Determination of the Possibility of Ground Water in the Holy Governorate of Karbala using the Thermal Classification of Satellite Images Using Remote Sensing

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Abstract

The study of groundwater and quality and characteristics of the mispronounce very important to witnessed the world of lack of water resources, this is illustrated by the global conflict over water resources. As for Iraq currently there is a shortage of water in the Tigris and Euphrates Rivers in addition to the shortage in the amount of rain water. Therefore, attention should be given to the study of groundwater, the search for the sources of this water and the prediction of its location through the use of remote sensing data and geographic information systems. We will rely on our research on the discovery of groundwater in the holy Karbala study area by using satellite images of landsat8 based on thermal band. After conducting the mosaic process using the erdas program and subtracting the image of Karbala governorate using arc map and introducing some special thermal equations, the temperature of the surface will indicate the wet areas, which estimate the possibility of the presence of groundwater in those areas in addition to the variation of vegetation in those places as well. This study can be used to shorten the time factor and reduce the material costs, as well as the possibility of developing plans and programs that enable us to use underground water in the process of agriculture and the promotion of drinking water sources in Karbala governorate, which is center for receiving millions of visitors annually.

Key words: groundwater, erdas program, Karbala, thermal equations, water resources

Introduction

The problem of water scarcity has increased dramatically over the last few decades, particularly in the arid and semi-arid areas. There is concern that the world is heading towards the water crisis. Lack of water and deterioration of its quality hinder the economic development in many developing countries. Throughout the world, the agriculture sector is the largest consumer of water. Agriculture sector consumes approximately 67% of the total water withdrawal and accounts for 86% of total consumption in 2000. By 2025, an irrigation water requirement is expected to increase by 1.2 times. More efficient use of agricultural water through waste water reuse and groundwater is essential for sustainable water management.

It is important to look for other sources of water or reuse safely for various purposes, especially in the field of agricultural.

Groundwater is used for domestic and industrial water supply and irrigation all over the world geographically Iraq is one of the Middle East countries. Water in this region is inherently scarce as a result of naturally and climatic conditions Karbala is one of the major Iraqi cities, which also suffers from water scarcity and this city receives its water requirements from the Euphrates River. In addition to all that the city is one of the religious cities receives millions of visitors annually, which constitutes an additional stress on water requirements.
The researcher has adopted the study of places expecting presence of groundwater, and analyzed the images of space moon Landsat 8 by category thermal of tenth band using GIS.

Study Area

Karbala governorate is located between latitudes (32˚ 50′ 24″ - 32˚ 01′ 11″) North, and longitudes (44˚ 18′ 03″ - 43˚ 01′ 04″) East [1].It is located in the center of Iraq in western part of the sedimentary plain and in the east of the western plateau as in Figure (1).

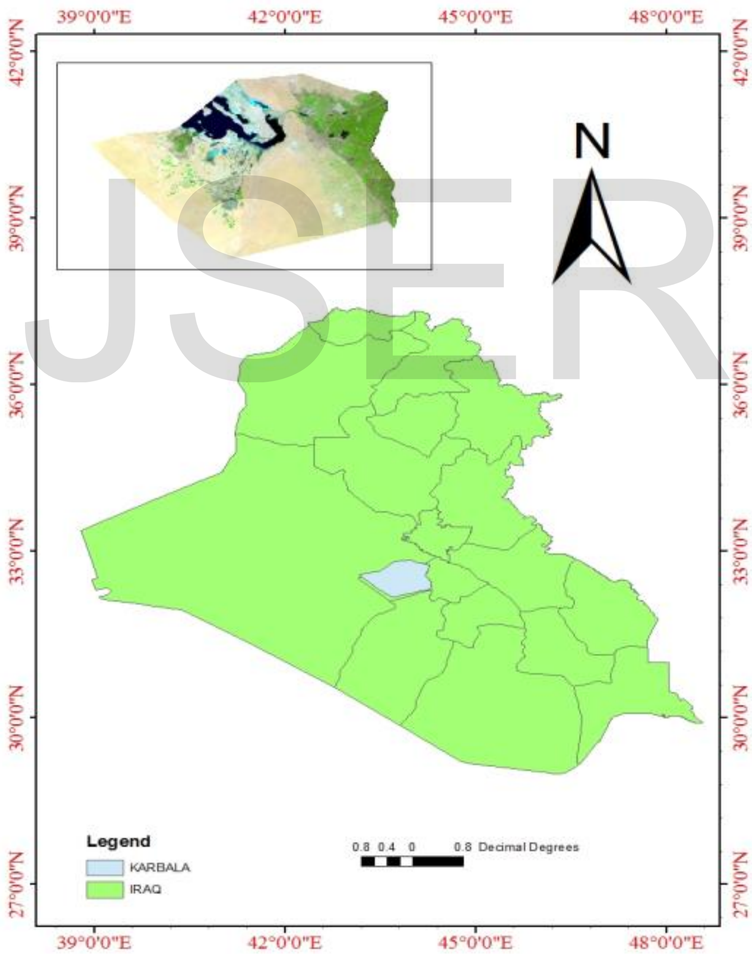


Figure 1: Location of Karbala province of the Republic of Iraq

Karbala governorate is located in a geographical region is one of the largest regions densely populated and the area of Karbala province 5034 km^2 and represents 1.2% of the total area of Iraq[2]. The study area, which is part of the stable region of

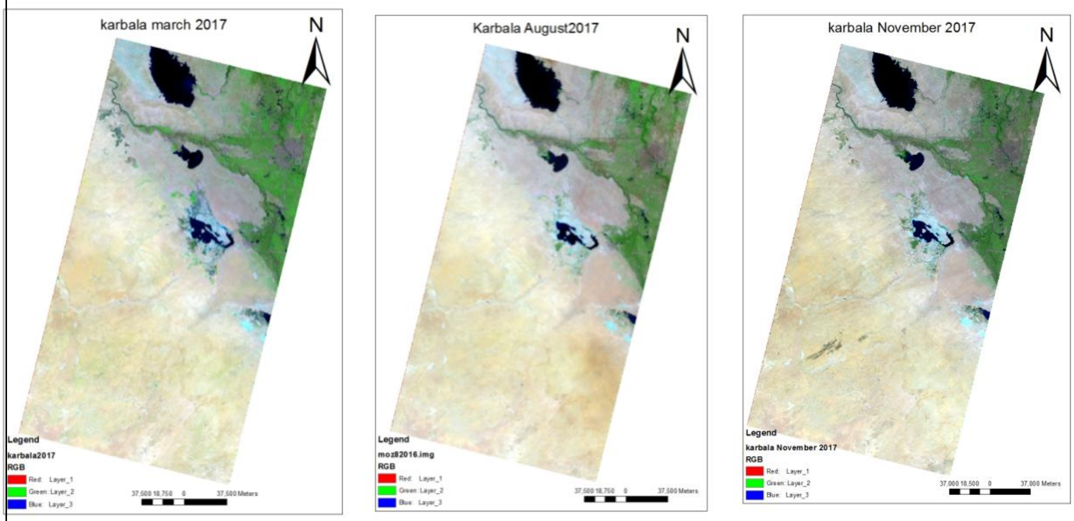
the surface of Iraq, is characterized by simplicity and geological continuity, where the geology of Karbala province is related to the geological development of Iraq, which affected by two important factors mass of Gondwanaland in the west, which characterized by the rigidity of its rocks and it was affected by the repeated flooding of the Sea of Tethys in periods and retreat from him in other periods [3].
The study area is also characterized by the possession of four basic formations of groundwater, namely the composition of Dammam, Dibdiba, Umm Ere Rodham and Zahra formation [4].

Methodology

Satellite images from the Landsat 8 satellite were used by USGS [5], which carry the OLI/TIRS sensor, a multi spectral type taken in 2017 and for the month of March, August and November.

Image Color Composites

The space visualization domains of the multi-spectrum type were merged to produce new colored visuals by integrating the bands 7, 5, and 3[6].
By using program Arc map Ver10.2 .The Erdas program was used to create mosaic images that were merged to include the study area as in figure(2).

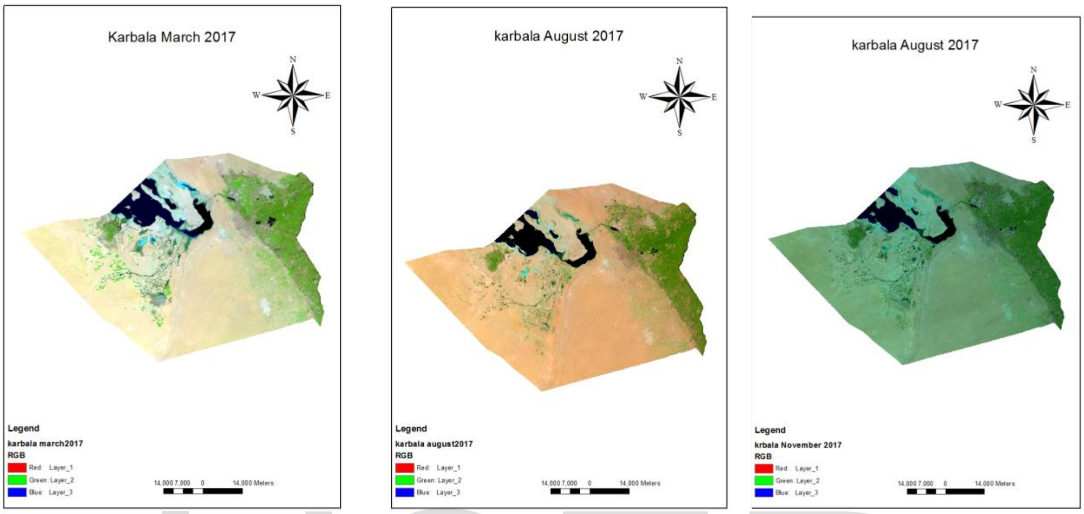


(a) (b) (c)

Figure 2: (a) mosaic of the image of Karbala for the month of March (b) mosaic of the image of Karbala for the month of August (c) mosaic of the image of Karbala for month of November.

Study Area Subset

The study area was made to use of satellite images using a program ArcGIS (10.2), because the visual area is larger than the study area. The method was used Extraction by mask as in figure 3.

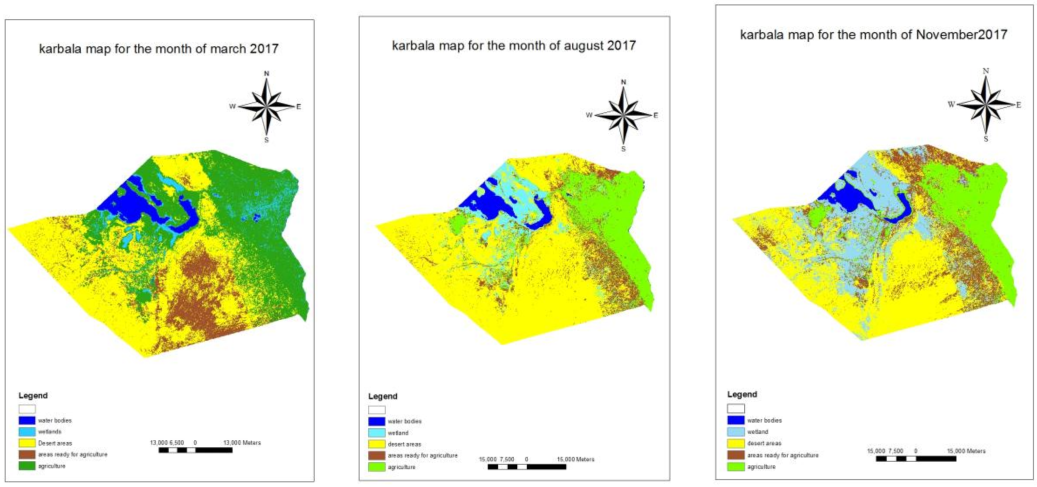


(a) (b) (c)

Figure 3: (a) study area the month of March in the period of heavy rain, (b) study area the month of August in the period without rain, (c) study area the month of November in the absence period of cultivation.

Satellite Image Classification

Has been applied technology supervised classification the visuals satellite the month March, August and November of the year 2017. They have been using the method of Likelihood Classification Maximum provided by the program ERDAS IMAGINE 2014. Five species were identified within the study area, representing three types of soil cover; water, soil and plants. The images were classified into water bodies, wetlands, green areas (agricultural land and natural vegetation with varying densities), arable land and deserts as in figure 4.Thus, we were able to obtain supervised classification[7], which showed the variation in agricultural land, water bodies and deserted lands during the rainy season in March, without rain during the month of August and last in the period of non-agriculture in November in the holy province of Karbala.



(a) (b) (c)

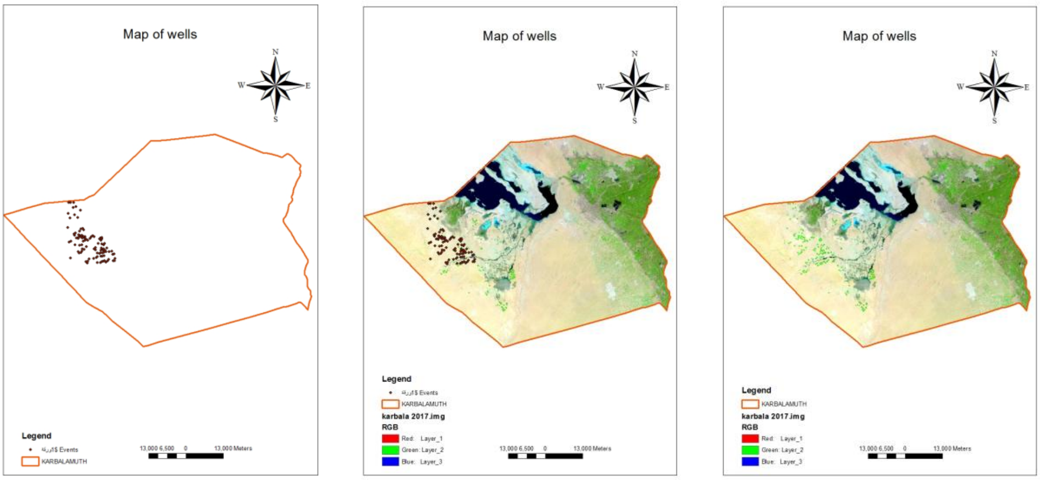
Figure 4: (a) supervised classification of the study area for the month of March (b) supervised classification for the month of August (c) supervised classification for the month of November.

Well Positions Map

The locations of 100 wells were identified by the use of a device Global Positioning System (GPS) in the area of Ain-Altamar in the holy province of Karbala as in Table (1). The area of ain-altamar is characterized by the absence of surface water, although it is of a dry agricultural nature based mainly on groundwater. Produced a map showing the location of these wells and was identical with the field farms indicated by the satellite image of the study area, the satellite image proved that there is a possibility of wells within the field as in figure (5).

Table (1) Geographical Coordinates of wells.

Well No.	LONGITUDE	LATITUDE	X(UTM)	Y(UTM)
1	43 30 48.049	32 26 44.575	360673	3589104
2	43 31 3.068	32 26 55.492	361665	3589104
3	43 31 47.319	32 27 6.306	362161	3589303
4	43 32 8.812	32 27 2.705	362657	3589468
5	43 32 29.039	32 27 5.087	363650	3589270
⋮	…	…	…	…
96	43 26 4.91	32 36 16.92	352253	3608267
97	43 25 32.099	32 36 6.845	353086	3608545
98	43 25 32.391	32 37 2.691	352332	3609973
99	43 24 51.795	32 37 2.18	351181	3609934
100	43 24 30.191	32 37 4.054	350625	3610053



(a) (b) (c)

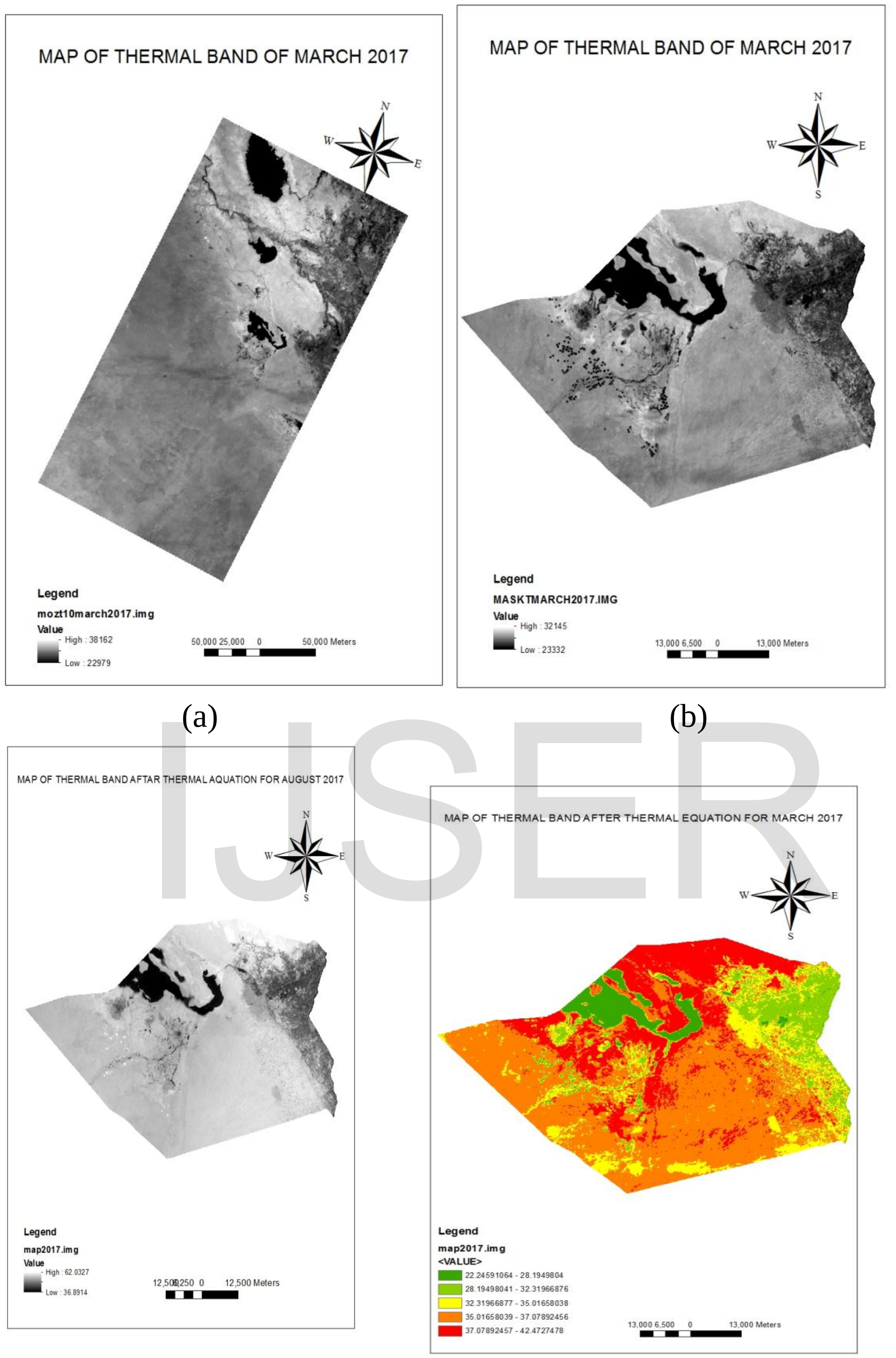
Figure 5: (a) Map of the wells of the study area, (b) Map of wells with vegetation Cover the study Area, (c) Map of the land cover of the study area.

Thermal Band Study

The production of maps mosaic band thermal tenth months March, August and November of 2017 by using the program ERDAS 2014.After that is deducted study area of the band thermal by using Arc Map 10.2 by Extraction by Mask. After that, have been using the following equation to find actual surface temperatures for study area.

$$T=K2/L\lambda\ ((K1/\ ((Lmax- Lmin)/254^*\ (DN-1)) + Lmin) +1) - 273.15 \ldots\ldots\ldots [1]$$

where the:
K1, K2 represents the values of fixed with each type of devices sensor.
$L\lambda$:(DN-1) represents the coefficient transformation unit.
Lmin, Lmax represents the radiation spectroscopy per rang of values digital 0, 254 respectively.
We then on maps thermal surface area of study shows disparity in the temperature of the surface, and finally been rated this images to five areas thermal as in figure 6.



(c) **(d)**

Figure 6: (a) mosaic of thermal band of March 2017(b) study area subset by extraction by mask, (c) Thermal band after using thermal equation (d) classification of thermal band.

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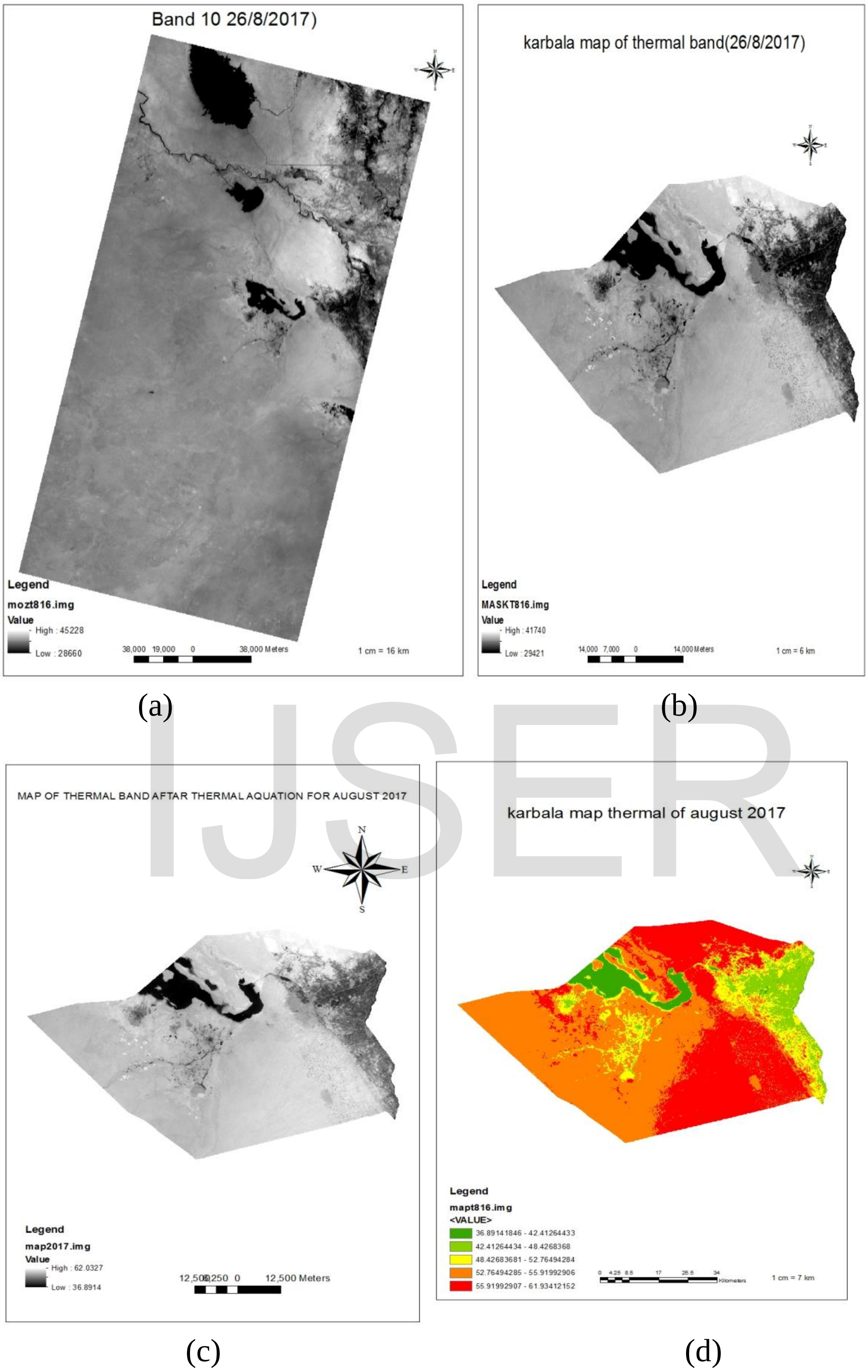
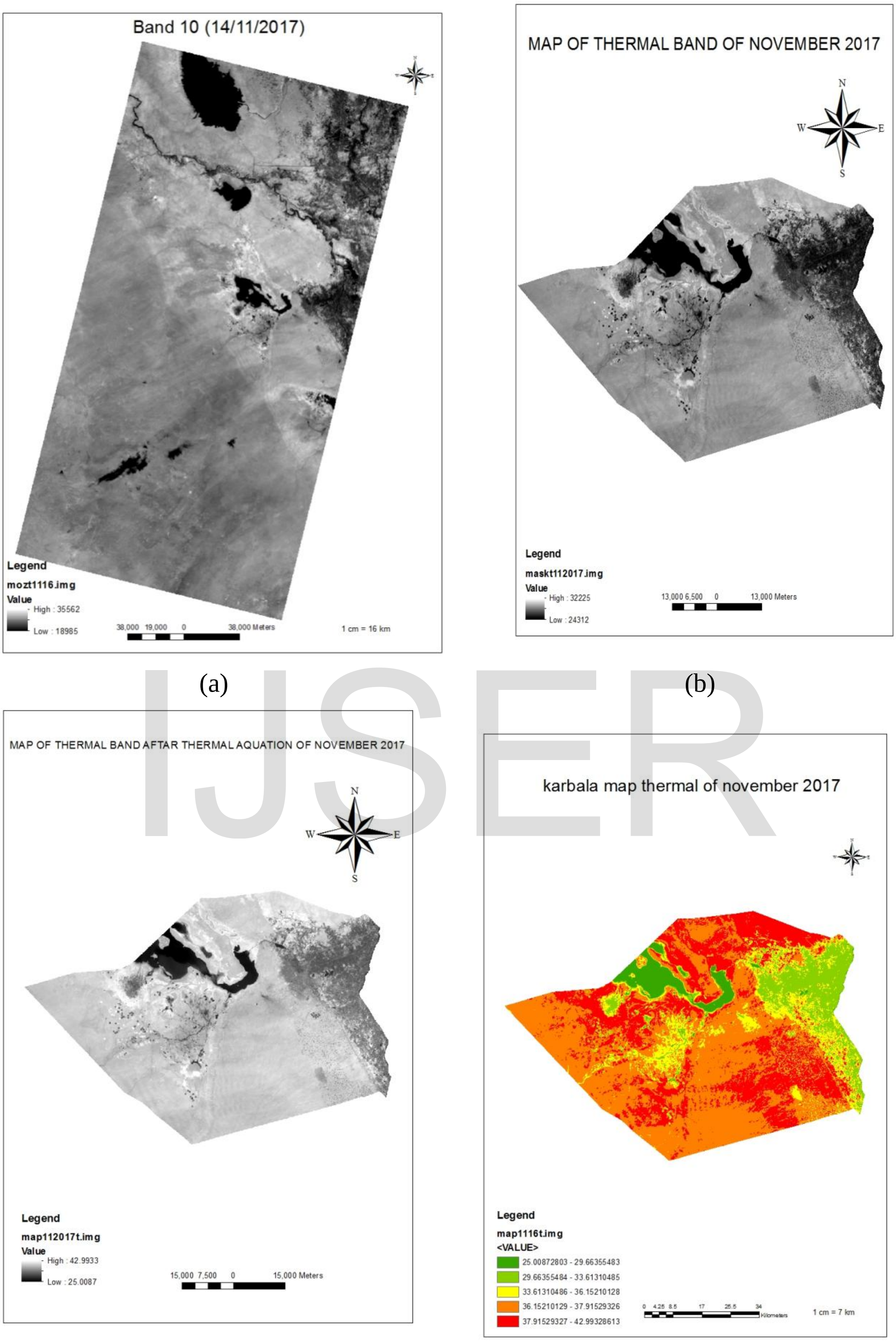


Figure 7: (a) mosaic of thermal band of August 2017, (b) study area subset by extraction by mask, (c) Thermal band after using thermal equation and (d) classification of thermal band.



(c) (d)

Figure 8: (a) mosaic of thermal band of november 2017, (b) study area subset by extraction by mask, (c) Thermal band after using thermal equation and (d) classification of thermal band.

Results and Discussion

Through the analysis of the satellite image and after carrying out the composites of the spectral beams, and the acquisition of vegetation maps ,we were able to identify the central farms within the study area, which indicate the presence of wells excavated in that area.

Through the production of supervised classification maps on the satellite image taken in 2017, we noticed that vegetation is at its peak in the month of March the heavy rain season while decreasing in August for no rain. And decreases further in November due to the lack of field cultivation in this month in the study area.

After studying the thermal band of the study area according to the use of thermal equation(1).

After the production of thermal maps, the variation in the surface temperature of the study area was revealed. In March, it ranged between (22c◦-42c◦), in August (36c◦-63c◦) and in November between (25c◦-42c◦).

Conclusions

Through the production of the thermal map for the month of March, the temperature of the bodies of water varies between (22-28) c◦, the vegetation area ranges from (28-32) c◦, areas with a temperature range (32-35) c◦ are the most likely to have groundwater near the temperature of vegetation cover, and water bodies and were practically identical with pre-drilled wells and consistent with the current conclusion.

The map of the thermal month of August was the temperature of the water bodies between (36-42) c◦, the vegetation area was between (42-48) c◦, either areas whose surface temperature ranges from (48-52) c◦ it is more likely to have groundwater in proximity to the temperature of vegetation cover and water bodies, which matched the sites of wells dug in advance within the study area.

The map of the month of November thermal showed that the temperature of bodies of water was between (25-29) c◦, areas of vegetation ranged temperature between (29-33) c◦, the areas of heat between (33-36) c◦ it is more likely to have groundwater in proximity to the temperature of vegetation cover and water bodies, which matched the sites of wells dug in advance within the study area.

We conclude that previously that he can locate the likelihood of groundwater by classified thermal band of packets spectral Landsat 8, which was the results of this category months March, August and November identical in practice with all the wells that have been drilled in the study area.

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