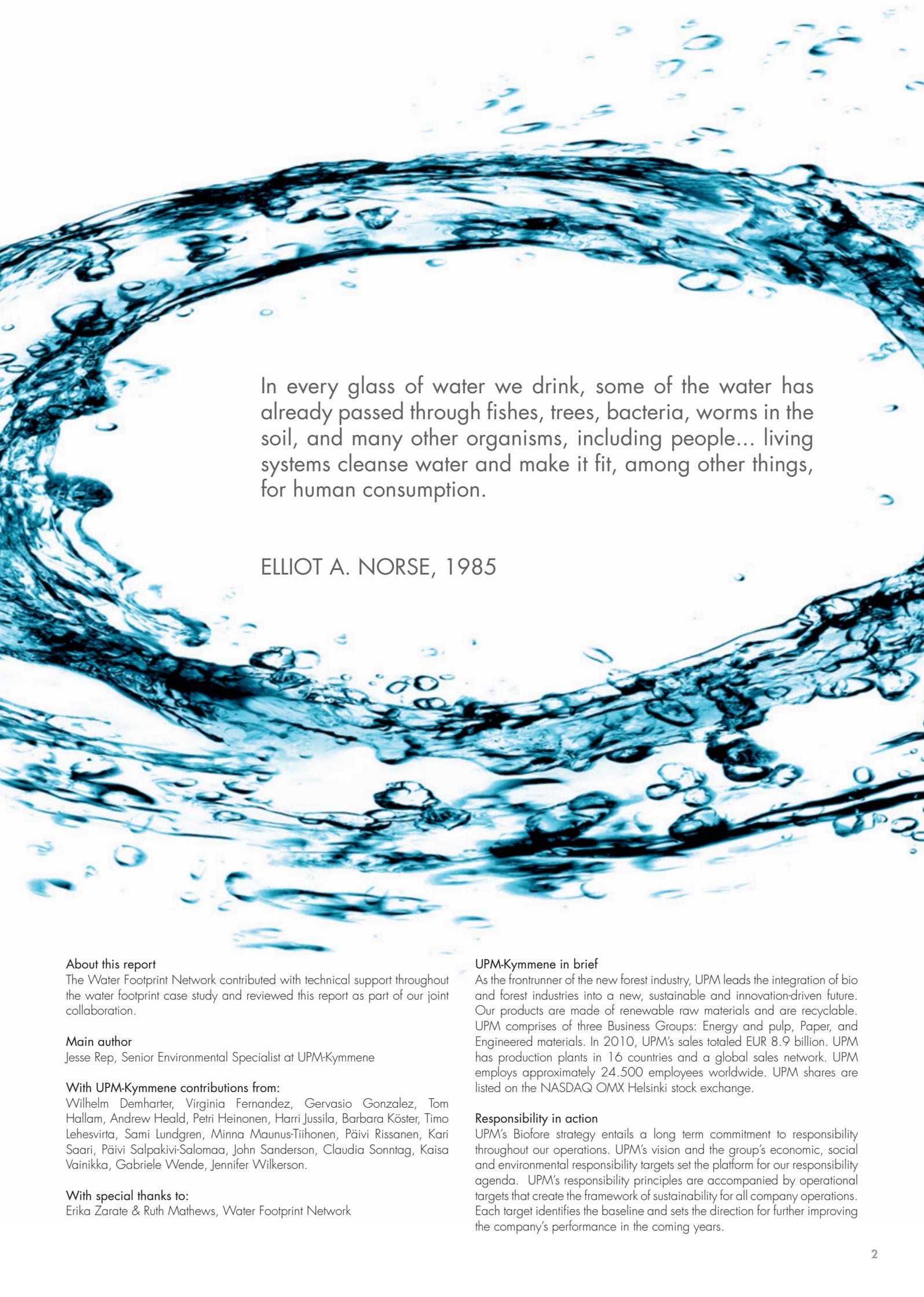


# From forest to paper, the story of our water footprint



A case study for the UPM Nordland Papier mill  
August 2011

Presented by: UPM-Kymmene



In every glass of water we drink, some of the water has already passed through fishes, trees, bacteria, worms in the soil, and many other organisms, including people... living systems cleanse water and make it fit, among other things, for human consumption.

ELLIOT A. NORSE, 1985

**About this report**

The Water Footprint Network contributed with technical support throughout the water footprint case study and reviewed this report as part of our joint collaboration.

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**With special thanks to:**

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**UPM-Kymmene in brief**

As the frontrunner of the new forest industry, UPM leads the integration of bio and forest industries into a new, sustainable and innovation-driven future. Our products are made of renewable raw materials and are recyclable. UPM comprises of three Business Groups: Energy and pulp, Paper, and Engineered materials. In 2010, UPM's sales totaled EUR 8.9 billion. UPM has production plants in 16 countries and a global sales network. UPM employs approximately 24.500 employees worldwide. UPM shares are listed on the NASDAQ OMX Helsinki stock exchange.

**Responsibility in action**

UPM's Biofore strategy entails a long term commitment to responsibility throughout our operations. UPM's vision and the group's economic, social and environmental responsibility targets set the platform for our responsibility agenda. UPM's responsibility principles are accompanied by operational targets that create the framework of sustainability for all company operations. Each target identifies the baseline and sets the direction for further improving the company's performance in the coming years.



## TABLE OF CONTENTS

Executive summary .....	4
1. Introduction .....	5
2. Case study objectives .....	5
3. Methodology .....	6
3.1 Setting goals and scope .....	6
3.2 Water footprint accounting .....	7
3.3 Water footprint sustainability assessment .....	9
3.4 Water footprint response formulation .....	9
4. Water footprint accounting results .....	10
4.1 Raw materials and their production .....	10
4.1.1 Semi-natural boreal forests and plantations ...	10
4.1.2 Pigments .....	10
4.1.3 Maize starch .....	10
4.1.4 Energy .....	10
4.2 UPM Pulp mills .....	11
4.3 UPM Nordland Papier .....	11
4.4 Accounting the results of the whole water footprint ...	12
5. Water footprint sustainability assessment .....	13
5.1 Identification of the sustainability criteria .....	13
5.1.1 Location & community .....	13
5.1.2 Permit allowance .....	14
5.1.3 Operational efficiency .....	14
5.1.4 Forest management .....	14
5.1.5 Certification and labels .....	14
5.1.6 Sustainability of the water footprints .....	15
5.1.7 Catchment ecological status .....	16
5.1.8 Sustainability assessment results .....	17
6. Water footprint response options .....	19
6.1 Direct operations .....	19
6.2 Indirect operations .....	19
7. Results of the case study objectives .....	19
8. Conclusions .....	20
Literature .....	21

# Executive summary

Humans increased appropriation of freshwater resources along with climate change will place increased strain on global water resources, and the importance of freshwater resources and management of freshwater cycles will receive greater attention in the future. UPM is part of this global freshwater cycle, interacting with water resources through our activity in forests and production facilities.

In order to develop a common approach and understanding about the role of water in the production of paper, UPM has partnered with the Water Footprint Network. This partnership included a case study of the UPM Nordland Papier mill in Germany where both the operational and supply chain water footprints (WF) have been assessed; the study also included a sustainability assessment of the final water footprint.

The findings of the case study show that around 99% of the water footprint originates from the raw material supply chain and the remaining 1% from UPM Nordland Papiers production processes. In this case study the total water footprint of one A4 sheet of wood free\* uncoated paper (WFU) is 13 litres and for wood free coated (WFC) 20 litres, consisting of 60% green WF, 39% grey WF and 1% blue WF.

The water footprint accounting phase can result in a WF of 13, 20 or even 300 liters per sheet of paper. This however does not tell much about the actual impact of paper production on the local water resources. Intuitively one would assume that similar to a product carbon footprint a low WF is considered better for the environment and a preferred choice. But for WF one can only draw such a conclusion after a sustainability assessment on local level. Based on the joint evaluation of sustainability criteria with the Water Footprint Network, the conclusion can be drawn that UPM's pulp and paper mill operations and forest management practices are in balance with the local freshwater cycles and thus the WF of the paper produced at the UPM Nordland Papier mill is considered sustainable.

The results and conclusions in this report provide a starting point for sharing information on the water footprint of a forest product such

as paper. Although the current method developed by the Water Footprint Network is based on the latest understanding, UPM sees a need for further development. The two main areas which require further consideration are those of the green and grey WF. A tree has a potentially large green WF mainly from evapotranspiration, but whether this is a good indicator of human appropriation of freshwater resources is open for debate. For the green water footprint a more in depth analysis and representation of the positive role of forests in the global water cycle would increase credibility and acceptability of water footprinting in the forest industry sector. The grey water footprint requires more data at a local level concerning water quality standards in order to ensure results are more accurate and comparable.

The blue WF of the production chain of paper is small and occurs mainly from evaporative losses in drying processes. Although this is a loss at a local level, in a wider perspective this evaporated water becomes part of the global water cycle and will eventually be available again for other purposes.

In general the WF study provided very useful information for UPM on water consumption and emissions along UPM's production chain, as well as identification of potential future water risks. The information also provides valuable insights for making decisions in future UPM operations from the water point of view.

For UPM pulp and paper mills a long term target for effluent discharge will further increase our reuse of water, and optimised waste water treatment will reduce the grey water footprint. Forest certification standards such as FSC® and PEFC™ are an integral part of UPM's sustainable forest management practices. These standards consider water consumption and protection of water resources and water habitats in forests.

UPM's partnership with the water footprint network and this study is one step towards our goal to achieve a water footprint with the lowest negative impacts in our industry. We will achieve this by minimizing local impact on water resources and using water efficiently and responsibly over the whole production chain of our products.

\***Wood-free paper** is paper made from chemical pulp instead of mechanical pulp. Chemical pulp is made from pulpwood and is considered wood-free as most of the lignin is removed and separated from the cellulose fibers during processing, in contrast to mechanical pulp which retains most of its wood components and can therefore still be described as wood-containing.

# 1. Introduction

Fresh water is one of our planet's key natural resources and is essential to sustain life on earth. Water is in constant motion, evaporated from land and oceans and as moisture from plants by the sun's heat. Water returns to the earth as rainfall, most eventually flowing to the oceans. A small part falling on land feeds rivers, trees, plants, animals and replenishes underground reservoirs.

Water is one of the most basic and important resources for UPM's operations. Efficient and sustainable use of this key resource is a central focus throughout UPM's production chain. UPM has decreased the process wastewater volumes per tonne of paper by 44% and by 27% per tonne of pulp during the last ten years. Mechanical waste water treatment plants have been used since 1970's and advanced biological waste water treatment plants since 1990. All of UPM's effluent is treated using both primary and secondary treatment facilities, as a minimum, before being returned to receiving waters. A key indicator of the organic load of UPM's treated effluent is chemical oxygen demand (COD\*). During the last ten years our COD load has decreased by 54% per tonne of paper, and by 49% per tonne of pulp. Studies on the impact of the mill's effluent are regularly undertaken.

Recently, UPM has joined the United Nations Global Compact's CEO Water Mandate – a unique public-private initiative designed to assist companies in the development, implementation and disclosure of water sustainability policies and practices. UPM is also a partner in an innovative research programme in the Baltic Sea region. This project involves the use of charcoal mixed with soil to remove impurities from nutrient-rich water running from agricultural lands into the Baltic Sea.

\*chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution.

In October 2009 UPM commenced a partnership with the Water Footprint Network and started a water footprint study of the UPM Nordland Papier mill. The mill is located in Dörpen, Northern-Germany and is one of the biggest fine paper producing sites worldwide, with an annual production of about 1.5 mln tonnes of paper on four paper machines and two coating lines. The mill produces two paper grades, wood free coated (WFC) and wood free uncoated paper (WFU). UPM partnered with the Water Footprint Network as their concept is considered to be the latest scientific method to study freshwater consumption over a whole production chain.

This water footprint study included an accounting component in which volumes of water for each production phase is assessed, followed by an interpretation of the water footprint in the form of a sustainability assessment at water catchment level for both the UPM Nordland Papier mill and the three UPM pulp mills which supply the majority of pulp used at the paper mill. Of the three pulp mills assessed UPM Kaukas and UPM Pietarsaari are located in Finland and UPM Fray Bentos in Uruguay.

UPM and the Water Footprint Network are among the first to start a water footprint case study for a forest product such as paper. The whole concept of water footprint is at an early stage of development and the case study was an opportunity to test the practical application of a scientific theory for this sector. This report will discuss the approach and results of the study, the obstacles encountered and suggestions for methodological improvement.

## 2. Case study objectives

Over the coming years a global increase in water demand will draw more attention to how businesses manage water responsibly. The paper industry is a large user of fresh water although most of this water is returned to surface water bodies after treatment. UPM recognises the importance of sustainable water management and desires to learn more about the role of freshwater consumption and emissions along the whole production chain of paper.

**The four objectives of the case study are to:**

1. Calculate the total water footprint of the two paper grades produced at UPM Nordland Papier mill.
2. Assess the sustainability of Nordland's water footprint and that of its two paper products.
3. Develop the water footprint methodology for paper products, with a special focus on green water footprinting (linked to forestry)
4. Increase the understanding of paper production's supply chain water footprint



# 3. Methodology

The methodology set out in the Water footprint Assessment Manual by Hoekstra (Hoekstra et al., 2011) was applied of which all four phases are included in this study.

1. Setting goals and scope of water footprint assessment
2. Scope of water footprint accounting
3. Scope of water footprint sustainability assessment
4. Water footprint response formulation strategies

Throughout the study there has been on-going cooperation and discussion with the Water Footprint Network on the methodological development and new research. The methodology proposed by the Water Footprint Network has been followed closely. One of the case study objectives has been to table suggestions and concerns and create constructive dialogue on how to best develop a water footprint for forest products such as paper. For more information on this see chapter 8 Conclusions.

## 3.1 Setting goals and scope

In order to produce paper there are a wide range of different suppliers contributing raw materials. However, it is out of this scope to assess the water footprint for each of these individual suppliers. Therefore a selection was made based on the actual weight contribution of each raw material to the final paper product (see Figure 2). The data used in this study is for 2009. The main raw material inputs selected for the water footprint study are:

- Chemical pulp, this included a product water footprint assessment for the pulps coming from the UPM Kaukas, UPM Pietarsaari and UPM Fray Bentos mills (see figure. 1). The majority of pulp used at UPM Nordland Papier comes from these three UPM mills. The mills assessment looked at the green, blue and grey water footprint. For the non-UPM pulps (external supply) an average water footprint of the three UPM pulps was used.

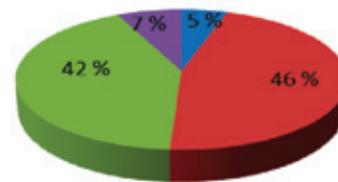
All of the wood that is used at the UPM pulp mills is grown in semi-natural managed forests and plantations. For both forests and plantations the water footprint was assessed, the method implies that the wood water footprint consists of the forest evapotranspiration rate and the wood yield per hectare. UPM's own data on yield and evapotranspiration rate are used.

- Maize starch is used as a binding agent in paper production, it is derived from maize which it is processed with a small amount of chemicals to create starch. Starch is used to increase the strength of paper and improve its stiffness and printing quality. The water footprint assessment of this externally supplied raw material looked at the maize factory operational water flows, direct water intake, outflow and water losses (blue water footprint). The Water Footprint Network provided data on the average water footprint of maize itself which mainly consists of green water (rain fed) and a small amount of blue water (irrigation water). The grey water footprint was excluded due to data limitations on effluent and local water quality standards.
- Pigments and fillers are minerals that are used for improving a paper's properties. They are used for filling and coating applications which enhance the surface quality of paper, making it more suitable for high quality printing. As an example of such minerals the water footprint of precipitated calcium carbonate (PCC) was assessed in cooperation with a paper pigment

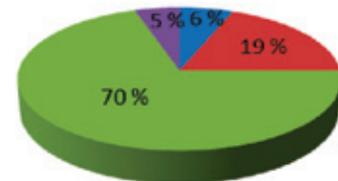
Figure 2. UPM Nordland Papier average product composition

### UPM Nordland Papier product composition

Woodfree coated



Woodfree uncoated paper



- Moisture
- Pigments & Fillers
- Chemical pulp
- Binders



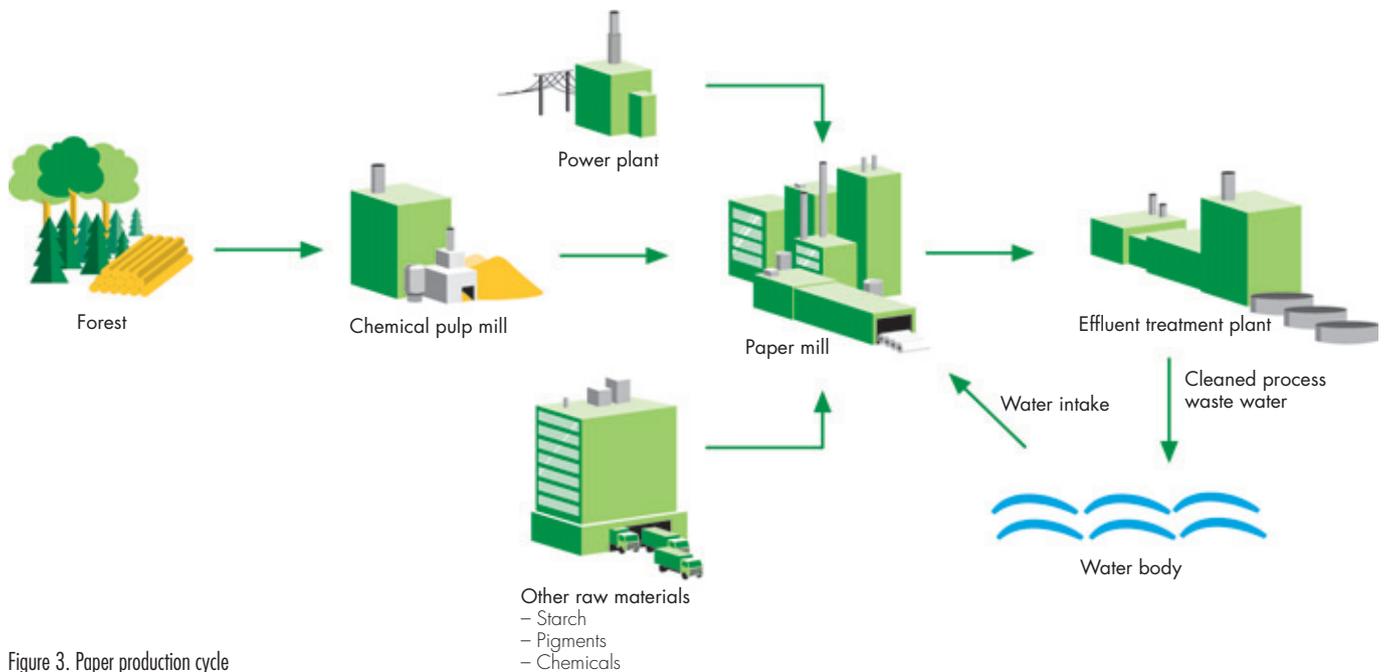


Figure 3. Paper production cycle

producer. The assessment looked at the operational water flows, direct water intake, outflow and water losses (blue water footprint). The original mining activity was excluded from the assessment.

- Natural gas, although it is not a direct material input to paper itself, it is an important energy input to the operational side of paper production (e.g. powering the boilers and paper drying sections). Data on the overall water footprint of natural gas came from the Water Footprint Network (Gerben-Leenes 2008), there is no breakdown available on the elements (green, blue, grey) of this water footprint.

Labour and transport are excluded from this water footprint assessment, as they are expected to have a minor contribution to the overall water footprint of a paper product. Thermal pollution is excluded from the grey water footprint assessment, this study only focussed on the pollutant load in the effluent discharged.

### 3.2 Water footprint accounting

A water footprint is represented by three different colours each indicating a type and volume of water consumed.

#### Green Water Footprint

The green water footprint of paper mainly refers to rainwater that is evaporated during tree and plant growth. Based on the report 'The Green and Blue Water Footprint of Paper Products', van Oel and Hoekstra (2010) the simplified formula given below was used to calculate the water footprint of wood coming from forest operations in semi-natural boreal forests in Finland, and UPM's eucalyptus plantation in Uruguay. For the northern hemisphere forest sources, calculations covered three different types of tree: broadleaves, pine and spruce. For the southern hemisphere eucalyptus from UPM's own plantation in Fray Bentos, Uruguay was assessed. These are the main species used in UPM's production processes for pulp and paper. The blue and grey water footprint in the form of irrigation water and fertilizer application were not included in the study scope. Fertilizer is only applied in small amounts in the case of tree nurseries and irrigation used only in rare occasions (e.g. extreme drought). The two are considered to have a small contribution to the final water footprint of paper are therefore excluded from the study.

$$WF_{forestry} [P] = \frac{ET_a + (Y_{wood} \times f_{water})}{Y_{wood}}$$

- $ET_a$  is the evapotranspiration from a forest/woodland ( $m^3/ha/year$ ).
- $Y_{wood}$  the wood yield from a forest/woodland ( $m^3/ha/year$ ).
- $f_{water}$  the volumetric fraction of water in freshly harvested wood ( $m^3/m^3$ ).

The data used for  $ET_a$ ,  $Y_{wood}$ ,  $f_{water}$  was taken partly from FAO databases and UPM's own forestry and plantations studies. The forest evapotranspiration rates for Finland represents northern parts of south-boreal vegetation zone, central-Finland. Wood yield estimates are mean values and are calculated for the period of whole forest growing cycle. Fraction of water in harvested wood is mean values which can vary.

Figure 4. Forestry water data

	Finland	Uruguay
<b>Forest Evapotranspiration (<math>m^3/ha/yr</math>)</b>		
Boreal forest	3600	
Subtropical plantation		9300
<b>Wood yield (<math>m^3/ha/yr</math>)</b>		
Broadleaves	7	
Pine	6	
Spruce	7	
Eucalyptus		33
<b>Fraction of water in harvested wood (<math>m^3</math> water/<math>m^3</math> wood)</b>		
Broadleaves	0,45	
Pine	0,55	
Spruce	0,53	
Eucalyptus		0,50

It is important to note here that there is a clear distinction between a green water footprint from an agricultural product versus that of forestry. The former often require intensive management to be productive whereas forests are an integral part of a natural water cycle. Compared to agriculture their growth does not require much human intervention and can be considered more natural.

## Blue Water Footprint

Blue water footprint is freshwater withdrawn from rivers, lakes or groundwater reservoirs that is used in the pulp and paper production phase which does not return to the place of origin during the same period of time, either because it is evaporated, incorporated into the product, transferred to another basin or returned later on. For pulp and paper production the blue water footprint was calculated by assessing the water flows of the UPM Nordland, UPM Kaukas, UPM Pietarsaari and UPM Fray Bentos mills and that of externally produced maize starch and pigments. The blue water footprint assessment included:

1. Water that evaporates in the drying section of pulp and paper production.
2. Water stored in the pulp and paper product
3. Water in the effluent sludge that is a by-product from the waste water treatment plant
4. Other losses including water leakage and water that is not returned to the same catchment area

For each of these six production sites the process blue water footprint is calculated as:

$$WF_{proc,blue} = \text{Blue Water Evaporation} + \text{Blue Water Incorporation} + \text{Lost Return Flow [volume/time]}$$

[Source: Water footprint Assessment Manual by Hoekstra, 2011]

## Grey Water Footprint

Grey water footprint is the volume of freshwater needed to assimilate a given load of pollutants on reaching freshwater sources (for example a production process effluent discharged to a receiving water body), based on natural background concentrations and existing ambient water quality standards. For pulp and paper production the grey water footprint was calculated by assessing the effluent flows of the UPM Nordland, UPM Kaukas, UPM Pietarsaari and UPM Fray Bentos mill. The externally produced maize starch and pigments were excluded due to data limitations on water quality standards and effluent pollutant load. The grey water footprint for thermal pollution is excluded from this assessment. For the grey water footprint calculation the below shown formula is used:

$$WF_{proc,grey} = \frac{L}{C_{max} - C_{nat}} = \frac{Effl \times c_{effl} - Abstr \times c_{act}}{C_{max} - C_{nat}} \quad [\text{volume/time}]$$

[Source: Water footprint Assessment Manual by Hoekstra, 2011]

- $L$  : additional pollutant load to that already contained in the receiving water body, mass/time
- $Effl$  : effluent volume in time
- $Abstr$  : water volume of the abstraction, volume in time
- $C_{act}$  : actual concentration of the intake water, mass/volume
- $C_{nat}$  : the natural concentration of the pollutant in the receiving water body (river, lake etc.). For human-made substances that naturally do not occur in water  $C_{nat} = 0$
- $C_{max}$  : ambient water quality standard, mass/volume

The emission load studied included measures of AOX, ammonium, chloride, phosphate, nitrate and TOC. Data on  $Effl$ ,  $Abstr$  and  $C_{act}$  came from UPM's own databases. Data on  $C_{nat}$  and  $C_{max}$  was obtained via the German local authorities\* for the UPM Nordland water catchment but not at the local level for UPM Kaukas, UPM Pietarsaari and UPM Fray Bentos. For those mills UPM Nordland's  $C_{nat}$  and  $C_{max}$  were used. Two of the limitations of the grey water footprint assessment are finding reliable local level data on  $C_{nat}$  and  $C_{max}$  for specific pollutants, together with the option of choosing which pollutants to include in the assessment. These limitations causes variability and increase inaccuracy.

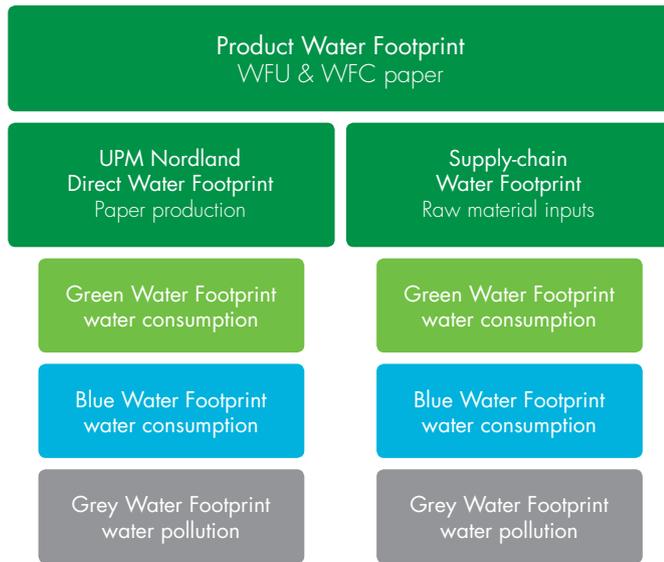


\*[Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten-und Naturschutz (NLWKN), Chemische Güteklassifizierung. [www.nlwkn.de](http://www.nlwkn.de)].

### Product Water Footprint

According to the WF manual allocation of the water footprint over the output products can be done in several ways, e.g. according to mass, energy content or economic value. The WF manual recommends allocating according to economic value. Because in case of pulp and paper production only one product is produced, allocations according to mass and to economic value are the same, thus allocation according to mass is used in this study. The weight of the WFC paper is taken as 150 gram per m<sup>2</sup> and for WFU 80 gram per m<sup>2</sup>. For forestry it has been assumed that the trees are used for pulp and paper production only, a 'worst case scenario'. In reality however allocation according to economic value would deliver much smaller results because forests deliver a variety of additional values (e.g. bind carbon, control erosion and recreation), not all of which are easy to measure in economic terms.

Figure 5. The components of a paper water footprint



## 3.3 Water footprint sustainability assessment

The accounting phase measures the quantity of freshwater that is consumed throughout the production chain and categorizes it in green, blue and grey water footprints. However, in order to make a water footprint study more realistic and meaningful the local context needs to be taken into account. This is achieved by a sustainability assessment phase where water scarcity hotspots are identified and water footprints are compared to actual water availability. The mills selected for the sustainability assessment are UPM Nordland Papier, UPM Pietarsaari, UPM Kaukas and UPM Fray Bentos. The mills provided information on their operations environmental permits, sustainable forestry management and use of freshwater resources in the production process. At a water catchment level further information was needed from external sources such as local authorities. The World Business Council for Sustainable Development Global Water Tool was used to support the assessment of the local water scarcity situation for each of the specific catchments.

A sustainability assessment has three pillars, social, economic and environmental. The following criteria were selected to assess each of these pillars:

### Social

The social assessment looked at the local freshwater availability and the potential for conflict over freshwater resources in the region over time. The WBCSD Global Water Tool allowed for mapping on each of the mills local projected annual renewable supply per person for year 2025.

### Economic

The WBCSD Global Water Tool also provided information on the physical and economic water scarcity of the region. If freshwater is abundant for current and future operations then water can be allocated and used in an economically efficient way, taking into account the different stakeholders' and environmental flow requirements. The WBCSD Global Water Tool mapping exercise itself is useful to identify freshwater hotspots and potential conflicts over water. It is however not a conclusive tool to claim that operations are sustainable. It has more of a supporting role and creates a general understanding of the water situation in a specific location.

### Environmental

A mill can demonstrate good environmental performance by complying with local permit level allowances for water uptake and discharge, improving operational efficiency over time, and setting targets to further improve effluent quantity and quality. In addition certified management systems, and certification to eco-labels demonstrate good environmental management. (e.g. ISO 14001 and EU ecolabel).

These criteria contribute to sound environmental management but do not prevent a mill from having a grey or blue water footprint. Therefore it is important to assess the environment sustainability of both the blue and grey water footprint. The sustainability of a grey water footprint is assessed using 'water pollution level' (WPL), where a water pollution level of 100% means that the waste assimilation capacity of the river has been fully consumed. Ambient water quality standards would be assessed as violated in cases where the WPL is beyond 100%. WPL is calculated as follows:

$$WPL [x,t] = \frac{\sum WF_{grey} [x,t]}{R_{act} [x,t]} \quad [-]$$

- $R_{act}$  : actual run-off from the catchment, this data comes from local authorities or is measured by the mills.
- $\sum WF_{grey}$ : total of grey water footprints in a catchment. Please note that at this stage only the grey water footprint of UPM's operations are included, other of actors' grey water footprint in the catchment are excluded due to data limitations.

The sustainability of the blue water footprint is assessed by looking at the blue water scarcity indicator shown below. A blue water scarcity of 100% means that the available blue water has been fully consumed, everything beyond a 100% is considered unsustainable.

$$WS_{blue} [x,t] = \frac{\sum WF_{blue} [x,t]}{WA_{blue} [x,t]} \quad [-]$$

- $\sum WF_{blue}$ : total of blue water footprints in the catchment. Please note that at this stage only the blue water footprint of UPM's operations are included, other actors' blue water footprint in the catchment are excluded due to data limitations.
- $WA_{blue}$ : blue water availability, this data comes from local authorities or is measured by the mills.

## 3.4 Water footprint response formulation

Once green, blue and grey water footprints have been identified and quantified it is then possible to reduce them and their linked impacts. The blue water footprint can for example be reduced by minimizing evaporation losses from direct production processes and closing water cycles in the mills. The grey water footprint can be lowered by removing the pollutant load from the process water. In the supply chain, contracts can include requirements on reducing suppliers water footprints, which indirectly have an impact on the final water footprint of paper. These response options will be discussed in chapter 6. Water Footprint Response Options.

# 4. Water footprint accounting results

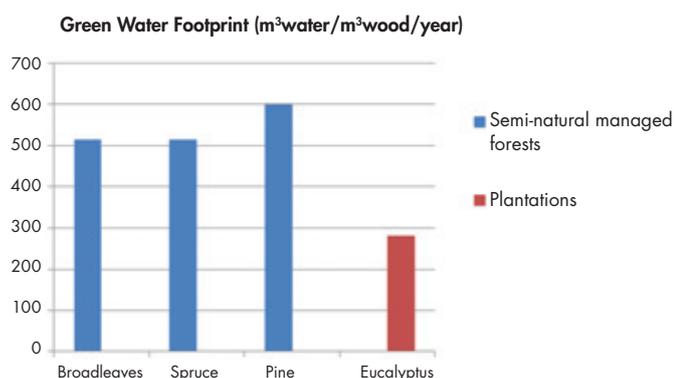
## 4.1 Raw materials and their production

### 4.1.1 Semi-natural boreal forests and plantations

The accounting results show that the green water footprint of the eucalyptus plantations is half of that for boreal forests with tree species of broadleaves (e.g. birch), pine and spruce. Although a subtropical eucalyptus plantation has about triple the evapotranspiration rate, the wood yield per hectare is approximately five times that of boreal forests. This gives a lower overall water footprint per cubic meter of wood harvested.

In terms of water footprint alone, the conclusion can be made that eucalyptus from plantations in the southern hemisphere are preferred over northern hemisphere tree species like pine and spruce. This is however a narrow conclusion based on only one environmental parameter. Further consideration and interpretation is needed in the form of a sustainability assessment to draw such a conclusion more broadly. For more information see chapter 5.1.4 Forest Management.

Figure 6. Green Water Footprint per wood type



### 4.1.2 Pigments

Pigments and fillers are minerals that are used for improving a paper's properties. As an example for minerals, UPM worked with an external pigment supplier to assess the operational water footprint of the production process of PCC (precipitated calcium carbonate). PCC is produced from a process in which limestone is mined, burned and processed together with water and carbon dioxide. For the location assessed the water footprint of pigment production is around 1 m<sup>3</sup>/tonne of pigment. This includes only blue water loss via the effluent (when not returned to the same river basin or within the same period of time) and water stored in the final pigment product. Grey water footprint could not be assessed due to lack of data, and mining of the base minerals is also out of the scope of this assessment. There is no green water footprint in the process of paper pigment production. The mill is located where there is a sufficient quantity of freshwater to run their operations (WBCSD Global Water Tool mapping).

### 4.1.3 Maize Starch

Maize or potatoes can be used as the raw material for starch. For this water footprint assessment there was close cooperation with a maize starch producer which provided insight to the producer's water balance.

The maize is grown in agricultural fields, after which it is harvested, transported to the mill and processed with a small amount of chemicals into starch slurry and ultimately maize starch. The Water Footprint Network provided data on the average water footprint of raw maize which mainly consists of green water (rain fed) and a small amount of blue water (irrigation water). Due to the agricultural origin of the maize, the green water footprint is 660 m<sup>3</sup>/tonne of starch and the blue water footprint 3 m<sup>3</sup>/tonne of starch, which brings the total water footprint to 663 m<sup>3</sup>/tonne of starch.

The mill's process water comes partly from the city water net and the neighbouring river. The blue water footprint consists of water lost as part of the final product or by the effluent (when not returned to the same river basin or within the same period of time). The mill has a large cooling water requirement and takes this water from the adjacent river. As the cooling water is also returned to this same river it is excluded from the blue water footprint. The mill itself is operating in a relatively sufficient water region (WBCSD Global Water Tool mapping).

### 4.1.4 Energy

Paper mills require energy. In the case of the UPM Nordland Papier mill this is generated directly from the combustion of natural gas as well as taking electricity from the grid. The Water Footprint Network provided data on the global average water footprint of these specific energy carriers, however there was no breakdown available on the elements (green, blue, grey) of this water footprint. The results show that the water footprint of energy is low (<0,0001%) and not significant within the total water footprint of paper. However, if the mill's current energy mix changed to for example hydropower and biomass energy, the energy water footprint would increase considerably.

## 4.2 UPM Pulp mills

The three pulp mills do not have a direct green water footprint themselves, but due to the wood originating from forestry there is an indirect green water footprint. The wood is processed to pulp and then dried after which it is transported to the UPM Nordland mill.

For the UPM Kaukas and UPM Fray Bentos mills the blue water footprint is mainly water that is evaporated during the pulping production process. Their blue water footprint is small since the mills return their water to the original source after use in the production process. For UPM Pietarsaari, the blue water footprint is slightly higher as the mill returns the water used in the processes to a different catchment. For the three pulp mills a small part of the blue water footprint leaves the mills in their effluent sludge and as moisture in the final pulp product.

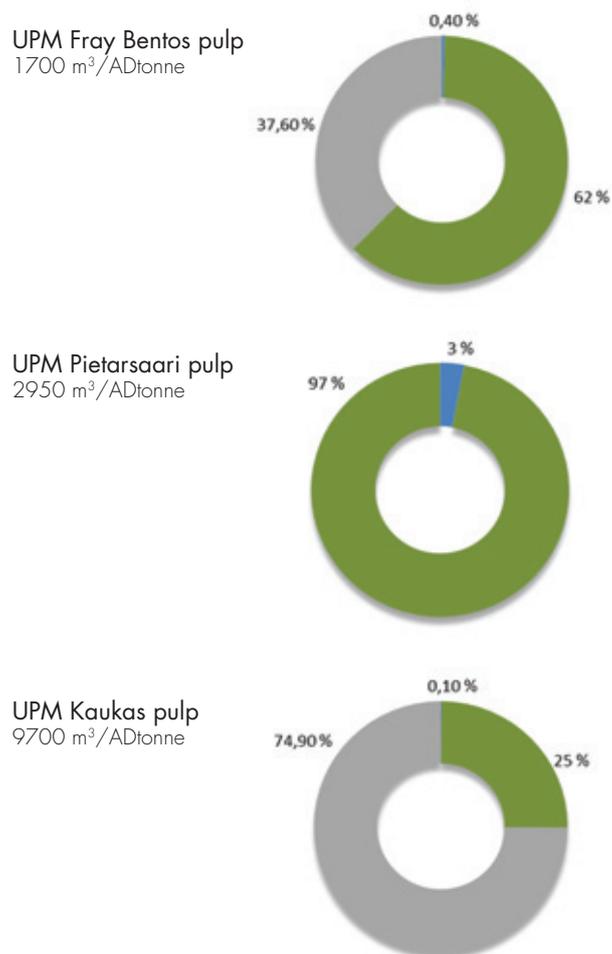
One of the limitations for assessing the Grey water footprint for the three UPM pulp mills is the lack of data on the local natural and maximum concentration of specific (background) pollutants in the receiving water bodies. This data was available for the UPM Nordland water catchment but not at the local level for UPM Kaukas, UPM Pietarsaari and UPM Fray Bentos. Early testing of the grey water footprint showed that for paper and pulp mills AOX\* is the most critical parameter, as it requires the highest dilution factor based on the water footprint network method. However, this does not necessarily indicate that AOX is the most important indicator from an environmental impact point of view (see chapter 5.1.6 for more information).

The assumption was made that AOX does not occur naturally in the pulp mill's receiving water body (AOX<sub>Cnat</sub> = 0) and that the maximum allowable concentration should be the same as that for the Nordland mill (50 µg/l). This is however an assumption and the grey water footprint results are therefore considered a best estimate. Other information on AOX in the mills water intake and in the effluent discharged is available from mill monitoring data and was also entered in the grey water footprint model. Although all three mills are operating well within their permitted level for all effluent indicators including AOX, UPM Fray Bentos and UPM Kaukas have a grey water footprint. As UPM Pietarsaari's effluent is ultimately discharged to the sea, their grey water footprint is taken as zero as no freshwater would be required to assimilate the pollutant load. The three pulp mills use EECF\*\* (Enhanced Elementary Chlorine Free) bleaching with oxygen delignification and their waste water is treated in biological waste water treatment plants.

## 4.3 UPM Nordland Papier

UPM Nordland Papier receives pulp bales and other raw materials such as pigments and starch from external suppliers to produce wood free coated (WFC) and wood free uncoated paper (WFU). The mill has no intake of recycled fibres or fresh wood. In the production process of paper water has multiple functions such as transport, cooling, cleaning and binding of paper fibres. All of these different processes impact the water quality; it is for that reason that process effluent treatment plants are an integral part of the paper production process. Treating the process waste water is part of UPM's environmental mill management practices and minimises any negative effect on receiving water bodies. The UPM Nordland mill's direct water footprint consists of blue and grey. The green water footprint of the mill occurs indirectly from the sourcing of pulp which is derived from wood. This green water footprint is discussed in chapter 4.1.1.

Figure 7. The Water Footprint breakdown for the UPM pulp mills



\* AOX: Absorbable Organic Halogen Compounds (usually chlorinated compounds). AOX is a measure of the amount of chlorine that is combined with organic substances. It is formed during bleaching with chlorine-containing chemicals, as well as naturally.

\*\* Elemental Chlorine Free, bleaching without chlorine gas or hypochlorite, but with chlorine dioxide (ClO<sub>2</sub>) used in one or more stages. Enhanced ECF includes Oxygen delignification

Fresh water is extracted from eight groundwater wells in the region and a minor part arrives via the moisture in raw materials. About 2/3 (68%) of the blue water footprint is process water. This process water is used several times in the paper production process after which it is treated and brought to the Ems River adjacent to the mill. Around 30% of the blue water footprint comes from evaporation in the paper drying process and is thereby lost to the atmosphere. The remaining part, around 2%, is water that leaves the mill as moisture in the effluent sludge and in the final paper product.

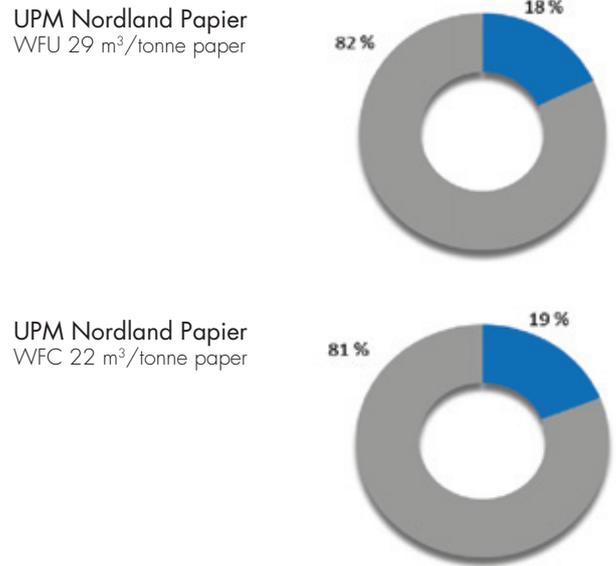
The grey water footprint assessment required data on the natural background concentration and maximum allowable concentration of the mill's effluent indicators. Background data on the natural concentration (C<sub>nat</sub>) and maximum acceptable concentration (C<sub>max</sub>) of specific effluent parameters in the receiving water body

(river Ems) was provided by the local German authority on coastal protection and nature conservation (Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten-und Naturschutz (NLWKN), Chemische Güteklassifizierung, www.nlwkn.de).

For the calculation, the maximum acceptable concentration of AOX (Cmax) for the Ems river at the point of effluent discharge is set to the level which is defined as having a 'significant impact' (50 µg/L). The natural concentration of AOX was set as if there were no industry or human activities present (0 µg/L). AOX also occurs naturally in water bodies but only in low levels. The mills processes water comes from wells, the actual concentration for the different substances is measured at the mills, for AOX Cact is zero.

Even though UPM Nordland Papier is operating well within the authorised permit level, the mill is assessed as having a grey water footprint which makes up about 80% of the mill's total water footprint. This Grey WF consists of the water needed to assimilate AOX in the mills effluent to a natural quality status. It is interesting to note that all of the AOX enters the mill indirectly via the raw materials (mainly chemical pulp) and does not result from the mill's actual operations.

Figure 8. The Water Footprint breakdown for UPM Nordland Papier



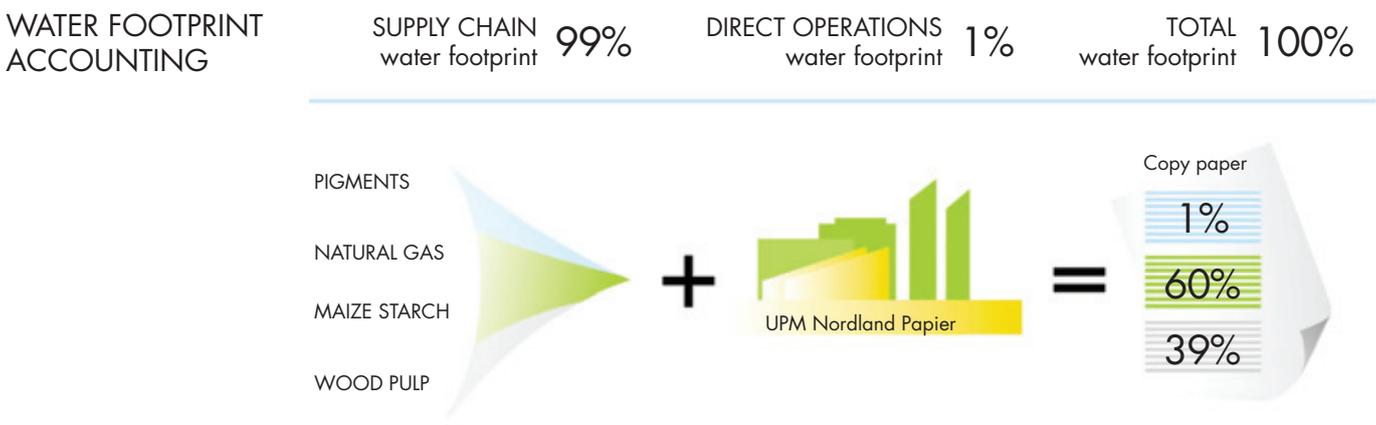
### 4.4 Accounting the results of the whole water footprint

The supply chain water footprint together with the direct water footprint gives the total water footprint of paper. The bulk of the total water footprint mostly originates from the supply chain (99%) and only a very small part (1%) comes from the UPM Nordland Papier mill itself. The blue water footprint is relatively small; meaning that only a small portion of freshwater is lost in the production process of paper. Although sustainable forestry practice is followed, the green water footprint is large because the volumes of forest evapotranspiration during tree growth are included. The grey water footprint includes actual data and estimations on the maximum allowable concentration of AOX, in the receiving water body. The grey water footprint results are therefore a best estimate at this stage.

As water footprint methodology matures, the value of forests in the global freshwater cycle is better understood and more data on local freshwater quality levels is made available, both the green and grey water footprint will give a more realistic picture.

The current results for this case give a total water footprint for wood free uncoated of 13 litres and for wood free coated 20 litres per A4 sheet of paper produced, consisting of 1% blue, 60% green and 39% grey (AOX). For all the four UPM mills AOX is the leading indicator for the grey water footprint, when applying the Water Footprint Network methodology.

Figure 9. Total water footprint for UPM Nordland Papier



According to the water footprint study, around 99% of the water footprint comes from the supply chain and the remaining 1% from the actual paper mill production processes.

# 5. Water footprint sustainability assessment

A water footprint figure itself does not indicate if freshwater is being used sustainably along a production chain. A sustainability assessment is needed to give a better understanding on whether the production is in balance with what local water catchments can sustainably support and to identify potential hotspots which would indicate priority action area for UPM. There are three pillars to a water footprint sustainability assessment, namely environmental, social and economic. For each of the three, UPM has defined sustainability criteria in line with those proposed by the Water Footprint Network. Eleven different criteria were selected on which to rate the sustainability of operations in a given water catchment. This sustainability assessment focuses again on the UPM Nordland Papier mill itself and the UPM pulp mills Kaukas, Pietarsaari and Fray Bentos. As pulp is derived from forests and plantations, this part is also discussed below.

Development's Global Water Tool provides information on local water availability (current and projected), water scarcity, access to safe drinking water sources and sanitation, as well as population and industrial growth. The four UPM mills were mapped using this tool on 'Projected annual renewable supply per person in 2025, Environmental water scarcity index, Mean annual relative water stress index and Physical and economic water scarcity'. The WBCSD Global Water Tool allows for identification of freshwater hotspots and potential conflicts over water in a specific location. It should however not be seen as conclusive tool. Further detailed evaluation needs to be made in order to draw conclusions on the sustainability of the water footprint.

The mapping results show that all four of the mills are operating in water abundant or water sufficient regions, facing no environmental water scarcity or water stress in any of their watersheds. This indicates that for now and in the future a good quantity of the freshwater is available in the mill's catchment.

## 5.1 Identification of the sustainability criteria

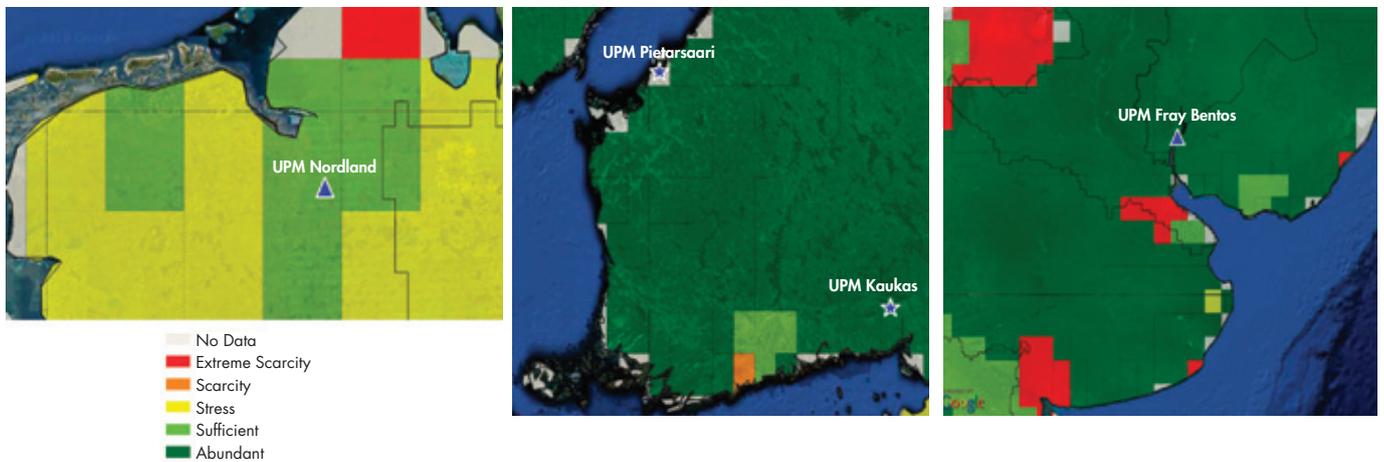
### 5.1.1 Location & community

An important prerequisite for sustainable operations is that paper and pulp mill sites are located in countries which have abundant water supply. The World Business Council for Sustainable

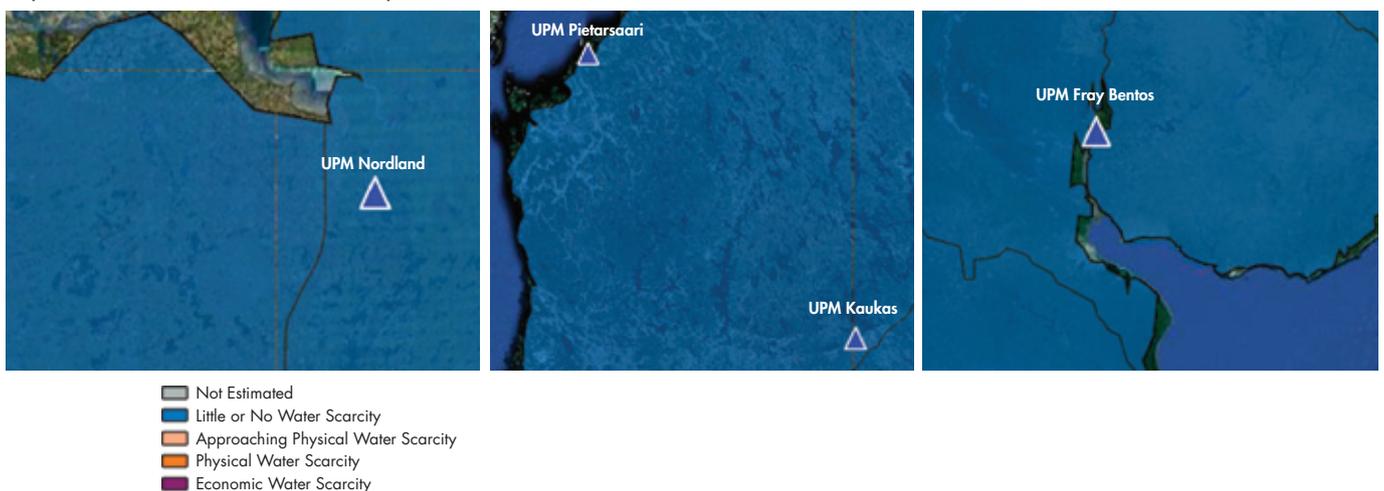
Local governmental institutions have adequate knowledge to consider the long term impacts of mills operational water needs versus the freshwater needs of the adjacent community and other industries. Local permits are based on the total water available in a catchment and its equal distribution between the different stakeholders. Permit levels are regularly monitored by local institutions and if needed corrective actions are taken in the form of lower permit level allowances.

Figure 10. WBCSD Global Water Tool

Watershed projected annual renewable supply per person, year 2025



Physical and economic water scarcity



### 5.1.2 Permit allowance

For the pulp and paper mill's production process operations, an indicator for a good and functional mill environmental management system is to have effluent quality that is within predefined effluent limits for all effluent discharged. A mill's effluent discharge permit levels are a good guideline to the locally agreed maximum for a certain substance in a specific receiving water body. In countries such as Finland, Uruguay and Germany government institutions have the expertise and information to understand the ecosystem impact of a mill's effluent on the local water body.

In addition to a mill's treated and discharged water, the actual water intake should remain within the limits of the natural recharge rate of the freshwater body be it a river, lake or groundwater reservoir. Over exploitation of a freshwater body is considered unsustainable and to be avoided. All four of the UPM mills assessed are operating well within their effluent permits levels. In some instances the permit levels have been tightened over time but the mills continued to manage operations within the new permit boundaries. The mill's permit on water intake volumes varies between the mills but all mills water withdrawal is within their permit level allowance. However, because there is not always a match between water withdrawal permits and water scarcity, UPM feels the need to go one step beyond the compliance of water intake permits and have a look to the actual sustainability of its water footprints.

### 5.1.3 Operational efficiency

Improved water efficiency gives an indication of whether the mill has incentives to reduce freshwater in the production process. In regions where there is freshwater abundance, water is often under-priced and there is little economic incentive to optimize its use. Water use efficiency can be improved by closing some of the mill internal water loops and reusing water several times in the production processes before it is discharged.

Over the last ten years (2001–2010) the four UPM mills have achieved significant improvements in the specific water use efficiency (improved 15%–30%).

In 2010 UPM published a long-term target for its pulp and paper mills to further reduce the quantity of waste water volume and improve the quality of the effluent leaving the mill. For both the pulp and paper mills the target is to have a 15% reduction in waste water volumes and 15% reduction in COD load by the year 2020 (base year 2008). These targets require improvements in freshwater use efficiency and enhanced treatment of process waste water to further reduce the effluent load. A COD (chemical oxygen demand) test is commonly used to indirectly measure the amount of organic compounds in water. COD determines the amount of organic pollutants in treated wastewater, making COD a useful and widely applied measure of water quality for pulp and paper mills.

### 5.1.4 Forest management

All wood sources reviewed in this study originate from sustainably managed forests. Sustainable forest management is a well-established concept balancing the requirements of economic, socio-cultural and ecologic sustainability. The principles of the management approaches are negotiated in an open process with stakeholders under different forest certification schemes such as FSC® (forest stewardship council) and PEFC (programme for the endorsement of forest certification schemes). The dialog is on-going by nature and hence the approaches are evolving continuously as knowledge on different issues accumulates. Water consumption and protection of water resources and water habitats are addressed among many other subjects in the forest certification standards and on-going dialog.

Forest operations may have a significant impact on water systems, particularly at the sources of the freshwater supplies on higher and smaller watersheds, i.e. small streams, ponds and lakes. Techniques for water protection have been in place in forestry already for some years. These techniques include various measures, such as

- Defined buffer zones in riparian forests in relation to timber harvesting, soil preparation, fertilizing and using pesticides. The riparian buffers prevent siltation and nutrient leaching into waterways but at the same time they protect water habitats.
- Organising wood harvesting on sensitive fine grain and/or wet soils in winter time or dry season.
- Instructing water protection practices in ditching of peat lands and wetlands.
- Placing wood stores and machinery maintenance sites at safe distance from water resources.
- Defining important ground water areas as fertilizer and pesticide-free areas. Some heavier soil preparation methods are limited there, too.
- Defining valuable aquatic habitats as set-aside areas.

The water protection methods are subject to constant development as experience and research bring in more knowledge.

### 5.1.5 Certification and labels

#### ISO 14001

The international standard organisation (ISO) has developed a tool (ISO 14001) that can be used to establish



an environmental management system. The standard focuses on controlling and improving an organization's environmental performance while maintaining profitability. There are three fundamental commitments required in an environmental policy that meets the requirements of ISO 14001. These include:

- prevention of pollution
- compliance with legislation
- continual improvement of the environmental management system

Certification of ISO 14001 is awarded by third parties. All four of the UPM mills are ISO 14001 certified to ensure that in addition to other environmental topics, water is managed responsibly.

#### EMAS

Although originally meant for European companies, nowadays also non-European can voluntarily join the EU Eco-Management and Audit Scheme (EMAS) which is a management tool for companies to evaluate, report and improve their environmental performance. The core elements of EMAS are performance, credibility and transparency. By carrying out annual updates of environmental policy targets and actions to implement and evaluate them, registered mills continually improve their environmental performance and provide evidence that they comply with all environmental legislation that is applicable to them. Third-party verification from independent auditors adds credibility by guaranteeing the value of both the actions taken and the disclosed environmental information.



Transparency is generated by the environmental statement, which an organization is required to publish as part of EMAS registration. The EMAS report provides public information on the environmental impact and performance of the organization. UPM Nordland Papier, UPM Kaukas and UPM Pietarsaari have EMAS in place which in practice means that they publish their environmental parameters on annual basis, although it is a European tool UPM Fray Bentos also publishes this information voluntarily.

**EU Eco-label**

The European eco-label was introduced in 1992 for paper products in Europe. It is awarded after verification that the product meets high environmental and performance standards on for example waste management and emissions to water and air. Eco-label criteria are based on studies that analyze the impact of the product or service on the environment throughout its life-cycle, starting from raw material extraction in the pre-production stage, through to production, distribution and disposal. UPM Nordland Papier has achieved EU Eco-label for all of its products. The pulp coming from the three UPM pulps mills is also approved to be used on EU Eco-labelled paper products.



**Forest Certification Schemes**

Development of forest certification schemes started in the 1990's in various parts of the world, and today there are well-established schemes available for forest owners and forest managers. These systems typically include:

- Standards with criteria defining the approved measures in forestry practices.
- Methods for Chain of Custody to control the origin of the wood processed at the mills.
- Third party independent auditing programs
- Standard revision schedule

A majority of the wood reviewed in this study is from forests certified either under FSC or PEFC standards, and the rest is classified as controlled wood originating from non-controversial sources.



The mark of responsible forestry



**5.1.6 Sustainability of the water footprints**

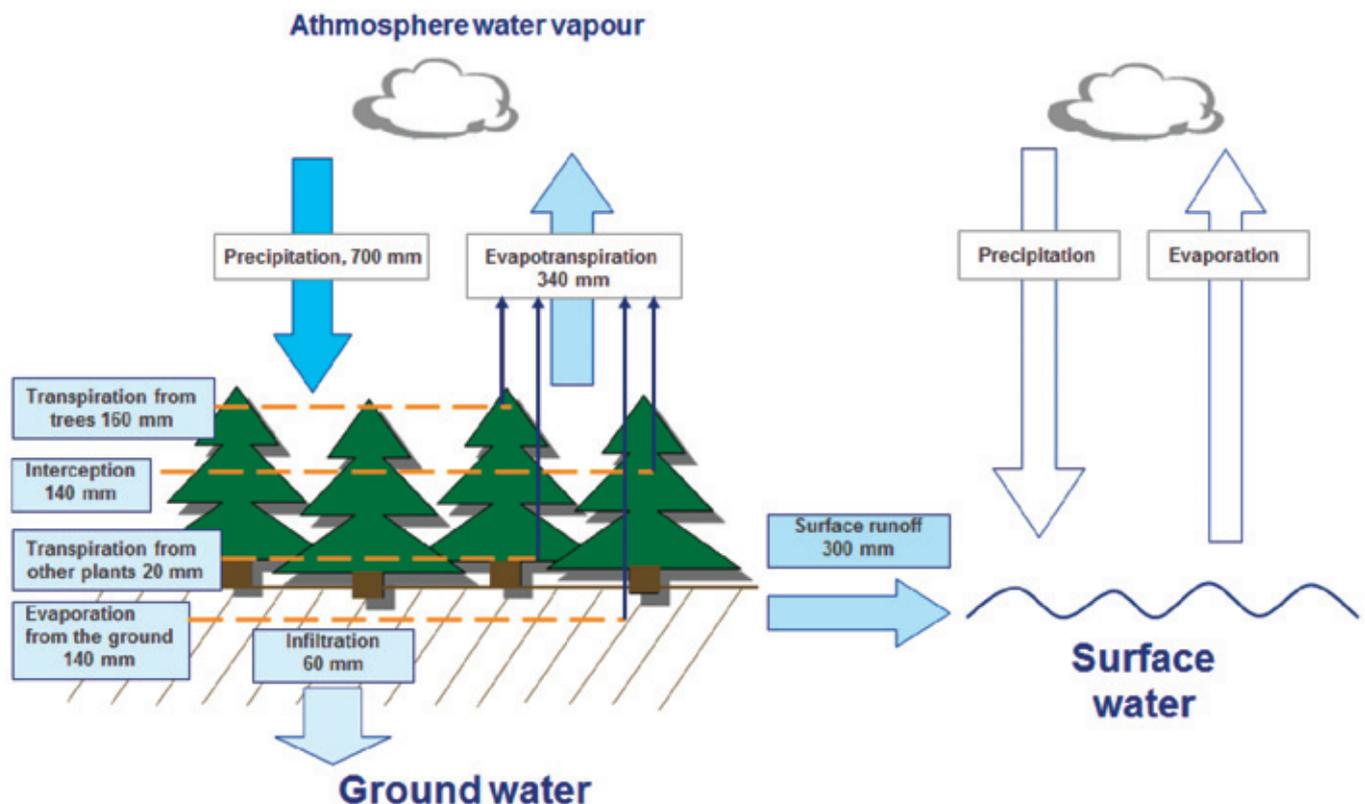
**Green Water Footprint**

Both UPM's plantation and semi-natural forests have certified sustainable forest management practices in place. Sustainably managed forests and plantations improve surface water quality. They act to process precipitation into high quality surface waters. Managing forests can improve the water cycles in forests and ultimately the quality of stream flow. Timber harvesting can decrease evapotranspiration resulting in increased stream flow and groundwater recharge. But the significance of these hydrological changes decrease as the forest re-grows. The impacts of timber harvesting are controlled by limiting the operations in time and space in each watershed.

Managed forests as well as natural forests can of course also negatively affect forest water cycles, unforeseen natural disturbances like fires, storms and insect invasion can have detrimental effects on water quality in forests. Almost all of the world's fresh water originates from forests and maintaining or increasing forest cover is beneficial to water resources. Other land uses such as agriculture are known to have a much greater impact on water quality with respect to siltation, nutrient leaching, and pesticide and fertilizer use.

Boreal forests are characterized by humid climate where precipitation is higher than evaporation. The picture above is based on the scientific measurements of a forest stand located in the Forest Station of Helsinki University. The total annual precipitation is 700 mm, 340 mm of water is returned to the atmosphere via evapotranspiration which is composed of transpiration of trees (160 mm), transpiration of ground vegetation (20 mm), interception (140 mm) and evaporation from the ground (20 mm). Transpiration is the water that trees (and other plants) obtain from the soil and use in their metabolism. Interception is the rained water sustained in the foliage of the trees and released back to the atmosphere. The surface runoff going to surface water courses is 300 mm. The forests sustain and slow down the surface runoff preventing flooding, erosion and leaching of nutrients. The evapotranspiration and surface runoff sum up to 640 mm per year. The remaining 60 mm infiltrates down to the ground water thus charging the ground water volume. In

Figure 11. Water cycle in Finnish boreal forests



regeneration felling care is taken that the increased surface runoff does not result in environmental emissions into watercourses. The control is implemented by leaving sufficient riparian buffer zones along all water courses. In other forest management activities (ground preparation, ditching, road construction) methods are in place to manage emissions. These include methods such as sedimentation ponds, dam constructions, ditch breaks and surface runoff filtration.

For eucalyptus plantations it is important that forest locations are chosen where there is plentiful of rainfall to support the tree growth. The hydrological cycle of UPM's eucalyptus plantation in Uruguay has been part of an independent assessment initiated by the Uruguayan government. A study (Lima, 1997) assessed the potential impacts of eucalypt plantations and the implications for water resources. The study concluded (in respect with hydrology) that as the average rainfall for the country is about 1,200 mm, and the potential maximum evapotranspiration (water use) in the regions where the plantations were envisaged is about 1,152 mm, it was highly unlikely that the water balance (macro scale) be drastically altered with increased afforestation (Lima, 1997).

### Blue Water Footprint

The blue water scarcity level (WSBlue) measures the mill's blue water footprint in comparison to the blue water available in a catchment over a period of time. Data on the blue water availability comes from the mills own monitoring studies, the environmental flow requirements (EFR) which indicates the quantity of water flows required to sustain ecosystems is excluded from the assessment. The blue water availability is therefore equal to the natural run-off in the catchment, this data came from own studies and that of local authorities. Excluding the EFR from the assessment implies that calculated blue scarcity levels are underestimated. EFR is part of the mills permit levels for water abstraction which are set by local authorities. The permit levels are based on what catchments can sustainable support, taking into account all the processes and their respective impacts.

A blue water scarcity of 100% indicates that the blue water available in the catchment is fully consumed and practices are unsustainable. For UPM Nordland the water scarcity level is 42%, for UPM Pietarsaari it is 23 % and for UPM Kaukas and UPM Fray Bentos almost negligible (0,005%). This assessment only includes UPM's contribution; other actors in the catchment are not included. Such a complex analysis is out of the scope of this study. Therefore general conclusions about UPM's WSBlue cannot be made based solely on the information presented. It does however give a good indication on UPM's share on the amount of freshwater that is available.

### Grey Water Footprint

The grey water pollution level measures the portion of the pollution assimilation capacity that is used in a river or lake. A water pollution level (WPL) beyond 100% is not considered sustainable, as assimilation capacity of the receiving water body has been fully used. For all the four UPM mills the WPL is between 0,5–10%. In the case for the four UPM mills their grey water footprint is compared versus the actual run-off in their catchment. Data on the actual catchment run-off comes from the mills own monitoring studies. This assessment however only includes UPM's contribution, the grey water footprint of the other actors in the catchment are not included. Such a complex analysis is out of the scope of this study. Nevertheless the results give an indication on UPM's direct share on the amount of water that is available to assimilate process effluent. UPM Pietarsaari discharges its effluent to the Baltic Sea, the mill has therefore no grey water footprint or WPL; this is a clear weakness of the current WFN method.

Based on the WFN methodology and the assumptions made, AOX is identified as the indicator that requires the highest dilution factor in the grey water footprint calculation, this must not be interpreted as meaning that it is also the most critical indicator from an environmental impact perspective.

The grey water footprint testing, appointing AOX as the most critical pollutant is valuable as the results encouraged UPM to look at available research studies to understand the conditions and reproducibility of them under a number of river flow conditions, the type of species affected and the long term consequences of this type of emissions. AOX has been studied intensively when comparing ECF\* and TCF\*\* bleaching techniques for pulp production (Hamm & Göttsching 2002, Niemelä 2007, Tana 2010). ECF pulp bleaching produces small amounts of low- and high-molecular-weight organic material, usually characterized as AOX. There is currently a lot of sound evidence to show that the current AOX levels in the treated effluents do not correlate with toxicity or biological responses in general (ÅF-Consult, 2011). The recalcitrant AOX material in the final effluents normally degrades over time in the receiving waters and AOX can also be derived from natural processes. For AOX waste water loadings between 0,05 and 0,25 kg/tonne of pulp there is no correlation between AOX and acute or long-term toxic effects in the receiving watercourse according to available research documentation. The study conducted by the German Federal Agency in 2008 concluded that the AOX impacts on the environment are minimal (Gartiser 2008). For the three assessed UPM pulp mills AOX levels are between 0,04 and 0,16 kg/tonne of pulp, which implies that there is no direct environmental impact coming from AOX in the mills effluent. Furthermore, advanced biological treatment of wastewaters has resulted in effluents that typically have little or no effect on aquatic community structure.

\*Elemental Chlorine Free, bleaching without chlorine gas or hypochlorite, but with chlorine dioxide (ClO<sub>2</sub>) used in one or more stages.

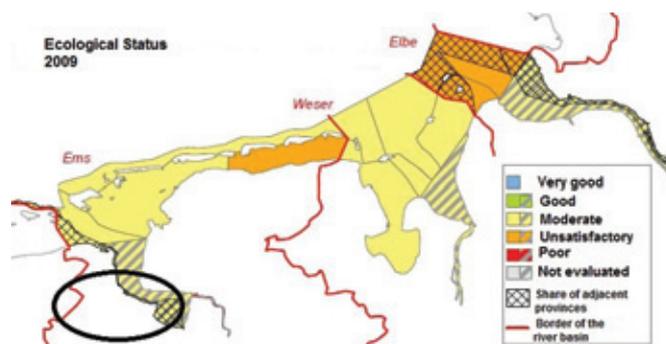
\*\*Total Chlorine Free, bleaching without chlorine chemicals, where oxygen-containing chemicals such as oxygen, hydrogen peroxide and ozone are used.

## 5.1.7 Catchment ecological status

### UPM Nordland Papier

The Nordland Papier mill is located in the village of Dörpen next to the river Ems which is about 370 km in length and runs between the borders of Germany and the Netherlands. The ecological state of the Ems catchment can be defined as moderate (see figure 12). UPM participated in an orienteering investigation on bio-test for a paper mills effluent (a study conducted in 2008 by German Federal Agency, Berlin). The evaluation of Nordland's effluent tests (e.g. Daphnia toxicity test, Algae test, Lemma test, Fish egg test, Luminescent bacteria test and gen toxicity test) showed that there is no relevant toxicity of the Nordland mill's effluent after the waste waters biological treatment process. Although the mathematical dilution ratio according to WFN method is the highest for AOX (because the natural background concentration is extremely low), the actual environmental impact assessed by applying a range of bio-test directly in the treated effluent shows that there is no relevant environmental impact from the mills effluent from any parameter.

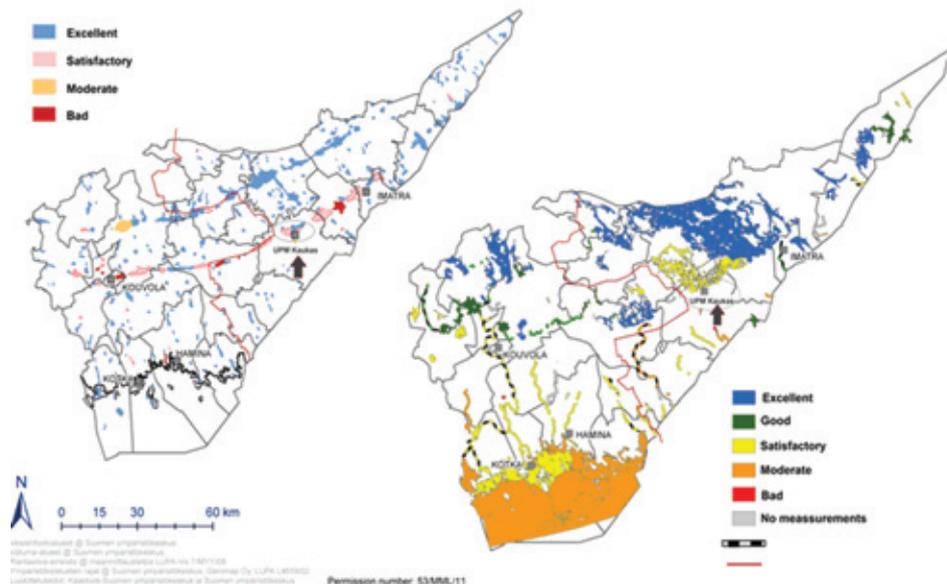
Figure 12. Ecological status of UPM Nordland water catchment



Source: Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz/ Lower Saxony Water Management, Coastal and Conservation management plan 2009.

Figure 13. Ecological status of UPM Kaukas water catchment

Source: Kaakkois-Suomen elinkeino-, liikenne- ja ympäristökeskus/ Southeast Finland Regional Economic Development, Transport and the Environment.



### UPM Fray Bentos

A comparison of the monitoring data before and after the startup shows that the water quality of the Río Uruguay has not changed as a result of the mill. Ecological impacts of Fray Bentos pulp mill have been studied extensively, but long term studies are not available due to mill's relatively recent start in late 2007. However an independent study (Ecometrix 2010) states that "monitoring programs conclude that the biological communities within the Río Uruguay have not been affected by the mill discharge".

### UPM Kaukas

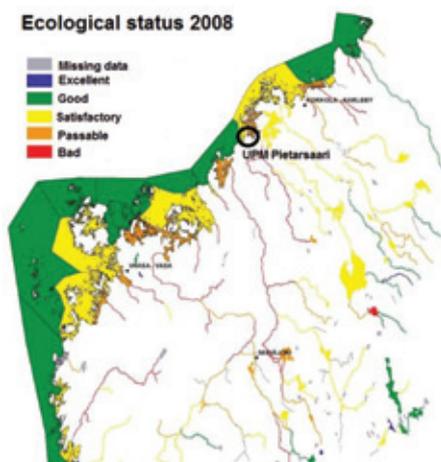
A decreasing water emission trend is typical in all Finnish pulp and paper mills. Investments first in mechanical treatment of waste waters in 1970's and early 1980's, followed by biological treatment in late 1980's and 1990's associated with modernised processes have had a remarkably positive impact. UPM Kaukas is located in south-eastern Finland. The mill is in western "Pien-Saimaa" which is part of the fourth biggest lake in Europe, Lake Saimaa. According to studies by local authorities (see Figure. 13), the ecological state of the water is satisfactory in Pien-Saimaa, despite of the impacts of industry, communities and agriculture. In addition to UPM Kaukas, there are several other pulp mills in the area.

### UPM Pietarsaari

UPM Pietarsaari is located on the west coast of Finland. It takes water from Lake Luodonjärvi and discharges treated waste water to the Baltic Sea. The ecological state of the water has been classified based on the studies of the authorities and preliminary classification of the forthcoming Water Framework Directive criteria. Results show that the sea water at inner archipelago in the front of the city of Pietarsaari can be classified between moderate and satisfactory (see Figure. 14).

Figure 14. Ecological status of UPM Pietarsaari water catchment

Source: Suomen ympäristökeskus, alueelliset ympäristökeskukset/ Finnish Environment Institute, the Regional Environment, license nr 7/MYY/08.



### 5.1.8 Sustainability assessment results

The accounting phase of the water footprint study shows the types and the quantity of water that is used in the production chain of paper. The second step to better understand the impact of this water footprint at a local watershed level is carried out with the help of a sustainability assessment. The criteria included in this assessment have been chosen based on the mills location and community, permit allowance, operational efficiency, forest management, certification and labels and the sustainability of the grey (WVPL) and blue water footprint (WSBblue) and the catchments ecological status. Given the above mentioned criteria, UPM considers its operations and overall water footprint for the four assessed mills to be sustainable for the following reasons:

1. The mills are located in water abundant catchments and support responsible and efficient use of freshwater resources in their production, both in the short and long term. The mills water intake and effluent discharged are well within the permit levels set by local authorities.
2. The overall ecological status for each mills catchment varies between moderate and satisfactory. UPM has identified places that could potentially come under greater pressure in the future (namely those identified with a "moderate" ecological status) and as part of the EU Water Framework Directive UPM supports its goal to achieve good status for all water bodies.
3. Over the last ten years (2001–2010\*) the mills assessed have improved their specific water use efficiency and have targets\*\* in place to further reduce freshwater intake and improve the quality of the effluent discharged.
4. Green water footprint has the highest contribution (60%) to the total water footprint of paper. However, all the wood reviewed in this study originates from sustainably managed forests (FSC & PEFC). The water cycles in these forests are managed according to the best available water protection methods.
5. All of the four assessed UPM mills have certification and labels in place that promote sustainable management of forests (FSC & PEFC) and mill operations (ISO 14001 and EMAS). This environmental performance is recognized by third parties in the form of EU Ecolabel certified and approved products.
6. The mills location, operational management and forestry practices support the sustainability principle to produce water intensive products such as pulp and paper in water-abundant areas like Finland, Germany and Uruguay. As this reduces the need to use water for producing them in water-scarce areas.

Table 15. Sustainability criteria, based on joint evaluation with the Water Footprint Network

		UPM Nordland Papier Germany	UPM Kaukas Pulp mill Finland	UPM Pietarsaari Pulp mill Finland	UPM Fray Bentos Pulp mill Uruguay
Location & Community	Mill operations in water abundant regions (method: WBCSD Global Water Tool maps. See figure 10.)	YES	YES	YES	YES
	Mills water use in balance with local social needs (method: WBCSD Global Water Tool maps)	YES	YES	YES	YES
Permit allowance	Freshwater uptake, % used of total permit allowance (year 2009)	70 %	No uptake restriction	30 %	50 %
	Discharged effluent within permit level indicators (year 2009)	YES	YES	YES	YES
Operational Efficiency	Specific water use efficiency 2001 vs. 2010	Improved 15%	Improved 30%	Improved 30%	Improved 30%*
	Water quantity and quality target in place**	YES	YES	YES	YES
Forest management	Sustainable forestry management and wood supply (FSC & PEFC)***	100%	100%	100%	100 %
Certification & labels	Environmental certification and labels	ISO 14001 EMAS EU Eco-label FSC & PEFC	ISO 14001 EMAS EU Eco-label approved FSC & PEFC	ISO 14001 EMAS EU Ecolabel approved FSC & PEFC	ISO 14001 EU Ecolabel approved FSC
Grey water footprint	Sustainability of grey water footprint (WPL)	10%	10%	Sea flow (no grey wf)	0,5%
Blue water footprint	Sustainability of blue water footprint (WSBlue)	42%	0,005%	23%	0,005%
Catchment ecological status	Ecological status of local water catchment	Moderate	Satisfactory	Moderate-Satisfactory	N.A.

\* The Fray Bentos pulp mill started operations in 2007, water use efficiency is therefore calculated from 2008–2010.

\*\* UPM Water targets 2020, 15 % reduction in waste water volume, 15 % reduction in COD load, both targets are for pulp and paper production. The targets are set for 2008–2020.

\*\*\* UPM Forestry target is to have 80% share of certified fibre by 2020.

# 6. Water footprint response options

## 6.1 Direct operations

### Nordland's blue water footprint

The sustainability of Nordland Papier's blue water footprint was assessed as 42%. Although this is at an acceptable level, (> 100% unsustainable, taking into account all the users in the catchment), a response option could be to further reduce the mills direct blue water footprint. Although the mill's process water use efficiency is already at a very good level, additional recycling and reusing of process water (68% of blue wf) and reducing the evaporation losses during paper drying and other losses (30% of blue wf) could potentially bring the blue water footprint close to zero. Finding the right balance (the water-energy nexus) between recycling and closing water loops has potential but only when there is a clear regulatory, environmental or economic need. The mills assessed in this report operate in water abundant regions and only take water from water bodies that are strictly monitored and controlled by local authorities and institutions.

### Grey water footprint

The assumption was made that AOX does not naturally occur in all of the pulp mill's receiving water body and the natural and maximum concentration of a specific (background) pollutant in the respective receiving water bodies was taken from the UPM Nordland water catchment. Keeping these assumptions in mind, the grey water footprint varies considerably. As indicated earlier (Chapter 5.1.6, Grey water footprint), AOX impacts on the environment are minimal (Gartiser 2008). UPM has therefore based its long term water quality and quantity targets (year 2020) on COD, which is commonly used in pulp and paper industry to measure the water quality.

## 6.2 Indirect operations

### Sustainable forestry

The majority (60%) of the water footprint of paper comes from forestry, it is therefore of importance that the natural water cycles in forests are understood and sustainably managed in order to maintain and safeguard watercourses. Almost all of the water entering the forest is rainfall (precipitation) which is part of a natural cycle. There are however forest management practices that can support efficient use of this water. For example by matching forest sites and tree species in such a way that there is a minimum impact and maximum wood yield, also by creating buffers zones

which prevent siltation and nutrient leaching into waterways (see chapter 5.1.4). By on-going participation in the development of forest certification schemes such as FSC and PEFC UPM shares best-practices to improve water cycles in forests. Today 100% of UPM's wood comes from sustainably managed forests or controlled sources.

### Supply chain participation

The supply chain has a large contribution to the water footprint of paper (99%). Better understanding is needed of the role and importance of water in suppliers operations, UPM obtains such information by sending out supplier questionnaires to suppliers (e.g. chemical pulp and chemicals). These questionnaires focus on the supplier's specific water intake, process waste water load and water risks. One possible future step could be to create a partnership on water with critical key suppliers and find common ways to further reduce the water footprint over the production chain of paper, agreeing reduction targets and sharing best practices.

### Local collaborative action

Although the mills operate in water abundant catchment areas, the ecological status of the water in the catchments varies between moderate and satisfactory. Communities, industries and agriculture have their contribution to the catchments ecological status. In industrialized countries local authorities have the expertise and control to maintain or improve the catchments ecosystem. UPM is operating within set permit level boundaries and has targets in place that support responsible and efficient use of freshwater resources that contribute to healthy ecosystems. Nevertheless, poor environmental performance of other actors in the catchment can have an impact on UPM's license to operate. Cooperation with local stakeholders is vital to improve the sustainability of a catchment. Such a collaborative effort can be seen in the Baltic Sea Action Group (BSAG) which UPM joined in 2010. The BSAG idea is to provide a platform for arriving at practical commitments and actions to save the Baltic Sea together with business community, governments and NGOs. UPM's action involved a joined project to use charcoal mixed with soil to remove impurities from nutrient-rich water running from agricultural lands into the Baltic Sea, adjacent to UPM Pietarsaari. Such collaboration projects which involve different stakeholders are an example of UPM's options to improve local water resources and reduce environmental impacts.

# 7. Results of the case study objectives

The four objectives that were set out for this water footprint case study will be discussed in this chapter.

## 1. Calculate the total water footprint of the two papers produced at UPM Nordland Papier mill.

UPM Nordland Papier produces two paper grades namely WFC and WFU paper. Their respective water footprints are 20L/sheet and 13L/A4sheet. The difference between the two grades arises from the difference in paper recipes. The percentage breakdown of the water footprint for blue, green and grey is similar for both products.

In addition to a product specific water footprint for the UPM Nordland Papier mill, footprints were also developed for the UPM pulp and paper mills of Kaukas and Pietarsaari and for the pulp of UPM Fray Bentos.

## 2. Assess the sustainability of Nordland's water footprint and that of its two paper products.

The mills assessed are located in water abundant regions and they have environmental management practices in place for forests, wood sourcing and direct mill operations that ensure responsible use of local freshwater resources. This means in practice that

throughout the production chain of paper, from forest management all the way through the actual processing and production, water flows are protected, monitored, reused, cleaned and used as efficiently as possible. UPM considers that sustainable management of freshwater resources provides long-term strategic advantages. UPM's long-term water targets to further reduce the quantity of water taken in and to improve the quality of the effluent leaving the mill by the year 2020 reflect this strategic thinking.

### 3. Increase the understanding on paper production's supply chain water footprint

In our case study around 99% of the total water footprint of paper comes from the supplied ingredients such as chemical pulp, pigments, maize starch and natural gas. In addition to information from UPM's own pulp mills, there was good cooperation with external producers of paper pigments and maize starch. As the supply chain plays such an important role in the overall result of a water footprint, it is crucial to have sustainable water management practices in both direct and indirect operations to produce a sustainable product. The supplier information provided insight on how water is managed in these respective production processes.

## 8. Conclusions

UPM considers the water footprint method as proposed by the Water Footprint Network to be a useful tool to look beyond direct operations and understand the role of water in the supply chain. It increases the understanding on where, in what way and in what quality water is consumed. This information can be useful to map water-related risks and opportunities over the whole production chain of a product and look for ways to reduce a water footprint. Throughout this case study four important lessons were identified that UPM considers important in the current and future development of the water footprint method for forest industry products such as pulp and paper. These are four important conclusions.

1. **In general:** A water footprint figure itself be it 13, 20 or even 300 litres per sheet of paper does not tell much about the actual impact of operations at the local watershed level. A low water footprint could be less sustainable than a high water footprint, whereas intuitively one would assume the opposite. A sustainability assessment is needed to gain a better understanding on whether the mill operations and forest management practices are within the boundaries of what a water catchment can sustainably support. In that respect a water footprint is different to a carbon footprint which results in an actual and comparable figure. Thus, guidelines for the communication and use of water footprint results are a topic which needs to be discussed and developed further.

A water footprint study itself is not an exhaustive indicator but rather should be seen as part of a toolkit, that together with others such as carbon footprint, life cycle assessment and sustainable forest management practices provide understanding of relevant issues when making informed decisions.

2. **Green water footprint:** In the green water footprint accounting method, forest evapotranspiration rates are used as an indicator for human appropriation of fresh water resources. This however does not give an accurate representation of the role of (sustainable) forest management on water cycles. In the current method forest evapotranspiration is only allocated to the wood harvested (Hoekstra et al., 2011). In reality (managed) forests interact with water in a complex way. Forests control erosion and flooding,

This provides good background information to identify opportunities for future collaboration.

### 4. Develop the water footprint methodology for paper products, with a special focus on green water footprinting (forestry).

UPM propose the following methodological developments for a paper water footprint:

- The appropriateness of a green water footprint for forestry products needs to be discussed further. If a green water footprint is deemed appropriate then the right parameters need to be selected in order to more accurately show the link between forest water cycles and human appropriation of this freshwater via forest management for wood production. By showing this linkage the green water footprint method would become more credible, accurate and widely used in the forest industry.
- A water footprint sustainability assessment for paper gives an overview of the actual impacts of forest and mill operations on the local freshwater resources. The sustainability criteria (see table 15) selected for this case study are relevant for the pulp and paper industry and can provide a good starting point for future water footprint sustainability assessments.

filter water, clean air, bind carbon, slow down desertification and provide recreation and food. This needs to be included when showing the link between water use of forests and forest management in the form of human appropriation of freshwater resources. UPM sees the need for further cooperation between the WFN and the forest industry to improve the green water footprint accounting and the sustainability assessment method in order to avoid wrongful calculation and miss-interpretation.

3. **Blue water footprint:** The blue water footprint of paper is minor (1%) and consists of the water that is lost during the production process. According to the water footprint methodology, evaporated water is accounted for it is locally no longer available for other (possibly competing) purposes. The term 'lost' should be seen in a wider perspective, as for paper and pulp production most of the blue water footprint arrives from evaporation during the production processes. It consists of process water that is vented to the atmosphere, where it again becomes part of the global water cycle. In the paper and pulp industry it is not very common to measure the evaporation of water. In this study we have used actual data to measure the evaporation rates which contributed to the blue water footprint.

4. **Grey water footprint:** The grey water footprint and water pollution level (WPL) bring an insight and additional information to permit level requirements. It should however not be seen as a conclusive assessment of the environmental impact of a mills effluent. Bio-tests and ecological status mapping are more informative and suitable as they measure the actual impact of a specific pollutant on local aquatic communities. As there are currently no common local water quality standards, the choice of the leading effluent parameter as well as the threshold for pollutants chosen will cause variability and a lack of accuracy. For UPM Pietarsaari the effluents are discharged to the sea and therefore the grey WF is zero because no freshwater is used for assimilation of the pollutants. Instead the mills effluent is accounted for in the blue water footprint. This is a shortcoming off the current method and suggests that there is no potential impact of effluent discharged to seawater.

As the current water footprint methodology develops and more data is made available, the overall results will become more accurate and meaningful. For now UPM has applied and tested the method as developed by the Water Footprint Network. The limitations and recommendations encountered will be documented and brought forward to the Water Footprint Network. In 2011 UPM will work with the Water Footprint Network and CEPI (Confederation of European Paper Industries) to build on the current study and further develop the methodology for paper products.

For UPM long term sustainable management of freshwater resources is essential. Therefore UPM has set a long-term goal to have the lowest water footprint impacts in our industry. We will achieve that by having the lowest negative impacts on local water resources and using water efficiently and responsibly over the whole production chain of our products. This supports our vision to be the frontrunner of the new forest industry, leading the integration of bio and forest industries into a new, sustainable and innovation-driven future.

If at any stage you would like to receive more information on the topic of water footprint kindly use the following email address: [environment@upm.com](mailto:environment@upm.com)

More information on UPM in general or our environmental responsibility and water footprint study material can be found at <http://www.upm.com/EN/RESPONSIBILITY/Pages/default.aspx>

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