DETERMINATION OF FEASIBLE SOLUTIONS TO ENVIRONMENTAL PROBLEMS BY USING FUZZY SOFT SETS THEORY

[1]Krishna Gogoi, [2]Alock Kumar Dutta, [3]Chandra Chutia

1 Department of Mathematics, Devicharan Barua Girls' College, Jorhat, Assam, India. Email: Krishnagogoi6@gmail.com

2 Department of Mathematics, Bahona College, Bahona, Jorhat. Assam, India. Email: alockkumardtt@gmail.com

3 Department of Mathematics, Jorhat Institute of Science and Technology, Jorhat, Assam, India.
Email: Chutiachandra12@rediffmail.com

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Abstract

Modern human civilization has been plagued with a host of ecological challenges. The rapid pace of global warming, rising sea level leading to loss of habitats and unprecedented flood causing havoc in both rural and city lives and other problems have still found no permanent solutions. In fact, the best ever scientific and technological interventions have failed miserably to mitigate these issues. Traditional and innovative ideas have been proved inadequate to address the issue of flood that has a global presence in varied form or severity. Hence there are many scopes for research and development of mathematical models or interventions to offer solution to this issue of global and local concern. So it is a most appealing branch of study to develop feasible solutions to these problems. In this paper we have considered one of the most burning problems, the flood problem and try to develop the best feasible solution this problem by using Fuzzy Soft Set theory which was introduced by Molodtsov in the year 1999. We have developed a sequence of key factors responsible for the flood problem as follows.

{Population explosion, Deforestation, Global Warming, Big dam, Embankment, Blockage, Heavy rainfall}

From this sequence we found that population explosion is the main cause for flood problem. Therefore, it is high time to control the population through a worldwide common policy. Subject Classification: 21 (1940-1958)

Key words: Fuzzy Topology, Fuzzy Softset, Decision Matrix

Introduction:

Among all the natural calamities, flood is an old and disastrous one that requires urgent and effective solution. In spite of rapid development in the technological field, the threat posed by flood remains unresolved. Loss of lives and damages to livelihood caused by flood annually to a country like India is huge. It is more so in a state like Assam that has been recently ravaged by furious flood this monsoon season. Apart from severing all road and rail connectivity in the Hills district and in Barak Valley, many lives got lost in this flood. So, adverse affect caused by flood needs serious research for effective solution. Innovative and well thought out Mathematical models can be developed to arrest this natural calamity. So, here in this paper, efforts have been put to find and develop such a model.

If we explore the causes behind occurrence of flood, we find there are natural and human induced factors. Natural factors like failure of water bodies to contain excess water in regions of the world with heavy rainfall and rising sea level due to global warming and excess siltation leading to the rising river beds etc significant. Behind all these, it can be argued that, there are human agencies which directly and indirectly impact flood problem of the world. Booming population in countries like China and India is a significant agency that leads to rising flood problem globally. Deforestation, Urbanisation, industrialisation and all other aspects of modern human civilization have contributed towards each ecological problem and flood is definitely an offshoot of population explosion. It can be studied systematically and mathematically and solution to curb flood can be offered through effective and feasible models of mathematics.

It is seen that many of the real-life problems in engineering, medical sciences, environmental and social sciences, management etc often involve data which are not precise and deterministic in character. It is only because such problems are essentially humanistic and more subjective in nature and so, they need to be handled in different ways. Recently many theories have been developed for handling such problems with imprecise data such as probability theory, fuzzy sets, rough sets etc. Molodtsov [1] has shown that each of the above topics suffers from some inherent limitations that they lack the parameterization tool and introduced a "Soft set theory" having parameterization tools for dealing with various uncertainties. Subsequently Maji et al. [2, 3] extended soft set theory of Molodtsov and introduced fuzzy soft sets.

Following above mentioned tools and concepts, in this paper we consider the flood problem in Assam (INDIA) which is one of the most burning problems of this region and find a partial solution to this problem by using the theory of Fuzzy soft sets. For this purpose, we classified the society into six groups such as **Effected people**, **Scientist**, **Planner, Layman, Politician**, and **Naturalist** to take their opinion on the relevant possible causes of flood namely **Deforestation, Big dam, Embankment, Population explosion, Blockage and Global Warming and Heavy rainfall.**

Before going to the solution to problem let us give a brief description of the Methodology.

Methodology:

To find the best feasible solution of the Flood problem we use the following method.

Step -I:

First, we distribute the questionnaires to the classified groups of the society of different districts selected on the basis of badly affected areas, through surveying agencies to collect their opinion by correlating the problem with the choice parameter **Deforestation, Big dam, Embankment, Population explosion, Blockage, Global Warming and Heavy Rainfall.**

Suppose there are m choice parameters $P = \{p_1, p_2, p_3, \ldots\ldots\ldots, p_m\}$ for the people and l different classified group of the society $S = \{s_1, s_2, s_3, \ldots\ldots\ldots, s_l\}$ the choice evaluation is expressed as a Fuzzy set (F, S) over P where $F : S \to l^p$ for each district .

Thus,

$$R_1 = \begin{bmatrix} a_{11}^{(1)} & a_{12}^{(1)} & a_{13}^{(1)} & \ldots\ldots\ldots\ldots & a_{1l}^{(1)} \\ a_{21}^{(1)} & a_{22}^{(1)} & a_{23}^{(1)} & \ldots\ldots\ldots\ldots & a_{2l}^{(1)} \\ a_{31}^{(1)} & a_{32}^{(1)} & a_{33}^{(1)} & \ldots\ldots\ldots\ldots & a_{3l}^{(1)} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots\ldots\ldots & \ldots\ldots \\ a_{m1}^{(1)} & a_{m2}^{(1)} & a_{m3}^{(1)} & \ldots\ldots\ldots\ldots & a_{ml}^{(1)} \end{bmatrix}$$

for district d_1.

Similarly,

$$R_2 = \begin{bmatrix} a_{11}^{(2)} & a_{12}^{(2)} & a_{13}^{(2)} & \ldots\ldots\ldots\ldots & a_{1l}^{(2)} \\ a_{21}^{(2)} & a_{22}^{(2)} & a_{23}^{(2)} & \ldots\ldots\ldots\ldots & a_{2l}^{(2)} \\ a_{31}^{(2)} & a_{32}^{(2)} & a_{33}^{(2)} & \ldots\ldots\ldots\ldots & a_{3l}^{(2)} \\ \ldots\ldots & \ldots\ldots & \ldots\ldots & \ldots\ldots\ldots\ldots & \ldots\ldots \\ a_{m1}^{(2)} & a_{m2}^{(2)} & a_{m3}^{(2)} & \ldots\ldots\ldots\ldots & a_{ml}^{(2)} \end{bmatrix}$$

for district d_2, and so on.

Step-II:

Then taking average of all the above fuzzy sets we get the choice evaluation matrix as,

$$R=\begin{bmatrix} \bar{a}_{11} & \bar{a}_{12} & \bar{a}_{13} & \ldots\ldots\ldots & \bar{a}_{1l} \\ \bar{a}_{21} & \bar{a}_{22} & \bar{a}_{23} & \ldots\ldots\ldots & \bar{a}_{2l} \\ \bar{a}_{31} & \bar{a}_{32} & \bar{a}_{33} & \ldots\ldots\ldots & \bar{a}_{3l} \\ \ldots & \ldots & \ldots & \ldots\ldots\ldots & \ldots \\ \bar{a}_{m1} & \bar{a}_{m2} & \bar{a}_{m3} & & \bar{a}_{ml} \end{bmatrix}$$

where, $\bar{a}_{ij} = \frac{1}{n}\sum_{i=0}^{n} a_{ij}^{(k)}$

To give opinion on such a serious matter the individual must have a clear-cut idea about the consequences of each alternative choice parameters. Therefore, we cannot assign equal weightage to the opinion of each classified group of the society. Therefore, weightage for each group must be different. Let $W=\{w_1, w_2, w_3, \ldots\ldots\ldots, w_l\}$ is the weightage matrix for the classified groups respectively where $\sum_{p=1}^{l} w_p \le 1$. This restriction is to maintain the Fuzzy property of membership value.

To get the decision matrix D we multiply **R** by the weightage matrix W such that $D=\left[\bar{a}_{ij} W_j\right]_{m\times n}$
The comprehensive decision matrix is

$$D=\begin{bmatrix} d_{11} & d_{12} & d_{13} & \ldots\ldots\ldots & d_{1l} \\ d_{21} & d_{22} & d_{23} & & d_{2l} \\ d_{31} & d_{32} & d_{33} & \ldots\ldots\ldots & d_{3l} \\ \ldots & \ldots & \ldots & \ldots\ldots\ldots & \ldots \\ d_{m1} & d_{m2} & d_{m3} & & d_{ml} \end{bmatrix}$$

Then we construct a comparison table for choice alternatives for best possible solution of the problem. The comparison table is a square table with equal number of rows and columns whose both rows and columns are labelled by choice alternatives and the entries where i, j = 1,2,3,…..m given by

c_{ij} = the number of selection criteria for which the membership value of exceeds or equal to the membership value of

Step-III:

The row-sum of the choice parameter p_i denoted by r_i where $r_i = \sum_{j=1}^{m} c_{ij}$, r_i will indicate the number of parameter in which p_i dominates all the members of p. On the other hand the column-sum of a choice parameter p_j denoted by c_j where $c_j = \sum_{i=1}^{m} c_{ij}$ here also c_j indicates the total number of parameters in which p_j is dominated by the members of p.

The score for the choice parameter p_j is s_j where $s_j = r_i - c_j$

Then the sequence of s_j put in decreasing order gives the order of choice parameter which gives the best possible solution of the flood problem.

Result:

The opinion of six classified groups of the eight districts are found as follows DISTRICT -1 (badly affected district)

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.49	0.61	0.51	0.78	0.88	0.15	0.50
Scientist	0.76	0.70	0.60	0.86	0.30	0.30	0.11
Planner	0.40	0.20	0.30	0.60	0.80	0.45	0.09
Politician	0.90	0.52	0.60	0.80	0.30	0.40	0.56
Layman	0.70	0.60	0.70	0.60	0.20	0.70	0.15
Naturalist	0.87	0.65	0.59	0.81	0.23	0.87	0.11

DISTRICT -2 (badly affected district)

	Deforestation	Big dam	Embankmen t	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.52	0.59	0.6	0.85	0.91	0.10	0.50
Scientist	0.79	0.75	0.65	0.74	0.25	0.83	0.23
Planner	0.15	0.22	0.40	0.70	0.90	0.50	0.15
Politician	0.75	0.73	0.70	0.82	0.29	0.42	0.49
Layman	0.67	0.53	0.75	0.65	0.30	0.71	0.75
Naturalist	0.81	0.63	0.73	0.63	0.32	0.84	0.41

DISTRICT -3 (badly affected district)

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.55	0.63	0.54	0.75	0.91	0.15	0.60
Scientist	0.88	0.86	0.70	0.78	0.40	0.79	0.50
Planner	0.53	0.30	0.50	0.70	0.90	0.50	0.46
Politician	0.78	0.75	0.69	0.80	0.25	0.43	0.69
Layman	0.85	0.84	0.78	0.65	0.62	0.68	0.58

Naturalist	0.79	0.8	0.61	0.83	0.68	0.91	0.36

DISTRICT - 4(badly affected district)

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.58	0.67	0.56	0.86	0.95	0.57	0.60
Scientist	0.89	0.77	0.69	0.85	0.36	0.91	0.51
Planner	0.56	0.27	0.34	0.68	0.89	0.47	0.49
Politician	0.50	0.50	0.55	0.75	0.25	0.39	0.52
Layman	0.65	0.71	0.73	0.61	0.23	0.74	0.36
Naturalist	0.83	0.7	0.56	0.79	0.66	0.74	0.31

DISTRICT -5(badly affected district)

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.58	0.64	0.54	0.85	0.85	0.39	0.56
Scientist	0.85	0.71	0.70	0.73	0.35	0.89	0.36
Planner	0.20	0.30	0.37	0.60	0.79	0.52	0.54
Politician	0.53	0.55	0.51	0.85	0.35	0.37	0.48
Layman	0.72	0.80	0.74	0.66	0.50	0.71	0.39
Naturalist	0.79	0.68	0.59	0.86	0.45	0.66	0.58

DISTRICT -6 (badly affected district)

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.55	0.63	0.54	0.75	0.91	0.15	0.55
Scientist	0.88	0.65	0.70	0.59	0.40	0.86	0.49

Planner	0.20	0.30	0.50	0.70	0.90	0.50	0.54
Politician	0.78	0.75	0.69	0.80	0.25	0.43	0.49
Layman	0.85	0.67	0.78	0.65	0.62	0.68	0.52
Naturalist	0.67	0.53	0.68	0.87	0.54	0.78	0.36

DISTRICT -7(badly affected district)

	Deforestation	**Big dam**	**Embankment**	Populationexplosion	**Blockage**	GlobalWarming	**Heavy rainfall**
Effected people	0.58	0.67	0.56	0.86	0.95	0.80	0.29
Scientist	0.89	0.63	0.69	0.85	0.36	0.35	0.31
Planner	0.19	0.27	0.34	0.57	0.89	0.47	0.36
politician	0.50	0.50	0.55	0.75	0.25	0.39	0.42
Layman	0.85	0.56	0.73	0.61	0.23	0.74	0.45
Naturalist	0.68	0.77	0.75	0.49	0.54	0.65	0.39

DISTRICT -8 (badly affected district)

	Deforestation	**Big dam**	**Embankment**	Populationexplosion	**Blockage**	GlobalWarming	**Heavy rainfall**
Effected people	0.58	0.64	0.54	0.85	0.85	0.56	0.65
Scientist	0.85	0.71	0.70	0.50	0.35	0.83	0.36
Planner	0.20	0.30	0.37	0.60	0.79	0.52	0.42
politician	0.53	0.55	0.51	0.85	0.35	0.89	0.38
Layman	0.63	0.80	0.74	0.66	0.50	0.71	0.44
Naturalist	0.80	0.68	0.75	0.80	0.54	0.89	0.37

Taking the average of the above fuzzy softsets we get the preference evaluation matrix as

R =

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Effected people	0.55375	0.63500	0.54875	0.81875	0.90125	0.35875	0.53130
Scientist	0.84875	0.72250	0.67875	0.73750	0.34625	0.72000	0.35880
Planner	0.30375	0.27000	0.39000	0.64375	0.85750	0.49125	0.38130
politician	0.65875	0.60625	0.60000	0.80250	0.28625	0.46500	0.50380
Layman	0.74000	0.68875	0.74375	0.63625	0.40000	0.70875	0.45500
Naturalist	0.78000	0.68000	0.65750	0.76000	0.49500	0.79250	0.36130

Let us assign weightage to the opinion of classified groups as follows

W =

	Effectedpeople	Scientist	Planner	Politician	Layman	Naturalist
weights	**0.10**	**0.22**	**0.18**	**0.15**	**0.15**	**0.20**

The comprehensive decision matrix is D obtain by multiplying the matrix by the weight matrix **W** as

D =

	Effectedpeople	Scientist	Planner	Politician	Layman	Naturalist
Deforestation	0.055375	0.186725	0.054675	0.0988125	0.1110000	0.15600
Big dam	0.063500	0.158950	0.048600	0.0909375	0.1033125	0.13600
Embankment	0.054875	0.149325	0.070200	0.0900000	0.1115625	0.13150
population explosion	0.081875	0.162250	0.115875	0.1203750	0.0954375	0.15200
Blockage	0.090125	0.076175	0.154350	0.0429375	0.0600000	0.09900
Global Warming	0.035875	0.158400	0.088425	0.0697500	0.1063125	0.15850
Heavy rainfall	0.053125	0.078925	0.068625	0.0571875	0.0682500	0.07225

The comparison table for the above comprehensive matrix is

	Deforestation	Big dam	Embankment	Populationexplosion	Blockage	GlobalWarming	Heavy rainfall
Deforestation	7	5	4	3	4	4	5
Big dam	1	7	4	1	4	3	5
Embankment	2	2	7	1	4	3	6
Population explosion	3	5	5	7	4	4	6
Blockage	2	2	2	2	7	2	3
Global Warming	2	3	3	2	4	7	5
Heavy rainfall	1	1	0	0	3	1	7

The row-sum and column-sum from the comparison table and the score for each choice parameter as below

	Row-Sum	Column-Sum	Difference between row sum and column sum
Deforestation	32	18	**14**
Big dam	25	25	**0**
Embankment	25	25	**0**
Population explosion	34	16	**18**
Blockage	20	30	**-10**
Global Warming	26	24	**2**
Heavy rainfall	13	37	**-24**

Hence, we have the sequence {population explosion, Deforestation, Global Warming, Big dam, Embankment, Blockage, Heavy rainfall}

We observed that the maximum score is 18 which is scored by the choice parameter POPULATION EXPLOSION. Thus, we come to the following conclusion.

Conclusion:

Throughout this study it is found that control of population explosion is the best possible solution to the Flood Problem. If we control the population then automatically the rate of deforestation will reduce and consequently will minimise the rate of global warming which are closely related to each other and the main causes for devastating flood. One can consider more parameters and more section of people by covering each and every corner of the respective region of study to get more accurate solution to the problem region wise. This is a model for finding feasible solution to the problem.

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