Water Footprint for the Oil Palm Industry

Vijaya Subramaniam*; Halimah Muhammad*; Zulkifli Hashim* and Choo Yuen May*

INTRODUCTION

Currently carbon footprint is such a catchphrase in the world that it has become a must for responsible producers to quantify their carbon footprint or also known as greenhouse gas (GHG) emissions. The European Union (EU) directive has imposed a non-tariff barrier on the imports of palm biodiesel based on GHG emissions calculations. If the exporters do not meet the minimum GHG savings when compared to fossil fuel, their exports will not qualify for the incentives making the feedstock higher in price. This has brought a big impact to the oil palm industry on the market access of palm biodiesel to EU. Just as how carbon footprint or GHG emissions are playing such an important role in the oil palm industry, the next thing the world is moving into is water footprint. For example the study by Gerbens et al. (2009) came to conclusions that jatropha is not a suitable feedstock for biodiesel production due to its high water footprint. This study compared the water footprint between soya, rapeseed and jatropha, and the recommendation was that soya is the best crop for biodiesel just based on the water footprint. This kind of studies shows the trend of how water footprint is slowly being used as an indication for choosing a feedstock, just as how carbon footprint is being used now.

THE NEED FOR WATER FOOTPRINT

Studies show that it takes roughly 132 gallons of water to make a 2-litre bottle of soda, and about 500 gallons, including water used to grow, dye and process the cotton, to make a pair of Levi’s stonewashed jeans (Alter, 2009). Though much of that water is replenished through natural cycles, many companies have started tracking such ‘water footprints’ as a growing threat of freshwater shortages looms. Some are measuring not just the water used in the manufacturing process, but also the water used to grow ingredients such as cotton, sugar, wheat, tea and tomatoes. The drive to calculate the water footprint comes as groundwater reserves are being depleted and polluted at unsustainable rates in many regions.

Climate change has caused glaciers to shrink, eroding vital sources of fresh water. The growing global demand for food and energy is placing even more pressure on diminishing supplies. Two-thirds of the world’s population is projected to face water scarcity by 2025, according to the United Nations. The water footprint of humanity has exceeded sustainable levels at several places and is unequally distributed among people. There are many spots in the world where serious water depletion or pollution takes place: rivers running dry, dropping lake and groundwater levels and endangered species because of contaminated water. The water footprint refers to the volumes of water consumption and pollution that are ‘behind’ your daily consumption (Alter, 2009).

It is generally accepted that emissions of GHG, such as CO₂ from fossil energy carriers, are responsible for anthropogenic impacts on the climate system. In this context, there has been a remarkable shift in policy attitudes towards CO₂-neutral energy carriers.
such as biomass. The production of biomass for food and fibre in agriculture requires about 86% of the worldwide freshwater use. In many parts of the world, the use of water for agriculture competes with other uses such as urban supply and industrial activities. In a scenario of increasing degradation and decline of water resources, a shift from fossil energy towards energy from biomass puts additional pressure on freshwater resources (WFN, 2009).

There are large differences among the water footprints for specific types of primary energy carriers. As a whole, the water footprint of energy from biomass is 70 to 400 times larger than the water footprint of the other primary energy carriers (excluding hydropower). Nevertheless, it depends on crop type, agricultural production system and climate. The trend towards larger energy use in combination with increasing contribution of energy from biomass to supply will bring with it a need for more water. This causes competition with other claims, such as water for food crops (WFN, 2009).

**THE CONCEPT OF WATER FOOTPRINT**

The water footprint means the amount of water that is needed to produce different goods and services (Chapagain and Hoekstra, 2004). It consists of water withdrawn from surface water and groundwater and the use of soil water. The water withdrawn from surface water and groundwater is called blue water and the water stored in the soil is called green water. The water footprint is a new concept. It was first introduced by Hoekstra in 2002. In 2004, Chapagain and Hoekstra made a more specific study about the water footprints of nations. Using similar principles, the water footprint can also be calculated for a person or for a business. According to Chapagain and Hoekstra (2004), the water footprint has been developed in analogy to the ecological footprint, which was introduced by Wackernagel and Rees in 1996.

The ecological footprint describes the area of productive land and aquatic ecosystem needed to produce all the goods and services and to assimilate the wastes by a certain population. The water footprint describes, as stated previously, the volume of water that is needed in the production of the goods and services. Waste water flow was not included in the study by Chapagain and Hoekstra (2004), but it can be included in the water footprint. In the study made by Chapagain et al. (2006) about the water footprint of cotton consumption, the waste water flow was included by estimating how much water is needed to dilute the concentration of a pollutant to such level that it is longer considered harmful.

The amount of water that is needed to produce a commodity or a service is called virtual water (Chapagain and Hoekstra, 2004). The virtual water concept was introduced earlier than the water footprint concept as Tony Allan introduced it in the early 1990s. The virtual water amount depends highly on the conditions where the goods or services have been produced. For example, the virtual water content of a tonne of wheat is 465 m³ when it is produced in Slovakia and 18 070 m³ when it is produced in Somalia.

**TABLE 1. WATER CONSUMPTION FOR PRIMARY ENERGY CARRIERS**

<table>
<thead>
<tr>
<th>Primary energy carriers</th>
<th>Global average water footprint (m³ GJ⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-renewable</td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td>0.11</td>
</tr>
<tr>
<td>Coal</td>
<td>0.16</td>
</tr>
<tr>
<td>Crude oil</td>
<td>1.06</td>
</tr>
<tr>
<td>Uranium</td>
<td>0.09</td>
</tr>
<tr>
<td>Renewable</td>
<td></td>
</tr>
<tr>
<td>Wind energy</td>
<td>0.00</td>
</tr>
<tr>
<td>Solar thermal energy</td>
<td>0.27</td>
</tr>
<tr>
<td>Hydropower</td>
<td>22</td>
</tr>
<tr>
<td>Biomass energy</td>
<td>70 (range: 10-250)</td>
</tr>
</tbody>
</table>

The water footprint can also be divided into two parts: to internal water footprint and to external water footprint. The internal or direct water footprint represents how much water is consumed in the production of a product or a service in the country, where the product or service is consumed. The external or indirect water footprint reveals how much water is consumed in some other country to make the product or service. For example, the water footprint of a bakery that bakes breads can form an internal and external water footprint. If the bread that is sold in the bakery is made from grain that is grown in some other country than where the bread is made and sold, the external water footprint consists of the water volume that is needed to grow the needed amount of grain. The internal water footprint consists of the water amount that is needed in processing the grain to bread.

**METHODOLOGY OF WATER FOOTPRINT**

Water consumption will be determined into three categories as shown below in Figure 1.

A water footprint consists of three components: the blue, green and grey water footprint. The blue water footprint is the volume of freshwater that evaporated from the global blue water resources (surface water and ground water) to produce the goods and services consumed by the individual or community. The green water footprint is the volume of water evaporated from the global green water resources (rain water stored in the soil as soil moisture). The grey water footprint is the volume of polluted water that associates with the production of all goods and services for the individual or community. The latter can be estimated as the volume of water that is required to dilute pollutants to such an extent that the quality of the water remains at or above agreed water quality standards (Hoekstra et al., 2011).

According to Hanna (2008), the water footprint concept is closely linked to the virtual water concept. The calculation of virtual water content of a crop is based on the crop water requirement, which means the total water amount that a crop needs for evapotranspiration, from planting to harvest in a certain climate regime per 1 ha. The virtual water content is quantified in units of m³ per 1 t of crop. When crop water requirement is known, the crop water use (CWU), which means the total amount of water that is used for crop production

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*Figure 1. Water footprint categories.*

Source: Hoekstra et al. (2011).
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during the year, is calculated with the equation,

\[ CWU = \frac{CWR \times \text{Production/yield}}{\text{Production/yield}} \]  

\[ \text{(1)} \] in which,

\[ CWR = \text{crop water requirement (m}^3\text{ ha}^{-1}) \]
\[ \text{Production} = \text{total amount of crop produced during the year (t)} \]
\[ \text{Yield} = \text{crop yield (t ha}^{-1}) \]

When CWU is known, the virtual water content (VWCcrop) of primary crops is calculated with the equation,

\[ \text{VWC}_{\text{crop}} = \frac{\text{CWU}}{\text{production}} \]  

\[ \text{(2)} \] in which,

\[ \text{CWU} = \text{crop water use (m}^3\text{)} \]
\[ \text{Production} = \text{total amount of crop produced during the year (t)} \]

The crop water requirement is the water amount that a certain plant needs for evapotranspiration, when there is sufficient amount of soil water for the plant to use (Chapagain and Hoekstra, 2004). It means that the soil gets water through rainfall or irrigation in such amounts that water is not the limiting factor for plant growth or crop yield.

Equations 1 and 2 imply that the virtual water content of a crop depends on the crop water requirement and the crop yield per hectare. Also if there are any changes in these figures, the virtual water content of a crop changes (Hanna, 2008).

**WATER FOOTPRINT OF THE OIL PALM INDUSTRY**

The Malaysian oil palm industry is a very important industry which contributes immensely to the nation's economy. The industry is asked again and again to prove the sustainability of their products. Sustainability is no longer an option because it will be the primary driver of economic development in the long-term. Sustainability has to be part of the oil palm industry's business strategy. The interest of the oil palm industry will be best served if stakeholders maximise their financial performance by strategically managing their economic, social, environmental and ethical performance. Central to this, is that the sustainable development of the oil palm industry which is vital for the long-term profitability of the oil palm business.

In view of the imminent need for the oil palm industry to be accountable for its water consumption, it is very crucial to first quantify the water footprint of the industry and identify areas of high water intensity. The next step will be to reduce the water consumption as much as possible. In this manner, the oil palm industry will remain competitive and sustainable in the global market. This will also ensure the market access and the ability to compete with the other vegetable oils.

MPOB has embarked on a cradle to gate water footprint of the production of crude palm oil (CPO). Even though the study for now covers up to the palm oil mill as shown in Figure 2, it will be further expanded to also cover right up till the production of palm biodiesel and other downstream products. Once the water footprint of the feed is quantified the water footprint of the rest of the downstream products will be carried out.

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**Figure 2. System boundary.**

<table>
<thead>
<tr>
<th>Nursery</th>
<th>Cultivating of oil palm seedlings 10-12 months seedlings for transplanting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plantation</td>
<td>Transplanting of oil palm seedling, oil palm cultivation Harvesting of FFB &amp; transportation to the mills</td>
</tr>
<tr>
<td>Palm Oil Mill</td>
<td>Processing of FFB Production of CPO and palm kernels</td>
</tr>
</tbody>
</table>
CONCLUSION

In the past, more often than not environmental management was conducted more for image enhancement. However recent developments show a trend towards wanting a greener earth which has transformed environmental demands into marketing tools. Increasingly it has become a non-tariff trade barrier and a determining factor for use of products. In view of the current shift for higher environmental demands from customers, importers as well as the emergence of eco labels, the need for the oil palm industry to also align itself with the current trend is no longer avoidable. This shift is vital for the Malaysian oil palm industry to remain competitive in order to increase its long-term profitability and sustainability. The present reality is that we have to deal with environmental deterioration with what we have. Currently, the main sustainability issues that the palm oil industry has to deal with are climate change and deforestation and the trend now shows a shift towards water scarcity issues which are directly linked with water footprint. Mitigation measures to address these environmental concerns must be viewed as an investment for our future generation if not for ourselves because efforts in mitigation of environmental degradation will translate into a concerted effort to combat the many environmental impacts resulting from mismanagement of natural resources and energy. Time and investment on environmental studies such as carbon footprint and water footprint will be rewarded by the sustainable and secured development of the palm oil industry.

REFERENCES


