System of Sustainability Indicators Applied in River Basin Management

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Abstract

The historical context of the indicators clearly shows their complementary role in the decision-making processes, seeking to make perceptible a current condition resulting from a historical process of past practices and actions, reflecting the reflexes of previous planning. This tool can be used for river basin planning and management, including monitoring, assessment and reporting. The general aim of this research is to suggest a model of sustainability indicators for the PCJ basin committees management, as an auxiliary tool for assessing the region's sustainability level. The research to be developed has quantitative and qualitative characteristics, characterized as a mixed method. The Preliminary findings of this research point to the need for institutional innovations and their formalization and emancipation before public management, with the creation and performance of participatory procedures prescribed in specific laws, such as in the area of water resources, where the participation of multi-stakeholders through the Watershed Committees represents a significant breakthrough for good governance. It is necessary to consolidate the articulation between institutions at the municipal level so that the dimensions of sustainability are treated in a fair and proactive way, so that progress towards regional sustainable development is possible.

Keywords: sustainability indicators, river basin management, PCJ basin committees.

Introduction

Sustainability supports a universally shared common vision of progress towards a just, secure and sustainable society for humanity. This concept recognizes not only the need for environmental protection but also the urgency to improve the quality of life through strategies that create socio-economic growth and address a wide range of cross-cutting issues. While there is a growing consensus that a more sustainable society embraces all individuals, opinions about what sustainability means and how that can be achieved are diverse (ALSHUWAIKHAT *et al.*, 2017).

In the monitoring of regional environmental and sustainability issues one of the main goals is to support decision-making processes, thus improving regional sustainability management and achieving better development results. In the face of heterogeneity of methods and tools for measuring sustainability, indicators almost always play a fundamental role. Sustainable Indicators are one possible way of ensuring that sustainability issues are being consistently and transparently integrated into sector activities on a local, regional and national scale. Indicators provide substantial sustainability performance measurement, reporting and transparency to stakeholders (RAMOS, 2009). According to Santos (2004), regardless of the objectives or the planned site, this strategy requires the specialization of a broad set of data that needed to be compared, overlapped and evaluated in a holistic way.

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practices and actions, reflecting the reflexes of previous planning. When an indicator is analyzed, its current portrait is viewed from the historical perspective, sustaining the ability to project future trends and conditions to develop ways to monitor and measure its temporal behavior (BATALHÃO; TEIXEIRA, 2017).

Sustainability indicators are essential tools to ensure the identification of a comprehensive strategies and realistic way of assessing and improving sustainability. This tool can be used for river basin planning and management, including monitoring, assessment and reporting. Also, indicators are important assessment tools to identify social needs and contribute to public planning and management. However, the proper use of indicators in the public management is still a methodological and political challenge with rather vague guidelines in many scales. Few studies explored the different potential uses and impacts of indicators as complementary tool to decision-making in water management and planning processes (WU; LEONG, 2016).

The development of strategies related to the monitoring of sustainable development requires data and information of various natures. Indicators fulfill this role, with quantitative and qualitative attributions, as they quantify and simplify complex phenomena and realities to a manageable amount of significant information to foment the decision-making process (HARMANCIOGLU; BARBAROS; CETINKAYA, 2013).

At regional scale, planning for the proposal of sustainable development is more comprehensive and robust, by the size of the territory and by the number of key actors, which facilitates the identification

of problems, community demands and local knowledge, with greater possibilities for participation. Mickwitz *et al.* (2006) emphasizes that on a regional scale any attempt at methodological generalization can be questioned because the problems are different and need customized tools.

Meet the sustainability development demands are critical to a renewal and maintenance of practices that enable an effective and secure flow of information to strengthen the most important decision-making processes. From the management of water and the environment we can perceive multiple relationships and interactions and their regional interests. Therefore, it is necessary to promote assessments and work with findings to project trends. This is justified by the increasing demand for evaluation systems using indicators that capture the subjectivities of the research object and make them objective.

In this perspective, this study can also assist river basin committees and public management, serving as a reference for the development and maintenance of public policies aimed at basin sustainability, considering the use of water, its economic importance, environmental degradation, and the level of productivity, among its multiple dimensions. This contributes to broadening the vision of all the actors involved in the management of the basins and the municipalities that constitute these spaces, generating new discussions about the factors that may enable a way to promote development, not forgetting the social and environmental demands, leaving behind the concept that development is only chained to economic growth. Scientifically, its relevance is in the development and reproducibility of the methodology, considering possible

adaptations to the regions of analysis, and can serve as a starting point for future work.

For this, the research's main issue should answer the question:

- Is it possible to find ways to evaluate the sustainability level of Piracicaba, Capivari and Jundiá (PCJ) basin region in Brazil using the Basin Plan as a reference and involving key stakeholders (decision makers, basin committees, organized civil society, municipal/state/federal agencies, consultancies and other users) based on a set of indicators which considers the characteristics of sustainability and meets the wishes and demands of the stakeholders, to improve the management of the subjects related to sustainable development?

In addition, confirm or falsify a main hypothesis which is:

- It is possible to develop a model (structure) of indicators based on the participation of the key stakeholders, which can serve as an evaluation tool for the elaboration of a situational picture of the object, and also as a complementary tool for the management of sustainable development within the framework of PCJ basin.

The general aim of this research is to suggest a model of sustainability indicators for the PCJ basin committees the management, as an auxiliary tool for assessing the region's sustainability level. In order to achieve the major goal, the research plan will be developed in five tasks that are shortly described:

To provide an overview of the challenges and demands present in the literature and associate them with the main

stages of elaboration and implementation of sustainability indicators.

- To analyze the main models of systems of indicators applied in river basins region based on initiatives of indicators in the world;
- To evaluate practices and environmental and sustainability management) related to municipal water resources based on self-assessment;
- To identify and involve the decision makers of the basin committees and other stakeholders in order to ensure their participation in the process of selection and development of the set of indicators based on Agenda 2030 (building the archetype);
- To apply the new methodological proposal of indicators systems developed in the previous stage, in order to evaluate the level of sustainability of the region and to visualize future scenarios.

Methods

Study area

The study area of this research is delimited by the region of PCJ river basins, and has an approximate area of 15,320 km². Approximately 92% of this area about 14,040 km² are in the State of São Paulo and the remaining 1,280 km² belong to the State of Minas Gerais, Brazil, where the headwaters of the Jaguari, Camanducaia and Atibaia rivers are located. This area is located between the meridians 46° and 49° west and the latitudes 22° and 23.5° south, presenting an approximate extension of 300 km, in

the east-west direction, and of 100 km, in the north-south direction (AGENCIA DAS BACIAS PCJ, 2016).

The region of PCJ river basins covers areas of 76 municipalities, and 62 are headquartered in the region's drainage areas. Of these, 58 are in the State of São Paulo and four in Minas Gerais. With approximately five million inhabitants, this region is considered one of the most important in Brazil due to its economic development, which represents about 7% of the National Gross Domestic Product (GDP). The municipalities of the State of São Paulo with headquarters in the region belong to Campinas, which also includes municipalities located in the Alto Mogi-Guaçu basin. In the PCJ basins there are five Government regions of São Paulo's State: Campinas region, Jundiaí region, Piracicaba region, Limeira region and Bragança Paulista region, which are intermediate levels of political-administrative management between the Administrative Region and municipalities. (PCJ, 2016).

The main justification for choosing the hydrographic basins of the Piracicaba, Capivari and Jundiaí rivers for research is the emerging need to communicate (information system) the society and the main stakeholders about the levels of development and sustainability of these basins, which has great economic and strategic importance for the State of São Paulo, Brazil, in order to evaluate the environmental, economic, social and institutional spheres seeking the understanding of the sustainable society- environment relationship.

Figure 1 – Spatial location of the object of study. Source: Agência das Bacias PCJ, 2016.

Methodological resources

The research to be developed has quantitative and qualitative characteristics, characterized as a mixed method. The quantitative part will be based on a structured procedure for the collection of secondary data, sought in reference sources already used in the Basin Plan, and other sources that are in line with the research objectives. Already, in the qualitative part will be used the semi-structured questionnaire instruments and individual and collective interviews, personally and electronically, with the participants chosen for the research, representing a focus group. In this case, the scope of potentially relevant information provided by the interviewee is restricted, where the interview guide has a directive function. Mixed methods allow better exploration

and explanation of data and information, and are an opportunity to develop new methodological skills for research.

The triangulation method will be used to combine the results of quantitative and qualitative methods. In this case, the different methodological perspectives are complemented for the analysis of a theme, this process being understood as the complementary compensation of the deficiencies and the obscure points of each isolated method. The basis of this view is that "qualitative and quantitative methods must be seen as complementary rather than rival fields" (JICK, 1983, p. 135). However, the various methods remain autonomous, continue to operate side by side, having as a meeting point the subject under study.

Figure 2 contains the methodological summary in a simplified way.

Figure 2 – Methodological summary of study. Source: Prepared by the authors.

Preliminary results

So far we can offer some preliminary results of this research. We generate the profile of river basin initiatives in the world that use indicators in their experiences. These findings generate the general profile:

- Regional area;

- Using pure indicators approach;
- Based on environmental scope; (it limits the evaluation of sustainability, and does not reflect the interactions between environment and society).

These findings may be better perceived in Figure 3.

Figure 3 – Profile of river basin initiatives in the world using indicators. Source: Prepared by the authors.

In indexes the scope does not have a centrality in the environmental dimension, using different dimensions (ecological, social, economic, and institutional). Here the non-monetized was greater than the monetary valuation. So far we have the following findings regarding field research:

- 76 municipalities are involved in this research;
- 42% were concluded so far being 70% face-to-face visits;
- 58% of them had a high level of response (75% - 100%).

Figure 4 presents these preliminary fieldwork findings.

Figure 4 – Preliminary results of fieldwork.

According to the literature of the topic studied, the level of response is considered acceptable for analysis of the results. However, we are still looking to improve these numbers to provide a more robust result.

There is increasing recognition of one's own institutional limitations in dealing with complex problems at all spatial scales. The findings of this research point to the need for institutional innovations and their formalization and emancipation before public management, with the creation and performance of participatory procedures prescribed in specific laws, such as in the area of water resources, where the participation of multi-stakeholders through the Watershed Committees represents a significant breakthrough for good governance. It is necessary to consolidate the articulation between institutions at the municipal level so that the dimensions of sustainability are treated in a fair and proactive way, so that progress towards

regional sustainable development is possible. The difficulty in this research so far is to access and streamline a link with the various stakeholders and to build interfaces with inter-sectoral relationships to stimulate the flow of information in these networks.

Many challenges have been found for the construction of evaluation systems with indicators like: geographical or spatial delimitation; temporal discontinuity; validation; type of aggregation; lack of information; subjectivity of the concept of sustainability; access to data; decision support/policy advisor; methodological consensus; integration of information; measurability; complexity; quality of data; potential use; medium and long-term approach - targets; legal congruence; participatory approach; relevance; credibility; legitimacy; transparency; technical knowledge; effective communication; comparative analysis; operationalization; selection; monitoring; self-evaluation; scope definition.

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