Eco. Env. & Cons. 26 (4) : 2020; pp. (1847-1851)

ISSN 0971–765X

Threats of plastic pollution and awareness among common people: A multi attribute problem

Supratim Mukherjee

Department of Mathematics, Government General Degree College, Tehatta, India

(Received 24 February, 2020; Accepted 2 May, 2020)

ABSTRACT

Pollution is a global issue. It does not consider the international borders or any other human restricted conditions while spreading. Specially Plastic Pollution has been a recent topic of deep concern due to its immense capacity of causing Environmental threats. This work searches for the logical consistency between the threat and the awareness of the threat among common people. Uncertainty based logical tools have been used to determine the nature of the Multi Attribute Problem.

Key words: *Plastic pollution, Fuzzy logic, MADM, Grey sets, Fuzzy sets, TFN.*

Introduction

Fuzzy logic accommodates semantics for multivariate logic. Normally crisp sets are Cantorian collections consisting of core elements, but Fuzzy sets are like Russellian classes, based on membership grades criteria. Because Fuzzy sets are locally subjective, while assigning membership degrees, at least one membership degree has to be made subjective and also it relies on expert's choice, i.e., in broad sense it is context dependent. Fuzzy logic is a concept derived from the branch of mathematical theory of Fuzzy Sets. Unlike the basic Aristotelian theory that recognizes statements as only "true" or "false" (i.e., 1 or 0) as represented in digital computers, Fuzzy logic is capable of expressing Linguistic terms such as "may be false" or "sort of true". Fuzzy Logic allows one to emulate the human reasoning process, quantify the imprecise information, provide decision based on vague and incomplete data and arrive at a definite conclusion. The logic underlying Fuzzy set theory is multivalent. In general, a multivalent logic can be regarded as a calculus of either on the level of credibility of propositions or on the truth values of the Fuzzy predicates. In most of the multivalent logics there is no longer an excluded middle law; this environment can be rendered as either the absence of decisive belief in one of the sides of an alternative or the imbrications of contrastive Fuzzy concepts.

The threats of plastic pollution are now a global issue. Almost in every Country, regular awareness programs are being arranged and executed to resist the threat. In this work, the aim is to evaluate country wise threats of Plastic Pollution by Fuzzy Multi Attribute Decision Making. In section 2, preliminaries on Fuzzy Sets and Fuzzy Logic are discussed. Section 3 briefly describes the model of Fuzzy Multi Attribute Decision Making Problem. In Section 4, some analytical results are revealed. Section 5 concludes the findings.

Fuzzy Logic and Fuzzy Sets

A Fuzzy set is normally expressed as a collection of elements with a continuum of grades of membership. It is characterized by a membership function,

(Assistant Professor)

which assigns to each object a grade of membership in the real interval *[0, 1].* Let X be the universe of discourse for a certain problem, covering a definite range of objects. And $\tilde{A}$ is a subset where transition between membership and non-membership is antiphon rather than precipitous. The grades of membership reflect an "ordering" of the objects in X, caused by the predicates associated with. This ordering, if exists, is more important than the membership values themselves.

'The notion of a Fuzzy set provides a convenient point of departure for the construction of a conceptual framework used in ordinary sets, and, may prove to have a much wider scope of applicability, particularly in the fields of pattern classification, information processing, statistical process control etc'. Fundamentally, such a framework provides a natural way of dealing with problems in which the source of imprecision is the absence of sharply defined criteria of class membership. For most control-oriented problems, it is assumed that the membership functions are linear- usually triangular in shape. But for other problems, these triangular membership functions are not appropriate, as they do not represent accurately the linguistic terms being modelled and so will have to elicited directly from the expert, by a 'statistical' approach or by automatic generation of the shapes.

In 1965, Prof. Lotfi A Zadeh (UC Berkley) introduced his revolutionary paper on Fuzzy Sets. The idea of the graded membership turned there. Like most of the other mathematical theories, initially it received sharp criticism from academic communities and different intellectuals. Someone knocked it as the Probability theory in disguise; someone criticized as the waste of Govt. funds.

From 1965 to 1975, Zadeh continued to broaden the foundation of Fuzzy Set theory. Several definitions and problem formulation like Fuzzy multi stage decision making, Fuzzy similarity relations, Fuzzy restrictions, linguistic hedges etc were introduced in this period. Very few articles or research methodologies on Fuzzy Logic and Fuzzy Mathematics is available within this pre-transmutation period. 1970 is also a significant year in this respect as the first research group on Fuzzy Mathematics was formed in Japan. The rest of the world observed it keenly and at least the term "Fuzzy" got a platform to hang on. In 1974, Mamdani (United Kingdom) developed the first ever Fuzzy controller. Most expectedly it had drawn the attention of the whole world with some respect. In 1977, Dubois applied Fuzzy Sets in a comprehensive study of traffic conditions and the second significant practical implementation of the theory was spot on. The barrier was no more. From 1976 to 1987, the industrial applications of Fuzzy Logic were spreaded over mainly Europe and Japan. After that almost every system controller was tried to be upgraded by Fuzzy Logic. From 1987 to the present time, the entire era is often known as the "Fuzzy Boom". The number of research articles are rapidly increasing as well as new fields are upcoming as the application.

As a matter of fact, fuzziness seems to riddle most human perception and thinking processes. No non-trivial first order logic-like experimental predicate can be established on a data based predicates on such a space are not classical predicates but vague one.

Fuzziness can be found in many areas of real life, such as, in engineering, in medical field, in meteorology, in manufacturing and others. It is particularly frequent, however, in all areas in which human judgment, evaluation and decisions are important. These are the areas of decision making, reasoning, and learning and so on. Actually fuzziness differs from imprecision. In tolerance analysis, imprecision refers to lack of knowledge about the value of a parameter and is thus expressed as a crisp tolerance interval. This interval is the set of possible values of the parameters. Fuzziness occurs when the interval has no sharp boundaries, i.e., is a Fuzzy set. Then the membership value of any element x in is interpreted as the degree of possibility (Zadeh, 1978) that x is the value of the parameter fuzzily restricted by. Fuzziness has not been so far defined uniquely semantically, and probably never will. It means different things, depending on the application area and the way it is measured. The most important thing to note is that there is nothing "Fuzzy" in Fuzzy set theory. It provides a strict mathematical framework in which vague conceptual phenomena can be exactly and strictly analyzed. It can also be considered as a modeling language well accommodated for situations in which Fuzzy relations, criteria and phenomena exist.

Multi Attribute Decision Making- Fuzzy Approach

Now-a-days in most of the decision making problems, many decision indexes are qualitatively defined, i.e., the available information about them is uncertain. Thus the decisions in real life often need to be executed in Fuzzy environment. At that time its attribute values are random variables varying with the natural state. So, it is impossible for the decision makers to view the actual state, accurately. While trying to make a decision, the inherent uncertainty builds the consumption of precise numbers, baffling in multi attribute model. A number of quantitative techniques have been used for MADM problem by Liu and Liu (2010) and many others. Some of them are weighing methods, Analytical Hierarchy Process (AHP), data envelopment analysis (DEA), TOPSIS (Technique for Ordered Preference by Similarity to Ideal Solution), ANP (Analytical Network Process) methods, etc. Research reveals that the application of AHP raises the decision making process and reduces the time taken to select the optimum alternative. TOPSIS assumes that each attribute has a tendency toward monotonically increasing or decreasing utility. So it is obvious that there exists one positive ideal and one negative ideal solution.

TOPSIS (Technique for order preference by similarity to ideal solution) is based on a very simple principle. Here, under the framework of MADM model, the evaluator has to build an ideal solution which stands best among the given alternatives with respect to all the attributes. Now the chosen alternative should be as close to the ideal solution as possible. The ideal solution is formed as a composite of the best performance values exhibited by any

Table 1. Country wise details of the plastic waste inputs (Jambeck J. R. *et al.* (2015)

Country	Waste generation rate (kg per person per day)	Plastic waste (MMT per year) MMT stands for millions of metric tons	Marine Debris (MMT per year) MMT stands for millions of metric tons
China	1.10	8.82	1.32-3.53
Indonesia	0.52	3.22	0.48-1.29
Philippines	0.5	1.88	0.28-0.75
Vietnam	0.79	1.83	0.28-0.73
Sri Lanka	5.1	1.59	0.24-0.64
Thailand	1.2	1.03	0.15-0.41
Egypt	1.37	0.97	0.15-0.39
Malaysia	1.52	0.94	0.14-0.37
Nigeria	0.79	0.85	0.13-0.34
Bangladesh	0.43	0.79	0.12-0.31
South Africa	2.0	0.63	0.09-0.25
India	0.34	0.60	0.09-0.24
Algeria	1.2	0.52	0.08-0.21
Turkey	1.77	0.49	0.07-0.19
Pakistan	0.79	0.48	0.07-0.19
Brazil	1.03	0.47	0.07-0.19
Burma	0.44	0.46	0.07-0.18
Morocco	1.46	0.31	0.05-0.12
North Korea	0.6	0.30	0.05-0.12
United States	2.58	0.28	0.05-0.11

Table 2. Expression of linguistic terms in TFN

Linguistic Term for Attribute Ratings	TFN	Linguistic Term for Attribute Weights	TFN
Very Poor	(1, 2, 3)	Very Low	(0.1, 0.2, 0.3)
Poor	(2, 3, 4)	Low	(0.2, 0.3, 0.4)
Fair	(4, 5, 6)	Medium	(0.4, 0.5, 0.6)
Medium Good	(6, 7, 8)	Medium High	(0.6, 0.7, 0.8)
Good	(8, 9, 10)	High	(0.8, 0.9, 1.0)
Very Good	(9, 10, 10)	Very High	(0.9, 1.0, 1.0)

Table 3. Fuzzy Decision Matrix

Country	Waste Generation Rate (H)	Marine Debris (MH)	Plastic Waste (VH)	Awareness Level (H)
China	P	VP	VP	G
Indonesia	F	MG	P	P
Philippines	F	G	F	P
Vietnam	P	G	F	F
Sri Lanka	VP	G	F	P
India	G	G	VG	F

alternative for each attribute. The comparison can be executed by some distance functions or by preference or possibility degree measures.

In revised TOPSIS (Mukherjee and Kar (2013) an extra fictitious alternative is formed, called the negative ideal solution. It is formed by collecting the worst performance degrees of all the alternatives with respect to all the attributes. The chosen alternative, additionally now, should be as far from this negative ideal solution as possible.

Actually, TOPSIS assumes that each attribute has a tendency towards monotonically increasing or decreasing utility. The general working algorithm of this method is follows.

1. Obtain performance data for n alternatives over k criteria. Raw measurements are usually standardized; converting raw measures x_{ij} into standardized measures s_{ij}.
2. Develop a set of importance weights w_k, for each of the criteria. The basis for these weights can be anything, but, usually, is *ad hoc* respective of relative importance. Scale is not an issue if standardizing was accomplished in Step 1.
3. Identify the ideal alternative (extreme performance on each criterion) $s+$:
4. Identify the nadir alternative (reverse extreme performance on each criterion) $s_{\bar{j}}$:
5. Develop a distance measure over each criterion to both ideal ($D+$) and nadir ($D_{\bar{j}}$).
6. For each alternative, determine a ratio R equal to the distance to the nadir divided by the sum of the distance to the nadir and the distance to the ideal,

$$R = \frac{D^-}{D^- + D^+}$$

7. Rank order alternatives by maximizing the ratio in Step 6.

The decisions on the attribute rating and alternative rating are considered as Fuzzy numbers in Fuzzy TOPSIS. The technique for separation measure of each alternative from the PIS and NIS is proposed in literature in different ways.

Methodology and Results

Some country wise details of the plastic waste inputs from land into the ocean is displayed in Table 1.

Now two types of Linguistic Scales along with Triangular Fuzzy Numbers are taken into consider. Those are displayed in Table 2.

Based on the statistics as shown in Table 1 and the available resources regarding various awareness programs offered by these countries, a linguistic table of decision input is constructed in Table 3.

Applying Fuzzy TOPSIS it has been found that, the ranking of the countries, in terms of threats to the Environment is China >> Sri Lanka > Indonesia > Philippines > Vietnam > India.

Conclusion

The threats of Plastic Pollution have been investigated by means of Uncertainty based approach, Fuzzy approach. The concept is new and more application in this area will surely enrich the domain. Other approaches, like, Grey Systems, Soft Sets, Rough Sets can be applied considering the same problem.

References

Boer, L., Labro, E. and Morlacchi, P. 2001. A review of methods supporting supplier selection. *European Journal of Purchasing and Supply Management*. 7: 75-89.

Byung-Soo, L. and Mee-Kwang, K. 1997. Journal of the Korea Society of Mathematical Education Series D: *Research in Mathematical Education*. 1(1) : 75-85.

Guo-Dong, Y. Dasiuke, N. Masatake 20077. A Grey-based decision-making approach to the supplier selection problem. *Mathematical and Computer Modelling.* 46: 573-581.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, R.T., Perryman, M., Andrady, A., Narayan, R. and Law, L.K. 2015. Plastic waste inputs from land into the ocean. *Science*. 347(768): 768-771.

Karr, L. and Gentry, E. J. 1993. Fuzzy control of pH using genetic algorithms. *IEEE Trans. Fuzzy Systems.* 1 (1): 46–53.

Kim, J. and Russell, B. D. 1993. Automatic generation of membership function and Fuzzy rule using inductive reasoning. In *Proceedings of the Industrial Fuzzy Control and Intelligent Systems.* pp. 93–96.

Kim, J. K., Cho, C. H. and Kwang, H.L. 1998. A note on the set theoretical defuzzification. *Fuzzy Sets and Systems.* 98 : 337-341.

Mukherjee, S. and Kar, S. 2013. A three phase supplier selection method based on fuzzy preference degree. *Journal of King Saud University-computer and Information sciences*. 25 : 173-185.

Oliveria, J.V. 1995. A set-theoretical defuzzification method. *Fuzzy Sets and Systems.* 76 : 63-71.

Vero, J. and Werquin, P. 1998. Un reexamen de la mesure de la pauvrete. Comment s'en sortent les jeunes en phase d'insertion professionnelle. *Economie et Statistique.* 308-309-310 : 143-148.

Zadeh, L. A. 1965. Fuzzy Sets. *Information and Control.* 8 : 338-353.

Zadeh, L. A. 1978. Fuzzy sets as a basis for a theory of possibility. *Fuzzy Sets and Systems.* 1 : 3–28.

Zadeh, L.A. 1975. The concept of a linguistic variable and its application to approximate reasoning-I. *Information Sciences.* 8 : 199-249.

Zadeh, L.A. 1971. Similarity relations and Fuzzy orderings. *Information Sciences.* 3 : 177-200.