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AN INTROSPECTIVE STUDY ON ENVIRONMENTAL HAZARDS OF HUMAN HEALTH IN THE CURRENT ERA, USING MULTI-STEP FUZZY COGNITIVE MAP MODEL

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ABSTRACT

Environmental health is the science of looking at the visible factors, that can influence a person's health and behavior. All organisms depend on their environments for basic needs, to maintain the healthy life. Advances in cultivation, water treatment, public health and hygiene have a far greater impact on human health than medical technology. Risk of dental problems, kidney diseases, lung problems and many other illnesses are increased by the ecological threats. If the present situation continues, without paying attention to the environmental hazards the survival of the future generation will be affected. This paper investigates the most identifying, Environmental hazards of human health by using multi step fuzzy cognitive map model. This methodology is based on Fuzzy Cognitive Map (FCM), which is a knowledge based approach, combines elements of fuzzy logic and neural networks.

KEYWORDS: Environmental Threats, Fuzzy Cognitive Map (FCM), Health Problems & Multi-Step FCM

INTRODUCTION

Health and Environment are two inseparable entities in the sense that they impact each other. Though health generally refers to human health, environmentalists include plants and animals into this sphere. Environmental hazards affect necessary human health and quality of the environment[3].

This paper analyzes the various factors of environmental hazards of human health. It is none other than modelling social problem with unsupervised data. To deal with the unsupervised data, one of the most efficient tools is Fuzzy Cognitive Maps (FCM). FCM is capable of preparing human knowledge in a given system of concepts and mutual dependence.

In FCM there are several forms to deal with a ecological, social, variety of industries / engineering problems. Among them, a multi-step fuzzy cognitive map as the most adaptable one. Multi-step fuzzy cognitive mapping approach was developed by Ozesmi (1999a), for analyzing an eco-social system [15]. The multi-step approach is a synthesis of relevant, useful techniques from many disparate limitations of cognitive mapping [14].

This paper considers seven sections. Section 1 shortly describes about FCM and its procedure, Section 2 deals with the Multi-Step FCM approach. Section 3 explains about the problem description and Section 4 says about the factors which are affecting the environment and the next section, about Coding adjacency matrices for the environmental problems of human health. Section 6 says the analysis on obtaining FCMs, final section describes about results and reveals the

discussion relating the study.

Fuzzy Cognitive Maps (FCMS)

Fuzzy cognitive map(FCM) is an approach for analyzing and depicting human perception of a given model. The method produces an abstract model which is not limited by exact values and measurements, and thus is well suited to represent relatively unorganized knowledge and causalities expressed in imprecise forms. FCM is a powerful tool because cause-effects relations and feedback mechanisms are involved. A FCM can be produced by one person or by several persons together, and more maps can be joined into a larger fuzzy cognitive map covering more aspects of the system [13]. FCM focuses on the components and structure of the system and is fairly simple and easy to understand for the participants, which opens up the possibility of involving lay people as well as experts.

FCM develops from the cognitive maps which were based on directed graphs [13]. Fuzzy cognitive map was developed by Bart Kosko in 1986, which is the generalisation of cognitive map (Axekord 1976). In recent years, FCM has been applied in multi disciplinary research, for presenting expert knowledge [12].

Multi- Step FCM Approach

Multi-step FCM analysis approach includes the following steps [13].

- Obtaining the Fuzzy Cognitive Maps.
- Defining the sample size.
- Converting the Fuzzy Cognitive Maps into adjacency matrices.
- Augmenting individual Cognitive Maps and then adding the matrices to form combined social Fuzzy Cognitive Maps.
- Studying the structure of individual and social Fuzzy Cognitive Maps using matrixes.
- Reducing cognitive maps into simpler maps for correlation purposes.
- To obtaining the outcomes of CMs for the neural network computation..

3. Problem Description

Over the past decades, public health was most distressed about the localized environmental degradation[6]. Nowdays, people's awareness about the current and future health problem of the environmental issues have changed. The paradigm of community health worked well to deal with these health problems. As a result, some of the environmental effects have been solved in certain parts of the world. The main drivers of global ecological changes are population growth, increased human stress on the environment and also climate change, land use, soil and water degradation, food waste and contamination are the aspects of threats to human health[10].

According to the survey, while 24 percent of the dangerous disease interms of healthy life and 23 percent of all deaths caused by environmental risk factors. In devoloping countries, 25 percent of all deaths are accountable to environmental risk factors but only 17 percent in the developed countries are attributable to these factors. In the sense that, children are most affected by the adverse impact of environmental risk factors, while 24 percent of all deaths below 15 are due to some environmental related diseases[11].

4. Adaptation of Multi-Step FCM Approach to the Undertaken Problem

Table1: Environmental Risk Factors and the Diseases Contributed

Risk Factors	Related Diseases
Indoor air pollution	Pneumonia, COPD, Lung cancer
Outdoor air pollution	Respiratory infections, cardiopulmonary disease, lung cancer
Water, sanitation	Diarrheal diseases, Tacoma, hookworm disease
Climate change	Diarrheal diseases, including cholera, malaria and other vector-borne diseases, asthma, COPD, malnutrition Source: Adapted from Ref [11] COPD, chronic obstructive pulmonary disease

In this paper, the environmental risks of human health are discussed. FCM helps the decision makers understand the complex dynamics between goals and the related environmental and cognitive factors. In the discussion, this paper considered nine identified environmental risks as key factors [7].

- Environmental Pollution (land, noise, water, thermal, ocean).
- Contaminants in food.
- Weather conditions (droughts, heat waves).
- Natural disasters (hurricanes, earthquakes, floods).
- Uses of Pests and Pesticides.
- Unfiltered Industrial effluents and drainage wastage.
- Malnutrition.
- Communicable and non-communicable diseases.
- Lack of good water and inadequate sanitation.

Obtaining Cognitive Maps and Coding into Adjacency Matrix

The above mentioned key factors are observed well by the expert and the FCMs are drawn separately. Then FCM is coded into the corresponding connection matrix as follows:

$$M=\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \end{array}\begin{array}{c} \begin{array}{ccccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \end{array} \\ \begin{pmatrix} - & 0.61 & 0.92 & 1 & 0.82 & 0.91 & 0.82 & 0.91 & 0.52 \\ 0.5 & - & 0.4 & 0 & 0.8 & 0.85 & 0.9 & 1 & 0.7 \\ 0.6 & 0.74 & - & 0.95 & 0.3 & 0.78 & 0.85 & 0.7 & 0.6 \\ 0.75 & 0.8 & 0.7 & - & 0.2 & 0.69 & 0.73 & 0.8 & 0.9 \\ 0.9 & 1 & 0.6 & 0.5 & - & 0.34 & 0.9 & 0.78 & 0.81 \\ 1 & 0.94 & 0.34 & 0.63 & 0.72 & - & 0.31 & 0.81 & 0.8 \\ 0.71 & 0.69 & 0.45 & 0.6 & 0.84 & 0.61 & - & 0.76 & 0.8 \\ 0.83 & 0.7 & 0.69 & 0.71 & 0.63 & 0.59 & 0.78 & - & 0.9 \\ 0.8 & 0.95 & 0.47 & 0.43 & 0.71 & 0.71 & 0.8 & 1 & - \end{pmatrix}_{9\times 9} \end{array}$$

Analysis for Obtaining Fcms

FCMs are nothing but the weighted directed graphs only. So, to analyze the complex cognitive maps, the tools of graph theory indices have been used. Multi-step FCM approach is useful to study the structure of the maps and make comparisons among stakeholder groups. In this study, our aim is to study the structure of the maps and to compare environmental risks of human health.

To analyze a cognitive map, the following formulae are needed:

1. The density (D)= $\frac{C}{N(N-1)}$or $D = \frac{C}{N^2}$.

Where C is the no. of connections between the variables and N is the number of variables. The density of a directed graph lies in the range 0 to 1 [2].

2. The type of variables in a map is important because it shows how the variables act in relation to the other variable. The three types of variables are: transmitter variables (given, forcing functions, tails), receiver variable (ends, utility variables, heads), and ordinary variable (means)[2]. These variables are defined by their Outdegree [Od(Vc)] and indegree [id(vi)] as **Od(□i) =**$\sum_{i=1}^{N} \bar{a}_i R$**, id(Vi) =** $\sum_{i=1}^{N} \bar{a}_i R$, where outdegree is the row sum of the absolute values of a variable and Indegree in the column sum of absolute values of a variable in the adjacency matrix.

3. The Centrality (immediate domain, total degree [td (qi)]; [5]) of a variable in the summation of indegree and outdegree [1]:

$$\mathbf{C_i = td\ (V_i) = 0d\ (V_i) + id\ (V_i)}$$

The centrality shows how connected the variable is to other variables and what are the cumulative strength of these connections.

4. Index of complexity is the total number of receiver variables. As the index of complexity value increases, the FCM considers many outcomes and the implication that is a result of the system[4]. However, a large number of transmitter variables indicate thinking top down influences, a "formal hierarchical system" and also show "flatness" of a CM where casual argument are not well elaborated. Hence CMs are compared in terms of the ratios R/T.

5. Another structural measure of a CM is the hierarchical index (h) [9].

$$h = \frac{12}{(N-1)N(N+1)} \sum i \left[\mathbf{Od(V_i)} - \frac{[\sum \mathbf{Od(V_i)}]}{N} \right]^2$$

Where N is the total number of variables.

- **Case (i):** When h = 1, the map is fully hierarchical.
- **Case (ii):** When h = 0, the system is fully democratic. [15] Calls this domination

(Hierarchical) and adaptation eco-strategies (democratic and delivered that democratic maps and delivered that democratic maps are much more adaptable to local environmental changes because of their high level of integration and dependence [13].

The above calculations are implemented for the values in the connection matrix M.

The results are shown in the following table.

Table: Graph Theory Indices for the Connection Matrix M.

Variables/ Indices	1	2	3	4	5	6	7	8	9
1.Column total,	6.09	6.43	4.57	4.82	5.02	5.48	6.09	6.76	6.03
2.Row total	6.51	5.15	5.52	5.57	5.83	5.55	5.46	5.83	5.87
3.Centrality	12.6	11.58	10.09	10.39	10.85	11.03	11.55	12.59	11.9
4.No.of Transmitter Variables	1								
5.No.of Receiver Variables	1								
6.No of Ordinary Variables	7								
7.Total no. of Variables	9								
8.No.of Connections	71								
9.Complexity Receiver/ Transmitter	1								
10.Density, D	0.8765								
11.Hierarchy Index , h	0.0228								

DISCUSSIONS

From the above Graph Theory indices for the Environmental risks factors of human health, the following results are obtained the causal relationship among the variables is high, when the density of the map attains the maximum value[13].

From the density values in the table, it is concluded that in the above factors, the variables have a larger number of connections. The variables of existing factors have more connections. i.e., the relationships among the factors are more.

The outdegrees of variables are comparatively larger than the indegrees (except contaminants in food, malnutrition, communicable and non-communicable diseases, lack of good water and inadequate sanitation). It shows that, the cumulative strength of connections in the existing variable is more than the entering the variable [13]. That is, while saying in FCM language, the variables have larger implications, i.e., causal objects [8]. A variable can be more central although it has fewer connections in fuzzy cognitive maps, if the connections carry large weights.

The centrality values are larger in all the factors. So it is delivered that, the variables are connected strongly and the cumulative strengths of the connections are more.

Complex maps will have larger complexity ratios (R/T) because they define more utility outcomes and less controlling force functions [13]. Here the complexity ratio is 1. This result considers that the communicable and non-communicable diseases is the most impactful factor(receiver variables) and environmental pollution is the influencing factor (transmitter variables) for the present scenario.

Finally, while discussing the hierarchical index (h) [9] the h value of impact factors is 0.0228 which indicates that

the map is democratic [15]. In local ecological changes democratic map is most adaptable one because of their high level of integration and dependence.

CONCLUSIONS

The environmental risk has a major impact on health and investing in environmental health is certainly a good investment. Rapid urbanization, globalization and an increasing population are putting further stress on the environment. If crucial actions are not taken immediately by all sectors, the problem is likely to worsen the human health directly. The impact will be hardest on the poor people and vulnerable sections of the population. Now there is an opportunity to begin studies in areas where environmental risks have remained high and localized. Human health was influenced by the negative consequences of environmental degradation. If the present scenario continues, over the next few decades the situation becomes more worse. To overcome this challenge, the technical studies and training have been conducted, to improve the quality of the environment.

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