Ecosystem approach and the Fuzzy logic: a dialectical proposal for information on Environmental Health

Abordagem ecossistêmica e lógica Fuzzy: uma proposta dialética para o uso da informação em Saúde Ambiental

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Abstract

The ever-growing production and the problematization of Environmental Health have shown the need to apprehend complex realities and deal with uncertainties from the most diversified instruments which may even incorporate local aspects and subjectivities by means of qualitative realities, while broadening the capacity of the information system. This paper presents a view on the reflection upon some challenges and possible convergences between the ecosystemic approach and the Fuzzy logic in the process of dealing with scientific information and decision-making in Environmental Health.

Keywords: environmental Health; ecosystemic approach; health indicators; Fuzzy logic.

Resumo

O avanço da produção intelectual sobre Saúde e Ambiente tem demonstrado a necessidade de apreender realidades que são complexas, além de lidar com suas incertezas. Nesse sentido, os instrumentos utilizados deveriam incorporar aspectos subjetivos e qualitativos, além dos elementos de cunho quantitativo, ao retratar uma condição local. Esse artigo apresenta uma reflexão a respeito dos desafios e dos possíveis pontos de convergência entre uma abordagem ecossistêmica e a lógica Fuzzy nesse processo de lidar com a informação para apoio a tomada de decisão envolvendo Saúde e Ambiente.

Palavras-chave: saúde Ambiental; abordagem ecossistêmica; indicadores de saúde; lógica Fuzzy.

Introduction

The meanders of the relation between health and environment have been unveiled in a more intense manner in the last few decades, with syntheses, research and productions which denote an ever-growing interest in the area. Thus, it is possible to resort to a diversity of assumptions, models, approaches and methods. This is justified due to the complexity inherent to the relations involving society and environment. Moreover, their implications require constant improvement of knowledge and interaction with the area, especially in terms of the need to improve the means to qualify and establish a dialogue with the subjects in environmental situations, who are crucial elements in the sense of obtaining broad understanding and effective management measures.

Methodology

This paper is a literature review and presents a view of the reflection about some challenges and possible convergence between the ecosystemic approach and the Fuzzy logic in the process of dealing with scientific information and the decision-making in Environmental Health.

At first, some comments are made in the theoretical framework which has positioned the information in a broader and more relational discussion, placed in the process of establishing a new knowledge production paradigm and guidance intervention. The Ecosystemic Approach, as a line of thought that incites the expansion and the interaction of the analysis with the local and global peculiarities, is allied. Then, by the light of this panorama, the text starts by presenting challenges and potentialities of the application of the Fuzzy logic in this context.

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Discussion

The relationship between conceptual landmarks and scientific information in Environmental Health

In a worldwide scope, the standard proposals for the relation between the environmental issue and information have been presented in the last few decades by the United Nations Organization (UN). In the 20th century, two important thematic conferences took place in different venues — in 1972 it was in the city of Stockholm, Sweden, and, twenty years later, in Rio de Janeiro, Brazil. In the latter came Agenda 21, which is a document based on the commitment to promote the concept of sustainable development among countries. By establishing a dialogic role between conceptual basis and practice, it leads to a greater effort on the environmental theme towards a more regional focus. Thus, community leaders, managers, professionals from the fields of education, health, among others, targeted their interests to local discussions. In this period, Agenda 21 focused on neighborhoods, municipalities, federation units, countries and even certain companies and schools.

In this direction, the social actors are placed in the frontline. Agenda 21 incites the participation and the involvement in the promotion of analysis, discussions, and propositions, and also in the monitoring of environmental situations. This fact must not be understood without a critical eye, according to the analysis of Acselrad, Mello e Bezerra (2006), when they highlight the decrease of the State's action regardless of these responsibilities and the calling made to the citizens. Nevertheless, one must not disregard that the organization of Agenda 21 increases the use of information, even to capture regional peculiarities. In order to answer these demands, the creation and proposition of several indicators in the past few years, used to interact with the environmental reality, in a diagnosed and propositional way, take place.

Aiming at a possible comparison and standardization of the local basis initiatives, the UN has started a series of activities to develop standardized methodological criteria, conceptual models, and measures that could serve as reference for some countries on a global scale. Such function was performed by the Sustainable Development Commission, which is part of the Millennium Ecosystem Assessment that started in 2001.

This initiative aims at studying the different situations rising from the relationship between human beings and ecosystems, by underpinning scientific basis for actions and strategies. In one of the guiding documents, the conceptual model called FPSEEA (which stands for driving force, pressure, state, exposition, effect and action) is presented as a possible instrument to understand the relations between health and the environment (ONU, 2001).

The presentation of the "Millennium Development Goals" is also part of this process. Due to its concise perspective, with a less technical profile and the coverage of more generic population groups, it ends up having a diverse tone, in a certain way, from the premises found in Agenda 21. In Brazil, the version was named "8 Ways to Change the World". Concerning the discussion on the use of information, the "ways" seem to force a more significant demand so that the state-of-the-art of the situations could be provided.

The purpose which deals more specifically with the issue of quality of life and the environment, for instance, can be illustrated and debated with diverse claims. Nowadays, some research has been consolidated by the academy, non-governmental entities and the public power at hand which problematizes themes such as air, soil or water pollution, climate changes and biome degradation, to mention just a few.

In addition to the systematization of information to describe the purposes of the millennium, other stimuli have taken place simultaneously. For example, Schirnding (2002), in his publication, which was an important landmark supported by the World Health Organization (WHO), details a series of possibilities for analysis and planning based, in the local and global spheres, on indexes aiming at the sustainable development.

Nowadays, the production and release of information on Environmental Health is diverse. A considerable part has been made available and is being accessed by technicians and other people, who have been recently interested on the subject, in the documents housed in libraries and virtual data centers. Countries such as England, France and Canada offer a compelling list of online data. Developing countries, on the other hand, continue to invest so that they may consolidate the practice and improve both the quantity and the quality of the information available. Brazil in particular presents a long list of health data covered by information systems. However, there is greater need for attention related to Environmental Health and, specifically, to the viability of the National System of Environmental Surveillance (AUGUSTO & BRANCO, 2003; BARCELLLOS & QUITÉRIO, 2006).

As one of these emerging issues there is precisely the relationship between these pieces of information on Environmental Health and virtual space. Bullard (2000) mentions the internet as a tool with the potential to disseminate information. While commenting on Agenda 21, he highlights that it may contribute with aspects such as social participation and social inclusion, as long as it does not end privileging the relationship established in the real realm of everyday life. The publication of instruments in websites and the formation of nets for spreading the situations concerning Environmental Health are set as alternatives in the near future and, thus, they need to be stimulated.

Nevertheless, once the access to digitalized means is unequal, especially in developing countries, the use of virtual space with a critical eye, therefore, makes much sense. When discussing technology and equity to the auspices of environmental justice, Ottinger (2011) points the need for initiatives that can facilitate the inclusion of most

participants, such as local members of communities, in the consulting processes, in the use and in the elaboration of information.

To sum up, the conceptual landmarks itemized in the last few decades have established an important movement. On one hand, they stimulate the use of information on Environmental Health, mainly concerning its quantitative and local aspects. On the other hand, they give the tone to aggregate more interactive dialogues, to use different methodologies, and to amplify the debate with different participants.

The Ecosystemic Approach and the new approaches to Environmental Health

The ecosystemic approach presents contributions to the theme under question since it considers transdisciplinarity and the participation of different subjects as essential attributes (LEBEL, 2003). According to Minayo (2002), this kind of focus on ecosystems links strategies that encompass both the environment and the health in face of a holistic approach. In this sense, the challenge of articulating cultural, health-related, economic and environmental components in a dialogic perspective is proposed. In order to overcome fragmentation and isolated interpretation, it leans on complex thinking (MORIN, 2005).

The situation of the current environmental and health issues requires researches with integrated, participatory methodologies that can relate not only the biophysical parameters, but also the social aspects. Waltner-Toews (2004) summarizes the integrated work with people and their contexts, in which from both the measurements, instruments and probable actions are originated, as an important role of the ecosystemic approach.

The issue has a strategic sense, especially in the context of Latin America, where great reservoirs and areas under environmental protection are found, while at the same time fast and intense socio-environmental changes, as the ones which arise from demographic growth, urbanization and the economy based on the export of natural resources, still occur. It faces challenging situations regarding Environmental Health, with the recrudescence of diseases, serious inequity situations and environmental conflicts. Freitas *et al*. (2007) show that very important elements, such as social participation and the amplification of interfaces between human health and ecosystems, are yet at an incipient stage.

Ferry (2009), under the light of philosophy, reflects about the influence of the Cartesian view, which considers nature as a human domain, until the current ecological concern with its strands. The democratic and political ecology, in line with environmental news, approached by the author, may present intense connections with the ecosystemic approach in this sense.

The more integrated view for understanding the interaction between the questions of the health-disease process and the environment, encompassed by the ecosystemic thought, finds reciprocity and advances into international formulations. According to Parkes and Horwitz (2009), this is the converging aspect of the Millennium Development Goals and the current research carried out by the Commission of Social Determinants in Health from the WHO, for example. The authors' conclusion is a stimulus, since it recruits researchers, managers, and professionals who are willing to dialogue and experiment new approaches in this concept, in order to promote both health and sustainable development.

The challenges in the use of information under the ecosystemic view

Aiming at approaching this summoning, one of the remaining tasks in the last few decades has consisted in using the information on Environmental Health to elaborate instruments such as indicators or indexes. However, the reflection on the appropriation and efficiency of such tools remains discrete.

Likewise, most of these measures in environmental law are actually incompatible with the ecosystemic approach, which notably emphasizes the need for partners, participation and social commitment in the decision-making process. The involvement of subjects remains restrict and limited. Instances which privilege the articulation between managers, community and Environmental Health issues, in general, are distinct in the current scenario.

Thus, a virtuous cycle which will promote full articulation among the sectors by using instruments and relating roles and yearning, is not favored. Freitas (2005) characterizes this aspect very well in the study he conducted on the scientific production regarding environment and collective health in Brazil throughout the period of ten years. While investigating the participation of the subjects involved in the problems, he noticed that almost 80% of the papers produced did not even predict any involvement.

Another worth-mentioning challenge involves the difficulty of appropriation by the users of the instruments presented. In the attempt to shelter the systemic relation under the scope of indicators, several proposals appeared. In order to understand the variety, Ness *et al*. (2007) performed the categorization of the instruments used to evaluate sustainability. In that single paper, more than 30 instruments are demonstrated and each of them present a dense conceptual framework. The matrix FPSEEA, for instance, is classified by the authors under the perspective of non-aggregated indexes. In its operationalization, it unfolds in a range of almost six dozens.

In this sense, Ravetz (2004) highlights that neither the quantity of indicators nor the possible intersectorial constitution, with socio-economical, environmental and health components, are enough to constitute a framework able to capture and dialogue with local issues, such as the relations between community and environment, the inherent uncertainties and the possible consequences to health and human well-being.

In order to exemplify the notes, there is the Health Family Strategy (HFS), a Brazilian program concerned with basic health care which works on territorially-based actions focused on the integrality of health actions, especially in terms of promotion and prevention (BRASIL, 2006). The HFS has been facing difficulties to produce information which may characterize relevant and intersectorial aspects of health (ESCOREL *et al*., 2007). In order to illustrate it better, instead of more experts in the health field, community agents are the collaborators in basic attention. Since they are closer to the community and its reality, they present more conditions to have a multidisciplinary understanding of the problems that, nevertheless, are characterized in a qualitative way and, at first, do not find the means to generate indicators according to the current methodologies used in the information systems (IANNI & QUITÉRIO, 2006).

As an example, Giatti *et al*. (2010) studied a Brazilian urban community placed in an area formerly used as a landfill, where there was collection and use of water from wells containing heavy metals to supply human needs. In this context, the dwellers that were exposed to such conditions understood the process of environmental degradation, but did not associate this to the possibility of chronic diseases, since they thought the water was potable. In a situation like this, even though there is public water supply, the choice for water from wells for domestic use may prevails. However, the production of information regarding the supply of potable water becomes possible, although the subjects' preferences and the risk are not captured and systematized, remaining only as knowledge for the ones who are aware of the situation on a daily basis, such as the health community agents.

Thus, it seems necessary that new methodological resources be explored so that most of the expectations of the ecosystemic view may be reached.

The incorporation of uncertainty and other possible contributions from the Fuzzy logic

It is also important to highlight that the recent issue of Environmental Health, with critical growing questions coming from human intervention, has relations yet to be known. Thus, the uncertainty in the relation with knowledge is real. In other words, it is rather an epistemic question than an ontological one.

Janssen *et al*. (2010) argue with the issue of imperfect knowledge and propose a model which, aiming at getting closer to a description of reality with different uncertain dimensions, does it precisely. Actually, by being supported in an ecosystem approach, according to Nielsen (2001), it is necessary to adapt since uncertainty will be a constant, not having to be reduced or even despised.

To consider the uncertainty of knowledge in the relation between health and environment means to legitimate its value in terms of complexity and inherent unpredictability. A good example would be the judgment or attribution of values, by different groups of people, to the choice of policies that would have to be priority in the allocation of resources, or even in their everyday practice. In this case, to reach systematization, besides the instruments one must resort to information in a subjective way and involve a variety of opinions from the participants. It is a challenging process. Ascough II *et al*. (2008) point to the incorporation of uncertainty in the environmental research field in order to enable the decision-making process as a great necessity. Thus, estimating without despising this panorama ends up being imperative.

Andriantiatsaholiniaina, Kouikoglou and Phillis (2004) claim that the dynamics of any given socioenvironmental system is described in a precarious way when supported by the method of classic logics. There is the need to contemplate the polymorphism of the sustainability concept and the eventual doubts that underlie it. According to this assumption, Carpenter *et al*. (2006) criticize the initiatives that work in an isolated perspective in relation to the fields of knowledge and do not explore the identification, the estimates and the communication of uncertainties. The authors emphasize the need for new coalitions among different fields or to resume aspects from the ecosystem approach, by having some transdisciplinary proposals.

The paradigm of complexity, as Almeida Filho (2004) would put it, supported by his own reflections and those by Edgar Morin, represents the opening of science to the phenomena which were before excluded from old paradigms. Among them, there is the contribution of the Fuzzy logic model, since it manages to approach the phenomena by considering imprecision, which is a clear advantage over the classic logic model. Contrary to this binary focus which, therefore, requires a high degree of precision bearing in mind that interpretations are always dual, in the Fuzzy logic model intermediate values that approach the concept of partial truth are possible (ZADEH, 1965).

In order to deal with the nature of the existing uncertainty in the area of Environmental Health, the Fuzzy logic model is a relevant tool. As aforementioned, there are many situations of knowledge concerning the incomplete phenomenon or conflicting information. Zadeh (2008), while commenting on the potentialities of the theory of groups called Fuzzy, highlights the ability to learn and to incorporate these characteristics from reality. This can be understood as a great feature, since essential aspects are not lost in relation to the problems which were analyzed. According to the author, one of its properties is to offer precise focuses in imprecise environments.

When presenting the use of the Fuzzy logic, Tran *et al*. (2002) are emphatic by justifying the choice in detriment to a probability approach. In their work, the authors wished to hierarchically integrate some indicators in order to classify the ecological vulnerability of a given region. If the vulnerability among the indicators was not related to the unawareness as to how the relationship between each one was established, among other aspects, a subjective questioning, it is possible that the analysis of probabilities would be indicated. The task ends up being more complex when the amount of indicators selected by the

authors in reunited. It is not only by its quantitative aspect, but also by the possible relations established among the instruments which had remained unknown until then. The authors justify that once an event has this characteristic, the Fuzzy logic would be the best tool.

Su, Fath and Yang (2010) present an argument which is in accordance with another particular feature. The authors emphasize, for the ecosystemic analysis, the centrality of capturing the choices and the judgment of human beings. The Fuzzy logic is skillful and capable of incorporating and manipulating linguistic variables, so it is characteristic of the human process of reasoning. To illustrate it, a relevant essay shows the suitability of the Fuzzy logic to a holistic indigenous knowledge which apprehends the characteristics of the environment by means of ongoing readings and the collection of a great number of qualitative variables (BERKES & BERKES, 2009).

Last, but not least, it is not our intention to present a review of the literature with research that uses the Fuzzy Logic. However, one may not forget that studies are increasing in number, as shown in the registers of the research database. The study by Massad *et al*. (2010) is worth mentioning, in which the authors compile fundamentals and also present applications and research conducted especially in the field of health.

In the environmental field there is the application of the Fuzzy logic, for example, in the hierarchical analysis of processes, evaluation of impacts or even elaboration of a model to provide support for the decision-making process (SILVERT, 1997; FISHER, 2003; ZENG; *AN; SMITH,* 2007; MORÓN *et al*., 2009; KAHRAMAN & KAYA, 2010). The research developed by Ocampo-Duque *et al*. (2006) illustrated how a fuzzy mathematical model can be developed that produces a summary measure to monitor some region. In this case, the method was used for the elaboration of an index of quality of water. The study compared the results from the model with other indicators and reports. In conclusion, the authors highlighted the robustness of the model using the Fuzzy logic.

Facing the current and emerging issues, by improving the relationship between information and the contributions in the realm of Environmental Health, the Fuzzy logic is a remarkable ally of the Ecosystemic Approach, because on a first level, it may open ways for the establishment of a dialogue between different kinds of knowledge regarding the complex realities on a local basis with the information systems, which are traditionally quantitative and reductionist. Inside a systemic logic, this flow of information may constitute a significant process of feedbacks (KAY *et al*., 1999) if it is connected to the more precise alternatives in the managing process of environmental and health problems.

Therefore, there is property relevance with conceptual landmark. In this case, it is expected that successive studies may privilege the ecosystemic approach allied to the methodological options supported by the Fuzzy logic.

Conclusions

There are converging aspects in this reflection. First, the observation that the theoretical framework, such as Agenda 21 and the Millennium Development Goals, has increased the analysis and the use of information. Towards the challenges of dyadic information and Environmental Health, the ecosystemic approach has been pointing towards important routes, such as social participation and transdisciplinarity, and deserves to be valued. The Fuzzy logic needs to be more explored, once it presents converging aspects with the wish for systemic analysis, allowing it to have a glimpse at transdisciplinarity and, possibly, portraying the investigative reality in the field of Environmental Health. For these aspects, the ones involved in Environmental Health must privilege science and technique grounded in the local-global emerging issues. Thus, to the eyes of environmental justice, they need to explore the effective potential of the instruments and promote the concise and judicious use of the information.

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