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Study Air Pollution Using Fuzzy Relational Maps

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Abstract - The concept of Sustainable development based on an integrated view of environmental policies and development strategies intends to minimize the risks and hazards to the environment. The time has come for efforts to be made on the environmental front towards sustainable development without endangering the ecological assets of the future generation. In this paper we analyze the effects of health hazards in sustainable development of agriculture using Fuzzy Associative Memories (FAM). We arrive at the conclusions by this study how sustainable development is being affected by the pollutions.This paper has four sections. In section one we recall the notion of Fuzzy Relational Maps (FRM) and its properties. In section two we describe the problem. In Section three we adopt FRM to this problem and analyze the problem. Section four gives the conclusions based on our study.

KEY WORDS: Fuzzy Relational Maps (FRM), sustainable development, air pollution.

I. SECTION ONE: FUZZY RELATIONAL MAPS (FRMS)

The new notion called Fuzzy Relational Maps (FRMs) was introduced by Dr. W.B.Vasantha and Yasmin Sultana in the year 2000. In FRMs we divide the very casual associations into two disjoint units, like for example the relation between a teacher and a student or relation; between an employee and an employer or a relation; between the parent and the child in the case of school dropouts and so on. In these situations we see that we can bring out the casual relations existing between an employee and employer or parent and child and so on. Thus for us to define a FRM we need a domain space and a range space which are disjoint in the sense of concepts. We further assume no intermediate relations exist within the domain and the range space. The number of elements in the range space need not in general be equal to the number of elements in the domain space. In our discussion the elements of the domain space are taken from the real vector space of dimension n and that of the range space are real vectors from the vector space of dimension m (m in general need not be equal to n). We denote by R the set of nodes $R_1, \ldots, R_m$ of the range space, where $R_i = \{(x_1, x_2, \ldots, x_m) / x_j = 0 \text{ or } 1\}$ for $i = 1, \ldots, m$. If $x_i = 1$ it means that the node R_i is in the ON state and if $x_i = 0$ it means that the node R_i is in the OFF state. Similarly D denotes the nodes $D_1,\ldots,D_n$ of the domain space where $D_i = \{(x_1,\ldots, x_n) / x_j = 0 \text{ or } 1\}$ for $i = 1, \ldots, n$. If $x_i = 1$, it means that the node D_i is in the on state and if $x_i = 0$ it means that the node D_i is in the off state. A FRM is a directed graph or a map from D to R with concepts like policies or events etc. as nodes and causalities as edges. It represents casual relations between spaces D and R. Let D_i and R_j denote the two nodes of an FRM. The directed edge from D to R denotes the casuality of D on R , called relations. Every edge in the FRM is weighted with a number in the set {0, 1}.

Let $e_{i\,j}$ be the weight of the edge $D_i R_j$, $e_{i\,j} \in \{0.1\}$. The weight of the edge D_iR_j is positive if increase in D_i implies increase in R_j or decrease in D_i implies decrease in R_j. i.e. casuality of D_i on R_j is 1. If $e_{i\,j} = 0$ then D_i does not have any effect on R_j. We do not discuss the cases when increase in D_i implies decrease in R_j or decrease in D_i implies increase in R_j. When the nodes of the FRM are fuzzy sets, then they are called fuzzy nodes, FRMs with edge weights {0, 1) are called simple FRMs. Let $D_1, \ldots, D_n$ be the nodes of the domain space D of an FRM and $R_1, \ldots, R_m$ be the nodes of the range space R of an FRM. Let the matrix E be defined as $E = (e_{i\,j})$ where $e_{i\,j} \in \{0, 1\}$; is the weight of the directed edge D_iR_j (or R_jD_i), E is called the relational matrix of the FRM. It is pertinent to mention here that unlike the FCMs, the FRMs can be a rectangular matrix; with rows corresponding to the domain space and columns corresponding to the range space. This is one of the marked difference between FRMs and FCMs.

Let $D_1, \ldots, D_n$ and $R_1,\ldots,R_m$ be the nodes of an FRM. Let D_iR_j (or $R_j D_i$) be the edges of an FRM, $j = 1, \ldots, m$, $i = 1, \ldots, n$. The edges form a directed cycle if it possesses a directed cycle. An FRM is said to be acycle if it does not posses any directed cycle. An FRM with cycles is said to have a feed back when there is a feed back in the FRM, i.e. when the casual relations flow through a cycle in a revolutionary manner the FRM is called a dynamical system. Let D_iR_j (or R_jD_i), $1 \le j \le m$, $1 \le i \le n$. When R_j (or D_i) is switched on and if casuality flows through edges of the cycle and if it again causes $R_i(D_j)$, we say that the dynamical system goes round and round. This is true for any node R_i (or D_j) for $1 \le i \le m$, (or $1 \le j \le n$). The equilibrium state of this dynamical system is called the hidden pattern. If the equilibrium state of the dynamical system is a unique state vector, then it is called a fixed point. Consider an FRM with $R_1, \ldots, R_m$ and $D_1, \ldots, D_n$ as nodes. For example let us start the dynamical system by switching on R_1 or D_1. Let us assume that the FRM settles down with R_1 and R_m (or D_1 and D_n) on i.e. the state vector remains as (10…01) in R [or (10…01) in D], this state vector is called the fixed point. If the FRM settles down with a state vector repeating in the form $A_1 \to A_2 \to \ldots \to A_i \to A_1$ or ($B_1 \to B_2 \to \ldots \to B_i \to B_1$) then this equilibrium is called a limit cycle.

Methods of determination of hidden pattern:
Let $R_1, \ldots, R_m$ and $D_1, \ldots, D_n$ be the nodes of a FRM with feed back. Let E be the $n \times m$ relational matrix. Let us find a hidden pattern when D_1 is switched on i.e. when an input is given as vector A_1= (1000...0) in D the data should pass through the relational matrix E. This is done by multiplying A_1 with the relational matrix E. Let $A_1E = (r_1, \ldots, r_m)$ after thresholding and updating the resultant vector (say B) belongs to R. Now we pass on B into E^T and obtain BE^T. After thresholding and updating BE^T we see the resultant vector say A_2 belongs to D. This procedure is repeated till we get a limit cycle or a fixed point.

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II. SECTION TWO: DESCRIPTION OF THE PROBLEM

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution.Pollutions are different types one of the most dangerous pollution is air pollution.

What is air pollution? 'I'll go out for a breath of fresh air' is an often-heard phrase. But how many of us realize that this has become irrelevant in today's world, because the quality of air in our cities is anything but fresh. Air pollution is a serious problem in our society these days. We come across it indoors, when people have been smoking, and outdoors, where motor vehicle exhaust pollutes the air. For years scientists have been warning us that polluted air is a hazard to our health. It seems these warning are not being taken acutely enough. The truth is that air pollution is growing worse, especially in compactly populated societies. We must for that reason take instantaneous action to progress the quality of air we breathe. The moment you step out of the house and are on the road you can actually see the air getting polluted; a cloud of smoke from the exhaust of a bus, car, or a motor vehicle; smoke billowing from a factory chimney, flash produced by thermal power plants, and speeding cars causing dust to rise from the roads. Natural occurrences such as the eruption of a volcano and even someone smoking a cigarette can also cause air pollution. Pollution is the infection of the earths. One of the first things you can start doing is to preserve energy. We can also contribute to reducing air pollution to some extent. During the day, use only the required number of lights. Natural phenomena such as the eruption of a volcano and even someone smoking a cigarette can also cause air pollution. Walk or ride a bicycle to the market or to your friend house. Cars that use CNG have also been introduced. Look after the trees in your neighborhood, along with your friends, begin a tree watch similar to a neighborhood watch. At the same time, our contaminated atmosphere is becoming a better insulator, averting heat from evading back into space and leading to an increase in universal average temperatures. Air pollution harms plants, animals, and the ecosystems (environment) in which they live. Many cities around the world now have pollution control checks for vehicles. At the moment, the fact that the earth might be affected greatly with the passage of time seems ridiculous to some. These are some of the things we can do to help prevent air pollution. Although some environmental pollution is a consequence of natural causes like volcanic eruptions, most is caused by human actions.

Facts about Air Pollution:

Here are a few facts about air pollution:

- Almost 232 million different types of vehicles are driven by U.S. citizens every day, adding greenhouse gases into the air
- U.S. vehicle emissions contribute 45% to global warming
- The average adult consumes 3,000 gallons of polluted air every day
- Vehicle exhaust contributes to 60% of carbon monoxide emissions in the U.S. and up to 95% in large cities

Every year 335,000 Americans die of lung cancer, which is a direct result of air pollution

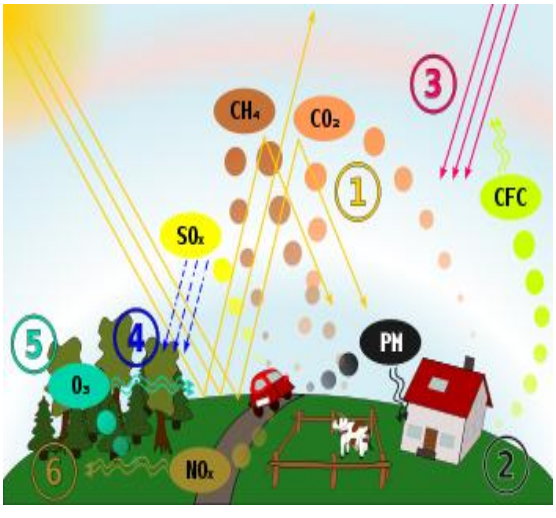
The world has seen one of the greatest air pollution during 'Bhopal Disaster '. All technologies and scientific endeavors stand in speechless silence in the face of such natural and /or man-made calamities. Many human lives are lost while others and their progeny suffer and have to suffer from umpteen infirmities due to resultant contaminated atmospheric changes. Did we ever stop to ponder for a moment what would happen if more and more soil area is used for storage of industrial wastages? Did we ever think what would happen if untreated waste water released in water sources such as ponds, rivers and oceans? We have to pay very heavily if ecological balance is altered drastically. The Fuzzy concepts, i.e. attributes are first given in the form of matrix relational equations and then solved.

Thus we study this problem of Sustainable development mainly in the context of health hazards .

Pollutants:

Main articles: Pollutant and Greenhouse gas

Before flue-gas desulfurization was installed, the emissions from this power plant in New Mexico contained excessive amounts of sulfur dioxide.



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Schematic drawing, causes and effects of air pollution: (1) greenhouse effect, (2) particulate contamination, (3) increased UV radiation, (4) acid rain, (5) increased ground level ozone concentration, (6) increased levels of nitrogen oxides.

A substance in the air that can be adverse to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. In addition, they may be natural or man-made. Pollutants can be classified as primary or secondary. Usually, primary pollutants are directly produced from a process, such as ash from a volcanic eruption, the carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. An important example of a secondary pollutant is ground level ozone — one of the many secondary pollutants that make up photochemical smog. Some pollutants may be both primary and secondary: that is, they are both emitted directly and formed from other primary pollutants.

Major primary pollutants produced by human activity include:

- Sulfur oxides (SO_x) - especially sulfur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain.[2] This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.
- Nitrogen oxides (NO_x) - especially nitrogen dioxide are expelled from high temperature combustion, and are also produced naturally during thunderstorms by electric discharge. Can be seen as the brown haz 56 above or plume downwind of cities. Nitrogen dioxide is the chemical compound with the formula NO_2. It is one of the several nitrogen oxides. This reddish-brown toxic gas has a characteristic sharp, biting odor. NO_2 is one of the most prominent air pollutants.
- Carbon monoxide (CO)- is a colourless, odourless, non-irritating but very poisonous gas. It is a product by incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.
- Volatile organic compounds - VOCs are an important outdoor air pollutant. In this field they are often divided into the separate categories of methane (CH_4) and non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases via their role in creating ozone and in prolonging the life of methane in the atmosphere, although the effect varies depending on local air quality. Within the NMVOCs, the aromatic compounds benzene, toluene and xylene are suspected carcinogens and may lead to leukemia through prolonged exposure. 1, 3-butadiene is another dangerous compound which is often associated with industrial uses.
- Particulates, alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to particles and the gas together. Sources of particulates can be manmade or natural. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged over the globe, anthropogenic aerosols—those made by human activities—currently account for about 10 percent of the total amount of aerosols in our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.
- Persistent free radicals connected to airborne fine particles could cause cardiopulmonary disease.
- Toxic metals, such as lead and mercury, especially their compounds.
- Chlorofluorocarbons (CFCs) - harmful to the ozone layer emitted from products currently banned from use.
- Ammonia (NH_3) - emitted from agricultural processes. Ammonia is a compound with the formula NH_3. It is normally encountered as a gas with a characteristic pungent odor. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and fertilizers. Ammonia, either directly or indirectly, is also a building block for the synthesis of many pharmaceuticals. Although in wide use, ammonia is both caustic and hazardous.
- Odors — such as from garbage, sewage, and industrial processes
- Radioactive pollutants - produced by nuclear explosions, nuclear events, war explosives, and natural processes such as the radioactive decay of radon.

Pollution in the sky of Athens, Greece.

III. SECONDARY POLLUTANTS INCLUDE

- Particulates created from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution; the word "smog" is a portmanteau of smoke and fog. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulfur dioxide. Modern smog does not usually come from coal but from vehicular and industrial emissions that are acted on in the atmosphere by ultraviolet
- light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

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- Ground level ozone (O_3) formed from NO_x and VOCs. Ozone (O_3) is a key constituent of the troposphere. It is also an important constituent of certain regions of the stratosphere commonly known as the Ozone layer. Photochemical and chemical reactions involving it drive many of the chemical processes that occur in the atmosphere by day and by night. At abnormally high concentrations brought about by human activities (largely the combustion of fossil fuel), it is a pollutant, and a constituent of smog.
- Peroxyacetyl nitrate (PAN) - similarly formed from NO_x and VOCs.

IV.SECTION THREE: FRM MODEL TO STUDY ABOUT AIR POLLUTION

Let us consider there are n attributes say $M_1, \ldots, M_n$ where n is finite associated with the atmospheric pollution and let $y_1, \ldots, y_p$ be the attributes associated with the health and environmental effects, where p is finite. On the suggestion of the experts and the environmental labourers the following attributes are taken.

Attributes Related to the Domain space M given by M = {$M_1, \ldots, M_5$}

M_1 - Agriculture.
M_2 - Mining and quarrying.
M_3 - Power generation.
M_4 - Transport.
M_5 - Community services.

Attributes Related to the Range space Y given by Y = {$Y_1, \ldots, Y_7$}

Y_1 - Increase lung cancer and Heart failure.
Y_2 - Crop and forest damage.
Y_3 - Global climate change.
Y_4 - Ozone depletion
Y_5 - Effects on wildlife.
Y_6 - Eutrophication.
Y_7 - Acid rain.

Now using the expert's opinion who is an environmental officer we have the following relation matrix. We have $M_1.M_2$, M_3,M_4,M_5 as the rows and $Y_12,Y_2,Y_3,Y_4,Y_5,Y_6,Y_7$ are the columns.

$$A_1 = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix}.$$

The hidden pattern of the state vector X = (0 1 0 0 0) is obtained by the following method:

XA_1 ↪(0 1 0 0 0 0 0) = Y
YA_1^T ↪(0 1 0 1 0) = X_1
X_1A_1 ↪(0 1 0 0 1 0 0) = Y_1
$Y_1A_1^T$ ↪(0 1 0 1 1) = X_2
X_2A_1 ↪(1 1 0 0 1 0 0) = Y_2
$Y_2A_1^T$ ↪(0 1 0 1 1) = X_3 (say)
X_3A_1 ↪(1 1 0 0 1 0 0) = Y_3 (say)

(Where ↪ denotes the resultant vector after thresholding and updating)

When we take M_2 in the ON state (i.e. mining and quarrying) and all other attributes to be in the off state.

We see the effect of X on the dynamical system A_1 is a fixed point given by the binary pair
{(0 1 0 1 1), (1 1 0 0 1 0 0)}.

When we take mining and quarrying node alone in the on state we get say X = (0 1 0 0 0)
The resultant to be the fixed point given by the binary pair {(0 1 0 1 1), (1 1 0 0 1 0 0)}.

When the on state is taken as node M_2 we see the hidden pattern is the fixed point which is the same binary pair, which makes the nodes M_4 and M_5 to be in the on state in the domain space and makes the nodes Y_1, Y_2 and Y_5 of the range space to be in the on state. Since the working is time consuming, a C program is formulated for finding the hidden pattern. The casual connection matrix A_2 is given by the second expert who is a doctor.

Let $M_1.M_2$, M_3,M_4,M_5 taken along the rows and $Y_1,Y_2,Y_3,Y_4,Y_5,Y_6,Y_7$ along the columns.

$$A_2 = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix}$$

Suppose the state vector X = (0 0 0 1 0) ie., the transport is in the on state condition and all other nodes are in the off state. We see the resultant binary pair using the C - program is given by {(1 0 0 1 0), (0 1 0 0 0 1 0)} which is the fixed point.

When we take the state vector X_1 = (0 0 0 1 0) ie., transport i.e., M_4 in the on state and all other attributes be in t[illegible]ate we see the effect of X_1 on the dynamical system A_2 is a [illegible]oint given by the binary pair {(1 0 0 1 0), (0 1 0 0 0 1 0)}.The interpretation of the hidden pattern of several state vectors using several experts is used in this paper to arrive at the conclusion. To show the mode of working we have just given two experts opinion.

V. SECTION FOUR: CONCLUSIONS AND SUGGESTIONS

NGO's and Government should take more concrete efforts to promote safe environment. Recycle paper, plastic, glass bottles, cardboard, and aluminum cans. (This conserves energy

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and reduces production emissions.). Keep woodstoves and fireplaces well maintained. You should also consider replacing old wood stoves with EPA-certified models. Plant deciduous trees in locations around your home to provide shade in the summer, but to allow light in the winter. Buy ENERGY STAR products, including energy efficient lighting and appliances.
They are environmentally friendly products. Choose efficient, low-polluting models of vehicles. Plan your trips. Save gasoline and reduce air pollution. When possible, use public transportation, walk, or ride a bike. Check daily air quality forecasts, which tell how clean or polluted your air is, and the associated health concerns. Remove indoor asthma triggers from your home and avoid outdoor triggers in order to effectively control your asthma. Minimize your sun exposure. Wear sun block and UV protection sunglasses. To find out about current forecasts of UV where you live, go to.

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