GREY WATER FOOTPRINT OF RICE CULTIVATION IN SOUTHERN PROVINCE OF SRI LANKA: COMPARISON BETWEEN TWO LEVELS OF FERTILIZER APPLICATION.

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Introduction

Global freshwater ecosystems are currently being under severe pressure due to growing of populations, socio-economic developments and climate change (Russi *et al.*, 2013). And, the non-point source pollution due to agricultural runoff has become more destructive (Overmann, 2014). In Sri Lanka, paddy cultivation is the major agricultural practice and, chemical substances released to ground or surface water bodies from agricultural lands has caused for water pollution and environmental issues. Previous studies have identified Nitrate – nitrogen as the major pollutant that is leached from crop lands (Deurer *et al.*, 2011; Hoekstra *et al.*, 2011; Herath *et al.*, 2013). Grey Water Footprint (GWF) is an indicator of the total volume of water required to assimilate a pollutant load that reaches a water body (Franke, Boyacioglu and Hoekstra, 2013). Therefore, this study was focused on determining GWF of paddy cultivation in Southern Province of Sri Lanka.

Methodology

Study area was located in the right bank of "*Nilwala*" downstream, Southern province, Sri Lanka. And the study was conducted during the "*Yala*" cultivation season of Sri Lanka. Two levels of fertilizer application (Table 1, Table 2) were used (each plot: 90 m^2 and, 3 plots per each level). After every sub-fertilization step, water sampling was done once a day for a week. In each field plot, 3 sampling sites were located. 3 samples were collected from each sampling site with 5-minute intervals and, composite samples were prepared.

Nitrate concentration [NO_3^-] of collected water samples were measured using Ultraviolet Spectrophotometric Screening method. In addition, pH values and electrical conductivity (EC) of collected water samples were measured so that variations in water quality of field plots could be determined. Climatic data of the study period was gathered from the meteorological station. And data on average crop yield was recorded. Data on water quality standards was collected from the Sri Lanka Standards.

GWF of rice cultivation was calculated using following Equation introduced by Hoekstra *et al.*, (2011);

$$GWF = \frac{\text{Pollutant Load}}{\text{Critical load of pollutant}} \quad \text{(Volume/mass)}$$

Table 1. Fertilization Level 1 (L1) - recommended fertilizer applications for rain fed cultivation systems – Wet zone of Sri Lanka (3 1/2 Month varieties).

Age of the crop	Urea (Kg/ha)	TSP (Kg/ha)	MOP (Kg/ha)	$ZnSO_4$ (Kg/ha)
Basal	-	55	-	5
3 weeks*	25	-	35	-
5 weeks*	30	-	45	-
7 weeks*	25	-	30	-
8 weeks*	20	-	-	-
Total	100	55	110	5

* Time extended from crop establishment

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keywords: Grey water footprint, rice cultivation, fertilization rates, nitrate concentration

(Department of Agriculture (DOA), Sri Lanka).

Table 2: Fertilization Level 2 (L2) - fertilizer application rate used by a selected farmer.

Age of the crop	Urea (Kg/ha)	TSP (Kg/ha)	MOP (Kg/ha)
Before crop establishment	16	58	-
Between 20 -31 days of crop establishment	74	-	-
At the initial tillering stage	58	-	58
Total	148	58	58

Results and Discussion

When consider the variation of average [NO_3^-], under 95 percent confidence level there was a significant difference between the measured [NO_3^-] of collected water samples (L1: 0.38 mg/L, L2: 0.54 mg/L). The average harvested yields were 3766.67 kg/ha (L1) and 1952.13 kg/ha (L2). In terms of unit crop harvest, the Grey Water Footprint of rice was calculated as 0.023 m^3/kg for L1 and 0.083 m^3/kg for L2. In addition, under the 95 percent confidence level the measured pH values (L1: 5.40, L2: 5.85) and EC (L1: 224.87 µS/cm, L2: 177.00 µS/cm) values of collected water samples were significantly different from each. This may be due to application of more fertilizer in level L2 than in L1. These results in return emphasizes the impact on water resources due to irresponsible fertilizer applications.

Conclusions

Excess nutrients released from paddy fields into natural water bodies has emerged as a severe environmental issue in Sri Lanka. This is mostly because of adding too much fertilizer to the farming fields regardless the requirement of the crop. Therefore, study was focused on determining the GWP of rice cultivation with respect to two levels of fertilization: L1 and L2. Results elaborate that fertilizer application as recommended by Department of Agriculture, Sri Lanka would generate higher yields and less water pollution than the increased fertilizer application rates used by farmers. Data on crop yield and GWF values clearly indicate the importance of shifting fertilization rates used by farmers with the recommended application rates, to achieve higher productivity and, avoid the potential negative impacts on water resources and the environment.

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