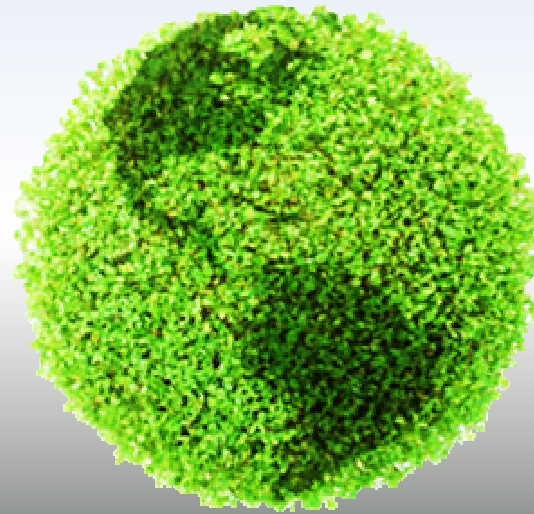


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THE MODELLING OF THE EVOLUTION OF THE CONCENTRATION OF PESTICIDES ON THE JIU RIVER COURSE

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Abstract:

Pesticides are among the most widely used chemicals in the world, and also among the most dangerous to human health. Pesticides can also have chronic health effects both because of acute poisonings and chronic exposure. Many studies have shown adverse health effects on humans. Many of the commonly used household insecticides are organophosphates. These have been linked in many studies to neurological damage in humans. The classic measurements used for pollution evaluation include the biological consumption of oxygen in a 5 days period of time and the chemical oxygen consumption, the amount of oxygen extracted from water by bacteria when agents of pollution are decomposing. The more organic matter can be found in discharged effluents the more the amount of oxygen necessary for decomposition of such pollutants increases and, consequently, the higher the pollution.

In this paper, a mathematical model of the evolution of concentrations of pesticides is widely studied. This model is a dynamic bi-dimensional system with three parameters. The variables of the system are the concentration of pollutant and the level of oxygen from water. We achieve this thing by determining both the time trajectories and the evolution of the degrees of oxygenating the waters as a function of the quantity of pollutant for various values of the parameters.

Keywords: pesticides, environment, dynamic bi-dimensional system, GC-MS.

1. Aims and scope of the paper

Water and groundwater contamination, resulting from the use of various pesticides, is becoming a growing concern. Pesticides generally have low solubility in water and are usually manufactured in powder form, as suspension concentrates or as miscible liquids. Under the 1980 EU Directive on Drinking Water Quality, the maximum admissible concentration for any pesticides in drinking water is $0.1\mu\text{g/l}$ (0.1 parts per billion)¹.

This paper presents a study of some organophosphorus pesticides, organochlorine pesticides and carbamates pesticides distribution on the Jiu River course; a river from south Romania. The concentration of pesticides was determined by GC-MS - gas chromatography with mass spectrometry detection.

2. Review of the Literature

Pretty considered that environmental health, economic profitability, and equity are the goals of sustainable agriculture. The following concepts are integral to sustainable agriculture: understanding of the interrelationship between air, water, and soil; the need to provide farmer and consumer safety; and the commitment to a stewardship of the land. The movement for sustainable agriculture addresses many social and environmental concerns, in addition to promoting innovative and economically viable farming methods such as crop diversification and biological pest control. Sustainable agriculture brings together such aspects of agricultural science as pest management, soil and water conservation, food safety, and animal welfare .

Candea, and Bran in 2001 said that the agriculture is an extensive industry using almost 58% of land surface in Jiu River Basin. Agriculture has long been a major source of income for many people living in the Jiu River Basin. But today agriculture is also a major source of pollutants including fertilizers and pesticides, as well as effluent from huge pig farms and agro-industrial units.

Inappropriate agricultural practices in some areas have polluted rivers and groundwater, and led to soil erosion.

In 2004 Hayes considered that water and groundwater contamination, resulting from the use of various pesticides, is becoming a growing concern. Pesticides generally have low solubility in water and are usually manufactured in powder form, as suspension concentrates or as miscible liquids.

3. Mathematic Models

- The economic models dated after 1950 mainly referred to the production dynamics. The following stage consisted of the improvement of the previous models, by including social criteria, such as those connected to welfare, poverty, etc. After 1980, restrictions have been introduced regarding the environment. This new evolution occurred as a consequence of an increasing concern for the environment as a main factor determining the quality of life.
- Various types of pollution (water pollution, traffic pollution, noise effects, soil pollution, etc.) may be simulated mathematically, using new approaches, different from the classic ones. For this purpose, the dynamic systems prove to be very useful. The study of those systems provides the possibility to signal the interactions between the specific parameters, being a flexible method of optimally determining those parameters.
- Dynamic systems, studying determinist processes, have known an extraordinary development in the past years, as applications in various domains such as physics, chemistry, engineering, and ecology. A process is considered to be determinist if its subsequent and past behavior is uniquely determined by its present state; the dynamic system is the mathematical model of a determinist process.
- The usage of the dynamic model may outline through objective indicators the main characteristics and evolutions of the quality of water; with its help, one may register many dysfunctions with the most serious consequences on the environment. Through it, the environment policies become mostly anticipative.
- The mathematical modeling is some from most important instrument of scientific cognition, with its help we can realize a conventional image objects research, a simplification representation of reality. The model is a facsimile with degree of variable difficulty of real world or a parts component of them. The understanding of this phenomena segments of reality tackles, know in detail, quotient and act about phenomena analyses motivate the reason appealed to such representations. Most dense used-up idiom is the mathematical idiom. Afterwards, we appealed at this for surprised with a dynamic model the complex behavior for a system, for emphasize how structure variables determine the trajectories, respectively the temporally behavior.

4. Experimental

The samples have been taken in three months: January 2008, April 2008, July 2008, and October 2008. These represent four seasons: winter, spring, summer and autumn. Were determined some of the most dangerous pesticides from Jiu River, from seven different points of the Jiu River. These points were: (1) Campu' lui Neag (The West Jiu); (2) Livezeni (The East Jiu); (3) upstream the confluence with Sadu; (4) Balteni; (5) Podari; (6) Malu Mare and (7) Zaval, the point where the Jiu River flows into the Danube.

Samples must be collected in glass containers. The distance from the river side is about 2.00 – 2.50 meters and the depth was about 0.20 – 0.50 meters [Stoica, Stanescu, and Baiulescu 2003]. Conventional sampling practices should be followed; however, the bottle must not be prerinsed with sample before collection. The samples must be iced or refrigerated at 4°C away from light from the time of collection until extraction.

Preservation study results indicated that most method analytes present in samples were stable for 14 days when stored under these conditions [Suess 1982].



4.1. Mathematical model

The pesticides enter in the water at a constant rate. Bacterial action metabolizes (decomposes) the pollutant at a rate proportional to its mass. In doing so, the dissolved oxygen in the water is used up at the same rate that the pollutant decomposes. However, oxygen in the air re-enters the lake through surface-to-air contact (this is called re-aeration) at a rate proportional to the difference between the maximum dissolved oxygen level that the lake can support and its current actual value.

To find the dissolved oxygen level, in the water at any time, observe that its rate of change depends on an input that is proportional and with the deficit of oxygen, where is the maximum (saturation) level of oxygen in respective water, and an output that is proportional to the mass of the pesticides. Is obtained thus first equation for represents the evolution of this level, temporally, depending on the mass of pollutant [Beltrami 1990]:

where and are constants. At the same time, the rate of change depends on the constant input rate, and a decay rate is linear in itself. Thus, we can write:

Obtain thus, a dynamic linear affine system, bi-dimensional, which depends on three real parameters (α , β , and γ) by means of whom we can cause as much evolution temporally degrees of they oxygenate the waters and amount of pollutant gift and dependent degrees of pollute the waters depending on mass of pollutant. In the above-mentioned conditions evolution amount of oxygen in water is governed of problem Cauchy, for the system of differential equation of the first order:

Because it is a dynamic linear afin system the discrepancy among it and liniarized is translation equilibrium to origin. The two systems are topologic equivalent, indifferently of the type equilibrium [Arrowsmith, Place 1990].

5. Results and discussions

Figure 1 shows the variation of the concentration of some pesticides in the samples taken from the Jiu River in January 2008. The concentration for Lindane in all the harvesting points does not overtake the admitted limit. The concentration of Diazinon grows relatively constant from Campu' lui Neag to Zaval, but in Malu Mare and Zaval points the Diazinon concentration overtakes the admitted limit.

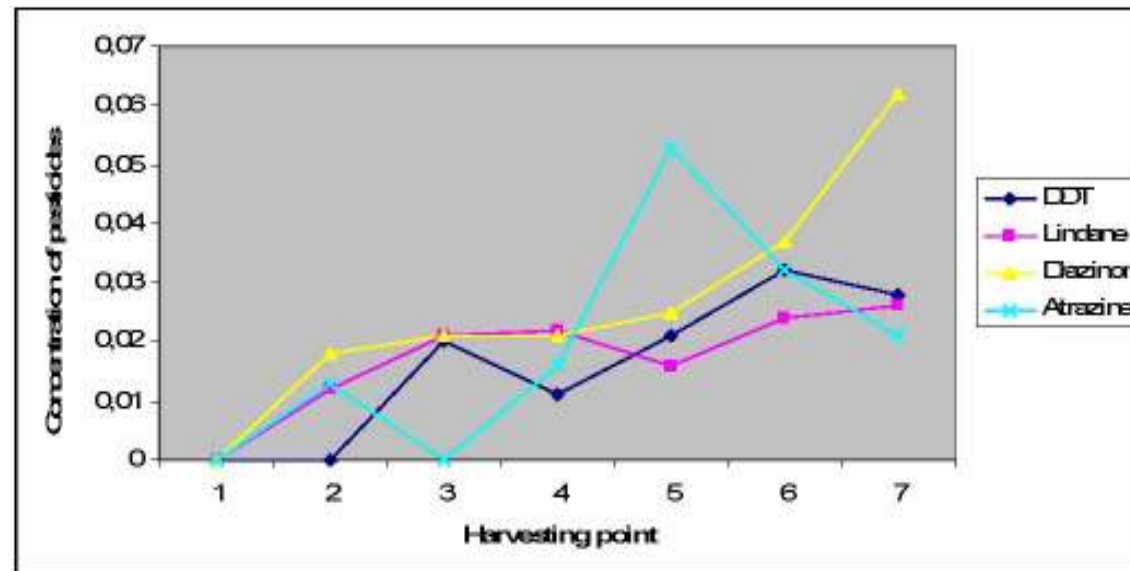


Figure 1. The concentration of some pesticides (mg/L) in the samples taken from the Jiu River in January 2008

5. Results and Discussion

Figure 2 shows the variation of the concentration of some pesticides in the samples taken from the Jiu River in April 2008. Of all analyzed pesticides, the Diazinon concentration overtakes the admitted limit in Malu Mare and Zaval points.

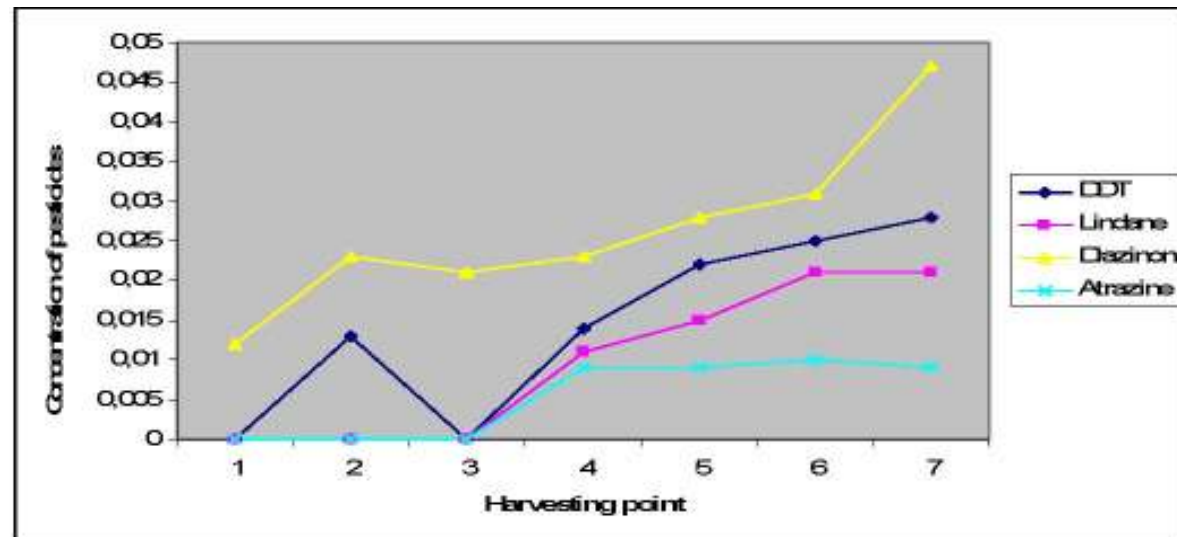
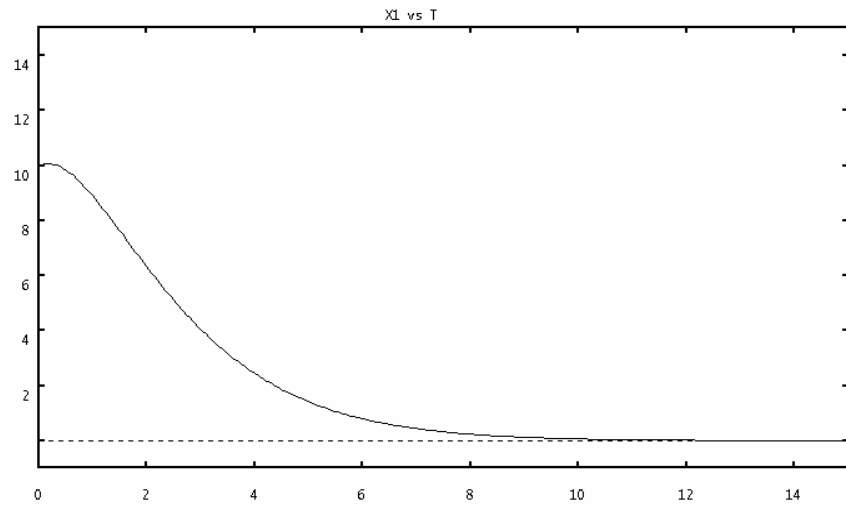
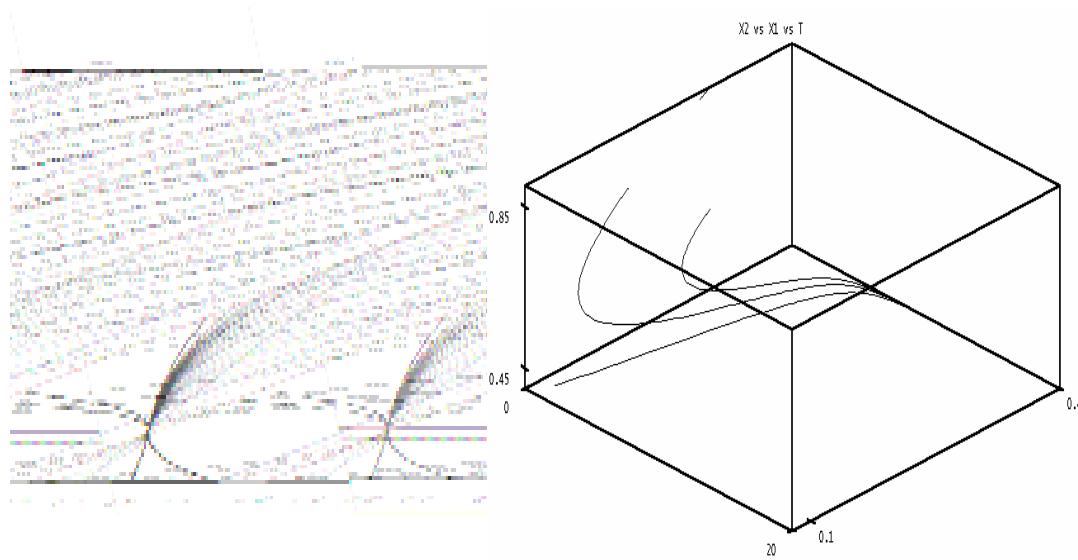


Figure 2. The concentration of some pesticides (mg/L) in the samples taken from the Jiu River in April 2008

$$\begin{cases} -\beta x - \alpha y + \beta x_m = 0 \\ -\alpha y + \sigma = 0 \end{cases}$$



6. Conclusions

- Concerning the containing of pesticides of the Jiu River, in 2008, the water of the Jiu River are from I class of quality, from (1) Campu' lui Neag point to (4) Balteni, and from II class of quality from (4) Balteni to (7) Zaval, the meeting point with Danube River.

The containing of pesticide of the Jiu River course is bigger in summer and autumn than winter and spring.

GC and MS are useful tools for chemical analysis, especially when used together.

The modeling of this phenomenon can let us causes a value of equilibrium and his gives estimates it a temporally behaviors of them. This dynamics is reflecting the diminishing of the punctiform emissions, mainly in industry and agriculture, as a direct result of cutting down the economic activity but also as a result of applying more extensive steps of protection as far as the water quality is concerned, as comparatively with the previous period, before 1989. As far as the phreatic waters are concerned, there are certain areas within the rural space, where relatively high concentrations of nitrogen and pesticides (DTT and Diazinon), still persist.

- However, to provide models for environmental systems is a difficult matter, owing to the complexity of the systems and of interactions that they have had with various other systems, an interaction which is sometimes difficult to determine.

For the future, we intend to develop a more complex model, taking into account the interaction between the physical and chemical factors (temperature, salinity, light, nutrients, water agitation) and the biological ones (the presence of an algae population in the area).

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