WULCA - AWARE Case study

Application of AWARE to bottled water and beverages

DANONE

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Abstract (1/4)

Background & Objectives

Since 2006, different water scarcity footprint methods have been published. The working group *Water Use in LCA (WULCA)* is working on the development of a consensual water scarcity footprint assessment method called *AWARE*. In order to validate the *AWARE* method, WULCA needs to apply this method on 10 case studies. This study is proposed as one of these 10 case studies.

The objective of this study is to provide an application of *AWARE* to five products from Danone Waters, to analyze the results, and to compare the results obtained with the one obtained using the method from *Pfister et al. 2009*[1] which is currently used by Danone Waters.

Goal & Scope

The method *AWARE* is applied to five products from Danone: five beverages manufactured in Mexico, Poland, Argentina and France respectively. Those products are analyzed from cradle to grave.

The functional unit is "to provide 1 L of product at retail".

AWARE 100 and *Pfister et al. 2009* water scarcity footprint methods are applied as default scenario. *AWARE 10* and *AWARE 1000* are applied as sensitivity analysis.

[1]Pfister S, Koehler A, Hellweg S (2009) Assessing the Environmental Impacts of Freshwater Consumption in LCA. Environ Sci Technol 43:4098–4104.

Abstract (2/4)

Key learnings

Compared to the method of *Pfister et al. 2009*, absolute results obtained with *AWARE 100* are multiplied by a factor of 30 up to 120. This is due to the choice of WULCA to set the characterization factor values between 0,1 and 100, whereas *Pfister's* characterization factor values are set between 0,01 and 1.

Although when comparing the water scarcity footprint of the different products studied the ranking is the same when using *Pfister et al. 2009* or *AWARE 100,* it may be different if other products would have been selected, considering other locations. Indeed, the ranking among country average characterization factors is significantly different when comparing *Pfister et al. 2009* and *AWARE 100* methods.

AWARE 100 proposes specific characterization factors for agricultural water use. It tends to increase the contribution of agricultural products to water scarcity footprint compared to other type of water use.

Finally, Sensitivity analysis on *AWARE 10* and *AWARE 1000* shows that at the country level, and at locations where the ratio 1/(Availability-Demand) is high, the cut-off rule has a significant impact on the results.

Abstract (3/4)

Recommendations for WULCA (1/2)

Depending on the water scarcity footprint method selected, the relative level of water stress of different locations may change significantly. Although it is most likely that the work done by WULCA increases the accuracy of characterization factors due to the conceptual improvements and the update of background data, these discrepancies among methods and characterization factors still can affect the trust that practitioners may have on water scarcity footprint methodologies.

Since the water scarcity footprint is supposed to reflect the local level of water competition, it would be interesting to have a bottom-up approach collecting local data on evidences of water competition, such as water conflicts, water restrictions, droughts, etc., and to compare these data of actual water competition issues with the characterization factors from AWARE 100 and other methods such as Pfister et al 2009. Showing that there is a higher correlation between these evidences of water competition and the characterization factors proposed by AWARE 100 than with other methods would increase the confidence in the method. WULCA already started this type of assessment through the assessment of closed and closing basins, which is an interesting starting point. We recommend to enhance this type of analysis considering more locations, and different scales (basins, but also country level).

Abstract (4/4)

Recommendations for WULCA (2/2)

Doing a distinction between Agri and Non-Agri characterization factors seems to make sense from a conceptual point of view. However, for some countries, Non-Agri characterization factors are higher than Agri-characterization factors. According to WULCA, it reflects the actual situation of these countries. We would be pleased to get more insights on this point.

The cut-off rule has a significant impact on characterization factors. This cut-off factor should be selected carefully considering that a higher cut-off would increase significantly country average characterization factors, which are often used in LCA since the exact location of water use of background processes are often unknown. We would appreciate some recommendations as of which cut-off method to use in which circumstances

Goal & Scope

Context & Objectives of the study

Context

- Since 2006, different water scarcity footprint methods have been published
- The working group *Water Use in LCA (WULCA)* is working on the development of a consensual water scarcity footprint assessment method
- This consensual method, called *AWARE* has been released in 2016. In order to validate the method, WULCA needs to apply this method on 10 case studies
- This study is proposed as one of these 10 case studies. The method *AWARE* is applied to five products from Danone Waters (beverages and bottled water)

The objective of this study is to provide an application of *AWARE* on five products from Danone Waters. More specifically, this project aims at:

- Applying *AWARE* method on five products
- Analyzing the results and perform sensitivity analysis
- Compare the results with the method from *Pfister et al. 2009*[1] which is currently used by Danone Waters

[1]Pfister S, Koehler A, Hellweg S (2009) Assessing the Environmental Impacts of Freshwater Consumption in LCA. Environ Sci Technol 43:4098–4104.

Target audience

This study is considered as a case study for the *AWARE* method. The main audience is the ***WULCA group*** which could use the results in order to validate the method. The results of the study could potentially be published.

Governance of the study

The study was commissioned by Danone and is destined for the WULCA group. The study has been performed by Quantis. The study has not been subjected to a critical review.

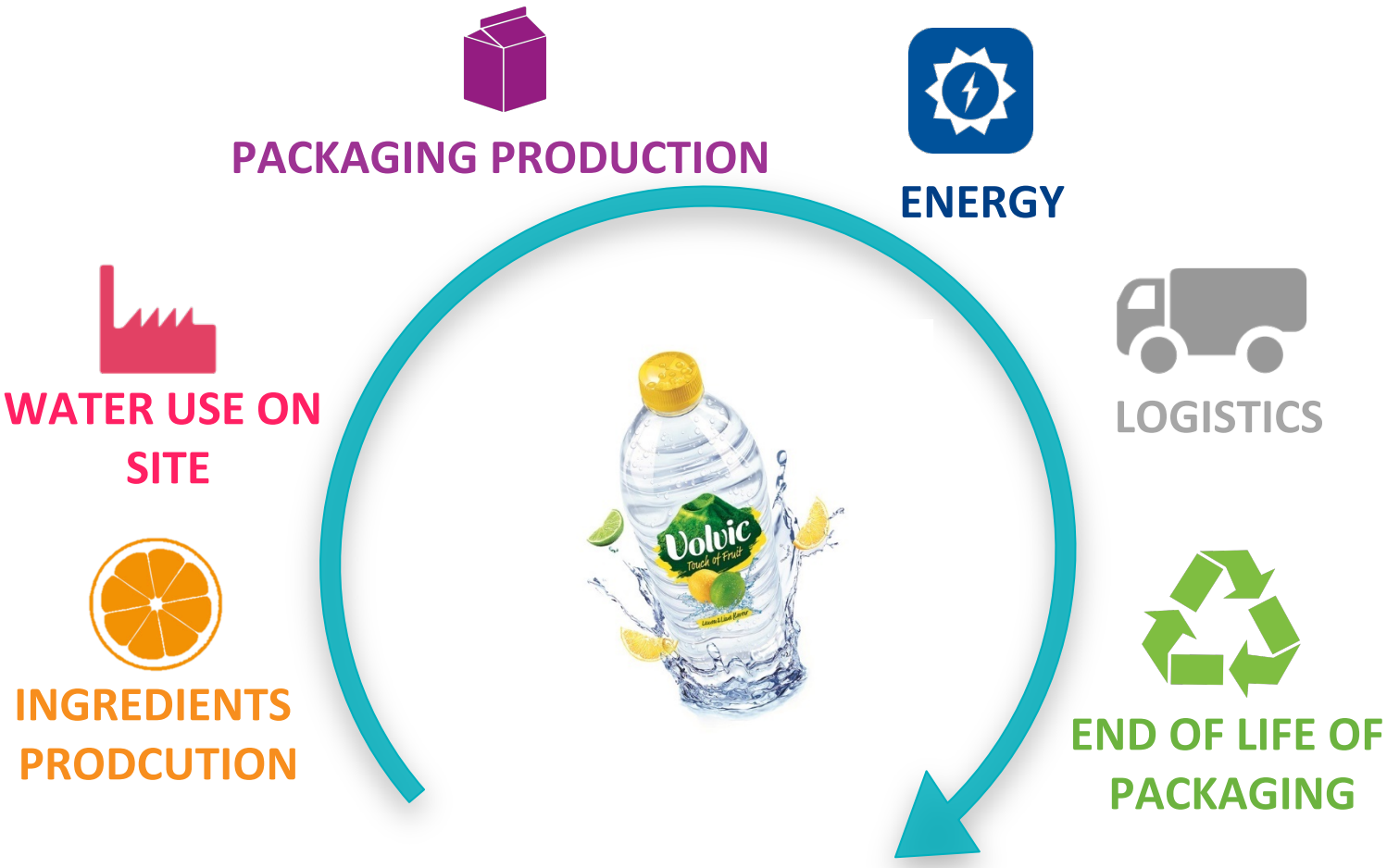
Scope of the project – product description

The water scarcity footprint of five Danone Waters products has been assessed. A general description of those products is provided below.

Product	Country of production	Country of consumption	Type of packaging	Capacity	Nature of product	Code (for this study)
Water with orange juice	Mexico	Mexico	PET bottle	0.5 L	Beverage	Mexico
Apple beverage	Poland	Poland	PET bottle	1.5 L	Beverage	Poland 1
Sweet beverage	Poland	Poland	PET bottle	1.5 L	Beverage	Poland 2
Water with orange juice	Argentina	Argentina	PET bottle	1.5 L	Beverage	Argentina
Flavoured water	France	Japan	PET bottle	0.5 L	Water	France

Scope of the project – system boundaries

The life cycles phases considered are as follow:



The use phase is excluded

Scope of the project - system boundaries

Life cycle phases	Description	AWARE Characterization Factor used
INGREDIENTS PRODUCTION	This step takes into account the water used during the production of products' ingredients, including the irrigation for fruits production	Country average CF, Agri
WATER USE ON SITE	This step takes into account the water used at the production site. Most of the water used is the water that is incorporated into the product (in the bottle)	Local CF, non agri
PACKAGING PRODUCTION	This step takes into account the water used directly or indirectly for the packaging production	Country average CF, Non agri
ENERGY	This step takes into account the water used directly or indirectly for production of energy (including electricity) used at the plant	For fossil fuels, global average CF, non-agri For electricity, country average CF, non-agri
LOGISTICS	This step takes into account the water used directly or indirectly during all the logistics steps: transportation of raw materials to Danone's plants (upstream logistic) and transpiration of finished products from plants to retail (downstream logistic)	Global average CF, non-agri
END OF LIFE	This step take into account the water used for the treatment of packaging waste (no product losses assumed)	Country average CF, Non agri

Scope of the project – Functional Unit, Data sources & Indicators

Functional unit

- The functional unit is the quantitative reference at which all the components of the life cycle, the calculations and impacts evaluations are related to.
- For this study, the functional unit is defined as « ***To provide 1 L of product at retail*** »

Data sources

- Primary data which means activities data are provided by Danone thanks to the reporting tool called « Danprint ». This tool lists the water consumption of the site, and all the data concerning the quantity of raw materials used, the type of packaging used and their quantities, the distances of transport, energy consumption, and the end-of-life scenario
- Water consumption data of background processes are taken from the Quantis Water Database[2]

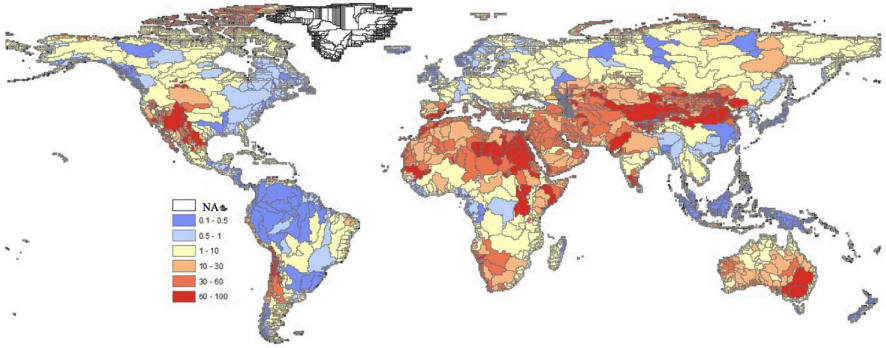
Water Scarcity Footprint indicators

- 2 water scarcity footprint methods are evaluated *: Pfister et al. 2009*[1] and *AWARE 100*
- 2 others water scarcity footprint methodologies are evaluated as sensitivity analysis *: AWARE 10* and *AWARE 1000*

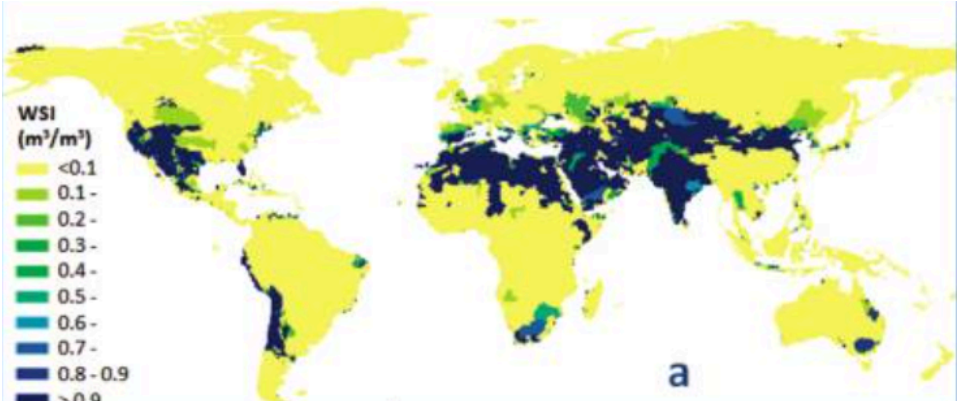
[1]Pfister S, Koehler A, Hellweg S (2009) Assessing the Environmental Impacts of Freshwater Consumption in LCA. Environ Sci Technol 43:4098–410
[2]Quantis (2012) Quantis Water Database v1.33.

Scope of the project – *AWARE 100* VS *Pfister et al. 2009* characterization factors

***AWARE 100* characterization factors**



***Pfister et al. 2009* characterization factors**



Results & discussions

Results & discussions – absolute value

The table below presents global results obtained for each product and each method.

Compared to Pfister et al. 2009 method, results are multiplied by a factor of 30 to 120. This is mainly due to the choice of WULCA to set the characterization factor values between 0,1 and 100, whereas Pfister's characterization factor values are set between 0,01 and 1.

Product	Code	*Pfister et al. 2009* (l-eq/L)	*AWARE 100* (l-eq/l)	Multiplying factor
Water with orange juice	Mexico	50.20	2 173.78	**X 43**
Apple beverage	Poland 1	0.35	11.23	**X 32**
Sweet beverage	Poland 2	0.39	12.15	**X 31**
Water with orange juice	Argentina	4.27	502.66	**X 118**
Flavoured water	France	1.94	124.72	**X 64**

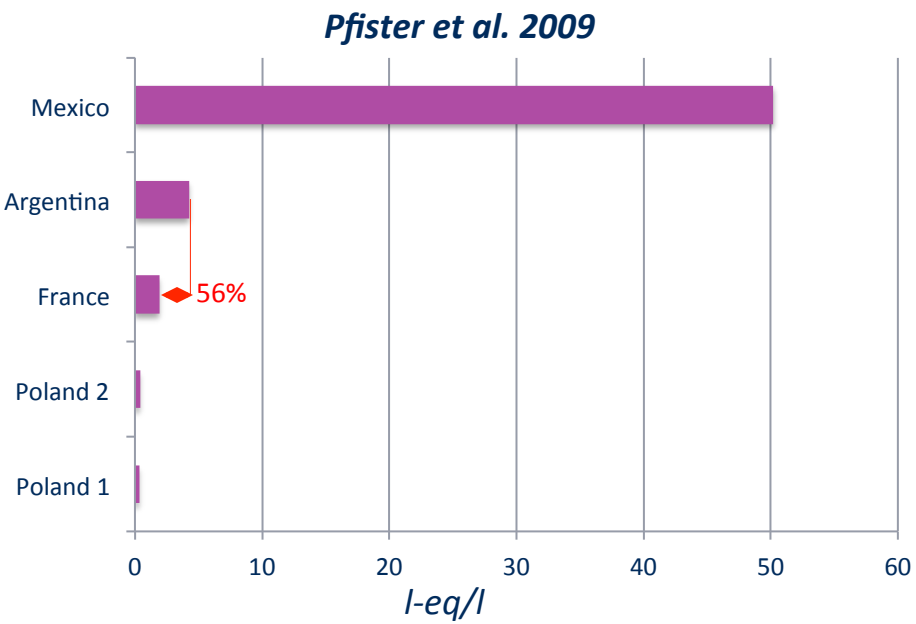
Results & discussions – product comparison

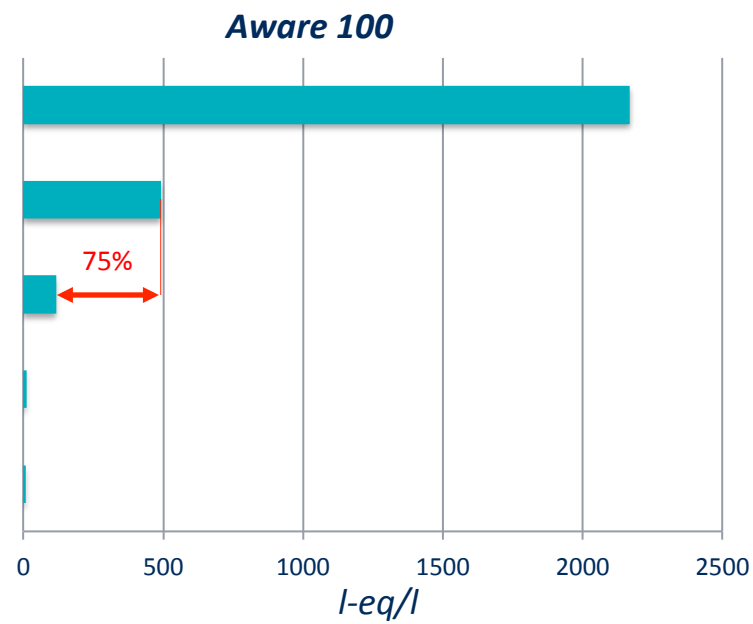
At a macroscopic level we observe the same ranking among products: the product from Mexico still has the highest water scarcity footprint and the product from Poland has the lowest one.

Significant differences in relative impacts are however observed for some products (e.g. France and Argentina)

- The difference between France and Argentina products jumps from 56% to 75% when switching *from Pfister et al. 2009* to *AWARE 100.*

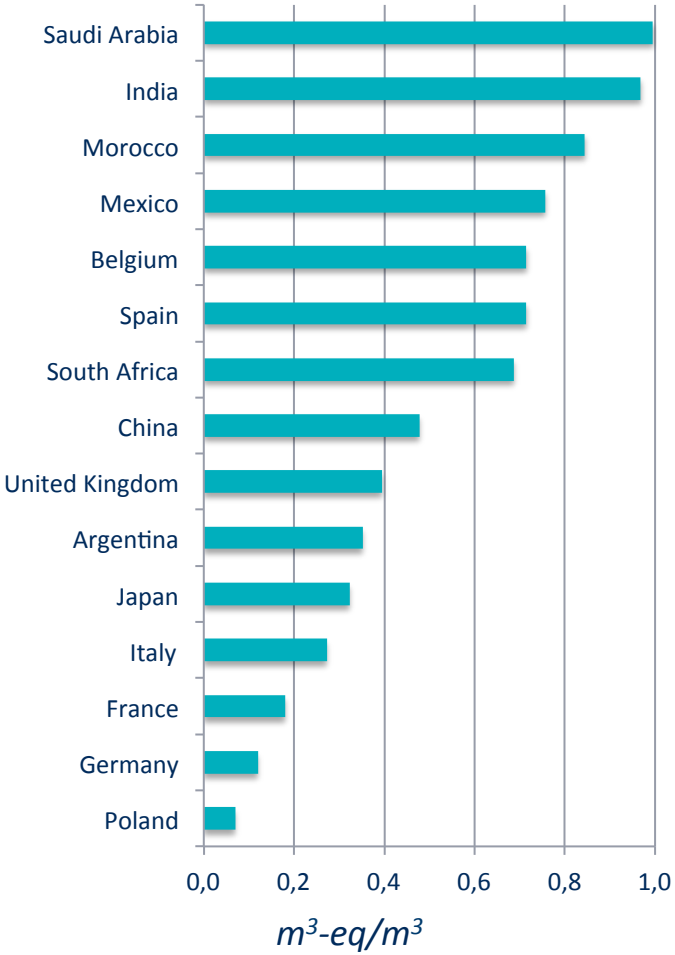
However ranking could be reversed when considering more products produced in different locations (see next slide).





Deep-dive – characterization factors comparison

Country average characterization factors – *Pfister et al. 2009*



Country average characterization factors – *AWARE 100*

This figure presents a comparison between characterization factors at the country level for a sample of countries.

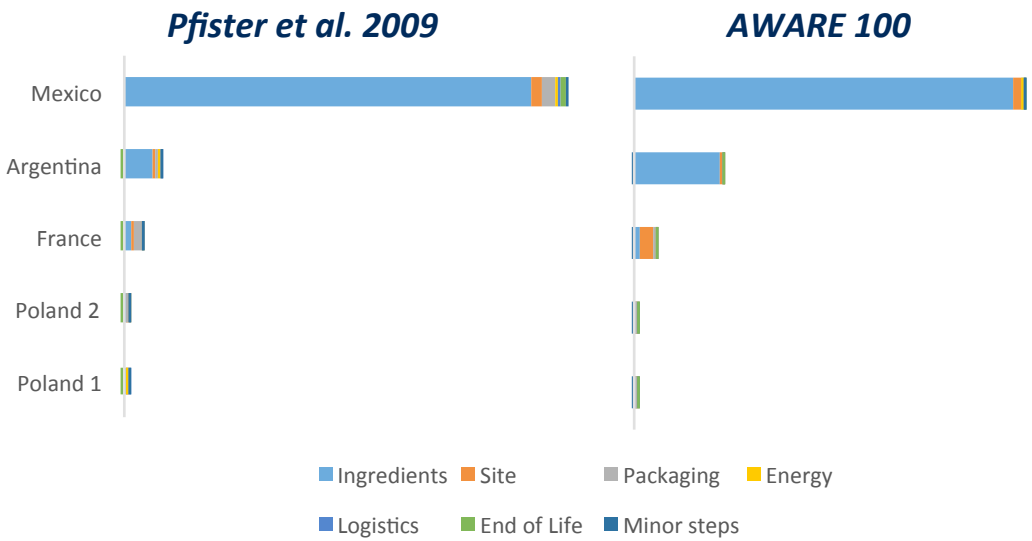
This figure shows that the ranking among the different countries is different. It means that conclusions of a water scarcity footprint study could be significantly affected according to the method selected.

- e.g. according to *Pfister*, the country average water scarcity in Saudi Arabia is about 1,4 times more important than in Spain. According to *AWARE 100*, the water scarcity is 4,1 times more important in Spain than in Saudi Arabia

Results & discussions – Contribution analysis

The figure below shows the contribution of the different life-cycle phases to the Water Scarcity Footprint according to the two methodologies applied. The following conclusion can be highlighted:

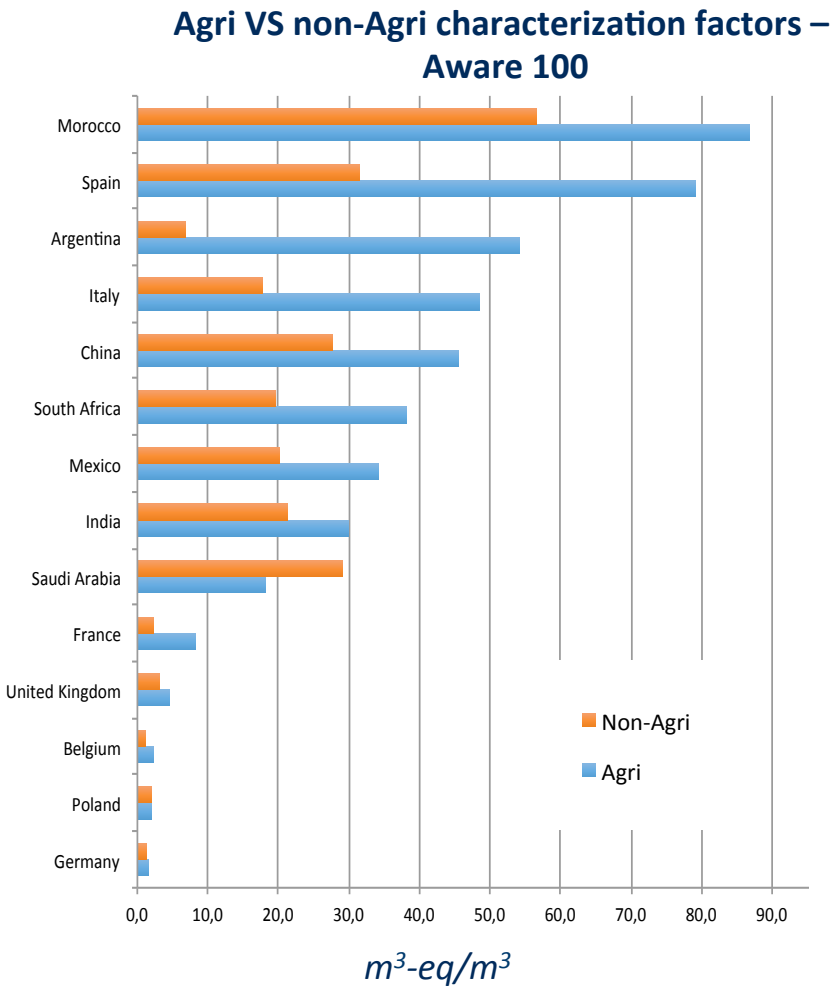
- Ingredients production remains the main contributor to water scarcity footprint. It is due to the significant water volumes requirements for irrigation (fruits production), compared to the water that is in the bottle
- When applying *AWARE 100*, the contribution of ingredients production is higher than when applying *Pfister et al. 2009*, as shown in the table below for Argentina. It can be explained as *AWARE 100* proposes specific characterization factors for agricultural water use. These factors are generally higher than non-agricultural characterization factors (see deep-dive next slide)
- From a general point of view, switching from *Pfister et al. 2009* to *AWARE 100* will tend to increase the contribution of agricultural phases



Contribution analysis - Argentina

Life-cycle stages	Contribution *Pfister et al. 2009*	Contribution *AWARE 100*
Ingredients	**75,6%**	**95,3%**
Site direct	6,1%	0,2%
Packaging	12,6%	2,0%
Energy	4,3%	2,0%
Logistics	2,4%	0,7%
End of life	-1,1%	-0,2%

Deep-dive – Agri VS non-Agri characterization factors



This figure highlights the difference between Agri and Non-Agri characterization factors for *AWARE* 100 for a sample of countries. Depending on the country, the difference can be significant.

Agri- characterization factors are generally higher than Non-Agri characterization factors. It is logical considering the concept of the method. However, for several countries like Saudi Arabia (and all Middle East countries), some African countries (Nigeria, Ethiopia, Mozambique, …) and others, Non-Agri characterization factors are higher than Agri-characterization factors. According to WULCA[1], this reflects the fact that the Agri-factor are weighted based on current agricultural consumption, and although this normally occur in dryer regions and months, this is not the case for some desert areas where water resource is so limited that no irrigation is actually occurring and hence these regions are not represented in country-scale averages, whereas some other types of water consumption may be occurring

[1] Personal communication, Anne-Marie Boulay, 31/05/2016

Sensitivity analysis

Sensitivity analysis – *AWARE 10* and *AWARE 1000 - REMINDER*

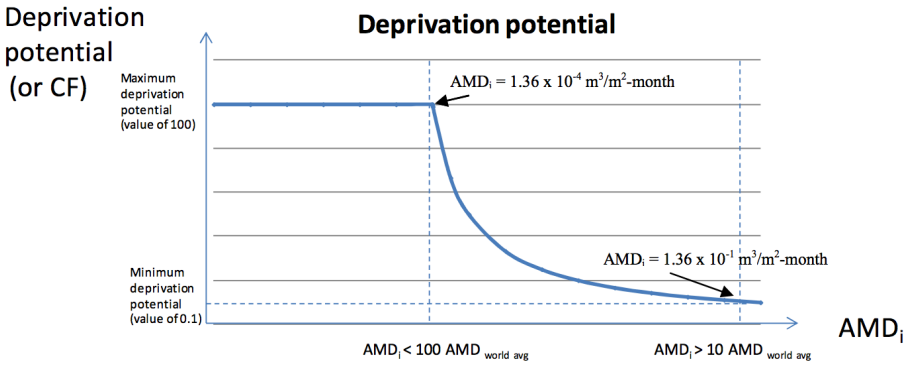
AWARE characterization factors are function of the ratio (1 / Availability – Demand). This ratio can be infinite or negative in locations where the water demand is superior or equal to water availability.

Therefore, WULCA decided to apply a cut-off rule: the maximum value of the characterization factor is set to 100 when Demand ≥ Availability.

Two other cutoff rules have been proposed by WULCA:

- Maximum characterization factor set to 10 *(AWARE 10)*
- Maximum characterization factor set to 10 *(AWARE 1000)*

These methods are applied as sensitivity analysis.



Sensitivity analysis – *AWARE 10* and *AWARE 1000*

AWARE 10 and *AWARE 1000* have been applied as sensitivity analysis. Results are presented below. We can observe that:

- Products have the same ranking with different ranges. It is a direct consequence of the cut-off rule.
- The difference observed between the products is also different. Depending on the location, results are not impacted the same way. For example with *AWARE 1000* results for Argentina are multiplied by a factor 6 compared to *AWARE 100* while results for Poland 1 are multiplied by a factor 3
- Thus, the cut-of rule has a significant impact on results interpretation

Product	Code	*AWARE 10* (l-eq/l)	Multiplying factor VS AWARE 100	*AWARE 1000* (l-eq/l)	Multiplying factor VS AWARE 100	*AWARE 100* (l-eq/l)
Water with orange juice	Mexico	428	0,19	17 000	7,8	2’170
Apple beverage	Poland 1	9.52	0,85	42.6	3,8	11.2
Sweet beverage	Poland 2	10.5	0,94	43.3	3,5	12.2
Water with orange juice	Argentina	73.7	0,15	3’190	6,3	503
Flavoured water	France	41.6	0,33	589	4,7	125

Sensitivity analysis – *AWARE 10* and *AWARE 1000*

The tables below present characterization factors for *AWARE 10*, *AWARE 100* and *AWARE 1000* (non-Agri), for Danone production plants location (site level), and at the country level (country average), respectively.

- At the **site level, for all sites, characterization factors are the same** for AWARE 10, AWARE 100 and AWARE 1000. These characterization factors are below the cut-off rules. The change of the cut-off does not affect these characterization factor.
- At the **country scale, significant differences can be observed** (except for Poland). It means that at the country scale, there are some locations where the characterization factor is above the cut-off rule. Depending on the level of the value 1/(Availability-Demand) in these location, it can increase significantly the country average characterization factor. The higher the cut-off rule, the bigger this issue
- Life cycle phases where global average characterization factor or country average characterization factor is used would have a larger contribution to the water scarcity footprint when the cut-off is higher (ex: AWARE 1000). **Cut-off rule has a major impact on the results.**

Site level	Mexico	Poland	Argentina	France
AWARE 10	7.73	1.95	0.99	2.45
AWARE 100	7.73	1.95	0.99	2.45
AWARE 1000	7.73	1.95	0.99	2.45

Country average level	Mexico	Poland	Argentina	France
AWARE 10	4,58	1.94	2.42	1.69
AWARE 100	20,16	1.94	6.82	2.31
AWARE 1000	123,34	1.94	31.19	6.98

Conclusion & recommendations

Key learnings from the case study

1. Compared to *Pfister et al. 2009* method, **absolute results are multiplied by a factor of 30 to 120**. This is due to the choice of WULCA to set the characterization factor values between 0,1 and 100, whereas *Pfister's* characterization factor values are set between 0,01 and 1.

2. Although in the present study the ranking between the different products is the same when using *Pfister et al. 2009* or *AWARE 100*, it might different if other products were selected, considering other locations**. Indeed, the ranking among country average characterization factors is significantly different when comparing *Pfister et al. 2009* and *AWARE 100* methods.**

3. Aware 100 proposes specific characterization factors for agricultural water use. It tends to **increase the contribution of agricultural products** to water scarcity footprint compared to other type of water use in the value chain.

4. At the country level, and at locations where the ratio 1/(Availability-Demand) is high, **the cut-off rule has a significant impact on the results**. The cut-off rule should be selected carefully, based on a science-based approach.

Recommendations to WULCA (1/2)

1. Depending on the water scarcity footprint method selected, the relative level of water stress of different locations may change significantly. Although it is most likely that the work done by WULCA increases the accuracy of characterization factors due to the conceptual improvements and the update of background data, these discrepancies among methods and characterization factors still can affect the trust that practitioners may have on water scarcity footprint methodologies.
   Since the water scarcity footprint is supposed to reflect the local level of water competition, it would be interesting to have a bottom-up approach collecting local data on evidences of water competition, such as water conflicts, water restrictions, droughts, etc., and to compare these data of actual water competition issues with the characterization factors from AWARE 100 and other methods such as *Pfister et al 2009*. Showing that there is a higher correlation between these evidences of water competition and the characterization factors proposed by AWARE 100 than with other methods would increase the confidence in the method. WULCA already started this type of assessment through the assessment of closed and closing basins, which is an interesting starting point. We recommend to enhance this type of analysis considering more locations, and different scales (basins, but also country level)

Recommendations to WULCA (2/2)

2. Doing a distinction between Agri and Non-Agri characterization factors seems to make sense from a conceptual point of view. However, for some countries, Non-Agri characterization factors are higher than Agri-characterization factors. According to WULCA, it reflects the actual situation of these countries. We would be pleased to get more insights on this point.

3. The cut-off rule has a significant impact on characterization factors. This cut-off factor should be selected carefully considering that a higher cut-off would increase significantly country average characterization factors, which are often used in LCA since the exact location of water use of background processes are often unknown. We would appreciate some recommendations as of which cut-off method to use in which circumstances