

# Impact of soybean expansion on Water Footprint in the Amazon under climate change scenarios

Laura Miguel Ayala, Michiel van Eupen, Marta Pérez-Soba; Guoping Zhang; Lucieta G. Martorano, Leila S. Lisboa, Norma E. Beltrão.

Alterra Wageningen UR (The Netherlands); Water Footprint Network (The Netherlands); Embrapa Eastern Amazon (Brazil).

## Rationale

The expansion of soybean fields and the subsequent land use change is remarkably increasing in countries like Brazil in the last decades. The increase in water and nutrient use in relation to soybean production are known as potential sources of contamination (Lathuilière et al., 2014) and can have negative impacts in the adjacent water bodies. These impacts can be intensified by the projected Climate Change effects in tropical areas.

We present a Water Footprint Assessment developed to account WF related to the production of soybean based on globally available data in the Amazonian 'Tapajos' region in Brazil where a large expansion of soybean in deforested areas has taken place and production has been intensified in the last decades.

We identified hotspots (potential unsustainable areas) according to the Water Footprint Network methodology (Hoekstra et al., 2011) and calculated WF with globally available current data (WorldClim Global Climate data, 2010). The WF was spatially plotted along the river basin with ArcGIS in order to assess the current impact of soybean expansion (baseline). We also calculated potential areas of change in WF 2050 projection by using a land use change scenario (Ssp5 scenario) that includes climate change effects (Van Eupen et al., 2013).

## Water Footprint Accounting

**The water footprint (WF) is an indicator of freshwater use defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community (Hoekstra et al., 2011).**

**The total WF of soybean production calculated: blue (surface & groundwater consumed), green (rainwater consumed) and grey (polluted assimilation capacity consumed).**

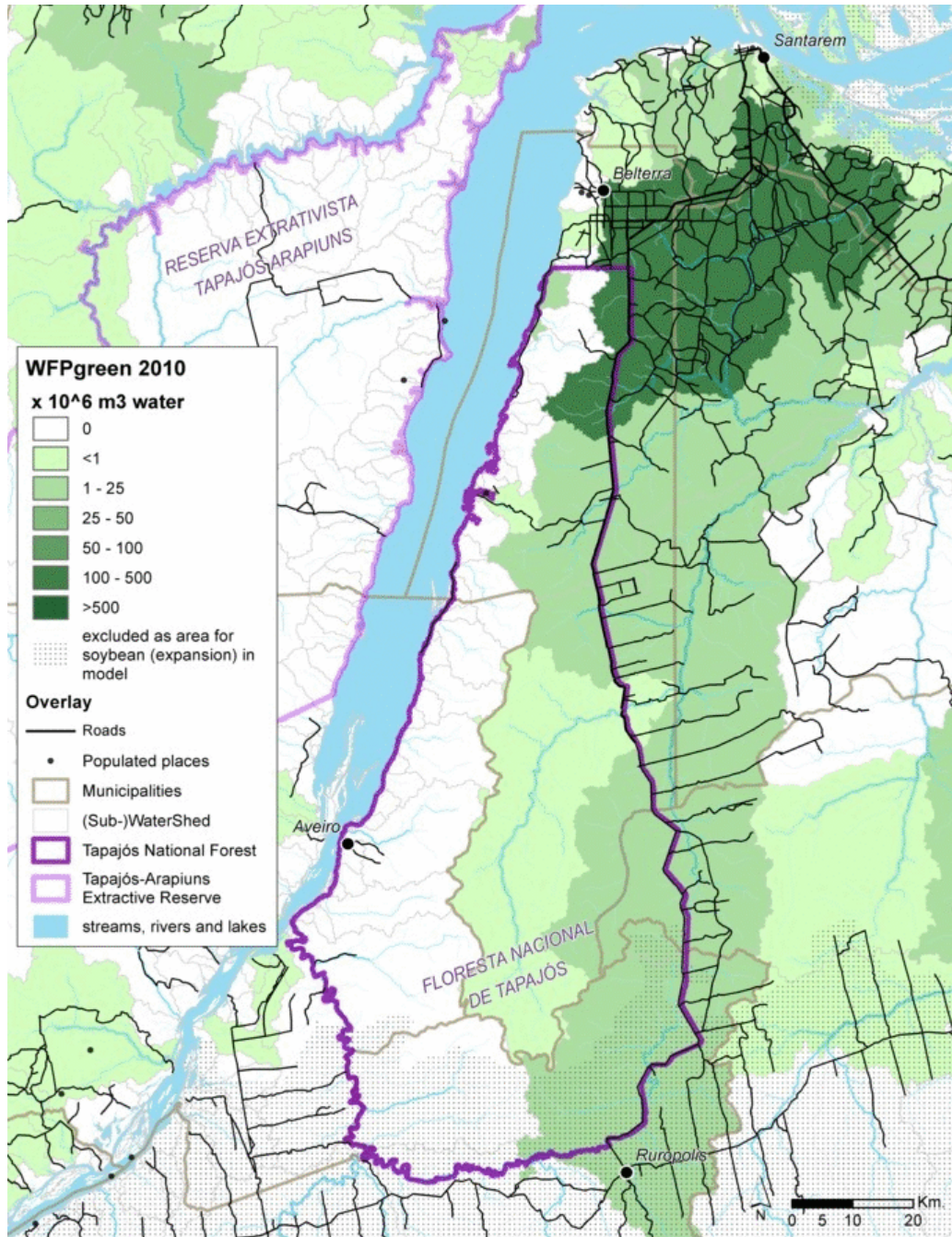
*WF<sub>green</sub> = Crop Water Use / Yield*

**Crop Water Use was obtained through the summation of monthly Evapotranspiration values for the growing period (105 days, from December to March), with an average yield of 2,5 tonnes/ha:**

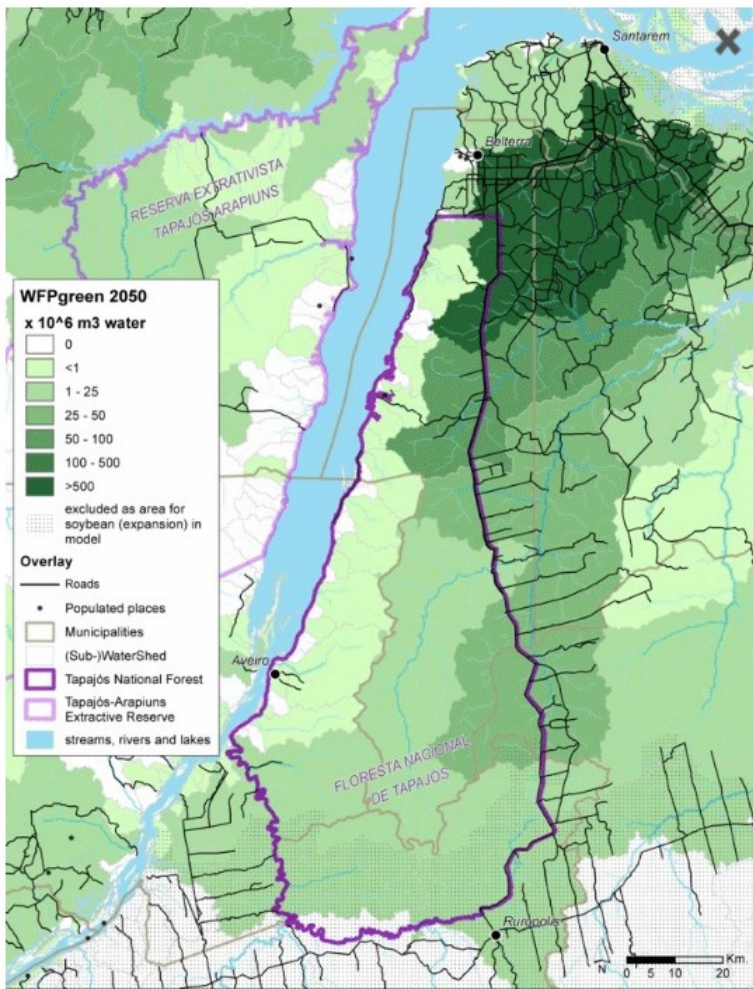
$$WF_{grey} = Load / (C_{max} - C_{nat})$$

We focused our  $WF_{grey}$  assessment on Phosphorus, which according to Fertisat data is the most critical contaminant.

Blue WF was accounted as 0 since there is no irrigation in Tapajós River basin.

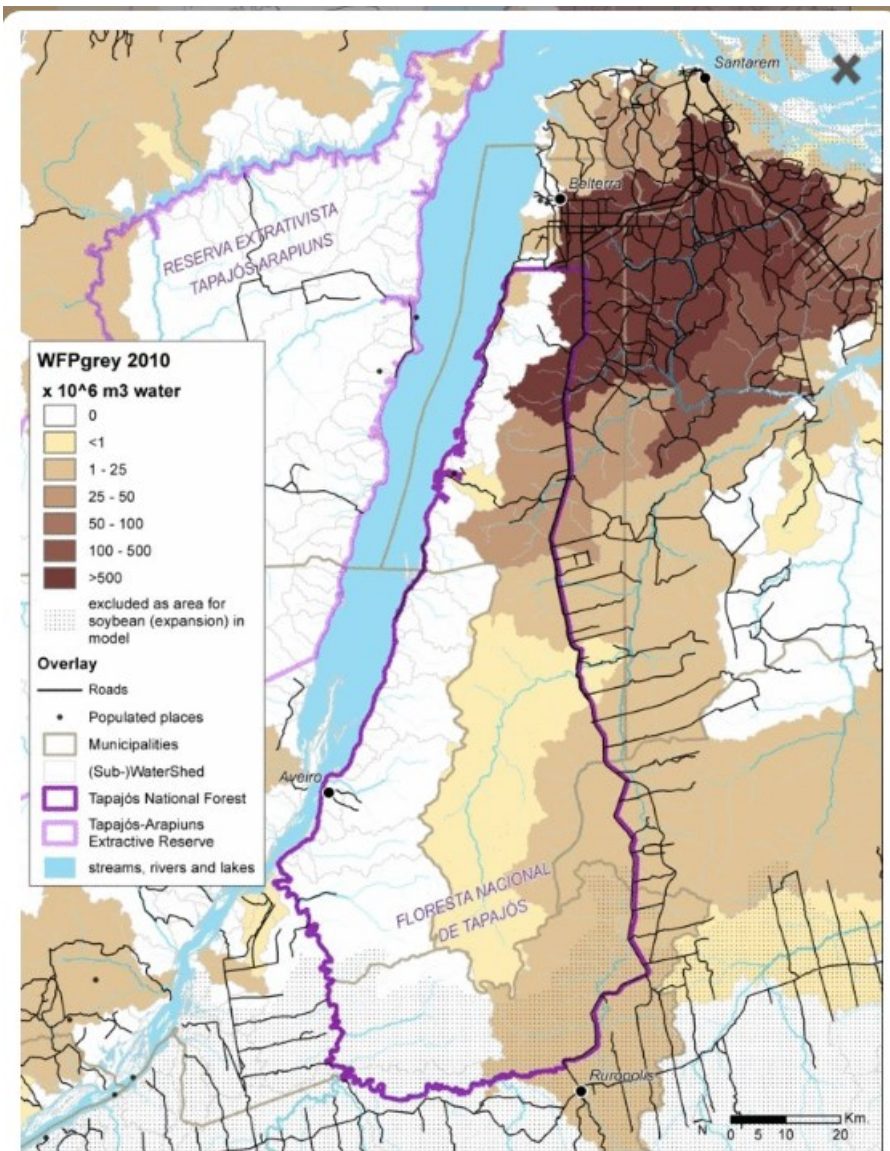


Green Water Footprint 2010

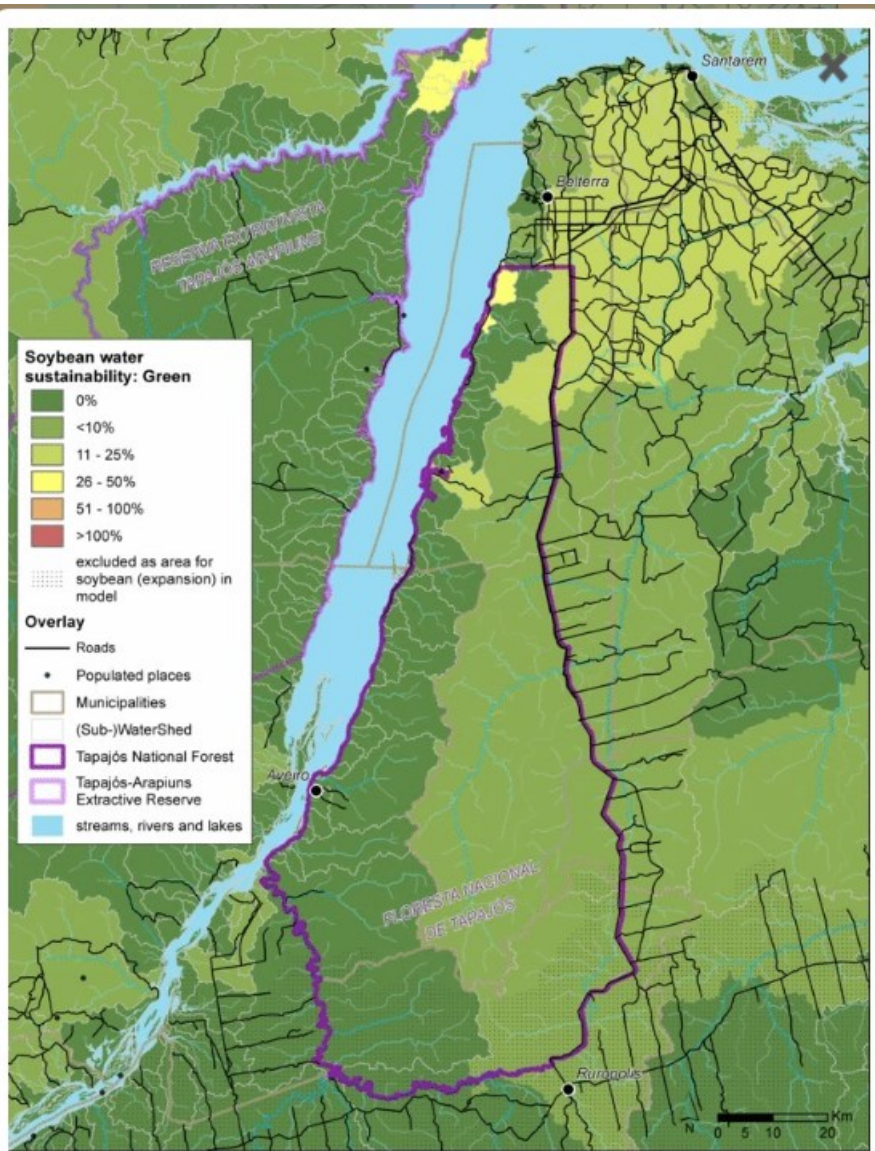


Green Water Footprint 2050



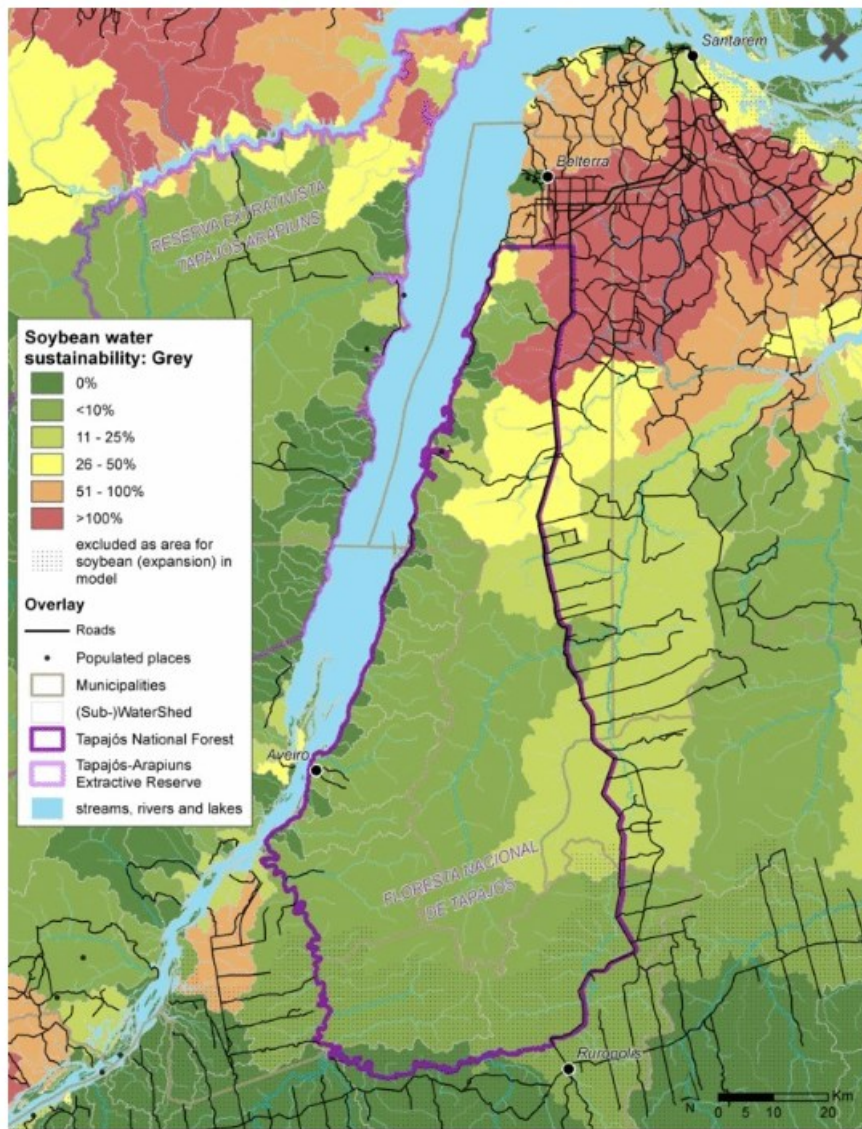


Grey Water Footprint 2010

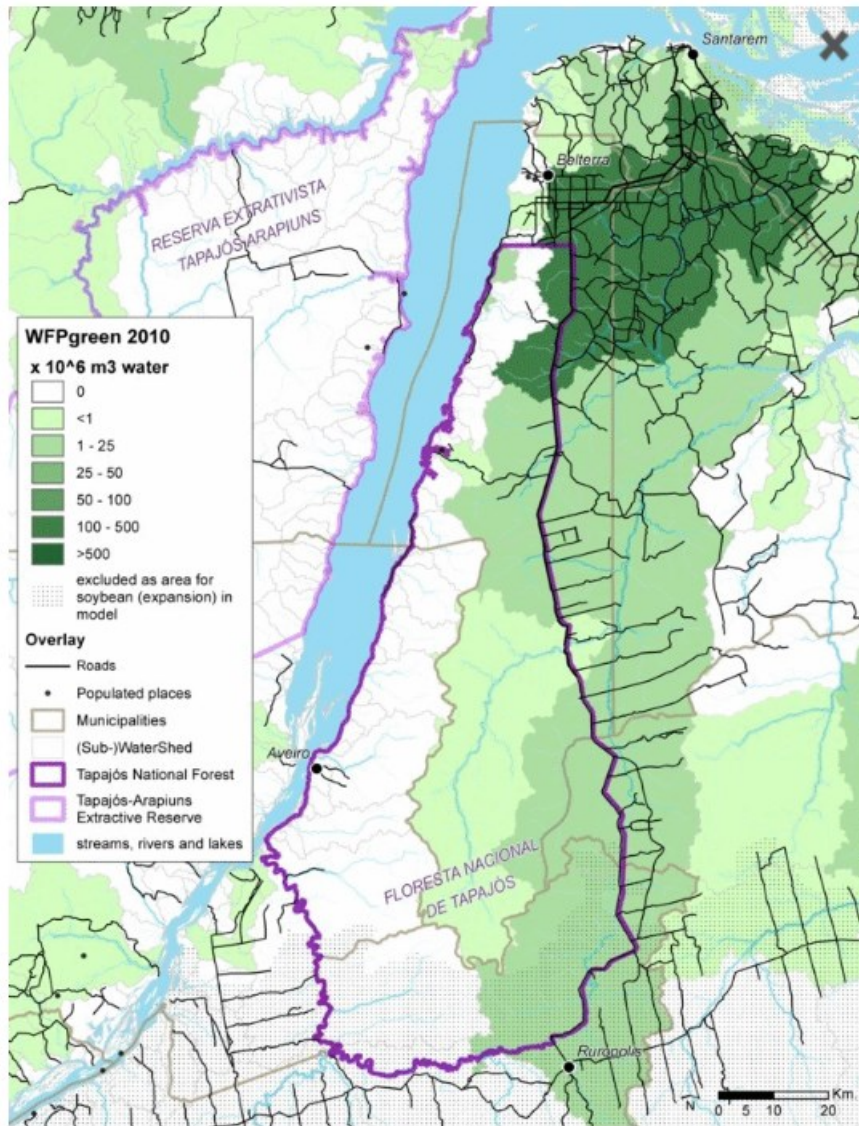


Soybean water sustainability 2010 : Green





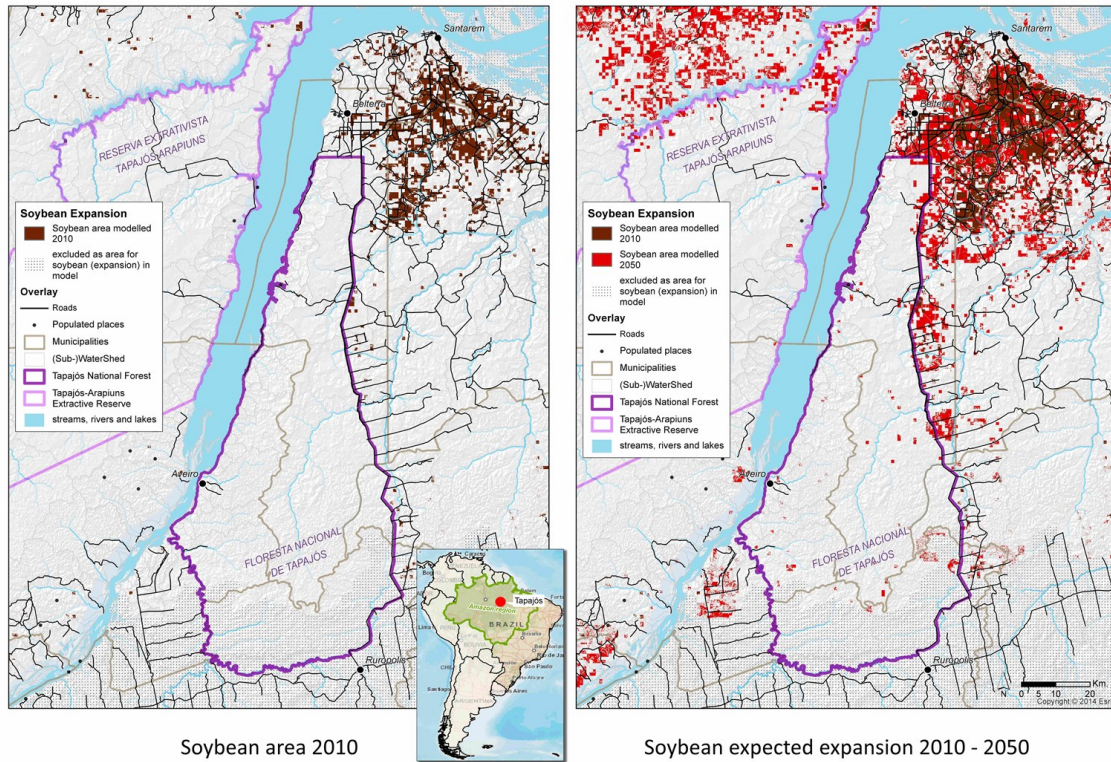
Soybean water sustainability 2050 : Grey



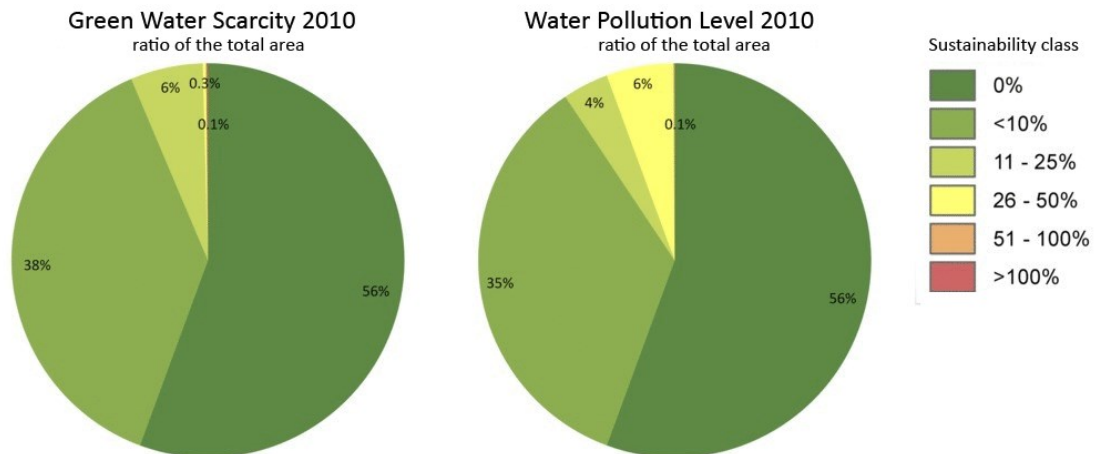
### Green Water Footprint 2010

Results indicate that soybean expansion is threatening sustainability of the WF locally. The values in 2050 are remarkably higher in the North-East and South-East of the area, which coincide with areas where more agricultural fields and more roads are concentrated. This increase will affect nature protected areas (Tapajós National Forest), showing the potential conflict between soybean expansion and nature protection.

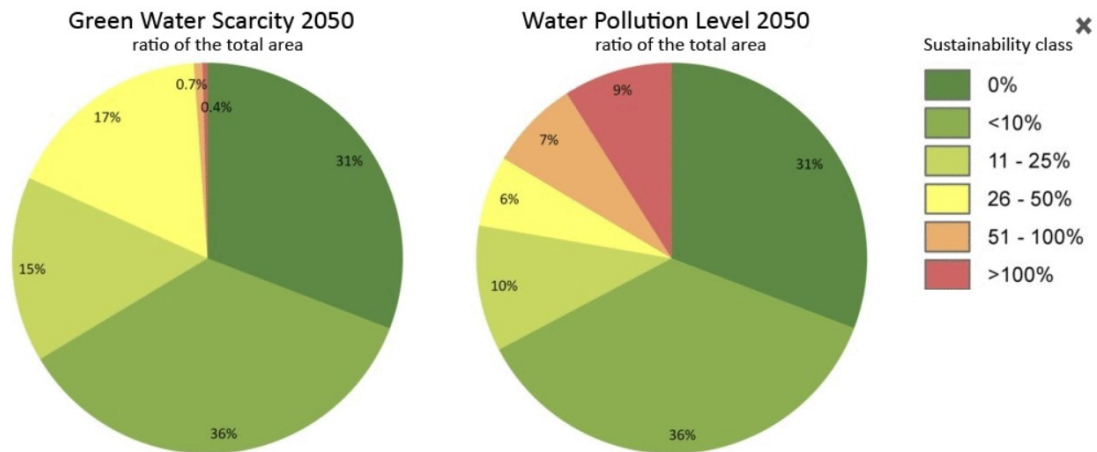




Soybean production areas are expected to expand significantly by 2050. North East area of the Tapajós river basin seems to be the most affected part. Some soybean expansion will also take place within the protected areas.







Sustainability is expressed in terms of Water Scarcity (WS) and Water Pollution levels (WPL). Unsustainable Hotspots are areas where  $WS > 100\%$  or  $WPL > 100\%$ .

$$WS = \frac{WF_{green}}{\text{Green Water Availability}}$$

$$WPL = \frac{WF_{grey}}{\text{Runoff}}$$

WS and WPL significantly increase in 2050 scenario. The unsustainable hotspots are the areas where more expected soybean expansion is projected to take place by 2050.

*Percentages within the pie charts indicate the ratio of total area covered by corresponding sustainability class.*