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"Review on Rule based System of Fuzzy Logic for Assessment of Environmental Impact"

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Abstract:- **Environmental Impact assessment (EIA) is an instructor and administration tool for planning and decision making. It is help to identify, predict, and estimate the probable environmental effects, both beneficial and harmful, of proposed developmental projects, plans and policies. In EIA studies the entire identified Environmental elements such as water environment, land environment, noise environment, air environment, socioeconomic environment and biological environment are considered. EIA report has a form vague, inherently imprecise immeasurable and fuzzy. Fuzzy logic describe imprecision or vagueness, used for decision-making and controls where uncertainty or vagueness is involved. Fuzzy Inference System (FIS) tool using for making decision and define involve uncertainty, imperialness and vagueness. The aim of this present paper is, to present the review of "fuzzy inference system" is used worldwide for impact assessment of environment.**

Key Words: Environmental impact assessment, fuzzy logic, fuzzy inference system, fuzzy rules

1. INTRODUCTION:

The practice of EIA mostly use for minimizing the environmental risk and balancing societal values. The vision of an EIA is to recognize, calculate and assess any changes in environment, socio-economic or human health effects which may result from the developmental activity before they occur, and to identify or develop suitable preventive or mitigation events to remove or reduce the undesirable effects.

EIA is the important precious, inter-disciplinary, objective decision making procedure with respect to interchange ways for development, process technologies and project sites. Economics, and sociology are important components, but the rules and risks are expressed using terms that are inherently imprecise, vague, immeasurable, or fuzzy. That is, they are expressed as linguistic concepts or linguistic variables.

Due to linguistic, vague and uncertain outcomes, presently environmental and social conditions cannot be compared and not quantitatively illustrated. Everything in the EIA is dependent on significance, and importance of consequence is found in every stage of EIA but there is no scale for identification of impact so that it can be precisely measured. And that creates a major source of conflict with accomplishment assessment of environmental impact.

There are differences sense and understanding between concepts we can directly measure and those we cannot. We can be measure distance, but we cannot measure near or far. We can measure size but we cannot measure small or large. For capturing this qualities and richness one require a methodology which can express values and is capable of expressing concepts such as near and far, small and large hot and cool etc. This can only be made possible if we use linguistic variables. The quotation of Lotfi Zadeh is quite relevant in the connection of use of "linguistic variables".

2. LITERATURE:

"Decision science" generally stands on how decisions are made and on how to make better decisions. Decision science also integrates fundamental from psychology, business, computer processing of information, and other interdisciplinary aspects of importance. Many of the ideas and techniques are adapted properly to EIA process while granting clearance to the project. This study present review on different past studies, on quantifying the effect on environment by adopting Fuzzy set theory. Which is help in taking decision while giving environmental clearance to the projects and also helpful in predicting the significance of the future environments under each alternative. From many decades Fuzzy logic has been utilized successfully for decision making in EIA and its components.

W. O. Duque et al., (2006) developed a working model for river water quality measurement by using fuzzy inference system (FIS). By using a method established on FIS, assess for water quality and a water quality index. And compared test result of the fuzzy index with others case study. At the end of the work, conclusion of these studies that the fuzzy process is a suitable and alternative tool to be used in developing effective water management plans.

Bernard E. A. Fisher, (2006) designed fuzzy program to improve environmental quality regards uncertainty by adaptable approaches to decisions making. Studied on forecasting of air quality easy and complex models, and concludes that decisions usually depend on combining two or more quite uncertain environmental criteria, and if fuzzy logic framework is accepted so approach is systematically.

A. C. Boclin and R. D. Mello, (2006) are developed a fuzzy logic computational method for taking decision while performing assessment of environmental impact, The aim of this studies was that satisfy the stakeholders in a way to get fuzzy and crisp variables and make presumption from resultant values of environmental, cultural, social and economical thematic indicators

S. Dahiya et al., (2007) studied on decision making constraint in the physicochemical quality assessment of groundwater, by using application of fuzzy set theory. By using the fuzzy artificial assessment models, evaluating the acceptability of the water depend on the prior approved limit of various regulatory bodies. These provide the appropriate levels for quality class and observation of the experts from the field of drinking water quality. On basic of fuzzy rule system optimization model, concludes that about 64% water sources were either in "desirable" or "acceptable" category for drinking purposes.

Y. Icaga, (2007) studied on guideline model for assessment of surface water quality using fuzzy rules based methodology. And judgment of water quality by using crisp set and conventional classification methods are close or far from the limits are considered. The parameters may be defined vague, uncertain, fuzzy and especially, in public thought consideration. Fuzzy rules based methodology used to quantify values of traditional quality classes, and then defuzzyfication of these values develops the index.

Md. P. Abdullah et al., (2008) worked on various classification process for evaluating the changing status and usability of groundwater in river basin, and found that, the output values of ambiguity in the quality or excellence field of water employed and precision vagueness ambiguity or fuzziness embedded in the choice judgment or decision making. By using fuzzy and conventional method evaluated status of river water quality and compared the output generated by both methods. Finally conclude that the value form fuzzy logic is more accurate as compare to conventional method.

K. F. Liu and C. W. Yu, (2009) studied the statement and reports of environmental impact for a development proposal or plan. They suggested following artificial, intelligence and management science and planned to assist: case based reasoning (CBR), fuzzy reasoning (FR) and importance performance analysis (IPA). And these tools are demonstrated by using a case study by proposed system.

E. Giusti et al., (2011) used synthetic fuzzy logic quality index process for the reinstallation of agricultural land with an affinity to become waterlogged into a natural wetland, visualized to reduce floods and to eliminate nutrients from the water drained from the cultivated plots. The pollutant removal from wastewater, efficiency of the wetland was evaluated by FQI. The three main variables were used as a base of FQI to describing the ecosystem quality: chlorophyll, dissolved oxygen and total suspended solids.

F. Soroush et al., (2011) studied river water quality evaluation by used fuzzy logic theory; system was based on limited observations. For industrial uses a fuzzy index (range of 0-100) used for evaluation of water quality. On the bases of quality classes and expert opinions it is found that FIS makes it possible to combine the certainty levels for the adequacy of water based on a given limit of various regulatory bodies'.

S. Kucukali, (2011) design a methodology of risk analysis, expert opinion and judgments for a river type hydropower plant projects by using a fuzzy logic rating tool. For analysis of project impact and risk a multi criteria decision making analysis methodology were used, which provided a flexible and easily understood way to analyze project risks and impacts on environment. On the bases of expert interviews, field studies and literature review, total eleven classes of risk factors were determined. Base for those factors are like geology of site, uses of land, environmental issues, grid connection, social receiving, macroeconomic, hazards due to naturally, modification of laws and regulations, terrorism, access to infrastructure and revenue.

R. Peche and E. Rodríguez, (2012) studied on fuzzy rule based tool for developed rigorous and versatile methodology to design and the consequent assessment of environmental quality indexes (EQI). This enables the design of specific indexes to evaluate the quality from different perspectives in any environmental compartment. The information required to design the EQI was took from a panel of experts in all the different aspects related to the quality under assessment.

Priya K. L., (2013) studied using the ground water for agriculture or irrigation purpose and the quality and quantity of ground water were classified by FIS. Four main parameters like that SAR, EC, chlorides and sulphates are developed as a membership functions. Results by the developed fuzzy model was more reliable for classifying ground water for agriculture purposes and avoids the ambiguity and vagueness in the decision making.

M. Phatak and N. Kanhe, (2014) are studied a mining project and assess by fuzzy logic tool. "Prepare EIA report of a mining project". Found that impact ive significance of the core of probable impact identification, prediction, evaluation and decision making in EIA. And degree of subjectivity is high in the recent EIA decision making process. They conclude that adopting the fuzzy rule based system which has ability to quantify human thinking and linguistics variable.

D. O. Ferraro et al., (2003) developed a fuzzy logic based model to assess the impact of pesticides and tillage on agro ecosystem and used land. Model required initial data like number and type of used pesticides, frequency of applying of pesticides, tillage tool used number and type, the quality of land on which pesticides are apply. These all the statement was made for fuzzy inference system for assess the potential environmental impact of pesticides and tillage.

I.P. Kotti et al., (2013) used a methodology based on fuzzy inference systems to wastewater treatment by construction wetland. Design a fuzzy logic based model for BOD removal from wastewater. A fuzzy based modal were developed and authorized by using experimental data of lab pilot unit to evaluate removal efficiency of organic matter

present in wastewater by free water surface constructed wetlands. They conclude that existing methodology is a good modeling tool for evaluating the efficiency of constructed wetlands.

EIA is a professional process for sustainable development and protecting natural resources and environment. Therefore, all over the world most developed countries have introduced EIA into their regulations, and the consequent approval of all projects (Council of European Union, 1996; EPA, 2007). Fuzzy logic has been successfully adopted and applied in the environmental fields and its components. A number of representative examples of such applications can be quoted in the last decades, such as evaluation of ecosystem sustainability (Tony Prato 2005 and H. Y. Wu 2012), a new method develop for life cycle impact assessment by fuzzy modeling (Feri A. 2014, and Marta H. et al., 2012), fuzzy logic and neural network for crop classification, and health of agricultural land (S. Murmu 2015 and Qiang Li 2012), fuzzy logic model for soil assessment, (De Gruijter et al., 2011, and Alex B. Mcbratney 1997), river water quality evaluation (S. Meyliou et al., 2003 and William 2006), continuous soil pollution mapping (M. Amini 2005 and M. D. Mays 1997), environmental impact and risk assessment (Kevin F. R. Liu 2009 and Julián Garrido 2015), water quality evaluation status (Han Yan et al., 2010 and K. Sasikumar 2015), water quality index (Hamed Gharibi et al., 2012 and Alison M. st. Clair 2015), environmental quality indexe (Roberto p. 2012), agricultural soils quality index and landfill siting (Esther R. 2016 and R. Gupta 2015), above literature work show that the fuzzy logic and fuzzy inference system mostly used as a decision making tool for assessment of environmental impact and components of environment.

The concept of the consequence is a major cause of problem within the EIA process. The word is commonly adopted EIA, environmental Acts and regulations. Sometimes meaning is defined and sometimes it is not. Everything in the EIA is dependent on consequence, and importance of consequence found in every stage there for it cannot be directly measured. Due to these cause it very difficult to conduct of EIA. There are differences in meaning and understanding between concepts we can directly measure and those we cannot. We can measure distance, but we cannot measure near or far. We can measure size but we cannot measure small or large. Indeedly, we fail to see the quality and richness inherent in the natural words, when we use Classical logic to include or exclude activities and events

3. NEED OF FUZZY LOGIC IN EIA:

The aim of EIA process is preserving societal values, minimizing environmental risk and sustainable development. Each stage of EIA projects are evaluated on the basic of defined terms. The projects are permit on the basic of determining limitation and mitigation suitable to manage and minimize environmental risk. Science, economics, and sociology are important components, but the values and risks are expressed using terms that are inherently imprecise, vague, immeasurable, or fuzzy. That is, they are expressed as linguistic concepts or linguistic variables.

There are a number of components which may or may not be included in EIA of a specific project. The challenge is finding methods and techniques that identify impacts, predict future environmental conditions, evaluate significance, and reflect societal values. The purpose of EIA is to effectively manage environmental risk, and such management can only be effective when the information is suitable to the task and the decision making process is as objective and comprehensive as possible.

4. AIM OF THE PRESENT PAPER

Fuzzy logic can be considered a beneficial method or useful tool to evaluate, assess, and calculate the different impact of environment or the total impact or adverse effect linked or associated with the implementation or execution of activities and projects. This is especially applicable when quantitative information about environmental impacts is short, inaccurate, and uncertain and described in linguistic terms. Therefore, the objective of this study is to develop a methodology based on FIS and fuzzy rule base to carry out EIA in cases where uncertainty is involved, but, unlike the aforementioned procedures, this proposed new approach formulates a different option of application of fuzzy logic to the EIA.

5. CONCLUSIONS:

Over all countries of the world accept EIA procedure which is discussed in detail. For EIA different methodology are also illustrated. However, effort to quantify environmental impacts by using classical set theory. Governments, and other EIA professionals, need practical and effective tools in order to be effective as EIA is an valuable technical and legal document used for protection of environment in most of the developed and developing countries. The existing methodologies of EIA are addressed develop a new methodology. This work presents application of fuzzy set theory for quantifying EIA to all over the world. On the basic of this literature review work, a new methodology for Environmental impact assessment that obviates the drawback of existing methodologies.

6. REFERENCES:

[1] A. M. Clair and Sunil K. Sinha, (2015) “Development of a FI performance index for ferrous drinking water pipelines”. ASCE 04014003-1- 04014003-11.

[2] Alex B. Mcbratney, Inakwu O.A. Odeh, (1997) “Application of fuzzy sets in soil science fuzzy logic, fuzzy measurements and fuzzy decisions”. Geoderma 77, 85-113.

[3] Bernard E. A. Fisher, (2006) “Fuzzy approaches to environmental decisions application to air quality”. Environmental Science & Policy, 22 – 31.

[4] Boclin A. S. and R. D. Mello, (2006) “A decision support method for EIA using a fuzzy logic approach”. Ecological Economics 58, 170– 182.

[5] Diego o. Ferraro, Claudio M. Ghersa, Gustavo A. Sznaider, (2003) “Evaluation of EI indicators using fuzzy logic to assess the mixed

cropping systems of the inland pampa, argentina". Agriculture Ecosystems and environment 96, 1–18.
[6] Dahiya, S., B. Singh, S. Gaur, V. K. Garg and H. S. Kushwaha, (2007) "Analysis of groundwater quality using fuzzy synthetic evaluation". J. Hazard Mater 147, 938-946.
[7] Esther Rodríguеza, Roberto Pechea, Carlos Garbisub, Inaki Gorostizac, Lur Epeldeb, Unai Artetxed, Amaia Irizare, Manuel Sotoe, José Mabecerrild, (2016) "Dynamic quality index for agricultural soils based on fuzzy logic". Ecological Indicators 60, 678–692.
[8] E. Giusti, S. Marsili libelli and S. Mattioli (2011), "A fuzzy quality index for the EA of a restored wetland". Water Science & Technology 63.9, 2061-2070.
[9] F. Soroush1, S. F. Mousavi, and A. Gharechahi, (2011) "A fuzzy industrial WQI, case study of zayandehrud river system". IJST, Transactions of Civil and Environmental Engineering, vol. 35, 131-136.
[10] Feri Afrinaldi and Hong-Chao Zhang, (2014) "A fuzzy logic based aggregation method for LCIA". Journal Of Cleaner Production 67, 159-172.
[11] Fathianpourb H, H. Khademia, and H. Flu, (2005), "Cntinuous soil pollution mapping using fuzzy logic and spatial interpolation". Geoderma 124, 223–233
[12] H. Gharibi, Md. H. Sowlat, A. H. Mahvi, H. Md. Zadeh, H. A. Rabalibeik, M. Keshavarz, N. Karimzadeh, and G. hassani, (2012) "Development of a dairy cattle drinking WQI based on FIS". Ecological Indicators 20, 228–237.
[13] H. Yan, Z. Zou, and H. Wang, (2010) "Adaptive NFIS system for classification of water quality status". Journal of Environmental Sciences 22(12), 1891–1896.
[14] Irini P. Kotti, Georgios K. Sylaios, and Vassilios A. Tsihrintzis, (2013) "Fuzzy logic models for BOD removal prediction in FWSCWs". Ecological Engineering 51, 66– 74.
[15] J. Julián Garrido and Ignacio Requena, (2015) Developing environmental risk assessment methodologies". ASCE 04014083-1-04014083-13.
[16] J. Gruijter, D. J. Walvoort, and G. Bragato, (2011) "Application of fuzzy logic to boolean models for digital soil assessment". Geoderma 166, 15–33.
[17] K. F. Liu and C. W. Yu, (2009), "Integrating case based and fuzzy reasoning to qualitatively predict risk in EIA review". Environmental Modeling & Software 24, 1241–1251.
[18] K. Sasikumar and P. P. Mujumdar (1998) "Fuzzy optimization model for WQM of a river system". J. Water Resour. Plann. Manage124, 79-88.
[19] K. R. Liu and J. H. Lai, (2009) "Decision support for EIA, a hybrid approach using fuzzy logic and fuzzy analytic network process". Expert Systems with Applications 36, 5119–5136.
[20] L. Suganthi, S. Iniyan, and A. A. Samuel, (2015) "Applications of fuzzy logic in renewable energy systems a review". Renewable and sustainable Energy Reviews 48, 585–607.
[21] M. Kaufmann, S. Tobias, and R. Schulin, (2009) "A quality evaluation of restored soils with a fuzzy logic expert system". Geoderma 151, 290–302.
[22] M. D. Mays, I. Bogardi, and A. Bardossy, (1997) "Fuzzy logic and risk-based soil interpretations". Geoderma 77, 299-315.
[23] Md. P. Abdullah, S. Waseem, Raman Bai V. and I. mohsin, (2008) "Development of new water quality model using fuzzy logic system for Malaysia". Open Environmental Sciences 2, 101-106.
[24] M. Herva, A. F. Uría, E. F. Carrasco, and E. Roca, (2012) "Application of fuzzy logic for the integration of environmental criteria in eco design". Expert systems with applications 39, 4427–4431.
[25] M. Aminia, M. Afyunia, and N. S. Kucukali (2011), "Risk assessment of river type hydropower plants using fuzzy logic approach". Energy Policy 39, 6683–6688.
[26] Peche (2006), "EIA by means of a procedure based on fuzzy logic: a practical application". Gest ambient 9, 99–113.
[27] priya k. l., (2013) "A fuzzy logic approach for irrigation WQA: a case study of karunya watershed, India". Journal of Hydrogeology & Hydrologic engineering.
[28] Q. li, and J. Yan, (2012) "Assessing the health of agricultural land with analysis and fuzzy logic in the major grain-producing region". Catena 99, 9–17.
[29] R. gupta, M. A. Kewalramani and R. V. Ralegaonkar, (2003) "EIA using fuzzy relation for landfill siting". J. Urban Plann. Dev.129, 121-139.
[30] S. Murmua, and S. Biswasa, (2015) "Application of fuzzy logic and neural network in crop classification: a review". Aquatic Procedia 4, 1203 – 1210.
[31] S. Meyliou, S. L. Lo, and C. Y. Hu, (2003) "Application of two-stage fuzzy set theory to river quality evaluation in Taiwan". Water Research 37, 1406–1416.
[32] Tony prato (2005) "A fuzzy logic approach for evaluating ecosystem sustainability". Ecological Modeling 187, 361–368.
[33] Yilmaz icaga (2007), fuzzy evaluation of water quality classification, ecological indicators; 7(3), 710-718.