

# International Journal of Innovative Research in Science, Engineering and Technology

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## A Fuzzy Approach to Find Land Use Index

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**ABSTRACT:** In present era land quality is one of the most important environmental issues as the green cover is reducing day by day mainly due to industrialization and urbanization. Industries discharge their effluents either on land or in water body and pollute the land. A thick cover of concrete is covering earthen land gradually. The Traditional report of Land use pattern is prepared by considering number of variables and hence becomes too technical and detailed. For purpose of analysis different indicators of land use pattern are identified and reported on basis of area covered. In present study fuzzy set theory has been used to develop Fuzzy Land Use Index (FLUI) to represent land use pattern of an area. FLUI will help in taking decision about utility of land for developmental activities.

**KEYWORDS:** Fuzzy Land Use Index, Fuzzy Water Quality Index, Fuzzy Set Theory, Fuzzy Air quality Index, Water Quality Index, Air Quality Index.

### I. INTRODUCTION

Every region has its land use plan. Land may be covered by forest; it is used for agriculture, mining operation, residential purpose etc. However, some portion of the land of a particular area is left unutilized with no green cover and no other habitable activity. This is barren land or waste land. When a specific 'developmental activity' is proposed in region, it becomes necessary to determine its Land Use index. The 'developmental activity' may have its impact on land use pattern of surrounding region by using its land for other purposes. It may result in deforestation of the region, conversion of agricultural land to some other purpose, submergence of forest area, agricultural area or industrial area etc.

So far there is no globally accepted Land use pattern measuring system, some countries and regions have used, or are using land use pattern data on basis of percentage analysis. Most land use pattern analysis rely on normalizing, or standardizing, data parameters by parameters according to traditional system having standing boundary conditions and some interpretation of 'good' verses 'bad'

Traditional reports on land use pattern tend to be too detailed, presenting monitoring data on individual substances, without providing a whole and interpreted picture of Land use. However, So far efforts have not been taken to find a single index value to report Land use pattern as has been done to develop Air Quality Index and Water Quality Index by various agencies. In addition to this completely new indices based on fuzzy set theory have also been developed, that is Fuzzy Air quality Index [4] and Fuzzy Water Quality Index [1].

### II. FUZZY SET THEORY

Modern world today has realized that the traditional approach of handling the data /information is not sufficed. The traditional knowledge works on the principle of yes or no, this or that, black or white. This traditional way (Boolean), does not take into account the variability between the two extremes. Thus fuzzy logic today has emerged as a valuable tool to handle such information.

Computers operate on a binary true or false basis. Unfortunately our world is not binary. The world we live in is full of ambiguities. "The temperature is quit warm" cannot be evaluated as strictly true or false rather we accept that this statement has certain ambiguities. Thus, the mathematical theory of fuzzy logic was developed. The theory of fuzzy logic basically states that rather than a statement being true or false, each statement has a certain confidence level. For example let's say a confidence value of 0.000 meant false and a confidence value 1.000 meant true, then the

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statement "this room is warm" might have a confidence value of .700 at 80 degree. The idea of fuzzy logic has had a insightful impact on Artificial Intelligence research, because human intelligence is quite fuzzy.

A fuzzy set theory is used to make decision in complex system when context of the problem is often unclear. It has been commonly used for imprecise information in a non probabilistic sense and allows integration of information of various parameters into the modeling and evaluation process. The concept of fuzzy sets describing imprecision or vagueness was introduced by Lotfi A. Zadeh (1965), and has been applied throughout in decision making and evaluation process in imprecise world. What Zadeh proposed is very much a paradigm shift that first gained acceptance in the Far East and its successful application has ensured its adoption around the world.

Fuzzy logic is a superset of conventional (Boolean) logic that has been extended to handle the concept of partial truth -- truth values between "completely true" and "completely false". Zadeh says that rather than regarding fuzzy theory as a single theory, we should regard the process of "fuzzification" as a methodology to generalize ANY specific theory from a crisp (discrete) to a continuous (fuzzy) form.[7]

Fuzzy logic begins with and builds on a set of user-supplied human language rules. The fuzzy systems convert these rules to their mathematical equivalents. This simplifies the job of the system designer and the computer, and results in much more accurate representations of the way systems behave in the real world. Additional benefits of fuzzy logic include its simplicity and its flexibility [6]. Fuzzy logic can handle problems with imprecise and incomplete data, and it can model nonlinear functions of arbitrary complexity.

## III. LAND USE INDEX

A rational approach in designing of Land Use Index is needed as present Land Use Pattern Analysis system have number of discrepancies and need to be rectified so that entire land use pattern could be reported with a single numeric value. In fact, Land Use Index by using Crisp set theory dealing with standing boundary condition has not been tried so far. In case of water analysis, water quality parameters considered for obtaining WQI is different for all indices. Some important parameters have not been considered at all and allotment of weightage factor is completely subjective. At the same time some parameters can change the results dramatically without justifying it. Because of these limitations of crisp set theory an advanced computation method is required which is capable of handling imprecise, vague and fuzzy information in decision making on water quality[1]. Hence there is need for more robust approach which can deal with uncertainty and ambiguity involved in assessment of water quality. To reduce uncertainty, ambiguity, vagueness and subjectivity in environmental issues fuzzy set theory has emerged as an excellent tool. In present work of finding Land Use Index by using fuzzy set theory, fuzzy logic has been used and new nomenclature is done as FLUI (Fuzzy Land Use Index).

Therefore, it is necessary to find impact on land environment by using a suitable index value. For this purpose the Input variables 'Agricultural and Forest Land' and 'Waste Land' are used in the model. The linguistic variable 'Worst', 'Acceptable' and 'Good' were identified for input variable 'Agricultural and Forest Land' in universe of discourse from 0 to 100. For input variable 'Waste Land', 'Acceptable', 'Poor' and 'Worst' were recognized as linguistic variable.

## IV. MODEL DEVELOPMENT TO FIND FUZZY LAND USE INDEX (FLUI) (PROGRAM)

'Agricultural and Forest Land' and 'Waste Land' were selected as input variable to find Fuzzy Land Use Index. The nature of the curve for membership functions were considered trapezoidal. For example, membership function for input variable 'Waste Land', linguistic variable "Poor" has four values in parameter column i.e. 20,40,50,70 that represents that truth value (membership function) varies from 0 to 1 for 20 to 40, between 40 to 50 it is 1 and between 50 to 70 it varies between 1 to 0.

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## Input Variables with their Membership Function

### (1) Agricultural and Forest Land

Membership Function for Input Variable Agricultural and Forest land 'Agri/Forest' is shown in Table-1 and its Fuzzy set is shown in Figure-1.

**Table 1**  
**Membership Function for Agri/Forest**

Sr. No.	Membership Function for Agri/Forest	Index Value
1	Worst	[0,0,20,40]
2	Acceptable	[20,40,50,70]
3	Good	[50,70,100,100]

Figure -1 shows fuzzy set of input variable "Agri/forest". Trepezoidal membership function is used for representong fuzzy set of input variable "Agri/forest". Linguistic variables Poor, Acceptable and Good of fuzzy set "Agri/forest" are also shown with their membership function.

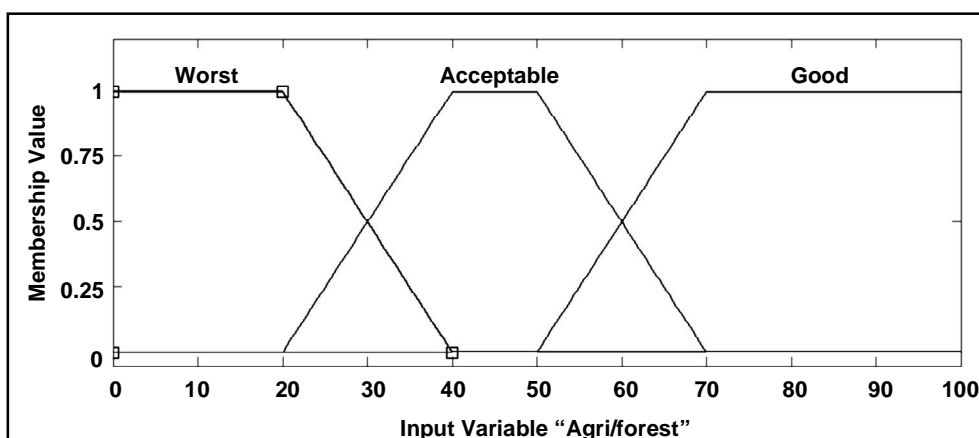


Figure 1: Fuzzy Set for Input Variable "Agri/forest"

### (2) Waste Land

Membership Function for Input Variable Waste land 'Waste Land' is shown in Table-2 and its Fuzzy set is shown in Figure-2.

**Table 2**  
**Membership Function for Waste Land**

Sr. No.	Membership Function for Waste Land	Index Value
1	Acceptable	[0,0,20,40]
2	Poor	[20,40,50,70]
3	Worst	[50,70,100,100]

Fuzzy set of input variable "Waste Land" is shown in Figure-2. Trepezoidal membership function is used for representong fuzzy set of input variable "Waste Land". Linguistic variables Acceptable, Poor and Worst of fuzzy set "Waste land" are also shown with their membership function.

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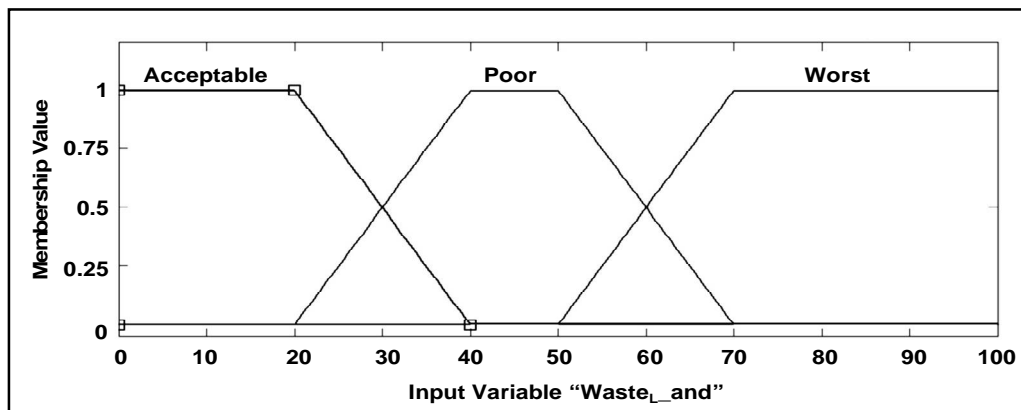


Figure 2: Fuzzy Set for Input Variable "Waste Land"

## Output Variables with their Membership Function Fuzzy Land Use Index (FLUI)

Membership Function for Output Variable Fuzzy Land Use Index 'FLUI' is shown in Table-3 and its Fuzzy set is shown in Figure-3.

Table 3  
Membership Function for FLUI

Sr. No.	Membership Function for FLUI	Index Value
1	Worst	[0,0,30,40]
2	Acceptable	[30,40,60,70]
3	Good	[60,70,100,100]

Figure -3 shows fuzzy set of output variable "FLUI". Trepezoidal membership function is used for representong fuzzy set of output variable "FLUI". Linguistic variables Poor, Acceptable and Good of fuzzy set "FLUI" are also shown with their membership function.

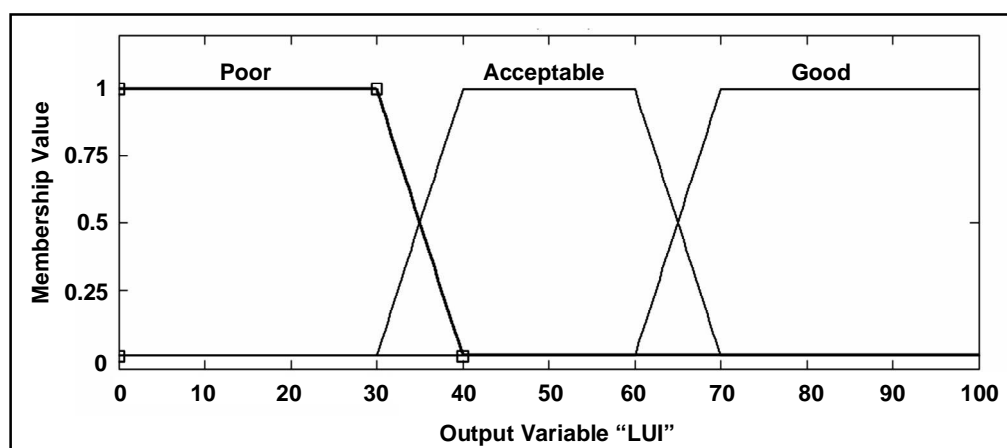


Figure 3: Fuzzy Set for Output Variable "FLUI"

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In first step all the rules in which each parameter value falls are identified. Based on these membership values and operators (OR / AND), the output fuzzy set is implicated. The implicated output from each rule is then aggregated and defuzzified to obtain the value of FLUI and its class. Rules formed to determine FLUI are shown in Table 4.

**Table 4**  
**Rules to Determine FLUI**

	IF			THEN
Rule	Agri/forest		Waste_Land	FLUI
1.	Worst	-	-	Poor
2.	Acceptable	AND	Acceptable	Acceptable
3.	Acceptable	AND	Poor	Acceptable
4.	Acceptable	AND	Worst	Poor
5.	Good	AND	Acceptable	Good
6.	Good	AND	Poor	Acceptable
7.	Good	AND	Worst	Acceptable

The land environment of a region depends on existing use of land, its utilization by ‘developmental activity’, soil quality and change in soil quality due to ‘developmental activity’. An attempt is made in Program to develop a fuzzy based Land Use Index. The implicated output from each rule is then aggregated and defuzzified to obtain the value of FLUI and its class, designed on basis of linguistic variable. Rule based fuzzy inference system for the FLUI model is shown in Figure 4.

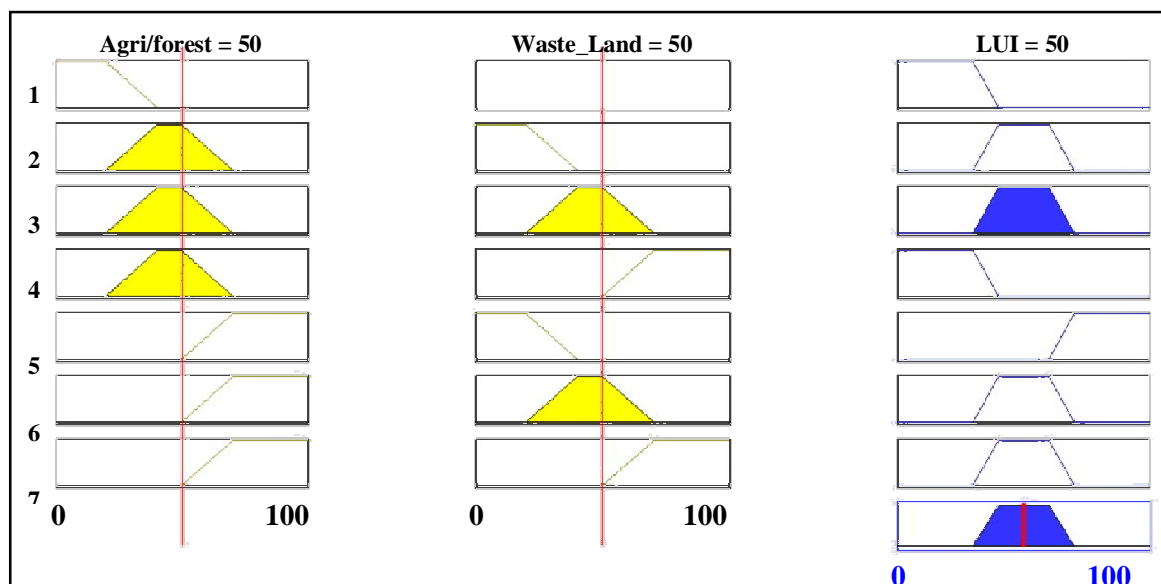


Figure 4: Rule View for Rule Based FLUI

The formation of the ‘Set of Rules’ is done by using AND operator. Total seven rules were formed by using AND operator to find output variable “FLUI”. The surface generated for rule based fuzzy inference system for the FLUI model is shown in Figure 5.

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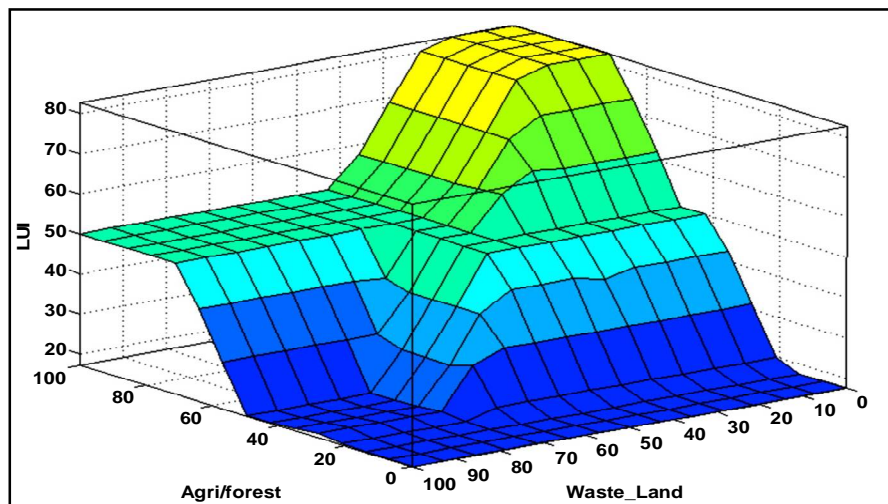


Figure 5: Surface Generated for FLUI by Rule Based Fuzzy Inference System

## V. CONCLUSION

Land Use Pattern Analysis is used to find land used or occupied by different activities. However, a single index is not available to represent land use environment in a nutshell which can represent land use pattern. Indices developed so far in case of Water and Air analysis are based on Crisp set theory which deals with standing boundary condition. However, so far no effort has been taken to develop Land Use Index based on Crisp Theory. Present study has been made to develop single index which can represent Land Use Pattern at a glance by using fuzzy set theory. The nomenclature of new Index is termed as Fuzzy Land Use Index (FLUI).

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