



## Water production in a Brazilian montane rainforest: Implications for water resources management

Jonatas Batista Mattos<sup>a,b,\*</sup>, Débora Alves Santos<sup>a</sup>, César Augusto Teixeira Falcão Filho<sup>b</sup>, Tailane Jesus Santos<sup>a</sup>, Maiquele Gama dos Santos<sup>a</sup>, Francisco Carlos Fernandes De Paula<sup>a</sup>

<sup>a</sup> Departamento de Ciências Agrárias e Ambientais, Universidade Estadual de Santa Cruz, Ilhéus, BA, Brazil

<sup>b</sup> PPGeo, Instituto de Geociências, Universidade Federal da Bahia, Salvador, BA, Brazil

### ARTICLE INFO

#### Keywords:

Ecosystem services  
Payment for watershed services  
National Park  
Environmental economics  
Northeastern Brazil

### ABSTRACT

The objective of this study was to evaluate water production within a national park in order to characterize quantity and quality when associated with preserved landscapes in rainforests. After acquiring the necessary qualitative-quantitative information, a second objective was defined, aiming to propose a new approach for water valuation in preserved forest areas within a scenario of integrated water resources management. Field campaigns were conducted in subwatersheds within the Serra das Lontras National Park in order to collect hydrological and hydrochemical data. Results showed that the effluent streams presented perennial water production of  $4,000 \text{ l ha}^{-1} \text{ day}^{-1}$  in the most conservative scenario. Regardless of flow rate regimes, waters were well-oxygenated and presented low salinity and low concentration of total suspended solids. These results prove the effectiveness of a montane rainforest in providing protection to water bodies and in delivering important ecosystem services. Thus, we propose the inclusion payments policies for watershed services (PWS) by water resources management from an alternative approach. In conclusion, these policies could be reviewed with the objective of adding water valuation, making programs more robust and attractive to rural producers and other stakeholders. Water catchment and treatment agencies could also be part of this process, including PWS in their revenue budgets, and using their prices to stimulate the ecosystem service market.

### 1. Introduction

Water is one of the main natural resources that living beings depend on, regarding both quantity and quality. Climatic changes and oscillations, population growth, and complex economic activities promote increases in pressure on water resources, compromising runoffs and the quality of the world's large freshwater ecosystems (Grafton et al., 2013). In this context, according to Tundisi and Barbosa et al. (1995), knowledge on environmental processes, water uses, and the socio-economic aspects of watersheds is paramount for formulating water resource management strategies.

The volume and hydrochemical characteristics of water produced by areas with preserved vegetation cover reflect the interactions of factors such as climate, soil, relief, geology, and vegetation of a watershed (Neary et al., 2009; Souza et al., 2013; Van Lear et al., 1985). According to Sopper (1975) and Neary and Leonard (1978), watersheds that present dense forest cover provide protection against soil erosion and excessive inorganic matter lixiviation into river waters. Areas with these characteristics are in better condition to produce high-quality

water (Bateni et al., 2013; Figuepron et al., 2013; Jayawardana et al., 2017).

Investing in the protection and conservation of forest areas in watersheds may be the most prudent and lucrative path, as shown by Chichilnisky and Heal (1998). This investment is able to reduce the cost of water treatments, as indicated in the studies conducted by Ernst et al. (2004) and Abildtrup et al. (2013). Thus, promoting mechanisms that alter agricultural land uses into forest land uses in zones that are strategic for fluvial and underground recharge is paramount to allow significant volumes of water with high environmental quality and low economic cost.

In Brazil, initiatives at the federal level (ANA - Agência Nacional de Águas, 2011) and also by state water supply agencies support maintenance and regeneration actions towards native vegetation in areas often as far as a hundred kilometers upstream, in order to guarantee the runoffs and to reduce the load of inorganic matter drained. These initiatives are structured within the principle of Payment for Ecosystem Services (PES). Regarding water resources, approximately 129 initiatives of Payment for Watershed Services (PWS) have been mapped

\* Corresponding author at: Departamento de Ciências Agrárias e Ambientais, Universidade Estadual de Santa Cruz, Ilhéus, BA, Brazil.  
E-mail address: [jon.geociencia@gmail.com](mailto:jon.geociencia@gmail.com) (J.B. Mattos).

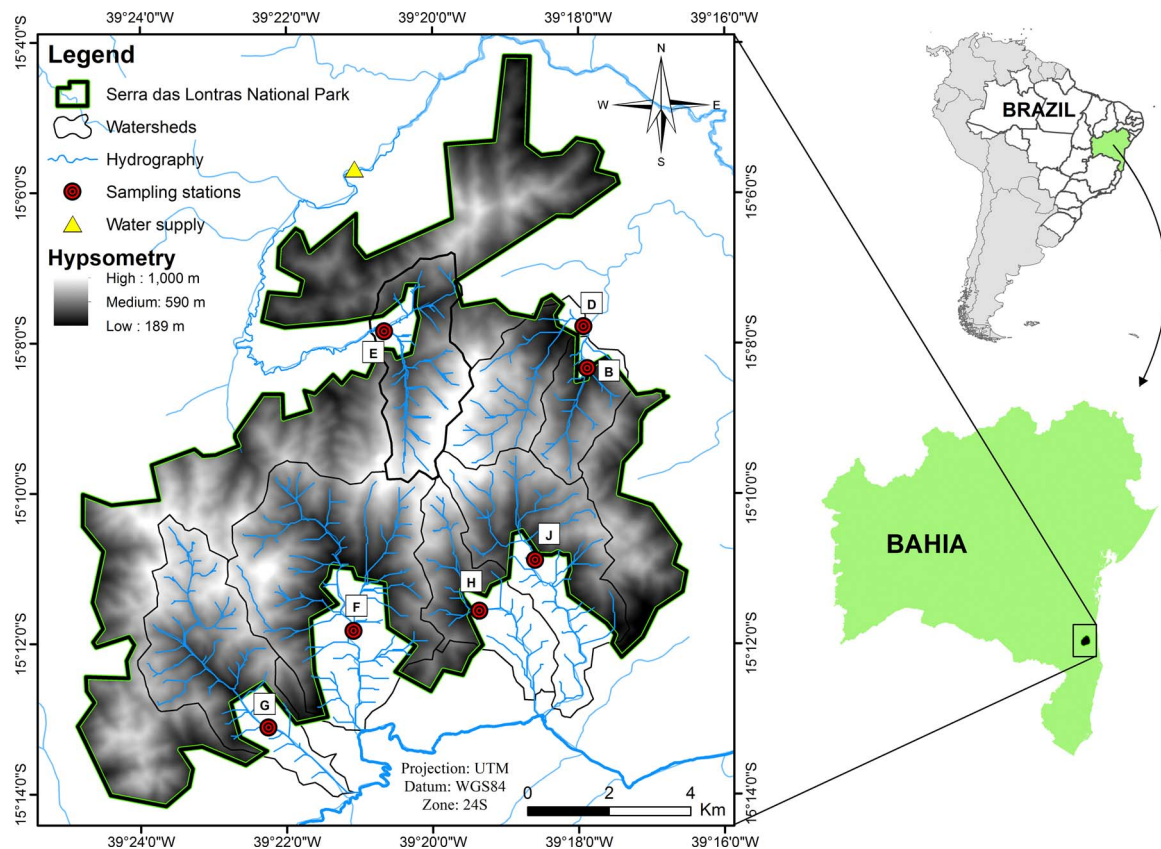


Fig. 1. Location of sampling stations in watersheds within the SLNP.

in Brazil (<http://www.brazil-forest-trends.org/>). According to Guedes and Seehusen et al., 2011, the effectiveness of most programs is assessed through monitoring activities regarding the preservation of a pre-determined area. However, according to Forest Trends (2015), the implementation of monitoring activities regarding water volumes produced and the quality of these waters is low.

Several aspects should be taken into account when executing PES-PWS in Brazil. Research studies should be especially encouraged in order to implement this type of program, be them of either a physical/environmental nature or from a political or socioeconomic standpoint. Studies are indispensable tools to measure the productive ability of a natural system and to identify the needs of a certain region in face of socioeconomic objectives. Liu et al. (2013) and Pereira et al. (2015) conducted participatory action research projects considering natural drivers in watersheds and the environmental perception of water users. According to Quintero et al. (2009), experiments such as these serve as tools for the decision-making process, diagnosing the implementation of a PWS program in a given region as either viable or not.

Araújo et al. (2015) reiterated that investments in research and development of water resource management plans are ineffective if monitoring and inspection actions are not implemented. Monitoring should aim to evaluate the effectiveness of the program regarding not only water production but also water quality, as indicated by He et al. (2015), who detected gradual and sharp changes in water quality after the implementation of a PWS program in essentially agricultural areas. In order to understand the processes related to PES programs, Grimmer et al. (2016) analyzed 40 PES programs in Latin America since 1990. These authors identified that an essential characteristic of successful programs was the use of data from local-regional studies, incorporated into cultural and political contexts.

The use of this type of data in order to guarantee the success of a program should be based on the execution of correct policies, encompassing innovative public incentive and subsidy mechanisms, as well as

awareness and transparency. These policies should necessarily follow these recommendations because environmental services become commodified and, therefore, promote complex relationships of power, which can cause value subjectivities and imbalances from one region to the other, causing dissatisfaction among those participating in the program. Thus, Guerra (2016) considers PES an important tool, but also one that requires careful analysis before implementation in order for it to be more coherent (optimization between theory and practice) and flexible, and to guarantee that the social and cultural aspects of the region are taken into consideration. According to Muradian et al. (2010), the effective policies of PES initiatives can be grouped according to three criteria: i) importance of economic incentive; ii) transparency in transactions between suppliers, intermediates and buyers of an environmental service; and iii) degree of commodification of these services.

A systemic approach was taken towards the relationship between a montane rainforest and water production and water resource management based on data obtained from subwatersheds located within a National Park in the southern portion of the State of Bahia (northeastern Brazil). The objective of the present study was to evaluate the quantity and quality of water produced within a preserved area in order to characterize these measures when associated with preserved rainforest landscapes. After acquiring the necessary qualitative information, a second objective was defined, aiming to propose a new approach to water valuation in PWS policies of preserved forest areas in a scenario of integrated water resources management.

## 2. Material and methods

### 2.1. Study area

The present study was conducted in the Serra das Lontras National Park - SLNP (ID No. 555,576,352 in the World Database on Protected

Download English Version:

<https://daneshyari.com/en/article/7466029>

Download Persian Version:

<https://daneshyari.com/article/7466029>

[Daneshyari.com](https://daneshyari.com)