A nitrogen footprint perspective for Brazilian water sector

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ABSTRACT

In the process of stablishing a national politics for the water management in Brazil, the linkages between population food, energy and water consumption are rarely mentioned. In this study, we present a perspective for the water sector into Brazilian N-footprint.

Preliminary results show that most of Brazilian federal units have low wastewater N removal factor (< 0.2). With population increase and reduction of investments in sanitation in Brazil due to the economic crisis, N flow could rise and may aggravate the impacts on ecosystems and human health.

Keywords: wastewater, sanitation, water quality, nitrogen footprint.

INTRODUCTION

Water management in Brazil, established nationally by law only in 1997, is based on meeting multiple water use and watershed management for “ensure current and future generations the necessary availability of water, in quality standards appropriate to their uses”. In the process of stablishing a national politics to the water sector, linkages between population food and energy consumption patterns are rarely mentioned.

Recent studies on environmental Sanitation in Brazil have shown that sewage collected is treated inadequately and inefficiently in major parts of the country. Population growth increases consumer-driven N flow[1] and excess in N may lead to eutrophication, causing negative impact on ecosystems and human health.

In this study, we show a preliminary perspective towards a nitrogen footprint for Brazil, specifically related to wastewater N removal factor within the ‘food component’ of the N-footprint.

METHODS

The N-Calculator model is a tool developed by Leach et al. (2012)[2] to estimate individual N-footprint, relating Nr losses and food and energy consumption by individuals.

Wastewater N removal factor

Considering collected and treated sewage in each federative unit, and the population with and without sewage collection, and treatment (data from the ANA, 2017). we calculated the Wastewater N removal factor for all the 26 Brazilian states and the Federal District. For this, we adapted the methodology of Leach et al. (submitted)[3], using the mass balance approach which calculates N removed from sanitary sewage using equation 1.

$$N\ Removal = \frac{N\ influent - N\ effluent}{N\ influent} \times 100 \qquad \text{Eq. 1}$$

Where N Removal is the percentage of N removed by the treatment, N influent is the amount of N in the total sewage produced, and N effluent is the sum of the amount of N leaving the wastewater treatment plant (WWTP) and the N in the untreated sewage released to the environment [4], For calculations, we consider that the typical concentration of total N in the sewage is 0.045 g / L[5]. And we opted to use 79% of N removal efficiency in treatment [6], since there is no reliable data on nutrient removal efficiency for all the WWTPs. We calculate the N sewage from equation 2, where VzWaste1 is the total flow of sewage produced by the population without treatment L/day.

$$N\ influent = VzWaste1 \times 0.045 \qquad \text{Eq.2}$$

Then, we calculate the N effluent from equation 3, where VzWaste2 is the total flow of sanitary sewage in the WWTP that is collected and treated in L/day, and VzWaste 3 is the untreated sewage released to the environment

$$N\ effluent = VzWaste2 \times 0.045 \times 0.79 + VzWaste\ 3\ \times 0.04 \qquad \text{Eq.3}$$

Calculation of N Wastewater Footprint

After calculating the N removal, we calculate the N Wastewater Footprint per person in Brazil, using equation 4, where N Wastewater Footprint is the excess of Nr that remains in the environment, in water bodies, that was produced for each inhabitant, given in kg/person/yr:

$$N\ Wastewater\ Footprint = Average\ N\ sewage\ produced\ per\ capita\ per\ year * (1 - N\ removal\ fator) \qquad \text{Eq.4}$$

The average of sewage produced is the result from the total sewage produced in a year per person, multiplied per 0.045 (concentration of N in sanitary sewer). And the N removal factor is the value of N Removal % expressed as factor.

RESULTS

Preliminary results show that on average, only 24.6% of the nitrogen load from sewage is removed, ranging from 12% to 38.4% and 2.7% to 65.6%. North and Northeast regions stood out with the lowest rates of N removal and the population's lowest access to basic sanitation services (water supply, garbage collection and sewage network).

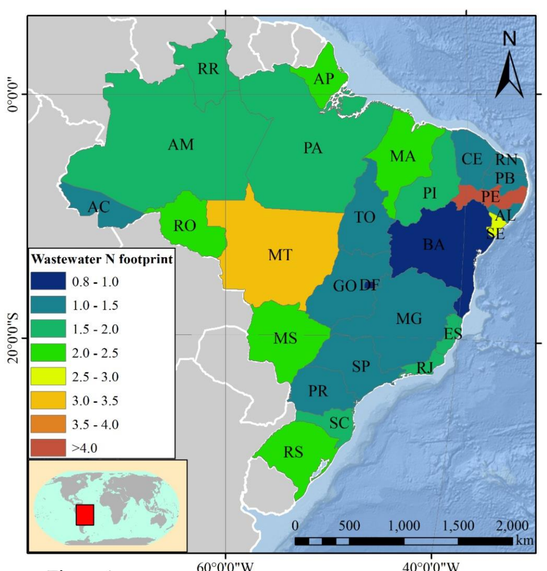

Figure 1

Almost 75% of the reactive nitrogen from the sewage returns to water bodies. Most of the Brazilian states have low wastewater N removal factor (<0.25).

The N Wastewater Footprint in the Brazilian states (*figure 1*) varied from 0.86 Kg/person/yr to 4.22 kg/person/yr, with an average for Brazil of 1.80 (kg/person/yr). Lowest values were found in the Southeast (1.57 kg/capita/yr), followed by the North and South regions (1.81 kg/capita/yr), the Northeast (1.88 kg/capita/yr), and the Central-West (1.91 kg/capita/yr).

CONCLUSIONS

This study presents the contribution of sanitation as to the N footprint. The results reflect the precariousness of sanitation and socioeconomic inequality in Brazil. It is possible to infer that countries that have poor sanitation tend to have problems with the high load of reactive N in water bodies, which causes damage to the environment and socioeconomic development. The results provide important insights to the development of the Brazilian N footprint and other developing countries.

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