© 2015 IJSRSET | Volume 1 | Issue 5 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Assessment of Sanitary Condition nearby Area of Solid Waste Disposal Site

Sonal Bhugra*, Dr. Srijit Biswas, FIE
Department of Civil Engineering, Manav Rachna International University, Faridabad, India

ABSTRACT

Environmental Impact Assessment (EIA) [4-5] describes a technique by which information about the environmental effects of a proposed project is collected from different sources, and then analyzed to make a judgment on whether proposed development should go ahead. By EIA we do a systematic analysis using this information. But the data so obtained are not always crisp or precise. Most of the data are not numeric, rather linguistic. Such type of imprecise data is fuzzy data [9] or intuitionistic fuzzy data [1]. In this paper we study a methodology to find out the overall environmental impact on the health of neighbours to a solid wastes disposal site where waste are dumping crudely. Here we use the application of fuzzy logic and its higher order fuzzy logic for such evaluation. To understand the methodology o, an hypothetical case study is presented here.
Keywords: EIA, Fuzzy Set, Intuitionistic Fuzzy Set, Fuzzy Number, Mean Fuzzy Set

I. INTRODUCTION

In many states of the world, the sanitary landfills are not practiced rather the vehicles engaged to carry the wastes from various sources of generation are dumping the wastes here & there in the landfill site where they felt suitable best [3]. There is no clear boundary in the dumping premises, nor are the vehicles heaping the wastes in sanitary manner, thereby creating hillocks of rubbish which are posing threat to nearby residential environment. This indiscriminate disposal of wastes has led to significant degradation of environment, leading to contamination of environmental resources and spread of diseases, increasing the risk of exposure to highly contagious and transmission prone disease vectors. With the increase of population and the changing character of generated wastes, solid waste management is becoming a felt problem, particularly in thickly populated rural areas. Though not fully aware of the potential health risks associated with solid waste management, people today are more concerned about the aesthetic aspects and possible health hazards. The disposal of wastes on land in open dumps or in low lying areas causes numerous adverse impacts on the environment such as:

- Ground water contamination by the percolation of leachate from waste body
- Surface water contamination by the run-off from the waste dump
- Odour generation, pests, rodents and wind-blown litter around the waste dump
- Epidemics through stray animals
- Acidity to the surrounding soil
- Generation of inflammable gas.

The environmental Impact Assessment (EIA) is a relatively new planning and decision making tool first enshrined in the United States in the National Environmental Policy Act of 1969. In India, the environmental action formally started with the participation of late Smt. Indira Gandhi in the UN Conference on Human Environment in Stockholm in 1972. It focuses the public views and comments on the periphery of the project (here it is disposal place of solid wastes). The general public attitude in a major project is often expressed as concern about the existence of unknown or unforeseen effect. The objective of EIA is mainly the following:

i. Predict environmental impact of projects
ii. Find ways and means to reduce adverse impacts
iii. Shape project to suit local environment
iv. Present the predictions and options to the decision-makers

Scoping (process of deciding on the imparts to be investigated) is an important and essential initial activity in any EIA. Involvement of public in scooping in many situations is helpful because EIA is a predictive exercise. Project data and the data on the existing environmental conditions are known as baseline data. In the next section we justify the necessity of intuitionistic fuzzy set theory in EIA.

A. Why Fuzzy Technique is to be Adopted?

An EIA involves prediction and thus uncertainty is an integral part. There are two types of uncernty associated with EIA: that associated with the process and, that associated with predictions. In EIA, general public views and observation are collected as important information. viz. “good”, “very good”, “less amount”, “too much polluted”, “not less than 30%”, “30 to 40 nos. in average” etc. to list a few only out of infinity. Such type of imprecise data is fuzzy in nature. Thus evaluation of many objects here is not always possible with numerical valued descriptions. Because, some part of evaluation is often associated with unavoidable hesitation. Some part of the evaluation contribute to truthness, some part to falseness and the rest part remain indeterministic. Some data so obtained are not point valued rather may contribute to truthness in the form of interval of numbers. Consequently it is ideal to adopt a proper mathematical tool to do a proper judgment or evaluation. Certainly fuzzy mathematical tools are a suitable one for this purpose. Because of this obvious reason we will adopt the fuzzy logic & intuitionistic fuzzy logic as most important tools in the present work of EIA.

B. Preliminaries

In this section we present some preliminaries which will be useful to our work in the next section

i Crisp Set

A set can be described either by list method or by the rule method. We know that the process by which individuals from the universal set X are determined to be either members or nonmembers of a set can be defined by a characteristic function or discrimination function. For a given set A, this function assign a value $\mu_A(x)$ to every $x \in X$ such that

$$\mu_A(x) = 1 \quad \text{iff} \quad x \in A$$
$$= 0 \quad \text{iff} \quad x \notin A$$

Thus in the classic theory of sets, very precise bounds separate the elements that belong to a certain set form the elements outside the set. In other words, it is quite easy to determine whether an element belongs to a set or not.

ii Fuzzy Set

Many sets encountered in reality do not have precisely defined bounds as in case of crisp sets that separate the elements in the set from those outside the set. That so the crisp characteristic function can now be generalized such that the values assigned to the elements of the universal set fall within a specified range and indicate the membership grade of these elements in the set in question. Such a function is called membership function and the set defined by it a fuzzy set. The membership function for fuzzy sets can take any value form the closed interval [0,1]. Fuzzy set **A** is defined as the set of ordered pairs $\mathbf{A} = \{ x, \mu_A(x) \}$, where $\mu_A(x)$ is the grade of Membership of element x in set **A**. The greater $\mu_A(x)$, the greater the truth of the statement that element x belongs to set **A**.

Let $X = \{x_1, x_2 \ldots\ldots, x_n\}$ be a finite discrete universe of elements x_i, $i = 1, 2, .., n$. A fuzzy set A defined over a set X is most often shown in the form $A = \{ (x_1, \mu_A(x_1)), (x_2, \mu_A(x_2)), \ldots, (x_n, \mu_A(x_n)) \}$.

iii Instuitionistic Fuzzy Set

An intuitionistic fuzzy set (IFS) A in E is defined as an object of the following form.

$$A = \{ (x, \mu_A(x), \nu_A(x)) \mid x \in E \}$$

Where the functions:

$$\mu_A : E \to [0,1]$$
$$\nu_A : E \to [0,1]$$

define the degree of membership and the degree of non-membership of the element $x \in E$, respectively, and for every $x \in E$ we have the relation $0 \leq \mu_A(x) + \nu_A(x) \leq 1$.

Let us call this condition $0 \leq \mu_A(x) + \nu_A(x) \leq 1$ by "Atanassov condition".

Obviously, each ordinary fuzzy set may be written as
$\{ (x, \mu_A(x), 1-\mu_A(x)) \mid x \in E \}$
and thus every fuzzy set is an intuitionistic fuzzy set but not conversely.

The amount $\pi_A(x) = 1 - (\mu_A(x) + \nu_A(x))$ is also called the hesitation part (i.e. the degree of non-determinacy or uncertainty) of the element , and this amount may cater to either membership value or to non-membership value or to both . Clearly, in case of ordinary fuzzy sets (Zadeh's fuzzy sets) it is presumed that

$\pi_A(x) = 0$ for every $x \in E$.

iv Concept of Fuzzy Numbers

Subjective estimation that deals with the imprecise object like

(i) waiting time of a car or vehicle at a traffic signal, or
(ii) Manufacturing cost of a flight etc.
can be expressed by a fuzzy sets. Based on experiences or institution , an expert or decision maker is able to state that waiting time of vehicle at a traffic signal is "around 20seconds","not more than 20 seconds " etc. such type of subjective estimations are characterized by certainly values. Intuitively it is clear that a flight cost that is "approximately $5,000" is certainly less than a flight cost of approximately $6,000". In another terminology, the fuzzy numbers is fuzzy set that is convex and normalized. The figure shows the graph of fuzzy number "approximately 20":-

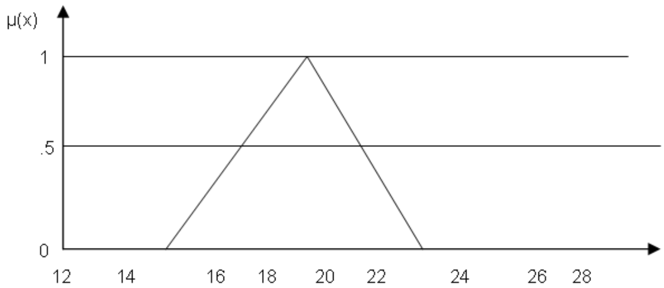

Figure 1: The fuzzy number "approximately 20 or approx.20

II. METHODS AND MATERIAL

In this section we present our proposal for common approach of fuzzy & intuitionistic fuzzy in EIA. First of all we present some definitions.

Definition 4.1 Attributes of the Assessment
The assessment is done by collecting information or values for certain attributes which are called the attributes of the assessment.

For example, consider a project of "EIA ON NEIGHBOURS NEAR TO THE SOLID WASTE DISPOSAL SITE", for which some relevant attributes could be "unusual number of mosquito breeding", "unusual number of fly breeding", "bad drainage system around the disposal site", "birds problems", "rodents problems" etc.

Definition 4.2 Universe of the Assessment
Collection of all attributes of the assessment is called the Universe of the Assessment.

Definition 4.3 Weighted Average of a Fuzzy Set
Let A be a fuzzy set of a finite set X. Suppose that to each element $x \in X$, there is an associated weight $W_x \in R+$ (set of all non-negative real numbers). Then the 'weighted average' of the fuzzy set A is the non-negative number a(A) given by

$$a(C) = \frac{\sum m(x_i) \cdot W_x i}{\sum W_x i}$$

where $m(x_i) = (l_i+u_i)/2 = m_i$ (say).

Definition 4.4 Mean Fuzzy Set of an IFS
Let E be an universe and X be an IFS of E. The mean fuzzy set of the IFS X is a fuzzy set m of E given by the membership function

$$m(x) = \frac{\mu_A(x) + 1 - \nu(x)}{2}$$

Definition 4.5 Weighted Average of an IFS
Let B be an IFS of a finite set X. Suppose that to each element $x \in X$, there is an associated weight $W_x \in R+$ (set of all non-negative real numbers). Then the

weighted average of the IFS-B is the non-negative number a(B) given by

$$a(B) = \frac{\sum m(x) \, . \, W_x}{\sum W_x}$$

Definition 4.5 Weighted Average of Interval valued Fuzzy Set

Let $I_i = [l_i, u_i]$ be the interval valued assessment for the object $x_i \in X$ (if it happens not to be a point valued). With no loss of generality, for every object's assessment we choose I_i as a subset of [0,1]. A point valued number , say .4 could be regarded as the interval [.4,.4] for the sake of presentation of our theory. Suppose that to each element $x_i \in X$, there is an associated weight $W_x i \in R+$ (set of all non-negative real numbers). Then the 'weighted average' of the objects of C is the non-negative number a(C) given by

$$a(C) = \frac{\sum m(x_i) \, . \, W_x i}{\sum W_x i}$$

where $m(x_i) = (l_i+u_i)/2 = m_i$ (say).

In particular situation, if for an object the value I_i is not an interval but a number n_i just, then we take $m_i = n_i$.

Definition 4.6 Mean Weighted Average Of Universe

Let a(A) be the weighted average of set-A, a(B) be the be the weighted average of set-B, and a(C) be the weighted average of set-C, then mean weighted average of universe will be

$$a(X) = [\, a(A) + a(B) + a(C)\,] / 3$$

Definition 4.7 Grading of Assessment Output

Depending upon the mean value of a(X), the grading of overall output could be temporarily proposed as below:

grade = A, if $.8 < a(A) \le 1$

grade = B, if $.6 < a(A) \le .8$

grade = C, if $.4 < a(A) \le .6$

grade = D, if $.2 < a(A) \le .4$

grade = E, if $0 \le a(A) \le .2$

In the next part we present the methodology by a hypothetical case study.

Algorithm

1. make the Universal set $X = \{ x_1, x_2, x_3, \ldots\ldots\ldots, x_n \}$
2. compute the sub set A , B, and C of set X such that
   $A = \{ x_{f1}, x_{f2}, x_{f3}, \ldots\ldots, x_{fn} \}$, $B = \{ x_{if1}, x_{if2}, x_{if3}, \ldots\ldots, x_{ifn} \}$
   and, $C = \{ x_{iv1}, x_{iv2}, x_{iv3}, \ldots\ldots, x_{ivn} \}$
   where , x_{fr} = all fuzzy data for r = 1 , 2 , 3 , ……….., n
   x_{ifr} = all instuitionistic fuzzy data for r = 1 , 2 , 3 , ……….., n
   x_{ivr} = all inter valued fuzzy data for r = 1 , 2 , 3 , ……….., n
3. Calculate the weighted average individually, a(A), a(B), and a(C) for the objects of sub set-A, sub set-B and sub set-C
4. Compute the mean weighted average for all objects of the universe by $a(X) = [\, a(A) + a(B) + a(C)\,]/ 3$
5. Select the suitable grade of the assessment of the project.
6. Recommendation of the project
7. Stop.
8.

III. RESULTS AND DISCUSSION

Case Study

Consider a project of "ASSESSMENT OF SANITARY CONDITION NEARBY AREA OF SOLID WASTE DISPOSAL SITE". To do the assessment let us consider the following attributes (for the sake of simplicity in presenting the method we consider here twenty eight attributes with no loss of generality) :-

x_1 = no. of vehicles disposing the wastes daily in landfill

x_2 = no. of other vehicles plying daily nearby the disposal site

x_3 = no. of scavengers working in the disposal site

x_4 = unusual number of mosquito breeding in disposal site

x_5 = unusual number of fly breeding in disposal site
x_6 = poor drainage system around the disposal site
x_7 = acute birds problems in disposal site
x_8 = acute rodents problems in disposal site
x_9 = unhygienic latrine in and around the disposal site
x_{10} = inadequate water facilities in disposal site
x_{11} = heavy rainfall intensity in disposal site area
x_{12} = poor management for disposal of waste timely
x_{13} = bad habit of neighbors in roaming around the disposal site
x_{14} = poor awareness of sanitation among the neighbors
x_{15} = poor awareness of sanitation among the scavengers
x_{16} = easy accessibility of dogs, pigs, cows, etc. in the disposal site
x_{17} = very crude dumping system of solid waste
x_{18} = heavy production of vegetables & fishes around the disposal area
x_{19} = poor barricade in between dumping area and neighbor
x_{20} = bad habit to use the recyclable materials by the neighbors
x_{21} = high mixing habit of scavengers and neighbors
x_{22} = bad approach road around the disposal site
x_{23} = huge quantity of solid waste dumping daily
x_{24} = nos. of scavengers found daily in the neighbor's area
x_{25} = huge amount of leachate found in outer open surface of landfill
x_{26} = poor mechanical condition of carrying vehicles
x_{27} = huge quantity of organic waste are dumping daily
x_{28} = nos. of local people taking food from shop nearby disposal site

Now the job is to assign values of these attributes. This can be done either by direct observation or by collecting views from a good number of nearby inhabitants in addition to the scavengers found in the disposal site.

Let us suppose that the data collected from the above sources are categories in three sub sets A , B and C of the universal set X.

Where,
A = { x_4, x_5, x_6, x_7, x_8, x_9, x_{16}, x_{18}, x_{19}, x_{21}, x_{22}, x_{27} }, based on all fuzzy data ,

B = { x_{10}, x_{11}, x_{12}, x_{13}, x_{14}, x_{15}, x_{17}, x_{20}, x_{26} }, based on all instuitionistic fuzzy data ,
and
C = { x_1, x_2, x_3, x_{23}, x_{24}, x_{25}, x_{28} }, based on all interval valued fuzzy data.

<u>for subset-A</u>

Let us suppose that the data collected from 100 people for an attribute x_i reveals that more or less 70 people are in support of the truthness of the attribute and the rest 30 are in support of falseness. We set for our fuzzy analysis that $\mu_A(x_i) = .7$.

Suppose that the data (hypothetical) collected are as shown below in a tabular form:

Attribute name	in support of truthness μ(x)	in support of falseness = (1-μ(x))	weight of the attribute W_x
x_4	.75	.25	35
x_5	.85	.15	35
x_6	.5	.5	40
x_7	.6	.4	60
x_8	.85	.15	65
x_9	.8	.2	50
x_{16}	.9	.1	65
x_{18}	.45	.55	25
x_{19}	.9	.1	15
x_{21}	.75	.25	40
x_{22}	.8	.2	10
x_{27}	.85	.15	15

These data leads to the fuzzy set A of the universe E, where

E = { x_1, x_2, x_3, x_4, x_5, …………, x_{28} },

And the fuzzy set A is given by

$$A = \frac{x_4}{.75}, \frac{x_5}{.85}, \frac{x_6}{.5}, \frac{x_7}{.6}, \frac{x_8}{.85}, \frac{x_9}{.8}, \frac{x_{16}}{.9}, \frac{x_{18}}{.45}, \frac{x_{19}}{.9}, \frac{x_{21}}{.75}, \frac{x_{22}}{.8}, \frac{x_{27}}{.85}$$

We now calculate the weighted average a(A) of this fuzzy set which is **.750 .**

for subset-B

Let us suppose that the data collected from 100 people for an attribute x_i reveals that more or less 70 people are in support of the truthness of the attribute, 20 are in support of falseness and the rest 10 people are without any comment due to hesitation. We set the following for our intuitionistic fuzzy analysis :-

$\mu_A(x_i) = .7 \quad \nu(x_i) = .2$

Suppose that the data (hypothetical) collected are as shown below in a tabular form:

Attribute name	**in support of truthness μ(x)**	**in support of falseness ν(x)**	**indeterministic part**	**weight of the attribute W_x**
x_{10}	.6	.1	.3	25
x_{11}	.8	.1	.1	5
x_{12}	.5	.5	0	45
x_{13}	.4	.2	.4	50
x_{14}	.8	.1	.1	70
x_{15}	.7	.1	.2	20
x_{17}	.8	0	.2	80
x_{20}	.3	.4	.3	65
x_{26}	.9	.1	0	35

These data leads to an IFS X of the universe E where

$E = \{ x_1, x_2, x_3, x_4, x_5, \ldots\ldots\ldots\ldots, x_{28} \}$,

Now calculate the mean fuzzy set m of the IFS X. We find that

$$m = \frac{x_{10}}{.75}, \frac{x_{11}}{.85}, \frac{x_{12}}{.5}, \frac{x_{13}}{.6}, \frac{x_{14}}{.85}, \frac{x_{15}}{.8}, \frac{x_{17}}{.9}, \frac{x_{20}}{.45}, \frac{x_{26}}{.9}$$

We now calculate the weighted average of this IFS which is **.718**,

for subset-C

Let us suppose that all interval valued data (hypothetical) are as below in a tabular form:

Attribute name	**Interval valued assessment I_i**	**The value m_i**	**weight $w_x i$**
x_1	[.7,.8]	.75	20
x_2	[.82,.88]	.85	5
x_3	[.6,.7]	.65	15
x_{23}	.6	.6	5
x_{24}	[.8,.9]	.85	10
x_{25}	.8	.8	5
x_{28}	.9	.9	30

We now calculate the weighted average a(C) of this interval valued fuzzy set which is .769

Therefore the mean weighted average

$$A(X) = [\,.750+.718+.769\,] / 3 = .745$$

And consequently the grade to be awarded is "B". Thus the assessment reveals that the health condition of neighbours to the solid waste disposal site is not in a good book.

IV. CONCLUSION

EIA has a vast potential role to play at early stages of a project. The study present that for any type of 'Fuzzy EIA' analysis, fuzzy set & intuitionistic fuzzy set tools can be suitably applied because of the fact that both have the tremendous power to tackle the uncertainty. Such analysis is appealing as great tool to an engineer because they provide assistance in trying to grasp the overall effect of the project in the sense of assessing the collective impart of the "good" and the "bad" of the project.

However, the overall assessment or summarization of the environmental impact should only serve as one of the parameters just or criteria to the decision makers. There could be other parameters hidden or not hidden such as local politics, local constraints, etc which will influence the decision makers of the project.

V. REFERENCES

[1] Atanassov, K.T., Intuitionistic fuzzy sets, Fuzzy Sets and Systems 20 (1986) 87-97.

[2] Biswas, K. Dev. R. and Pattanaik, P.K., Soft sets: An ordinal formulation of vagueness with some applications to the theory of choice. Fuzzy Sets and Systems. 45 (1992) 45-58.

[3] Biswas, Srijit ., Environmental Impact Assessment : An Intuitionistic Fuzzy Approach, Published in the "Proceeding of the Second International Conference on IFS". Sofia, 3-4 Oct. 1998, P 23-27.

[4] Biswas, Srijit; Roy, Pankaj Kr; Datta, Sekhar, "Impact of Deforestation on IWRM : Assessment by Fuzzy EIA" published in ' International Journal of Fuzzy Systems & Rough Systems' Vol.2(1) - 2009, pp .21-24,

[5] Carter, Larry W., Environmental Impact Assessment, M. Graw Bill, New York, 1977.

[6] Carter, Steve and Murray, Environmental Management and Law of Government, Office of Research and Development, US Environmental Protection Agency Report Feb, 1974.

[7] Carter, Ful and Haefner, Incorporating environmental impacts on the transportation system evaluation process, Highway Research Record 46 (1973).

[8] Dubois, D. and Prade, H, Twofold fuzzy sets and rough sets: some issues in knowledge representation, Fuzzy Sets and systems 23 (1987)3-18.

[9] Helboom and David, A. methodology For Preparing Environmental Statements, Arthur D. Little Inc. Cambridge (Aug. 1973).

[10] Zadeh. I.A. Fuzzy sets, Infor: and Control 8 (1965) 338-353