



LAND USE DECISION USING INDICES AND FUZZY INFERENCE SYSTEM IN SOUTH OF IRAQ

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Article history:	Abstract:
Received: 26 th February 2025 Accepted: 24 th March 2025	A land use decision by using Fuzzy Inference System (FIS) to determine the validity to agriculture various types of crops according to the values of salinity index (SI) and Normalized Multi-Drought Index (NMDI) for each crop is presented. the SI and NMDI land feature for the bare soil only after a classification step are divided into three ranges (low, medium and high) and used to build the decision rule. the FIS applied on the AL-Khamisiyah area in the south of Iraq to classify it according to the crops should be implemented. The result showed the validity of this system to give a prior decision to use the land.

Keywords: land decision usage, Soil Indices, Normalized Multi-Drought Index, Iraq south soil, Fuzzy Inference System.

INTRODUCTION

The land use and cover is significant for frugality planning of area. Where earths applied linked at epidermal effectiveness interior, foundation, recuperation and mercantile. while the earths overlay linked for the different kind from lineaments that exist on the face of the ground (Hala A. Abed et al. 2024).

the collected datum from the satellite are explicit and remedy at various compose use grilled technicality nor visual mechanism. though the visible translation for image is being applied for numerous implementation, it does not explicate the image pixel by pixel, instead of supply synoptic datum regarding of image lineaments of known targets. As result, the data conclusion to ground applied and wrapped supply through epidermal translation is minimal precise and interfere at much area (Ashok, K. Sinha and surekha dudhani, 2004 _ Muna. R Harbi et al. 2024).

Fuzzy inference system used in a broad extent for issue fields. The regions for implementations are so vast : operation monitoring, administration and resolution working, procedure discuss, frugality (Nedeljkovic,2007). contend with simple (white and black) responses in no taller satisfying sufficient; adegree for organic (suggested by prof. zadeh in 1965) be anew mode to solution the problem. Vague combination is a specify whose components have grades to complete member (100 organic) or fractional member (o and 100 organic) (T. H. Mushtaq et al, 2024). The membership function is a mathematical mathematical function that determines the degree of membership of an element in an ambiguous combination (Salman, M. A.and Seno, N. E, 2011)

(Hegde, S., 2003) The ground cover change was studied using foggy logic. The source of information on the region was obtained using the satellite Landsat tm, and the result showed that the accuracy of the ambiguous classification is better than the fragile classification. (Mohamed, A. and Hawas, Y., 2004) Studied the determination of soil moisture using neuro-fuzzy logic model, the empirical findings described the concentration of ions and water content are sensitized by the system and this model is capable of predicting the water content of the tested soils. (Sharma, M. and et al, 2011) They categorized satellite images using an approved methodology. They used the foggy estimation system in the classification. They concluded that the accuracy of the classification is closely related to the identification

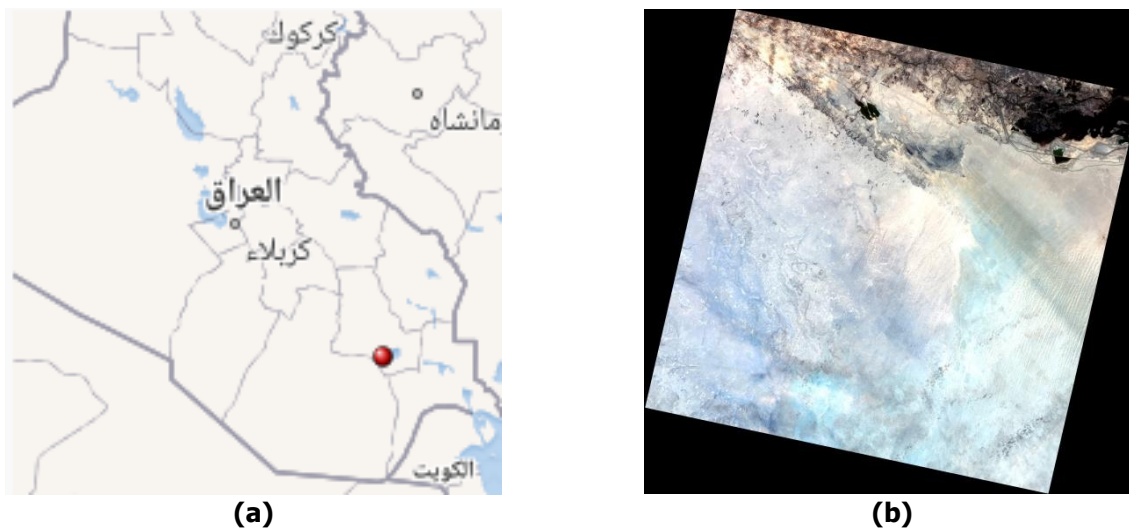
of the functions used. (Shah, P. and Vayada, M. G.,2015) Classed satellite image by using different techniques but the fuzzy logic method was mainly focus, a Satellite image is taken in which water will be detected using FIS (fuzzy logic system) and membership function editor. Similarly classification can be done in different areas for different region. (Taufik, A. and Ahmad,S.2016) have Studied Land cover classification, where they used landsat-8 satellite statements depending on foggy rationale, and It was found that this system can be explored and implemented in several areas of satellite data due to its effectiveness and accuracy.

the aim from this study, is arrive to land use decision and determine the area that valid to agriculture by applying fuzzy inference system.

And for this paper the most important is arrive to land use decision and determine the region that valid to agriculture by applying fuzzy inference system (FIS).

STUDT AREA

the survey region location at southern Iraq with zone 854km² and this area positions among (46° 33' 56.92" - 46° 53' 30.02") longitude and (30° 55' 53.11" - 30° 39' 28.99") latitude. Figure (1-a). the Landsat 8 satellite image data that picked up via Operational Land Imager (OLI) and Thermal Infrared Sensors (TIRS) which picked up at (3/11/2023) and site inside Landsat coordinates (row=38) and (path=167) which coverage the survey region with eleven spectrogram domains that are used in this study, Figure (1-b).



Figure(1) a shows Iraq site for the survey zone , b indicates the Landsat 8 satellite image of the survey zone.

DATA USED

In this study ENVI 5.3 and Matlab2016a are used. Where the fuzzy model was built in the MATLAB program and the Land use was added to the applicable model to obtain the desired decision.

Where the suggested indexes that are employ the salinity index (SI) and Normalized Multi-Band Drought Index (NMDI), giving by Eq. (1) &(2).

$$SI = \frac{(Red * NIR)}{(Green)} \quad (1) \text{ (Allbed, A. and Kumar, 2013)}$$

This indicator was used because the soil contains double salts and to detect these salts need an NIR package and this spectral indicator is also effective in detecting the degree of soil salinity.

$$NMDI = \frac{((NIR) - (SWIR1 - SWIR2))}{((NIR) + (SWIR1 - SWIR2))} \quad (2) \text{ (Wang, L. and Qu, J. J, 2007_ Mustafa A. Raheem, Amal J. Hatem, 2019)}$$

the Normalized Multi-Band Drought Index (NMDI), proposed for remote sensing for soil water content of aerospace through using 3 ducts NIR, SWIR1 and SWIR2. this indicator depends on The ramp contrast and this characteristics be helpful to excavated information about soil water status (Wang , L. and Qu, J. J, 2007).

METHODOLOGY

In order to obtain the land use decision, the following step are performed.

1. The study area contains many land features (soil, water, vegetation, ...etc.), therefore, the study image is classify using maximum Likely hood method (see figure 2-a), with help of MATLAB the bare soil is separated (figure 2-b) in order to account their salinity index and the Normalized Multi-Band Drought Index, where the resultant image for the both features are saved as bit map images.

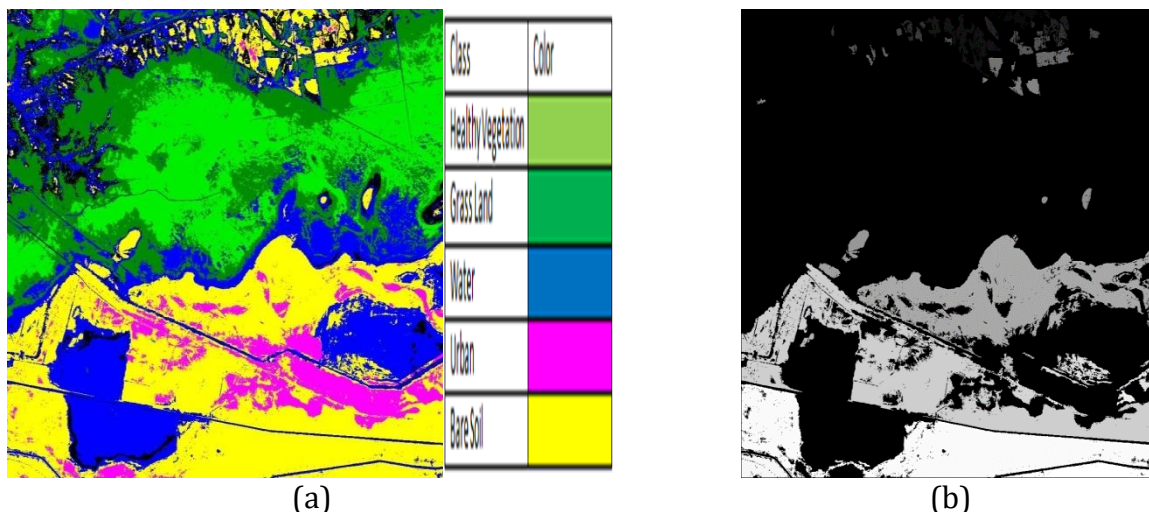


Figure 2(a) Categorized Image, (b) Segment Image for barren Soil category.

The saved feature images for both SI and NMDI is recalibrated to valuable for the SI & NMDI instead of the intensity values by calculating an empirical fitting equations by comparing the pixel’s intensity values with the SI and MNDI indexes (see figure 3).

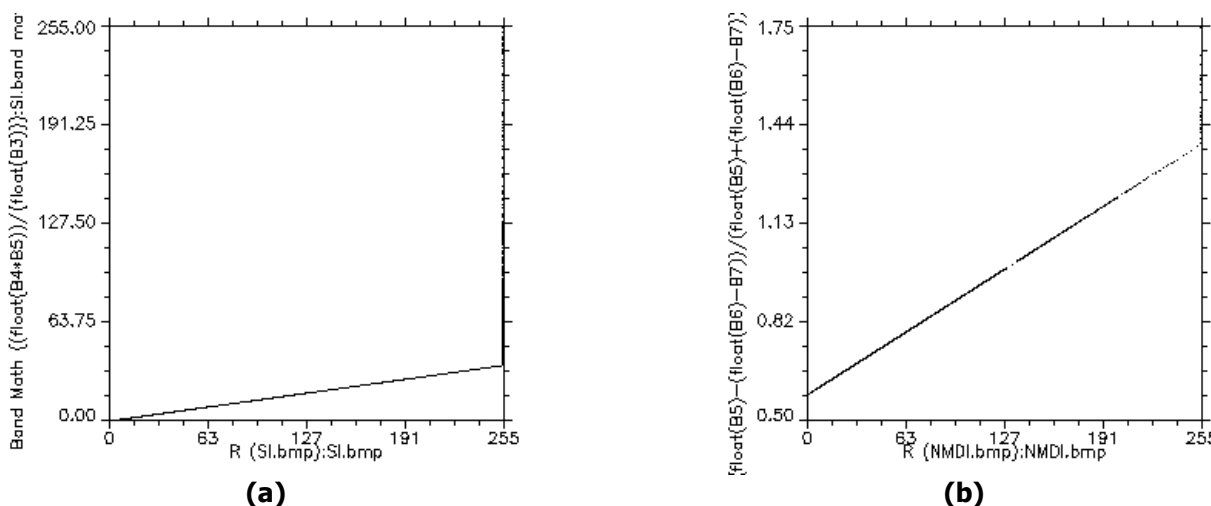


Figure 3. comparing the intensity values of the bare soil image with the SI and NMDI indexes

2. the FIS model is build using MATLAB fuzzy tool box using mamdani inference system (see figure 4), where the SI and NMDI are used as input parameter with Gaussian member ship and by split each of them to three ranges (low, mid and high). While the output was comprised from 9 membership functions (Pepper, Onion, Lettuce, Cabbage, Cucumber, Celery, Gao, Lob and Beet) with non over lab triangle umber function is used,

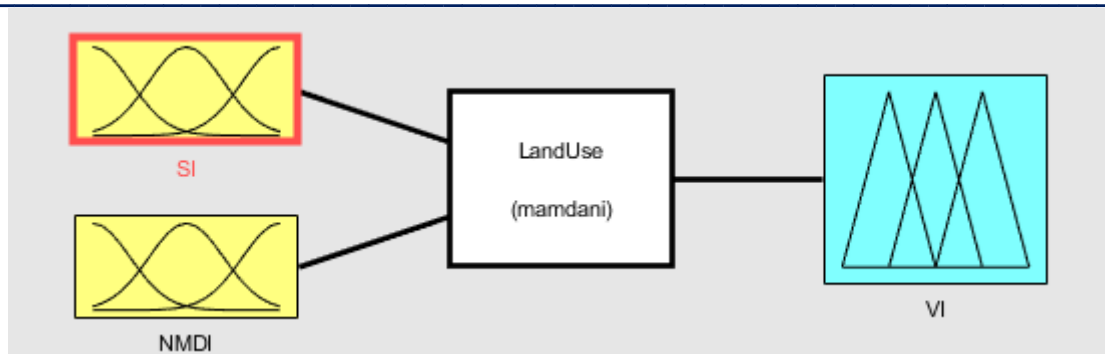


Figure 4. the inference system structure

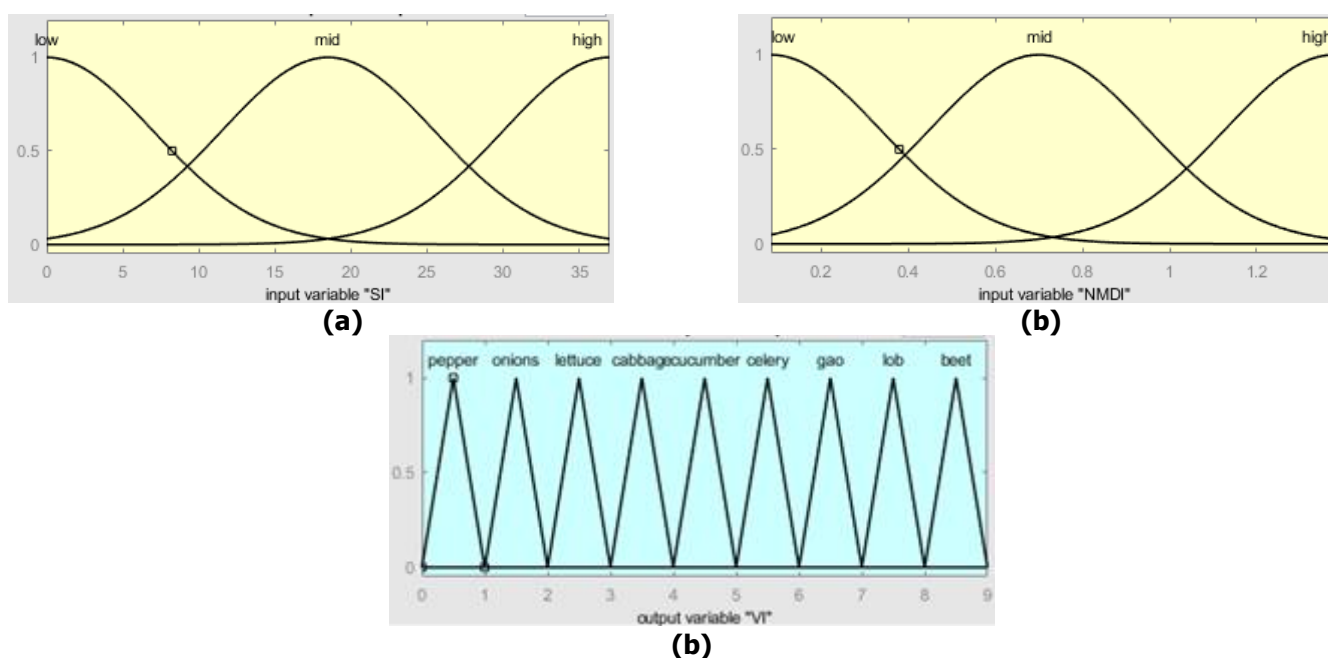


Figure 5. The Input and the Output of the vague inferred regime (a) SI index (b) NMDI index and (c) the output vegetation kind (index)

these crops are used since the need different condition of salinity index and different Drought Index, therefore the decision roll are build depending on their needs for each of the SI and NMDI values, see figure 6.

1. If (SI is low) and (NMDI is low) then (VI is pepper) (1)
2. If (SI is low) and (NMDI is mid) then (VI is onions) (1)
3. If (SI is low) and (NMDI is high) then (VI is lettuce) (1)
4. If (SI is mid) and (NMDI is low) then (VI is cabbage) (1)
5. If (SI is mid) and (NMDI is mid) then (VI is cucumber) (1)
6. If (SI is mid) and (NMDI is high) then (VI is celery) (1)
7. If (SI is high) and (NMDI is low) then (VI is gao) (1)
8. If (SI is high) and (NMDI is mid) then (VI is lob) (1)
9. If (SI is high) and (NMDI is high) then (VI is beet) (1)

Figure 6. the inference decision roll

The fuzzy inference model is build based on the previous structure and decision roll to map the two input indexes to one output variable of nine index, each index output index represent one kind of the selected crops, see figure 7 & 8.

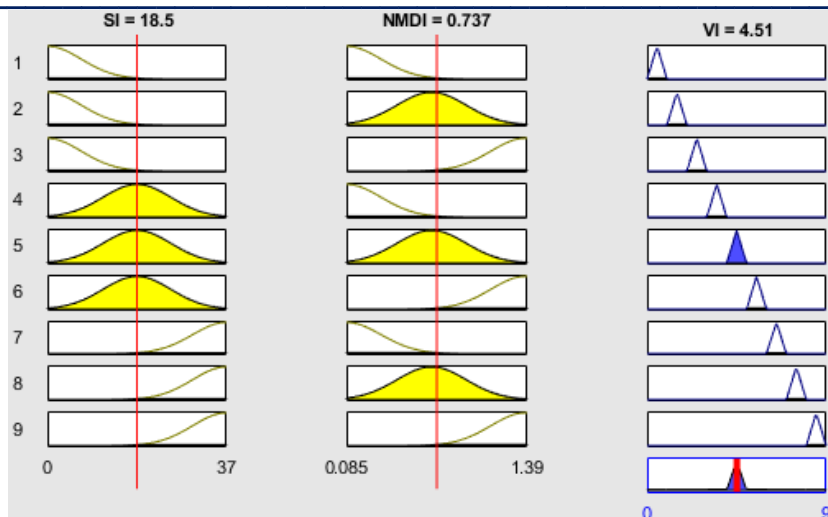


Figure 7. the infrastructure of the fuzzy inference model

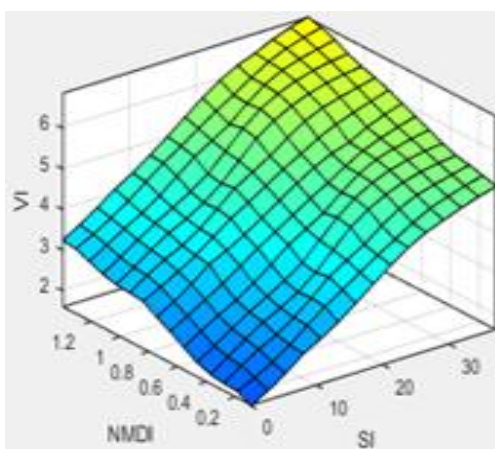
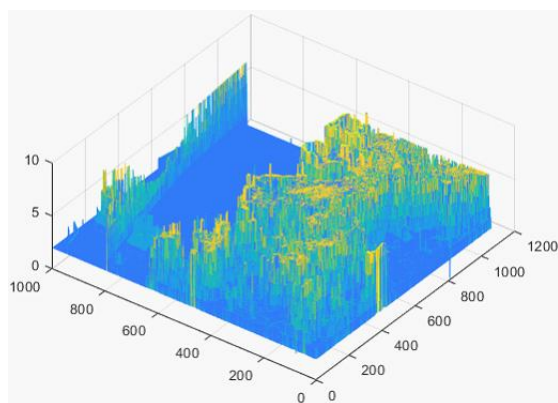
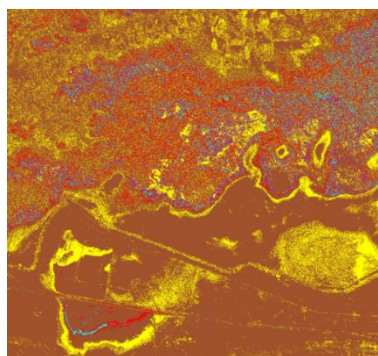


Figure 8. the decision surface based on the inference model

The study area is classified based on the fuzzy decision surface, by applying the decision surface by writing a MATLAB model remap the study area to specify crop according to the value of the Si and the NMDI values. The resultant crop map image is recolored to recognize each crop kind from the other, see figure 9.



(a)



(b)

Pepper	Green
Onions	Yellow
Lettuce	Brown
Cabbage	Red
Cucumber	Cyan
Celery	Dark Red
Gao	Black
Lob	Blue
Beet	White

Figure 9. the results of (a) mapping study area (b) after coloring based on the fuzzy inference decision surface.

RESULT AND DISSCUSION

the Minimum and Maximum Values for each of the SI and NMDI that extracted in the first step of methodology (1) are shown in the table 1.

Table 1. The minimum and maximum values of SI and NMDI.

Value	SI	NMDI
Minimum	0	0.085
Maximum	37	1.39

In Land use design (second step of methodology) (1) The range of membership functions (MF) values for input1 (SI) and input2 (NMDI) is indicate in table 2, where this values of ranges extracted from minimum and maximum values.

Table 2. The Ranges of Membership Functions (SI, NMDI).

MF	Input1(SI)	Input2(NMDI)
low	7- 0	0.25- 0.085
Mid	7 -24.666	0.25- 0.947
High	7- 37	0.25- 1.378

The resultant crop after mapping (figure 9-a), the number of pixels, area and percentage comparing with the total area are calculated, see table 3.

Table 3. The result of the land decision use using the fuzzy inference

Crop	Index	Pixel	Area m ²	Percent
Pepper	1	0	0	0
Onion	2	753456	678,110,400	71.64084
Lettuce	3	168443	151,598,700	16.01606
Cabbage	4	59898	53,908,200	5.69528
Cucumber	5	29304	26,373,600	2.786311
Celery	6	13913	12,521,700	1.322889
Gao	7	24985	22,486,500	2.375648
Lob	8	1714	1,542,600	0.162972
Beet	9	0	0	0
total		1051713	946,541,700	100

According to table 3, it can be noticed that the studied area can be grown by a special types of crops which are (Onions, Lettuce, Cabbage, Cucumber, Celery, Gao and Lob) where we note that are with varying degrees topped by the Onion after the Lettuce then Cabbage, Cucumber, Gao, Celery finally Lob crop, while other crops (Pepper and Beet) cannot be cultivated in the soil of this area.

CONCLUSION

In fact, the results validity the use of the Fuzzy inference to make decision which of the crops should be implanted in a manner close to human. This land use decision based on the soil characteristics of is salinity and moisture content indexes where the saline content is (low-mid), in comparison with moisture content (low-mid-high). On this basis, crops that need these conditions have been cultivated.

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