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Application of LCIA water use methods to renewable energy systems in Spain

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Introduction & Background

The topic of 'water' in LCA has emerged as an important approach to quantify the related effects of water use from consumption of goods and services.

After the introduction of Water Footprint (WF) concept by Hoekstra in 2000s as an indicator of freshwater appropriation [1], LCA community began to develop methodologies to include environmental impacts related to water in LCAs, and started to furtherly develop the ISO 14046:2014 standard. It provides principles, requirements, and guidelines for conducting and reporting a water footprint assessment as a stand-alone assessment, or as part of a more comprehensive environmental assessment [2]. Then, several assessment methods have been proposed by the scientific community, encompassing both the computation of water use and its impacts, but differing in the communication of results.

This work presents an exploratory assessment of the WF of the agricultural phase related to the biofuels production in Spain, as a part of a more comprehensive study about the current WF of Spanish biofuels along their entire life cycle. The evaluation has been performed by the application of the **Water Footprint Network (WFN)** methodology [3].

Materials & Methods

WFN method considers the volume of freshwater used to produce the product, measured over the full supply chain. It is a multidimensional indicator, showing three types of WF [3]:

- **Blue water,** which refers to consumption of blue water resources (surface and groundwater) along the supply chain of a product.
- **Green water,** which refers to consumption of green water resources (rainwater insofar as it does not become run-off).
- **Grey water,** which refers to pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants. In this preliminary study, this type has not been considered.

WFN has been applied for calculating the WF of cultivation of crops in order to manufacture bioethanol from wheat and barley, and biodiesel from rapeseed, sunflower and sorghum. Figure 1 shows the cultivation area of each crop (except for sorghum) along the Spanish surface.

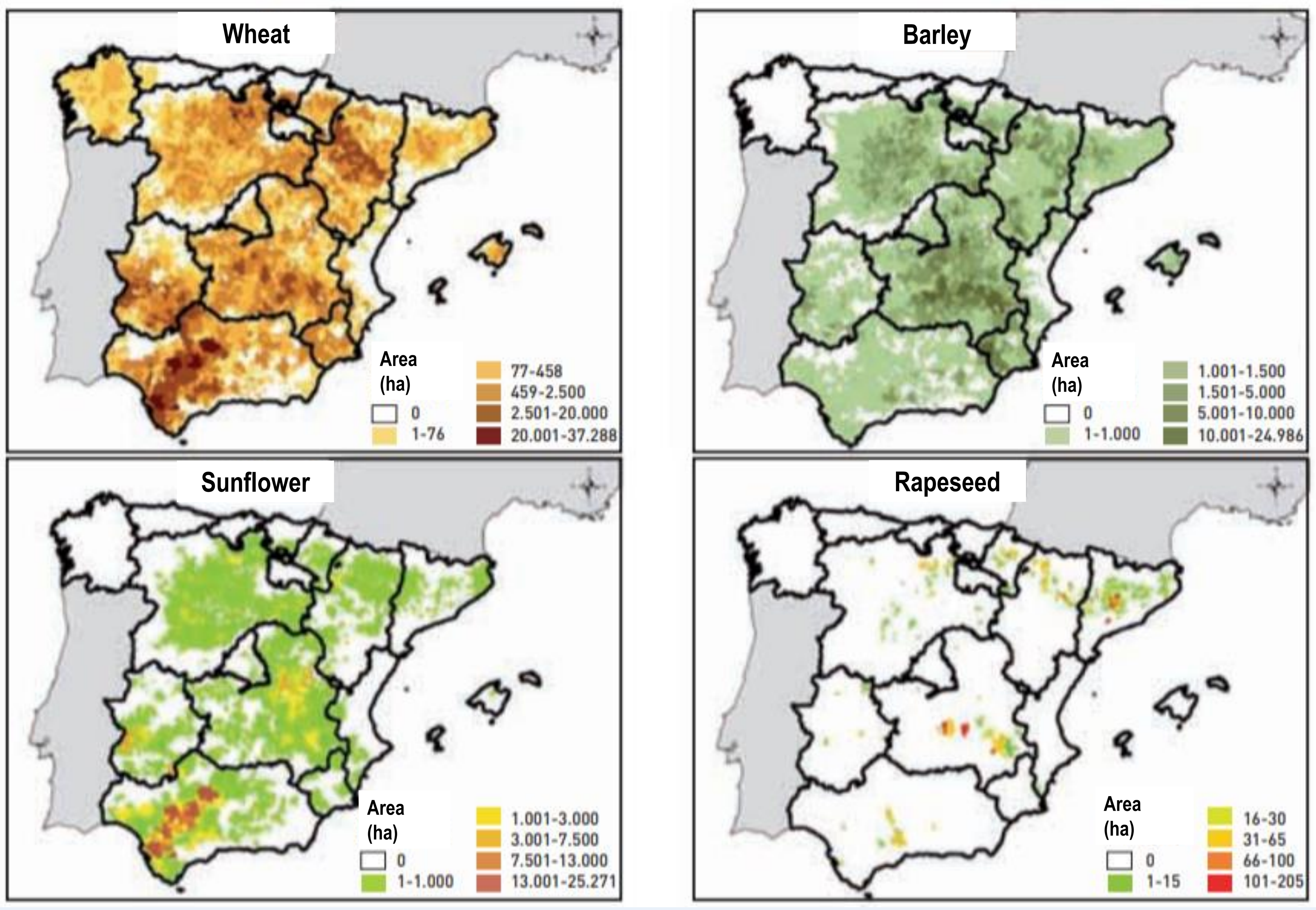

Figure 1. *Cultivated area of traditional crops in Spain [4].*

Results & Discussion

Figure 2 shows the WF of agricultural phases for bioethanol from wheat and barley and biodiesel from rapeseed, sunflower and sorghum. Results are expressed as the volume of water by hectare for each crop (irrigated and non-irrigated).

Green water has been calculated by means of CROPWAT 8.0 software, a decision support tool developed by FAO for the calculation of crop water and irrigation requirements based on climate, soil and crop data; whereas blue water has been directly obtained from [4]. Climate data of the 52 provinces of Spain have been considered for 2016.

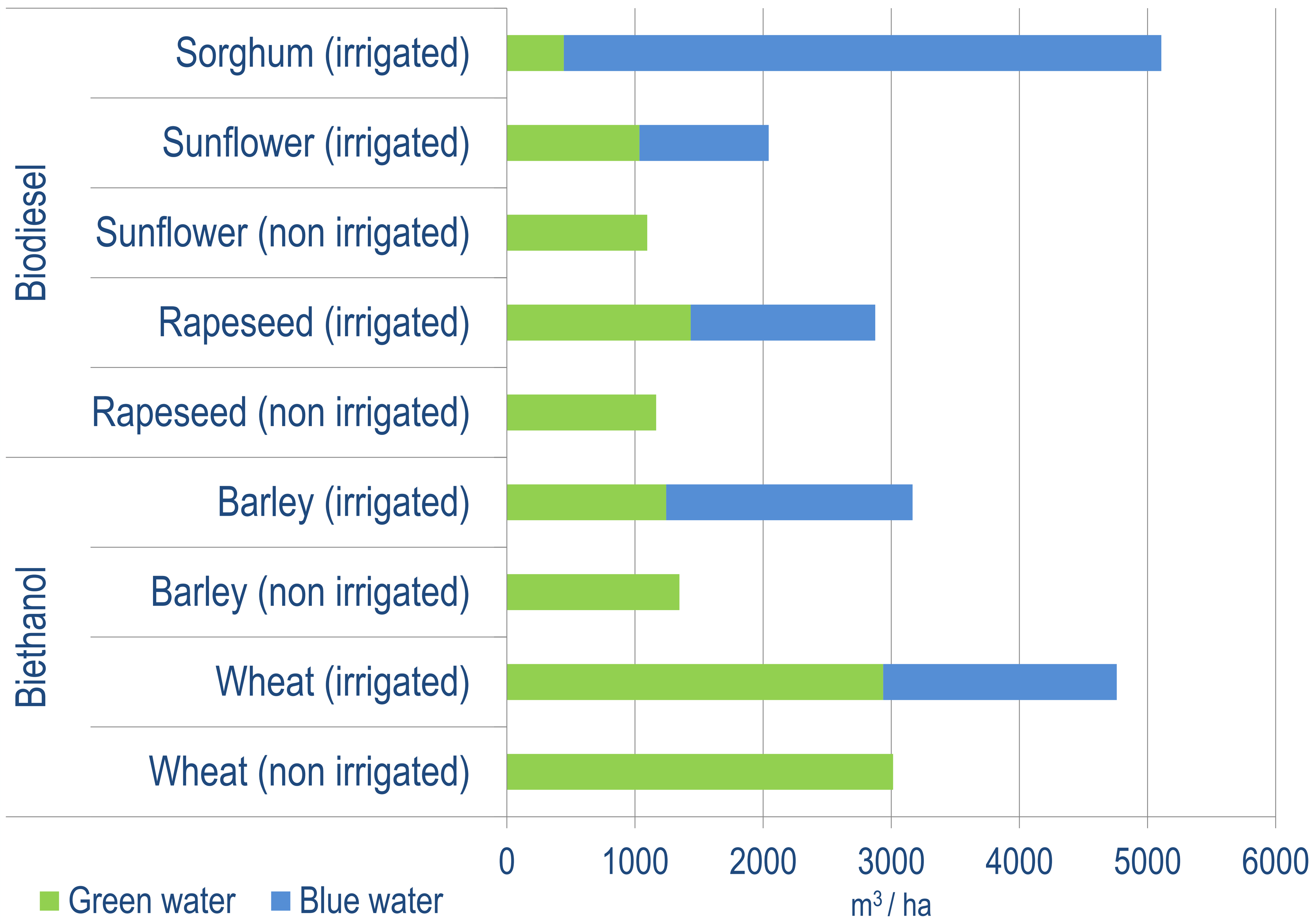

Figure 2. *Water footprint of farming stage of the selected biofuels.*

These preliminary results have been compared to those calculated by Hardy & Garrido [5] in 2010. These authors calculated values about 3500-5000 m^3/ha and 3200-4300 m^3/ha for wheat and barley respectively; and 3100-4200 m^3/ha and 5000-6300 m^3/ha for rapeseed and sunflower in that order. Our preliminary results are in the same range for bioethanol but lower in case of biodiesel. The reason for this decrease could be the differences on the calculation of blue water and the droughts periods at the beginning of the decade.

Conclusions & Further Developments

Due to the freshwater scarcity in the world, the calculation of WF of products, more specifically, of agricultural products, is of vital importance.

In this current project, the total WF for the whole life cycle of biofuels production in Spain will be calculated, including the grey water which could be around 5-10% of the total value, regarding other sources.

In addition, other recent methods as AWARE (*Available WAter REmaining*, developed by WULCA) [6] will be also considered in order to complete a more comprehensive study of biofuels environmental impact in Spain.

References

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