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Applying the MESMIS Methodology to the Nexus Approach: The Nexus Pampa Project

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Introduction

The Pampa is an old group of ecosystems that has its own flora and fauna, and is home to sizable biodiversity. It is a natural, genetic and cultural heritage of great national and global importance. Continuous introduction and expansion of monoculture, especially soybean (SILVEIRA, et al. 2015), and of pastures with exotic species (BARBOSA et al., 2013) has led the Pampa to rapid degradation and to the loss of its distinctive characteristics. This issue has prompted the creation of the project titled "Cattle Farming Production Systems in the Ibirapuitã River Basin and Their Relation to Water and Energy in Food Production – Nexus Pampa", supported by the Brazilian Ministry of Science and Technology. The goal is to diagnose the current situation and to model scenarios that are subsequent to the farming production systems used in the Ibirapuitã river basin, in the Brazilian Pampa biome.

The project adopts a collaborative transdisciplinary approach, and its research area is delimited to the Rio Ibirapuitã river basin. It focuses on the understanding of the reality of the area a result of the interactions between man and nature. Based on these premises we were able to explore factors related to the importance of water, energy, and food and their interrelations, in accordance with the multidisciplinary approach of the "Water-Energy-Food Nexus", that emphasizes that in order for an assessment to have long-term impact, it needs to be implemented as part of a wider process of involvement and should be discussed with specialists and interested parties (FAO, 2014). The project is structured into four axes, three of which are directly connected to the Water, Energy and Food focus, and a fourth, which unites the other three. The integrating axis works from the perspective of the MESMIS Method (*Marco de Evaluación de Sistemas de Manejo incorporando Indicadores de Sustentabilidade*) (MASERA, et al., 1999), combining the actions produced in each of the other axis through the construction of indicators that represent the systems that are under study.

The overall goal of the project is to produce a diagnosis of the current situation and to model future scenarios that derive from the farming systems present in the Ibirapuitã river basin. This is achieved by describing and quantifying the processes that cause surface runoff and their association to soil degradation due to erosion, the degradation of water resources through sedimentation, as well as the types of energy and their forms of consumption by the inhabitants, and the analysis of food production and its insertion into consumer markets. Another goal is to describe how the MESMIS methodology was adapted to the Water-Energy-Food scope by researchers and collaborators in this project.

Material and Methods

The research method used in this project is the *Evaluación de Sistemas de Manejo incorporando Indicadores de Sustentabilidade* (Framework for Assessing the Sustainability of Natural

Resource Management Systems) – MESMIS, as presented by Masera et al. (1999). The MESMIS operational structure consists of six stages (SPEELMAN et al., 2007) that are developed through collaborative methods, being that the outcome of each stage is a result of the insights and contributions of each of the subjects involved:
Stage 1 – definition and description of the system or systems that will be evaluated.
Stage 2 – identification of the system's critical points: positive or negative aspects that provide weaknesses and strengths, that is, socioeconomic factors, techniques or processes that may, individually or jointly, have a crucial effect on the attributes of the systems described.
Stage 3 – selection of the diagnostic criteria and indicators: the objective of this process is to provide the necessary connection between attributes and critical points on the one hand, and critical points and indicators, on the other. The difference between the diagnostic criteria and the indicators is that the first describes the sustainability attributes whereas the latter describes a specific process in the system.
Stage 4 – measurement and monitoring of the indicators:
Once the set of indicators has been determined, the procedures used for measuring and monitoring should also be established. Given that sustainability refers to system behavior in relation to time, the procedures need to collect information that contemplates the monitoring of processes during a certain period of time. Overall, these procedures include: literature review, direct measuring, simulation models, interviews and group techniques.
Stage 5 – integration of results.
In this stage of the cycle the results obtained through monitoring of the indicators are gathered and integrated. This is a crucial moment of the assessment because it represents the synthesis of the information that has been compiled in previous stages. Thus, it is essential that the process exposes the advantages and disadvantages of the systems analyzed in regards to each of the indicators for sustainability assessment. In order to do this, research results can be presented using quantitative and qualitative presentation techniques or graphic/mixed techniques.
Stage 6 – conclusions and recommendations regarding management systems:
In the sixth stage, the cycle is concluded by revisiting the results of the analysis so that a "value judgment" can be issued for comparing other systems in relation to their sustainability. In this stage, the process of evaluation is deliberated on, which leads to the elaboration of strategies for other possible cycles of evaluation in different qualitative situations.

Results and Discussion

The MESMIS operational proposal is structured in successive cycles that originate a spiral-form dynamic process. This contrasts with conventional methods in which systems are usually examined statically, and are considered in a given period of time (ASTIER et al., 2002). Therefore, the description provided in this study refers to the first cycle, and stage 6 refers to the validation of the MESMIS method to be applied in the Nexus Pampa Project.
The first three stages of the MESMIS took place between May and October 2018, by means of group meetings with researchers and extension specialists involved with the project. Thus, the production systems in the Ibirapuitã river basin had already been defined as study subjects (Stage 1). Nonetheless, so that all subjects involved could understand the systems in light of the Water-Energy-Food Nexus, several debates and discussions were held in order to provide an interdisciplinary view of the approach, rather than treating each field of activity (axis) separately.
After that, during Stage 2, the production systems were analyzed through SWOT analysis (Strengths, Weaknesses, Opportunities and Threats). At this point, it became important to come to terms with the fact that many had never been worked in this field of study, and that this fact was sometimes hindering. However, there were also moments in which the references from other fields and the information made readily available promoted argumentation and forming of opinions about the topic in discussion. Another important point is the appropriation of a systemic view by the group in which – to state one example –, researchers that worked in the field of

energy started to perceive the importance of energy when proposing alterations in product appreciation and value aggregation.
After this initial acclimatization that took place in May 2018, the coordinators of each axis, alongside the participants, took on the role of elaborating indicators that would be able to contemplate their dimension, but with a systemic view derived from the discussions that took place over those two days.
Stage three took place at the end of August and at the beginning of September 2018. Each axis presented their proposed indicators to be shared with and adjusted by the group. It is important to highlight that the food axis was divided in two, due to its characteristics: food production, and commercialization and consumption. At this stage, it was very important to define the importance of each of the indicators, since interdisciplinarity caused them to adjust to different views and opinions to those that are conventional of monodisciplinarity, promoting a discussion with a systemic view of the indicators, even though the indicator itself was delimited in character.
In this meeting it was decided that, after the preparation of the questionnaire that contemplated the indicators that were accorded on by the group, an initial version would be applied before making final adjustments. Only then would they be used in a more general way in the production systems of the Ibirapuitã river basin. The first measurements were taken in January 2019, as well as the monitoring of the indicators (Stage 4).
This made it possible for the other two stages to take place, thus completing the cycle: Stage 5 (integration of results) and Stage 6 (conclusions and recommendations regarding management systems). In this case, the last stage was replaced by the efficacy of the method in adjusting to the Nexus Pampa Project.
Four farmers were interviewed in this assessment. We verified that some of the questions needed to be better explained, but most of them were successfully answered. Hence, final adjustments were made to the questionnaires, such as organizing the questions in a logical sequence in a way that the order was independent of the axes. Adjustments were also made to the way the questions were phrased, in order to facilitate understanding.
The assessment cycle ends with the retrieval of the results of the analysis so that a “value judgment” can be issued for comparing other systems in relation to their sustainability. In this case, the application of questionnaires to the farmers in the region of the Ibirapuitã river basin, who are the focus of the project. Thus, the MESMIS structure successfully handles derivation, measuring and monitoring of indicators of sustainability as part of a flexible process of systemic, participative and interdisciplinary evaluation (LÓPEZ-RIDAURA et al., 2002).
In table 1 it is possible to observe the Water dimension, the scopes and their levels of importance, and the indicators and their levels of importance. Thus, it is possible to verify the different levels of aggregation that the method enables.

Table 1 – MESMIS methodology example adapted to the Nexus Pampa - Water dimension.

Dimension	Scope	Deliberation (%)	Indicator	Deliberation (%)
Water	Human consumption	20	Water amount	10
			Water quality	10
	Production	40	Water of Production	10
			Water use efficiency	20
			Susceptibility to warm droughts	10
	Degradation	40	Existence of conservative practices	30
			Perception of erosion	10

The scopes corresponding to the three dimensions are shown in Figure 1: water - human consumption, production and degradation; Energy – mechanical, thermal and electric; Food - organizational and institutional environment, productive and technological environment and marketing and consumption.

Figure 1. Indicators for Water, Energy and Food applied to farmers in Alegrete-RS, Brazil.

Conclusions and Outlook

Initial results indicate a positive capacity of the methodology used in this project for assessing the sustainability of production systems, contributing to human development and to reaching the objectives of sustainable development projected by the United Nation.

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Acknowledgments

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