GEOSCIENCES AND SUSTAINABLE LAND DEVELOPMENT IN AMAZONIA

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SUMMARY

Application of modern concepts of sustainable development to Amazon requires much more geoscientific information and research than those existing yet. Moreover, it is necessary to develop new tools to integrate the existing data and modeling the fluxes of energy and mass through the environmental components, including the antropic media, now existing or predictable. For these challenges there is a broad space for geoscientists as conductors and leaders.

INTRODUCTION

The development of a worldwide environmental conscience is relatively new and today few people unknow the environmental importance of the amazon land as a planetary element of climate equilibrium and potential source of genetic resources. The aim of this paper is to illustrate the most recent efforts and advances achieved by geoscientists on the understanding of the environmental equilibrium and the development of conservation and preservation models, and finally to anticipate probable and possible future actions.

The Amazonian land embraces a huge territory covering more than six million square kilometers (fig.1) characterized by a predominant but not exclusive dense equatorial rain forest. The ecosystem characteristic of the Amazon River basin is the biggest in the world, and contains more than 20% of all fresh water of Earth's surface. It appears as decorrence of the big climatic changes that occurred by the end of last glaciation, 10,000 years ago. Before this time climate was drier, equivalent to those existing in the actual savannas, as demonstrated by several widespread fossils and paleosoils registers. This "natural" equilibrium has been maintained practically without human intervenience until the arrival of Europeans, in 1,500 AC. Since then, it has appeared a new geologic agent able to modificate the environmental homeostasis, causing impacts; this became specially important at the beginning of the twentieth century, as exemplified with the construction of the railroad Madeira-Mamore, linking Bolivia to the Atlantic Ocean, and on the second half of the century by the construction of the new Brazilian federal capital – Brasilia, starting a tremendous movement of population toward the west.

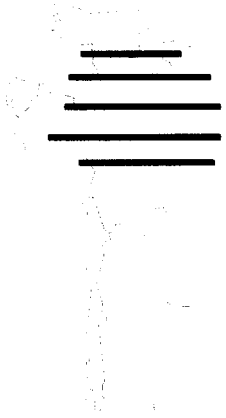

Fig.1 – Localization of Amazon

In the sixties and seventies the economic development of all countries which share the Amazon land, increased the demand for new natural resources, energy, timber, mining and food, accelerating, at the same time, the scientific research and the human occupation.

The seven countries that share the Amazon territory, conscious of the predictable environmental consequences of this race, celebrated, in 1978, the Treatise of Amazonian Cooperation – TAC, including Bolivia, Brazil, Colombia, Equator, Peru, Suriname and Venezuela. One of the main objectives of this agreement is the development of common strategies for the sustainable development and to achieve this goal it was promoted a program of economic and ecological zoning (EEZ) over the common frontiers zones. The EEZ projects represent the most expressive effort of all Amazon countries toward the sustainable development. In addition, inside each country, several internal EEZs were realized, covering a significative Amazon space.

INFORMATION TO THE TERRITORIAL MANAGEMENT

The biggest challenge, in terms of planing to support decisions environmentally wishables is, besides acquisition and divulgation of multidisciplinary information, to develop ability to make logical intersections, over the data bases, able to determine the best potentialities and to preview the impacts due to the appropriation of environmental goods. This has been the target of all methodologies regarding the territorial planing, as the EEZ and so far.

Among the main aspects of environmental information, it should be mentioned: thematic range, scale of resolution, and the use of international standards and, at last, organization and divulgation of data as digital databases. Taking in consideration the final objective of the territorial planing, expressed by the EEZ, it increased the need of spacialization of all information regardless his nature.

After a initial period, marked by low understanding about the relationship between cause/effect of the transformations due to anthropization, it developed a consensus regarding the necessity of superpose social-economic and biophysical information. To make this possible, it was necessary to create new concepts and processes that permit to represent, in the geographic space, the traditionally non-spaced statistic data of the anthropic media.

With some methodological differences, all the countries of Treatise of Amazonian Cooperation, promoted during the seventies, multidisciplinary studies, as the RADAM Project in Brazil, taking advantage of the new technologies, as the radar images and aerial photographs. Thematic studies included geology, geochemistry, geophysics, geomorphology, pedology, vegetation and hidroclimatology.

The level of resolution of these studies is of 1:1000.000, and locally 1:250,000 or 1:100,000. In the eighties and nineties, it was realized the existing hydrogeologic and limnologic studies took place, besides the studies regarding biodiversity and environmental fragility and finally the EEZ, as mentioned above, under coordination of the Organization of the American States – ASO. In Brazil, CPRM as the Geological Survey was called to conduct the binational EEZ projects under national coordination of the Secretaria de Assuntos Estratégicos (SAE), Superintendência do Desenvolvimento da Amazônia (SUDAM) and the Ministério do Meio Ambiente (MMA). This very high level of coordination was also followed by others participants of the TAC.

HOLISM AND SYSTEMIC THINKING

Although the spirit of multi and transdisciplinarity has been presented in all proposed methodologies for territorial

zoning, the current scientific thought is too impregnated by Cartesians and probably the biggest challenges to overcome is to understand, qualitative and quantitatively, the interdependence among the components of environment, and to predict the impacts of anthropic actions, or even conservation.

To evaluate the environment capacity to support life, it is needed to know its physical and biological constitution in the contexts of space and time and, therefore, the defeat thrown to the geoscientists is to validate methodologies based on the global changes. Of course they will be not alone, as they couldn't overcome a so big task isolately.

Geoscientists should overview the Amazonian territory – as any other, researching the geological evolution, since the Tertiary through the Quaternary and Pleistocene, until the moment when the Homo Sapiens, leaving the primitive stage as hunter and collector, invented agriculture, starting a new geologic period – the Quinary, as proposed by many geologists. Under this view, it will be possible to find new and previsible explanations for several phenomena, normally considered isolately. It is really very exciting to discover relationships between global tectonics and climatic changes, fluvial pathways, biological endemism or anthropological evolution.

SUSTAINABLE DEVELOPMENT

Sustainable development can be understood (qualitatively) as those who preserve the environment for the next generations. When merging deeply to this human value, it becomes difficult to precise, in real situations, the equilibrium conditions existing before and after anthropic intervenence. As geoscientists we know that the surface of Earth is in constant transformation, sometimes fast and catastrophic to the affected affected geossystems, as exemplified by the changes of the Atlantic coastal line of the neighborhood of Amazon (regression of 120 km/10,000 years).

As nothing is static, everything changes as times go by, the size and the speed of changes regionally and locally are the first consideration to be made. Believing that the nature of the geologic systems is alive or not, it should be admitted that they are characterized by a constant flux of energy and mass through their components. It can be defined as the state of equilibrium of a given geossystem, the result of all interactions among their physical, biological and anthropic components, as they represent the eternal flux of energy and mass that permeates the system.

Therefore, to stablish the bases for the sustainable development, it is needed to qualify and quantify the fluxes of energy and/or mass that inputs, permeates and outputs the geossystems (fig.2); as consequence, it should be remembered that a system is more than the simple addition of all components, as it is known from the *law of the emergent proprieties* (BROAD, C.D. in CAPRA,F. 1996 e ODUM, 1953). From this consideration it is inferred that the environmental sustainability for a given development model is defined by the value of the result of all processes existing in the geossystem, in terms of exportation of energy and mass. If the value is negative or shows increasing deficits, certainly the geossystem is under degradation, and will collapse at some point, in the future.

In other words, sustainable development is characterized as ecologically sustainable when it takes way natural resources at a rate or amount that does not conduct the geossystems to failure.

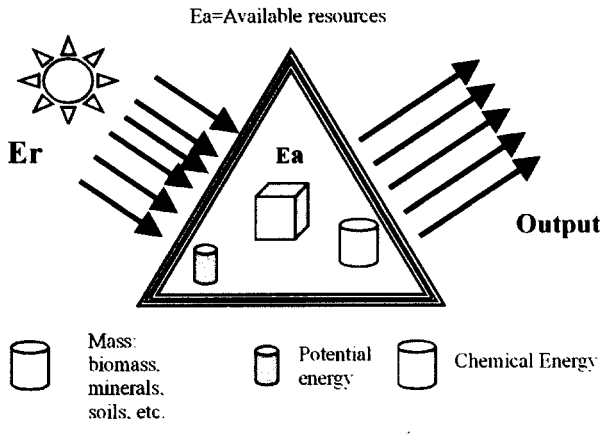

Fig.2: Environmental System

ENVIRONMENTAL DIANOSTIC-MASS /ENERGY BALANCE AND SUSTAINABILITY

Watching fig. 4 it is possible to see that to make an environmental diagnostic is necessary to know all environmental components, natural and anthropic. The first ones include geology, geomorphology, hydroclimatology, vegetation, soils and biodiversity are the field of geoscientists and biologists; the second ones belong to the economists and anthropologists.

From the natural environment (biophysical), it can be evaluated the nature and the available amount of mass components and energy, such as mineral resources, water, soils, and biogenetic resources. If occupation is thinked as a process of taking away the vegetal cover, then the relationships among the several components permit to calculate the degree of natural fragility and/or the capacity of support. This vulnerability has to be considered under the concept of "natural landscape units", regarding the concepts of ecotopes (fig. 03) of ZONNEVELD (1989). To this consideration it should be added the risk to degra

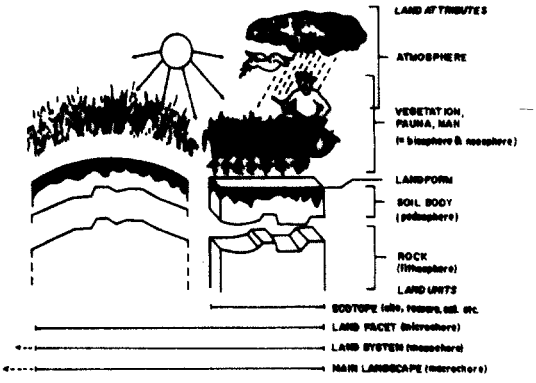

Fig.3 – Main components of Land Units, by Zonneveld I.S. (1989)

dation of fragile biologically essential ecosystems or sites of cultural value or beauty.

Having in mind the evaluation of environmental impacts, it must be underlined the perimeter of the hydrographic basins, since the basin should be the main unit of

land administration. Therefore, it is fundamental the application of hydrogeologic and hydrologic-sedimentometric and geochemical models.

By its turn, social environment has to be evaluated in terms of territorial distribution of population, social infrastructure, economy and the natural resources available. To compare all these aspects *versus* the natural environment data, it should be applied the concept of anthropic unit, which embraces a given part of the territory where a characteristic human activity was established.

Going forward, the knowledge of natural ecodynamics permits to evaluate the stocks of mass and energy (renewable or not), and the social ecodynamics (economic models) makes possible to predict the environmental sacks. At this point, alternative global ecodynamics scenarios will be delineated and the pathway to be followed is a matter of political consideration.

ENVIRONMENTAL RESOURCES OF AMAZONIA AND SUSTAINABLE DEVELOPMENT

Occupation of the Amazonian territory is greatly based on exploitation of natural resources, as timber, minerals, agriculture, fishing, cattle breeding, with small industrialization. Manaus, the Amazonas capital is the most important industrial pole. In the state of Para, there is the best potentiality for mining, agriculture and ecoturism, a recent alternative.

On the other hand, despite the low population density, it is possible to feel the pressure against some environmental resources, mainly the rivers and soils. Moreover, the great biological activity is not favorable to the surface water quality. To this must be added the high color indexes of the black waters. Regarding soils, they show moderate fertility and most times demand the use of mineral correctives. In many situations, when the soils overlap sandstone, the fertility is very low and the use of the vegetal cover is suppressed, the risk of desertification is imminent.

Talking about urban aspects, it should be mentioned that they grew dramatically in the last 40 years, pressuring the near environmental systems by increasing pollution and erosion and today, the disposal of liquid and solid wastes, water supply and floods are much more common problems than one could imagine few years ago. In this sense, urban planing should be included in the priorities for the sustainable development.

As a result, groundwater, raw materials, and limestone - as correctives of soils deficiencies are considered strategic for the Amazonian territory, even more than the expected new discoveries of giant metallic deposits.

At last, it should be highlighted that the Amazonian land is by any way monotonous, but includes an enormous diversity of geographic landscapes.

CONCLUSIONS

Considering all mentioned aspects, it could be concluded how essential it is the role of Geosciences for the future of Amazon, regarding to their planing and implementation of a sustainable development. It is geoscientists' duty to act as leaders in the processes of mapping the environmental components and understanding of mass and energy changes among their components. To do so, they will have to work with the Holocene as a laboratory, developing new tools and approaches. Environmental geochemistry and sedimentometric modeling should be a matter of great consideration.

Finally it must be emphasized the importance of integrated multidisciplinary studies, having as focus the sustainable social and economic development.

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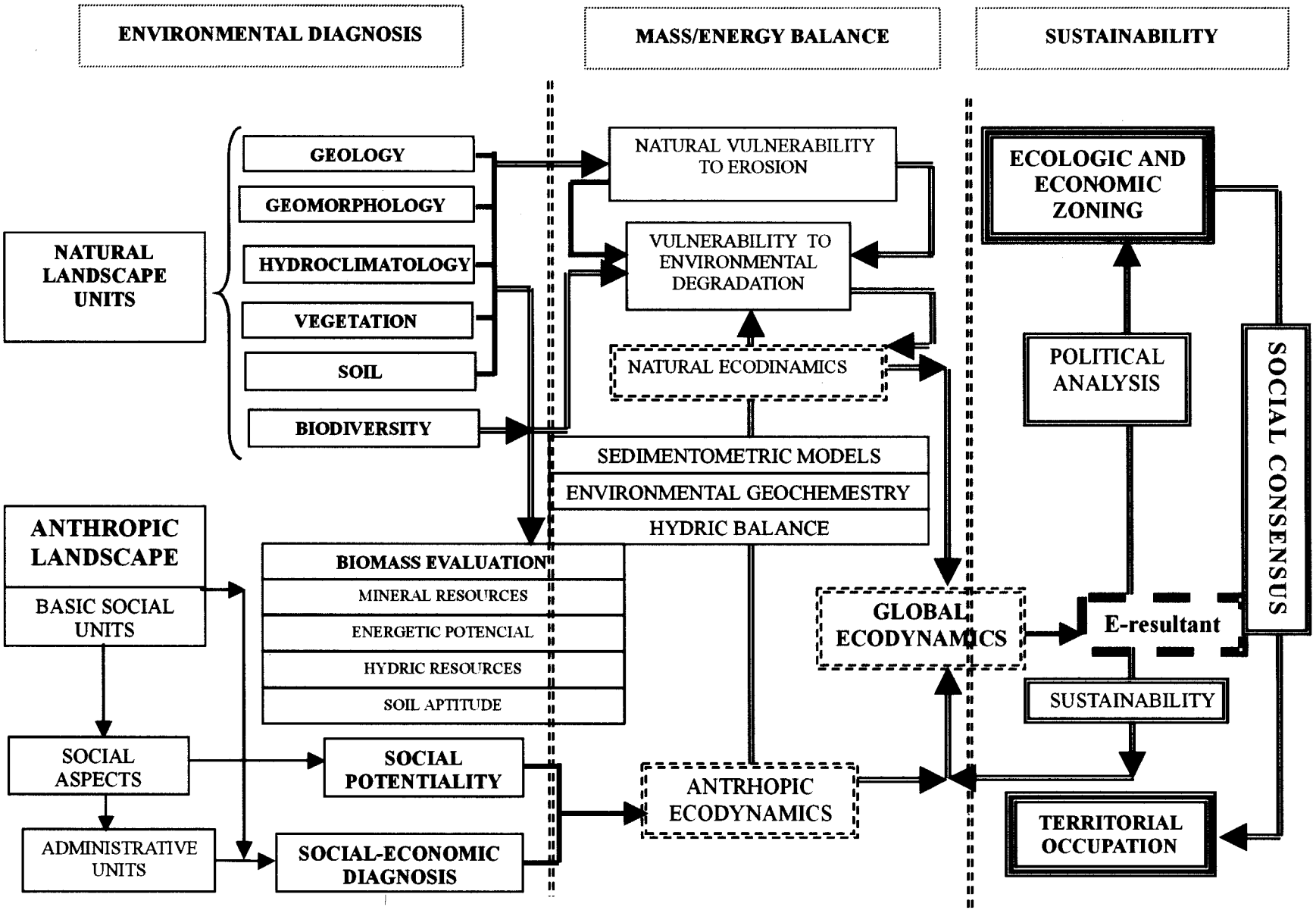

Fig. 4: Schedule for environmental equilibrium analisys