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Sustainability Assessment Method GEITEC: An interdisciplinary technology based on the Theory U

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Abstract— *This paper aims to develop a method for assessing the sustainability of sustainable use units through indicators. The specific objectives are to identify the characteristics of sustainability assessment criteria in Extractive Reserves (1), to elaborate a method for sustainability evaluation to those Extractive Reserves (2) and to develop a critical analysis bout the efficiency of the proposed method (3). The focus on Theory U, present in the work, allows an adequate operational interpretation about the use of indicators for the evaluation of sustainability. As a result, the GEITEC Method of Sustainability Endogenous Assessment was elaborated, in which the logical convergence of the object searched was pointed out. In this way, it presents the alignment of the academy, through strictosensu programs, in a search for means that guide appropriate technologies to be applied, not only as a phatic interpretation, but also to support actions to benefit the environment, to the social that should be adequately protected, to the economy in view of its importance for endogenous development and to the organizational structures that must be managed with skill for the success of the common interest. This research is a contribution to those involved in decisions related to sustainability.*

Keywords—Assessment method; Sustainability; Extractive Reserves.

I. INTRODUCTION

The discussion addressed in this article deals with the management of sustainability in Brazilian Conservation Units, specifically in the category of Extractive Reserves (RESEX), questioning the viability of the considered evaluation parameters for the people quality of life residing in these areas. In the specific case of RESEX, the economic production is based on traditional extractivism, combining precarious level of technologies, rural labor and low remuneration, resulting in an inefficient development model. The absence of modern ways of production results in significant difficulties to the population established there and their socioeconomic condition, even if there is an abundance of raw material offered from nature. These requirements provide the understanding necessary for the initiation of an in-depth investigation.

II. OBJECTIVES

In the Brazilian context, Conservation Units represent territorial space and its environmental resources, including jurisdictional waters, that should promote sustainable development though conservation of natural resources. Those areas have as main purpose to protect the natural resources necessary for subsistence of the traditional populations, respecting and valuing their knowledge, their culture and fomenting them socially and economically. The academy contributes with technology to manage natural resources and to qualify environmental services to

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be managed by individuals. So, This paper aims to develop a method for assessing the sustainability of Sustainable Use Units through indicators. The specific objectives are to identify the characteristics of sustainability assessment criteria in Extractive Reserves (1), to elaborate a method for sustainability evaluation to those Extractive Reserves (2) and to develop a critical analysis bout the efficiency of the proposed method (3).

III. THEORETICAL BACKGROUND

The literature review involves a theoretical-empirical approach or theme which identifies and constitutes a doctrinal framework to support a research work. It strengthens the discussion, guarantees the results related to the facts, phenomena or processes. Literature review is an effect of a bibliographical research, whose essence is the selection of themes, reading the contents, sorting the pertinent elements, analyzing their contents and criticizing their usefulness. This section is structured in subtopics and deal with assessment of sustainability, U Theory and conservation units in the Brazilian context.

3.1 Sustainability Assessment

The studied subject is the sustainability assessment of conservation units for sustainable use. In order to make possible the analyze was adopted as reference the conception that every conservation unit is a set of elements that needs management to reach its ends in an organizational perspective.

The sustainability analysis of conservation units has significant changed in terms of social participation, dynamics of the economy and the need to protect the environment, inserting these aspects in the normative context, or even under the perspective of social forces in the resources management. The literature indicates that in the elaboration of sustainability assessment methods is fundamental to solve the aggregation of indicators, since it is necessary to contemplate different dimensions, as Figure 1 presents.

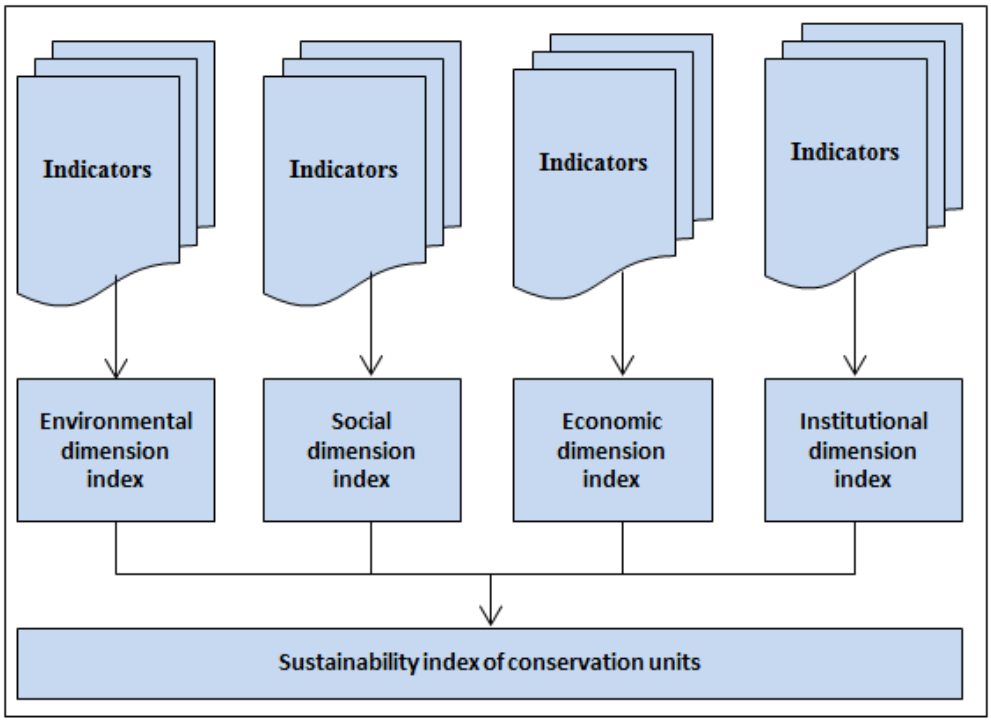

Fig.1: Diagram of indicators applicability
Source: adapted from IBGE (2012)

In order to the relationship among indicators occur in a logic system, it's necessary they have a uniform measure configuration that allows the relation analysis. In this context there is a severe difficulty in establishing criteria for the aggregation of indicators. Thus, according to Siche (2007), there is no possibility to be sustainable considering only one or two indicators that refer to a single aspect of the system, which commonly falls within the environmental perspective.

Indicators of IBGE allow monitoring the sustainability of Brazilian development standard in the environmental, social, economic and institutional dimensions, providing a comprehensive information overview to support policy decisions for sustainable development. In general terms, they measure environmental quality, population quality of life, economic performance and governance for sustainable development in biodiversity, sanitation, freshwater, health, education, safety, production and consumption patterns, and institutional capacity, among other aspects. The matrix

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of relationships between the different indicators facilitates an overall view, necessary for the understanding of this complex and multidimensional theme (IBGE, 2012).

3.2 Theory U

In the context discussed by Tinti (2014), Theory U can be a reference for the solution in a path of a new paradigm for conservation units. This could begin with the reflection on reality aligned with the evaluations that enable, through their leaderships, the adjustments required for integrated and sustainable local development. Theory U focuses on a management method for change, aiming the leadership in a process of innovation through social knowledge. The theoretical design is clear in three essential approaches to its validation: the answer to questions about what to do, how to do and what to do. The theoretical reading makes it possible to understand its applicability in the systematization of practices such as those involving the use of indicators for evaluation of sustainability in conservation units.

In order to face the current complex conceptual state in which conservation units are inserted, the individuals involved with this areas need to uncover and treat their blind spot, and rediscover how to do, what to do, and especially what to do. The first step is to establish indicators for evaluation, and later to take the management adaptations that meet the reflection of why doing management in conservation units. This process of unfolding is already foreseen in Scharmer (2010). According to the author, organizational leaders face levels of complexity. It is evident at present a systematic distance in the causal relation, which results in temporal acts without considering future effects. On the other hand social complexity is a product of diverse interests and conceptions of those involved. And a third way would be the emerging complexity where challenges are concentrated in the face of known problems. Figure 2 shows the components of Theory U and Table 1 their respective details.

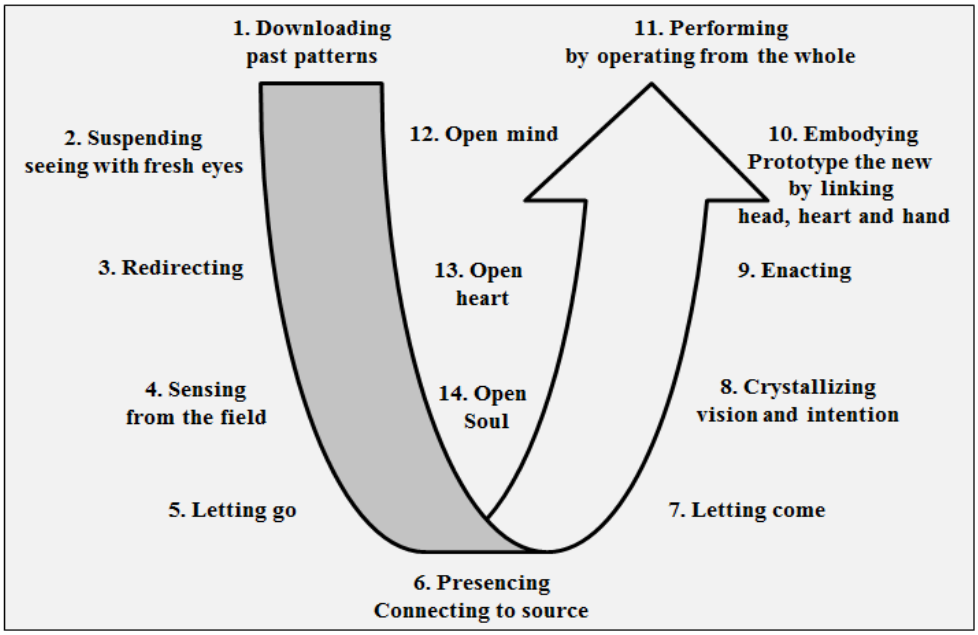

Fig.2: Theory U in a diagram of managerial perspective
Source: Adapted by the authors from Scharmer (2010)

Table.1: Operational perspective of Theory U specifications

Items	Specifications
Theory U	Theory that induces reflection about what to do, how to do, and especially why to do.
1. Downloading	Analysis of the adopted paradigms.
2. Suspending	To observe the environment to question reality beyond your own vision.
3. Redirecting	To look to the system from the outside and realize how your own actions contribute to the ecosystem.
4. Sensing	To feel the system dynamics and its contribuition to the ecosystem.
5. Letting go	To detach from current patterns and seek new paradigms.
6. Presencing	To unlearn and learn again.
7. Letting come	To assimilate the intention of the new paradigms.

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Items	Specifications
8. Crystallizing	To consolidate the vision and intent of new paradigms.
9. Enacting	To materialize the practices of new paradigms.
10. Embodying	To compromise with the future that emerged through new practices
11. Performing	To realize the desire and multiple interests of those involved.

Source: Adapted by the authors from Scharmer (2010)

In view of the above considerations, the conceptions about structural models and organizational strategies are always seeking the ideal way of development so they are inserted in the environment in order to perpetuate. These models and strategies shape the theories that define the directions of decision-making.

3.3 Conservation Units in the Brazilian Context

Brazil has established several public policies to reduce environmental impacts using education and inspection, such as the National System of Conservation Units. According to Milaré (2011), although protected areas exist since 1937, only the National Environmental Policy did it possible to erect a grouping of conservation units, even if they were casuistically and without a proper direction, always managed with few resources and without a defined public action of environmental policy. Obviously, such imprecise circumstances make difficult to achieve the purpose proposed for such units. In this period of historical evolution of conservation units in Brazil, processors of the 1988 Constitution were designated only to launch the challenge of regulation of what has been termed as specially protected territorial spaces. However in the edition of Law 9.985/2000 the National System of Nature Conservation Units was instituted.

Conservation Units represent territorial space and its environmental resources including jurisdictional waters. It must promote sustainable development of natural resources by practicing nature conservation. Its main purpose is to protect the natural resources necessary for subsistence of traditional populations, respecting and valuing their knowledge and culture, and promoting it socially and economically. Those areas are structures for solutions of maintenance and balance in the system of economic, environmental, social and institutional development; and like any other organization they must be sustainable.

The conservation units of sustainable use are part of a system where they have the function of contributing to the balance of the environmental, economic, social and institutional relationship, as well as to sustainability. However, the mere institutional existence with administrative structure of the conservation unit does not give them sufficient attributes to characterize as sustainable. In order to assign such quality, mechanisms are needed that allow the minimization of their references in the ecosystem paradigm.

For a conservation unit to be sustainable, it is necessary to integrate the different dimensions of the context they were created for. As these dimensions are dynamic, they influence and are influenced by social pressures. Because of this, it's necessary to construct capable assessment methodologies to monitor the sustainability in order to achieve the goals and objectives proposed in their creation. Miguel (2007) indicates that conservation units are structures with sufficient resources available for production and commercialization, since the physical-biotic formation represents an important natural heritage that can be understood in two different perspectives. The first to be configured in an ecosystem complex relevant to the global environment, and the second is the possibility of using the environmental resources in a sustainable way. These resources can be applied as surplus, without prejudice to the natural environment. However, the classic management model for these structures has predominantly adopted a conception focused on the environmental dimension. This way, the norm admits the existence of people, equipment of use, productive force, solidary economies and other required ways of subsistence.

IV. METHODOLOGY

This research aims to study assessment methods in conservation units, specially the category of Extractive Reserve of Sustainable Use. In this research the variables considered came from recurrent complexities to understand the social problem in study. The data treatment follows the operationalization from prevalence, analysis, critique, benchmark test, solutions of asymmetries, among other situations common to the method. It should be noted that, in order to comply with the prevalence criterion, the tabulation and the demonstration are significant elements when analyzing the data. It was used the software excel and its supplement Solver in data statistical analysis which made it possible to perform complex calculations and visualize results. The methodology describes the various processes or tools used to sustainability assessment. The methodology and procedures required are shown in Figure 3 and Table 2.

https://dx.doi.org/10.22161/ijaers.5.2.11 *ISSN: 2349-6495(P) | 2456-1908(O)*

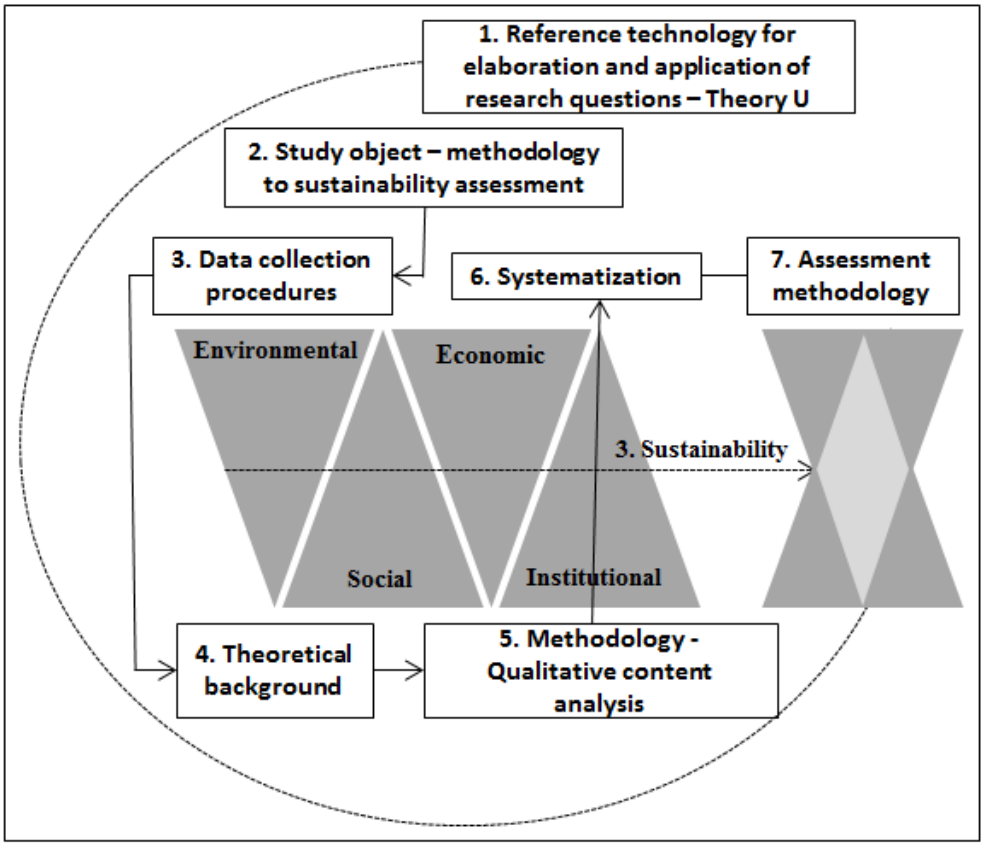

Fig.3: Methodology diagram
Source: Adapted by the authors from Pedro Filho et al (2014)

Table.2: Methodology diagram specifications

Items	Specifications
1. Theory U	Theory that induces reflection about what to do, how to do, and especially why to do
2. Study object	Researched phenomenon to search for an answer or description
3. Procedures and data collection	Phase of the research that guides the processes in time, form and criteria of selection of variables to be considered in the research.
4. Theoretical background	Concepts that will be supported in the standardization of the solution
5. Method	Group of procedures to be followed in search to the answer of the research problem
6. Systematization	Consistent organization of procedures to answer the research question.
7. Assessment methodology	Proposal considered as hypothesis of the study

Source: Adapted by the author from Pedro Filho et al (2014)

V. RESULTS

The scenario where the research intervention occurred was defined in the methodological scope. Thus, technical visits were done at Rio Ouro Preto Extractive Reserves in the Municipality of GuajaráMirim (A), at Lago do Cuniã in the Municipality of Porto Velho (B) and at Ouro Preto - Jacundá RESEX in the Municipality of Machadinho do Oeste (C), all in the State of Rondônia, Brazil, as can be seen in Figure 4.

https://dx.doi.org/10.22161/ijaers.5.2.11 *ISSN: 2349-6495(P) | 2456-1908(O)*

Fig.4: Research Locus

Source: Adapted by the authors from Medrado, et al. (2014)

5.1 Characteristics Identification for Sustainability Assessment

The first characteristic indicates the environment with natural and unnatural attributes. The second characteristic concerns the social aspect indicating relations and norms capable of limiting the behavior in face of other dimensions. The third characteristic is the economic dimension which enables the consumption of natural goods for the satisfaction and survival of humanity from their consumption demands. The fourth characteristic is the institutional dimension that composes the various institutions that regulate environmental, economic and social relations, seeking the best efficiency use of natural resources. The characteristics were presented according to the four dimensions of sustainability, as can be seen in Figure 5 and Table 3 in below.

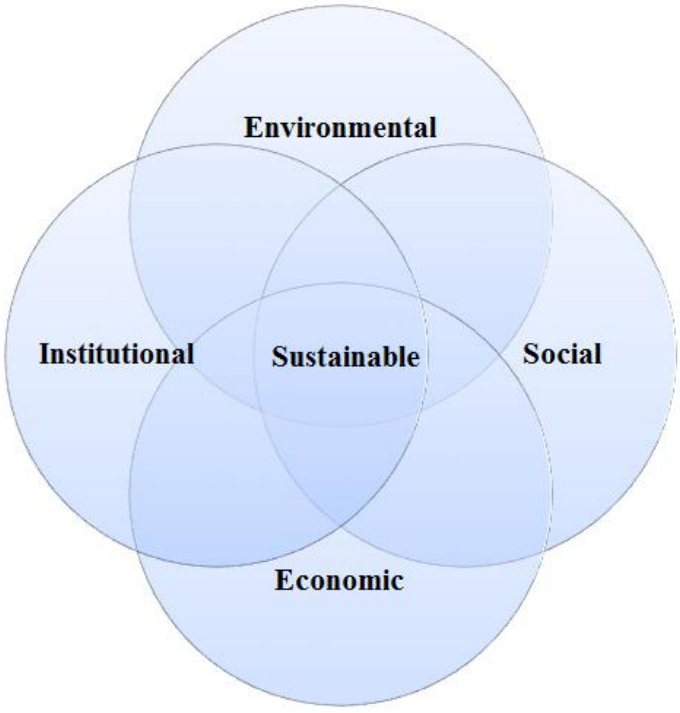

Fig.5: Basic paradigm diagram

Source: Adapted by the authors from IBGE (2012)

Table.3: Basic Paradigm Diagram Specifications.

Items	Specifications
1. Environmental	Elements of quality of life patterns to maintenance for present and future generations, involving the use of natural resources.
2. Social	Elements of social justice, satisfaction of human needs and improvement of the quality of life linked to equity and living conditions of the population.
3. Economic	Elements of production and consumption related waste, use of natural resources and energy.
4. Institutional	Elements of political positioning of the sectors and capacity to implement changes for sustainable development through new technologies

Source: Adapted by the authors from IBGE (2012)

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These methodological criteria allow monitoring the sustainability of the Brazilian development standard in the environmental, social, economic and institutional dimensions. They provide a comprehensive information overview that supports policy decisions in sustainable development. In general terms, they measure environmental quality, population quality of life, economic performance and governance for sustainable development in biodiversity, sanitation, freshwater, health, education, safety, production and consumption patterns, and institutional capacity, and other aspects.

The changes in the RESEX's scenarios are driven by the management of social actors, especially local residents, who are take decisions about their reality. It is possible to affirm that support for decisions, even at the local level, emerges from theories, tools and practices that assist leaders and organizations in coping with social problems. Here the actions sculpted in new ideas, which add to the quality of the critics of the social actors involved in the relation of the local issues emerge. This pathway demonstrated in this research would be the most adequate, not only for reflection, but also for the necessary endogeny. So, it is characterized the material sequence proposed by Theory U, as learning, collective dynamics, reflection on the state of order, and other logical attributes that are supported in that theoretical approach.

In the researched scenario was registered that residents and stakeholders face circumstances that demand decisions in varying degrees of importance. These decisions do not sufficiently include the required solutions, since they will always be influenced by contemporary paradigms. In addition, it will be necessary to consider the behavioral dynamics differentiated of the resident in the RESEX's in face of its culture, tradition and experience that delineate each moment of the cognitive process in the paradigm of the sustainability.

A simple request from a stakeholder to access the RESEX is already sufficient reason for a decision. This is because the formal requirements for such a procedure are considered. The counter-raid would be an affront to the pre-established criteria necessary for local maintenance. In this way, both residents and stakeholders should due to the need for attention to the sustainability paradigm, adopt organizational criteria capable of leading to sustainability efficiency.

The technical visits at the studied RESEX's allowed to identify that residents adopt well-delineated procedures in Theory U. The contemplative self-inquiry presupposed in that approach, such as what to do, how to do and why to do it was sufficiently revealed, as abstracted from obtained, and that they constitute the collection collected in this investigative task. Concluding this subtopic of this paper, the operative demonstration of Theory U is inserted here. These criteria are consonant with the formal logical values of the RESEX that is configured as an organization of these traditional peoples.

5.2 Assessment Method Construction

The proposed method, called GEITEC Sustainability Assessment Method, is based on qualitative and quantitative verification. Initially, quantitative indicators were collected from official publications offered by IBGE. In a second phase, the perceptions of residents and stakeholders were collected. In the third phase, the perceptions collected were qualitatively described and, in order to make possible their composition in the GEITEC Sustainability Index identification system, it was necessary to transform it into an indicator, which is solved by mathematical operation with its division by the base 100. The formulation mathematics of the GEITEC Index of Endogenous Sustainability Assessment is demonstrated using the following formula.

$$\boldsymbol{GEITEC\ Index} = \frac{\left(\sum_{i=1}^{20} \boldsymbol{IA_i} * \boldsymbol{RA_i} + \sum_{i=21}^{41} \boldsymbol{IS_i} * \boldsymbol{RS_i} + \sum_{i=42}^{53} \boldsymbol{IE_i} * \boldsymbol{RE_i} + \sum_{i=54}^{62} \boldsymbol{II_i} * \boldsymbol{RI_i}\right) * \mathbf{100}}{\mathbf{4}}$$

In which:

IA_i represents the values in percentages of the perception indicators of environmental *dimension.*

RA_i represents the values in percentages of the environmental dimension indicators extracted from the Relationship Matrix prepared by IBGE.

IS_i represents the values in percentages of the indicators of the perception of the social dimension.

RS_i represents the percentages of the social dimension indicators extracted from the Relationship Matrix prepared by IBGE.

IE_i represents the values in percentages of the perception indicators of economic dimension.

RE_i represents the percentage values of the economic dimension indicators extracted from the Relationship Matrix prepared by IBGE.

II_i represents the values in percentage of the perception indicators of institutional dimension.

RI_i represents the percentage values of the institutional dimension indicators extracted from the Relationship Matrix prepared by IBGE.

The formulation has a real divisor of four. The value of the divisor represents the amount of dimensions entered in the proposed model that are environmental, social, economic and institutional. The method adopts the paradigm proposed by UN (United Nations) that is adopted by IBGE in Brazil, which implies the divisor of this model can contain any number of dimensions, and only have to keep a mathematical relationship that makes it possible to infer the index to be evidenced. The Table 4 indicates the possibilities of indices for the degree of sustainability resulting from the calculation using the formula above.

https://dx.doi.org/10.22161/ijaers.5.2.11 *ISSN: 2349-6495(P) | 2456-1908(O)*

Table.4: Index range by level of sustainability

Index	Level of sustainability
≤ 0,0≤ 0,25	Unsustainable
≤ 0,26≤ 0,5	Insufficiently sustainable
≤ 0,51≤ 0,75	Sustainable
≤ 0,76≤ 1	Very sustainable

Source: elaborated by the authors

Considering Table 3, note that the four indexes together complete the totality of 100% of the percentage of levels of sustainability. In these conditions, there is a minimum percentage for a credible sustainability which allows to assign as relevant a percentage above the average until a suit of this totality with being sustainable. Below this percentage there is an insufficient metric until unsustainable; above this same metric will be more than sustainable.

The endogeny enters this mathematical model with the measurement of the stakeholder's perception on the intensity of sustainability of each indicator proposed by the UN/IBGE as considered in this research. This perception was measured by the Likert Scale. An average of the sample surveyed was inferred to each dimension and the individual number of indicators of these dimensions was also considered. This procedure was also adopted to infer the average indicator of each dimension proposed by the UN/IBGE; the endogeny in this model is in the approximation of published national indices; in this calculation a cross-check was made between the two listings; this crossing allowed us to find the new index of sustainability, which is now considered as ideal in terms of the assessment in the context of the Endogenous Development prescribed in this research.

These variables will take the values 1 if the indicator is selected or 0 if it is not selected. The environmental dimension is represented by $A_i,\ i = 1, 2, \cdots, 20$; the social dimension is represented by $S_i,\ i = 21, 22, \cdots, 41$; the economic dimension is represented by $E_i,\ i = 42, 43, \cdots, 53$; and the institional dimension is represented by $I_i,\ i = 54, 55, \cdots, 62$.

For the interconnection of the variables in their operability, the decision maker will need a logical function that indicates the efficiency in the matrix relationship evidenced, as well as to measure proportionality in the application of financial resources in RESEX among other measurements. Thus, we propose the objective function (FO), which is defined here as the sum of all variables.

$$FO = \sum A_i + \sum S_i + \sum E_i + \sum I_i$$

The objective function defines the minimum number of variables necessary to reach all the indicators of the dimensions. This is because an indicator can infer from one or more other indicators. The constraints for the indicators are represented by the expressions:

$$C_j = \sum_{j=1}^{20} A_i M_{ij} + \sum_{j=21}^{41} S_i M_{ij} + \sum_{j=42}^{53} E_i M_{ij} + \sum_{j=54}^{62} I_i M_{ij} \geq 1$$

In which $A \geq 1;\quad S \geq 1;\quad E \geq 1;\quad I \geq 1$ represents the Matrix of Relationship between the indicators adapted to the model by the authors. The element $C_j \geq 1$ means that each indicator must be reached at least once in the relationship with selected variables. The constraints for the indicators are represented by the expressions:

$$A = \sum_{j=1}^{20} A_i \geq 1;\quad S = \sum_{j=21}^{41} S_i \geq 1;\quad E = \sum_{j=42}^{53} E_i \geq 1;\quad I = \sum_{j=54}^{62} I_i \geq 1$$

In which A≥1; S≥1; E≥1; I≥1 means that for each dimension of sustainability at least one indicator must have been selected. This restriction can be modified according to the model of the decision maker. For the solution of the model described above, the Solver Excel software supplement was used. The decision maker, when verifying the index proposed by the GEITEC Method is indicating low sustainability of the researched scenario, might use the indicators of the mathematical model outlined here. In this way, it will define the area indicated in the variables where it will apply the resources, focusing on absorption of the positive reflection in the application of the projected resources. This providence implies in the logic of the relationship matrix that supports this synergistic effect. means that for each dimension of sustainability at least one indicator must have been selected. This restriction can be modified according to the model of the decision maker. For the solution of the model described above, the Solver Excel software supplement was used. The decision maker, when verifying the index proposed by the GEITEC Method is indicating low sustainability of the researched scenario, might use the indicators of the mathematical model outlined here. In this way, it will define the area indicated in the variables where it will apply the resources, focusing on absorption of the positive reflection in the application of the projected resources. This providence implies in the logic of the relationship matrix that supports this synergistic effect.

The GEITEC Endogenous Sustainability Assessment Method is a tool that can help managers of environmental resources. It provides support in the measurement of other systems that have sustainability indicators as a variable. The methodology is an auxiliary as a factor of endogeny, since it infers in values contained in the perception of the social actor, evidencing his interest in interventions directly related to his life goals.

5.3 Critical analysis of the model efficiency

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The research on RESEX's indicates that each resident is a manager with shared responsibility, while their actions depend on a set of other activities that reflect the objectives of RESEX. This way the local actors reflect about organizational adhesion clearly exposes the phenomenon studied and proves the fundamentals of Theory U.

With the new way of residents thinking, it was possible to maintain the stability in the RESEX area, since the construction of organizational system became a necessary element, starting to operate the structures of entry, processing and exits. The new attitude reflected directly on stakeholder attitudes. These have come to adhere to the thinking and manner of acting irradiated by the leaders and subjects of the RESEX, operating significant changes in the local scenario that culminated with operational regulations of conservation unit maintenance where it is possible, for example, to understand the capacity of individuals who may be present at the same time in the RESEX, assuming no more than the number accepted as being bearable by nature.

This number of visitors, carefully studied and delimited by residents indicates, for example, indicates a control over the quantity and type of vessels that can concomitantly navigate the lakes and rivers. This way, residents understand that the backwaters arising from the impact of the barges can be supported by the vegetation and soil from the shore. It remains evident that the conversions of thought congregate the constellations of stakeholders modeling a future in the collective. In this way, the innovation promulgated by the attitude of the residents operating the organization is able to emerge ideas that take shape and develop to integrate to the paradigm of sustainability.

The residents' practice integrated with the use of RESEX resources is oriented towards the evolution of governance. The sense is to make ecosystemic consciousness emerge, evidencing the innovation of reflexive thinking, in order to process the resources contained in the dimensions of sustainability.

VI. CONCLUSION

This research has its theoretical foundation in the organizational theories to configure innovation in RESEX in favor of sustainability. The scenario investigated is located in the conservation units of sustainable use Extractive Reserves. These units represent an important system of environmental protection, but there is a clear lack of efficient methods that can demonstrate their sustainability, especially methods that can be applied as a management tool for the application of resources in the most diverse sectors of society.

The Brazilian reality in general, and in particular in the Amazon indicates that the sustainability indicators do not reach the perspectives of the citizens that somehow have interests in this relation. Thus, in the euphoria to find a method of evaluation through indicators, we seek to rely on those offered by the United Nations Organization incorporated by the Brazilian Institute of Geography and Statistics.

It is through the search for the elimination of vices like this that serious studies are promoted for the methodological and technical convergence, in support of the decision for the endogenous development of the communities established in Extractive Reserves.

The support of Theory U allowed not only the adequate operational interpretation of the management method to the changes, in the route required by the leaderships; also made aware of the process of innovation from the social knowledge, the questions about what to do, how to do and why to do; and allows to understand the use of indicators to the assessment of sustainability, considering the cognitive trade off of information of reality.

In response to the research problem, it is possible to state technically and scientifically that the GEITEC Method of Endogenous Sustainability Assessment is adequate to what is provided, since the usual methods, which rely on indicators hitherto known and pointed out in this document, do not reach the perspectives, since they are alien to the reality of the context. Therefore, the contribution of the GEITEC Method of Endogenous Sustainability Assessment comes as an essential solution, pondering the state of order, promoting equity, and directed to efficiency by the satisfaction of stakeholders, thus serving as the benchmark in sustainability measurements. In the method concluded here it is possible to infer, from the relationship matrix of the indicators, an incidental logical coalition of one indicator that affects others, combining synergic efficiency over the others.

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