In Ortega, E. & Ulgiati, S. (editors): Proceedings of IV Biennial International Workshop "Advances in Energy Studies". Unicamp, Campinas, SP, Brazil. June 16-19, 2004. Pages 343-347

USING EMERGY ANALISYS IN A SUPPORT SYSTEM FOR PARTICIPATIVE CERTIFICATION PROCESS IN FOOD PRODUCTION

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ABSTRACT

Considering the inadequate scientific foundations of the Green Revolution, one could certainly expect environmental and social crises. Due to a greater awareness, there has been a demand for the adoption of both ecologically based and socially conscius agricultural techniques. Hence, society saw the rise of agroecological management techniques. Many chemical-based agricultural units have opted for organic production practices in order to obtain a better general performance and higher economic gains. Nonetheless, some characteristcs of agrochemical production were maintained. Thus, one needs norms capable of distinguishing the various social and environmental features of the farming systems. The building of a participative certification process is justified by the inability of audit-based certification to correctly assess brazilian familiar agriculture. Emergy analysis has been widely employed in agricultural systems' eficiency evaluation and environmental impact. This research, therefore, proposes the use of emergy analysis in an Internet support system for food participative certification process. The emergy indices which were obtained by the system through emergy analysis offer support on decision making for the improvement of participative certification processes and also for water basin regional planning.

1. INTRODUCTION

After decades of increasing environmental and social problems, society expressed the need for a harmonious usage of natural resources, along with more proper appreciation of the services provided by the environment, in a new paradigm for both production and consumption systems [01]. The production model praised by the Green Revolution show signs of exhaustion and farmers demand ecological practices, as well as scientific studies to support these new techniques and the recognition of their potencials [02].

When an agrochemical-based production turns to organic, it maintain several features, namely low levels of autonomy, self-sufficiency and sustainability. Therefore, food production certification processes have to assess the social and environmental aspects of food production in different farming models[03].

Certification of products from agroecological and organic farms have been in the spotlight during many years. The discussion is usually unfruitful because of misunderstanding about either procedures or principles. Procedure matters concern with the way the certification is carried out, while principle matters are related to the impact of practices and their contribution to promoting agroecology. A new certification model has been created in southern Brazil. This model, called network participative certification, differs from the traditional audit-based certification because there is no auditing company and the certification process is based on the producer ethics [04]. The standards verification process is decentralized through regional centers which are more acquaintaded to each region's character . This configuration allows the consumer to have an active participation in the process, which is recognized by the various centers estabilishing the network. Information is produced and flows from center to center, increasing credibility inside and around the participative certification [04]. Each step of this certification must contribute to regional agroecology. Therefore, the procedures and the standards should contemplate the dynamics to each agroecosystem [04].

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The emergy indices can be applied through standards building and extension services in the participative certification. Such indices, derived from emergy analysis, are able to describe agricultural systems into categories, since they are powerful tools to assess the system's eficiency and environmental impact [05]. Emergy analysis offers a trustworthy diagnosis of agricultural systems and allows for environmental conservation, economic viability and social.

In this paper, we propose the use of emergy analysis in a support system for food participative certification. This system is a web application whose architecture was based on a three-layer model and built with Java, which is programming language most suitable for internet-based software development. The system's most powerful functionality is on-line emergy analysis.

2. SYSTEM DESCRIPTION

Free software were used in the system development, making the project economically viable. The system was design as a distributed three-layer application (Figure 1) comprised of a (a) user or presentation layer, (b) a business layer and (c) a data layer [06,07,08].

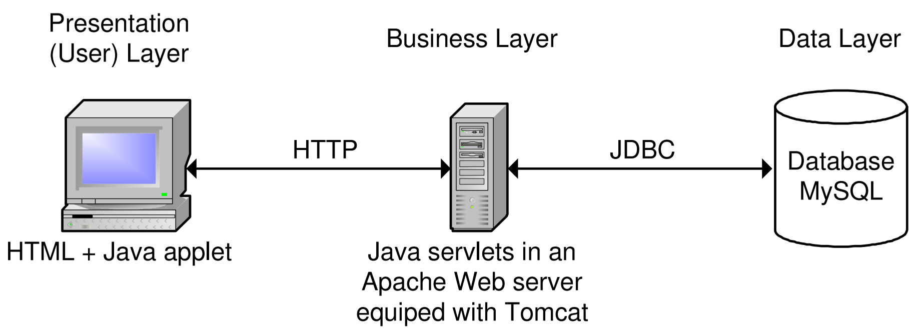

Figure 1. Three-layer architecture in which the system was implemented

The **data layer** consists of relational database built on MySQL, which was chosen due to its free software nature, ease of use, portability and safe transaction support, as well as access through other systems and programming languages [07]. The database model was created using DBDesigner, which provides a friendly graphical interface and allows the database to be directly constructed from the model [08]. The database has three essential tables: Producer, Property and EmergyAnalysis, which relate to secondary tables. The database stores personal information and login, properties' qualitative and quantitative data, emergy analysis information (resources transformity, produce caloric energy, money transformity) and indices, resource and produce information.

The **business layer** comprises an Apache webserver and a Tomcat jsp/servlet container and provides the comercial logic that operates on the database and communicates with clients [09]. This layer was implemented with Java servlets wich communicates with both the database through the JDBC API and the client through text and object-based HTTP connections. Servlets' greatest advantage resides in their maintaining longer connections to the database, which save process time, in contrast to CGI scripts, which open connections for every operation. This layer is also responsible for controlling sessions and access (Session Tracking API) and provinding simultaneous access to various users [10].

The **presentation layer** interacts with the user and, therefore, is also called user layer. It consists of Java applet coupled with an internet browser. There are several advantages of having the user interact with a Java applet, such as portability, a more friendly and usable interface, lower server-side processing, lower configuration and maintenance costs, and reduced traffic through the network [11]. The Java applet was developed in the the Sun Java 2 platform and the client machines should have the Java plug-in instaled in order to run the application in a web browser [12]. This layer embodies the graphical user interface, organized in overlapped panels containing interface elements such as buttons, labels, text fields, tables, and windows which the user must interact with.

The system structure is only accessed by administrators and authotized users which are offered four main functions: user login, property registration, emergy analysis and administration (restricted to administrators). The opperations to be performed by the administrators are: user inclusion and deletion, resource and resource's transformity inclusion, produce inclusion (along with composition and caloric energy), and basic data maintenance such as dollar exchange rate. When a user enters into the system, he (or she) must provide personal information and is allowed to register one farm. Farm registration asks for environmental data, technical parameters, external inputs, equipments and facilities used. On-line emergy analysis is the most important system functionality for it provides a survey of the farms' environmental performance [05], as proposed by Odum [13]. The first step to emergy analysis is to inform the supply of inputs as quantiries of chemiclas used, money transformity, dollar exchange rate, and production features. Then, the user must provide the quantities of each product and its sale price.

Using these numbers, the system calculates product energy (Ep) and sale income. The user is asked to provide other values so that the system can estimate emergy to every resource. The data values are expressed in well-known units (e.g. kg, liters, R$) and the system is responsible for converting them to emergy units. Unitary cost must given for each economical resource. The system performs the following calculations: (a) Renewable emergy flow (R), (b) Nonrenewable emergy flow (N), (c) Materials emergy flow (M), (d) Service emergy flow (S), (e) Local environmental emergy Inputs (I=R+N), (f) Feedback emergy flowing from the economy (F=M+S), (g) emergy output (Y), (h) total production costs. All these emergy indices are obtained in a table (Table 1) and can be used to perform environmental evaluation and characterization of the farm [03,05,14].

The software system is also able to assess the production's economic rentability, estimated through produce income and production costs. Finally, the system offers the possibility to save the information of the emergy analysis for further visualization or modification. An extensive report is generated and exhibits the user personal information, property data and emergy analisys. This report can be sent to the system's administratrors or printed for further detailed analysis.

Table 1. Emergy indices used in the properties' characterization and environmental evaluation

Indices	Expression	Explanation
Transformity (Tr)	Y/Ep	It evaluates the quality of the energy flows. It's the inverse of the ecosystem efficiency.
% Renewable Emergy Ratio (%R)	(R/Y) x 100	The percent local renewable of input.
Emergy Yield Ratio (EYR)	Y/F	This ratio indicates whether the process can compete in supplying a primary energy source for an economy.
Emergy Investment Ratio (EIR)	F/(R+N)	The investment compared to local resource use. It shows whetherif the investment is boosted by free local resources.
Emergy Exchange Ratio (EER)	Y/[($)x(sej/$)]	The ratio of emergy received for emergy delivered in a trade or sales transaction.

3. DISCUSSION

This article presents a web software as initial model for using emergy analysis in support for participative certification of food production. It can be easily used in a participative certification network, providing useful information for the production processes' improvement. Emergy analysis is a tool which has been applied to evaluation of different systems: ecological, industrial, economic, astronomic, etc. However usefull, nowadays, emergy analysis is used by few researchers [15]. Thus, an internet application like the proposed system can help to spread its usage in a wider context. The friendly interface allow its use by people not acquainted with emergy theory, since all input data are expressed in well known measure units which are subsequently transformed into emergy units.

The emergy indices make possible a quantitative analysis from an ecological perspective which empowers the producers to assess their goals: (a) decrease external resources dependency, (b) recover and maintain natural resources, (c) adopt economic practices. The storeage of the emergy indices provide the monitoring over time and its record.

Farm's registration provide qualitative information which, along emergy indices, construct a database for decision making, as well as creating and revising standards for participative certification. The system allows for an intergrated analysis by presenting the productor's personal analysis, farm's data (qualitative information) and emergy indices (quantitative information). The system can be improved by the adding of new functionalities due to its architecture, that was designed to be easily maintained, updated, modified and expanded.

4. CONCLUSIONS

This research proposes the use of emergy analysis in a support system for participative certification in food production, making certification part of the agroecological management, turning the producer into one of the main actors of the process, as well as offering information to decision making towards environmental, social and economic sustainability.

The proposed system is a web tool based in a three-layer model, being the data layer implemented with MySQL for holding the results of the emergy analysis. The business layer runs Java servlets which are resposible for interpreting and performing user commands such as database access, data handling, etc. The presentation layer is comprised of a Java applet which the user interacts with, allowing them to perform the emergy analysis even though they may not be acquainted with emergy theory.

A reported is generated which includes property data and the emergy analysis itself. The farm data usually includes qualitative information required for certification. The emergy indices provide quantitative information on the property's environmental performance and sustainability which help the decision making and certification processes. These indices may help applying certification standards to a wide range of properties in a way that their sociocultural and ecological features are taken into account.

ACKNOWLEDGEMENTS

The authros would like to thank the financial aid provided by CNPq.

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