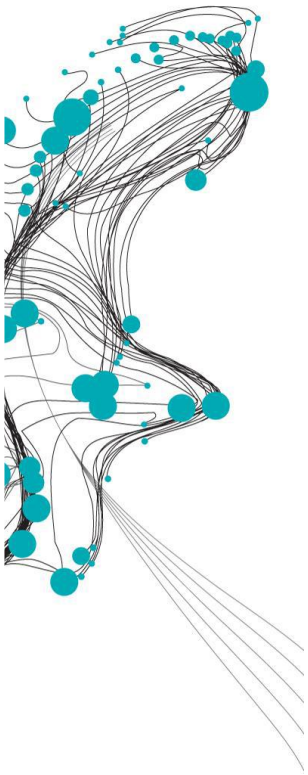
The Water and Land Footprint of Bioplastics



Petroleum-based plastics production has increased from 15 million tonnes in 1964 to 311 million tonnes in 2014. Plastics derived from fossil resources are causing different concerns, such as the greenhouse gas emissions (GHGs), resource depletion, and rise of oil prices. These concerns with petroleum-based plastics are generating interest in bioplastics.

This study aims to calculate the water and land footprint of bioplastics in several scenarios where all plastics are bio-based and assumes different types of biomaterials and recycling rates. In this study, nine sets of assumptions are used. Three sets of assumptions relate to the types of biomaterials and three sets of assumptions relate to different recycling rate. The types of biomaterials used is selected based on the result of water and land footprint calculation. Biomaterial with the highest water and land footprint value represents the 'high' value assumption, the lowest value represents the 'low' value assumption, and an average value represents 'average' value assumption. For the recycling rate, there are three scenarios as well which are 10%, 36%, and 62%.

This study shows that the water footprint of bioplastics vary between 1.4 m^3/kg to 9.5 m^3/kg. The land footprint of bioplastics vary between 0.7 m^2/kg to 13.75 m^2/kg. The water footprint if all the fossil-based plastics replace with bio-based plastics varies from 307 billion to 1,652 billion m^3 per year (Figure 1). If this number is compared to the global annual average water footprint (9,087 billion m^3/year), it accounts about 3% to 18% of the global annual average water footprint.

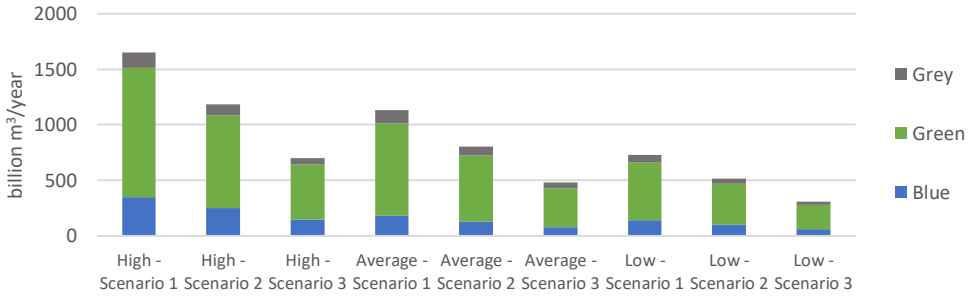


Figure 1. The water footprint if complete move from fossil-based plastics to bio-based plastics per year'

The land footprint of a complete shift varies from 30 million to 219 million hectares per year (Figure 2). If it compares to free arable land in 2020 which account about 360 million hectares, the land footprint of this replacement will take about 8% to 61%.

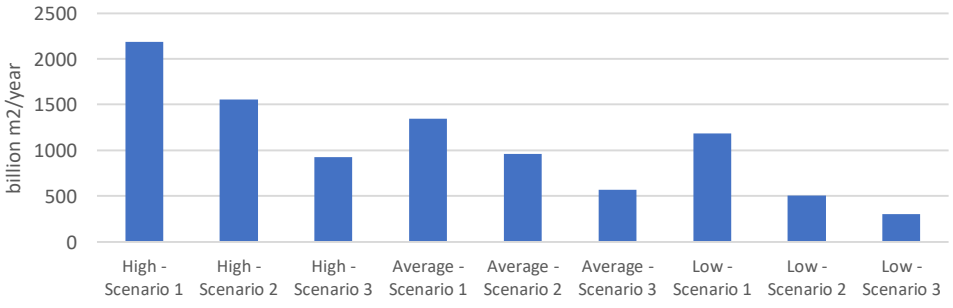


Figure 2. The land footprint if complete move from fossil-based plastics to bio-based plastics per year

Ratri Endah Putri

Graduation date:
25 January 2018

Graduation committee:
University of Twente
Prof.dr. A.Y. Hoekstra
MSc. Bunyod Holmatov

UNIVERSITY OF TWENTE.