Complex systems and slaughterhouse waste management

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Abstract

Environmental problems, such as pollution provoked by slaughterhouse wastes, can be examined with an integral, multidimensional and systemic approach. The objective was to design a strategy to use such wastes as organic fertilizers; this as a solution to the pollution and social problems they provoke. The methodology applied was the one proposed by García (1986, 1994) for the study of complex systems. The starting point was the conceptual shift of pollutant materials from “waste” to “byproducts”. The research started with the construction of the system subject of study -the Slaughterhouse-Complex- considering certain key elements and the interactions between them; once the system was constructed, a diagnostic survey was conducted focusing on the identification of processes and mechanisms corresponding to the dynamics of the problem under study. Afterwards, an analysis of the dynamics of the system itself was performed, as well as of the changes that resulted from the processes of destructuration-restructuration arisen with the new stationary state reached by the system. Finally, it is suggested that with the proposed conceptual and structural changes, the new stationary state of the Slaughterhouse-Complex system will contribute to solve the environmental problems and to achieve a sustainable agricultural development.

Keywords: complex systems, system dynamics, slaughterhouse waste products.

1 Introduction

The environmental problems in which humanity currently lives are extremely complex. This complexity is derived from the fact that there are really certain ecological, economic, political and social phenomena which are linked among themselves in a network of multiple interactions.
World scale environmental problems, such as desertification, greenhouse effect, poverty and hungry, ozone layer depletion and the loss of biodiversity, among others, can no longer be seen as isolated problems but as the result of interdependent processes derived from a conception of the world centered on economist discernments and short-term benefit.

On local and regional scale, these problems can be manifested as water contamination, the loss of fertility of farmland and soil, excess energy consumption and pollution from urban wastes, among others.

As an example of the last problem indicated previously, we have the case of the slaughterhouses. Municipal slaughterhouse wastes are an important source of public health problems. In general, liquid wastes are unloaded in rivers or ravines and solid wastes are sent to landfill or exposed outdoors. However, collection and utilization of these materials provide wide benefits as economical as sanitary.

Complex problematic such as this, in which the physic-biological environment, manufacturing, technology, social organization, economy and culture are involved, is characterized by the confluence of multiple processes which interrelations constitute the structure of a working system as an organized whole, which, Apostel [1] and other researchers have called “complex system”

Faced with these situations of this multidimensional reality, new methodological approaches are necessary. New methodological approaches which are based on an integral, multidimensional and systemic vision of the problem as well as from its historical analysis so as to be able to understand its origins, are required.

On considering reality as a complex system, several authors, such as Garcia [2]; [3] and Novo [4] point out that a key task with which to adequately interpret the problem is fundamental in order to identify the system which is the object of the study; as well as the connecting elements, the flows and the guidelines which connect the systems behaviors.

The methodology has two objectives: first, to obtain a diagnosis of the functioning of the system; second, to be able to act on the system. To achieve the first objective, it is necessary to construct the system which is the object of the study. In order to do this, it is necessary to take from reality the elements which have an impact on the environmental problems which are being interpreted, to discover the interactions which occur amongst them and to identify the processes which take place. In order to achieve the second objective, there is a tendency to formulate policies aimed at stopping or reverting the deteriorating processes within the system studied.

The elements or components of the system are not independent in the measure in which they mutually determine each other. The elements in question must be those in which the relationships are more significant. This selection of the elements is determined by the questions which orient the research. The election of the limits must be carried out in such a way that the problem to be studied has a certain organization or structure. The structure is determined by the group of elements which come about among the elements. The study of the structure of the systems explains their historicity. The study of the structures of the systems
has the study of the mechanisms for structuring and de-structuring as a central topic, which allows for the analysis of when and how a structure is transformed. The central study of the dynamics of the systems is the study of processes. The processes describe the changes which take place in the system. Once the system is constructed, the interactions between what remains within the system and what remains outside is taken into account through the conditions of the periphery or conditions of the limits. These conditions are specified in the form of flows. In the study of the flows, it is necessary to consider the speed of change. The speed of change is closely related with the temporal scale of the phenomena which are to be studied (Figure 1).

![Figure 1: Components of the complex system.](image)

The epistemic framework is the set of theories or theorizations which make up the “corpus” of knowledge based on which the study of a specific problem is approached. Thus the identification and selection of the data which is taken from the empirical reality is defined by it. In this way, the epistemic framework represents a certain conception of the world and on many occasions implicitly expresses the researcher’s evaluating body. The observable factors are data from experience which have been interpreted under a specific epistemic framework.

2 Description of the problem

The city of Puebla, Mexico, is located in the central western part of the Mexican Republic.

On average, the Puebla's Municipal Slaughterhouse sacrifice 400 pigs, 175 head of cattle and 35 sheep and goats per day.

From this sacrifice, approximately 5,000 liters of blood, 3.3 m³ of ruminal contents, 17,000 liters of effluents generated by the washing of the entrails, and 100 cm³ of hoofs and bristles are produced.
Blood and effluents produced by the washing of the entrails are unloaded, without any treatment, at El Conde ravine.

Ruminal contents, hoofs and bristles are thrown at posterior zone of the slaughterhouse. Here, these wastes are exposed outdoors and human settlements are nearness.

In this way, the Municipal Slaughterhouse in Puebla, and its surrounding area may be considered a spatial expression of a reality which is intermeshed with social, political, economic, cultural and ecological situations. These situations are characterized by the convergence of processes which are not interdependent among themselves but which are interrelated and constitute a complex system which functions as an organized totality which is not static but is instead dynamic.

The objective of this approach is to design a strategy to use slaughterhouse wastes as organic fertilizers; this as a solution to the pollution and social problems they provoke.

3 Posing of the system

When the environmental problem is analyzed considering the slaughterhouse in relation to its environment, an attempt is made to interpret the manner in which the relationships and interdependence between it and some elements which interact with it come about.

Owing to is impossible to consider all of the elements which are part of the reality, a certain number of relationships between certain elements of concrete and multidimensional reality in which the slaughterhouse is immersed are established.

The conducting thread with which to define the relationships and the elements which come about in the environmental problems is established by the “leading questions”. Waste products, such as blood, ruminal content, hoofs, bristles, which cause environmental contamination problems, once processed, could these be considered useful byproducts for agriculture in the production process of meat? And, what implications would this conceptual change have on the functional and structural relationships between the slaughterhouse and its environment?

Now, in order to refer to the Municipal slaughterhouse and the elements of the empirical reality which impact the environmental problems in question, the expression Slaughterhouse-Complex will be used. Both the limits and the elements or components of the Slaughterhouse-Complex were not well defined at the beginning of the research. Their characterization is elaborated based on leading questions and of a certain behavior in a specific number of social, ecological and/or productive activities which interact and are interdependent.

The selection of the elements for analysis is made on the basis of an interpretation of the function which they have within the organized totality which is strategic for the proposed analysis.

When the analysis of the Slaughterhouse-Complex is undertaken, blood, hoofs or ruminal content are not observed in an isolated manner but as “organic
waste” or “organic fertilizer”; categories which are the result of a conceptual elaboration related to the productive, economic, social and ecological activities. The blood, hooves and ruminal content are facts which are part of the empirical experience, while the organic waste and organic fertilizers are observable and are interpreted in the context of a specific epistemic framework.

The challenge then, consists of going beyond the identification of the elements selected (description of the system) to the understanding of the processes or processes which take place in the Slaughterhouse-Complex (interpretation of the system).

4 Construction of the Slaughterhouse-Complex system

The Slaughterhouse-Complex system is constructed based on the relationships which come about between the slaughterhouse and some elements or components in their environment: the operational systems related both to the process of slaughtering cattle, pigs, sheep and goats as well as the process of waste generation which occurs within the slaughterhouse, as well as the impact on the environment and society (environmental problems).

The environmental problem is not only the ecological damage or the contamination of water and soil, but also, it is related with social, political and economical processes such as the awareness of one’s neighbors, and political and economic processes, such as urban development and municipal management, among others (Figure 2).

![Figure 2: Construction of the Slaughterhouse-Complex system.](image)

The Slaughterhouse is the connection between the physical environment and livestock production with society, which at the same time provides the means of appropriation, transformation, circulation and consumption of production. In these articulations, two general types of interactions come about. The ecological
type interactions and the social-economic type interactions, in which the processes by which the animals are slaughtered play a determinate role generating processes of environmental and social deterioration (for instance, contamination and detrimental effects on the neighbors’ quality of life).

For methodological effects, a starting point may be a diagram with which to indicate the location of the Slaughterhouse-Complex within the empirical reality. Thus, some levels of macro, meso and micro organization can be established. The macro level is the totality of the empirical reality, in this case, the municipality of Puebla. Pue., at the micro level the slaughterhouse is defined by its “inside” elements. At the “meso” level the “portion” of empirical reality which includes elements from “outside” which interact with the slaughterhouse through the periphery conditions by means of the flow of matter, energy and information (Figure 3). In other words, the meso and micro levels correspond to the system which in the previous paragraph was denominated the Slaughterhouse-Complex.

Figure 3: The Slaughterhouse-Complex system and its surrounding area.

The limits of the Slaughterhouse-Complex system are represented by the meso and micro levels. These two levels, as was previously pointed out, are interacting amongst themselves by means of flows. The flows which enter are represented by: livestock cattle, pigs, sheep and goats, drinkable water, the exit flows are effluents of the washing of cattle entrails, blood, hoofs, ruminal content, bristles, foul smells, noise and flies. This is the initial stationary state of the system.

Nevertheless, the conceptual shift of pollutant materials from wastes to byproducts carry on changing the conception of the slaughterhouse and considering it a center for the integral production of meat as well as of useable byproducts for agricultural reinvestment, then the flows change, new elements are incorporated and a new structure with new properties and relationships among its components is reached.
5 Dynamics of the Slaughterhouse-Complex system

The changes in the time in which the Slaughterhouse-Complex system arises are reflected as a consequence of the processes of structuring and de-structuring. In these processes, elements or components of the empirical reality which were not initially part of the Slaughterhouse-Complex may come to be important elements of the system once a new stationary state is reached (Figure 4).

However, the posing derived from changes on conceptual level—wastes to byproducts—may lead the Slaughterhouse-Complex system to a situation of instability (“de-structuring”) which may eventually lead to the making of a new stationary state. In the new stationary state, the structure and functioning of the Slaughterhouse-Complex system is different. Some of the elements which make up the system are new, while others disappear; additionally, the conditions of the periphery, the limits and the relationship among them are different.

In this way, the set of internal relationships of the Slaughterhouse-Complex become disorganized. This is to say, on one hand some mechanisms come about which allow the slaughterhouse to become internally reorganized so that the waste products may be collected and now be considered byproducts in order that they may be processed and transformed into organic fertilizer. Additionally, the neighbors affected by the contaminated river begin to “disappear” from the Slaughterhouse-Complex system and turn into elements of the empirical reality which no longer fit into the new stationary state which the Slaughterhouse-Complex system would reach (“re-structuring”).

On the other hand, the incorporation of new elements which exist in the empirical reality, as is the case of some farmers or nursery workers from the region who are interested in the purchase of these products, The Department of Parks and Gardens for self-consumption on the part of the Municipality; as well
as the flow of money which occurs in the system due to the purchase/sale of the fertilizers leads to new types of relationships which will remain changeable for some time (figure 5).

![Empirical Reality (macro)](image)

**Empirical Reality (macro)**

<table>
<thead>
<tr>
<th>Development Plans</th>
<th>Inhabitants of Puebla</th>
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<tbody>
<tr>
<td>Landfill</td>
<td></td>
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<tr>
<td>Atoyac River</td>
<td></td>
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<tr>
<td>Neighbors</td>
<td></td>
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</tbody>
</table>

**Slaughterhouse-Complex (meso)**

<table>
<thead>
<tr>
<th>Municipal Parks and Gardens</th>
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<tbody>
<tr>
<td>Farmers</td>
<td></td>
</tr>
<tr>
<td>Nursery Workers</td>
<td></td>
</tr>
<tr>
<td>Cattle</td>
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**Slaughterhouse (micro)**

- Effluent Tea, Bloodmeal, Hoofmeal, Worm Compost.

Figure 5: The Slaughterhouse-Complex system and its surrounding area after structuring-destructuring processes.

Now, in an as yet undetermined period of time, the Slaughterhouse-Complex will stabilize under a different structure.

Finally, this new state might contribute to the solution of environmental problems caused by waste generated by the slaughterhouse. The idea that this waste be considered a useful byproduct for agriculture (change in the conditions of the periphery) would be a factor which would fuel processes which would finally lead the Slaughterhouse-Complex to this new stationary state.

6 Conclusions

It is suggested that with the proposed conceptual and structural changes, the new stationary state of the Slaughterhouse-Complex system will contribute to solve the environmental problems and to achieve a sustainable agricultural development.

The theory of complex systems points out that the modification of a sector in a system introduces changes—to a lesser or greater extent, with different temporal scales— in the entire structure of the system (Garcia et al., [5]). In this way, when changing the function of the contaminant materials—from waste to subproducts—the relations between the members carried the system to the conformation of a new structure, with new properties and emergencies.

The conceptual change from “waste” to “subproducts” was the determining factor that led to the stating of an alternative handling model of the contaminant materials. This model corresponds to the proposal stated in this work of research.
The solution proposed in this work is to evoke, starting from a conceptual change, a change of organizational structure, in this way, the relations of the slaughterhouse with its surrounding changes. Also, the participation of other sectors of society is required, as well as the development of technological processes to make the most of the contaminant materials.

References


