The water footprint of wine production in Portugal: a case-study on 'vinho verde'

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Objective

- To quantify the water footprint (WF) of a specific Portuguese white wine: the 'vinho verde' and to identify the main sources of water consumption.
- The white 'vinho verde' is produced at the northwest of Portugal.

Introduction

The WF of a product is the sum of all water consumed along the product life cycle.

The WF of agro-industrial products is relevant as they are widely known for having a significant footprint on water resources.

Agriculture is, by far, the largest consumer of freshwater, accounting for more than 70 % (UNEP 2007) of the worldwide freshwater withdrawals.

The WF is disaggregated into three components:

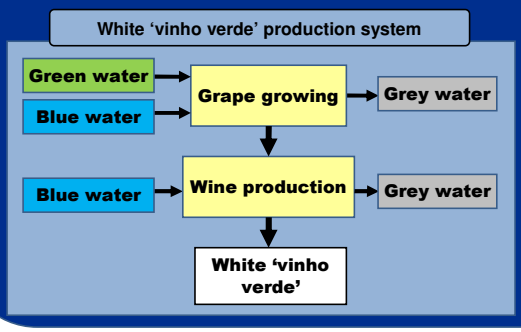
- green water - is the volume of rainwater consumed through crop evapotranspiration and incorporated into a product
- blue water - is the volume of surface or ground freshwater that is evapotranspirated, incorporated into a product, returned to a different catchment area, or returned to the same catchment area but during a different time period
- grey water - is the volume of freshwater required to dilute pollutants in an extent that guarantees that the quality of the natural environment remains above the water quality standards.

Methodology

The green, blue and grey water footprints were calculated using the methodology described by Hoekstra et al. (2009).

- The collected data relate to the 2008-2009 winery campaign and were provided by a Portuguese company (Aveleda) that produces almost 25 % of the Portuguese white 'vinho verde'.

$$WF_{Total} = WF_{grape\ growing} + WF_{wine\ production}$$



Functional unit

- The white 'vinho verde' bottle, i.e. 0.75 L of wine.

System boundary

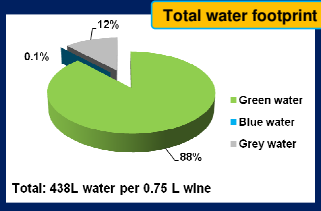
- The grape growing includes the stages of grafting, pruning, typing, interventions in green, sanitary treatments and grape harvesting. The plantation of the vine was excluded from the system as well as the period of about 3 years needed for vines to achieve maturation conditions.
- The wine production process involves three main stages: wine vinification, storage/preparation of lots and bottling.
- The production of electricity and other materials besides grapes, that are consumed in the grape growing and wine production processes (e.g. glass bottles, cork stoppers, packaging and fertilizers) as well as the corresponding transport were excluded from the study.

Sensivity analysis

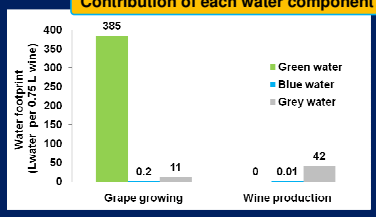
- A sensitivity analysis was performed to evaluate the effect of the variability of some input parameters on the total WF.
- The parameters considered to be more uncertain have been taken from the literature (crop coefficient during the initial stage of the grape growing - $K_{c,ini}$, critical depletion - p, the concentration of the pollutant in the effluent - c_{effl} and the leaching fraction of fertilizers and pesticides - α) or roughly estimated (effluent volume allocated to the wine production process - Effl).

Results

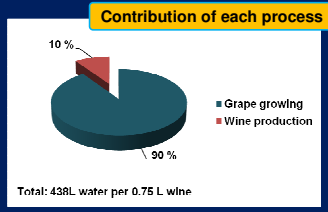
Total water footprint



Contribution of each water component



Contribution of each process



Sensivity analysis

Parameters	Variation range for the selected parameters (%)	Change in the calculated overall water footprint (%)
$K_{c,ini}$	-70 to +230	-14 to +49
p	-25 to +50	-1 to +5
α	-50 to +100	-1 to +2
c_{effl}	-80 to +70	-7 to +6
Effl	-90 to +140	-9 to +13

Conclusions

- The total WF of the white 'vinho verde' is 438 L per 0.75 L of wine.
- Green, blue and grey water represent 88 %, 0.1 % and 12 % of the WF.
- The major contributor to the WF is the green water consumption during the grape growing (385 L per 0.75 L of wine).
- The blue water is negligible because the crop field is not being irrigated and the consumptive use of blue water is insignificant both at the grape growing and the wine production.
- The largest grey WF results from the wine production process.
- The grape growing contributes by 90 % to the total WF. The WF depends mainly on the climate and soil conditions and on the properties of the crop, which are not of easy control by the wine producing companies.
- The WF may be reduced only to a certain extent by reducing both the pollutant load in the wastewater produced during the wine production and the amount of fertilizers applied during grape growing.
- The sensitivity analysis show that $K_{c,ini}$ is the parameter that has the largest influence on the total WF and, particularly, on the green water use during the grape growing.

References

UNEP, 2007. Global environment outlook - geo 4: environment for development. United Nations Environment Programme, Valletta, Malta.

Hoekstra, A. Y., Chapagain, A.K., Aldaya, M.M., Mekonnen, M.M., 2009. Water footprint manual: state of the art 2009. Water Footprint Network, Enschede, The Netherlands.

Acknowledgments

The authors would like to thank Aveleda S.A. for their collaboration in providing first hand information. The authors also gratefully acknowledge FCT (Science and Technology Foundation – Portugal) for the scholarship granted to Ana Cláudia Dias (SFRH/BPD/20363/2004).

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