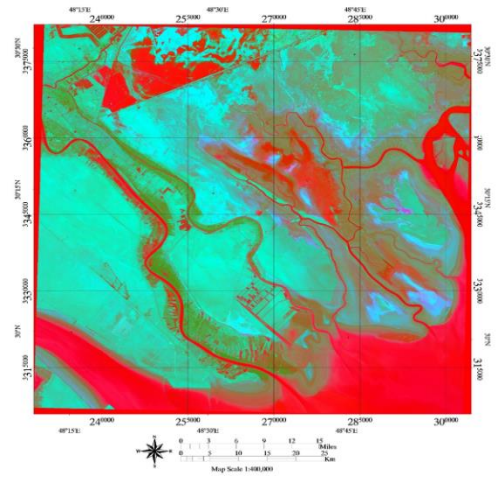

Figure 5- 456 PCA FCC landsat 8

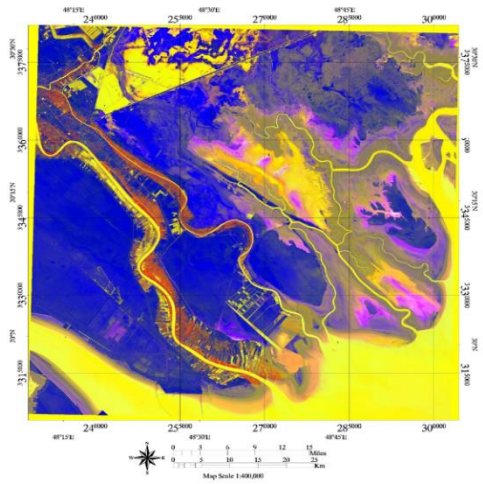

Figure 4- 246 PCA FCC landsat 8

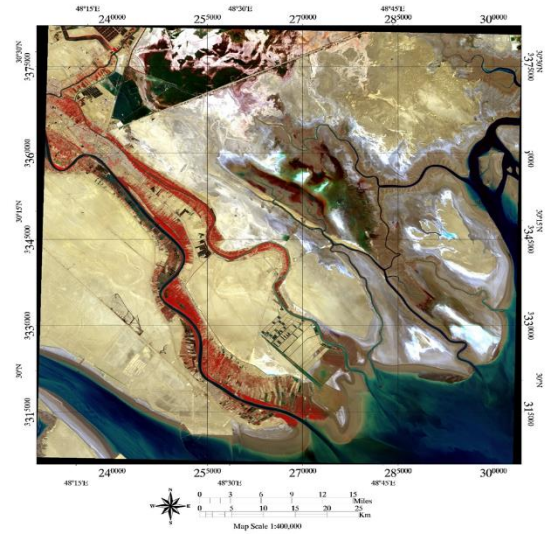

Figure 7- 542 FCC landsat 8

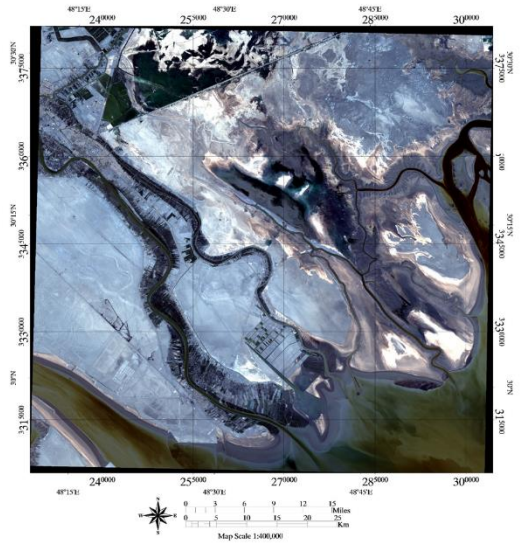

Figure 6- 234 FCC landsat 8

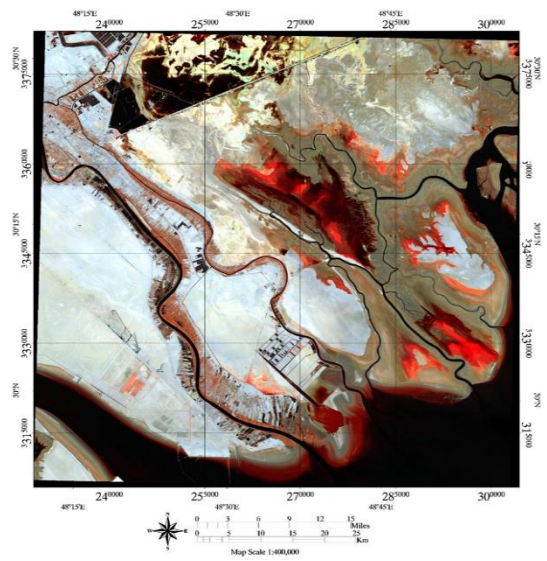

Figure 9- 642 FCC landsat 8

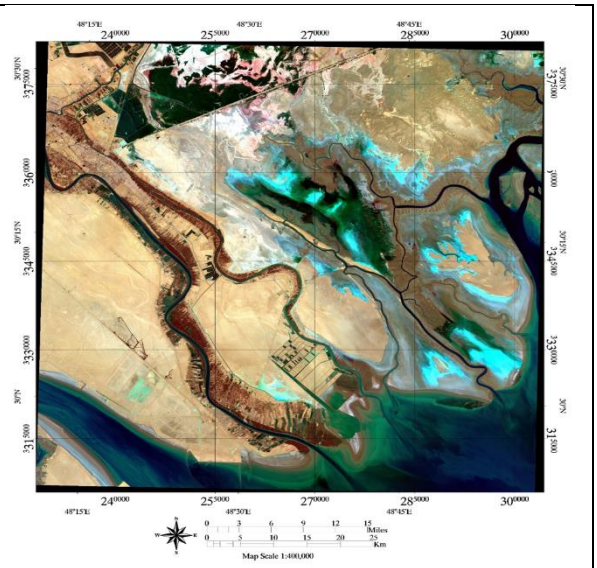

Figure 8- 567 FCC landsat 8

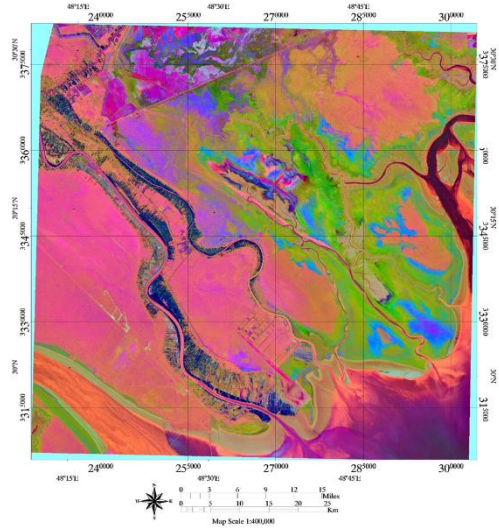

Figure 11- 345 PCA FCC Sentinel 2

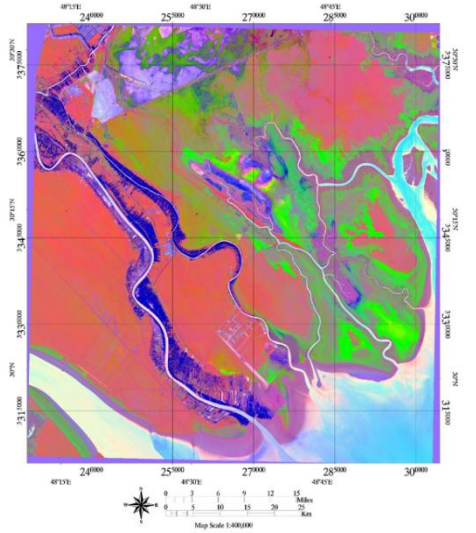

Figure 10- 321 PCA FCC Sentinel 2

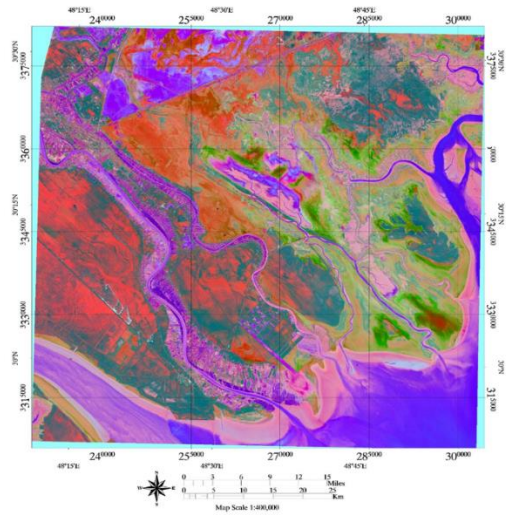

Figure 13- 741 PCA FCC Sentinel 2

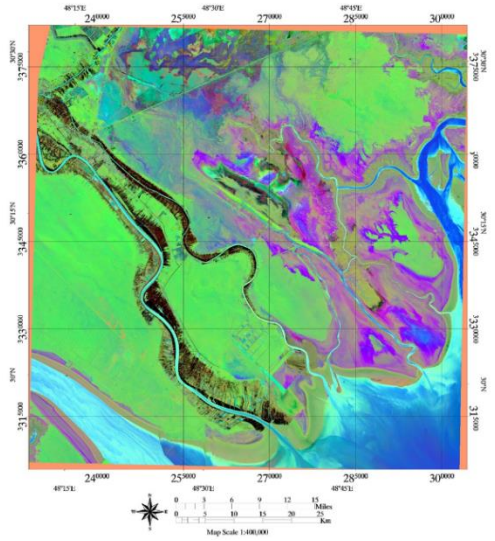

Figure 12- 432 PCA FCC Sentinel 2

The 432 principal components color combination of Sentinel 2 is suitable for distinguishing water and land areas, evaporative sediments and vegetation. The surface evaporate sediments are in blue to violet colors and sandy areas are light green in color (Figure 12).

The 741 principal components color combination of Sentinel 2 is suitable for distinguishing water and land areas, evaporative sediments and vegetation. Evaporative deposits are dark green to dark purple colors, which the green parts includes the high volume of evaporative, mud areas are often pale red, and sandy mud areas are visible in dark green (Figure 13).

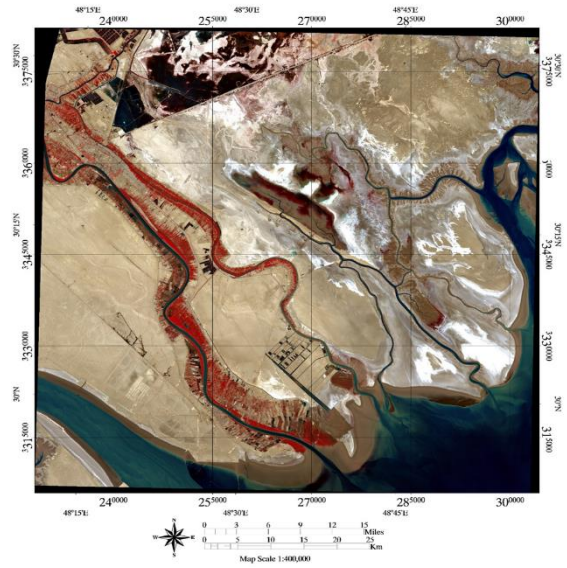

Figure 15- 843 FCC Sentinel 2

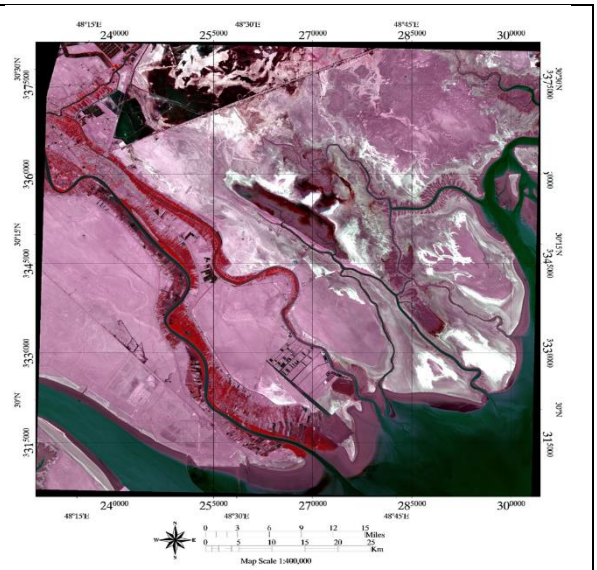

Figure 14- 834 FCC Sentinel 2

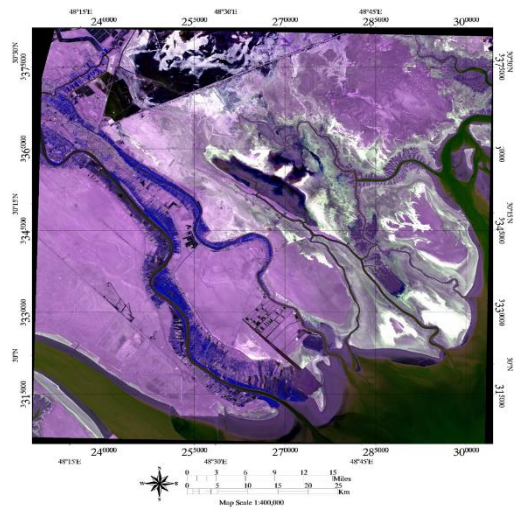

Figure 17- 428 FCC sentinel 2

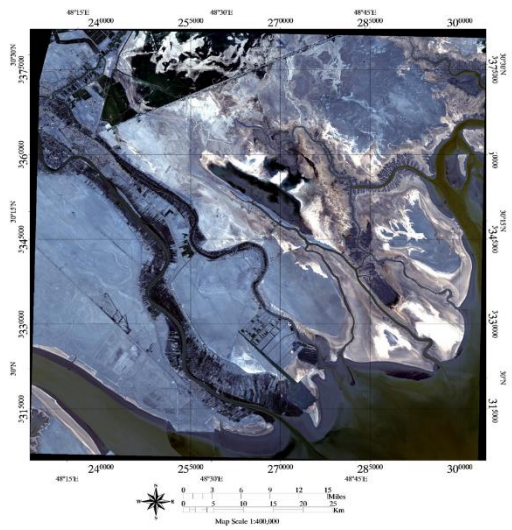

Figure 16- 234 FCC sentinel 2

The false color combination of 834 Sentinel 2 was suitable for the separation of water areas, vegetation and evaporative deposits. In this color combination, evaporative deposits are in white, vegetation in red, and water areas in olive green (Figure 14).

False color combination of 843 Sentinel 2 is suitable for distinguishing water and land areas, and areas with evaporative sediments. Landforms such as brown sand, white evaporate deposits, cream and brown tidal flats, cream and white salt flats, often cream-colored

mud flats Sand in the brown color, beach sand with a combination

of brown and white color and bush vegetation in light purple to pink color can be seen. The yellow to brown tone indicates the size of the sediments (Figure 15).

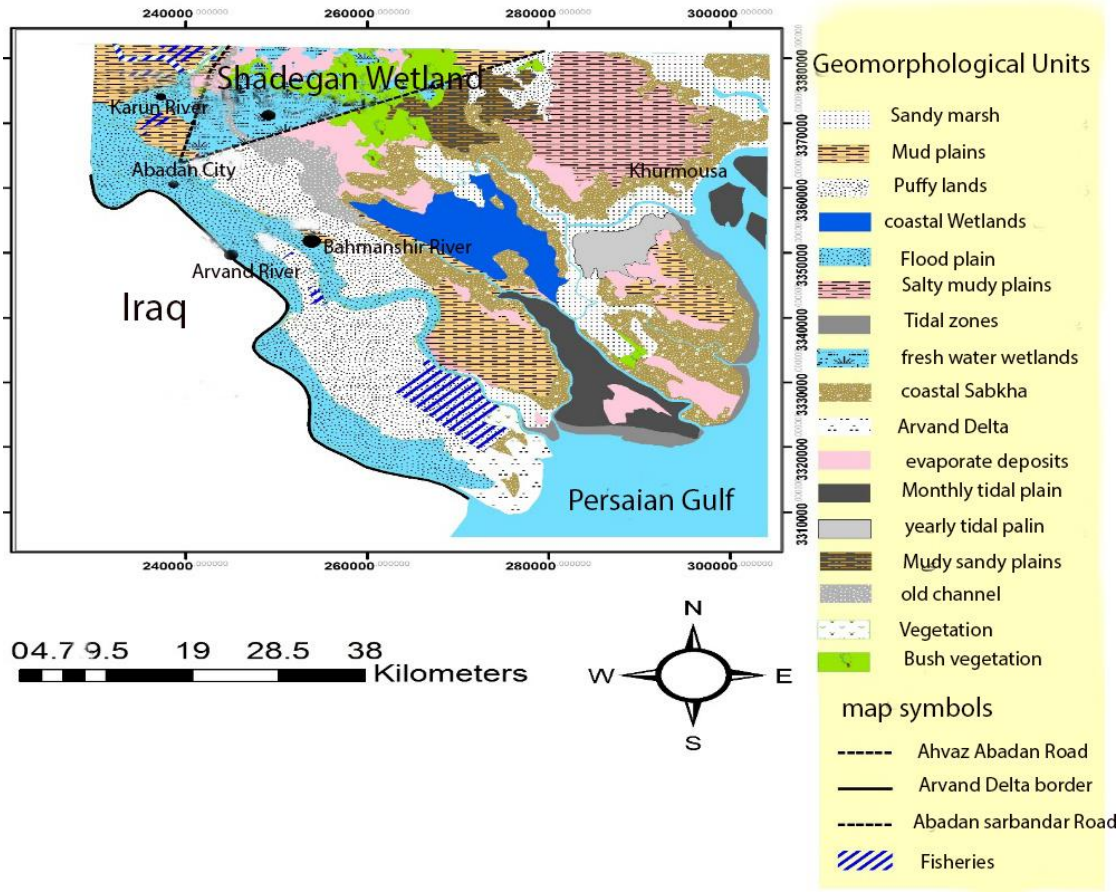

Figure 18- Geomorphological map of study area, composed based on satellite image interpretation.

The false color combination of 234 Sentinel 2 is suitable for distinguishing water zones, types of sediments and evaporate sediments. Landforms such as salt flats or areas with evaporative deposits are visible in white, gray to brown sand flats and mud flats in the gray color and tidal flats in the dark gray color. This band composition is good for separation of tidal areas (Figure 16).

False color combination of 428 Sentinel 2 is suitable for distinguishing fresh water, salt water, vegetation and evaporative sediments. In this color combination, the vegetation are in rich blue color, the coastal sabkha are in white and gray colors, evaporative deposits are in white color, waters with dissolved sediments are in olive green color and fresh water lagoon are in the dark blue to black colors (Figure 17).

According to the investigations of the band composition of the satellite images and the principal components, false color composition and visual interpretation methods, the important features and landforms of the region were plotted on the geomorphological map of the study area (Figure 18).

4- Conclusion

According to the investigations and the adaptation of geological maps from the study area, using Landsat 8 and Sentinel 2 satellite images and principal component, false color

composition, visual interpretation and Field visit methods. Several images were prepared for the study area. Then, by visual interpretation in the ArcGIS software environment, the geomorphological units of the region such as evaporate deposits in parts of the east and southeast, the Shadgan wetland and around the estuaries, tidal flats in the part of the east of the region and the southeast of the Bahmanshir river, fresh water pond in Shadgan wetland, mud flats in the east of the region and east of the Bahmanshir river and also in the north of Khorramshahr, sand flats in the northeast of the region, the edges of the Doreq and Goban estuaries and in a part of the Bahmanshir river were plotted on map. Sandy mud flats in the south of Abadan, coastal sabkha, shrub vegetation in parts of Shadgan wetland and parts south of Abadan road. the Arvand active delta in the south of Abadan, the annual tidal zones in the east of the area, the swollen lands in the south of Abadan road between the Bahmanshir and Arvand rivers, as well as in the eastern part of the Bahmanshir river, the floodplain on both sides of the Bahmanshir and Arvand rivers up to Minou Island and the southeast of the river distinguished. Karun and the coastal marsh in the center of the region in the east of Khor Goban were identified and included in the geomorphological map of the region (Figure 18). According to the results of this study, two satellite images (Sentinel 2 and Landsat 8), it is worth mentioning that both satellites have the ability to identify coastal geomorphological landforms and features, but Sentinel-2, in most of the combinations of available bands, in identifying landforms and features better, and also the area and size of the borders of the landforms identified in Sentinel-2 is more accurate than the area of the landforms identified in Landsat 8, and the forms identified in Sentinel-2 are more similar in color compared to Landsat 8. But it should be mentioned that using of two satellites can be better to identify coastal landforms and complications.

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