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# Water footprint: a study on crepe adhesive tape

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**ABSTRACT**

Given the global water scarcity, the term "water footprint" emerged, which takes into account both its direct use by a producer or consumer and its indirect use. There was also a scarcity of research on this theme. The study aimed to identify the water footprint in the industrial production of crepe adhesive tape in a chemical company and analyze the environmental implications of this calculation for the production process of the segment. The methodology used in the study is classified as applied, quantitative, exploratory and explanatory. The study concludes that the water footprint of the supplies is superior to the water footprint of the production process, that is, the water footprint of the supply chain (0.34 liters/roll) is greater than the water footprint of the internal processes (0.07 liters/roll). Internally, the highest water consumption is due to industrial activities (boilers and other equipment), followed by human consumption, losses and evaporation. Although the water footprint of the process is not significant, it should not be ignored. It guides the reuse of evaporated water in the industrial process and whenever possible eliminate the use of water when developing new products.

**KEYWORDS**: Sustainability. Sustainable development. Water footprint. Water scarcity. Crepe tape.

## 1 INTRODUCTION

The environment has been tirelessly exploited by human beings in an unlimited way, using it as one of the factors of the economic system, clearly focused on anthropocentric thinking. Man has explored nature, forgetting that he is also part of it, which means, harming it, is harming himself. The consequences of such exploration are seen in modernity as risks that impact planet Earth as a whole. The incessant search for exaggerated consumerism and economic growth causes various environmental damage and such damage threatens the continuity of the planet as well as human existence. Therefore, there is no way to conceive an economy that is not suitable for ecologically balanced development (BELCHIOR; VIANA, 2016). Therefore, in the face of a situation considered "chaotic" in which the world is inserted in, there has been more and more talk about sustainability and sustainable development.

The term sustainable development was defined and published in 1987, through the Our Common Future Report. This was the result of the World Commission on Environment and Development. The report defines sustainable development as being "one that meets the needs of the present without compromising the possibility and capacity of future generations to meet their own needs" (JUNQUEIRA; BIGGER; PINHEIRO, 2012, p. 38).

In relation to the concept of sustainability, this term cannot be based solely on harmony and balance with the environment, but it should also be considered that its roots are situated in an internal relationship within society, of an economic and politically balanced and equitable nature (RATTNER, 1999).

From the point of view of sustainable development and sustainability, the world is at a crossroads and one of today's concerns are global water scarcity, since water is a primary environmental good to life (CANTELLE; FILE; BORGES, 2018). Besides being an essential element for life on the Planet, in the context of economic activities water contributes to the economic growth of a country, being used for human and animal consumption, for food production, as raw material of industrial production processes, for the generation of electricity, leisure, among other various applications (MONTOYA, 2020). Given the relevance of this precious good and concerns for its scarcity, more and more ways have been sought to ensure the protection of this element.

Faced with this concern, the term "water footprint" then appears, which considers both its direct use by a producer or consumer and its indirect use (HOEKSTRA *et al*., 2011) and has as ideal to reduce the impacts of water scarcity that deprives countless people worldwide (MARACAJÁ *et al*., 2012).

The water footprint allows monitoring both consumption and periods of higher water consumption, thus becoming an indicator of water scarcity, contributing to the balance between the availability of water resources and better management of water resources (GIACOMIN; OHNUMA, 2012). In this sense, water consumption is related to the consumption of products, which therefore has a water footprint that arouses the increasing interest of consumers and companies (HOEKSTRA *et al*., 2011).

Also, according to Hoekstra *et al.* (2011, p. 61), the calculation of a company's water footprint offers a new perspective for the development of an informative corporate strategy on water use. This is due to the fact that "the water footprint, as an indicator of water use, differs from the indicator of water catchment in operations, adopted by most companies so far".

At the national level, the management of water resources was marked by the creation of Law No. 9,984/2000, which among the attributions establishes the National Water Resources Policy and the management of water resources through the granting and collection of water use (RIBEIRO, 2014). Despite this great achievement, it was only from 2011 that events related to the water footprint theme emerged, such as the Regional WFN Partner Exchange Meeting and the Regional Water Footprint training course in Brazil, held in the city of São Paulo (MARACAJÁ; ARAUJO; SILVA, 2014).

Brazilians can contribute to reducing the water footprint, either by changing habits or reducing the consumption of products. Consumers should know the water footprint of the products used, so that they reflect those that cause less or greater impact to the environment (MARACAJÁ, 2019).

Based on a broad assumption, water scarcity is present on a global scale, and it is necessary that governments, businesses, communities and consumers reassess the impact of their consumed and produced products. Thus, it will be possible to establish actions aimed at reducing water demand and directing consumption to the place and season, which is not so lacking (GIACOMIN; OHNUMA, 2012).

The term water footprint is considered a relatively new and little-disputed theme, especially in the chemical industries segment. When it comes to adhesive tapes, no studies on the subject have been found. In this context, a study was carried out in a chemical company located in the upstate of São Paulo, seeking to attribute an answer to the following research question: What is the water footprint of a crepe-type adhesive tape unit and what environmental implications does this calculation have for the production process of this segment?

The research aims to identify the water footprint in the industrial production of crepe adhesive tape in a chemical company and analyze the environmental implications of this calculation for the production process of the segment.

## 2 SUSTAINABLE DEVELOPMENT AND SUSTAINABILITY

Currently, environmental degradation is one of the most discussed issues worldwide nowadays and this issue is linked to the antagonistic relationship between the environment and man (OLIVEIRA, 2017).

At the end of the 20th century the world experienced the growth of society's awareness of environmental degradation derived from the development process. Due to the deepening of the environmental crisis, along with the reflection on the influence of society in such process, the concept of sustainable development emerged (BELLEN, 2004).

In the mid-1980s, the United Nations General Assembly originated the World Commission on Environment and Development, headed by Gro Harlem Brundtland, who in 1987 drafted the Brundtland Report (or Our Common Future). This report defined "Sustainable development is one that meets the needs of the present without compromising the possibility for future generations to meet their own needs" (GOLDEMBERG, 2015, p. 33).

In 1992, the United Nations Conference on Environment and Development (also known as Rio-92, Eco-92 or Earth Summit) took place in Rio de Janeiro. There were 172 countries, around 1,400 NGOs and 10,000 participants, in addition to gathering 108 heads of state. They sought ways to combine the conservation and protection of the environment with socioeconomic development. Out of the various documents prepared by Rio-92, the Earth Charter and Agenda 21 were the main ones (OTERO; NEIMAN, 2015).

With regard to sustainability, this term characterizes everything that can be maintained. The word "sustain" has several meanings, one of them can be in relation to something uninterrupted, that is, cyclical, with an aspect of continuity (VELLANI; RIBEIRO, 2009).

According to Boff (2017, p. 33), "sustainability represents the procedures we take to allow the Earth and its biomes to stay alive, protected, fed nutrients to the point of always being well maintained and up to the risks that may arise."

The author goes on to state that "sustainability is measured by the ability to conserve the natural capital, allow it to recover, rebuild and, even, through human intelligence, it can be improved so that we deliver to future generations not an impoverished Earth, but an enriched one and still open to co-evolving" (BOFF, 2017, p. 119).

In relation to the business, sustainability is based on three dimensions: economic, social and environmental. Such dimensions are known worldwide as a Sustainability Tripod (or Triple Bottom Line) (VELLANI; RIBEIRO, 2009).

When dealing with the Sustainability Tripod, Boff (2017, p. 45) states that:

> The concept was created in 1990 by The British John Elkington, founder of the NGO SustainAbility, which proposes to disseminate these three moments as necessary for all sustainable development. He also used another expression: the three "feet", Profit, People, Planet (product/income, population and planet), as sustainable supporters.

It can be said that sustainability and sustainable development are two terms in which each of them has its characteristics, but that both complement each other (NISTA *et al.*, 2020). It is clear to anyone that they both have the same ideal and represent something positive and good, whether for the human being, for the environment, or rather for the planet in general (FEIL; SCHREIBER, 2017).

Sustainability provides for the use of natural resources, considering current and future generations. In this aspect, water is an important natural resource that has been consumed in an uncontrolled way, generating water scarcity and so many other impacts on the environment. In the midst of this theme, the concept of water footprint emerges as an instrument for managing the use and consumption of water in the most diverse sectors.

## 2.1 Water footprint

Water is an essential good for all mankind. It is present in food, beverages, clothes, landscapes, quality of life, among others. It also plays a key role in energy supply, infrastructure, economic growth, health care, education and culture. The water cycle is global. Its availability, use and security transcend local, national and even continental borders (GUTHRIE, 2010).

The pressure stemming from population growth, intensification in food production, the development of energy sources that depend on water, and economic growth have caused an increase in water consumption. However, the growing demand for water and the limited possibility of promoting its supply means that there is a need for new management practices and tools that promote the efficient use of water in consumption, distribution and in the production process and that stimulate the rationalization of the use of this good (RIBEIRO, 2014).

Given the undeniable relevance that water has in the life of human beings and other living beings, there has been increasing discussion about the global water crisis. It has been constantly on the agendas of governments, academic and scientific communities, non-governmental organizations, public opinion and media (SEIXAS, 2011). In view of this situation, it is necessary to change the way in society and to review the principles of exploitation of natural resources, in order to reverse the trend of the rapid disappearance of water resources that is already clear today and which tends to worsen in the near future (FALSARELLA *et al*., 2021).

It is known that water is an essential production factor and that it helps both directly and indirectly economic activity in all sectors and regions of the global economy. Thus, its scarcity can therefore go beyond having consequences for people, society and ecological systems, but also bring negative effects to economic growth (DISTEFANO; KELLY, 2017).

In the last decade there has been a growing interest in research on the issue of the water footprint due to the increasing awareness of people about water conservation and the widespread acceptance of sustainable use (ZHANG *et al*., 2017).

The water footprint concept emerged in 2002 during a meeting of experts discussing the international virtual water trade in Delf, The Netherlands, by Arjen Hoekstra. The ideal of the water footprint is to reduce the impacts of water scarcity, which deprives countless people worldwide, so that better water management of such resource can be prevented, thus, the exploitation in scarcer places, and then directing consumption to places that have greater abundance of fresh water (MARACAJÁ *et al*. 2012). The term virtual water, mentioned above, represents the water incorporated in products, while the water footprint refers to the water needed for the production of a product (BLENINGER; KOTSUKA, 2015).

According to Hoekstra *et al*. (2011), the Water Footprint represents an indicator of water use, which considers both its direct use by a producer or consumer and its indirect use. In other words, the water footprint of a product refers to the volume of water that is used to produce it, measured throughout the production chain. There are three types of water footprints: blue, green, and gray. The blue water footprint of a certain product is consistent with the consumption of blue water, i.e., surface and groundwater. It is noteworthy that the term "consumption" concerns the loss of available water in a watershed. The green water footprint refers to the consumption of green water, i.e., rainwater, as long as it does not flow.

And finally, the gray water footprint concerns pollution, being defined as the volume of fresh water that is needed to assimilate the load of pollutants.

Hoekstra *et al*. (2011, p.3-4) state that:

> The evaluation of the water footprint refers to a wide scope of activities, aiming to: (i) quantify and locate the water footprint of a process, product, producer or consumer or quantify in space and time the water footprint in a given geographical area; (ii) assess the environmental, social and economic sustainability of this water footprint; and (iii) formulate response strategies. In general terms, the objective of quantifying water footprints is to analyze how human activities or specific products relate to issues of water scarcity and pollution and to verify how activities and products can become more water sustainable.

To calculate the water footprint of a product it is necessary to understand how its entire production chain works, in which it is necessary to identify the production system. Such a system comprises a sequence of stages of the process (SEIXAS, 2011).

It is noteworthy that it is possible to calculate the water footprint of a product, a community, a consumer, a company and a geographically delimited area (HOEKSTRA *et al*., 2011).

Regarding water footprint-related utilities, it provides an overall notion of water resource management; recognizes and promotes alternatives to minimize water stress; assists in analyzing the use of alternative energies; offers companies a new way to control their dependence on water resources, among other points (SEIXAS, 2011).

It is essential to understand the importance of the water footprint, so as to understand that most of the water that an individual consumes daily does not come from the taps of his residence, but from the products he uses and consumes (GIACOMIN, 2012).

## 2.2 Water footprint in Brazil

The first appearances on the water footprint in Brazil emerged between 2010 and 2011, and the first productive sectors to employ were the industrial (beverages, cellulose, cosmetic) and the livestock sectors (MARTINS, 2014).

In order to disseminate the term water footprint in Brazil, The Nature Conservancy promoted, together with WWF, the School of Engineering of São Carlos and the Water Footprint Network, the 1st Regional Course on water footprint in the country. The lecture was held by Professor Arjen Hoekstra of the University of Twente (in the Netherlands). Hoekstra was the creator of the water footprint concept and scientific director of the network. The lecture had about 50 participants from various institutions and sectors (TNC, 2011).

In addition, in Brazil, The Nature Conservancy also works in partnership with companies to calculate, reduce and supply the water footprint of its industrial plants, and participates in respected global water conservation forums, such as the Water Footprint Network and the Alliance for Responsible Water Use. It is noteworthy that, today, one in ten Brazilian citizens consume the water that The Nature Conservancy helps protect (TNC, 2011).

Recently, studies related to the water footprint in Brazil have emerged. However, contrary to what occurs in other countries, the concept of water footprint is still very little addressed and disseminated in Brazil. There are few studies that address this theme with a focus on national analysis. This is due both to the fact that this issue is still "relatively" recent, as well as due to the presence of various biomes and economic, climatic, socio-environmental and cultural conditions of the country, which can reproduce inaccurate results and difficulties in obtaining data (MARTINS, 2014).

**2.3 Agriculture – the sector that uses fresh water the most**

According to Maracajá *et al*. (2012) agriculture is the sector that uses freshwater the most, which corresponds to 70% of the total water consumption of planet Earth. In contrast, the industrial sector uses around 22% and domestic use 8%. Therefore, the size of the world's water footprint is defined through food consumption, industrial consumption and domestic consumption.

In relation to agriculture, its water footprint corresponds to $6,390x10^9$ $m^3$/year. On the other hand, the domestic and industry water footprint corresponds, respectively, to $344x10^9$ $m^3$/year and $71610^9$ $m^3$/year respectively. It soon becomes clear that the productive sector that consumes the most water is the irrigated agriculture (NASCIMENTO *et al*., 2021).

Freshwater has increasingly become a global resource, incited by increased international trade in commodities, which is responsible for high water consumption. There are world markets that trade products with high water consumption from agriculture and livestock. However, governments do not have a complete view of the sustainability of national consumption. Several countries have externalized their water footprint without checking whether imported products are linked to their pollution in producing countries or to water depletion (SEIXAS, 2011).

The use of water resources has become spatially disconnected from consumers. This factor can be investigated, for example, through the case of cotton, i.e., from the field to the final product. Cotton goes through various stages of production with various impacts on water resources. Such stages of production are often in different places and final consumption may be elsewhere (HOEKSTRA *et al*., 2011).

An example of lack of fresh water is what occurs in the Northeast region of Brazil. It has long suffered from the lack of fresh water due to drought. Therefore, agricultural production should work with minimal water without losing the quality of the product. Thus, the water footprint is more than necessary for northeastern agriculture, since with its use it is possible to identify at which stage of production there is greater waste of water and correct the problem (NASCIMENTO *et al.*, 2021).

Thus, the water footprint is a very useful and essential method in an attempt to reduce water use in the agricultural sector (NASCIMENTO *et al.*, 2021).

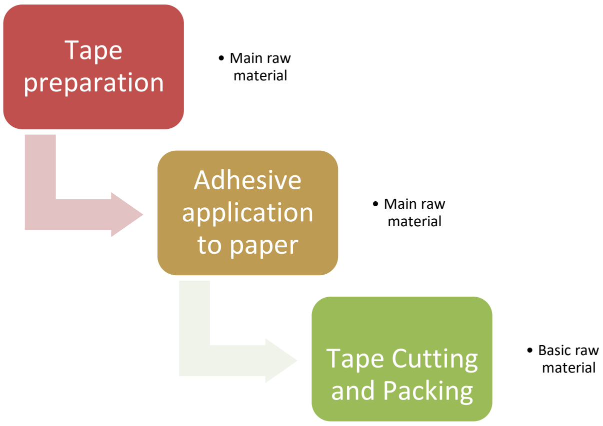
**3 METHODOLOGY**

To Hoekstra *et al.* (2011), the calculation of the water footprint of a production process is applied considering water consumption and pollution at all stages of the production chain. In this sense, we opted for the "Cumulative Sequential Method", proposed by Hoekstra *et al.* (2011), in which is considered the sum of the water footprint of the inputs and processes, the weight and price of the product and inputs.

The research is of a quantitative nature, exploratory and explanatory objective, as instructed by Gil (2019).

The water footprint was used to manufacture 1 (one) roll of 48X50mm adhesive tape, crepe type in a chemical company, located in the upstate of São Paulo, Brazil, in the city of Sumaré. The product chosen for water footprint calculation consumes a large amount of water compared to the manufacturing process of other products. In addition, the product is manufactured and sold very frequently throughout Brazil. These factors highlight the importance of the present study. Figure 01 synthetically presents the stages of the production process used to calculate the water footprint of the adhesive tape.

**Figure 01 - Stages of the production process used to calculate the water footprint.**

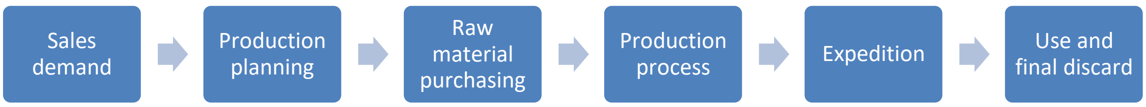



Source: Elaborated by the authors.

The quantification of the water footprint was based on the water consumption of basic inputs, such as cardboard boxes, washers, film and essential inputs for the production process, which are concentrated in the initial stage of production and the phase of application of chemical products to the product. The data collected from the raw material comprised direct consumption, that is, the data of inputs, considering only the production process of the raw material, without mapping the supply chain of the raw material itself.

Generally speaking, water is consumed in all stages of self-adhesive tape manufacturing and administrative processes, as shown in Figure 02. However, for this study, only the water consumption of the inputs and the manufacturing process were considered, so that the result is reliable in identifying the water footprint of the product studied.

**Figure 02 - Stages of the production process used to calculate the water footprint.**




Source: Elaborated by the authors.

Human water consumption, losses, evaporation, irrigation, water reuse and effluent disposal were excluded from the research calculation base.

## 4 RESULTS

The water footprint calculation was performed using the equations related to this study. The EQUATION PH*prod* [*p*] indicates the fraction of the final product, therefore provides the total water footprint of the product, whose unit of measurement is kg/m².

The following equation was used to calculate the water footprint of the product in question.

$$WF_{prod}\,[p] = (WF_{proc}\,[p] + \sum_{i=1}^{y} \frac{WF_{prod}\,[i]}{f_p\,[p,i]}) \cdot f_v\,[p]$$

Where:

*WF prod* [*p*] = water footprint of the final product "p" (m²/kg).

*WF proc* [*p*] = water footprint of the "i" input (m²/kg).

*WF prod* [*i*] = water footprint of the process that transforms raw materials "y" into the final product "z" (m²/kg).

*fp* [*p, i*] = Fraction of the final product (Kg)

*fv* [*p*] = Fraction of value (R$/Kg)

To obtain the fraction of the final product *fp* [*p, i*], indicated in the previous equation, the following equation was used:

$$f_p\,[p,i] = \frac{weight\,[p]}{weight\,[i]}$$

Where:

Weight [*p*] = weight of the final product

Weight [*i*] = weight of each input

The fraction of *fv* value [*p*], was defined by the equation:

$$f_v\,[p] = \frac{price\,[p]\ \cdot weight\,[p]}{\sum_{p=1}^{z}(price\,[p]\ \cdot weight\,[p])}$$

Where:

Price [*p*] = product price

The denominator and the sum of the "z" final products (*p*=1 to *z*) that resulted from the inputs.

The calculation of the water footprint of the crepe adhesive tape, considered the measurements of 48x50 mm and the length of 2.4m². The results obtained are expressed in Chart 01:

**Chart 01: Calculation of the water footprint of crepe adhesive tape.**

| Results | | Unit of measure |
|---|---|---|
| ***PH prod* [*p*]** | **0,11** | **Kg/roll** |
| *PH proc* [*p*] | 0,07 | liters/roll |
| *PH prod* | 0,34 | liters/roll |
| *fp* [*p, i*] | 2.759,46 | not applicable |
| *fv* [*p*] | 3,69 | not applicable |

Source: Elaborated by the authors, based on the research data.

Chart 01 presented the calculation of the water footprint for the production of a crepe adhesive tape roll equivalent to 0.11kg of water. It is noted that the water footprint of the supply chain (0.34 liters/roll) is larger than the water footprint of the internal processes (0.07 liters/roll).

As a suggestion, possible studies could be elaborated to minimize the water footprints of suppliers. The present study can positively influence this aspect. The water footprint of an isolated point, added to the water footprints of other companies, can contribute to the measurement of the amount of fresh water available *versus* consumed.

It is noteworthy that in this study only the water footprint of the product was calculated, without considering the blue water footprint, which comprises the advisory use of fresh or groundwater.

For information, the blue water footprint considers in its calculation the evaporated water, incorporated into the product and the lost return flow rate that is not available for reuse in the same watershed. In this context, the product in question suffers only the evaporation that is equivalent to the water added to the industrial process. Thus, it is concluded that the blue water footprint is equivalent to the water footprint of the process.

The green water footprint is commonly used for agricultural and forestry products and is equivalent to the total rainwater added to the water incorporated into agricultural and forestry products. For this reason, the green water footprint does not apply to the object of study.

In the case of the gray water footprint, the effluent of the company studied falls into the point source of diffuse pollution, where there is underground capture and surface release.

The water consumed in the production process for cooling equipment, greenhouses and boilers is reused internally, through a reuse cycle. All sewage generated, treated and disposed of in surface water, comes from human consumption, so it is admitted that the gray water footprint of the product is equal to zero.

Chart 02 presents some guidelines that contribute to the reduction of the water footprint.

**Chart 02 - Guidelines to minimize water footprint.**

| **PRODUCT-ORIENTED GUIDELINES** |
| --- |
| Zero blue water footprint: no evaporation losses - total recycling. |
| Set reduction goals with suppliers: replacement of suppliers, have greater or total control over the production chain and change the business model to incorporate or have greater control of the production chain. |
| Avoid using water when developing new products whenever possible. |
| **GENERAL GUIDELINES** |
| Invest in improving management and sustainable use of water in the basin where the company's water footprint (residual) is located. |
| Get the zero gray water footprint: no pollution – total recycling and treatment of return flows. The reduction of 1 m³ in the water footprint in one basin is equivalent to reducing the same amount of the water footprint in another basin, even when it presents greater scarcity or higher level of water pollution than the other. The reason for this is that considering the limited availability of water resources in the world – any decrease in the water footprint will contribute to reducing total demand for water resources. |

Source: Hoekstra (2011, p. 101) and revised by the authors (2022).

It is noteworthy that the guidelines of Table 02 are optional. Once implemented, it is believed that the result will be positive. After analyzing the results, it was concluded that the guidelines indicated are the most relevant, but are not limited to them, thus being able to develop new mechanisms for water contribution.

## 5 CONCLUSIONS

The study aimed to identify the water footprint in the industrial production of crepe adhesive tape and analyze the environmental implications of this calculation for the production process in companies in the chemical sector.

It was noticed in the study that there is little literature on the water footprint. This explains society's misunderstanding of the dimensions of water consumption to meet the economy, the scarcity of water resources due to exacerbated water consumption and pollution caused by the release of organic cargo into rivers.

The water footprint considers the direct and indirect use of water and is nothing more than an indicator of water use in various sectors, such as consumers, processes, companies, a certain type of product and even more comprehensively considering, for example, a certain geographical location or even an entire country.

In Brazil, there are already means for implementing the water footprint, such as dissemination of courses throughout the country, partnerships with companies to reduce and supply the water footprint of their industrial plants, and participation in global water conservation forums.

Despite the difficulties of obtaining data from suppliers and the complexity of the subject, the present study achieved the desired objective of calculating the water footprint of crepe adhesive tape and proposing guidelines for minimizing the water footprint.

It was concluded through the present study that the water footprint of the inputs is superior to the water footprint of the production process. The starting point to reduce the water footprint of the inputs can be obtained by reassessing the supply chain or replacing them. In the last case, it is possible to merge the purchase of the reserves between backup suppliers, however, this action depends intrinsically on the costs associated with the raw material.

Although the water footprint of the process is not significant, it should not be ignored. It guides the reuse of evaporated water in the industrial process and whenever possible minimize water use when developing new products.

To obtain more concrete data, it is recommended for future studies, the calculation of the water footprint of all products of the studied company, considering the respective processes and suppliers of inputs, as described in Table 01. Currently, the highest water consumption is due to industrial activities (boilers and other equipment), followed by human consumption, losses and evaporation.

**Table 01 - Examples of components of a company's water footprint.**

| *Operational water footprint* | | *Supply chain water footprint* | |
|---|---|---|---|
| *Water footprint directly involved in the elaboration of the company's products* | *Aditional water footprint* | *Water footprint directly involved in the elaboration of the company's products* | *Aditional water footprint* |
| • Incorporated water in the product<br>• Consumed water or poluted trough a washing process<br>• Termically poluted water because of refrigeration use. | • Consume or pollution of water related to use in kitchens, cleaning, gardening or clothing washing. | • Water footprint of the inputs purchased by the company.<br>• Water footprint of other inputs purchased by the company to process its products. | • Water footprint of infrastructure (construction, etc.)<br>• Water footprint of general use inputs (office supplies, cars, trucks, electricity, etc.) |

Source: Hoekstra (2011).

It is recommended that further research be carried out to develop the calculation of the water footprint of other similar products, with the aim of verifying the water footprint of the company as a whole. From this estimate, calculate the blue, green and gray water footprint for clearer definition of the total water footprint.

In general, companies estimate indoor water consumption, which is extremely important. However, this analysis should be expanded to understand the impact (natural resource extraction, water pollution, etc.) in relation to stakeholders (watershed, community and supply chain).

The water footprint must be a subject strongly implemented in all economic segments and sectors (e.g., agriculture). Considering from a specific product to national and global level, its importance is indisputable.

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## 7 REFERENCES

BELCHIOR, G. P. N.; VIANA, I. C. Sustentabilidade e meio ambiente: reflexões sob o olhar da complexidade. **Areel Faar – Amazon's Research and Environmental Law**, Ariquemes, v. 4, n. 1, p. 72-90, Jan. 2016. https://doi.org/10.14690/2317-8442.2016v41183

BELLEN, H. M. V. Desenvolvimento sustentável: uma descrição das principais ferramentas de avaliação. **Ambiente e Sociedade**, Campinas, v. 7, n. 1, p. 01-22, Jan./Jun. 2004. https://doi.org/10.1590/S1414-753X2004000100005

BLENINGER, T.; KOTSUKA, L. K. Avaliação dos conceitos de água virtual e pegada hídrica na gestão de recursos hídricos: estudo de caso da soja e óleo de soja. **Recursos Hídricos**, v. 36, n. 1, p. 15-24, maio, 2015. https://doi.org/10.5894/rh36n1-2

BOFF, L. **Sustentabilidade**: o que é – o que não é. 5. Ed. Petrópolis-RJ, 2017.

CANTELLE, T. D.; LIMA, E. C.; BORGES, L. A. C. Panorama dos recursos hídricos no mundo e no Brasil. **Revista em Agronegócio e Meio Ambiente**, Maringá, v. 11, n. 4, p. 1259-1282, Out./Dez. 2018. https://doi.org/10.17765/2176-9168.2018v11n4p1259-1282

DISTEFANO, T.; KELLY, S. Are we in deep water? Water scarcity and its limits to economic growth. **Ecological Economics**, v. 142, p. 130-147, 2017. https://doi.org/10.1016/j.ecolecon.2017.06.019

FEIL, A. A.; SCHREIBER, D. Sustentabilidade e desenvolvimento sustentável: desvendando as sobreposições e alcances de seus significados. **Cadernos EBAPE.BR**, Rio de Janeiro, v. 14, n. 3, p. 667-681, Jul./Set. 2017. http://dx.doi.org/10.1590/1679-395157473

FALSARELLA, O. M. *et al*. Sustainable development in watershed: Proposal for a knowledge management system. **International Journal of Humanities and Social Science**, v. 11, p. 29-37, 2021. https://doi.org/10.30845/ijhss.v11n3p4

GIACOMIN. G. S. Análise de resultados de pegada hídrica por países e produtos específicos. **Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental**, Santa Maria, v. 8, n. 8, p. 1562-1572, Set./Dez. 2012. http://dx.doi.org/10.5902/223611706721

GIACOMIN, G. S.; OHNUMA, A. A. Análise de resultados da pegada hídrica por países e produtos específicos. **Revista Eletronica em Gestão, Educação e Tecnologia Ambiental**, Cascavel, v. 8, p. 1562-1562, 2012. http://dx.doi.org/10.5902/223611706721

GIL, A. C. **Métodos e técnicas de pesquisa social.** 7. ed. São Paulo: Atlas, 2019.

GOLDEMBERG, J. Energia e Sustentabilidade. **Revista de Cultura e Extensão USP**, São Paulo, n. 14, p. 33-43, Nov. 2015. http://dx.doi.org/10.11606/issn.2316-9060.v14i0p33-43

GUTHRIE, P. **Global Water Security** - An engineering perspective. London: The Royal Academy of Engineering, 2010. Available in: https://www.raeng.org.uk/gws. Accessed in: 20 mai. 2022.

HOEKSTRA, A. Y. *et al*. **Manual de avaliação da pegada hídrica**: estabelecendo o padrão global. Water Footprint Network. 2011. Available in: https://waterfootprint.org/media/downloads/ManualDeAvaliacaoDaPegadaHidrica.pdf. Accessed in: 31 mai. 2022.

JUNQUEIRA, L. P.; PINHEIRO, F. P.; MAIOR, J. C. S. Sustentabilidade: A produção científica brasileira entre os anos de 2000 e 2009. **Revista Científica Hermes**, Osasco, v. 6, p.43-65, Jan./Jun. 2012. https://doi.org/10.24857/rgsa.v5i3.375

MARACAJÁ, K. F. B. *et al.* Pegada hídrica como Indicador de Sustentabilidade Ambiental. **REUNIR –** Revista de Administração, Contabilidade e Sustentabilidade, Campina Grande, v. 2, n. 2, p. 113-125, 2012. https://doi.org/10.18696/reunir.v2i2.75

MARACAJÁ, K. F. B.; ARAUJO, L. E.; SILVA, V. P. R. Regionalização da Pegada hídrica do Estado da Paraíba. **REUNIR –** Revista de Administração, Contabilidade e Sustentabilidade, Campina Grande, v. 4, n. 1, p. 105-122, 2014. https://doi.org/10.18696/reunir.v4i1.206

MARACAJÁ, K. F. B. **Nacionalização dos Recursos Hídricos**: um estudo exploratório da pegada hídrica no Brasil. **Qualitas Revista Eletrônica**, Campina Grande, v. 20, n. 3, p.39-54, set/dez, 2019. http://dx.doi.org/10.18391/req.v20i3.5385

MARTINS, R. S. L. **Empresas e gestão da água**: uma abordagem a partir do uso do indicador pegada hídrica. 178 f. Tese (Doutorado em Ciência Ambiental). Programa de Pós-Graduação em Ciência Ambiental, Universidade de São Paulo, São Paulo, 2014.

MONTOYA, M. A. A pegada hídrica da economia brasileira e a balança comercial da água virtual: Uma análise insumo-produto. **Economia Aplicada**, Ribeirão Preto, v. 24, n. 2, p. 215-248, 2020. https://doi.org/10.11606/1980-5330/ea167721

NASCIMENTO, N. V. D. *et al*. O uso das pegadas hídricas na agricultura do Brasil. **Research, Society and Development**, v. 10, n. 1, 2021. http://dx.doi.org/10.33448/rsd-v10i1.12055

NISTA, N. A. *et al*. Sociedade e desenvolvimento sustentável: O direito dos animais no discurso da sustentabilidade. **Ambiente e Sociedade**, Campinas, v. 23, p. 1-18, 2020. https://doi.org/10.1590/1809-4422asoc20180278r2vu2020L4AO

OLIVEIRA, M. J. M. **Degradação ambiental, sucessão ecológica e sistemas de uso da terra no semiárido brasileiro**: enfoques ao município de independência, estado do Ceará. 136 f. Dissertação (Mestrado em Geografia). Programa de Pós-Graduação em Geografia, Universidade Estadual do Ceará, Fortaleza, 2017.

OTERO, P. B. G.; NEIMAN, Z. Avanços e desafios da Educação Ambiental brasileira entre a Rio 92 e a Rio+20. **Revista Brasileira De Educação Ambiental (RevBEA),** São Paulo, v. 10, n. 1, p. 20–41, 2015. https://doi.org/10.34024/revbea.2015.v10.1842.

RATTNER, H. Sustentabilidade – Uma visão humanista. **Ambiente & Sociedade**, Campinas, n. 5, p. 233-240, Dez. 1999. https://doi.org/10.1590/S1414-753X1999000200020.

RIBEIRO, C. S. **Pegada hídrica e água virtual**: estudo de caso da manga no submédio do vale do São Francisco, Brasil. 79 f. Dissertação (Mestrado em Economia). Programa de Pós-Graduação em Economia, Universidade Federal da Bahia, Salvador, 2014.

SEIXAS, V. S. C. **Análise da pegada hídrica de um conjunto de produtos agrícolas**. 89 f. Dissertação (Mestrado em Engenharia do Ambiente, perfil de Gestão e Sistemas Ambientais). Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, Lisboa, 2011.

TNC - THE NATURE CONSERVANCY. **Relatório de atividades**. 2011. Available in: https://www.tnc.org.br/content/dam/tnc/nature/en/documents/brasil/relatorio-2011.pdf. Accessed in: 20 mai. 2022.

VELLANI, C. L.; RIBEIRO, M. D. S. Sustentabilidade e Contabilidade. **Revista Contemporânea de Contabilidade**, Florianópolis, v. 1, n. 11, p. 187-206, Jan./Jun. 2009. https://doi.org/10.5007/2175-8069.2009v6n11p187

ZHANG, Y. *et al*. Mapping of water footprint research: A bibliometric analysis during 2006-2015. **Journal of Cleaner Production**, v. 149, p. 70-79, 2017. https://doi.org/10.1016/j.jclepro.2017.02.067