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Global Water Stress Indices: An example of their industrial usage

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Abstract

Water stress assessments on basin level of 96 SCA sites and global water issues affecting industry are presented. Four tools are evaluated with the aim to find indices that measure water stress, i.e. lack of water of good enough quality for humans and the ecosystem. Water indices, developed through research, become more accessible when they are in water tools, developed by non-governmental organisations, corporations or financial institutions. Two indices in WBCSD's Global Water Tool and three indices in WWF-DEG's Water Risk Filter totally give each site five assessments. Both tools give assessments without showing the level of certainty, which makes it difficult to evaluate reliability without more local knowledge. Baseline Water Stress, one of the indices in the study, estimates the level of water stress in the basin. The index shows 47 SCA sites in basins with indications of water stress. Presumably, several sites are affected by water stress.

Keywords: water stress indices, global water tools, business water risk, CSR, NGOs, environmental models

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Contents

Key terms

Basin (Drainage basin): The tract of country drained by a river and its tributaries, or which drains into a lake or sea: the Amazon basin. How well what is called basin in an water assessment tool represents the actual basin in nature depends on the resolution of the hydrological model used to define the basin in the tool.

Blue water and green water: Water in rivers, reservoirs, lakes and aquifers is called blue water. Rainfall stored in soil moisture is called green water.

Business water risk: A full water risk assessment includes physical risk, regulatory risk and reputational risk. The assessment can be done according to the guidelines in Aqueduct Water Risk Framework, developed by Water Resources Institute (WRI).

Ecosystem function: In literature also referred to as natural infrastructure. Examples of ecosystem functions: water treatment in wetlands, food control by natural water systems, control of water quality by biodiversity.

Environmental model: A definition and method of how to estimate some aspect of nature. An environmental model could be a hydrological and geographical model or some other type of climate model.

Water scarcity: There is a difference between water stress and water scarcity. The difference is the distinction between quantity and quality, which is shown by the following example. If there is enough water available for human consumption in an area there is no water scarcity; but the same area can be affected by water stress if the available water is contaminated, or for some other reason cannot be used by humans or the ecosystem [Mueller et al., 2015]. In short, water scarcity is a quantitative assessment whereas water stress is a more qualitative assessment.

Water stress: Water stress is a qualitative estimate of whether there is an abundance or a lack of available freshwater. Mueller et al. [2015] define water stress as “the lack of sufficient water to meet human and ecological demands”.

Water index/indices: A water index is a method of using global geographical data to calculate a value for any location that is covered in the datasets. The calculated value is not an exact measurement it is an estimate. A water stress index can indicate/estimate that an area is experiencing some level of water stress defined in the index.

Watershed: An area between surrounding watercourses. In this context watershed-level is used synonymously as basin-level.

Abbreviations

CSR – Corporate Social Responsibility.

DEG – Deutsche Entwicklungsgesellschaft. A German investment corporation.

FAO – Food and Agricultural Organisation of the United Nations.

FP – Forest Products. A FP site is a SCA production site part of the Forest Products division.

IPCC – International Panel for Climate Change.

IWMI – International Water Management Institute. An international NGO.

NGO – Non-Governmental Organisation.

PC – Personal Care. A PC site is a SCA production site part of the Personal Care division.

TP – Tissue Paper. A TP site is a SCA production site part of the Tissue Paper division.

WBCSD – World Business Council for Sustainable Development. An international NGO.

WRI – World Resources Institute. An international NGO.

WWAP – World Water Assessment Programme of the United Nations.

WWC – World Water Council. An international multi-stakeholder platform.

WWF – World Wide Fund for Nature. An international NGO.

Chapter 1

Introduction

This degree project is about measuring water availability in different regions all around the world. The project was assigned by SCA, Svenska Cellulosa Aktiebolaget. The intention is to provide an industry perspective on how to assess current water conditions in areas of operation.

The world has been predicted to face a 40 % water supply gap by 2030 [The 2030 Water Resources Group, 2009]. It means that if water is not used more efficiently the global water demand in 2030 is estimated to be 40 % above the current estimate of available water. There are reasons for concern that the competition of freshwater will increase in regions with growing water scarcity [FAO (Food and Agriculture Organisation of the United Nation) and WWC (World Water Council), 2015; Revenga et al., 2000; WWAP (United Nations World Water Assessment Programme), 2015].

Water stress assessment is a method of estimating the availability of water. According a general definition by Mueller et al. [2015] a water stressed area does not have enough river runoff within the basin to meet human and ecological demands. Humans need drinking water and water for sanitation and cooking, and we also use water for production of goods. The ecological demand depends on the environment but Smakthin et al. [2004] showed that ecosystems that depend on freshwater need about 20 to 50 % of the mean annual river flow. To avoid water stress there should thus be sufficient amounts of water, of good enough quality, for the population and for the ecosystem.

By using water stress indices water stress can be measured. Although to measure water stress with an index is not an exact measurement and it is not as straightforward as measuring temperature with a thermometer. Even so, the index provides a method of calculating a value and a scale that will determine how to connect the calculated value to an assessment.

1.1 SCA

SCA is a global hygiene and forest products company with 96 sites in 27 countries at the start of this project.

SCA
Care of Life

Currently the total water usage is about 210 million cubic meters per year [SCA Sustainability Report 2014]. The company makes different types of products and the business is divided into three divisions: Forest Products (FP), Tissue Products (TP) and Personal Care (PC). More information about the divisions is given in Table 1.1.

Table 1.1: Divisions within SCA, their water intake and example of products.

Division		No. sites	Products	Total water intake (m^3/year)
Forest Products:	Sawmill	7	wood fibre	1 190 392
	Pulp & paper	4	pulp, raw paper	108 747 499
Tissue Products		61	tissue paper	93 656 183
Personal Care		24	diapers etc.	750 470

Pulp is an important forest product. It is the wet wood fibre mass that is used to make paper. About half of SCA's total water intake is used at four pulp & paper mills. About 46 % of the water is used at the TP sites. Only a small faction, about 1 % of the total water intake is used by the sawmills and PC sites together.

The water-demanding pulp & paper mills are all located in Sweden. Because there is rarely a shortage of water in the country the Swedish forestry industry is regarded as a sustainable industry [Eriksson et al., 2011]. SCA's Swedish mills do not produce all pulp that SCA uses. There are also external pulp suppliers in other countries. With regard to the entire value chain the external suppliers are among the highest water-demanding sectors.

1.2 Project description

The aim of the project is to describe and compare different indices that can be used to estimate the risk that a given location is experiencing water stress. A literary summary is done to present global water issues and to identify suitable indices that can be used to measure water stress in areas of operation.

1.2.1 Objectives

- One objective is to evaluate a number of global water stress indices.
- The main objective is to use suitable indices with the aim to identify SCA sites located in regions with indications of water stress.

1.2.2 Project scope and delimitation

A waster stress assessment can be made on a country, basin or a facility/site level. The basin level is preferred to the country level because water as a resource is not bound within national boundaries. The basin level is also preferred to the facility level because a local assessment for each site on a facility level would demand detailed information that would be very time-consuming to gather.

This study covers the area of water stress assessment, which can be used for assessing physical risk as a part of a larger water risk assessment. A full water risk assessment includes physical risk, regulatory risk and reputational risk. The study touch upon the area of water risk. However, to do a complete risk assessment for 96 sites is not within the scope of this project. Neither is any assessment made for the external pulp suppliers, mainly due to time constraint. Because of the low reliability, future predictions are not included in this report.

Chapter 2

Literary summary

Global water issues and CSR, corporate social responsibility, are presented to show the relevance for industry to have a water strategy, i.e. to work with water related questions. In addition, the literary summary includes information about four global water assessment tools and five selected indices.

2.1 Global water issues

In a study of global water resources Srinivasan et al. [2012] argued that agricultural and industrial production as well as human wellbeing is likely to be limited by water shortages. There is a consensus that severe problems will arise form a future shortage of water [WWAP, 2015b].

An example of a challenge is to secure water resources for food production. Currently the agricultural sector accounts for 70 % of all freshwater withdrawals [FAO AQUASTAT, 2014]. By 2050 the global demand for food is estimated to have increased 70 % compared to 2009 levels [Rodrigues et al., 2014]. In fact, global water resources could possibly satisfy the demand for water by agriculture in 2050, e.g. by increasing irrigation efficiency, but there is a remaining concern about water scarcity on a regional level [FAO & WWC, 2015]. Water demanding production is according to IPCC likely to be affected by increasing competition for water in many regions [Jimenez Cisneros et al., 2014].

Even if agricultural water demand is satisfied humanity still depends on water for other aspects of life, e.g. sanitation. Currently 40 % of the world's population lives in areas of water scarcity [Revenga et al., 2000]. In their study Revenga et al. [2000] estimated that 50 % of the global population could be affected by water scarcity by 2025. Over the last 100 years global water use has grown at twice the rate of population growth [Revenga et al., 2000]. A pressing issue is that water is unevenly distributed in space and time [Mancosu et al., 2015] and many areas lack funding to develop infrastructure to effectively distribute water [WWAP, 2015b].

Social aspects such as population dynamics increase the complexity of water assessment, which is already very complex [Burke et al., 2015; FAO and WWC, 2015; Jaeger et al., 2013; Revenga et al., 2000]. Srinivasan et al. [2012] concluded that how much water society should use is a choice, which reflects social and political values. Therefore some indices use social data, e.g. the IWMI (International Water Management Institute) index of physical and economical water scarcity [Brown and Matlock, 2011].

With regard to both economy and ecology it is important to value ecosystem functions [Burke et al., 2015; Jaeger et al., 2013]. In the reports referred to as PAGE (Pilot Analysis of Global Ecosystems) Revenga et al. [2000] concluded, "there are many signs that the overall capacity of ecosystems to continue to produce many of the goods and services on which we depend is declining". Among the ecosystems covered in the PAGE reports, freshwater systems appeared to be the most severely degraded [Revenga et al., 2000].

A final remark is that in almost every discussion of water resources, water is only scarce in relation to people's values [Jaeger et al., 2013]. Both water scarcity and water stress are anthropocentric concepts. According to Jaeger et al. [2013] we value aspects such as biodiversity loss, ecosystem functions and the pure existence of some ecosystems, e.g. free-flowing rivers. Yet freshwater resources are under-valued by society while the protection of freshwater ecosystems is absolutely vital for economic progress [WWAP, 2015b].

2.1.1 Corporate social responsibility

Corporate Social Responsibility (CSR) is an economical concept involving sustainability and ethics that has been growing in importance since the 1960s [Carroll and Shabana, 2010]. CSR relies on businesses ability to by self-regulation deal with ethical issues [Okpara and Idowu, 2013]. Okpara and Idowu [2013] gives examples of ethical issues related to CSR such as human rights, health and safety, environmental protection, social and environmental reporting and voluntary initiatives such as community projects and philanthropy.

As for the protection of freshwater resources it is a key issue of sustainable development [WWAP, 2015b]. Hence, the use of water stress indices as a strategy to act for global water security is in line with the concept of CSR. However, according to Maitra and Stuchtey [2013] many companies have changed their view of water scarcity as primarily a CSR issue. Maitra and Stuchtey [2013] argue that many companies now consider water scarcity a key business risk.

An important argument in support of CSR is that research evidence has established a positive link between CSR and a firm's financial performance [Okpara and Idowu, 2013]. However, for the use of CSR to be justifiable from an ethical perspective it is not only important for CSR to make economic sense [Frederiksen and Juul Nielsen, 2013]. From an ethical perspective it is appears evident that CSR should have the actual capacity to address global social problems such as poverty and environmental security. To put it more simply, CSR practices should not only look good. In a critical analysis of CSR van Oosterhout and Heugens [2008] conclude that the case for CSR is weak both from a theoretical and empirical standpoint. Van Oosterhout and Heugens [2008] argue that it is not clear what CSR is and that there is a lack of empirical data.

At the same time, Okpara and Idowu [2013] report that there is a growing support for CSR among academics and practitioners (i.e. businesses). In addition, the United Nations urges the manufacturing industry to take action for the protection of important water resources by corporate social responsibility [WWAP, 2015b].

In the context of this project there is one aspect of CSR that is important, namely if water stress assessment is a CSR practice that could be used to improve water security. There appears to be a link between CSR and water stress indices and CSR theory is here regarded as a suitable theory for discussions of water stress indices and global water assessment tools. To what degree water stress indices can be used to increase water security is not discussed here but in a following part of this paper.

2.2 Global water assessment tools

Many indices have been developed in the last 20 years for measuring water scarcity and water stress [Brown and Matlock, 2011]. A large number of indices have been incorporated into so-called global water assessment tools. In literature they are also referred to as water assessment tools or just assessment (or water) tools. These tools make the indices available for the public and companies. The water tools presented in the following sections are developed by Non-Governmental Organisations (NGOs) in collaboration with financial organisations.

Four global water assessment tools were evaluated to provide information of different types of tools. Table 2.1 shows what was found to be the most suitable use of the tools and which tools have water stress indices.

Table 2.1: Short presentation of four water assessment tools.

Name (Developer)	Description	Purpose of use	Water stress indices	Source
Aqueduct (WRI)	Online water risk assessment tool	Plotting sites on risk maps	YES	(WRI, 2015)
Aqua Gauge (Ceres)	Leadership-oriented excel-based tool	Developing a water strategy	NO	(Ceres, 2015b)
Global Water Tool (WBCSD)	Excel-based water assessment tool	Making water stress assessments	YES	(WBCSD, 2015b)
Water Risk Filter (WWF-DEG)	Online water risk assessment tool	Making water risk assessments	YES	(WWF-DEG, 2015b)

Mueller et al. [2015] put forward a number of important aspects to consider in the selection of a tool that will be used to measure water stress. These aspects are global applicability, public availability, valid input data and regular updates [Mueller et al., 2015]. The first feature was considered especially important for this project. Since the SCA have sites in many countries it was important to find a tool that covered most parts of the world. In short, the main condition for a tool to be selected for use was that the tool had indices that could be used to measure water stress on a basin level worldwide.

In order to carry out the assessment in this study it was important to find at least one tool that could be used to measure water stress indices on a basin level. In fact two tools, the Global Water Tool and the Water Risk Filter, were found to be suitable and were used in this study.

The tools listed in Table 2.1 are described in more detail in the following sections, firstly to present the tools and secondly to show different approaches to water stress assessment.

2.2.1 Aqueduct Water Risk Atlas (Aqueduct)

The Aqueduct Water Risk Atlas is both a publicly available global database and an online mapping tool. It was developed by the WRI (World Resources Institute) Markets and Enterprise Program. Maps are created with this tool that provides information on water-related risks. To make the maps 12 global water indices are used. Those indices have been developed by WRI and they are grouped into WRI's "Water Risk Framework", which is described by Reig et al. [2013]. It is a framework of how to measure water risk by combining index values into aggregated risk scores. "Physical Risk: Quantity" is one of the three aggregated risk scores, see Table 2.2.

Table 2.2: WRI's Water Risk Framework

Aggregated risk scores	WRI Indices
Physical Risk: Quantity (7 indices)	Baseline Water Stress, Inter-annual Variability, Seasonal Variability, Flood Occurrence, Drought Severity, Upstream Storage and Groundwater Stress
Physical Risk: Quality (2 indices)	Return Flow Ratio and Upstream Protected Land
Regulatory & Reputational Risk (3 indices)	Media Coverage, Access to Water and Threatened Amphibians

Companies can use the tool to prioritise actions and investors can use it to gain knowledge that can be used as leverage [Reig et al., 2013]. In addition Reig et al. [2013] present Aqueduct as a tool for governments that are interested in engaging with the private sector.

All indices in Aqueduct are described in detail by Gassert et al. [2013]. This tool includes Baseline Water Stress, which is a water stress index developed by WRI. However, Aqueduct is adapted to generate maps that incorporate many aspects besides Baseline Water Stress. Some WRI indices in Aqueduct are also incorporated into the Global Water Tool. In the latter tool the indices (e.g. Baseline Water Stress) were found to be more easily accessible.

2.2.2 Ceres' Aqua Gauge

The tool is developed by the World Business Council for Sustainable Development (WBCSD), Irbaris and the IRRC Institute in consultation with over 50 investors, companies and NGOs. On Ceres' webpage, where the tool can be downloaded as an excel document, the tool is presented as a tool that is leadership-oriented but it can be used by investors as well. This is an excel-based tool for evaluating a water strategy or for helping a company to construct a new water strategy.

With Ceres' Aqua Gauge a company's water risk management activities can be assessed on a four-level scale that goes from "No action" to "Leading Practice", see information document "The Ceres AQUA GAUGE The Framework for 21st Century Water Risk Management" [Ceres, 2015b].

The primary purpose of the tool is not to assess water stress or water risk at specific locations. It is developed to help companies to evaluate strategies of how to respond to water risk or to build up a new strategy. The tool is also developed for investors that want to understand how well companies are managing water-related risks and opportunities. The tool output is intended as a basis for a dialog with investors [Ceres, 2015b].

2.2.3 Global Water Tool

The Global Water Tool is provided by WBCSD and is presented as a free publicly available recourse for identifying corporate water risks and opportunities on WBCSD's webpage, see [WBCSD, 2015b]. The tool was developed by CH2M HILL, a member company of WBCSD, and was first launched in 2007. This paper relies on the latest available update of the tool from May 2015 [WBCSD, 2015b].

It is an excel-based tool that allows the user to store input data together with the results. It designed for companies operating in multiple countries and is meant to be a first screening of many production sites to capture indications of water risk, see tool user guide [WBCSD, 2015c]. The Global Water Tool can be used to make a water stress assessment on a basin or country level. In the Global Water Tool there are 24 water indices only on a country level and 7 on a country and basin level; all indices are described in WBCSD document "Dataset and definitions", see [WBCSD, 2015a].

To do a site-specific assessment of business water risk the Global Water Tool can be combined with a compatible tool, namely GEMI's Local Water Tool [WBCSD, 2015c]. The latter is also a free excel-based tool [GEMI (Global Environmental Management Institute), 2015].

The Global Water Tool can be used directly to assess water stress on a basin level. It was the first tool selected for this project, where it was used to measure indices for the assessment of SCA sites on a basin level. The assessment was made with two indices provided by WRI, namely Annual Renewable Water Supply per Person – 1995 and Baseline Water Stress. In both indices a five-level scale is used to define different levels of water availability. However, the indices use different methods of calculating water availability and the levels have different names. There are four indices related to water stress in the tool, but the two indices of scarcity by the International Water Management Institute (IWMI) were not available in the update used in this project.

The full assessment generated by the Global Water Tool includes more indices than the two used to measure water stress in this project. Table A.1 gives an overview of all indices in the tool that together make up the water assessment on a basin level. The table also includes information of the datasets, user input and the output of the tool.

2.2.4 Water Risk Filter

The Water Risk Filter was developed by the WWF (World Wide Fund for Nature) and DEG (Deutsche Entwicklungsgesellschaft). It was launched in 2012.

The Water Risk Filter is an online application for analysing business impact on water supply, understanding potential risk exposures, identifying water crisis areas and obtaining ideas for mitigating risk, see user guide [WWF–DEG, 2014]. A water stress assessment can be made in the Water Risk Filter on basin and country level. In the Water Risk Filter there were 33 water indices for basin related risk and 20 indices for country related risk at the time of this project. All indices on a basin level in the Water Risk Filter are listed in Table A.2.

WWF gives detailed information of all indices in the document "Risk Indicators" on the Water Risk Filter's webpage, see [WWF–DEG, 2015a]. The weighting of each index is shown on the tool webpage. An online user that has logged in to the Water Risk Filter can change the weightings so that the index scores will be calculated based on a given weighting instead of the default values. This adjustment of the weightings is recommended in the user guide for users that have better local knowledge [WWF–DEG, 2014]. A user might for example know that the default weighting of the pollution indices does not represent the risk of pollution at the site. The default weightings of the indices used to calculate the average risk scores (physical, regulatory and reputational risk) are shown in Table A.2.

The indices in this tool estimate the risk of a water related event somewhere within the basin where a production site is located. A final basin score is calculated as a weighted average of the 33 indices that measure physical, regulatory and reputation risk in the basin. Every index in the Water Risk Filter is calculated as a score of 1 - 5 where one is "very limited risk" and five is "very high risk". The risk assessment is presented in a format very similar to the Water Risk Framework that is used WRI's Aqueduct tool.

The Water Risk Filter can be used to assess the water situation at a facility level with what is called a company risk assessment, although it was not done for this project. The facility level makes it possible to do a local assessment based on a questionnaire made up of thirty site-specific questions.

At the time of this project the term water stress was not used in the Water Risk Filter to describe any indices on a basin level. As mentioned above the tool has 33 indices for measuring basin risk. Three indices in the category "Physical Risk" are closely related to water stress. These indices are Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat. Together the three indices make up 97,5 % of the average physical risk score and 67,5 % of the final basin risk, which is the average of 33 indices listed in Table A.2.

The Water Risk Filter is the second tool that was used to measure indices for the assessment of SCA sites on a basin level. The first index that was measured, Risk of Scarcity, gave a quantitative assessment of the risk of water scarcity. The second index, Risk of Pollution, gave qualitative assessment of the risk of pollution. The third index, Risk of Ecosystem Threat, gave an assessment of the resilience of the ecosystem. These thee indices were used to estimate water stress because together they incorporated the important features of a general definition of water stress. The concept of water stress is defined as the lack of sufficient water of good enough quality to meet human demands and ensure the health of the ecosystem [Mueller et al., 2015].

2.3 Selected water stress indices

Table 2.3 shows the selected indices with the names used to refer to them in this study. There are some variations with regard to how the indices are named within the tools and in literature with the exception of Baseline Water Stress. Two of the selected indices can be found in the Global Water Tool, three of them can be found in the Water Risk Filter, see Table 2.3.

Table 2.3: Selected water stress indices.

Global Water Tool	Annual Renewable Water Supply per Person – 1995
	Baseline Water Stress
Water Risk Filter	Risk of Scarcity
	Risk of Pollution
	Risk of Ecosystem Threat

The selected indices are also listed in Table A.1 and Table A.2 in Appendix A. The mentioned tables give an overview of the Global Water Tool and the Water Risk Filter respectively. Table A.1 and Table A.2 show more than the selected indices, all indices included in the output (water assessment) on a basin level are shown. The tables in Appendix A also have information of datasets available through the tools and what data users need to enter to use the tools.

The following sections describe the indices that were measured in order to make the water stress assessment that was the aim of this project.

2.3.1 Annual Renewable Water Supply per Person - 1995

Annual Renewable Water Supply per Person - 1995 is an index that gives a quantitative measurement of water availability. The data that is used to calculate the index was gathered by experts in a worldwide survey in 2000. To calculate the index on a basin level the estimated runoff value for a river basin (1995) is divided by the population in the basin (1995). WRI provides datasets to calculate a value on a basin or country level [WBCSD, 2015a]. The datasets are rough-grid and not updated but they cover most countries and basins in the world.

The index can be used to estimate whether or not there is sufficient amount of water per capita. It can be measured in the Global Water Tool. Stress is defined as "a situation where disruptive water shortages can frequently occur" [Revenga et al., 2000]. A site is described as stressed if the water supply in the basin is less than 1700 m^3 per person per year. The assessment "stress" is found at the third level of the scale used by this index, see Table 2.4.

Table 2.4: Score and assessment-scale of Annual Renewable Water Supply per Person - 1995.

	Score (m^3/pers/year)	Assessment
Level 1	> 4000	Abundant
Level 2	1700 - 4000	Sufficient
Level 3	1000 - 1700	Stress
Level 4	500 - 1000	Scarcity
Level 5	< 500	Extreme scarcity

The level for water stress can be compared to the following per capita water footprints: 2842 m^3/person/year (US), 1089 m^3/person/year (India) and 1071 m^3/person/ year (China) [Mekonnen and Hoekstra, 2011]. The higher levels of this index could be viewed as levels of higher stress, the higher levels are "scarcity" (500 - 1000 m^3/ pers/ year) and "extreme scarcity" ($<$ 500 m^3/ pers/ year), see Table 2.4.

2.3.2 Baseline Water Stress

Baseline Water Stress is another index that gives a quantitative measurement of water availability. The index can be used to express how much water is taken out of a river basin compared how much water there is in the basin [Reig et al., 2013]. The score is calculated by dividing an estimated value of total water withdrawal (2010) by the estimated mean annual blue water (1950 - 2008). The World Resources Institute (WRI) provides datasets to calculate a value on a basin level. The calculation method relies on estimations by WRI of total water withdrawals (i.e. water removed from freshwater sources for human use) and an estimate of total blue water from a publication by NASA in 2012. The NASA analysis covered the years 1950 - 2008. The datasets are rough-grid but cover most parts of the world. [Reig et al., 2013]

The index can be used to identify regions experiencing water stress since it gives an estimate of how much water is available for human use. It can be measured in two tools, Aqueduct and the Global Water Tool.

Stress is not defined as a special situation in Baseline Water Stress like it is in Annual Renewable Water Supply per Person - 1995. Instead stress is defined on a scale from low stress to extremely high stress, see Table 2.5.

Table 2.5: Score and assessment-scale of Baseline Water Stress.

	Score (%)	Assessment
Level 1	< 10	Low stress
Level 2	10 - 20	Low to medium stress
Level 3	20 - 40	Medium to high stress
Level 4	40 - 80	High stress
Level 5	> 80	Extremely high stress
	Arid & low water use	Scores as “high stress”

High scores in this index indicate low availability of water. The third level of the scale of this index is “medium to high stress” (20 - 40 %), see Table 2.5. A site with a third level score is located in a basin where 20 % of the available water is estimated to be withdrawn. The higher levels of Baseline Water Stress are “high” (40 - 80 %) and “extremely high” (> 80 %). In this index there is a special category for arid areas (e.g. deserts) and areas with low water use (i.e. largely uninhabited) but these areas score as high stress areas. Baseline Water Stress can be illustrated on maps and then arid, or low water use areas, are shown in grey to separate them from water stressed areas (yellow, orange, red).

2.3.3 Risk of Scarcity

Risk of Scarcity, provided by WWF-DEG, is the third among the selected indices that gives a quantitative measurement of water availability on a basin level. The full name of the index is Physical risk - Quantity (scarcity). This index could be described as an indirect water stress index because water scarcity, which generally means a lack of water, is one indication of water stress. In other words, the term water stress encompasses water scarcity [Mueller et al., 2015].

The score of Risk of Scarcity is calculated as a unitless number that is a weighted average of seven indices in in the Water Risk Filter, see Table A.2 in Appendix A. The indices with the highest weighting on the score are “annual monthly water depletion”, “number of months $>$ 40 % water depletion” and “scarcity in most depleted month”. These indices are measured with WaterGap, which is a hydrological model that simulates water flows [Eicker et al., 2014]. All three indices with the highest weightings relate estimated available water to water-consumption, which shows some similarities with Baseline Water Stress [WWF–DEG, 2015a].

Risk of Scarcity is used in the Water Risk Filter in a larger assessment of basin related risk. The index has a 65 % weighting in the calculation of the final basin risk score, which is an average of all indices in the Water Risk Filter on a basin level. Water Risk Filter is the only tool that measures Risk of Scarcity. The index is measured on a five-level scale from score 1 (very limited risk) to score 5 (very high risk), see Table 2.6. The same assessment scale is used for all indices in the Water Risk Filter.

Table 2.6: Score and assessment-scale of all indices in the Water Risk Filter, including Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat.

	Score (unitless)	Assessment
Level 1	1	Very limited risk
Level 2	2	Limited risk
Level 3	3	Some risk
Level 4	4	High risk
Level 5	5	Very high risk

2.3.4 Risk of Pollution

Risk of Water Pollutions, provided by WWF-DEG, is not a quantitative but a qualitative measurement. It is like Risk of Scarcity original to the Water Risk Filter. The full name is Physical risk - Quality (pollution). A high score in this index indicates that the available water may not be usable. A measurement that shows low water quality can indicate water stress because water quality is included in the definition of water stress [Mueller et al., 2015]. As a consequence, Risk of Pollution is regarded as a suitable water stress index.

The score of Risk of Pollution is calculated as a weighted average of nine indices, see Table A.2 in Appendix A. Each one of the nine indices measures a pollutant with a documented negative effect on water resources or biodiversity [WWF–DEG, 2015a]. The estimated pollutants and the respective weightings are: soil salinization (weighting 11 %), nitrogen loading (13 %) and phosphorus loading (13 %), mercury deposition (9 %), pesticide loading (13 %), sediment loading (12 %), organic loading (as Biological Oxygen Demand, BOD; 17 %), potential acidification (7 %), and thermal alteration (7 %). All nine indices are measured by measuring pollution in grid cells [WWF–DEG, 2015a]. The method was developed by Vörösmarty et al. [2010]. They divided the global landmass into grid cells, 30' (latitude × longitude), and pollution is measured in each cell based on country data for the area the cell covers.

In the Water Risk Filter Risk of Pollution has a 20 % weighting on the final basin risk [WWF–DEG, 2014]. Just as Risk of Scarcity it is an original index to the

Water Risk Filter, and it is only measured in the Water Risk Filter. The assessment scale shown for Risk of Scarcity, is used to measure this index as well, see Table 2.6.

2.3.5 Risk of Ecosystem Threat

Risk of Ecosystem Threat gives an estimate of the quality of the ecosystem. The index the third WWF-DEG index and the second qualitative index used to measure water stress in this study. The full name of the index is Physical risk – Ecosystem threat.

Many ecosystem functions are closely connected to freshwater availability [Brown and Matlock, 2011; WWAP, 2015b]. The ability to provide usable freshwater in sufficient amounts to satisfy the water demand within the basin is one example of an important ecosystem function. There is a recognised link between the degradation of ecosystem functions and depletion of freshwater resources [Brown and Matlock, 2011]. Risk of Ecosystem Threat could be regarded as a suitable water stress index since the index estimates the quality of the ecosystem, which is reported to be connected to water availability. In a basin with a high score there might be a lack of water due to ecosystem degradation.

The score of Risk of Ecosystem Threat is calculated as a weighted average of four indices in the Water Risk Filter, see Table A.2 in Appendix A. Among the indices used to calculate the average score the most important is “threats to biodiversity” with a weighting of 50 %. The indices “access to drinking water” and “access to sanitation” have 20 % weighting each. The forth index that is used to calculate the average score (i.e. Risk Ecosystem Threat) is “vulnerability of water ecosystems in the country”, it has a 10 % weighting on the average score.

Risk of Ecosystem Threat is included in the Water Risk Filter assessment of basin related risk. The index belongs to the category “Physical Risk” and it has a weighting of 12 % in the calculation of the final basin score, i.e. the weighted average of physical, regulatory and reputational risk, see Table A.2. Risk of Ecosystem Threat is only available in the Water Risk Filter and like all indices in the Water Risk Filter it is measured on the five-level scale shown in Table 2.6.

Chapter 3
Assessment methodology

The water stress assessment, which was the primary objective of this degree project, was carried out by measuring five water stress indices with the help of two different global water assessment tools. A challenge of this project was to choose which results should indicate water stress. Because it is not possible to measure water stress directly [Mueller et al., 2015] a choice was made of how water stress should be defined for each index. How the results that are presented in this study were measured and how the results can be connected to water stress is described below.

3.1 Measuring indices

Among the four evaluated tools two were selected, WBCSD's Global Water Tool and WWF-DEG's Water Risk Filter. These tools were used to make water stress assessments for 96 SCA sites that were listed in SCA's water data for 2014. For these sites corporate data was gathered such as site location, water intake and type of process.

Firstly the locations for the 96 sites were entered into each tool. Together with the datasets within the tools the calculations were based on location data (i.e. GPS coordinates). After the locations had been entered into a tool a value was calculated automatically for each site and each index in the tool. Many of the indices that were calculated automatically were not used in this project. For this project only the five indices selected in the literary study were of interest, i.e. Annual Renewable Water Supply per Person – 1995, Baseline Water Stress, Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat. The selected indices are presented in chapter 2 where Table 2.3 shows which index was measured in which tool.

All indices except Risk of Pollution were measured on a basin level. The index Risk of Pollution was measured on a country-grid level; the consequence of a basin level/ grid level measurement is described further, see "3.2 Defining water stress" below.

In the Global Water Tool the results were shown in the excel document (downloaded from WBCSD's webpage) after the site information (i.e. site name and location) had been filled in. That excel document contained all indices in the Global Water Tool on a basin and country level.

As for the results from the Water Risk Filter, these were found on the Water Risk Filter webpage. Here follows a short description of how the Water Risk Filer was used. Firstly an online account was created and site information (i.e. site name and location) was uploaded. Thereafter a full risk assessment (including all indices in the tool on a basin and country level) was generated more or less immediately. Finally, the results could be accessed and downloaded by a registered user to the above-mentioned online account.

After the indices had been measured each site had five assessments that was used further in this study, one assessment for each of the selected indices. However, the index scores that had been measured in the tools were not used directly as results. To get comprehensible results each score of the selected indices was linked to an assessment according to assessment-scales shown in Table 2.4 – 2.6.

3.2 Defining water stress

The assessment that a site showed indications of experiencing water stress was given if the site got high enough scores in the selected indices that had been automatically calculated in the tools.

In the Global Water Tool a site was assumed to show an indication of water stress if the site got the assessment "stress", "scarcity" or "extreme scarcity" in the index Annual Renewable Water Supply per Person - 1995 or the assessment "medium to high", "high" or "extremely high" in the index Baseline Water Stress.

In the Water Risk Filter a site was assumed to show an indication of water stress it the site got the assessment "some risk", "high risk" or "very high risk" in any of the indices Risk of Scarcity, Risk of Pollution or Risk of Ecosystem Threat.

Turning from the question of if there is water stress to another question. Where does the index show an indication of water stress? For the indices measured on a basin level the index score (and assessment) actually represents the basin, i.e. the score and assessment would be used for every site in the basin. There is one exception to the rule that all sites in the same basin get the same assessment. In the index Risk of Pollution it is possible that sites in the same basin could get different assessments because the datasets used to calculate Risk of Pollution are available on a grid level [WWF–DEG, 2015a].

Chapter 4
Results

The results clearly show that different indices give different water stress assessments. Because the indices were calculated for 96 sites the tables that list the sites and the corresponding assessments are quite long and these longer tables are shown in the Appendix B instead of this part of the report.

This chapter presents two main things, firstly how many sites show indications of water stress in each of the selected indices. Secondly the results show that the assessment depends on which index is used to make the assessment. The results shown here are a summary of the results in Appendix B where Tables B.1 - B.5 show the assessment and a selection of corporate water data from 2014 for each site in each of the selected indices.

In the sections below the results of each of the five selected water stress indices are shown as frequency diagrams, see Figure 4.1 - 4.5. These diagrams show the number of sites at each level of the assessment scale of the indices Annual Renewable Water Supply per Person – 1995, Baseline Water Stress, Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat respectively. In chapter 2 above the assessment-scales and the corresponding calculated scores could be seen side by side in Tables 2.4 - 2.6.

4.1 Annual Renewable Water Supply per Person - 1995, measured in WBCSD's Global Water Tool

Annual Renewable Water Supply per - Person - 1995 is one of the WRI indices that were measured in WBCSD's Global Water Tool [WBCSD, 2015b]. The summary of the results of the measurement of Annual Renewable Water Supply per Person - 1995 is shown in Figure 4.1.

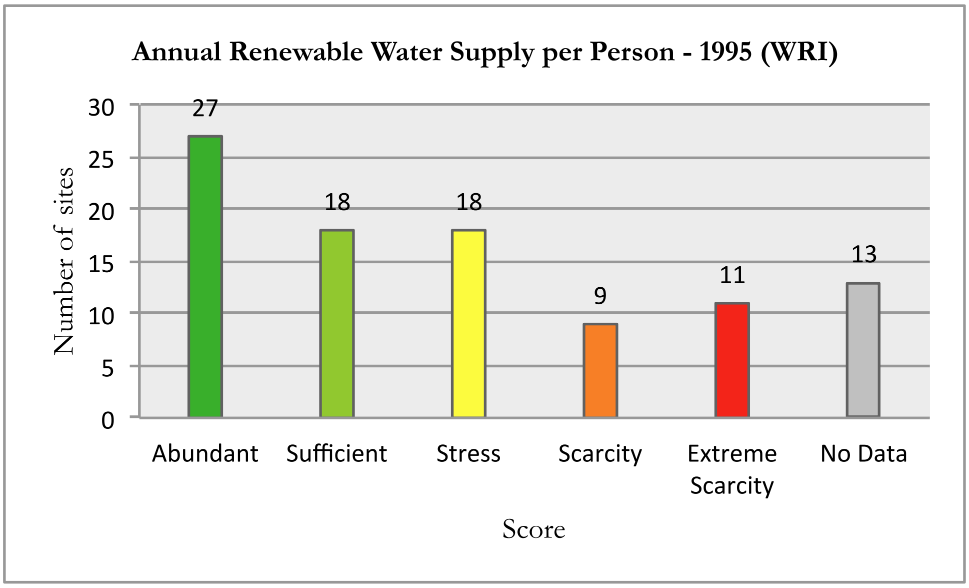

Figure 4.1: Number of sites given each assessment on the scale of Annual Renewable Water Supply per Person - 1995.

The first two columns to the left in Figure 4.1 show that 45 sites are located in areas that did not appear to experience water stress according to this index. There are 27 sites with the assessment "abundant". At these sites the annual water supply per person in the basin is estimated to > 4000 m^3 freshwater per person. Each person in the basin is estimated to have access to > 4000 m^3 freshwater per year under the assumption that water is shared equally [WBCSD, 2015a]. The assessment "sufficient" is given to 18 sites. In the basin where these sites are located the population is estimated to have access to sufficient amount of water, which is defined as 1700 - 4000 m^3 freshwater/pers/year.

In this index the water-deficit threshold is defined as < 1700 m^3 freshwater/pers/ year. It is a score that gives the assessment "stress". The threshold is found at the third level of the scale, see third column from the left in Figure 4.1. Altogether there are 38 sites that fall below the threshold. All these sites are thus located in basins that appear to experience at least some indication of water stress. Among the sites below the water-deficit threshold, 18 sites get the assessment "stress" (1000 - 1700 m^3/pers/year), 9 get "scarcity" (500 - 1000 m^3/pers/year) and 11 get "extreme scarcity" (< 500 m^3/pers/year), see Figure 4.1.

Finally the results show that all sites did not get a calculated score in this index. The column to the right in Figure 4.1 shows "no data" for 13 sites. Consequently, the datasets that were used to calculate the index did not cover all site locations (GPS coordinates). Therefore the conditions at 13 sites could not be evaluated by measuring Annual Renewable Water Supply per Person – 1995. Table B.1 in Appendix B shows which the unevaluated sites are and the assessments for all other sites.

4.2 Baseline Water Stress, measured in WBCSD's Global Water Tool

Baseline Water Stress is the second WRI index that was measured in WBCSD's Global Water Tool, see [WBCSD, 2015b]. The summary of the result of the measurement of Baseline Water Stress is shown in Figure 4.2.

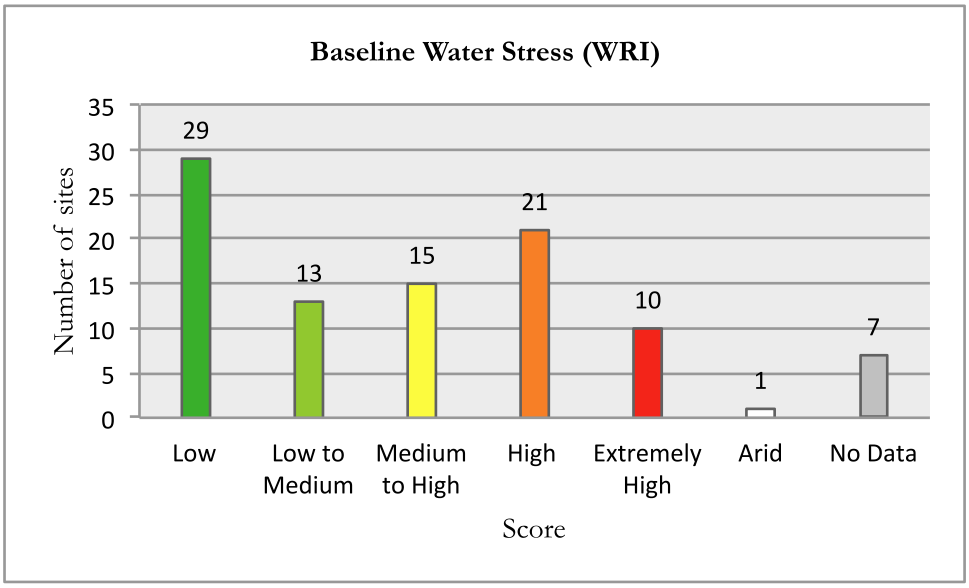

Figure 4.2: Number of sites given each assessment on the scale of Baseline Water Stress.

The first two columns to the left in Figure 4.2 show that there are 42 sites located in areas that did not appear to experience water stress according to the index Baseline Water Stress. There are 29 sites that get the assessment "low stress", which corresponds to the Baseline Water Stress score < 10 %, see assessments and scores side by side in Table 2.5. The next assessment on the scale "medium to high stress" (10 - 20 %) is given to 13 sites. For a site with "medium to high stress" WRI estimates 10 – 20 % of the available water in the basin is withdrawn for human use.

As mentioned in "2.3.2 Baseline Water Stress" the score of Baseline Water Stress is calculated as the estimated annual blue water withdrawal for human use divided by the estimated mean available blue water [Reig et al., 2013]. In other words Baseline Water Stress gives an estimate of how much water is withdrawn for human use compared to how much water is estimated to be available for human use. By consequence, at sites with the assessment "low stress" only a small part of the available water is estimated to be withdrawn. More specifically, the estimated amount of blue water that is withdrawn in the basin for human use is less than 10 % of the estimated amount of available water in the basin. When the index is calculated the water demand for agriculture, industry and municipality is not included in water withdrawal for human use [Reig et al., 2013].

The third level of the assessment scale of Baseline Water Stress is "medium to high stress" (20 - 40 %). This assessment is given to 15 sites. They are located in basins where the calculated value of baseline water stress is in the range 20 - 40 %. Counting sites with the score “medium to high” and the sites that get even higher scores it makes a total of 47 sites located in basins that appear to experience moderate to extremely high levels of water stress according to Baseline Water Stress. There are 21 sites that get the assessment “high stress” (40 - 80 %), 10 sites that get the assessment “extremely high stress” (> 80%) and one that gets the assessment “arid & low water use”. The assessment “arid” (which is only given to the site in Flagstaff) scores as high stress. As mentioned in “2.3.2 Baseline Water Stress” the assessment “arid” is introduced by WRI to separate low water use areas (e.g. deserts) from water stressed areas.

Finally, the summary of the measurement of Baseline Water Stress shows that only a few sites cannot be evaluated in this index, see Figure 4.2. The databases that were used to calculate the index covered all sites except 7. For the other sites there is a water stress assessment, which can be seen in Table B.2 in Appendix B.

4.3 Risk of Scarcity, measured in WWF-DEG’s Water Risk Filter

Risk of Scarcity is one of the water risk indices that were measured in WWF-DEG’s Water Risk Filter. In this index the score is not a value that shows some defined level of water stress. Unlike the WRI indices the score is a unitless risk score. For Risk of Scarcity the score is calculated in the Water Risk Filter as a weighted average of seven indices in the category Physical Risk, see Table A.2 in Appendix A. The frequency diagram that gives a summary or the results for this index is shown in Figure 4.3.

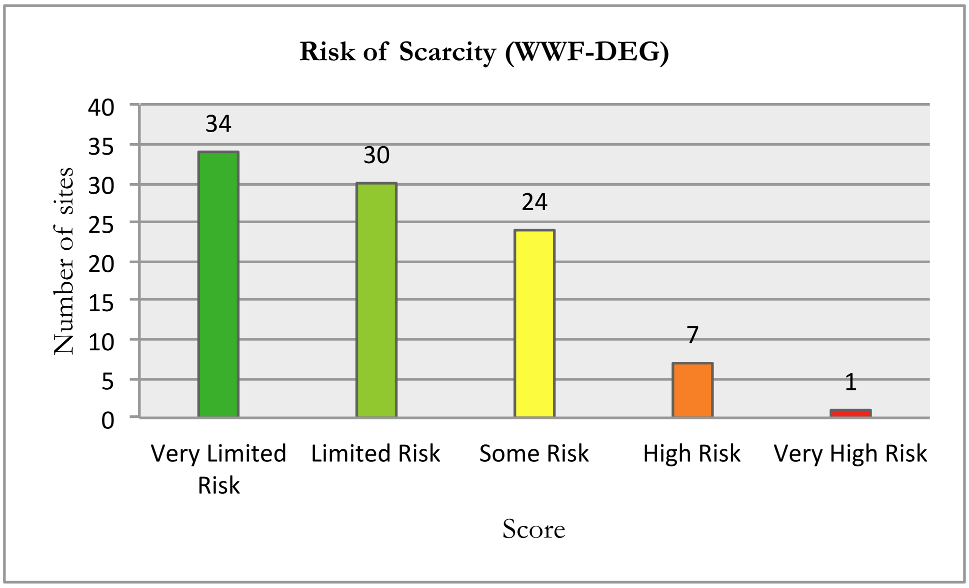

Figure 4.3: Number of sites given each assessment on the scale of Risk of Scarcity (Physical risk - Quantity (scarcity)).

With regard to the appearance of Figure 4.3, the diagram seams to show a cascading trend from left to right, i.e. the number of sites that get the respective scores 1 – 5 is decreasing as the level of stress goes up.

Two thirds of the sites get a low risk score, see Figure 4.3. In this study low risk of scarcity is interpreted as low risk of water stress in the basin, see "3.2 Defining water stress". There are 34 sites that get risk score 1, which indicates "very limited risk" of scarcity. Almost as many sites, i.e. 30 sites, get score 2 = "limited risk".

In total there are 32 sites that get medium to very high risk scores. The index Risk of Scarcity gives an indication of some to very high risk of scarcity in the basin where those sites are located. Moreover, scarcity is interpreted as an indication of water stress, as mentioned above. Among the sites with scores indicating some to very high risk, most sites get score 3 = "some risk". Only 7 get score 4 = "high risk" and only one site, Monterrey, gets score 5 = "very high risk".

The fact that there were gaps in the datasets could be seen in the risk assessment document, which was downloaded from the Water Risk Filter's webpage. The document showed gaps in one or two of the seven indices used to calculate the average score (i.e. Risk of Scarcity). Despite the mentioned gaps, a score of Risk of Scarcity had indeed been calculated in the Water Risk Filter for each site. By consequence, an assessment is shown for all 96 sites in Table B.3 in Appendix B.

4.4 Risk of Pollution, measured in WWF-DEG's Water Risk Filter

Risk of Pollution is the second among the selected water stress indices that were measured in WWF-DEG's Water Risk Filter. The unitless score of this index is calculated as a weighted average of nine indices, each indicating the level of pollution of one pollutant (e.g. nitrogen and phosphorus), which has a well-documented negative effect on water resources, biodiversity or both. The nine pollutants and their respective weightings are given in Appendix A, see Table A.2. The frequency diagram, which gives a summary of the results for Risk of Pollution, is shown in Figure 4.4.

As seen in Figure 4.4 most sites get high risk scores. Only 4 sites get score 1 = "very limited risk". 11 sites get score 2 = "limited risk".

The third level of the assessment-scale shown in Table 2.6 is the threshold above which the index gives at least "some risk" of pollution. In total there are 81 sites above this threshold. Vörösmarty et al. [2010] is given as the source for the index Risk of Pollution [WWF–DEG, 2015a]. Hence, 81 sites are located somewhere in an area where Vörösmarty et al. [2010] estimated moderate to high risk of pollution. The size of an area is defined by the resolution of the grid, which is 30' (latitude × longitude).

Since pollution can give rise to water stress the assessment "some risk" of pollution is also used as a threshold of water stress in this study, see "3.2 Defining water stress". In an area with a high score Vörösmarty et al. [2010] estimated that the human population or the ecosystem did not have access to usable water.

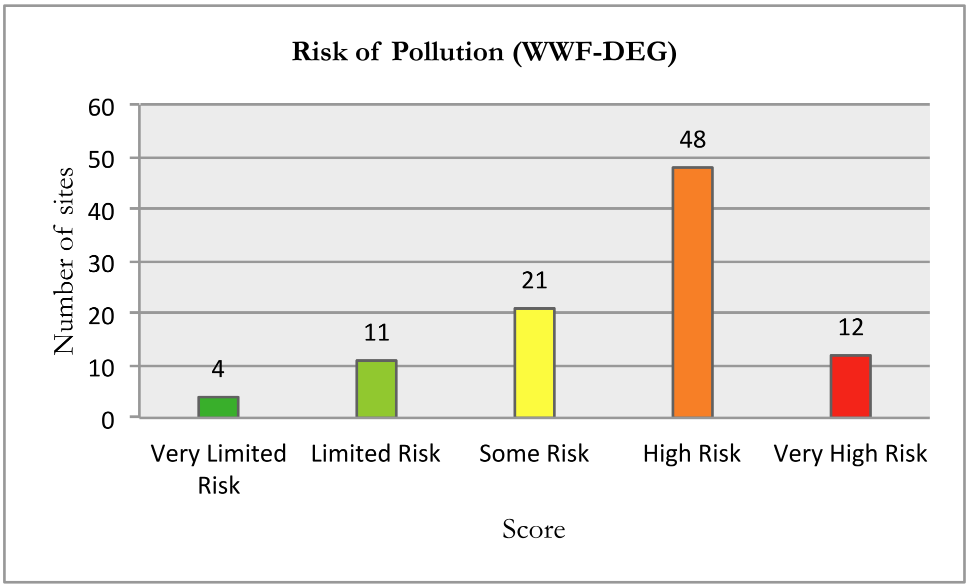

Figure 4.4: Number of sites given each assessment on the scale of Risk of Pollution (Physical risk - Quality (pollution)).

Figure 4.4 shows that there are 21 sites that get score 3 = "some risk" of pollution, There are 48 sites that get score 4 = "high risk" and 12 that get score 5 = "very high risk".

As a final remark, there are some question marks with regard to how Risk of Pollution was calculated in the Water Risk Filter. In the original WWF-DEG document, which contains the risk assessment, the scores of many indices can be seen. Both the average score (i.e. Risk of Pollution) and the individual scores of the nine pollutants are included in the document. The above mentioned document shows some significant gaps in the datasets. There are 10 sites that have an average score but gaps in every index of the nine pollutants. These sites are Beijing, Falkenberg, Munksund, La Riba, Puigpelat, Taipei, Sotteville, Yildiz (Istanbul 2) and two sites in Santo Domingo. It appears as if the locations of the above mentioned sites were not covered in the datasets used to calculate Risk of Pollution. The final question is how the average score is calculated. What is also remarkable is that the 10 sites with missing values for all pollutants get different assessments, i.e. some show an indication of high risk of pollution and some show low risk, see assessments for all sites in Table B.4 in Appendix B.

4.5 Risk of Ecosystem Threat, measured in WWF-DEG's Water Risk Filter

Risk of Ecosystem Threat is the third index in this study that was measured in WWF-DEG's Water Risk Filter. The score, which is unitless, was calculated as a weighted average of four indices of Physical Risk, listed in Table A.2. A high score in this index indicates that there is a risk that the ecosystem is not functioning well. That means at sites with a high score the ecosystem may not be able to supply freshwater of good enough quality to sustain the water demand in the basin. Therefore Risk of Ecosystem Threat could be used to indicate water stress according to the definition of water stress, see "3.2 Defining water stress". The frequency diagram, which shows the summary of the results for Risk of Ecosystem Threat, is shown in Figure 4.5.

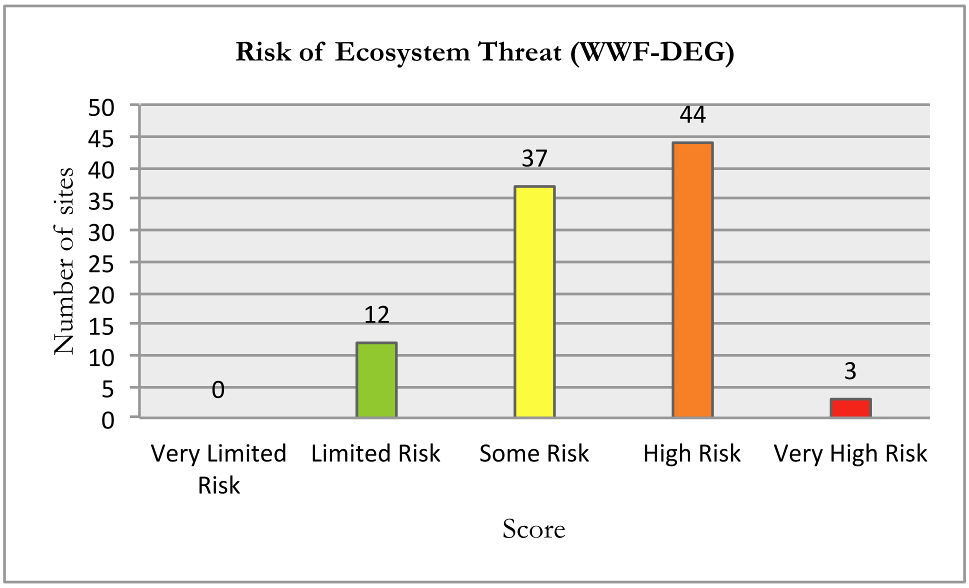

Figure 4.5: Number of sites given each assessment on the scale of Risk of Ecosystem Threat (Physical risk – Ecosystem threat).

Almost all sites get moderate to high scores, which means almost all sites are located in basins where the ecosystems appears to be threatened, see Figure 4.5. No site gets the assessment "very limited risk" and only 12 sites get the assessment "limited risk".

There are in fact 84 sites with scores 3 - 5, see Figure 4.5. Most sites are thus above the threshold that is used in this study to indicate water stress in the index Risk of Ecosystem Threat. Among the sites in areas above the threshold 37 sites get score 3 = "some risk" of ecosystem threat, 44 sites get score 4 = "high risk" and 3 sites get score 5 = "very high risk".

4.5.1 Comments: basin level assessment

Here follows some results of Risk of Ecosystem Threat and comments that show the implications of doing the assessment on a basin level. All three sites that get the highest score of Risk of Ecosystem Threat are located in the same basin according to the Water Risk Filter. It is the Italian sites Altopascio, Collodi and Lucca 1.

In a basin level assessment, the index score is calculated based on the same data for every location in the basin. The results of Altopascio, Collodi and Lucca 1 are presented here as an example. The fact that those Italian sites get the same assessment is a direct consequence of calculating an index on a basin level.

The basin names are shown in the document containing the water risk assessment, which was downloaded from the Water Risk Filter. It is thus possible to see which GPS coordinates the tool places in same basin. In the Water Risk Filter that basin is called Italy (Other) for Altopascio, Collodi and Lucca 1. It was noted that the mentioned Italian sites are also located in the same basin according to WBCSD's Global Water Tool. However, the Global Water tool gave another name (GHAASBasin2255).

In the Global Water Tool the basins either have a name (e.g. Mississippi) or a code (e.g. GHAASBasin2255). It was noted that the Water Risk Filter gives the same name for the basins with a name like Mississippi in the Global Water Tool. All basins that get code-names such as GHAASBasin2255 in the Global Water Tool the Water Risk Filter systematically calls "Country-name (other)". The basins in the Global Water Tool were found to be defined according to the Global Hydrological Archive and Analysis System (GHAAS) [Water Systems Analysis Group, 2014]. To summarise, it is possible that both water tools that were used in this study had the same system of defining basins, namely GHAAS.

Chapter 5
Analysis

This report presents the results of a water stress assessment, and in addition the report gives an example of how to carry out a water stress assessment. This assessment was made for 96 of SCA's production sites by measuring two indices in the Global Water Tool and three indices in the Water Risk Filter. In fact, there are many alternative methods to assess water stress. Brown and Matlock [2011] have for instance presented many indices of water stress and scarcity.

In principal, this assessment was defined by three choices. Firstly, the choice was made to do the assessment on a basin level. Alternatively, it would have been possible to estimate water stress on a country level or to estimate water stress by doing site-specific assessments. Secondly, the choice was made to measure indices instead of using maps. In case maps would have been used SCA's production sites would have been located on global maps that showed estimated water stress levels for different areas with the help of colours. The third choice that defined this assessment was to use tools to measure the indices. The water tools made it possible to measure the indices without directly accessing the databases that were required to calculate the indices.

The first section of the analysis deals with the strengths and drawbacks of the indices in this study, i.e. Annual Renewable Water Supply per Person – 1995, Baseline Water Stress, Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat. The second section gives a comparison of the Global Water Tool and the Water Risk Filter. The final section focuses on a selection of the results, which means that the assessments for some types of sites are discussed in more detail. One screening shows assessments for pulp & paper mills, the sites that together accounted for about 53 % of SCA's total water intake in 2014, see Table 1.1. Another screening shows the assessments of sites that used borehole-water in 2014 and showed an indication of water stress in at least one of the five selected indices in this study.

For reference, all results are presented in Table B.1 – B.5 in Appendix B. In Appendix B there is one table for each water stress index in this study.

5.1 Strengths and drawbacks of indices

It would be possible to choose to do a water stress assessment by just using one index. That choice immediately begs the question of which index to select. An alternative to selecting one index could be to use several, or all, indices that were measured in this study. The indices have similarities but they have different strength and drawbacks that could possibly make the results of some indices more important than others.

The greatest difference between the indices in this study is found between the indices that are quantitative in nature (Annual Renewable Water Supply per Person – 1995, Baseline Water Stress and Risk of Scarcity) and the indices that give a qualitative assessment (Risk of Pollution and Risk of Ecosystem Threat). The qualitative indices that estimate water and ecosystem quality could possibly be important to complement the quantitative indices that estimate water availability.

5.1.1 Older water stress assessment

Here follows some comments regarding a previous assessment. In fact, this study is not the first water stress assessment made of SCA sites. In the previous assessment the index Annual Renewable Water Supply per Person - 1995 was used to assess water stress on a basin level. The method used to calculate this index has been criticised for being a too simplified for assessing water stress [Brown and Matlock, 2011]. Yet, it is still one of the most widely used water stress indices [Brown and Matlock, 2011].

Since it is an accepted index one alternative could be to only use Annual Renewable Water Supply per Person - 1995. That would give the same results as using the previous water stress assessment plus adding the results for sites that were not included in the previous assessment.

Annual Renewable Water Supply per Person – 1995 was not the only index in the previous assessment. There were two more indices from the Global Water Tool. They are not included in this study because one (Total Renewable Water Resources per person by FAO, 2008) is measured on a country level and the other (Mean Annual Relative Water Stress Index by the University of New Hampshire, 2000) is not included in the updated version of WBCSD's Global Water Tool, which was used in this study.

5.1.2 Quantitative indices

Baseline Water Stress is one of the indices in this study that was used to make a quantitative assessment, i.e. an assessment of water availability. The other quantitative indices are Annual Renewable Water Supply per Person - 1995 and Risk of Scarcity. Baseline Water Stress was found to have more advantages compared to other indices. Mainly, this index was found to be easier to interpret than the other indices. The results of a measurement of Baseline Water Stress could be interpreted as an estimate of the level water stress in a basin. It was how the results were meant to be interpreted according to WRI [Reig et al., 2013]. The benefit of using Risk of Scarcity is discussed in the end of this section.

The fact that the concept water stress is part of the name clearly connects Baseline Water Stress to water stress. The connection to water stress is not that clear for the other indices. Therefore the connection to water stress had to be motivated in order to use the other indices to measure water stress. For example, the use of WWF-DEG's index Risk of Scarcity could be motivated since scarcity is closely connected to water stress, see "3.2 Defining water stress".

A strength of both Baseline Water Stress and Risk of Scarcity compared to Annual Renewable Water Supply per Person – 1995 is that the former relies on relatively recent data. There are reasons to suspect that the results of Annual Renewable Water Supply per Person -1995 could be questioned since it is clear that this index with data from 1995 is relatively old.

The fact that WRI includes Baseline Water Stress in their Water Risk Framework but not Annual Renewable Water Supply per Person - 1995 is taken as an argument that Baseline Water Stress is the better index of the two. Since Baseline Water Stress is included in WRI's Water Risk Framework the data sources and methods of calculation were described in detail in documentation provided by WRI, see [Reig et al., 2013]. The mentioned documentation shows that many aspects are taken in hand as WRI gives an estimate of Baseline Water Stress. "Water withdrawal", which is estimated, is for example not the outtake by all sectors but a rough calculation of how much water is annually withdrawn for human use [Reig et al., 2013].

One drawback of using Baseline Water Stress is that the GPS coordinates of all sites were not covered in the datasets. As a consequence, the sites that are located in areas that were not covered in the datasets did not get an assessment. However, the fact that WBCSD's Global Water Tool shows the result "no data" instead of an assessment strengthens the transparency of the overall assessment.

The index Risk of Scarcity is similar to Baseline Water Stress. Both indices are calculated by dividing an estimate of withdrawal with an estimate of available water, see [WWF–DEG, 2015a] and [Reig et al., 2013]. This calculation method is based on the idea that water stress would increase in an area where there is an increase in the amount of water withdrawn compared to the amount of water available in the freshwater sources that supply the area in question.

There is a benefit of measuring Risk of Scarcity in the Water Risk Filter compared to measuring Baseline Water Stress in the Global Water Tool. Although the score of Baseline Water Stress is based on calculations of other indices, [Reig et al., 2013], only the result of Baseline Water Stress is shown in the Global Water Tool. The indices that are used to calculate Risk of Scarcity are included in the document that shows the assessment of the Water Risk Filter. When Risk of Scarcity is measured in the Water Risk Filter it is possible to get information such as which month of the year water is most scarce according one index calculated with the WaterGap model.

The three quantitative indices in this study were used to estimate a similar property, namely if there was sufficient amount of water in the basins where the sites were located. If the quantitative indices that estimate water availability gave very reliable assessments it would be possible to assume that the same sites should get the same results in different quantitative indices. A close correspondence between indices was not shown in this study. However, about 60 % of the sites get the same assessment level in two or three quantitative indices.

5.1.3 Qualitative indices

Risk of Pollution and Risk of Ecosystem Threat were used as fully qualitative indices. The above mentioned indices stand out from the other indices in this study by not giving any information regarding water availability. Depending on the site it could be more important to estimate water and ecosystem quality than to estimate water availability and vice versa. The qualitative indices were used in this study because concepts such as good water quality and a well-functioning ecosystem were considered important. Mueller et al. [2015] argued that water stress is a condition that occurs if there is a lack of water of good enough quality for humans and the ecosystem. Thereof follows that qualitative aspects are important in order to estimate water stress.

Risk of Pollution can be used to identify sites that are possibly located in polluted areas, and pollution could in turn indicate water stress. The other qualitative index in this study, Risk of Ecosystem Threat, can be used to identify areas where there are indications of ecosystem-degradation, and that could also in turn be an indication of water stress. In case qualitative indices were used as a complement to quantitative indices it would become possible to identify sites that could be regarded as water stressed even though a quantitative assessment would show no indication of a lack of available water.

Although the qualitative aspects are important to estimate water stress, low water quality may not be important with respect to water security for individual sites. It is possible that a production site that depends on water may not depend on high quality water, e.g. cooling does not require clean water. But water quality may also be connected to water risk. In a polluted area there is a risk that regulations change with the result that the water treatment needs to be improved to meet the new demands from the municipality [Maitra and Stuchtey, 2013].

One of the more spectacular results of this study is that most sites that were assessed got high scores in the index Risk of Ecosystem Threat, see Figure 4.5. Since water stress assessment is in the developing stages it is difficult to know how well the result of the measurement of Risk of Ecosystem Threat corresponds to reality. This could be said for the result of other water stress indices as well. Unreliability is a major drawback of all of them. However, the threat to an ecosystem is assumed to be more difficult to estimate than parameters such as water availability and pollution. According to Brown and Matlock [2011] it is difficult to measure the connection between the reliability of a freshwater system and how well the ecosystem is functioning. Even so, there is a clear connection between the resilience of an ecosystem and water security [Vörösmarty et al., 2010]. Thereof follows that some estimation of ecosystem threat should be included in an ideal water stress assessment. The reliability of current water stress assessments is discussed further in the following section, see “5.2.1 Selection of one tool”.

5.2 Comparing water assessment tools

Water assessment tools were considered essential to this project since they provided a practical way to measure water stress indices. As the results of the different tools were compared it became clear that different indices gave different results. Therefore the total number of SCA sites in areas with an indication of water stress was not conclusively determined.

The decision of which tool to use could greatly impact the water stress assessment because different indices fundamentally give different assessments. The choice to use one tool will determine which indices will be used; vice versa the choice to use one index is a way to select a tool. Both tools in this study, Global Water Tool and Water Risk Filter, had different indices that estimated water availability or quality based on different methods.

One similarity for the tools is that all indices that were selected for this study were measured on a five level scale, see Table 5.1. That made it easier to compare the results of different indices. The assessment levels shown in Table 5.1 were also included in Table 2.4 – 2.6 that showed assessments and scores side by side.

Table 5.1: Five assessment levels. Each level corresponds to a water stress assessment, which is not the same for different indices. Following indices are included Annual Renewable Water Supply per Person -1995, Baseline Water Stress, Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat.

	Annual Renewable Water Supply per Person - 1995 (WRI) in Global Water Tool	Baseline Water Stress (WRI) in Global Water Tool	Risk of Scarcity (WWF-DEG) Risk of Pollution (WWF-DEG) Risk of Ecosystem Threat (WWF-DEG) in Water Risk Filter
Level 1	Abundant	Low	Very Limited Risk
Level 2	Sufficient	Low To Medium	Limited Risk
Level 3	Stress	Medium To High	Some Risk
Level 4	Scarcity	High (includes Arid & low water use)	High Risk
Level 5	Extreme Scarcity	Extremely High	Very High Risk

If a site get a score above the threshold of water stress in one index the site will not necessarily get a score that corresponds to water stress in other indices. For example, if a site gets the assessment “medium to high” which is the third level in Baseline Water Stress the site in question cannot be expected to get the third level in Risk of Scarcity, i.e. “high risk”. With regard to that example, this study shows that 7 of the 16 sites that get the third level in Baseline Water Stress also get the third level in Risk of Scarcity, see Table B.2 and Table B.3 in Appendix B.

5.2.1 Selection of one tool

It could be more practical and less time consuming to use one tool instead of two. The Global Water Tool and the Water Risk Filter are here compared in order to provide information that could possibly be of use in a future water stress assessment. The tools are compared from three aspects:

- Usability
- Indices in the tool
- Reliability

5.2.1.1 Usability

Firstly the tools are compared from the perspective of usability. The Global Water Tool was found to be more easy to use than the Water Risk Filter. The Global Water Tool was preferred firstly because it did not change indices and appearance during the time of this project and secondly because the site information used to calculate the index was stored in the same document as the results. Moreover, the Global Water Tool seamed more adapted to give an overview of all the company's sites whereas the Water Risk Filter seamed to focus on making an assessment for one site easily accessible.

5.2.1.2 Indices in the tool

The Water Risk Filter can be used to measure more indices, 33 water related indices are calculated on a basin level in the Water Risk Filter compared to 6 in the Global Water Tool. Yet relevant water stress indices for this study were easier to find in the Global Water Tool than in the Water Risk Filter.

5.2.1.3 Reliability

With regard to reliability both tools were found to provide the user with knowledge of water stress on a global scale. With regard to reliability of the actual assessment both tools have a major drawback. Neither of the tools provided any information of the degree of confidence of the score. It would have been very helpful if the scores had been shown together with confidence information (e.g. medium evidence, high agreement), which is the standard of IPCC's climate reporting [Jimenez Cisneros et al., 2014]. Without that kind of information it is difficult to know if one tool gives a more reliable assessment than the other. In this study both tools were therefore found to be more or less equal with regard to reliability.

Reliable sources could be found for all indices and databases in both tools used in this study. The WBCSD's webpage provided documents with sources of the indices and databases in the Global Water Tool, see [WBCSD, 2015a]. The WWF-DEG's online documentation included datasets and sources of the indices in the Water Risk Filter, see [WWF–DEG, 2015a]. In the datasets of Baseline Water Stress there is satellite data from NASA [Reig et al., 2013], which Mueller et al. [2015] gave as an example of high quality data. Satellite data was also incorporated in the WaterGap, which was the hydrological model that the index Risk of Scarcity was largely based on, see Table A.2 in Appendix A.

In case the results are used in another context than in a first screening or to gain general information neither of the tools can have given reliable information due to the large gaps in the datasets of all current water stress indices. The tools did not have access to datasets with high enough level of detail to estimate the water situation at a given location [Reig et al., 2013]. The datasets and models needed in order to accurately estimate water availability were not available at the time of this project and IPCC reported that more computing power and research would be needed in order to improve the spacial resolution of environmental models [WWAP, 2015b]. Because of shortcomings such as unreliability Mueller et al. [2015] concluded that information of the local water situation at production sites would still be essential for companies that use global water tools.

One difference with regard to transparency is that the Global Water Tool showed "no data" instead of an assessment for some sites. On the contrary, in the Water Risk Filter an average weighted risk score (e.g. Risk of Pollution) could be calculated apparently without any data for some, or all, indices that the Water Risk Filter uses to calculate the average score.

5.2.1.4 Selection

In spite of some differences of usability, the most important factor to consider for the selection of a tool was found to be which indices the tool can measure. Because Baseline Water Stress was preferred to the other indices used to estimate water stress in this study WBCSD's Global Water Tool that measures Baseline Water Stress was to some degree preferred to WWF-DEG's Water Risk Filter.

5.2.2 Using more than one index

This study provides an assessment of 96 SCA sites in both the Global Water Tool and the Water Risk Filter. The report includes tables that show how the sites are assessed in each index selected in this study, see Table B.1 – B.5 in Appendix B. On the one hand, it would be possible to select one index in this study and let the results of that index represent the assessment. On the other hand, to combine the indices in each tool could be an alternative to using one water stress index.

A question such as how many sites are experiencing water stress cannot be answered by measuring indices, regardless of how the assessment is made. An answer cannot be found primarily because water stress cannot be measured directly since the index score does not show water stress but an estimate of some aspect (e.g. water availability) that is assumed to be linked to water stress. However, the following section provides an answer to the question of how many sites are marked as water stressed in the Global Water Tool and the Water Risk Filter respectively. More specifically, how many sites in each tool are located in areas that appeared to experience water stress (i.e. the definition in this study) according to the results of at least one index in the respective tools.

In addition to finding out how many sites are possibly located in water stressed areas it could be important to identify sites for which it would be a problem to be located in a water stressed area. That can only be done to limited degree with the criteria presented in the following section. A future more detailed local assessment might show that water stress is a much more important risk to consider for some sites than for others. Whether or not it would be a problem that a site is located in a water stressed area is assumed to depend on factors such as water use and water treatment at the site in question as well as factors discussed by Srinivasan et al. [2012], e.g. infrastructure and governmental/ municipal water policy in the area.

5.2.2.1 Three criteria to compare tools

The aim of this section is to analyse the results and compare the tools with the help of three criteria, see Table 5.2. Water source and water use was taken in hand to narrow down on sites that could possibly be especially important among the 96 sites in the assessment. The first criterion excluded some sites that were not considered important because they did not use any water according to SCA water data for 2014. As a result of the second criterion 24 sites that belonged to the PC division were excluded from the count. It was observed that PC sites used very little water according to SCA water data for 2014, see Table 1.1. Because of low water intake the PC sites were considered to have limited impact on water in the areas where they were located. The third criterion resulted in an exclusion of all sites except sites that showed an indication of water stress and were known to use groundwater since they withdrew water from a borehole source. Only TP sites meet the third criterion. The importance of focusing on sites that meet the third criterion is further discussed in another section of the analysis, see “5.3 Screening of results”.

Table 5.2 compares the information presented in the following two sections that combines the results of indices in the Global Water Tool and the Water Risk Filter respectively.

Table 5.2: Comparing tools.

	Number of sites Global Water Tool	Number of sites Water Risk Filter
Indication of water stress	56	87
Criterion 1 (water stress + use water)	48	71
Criterion 2 (water stress + division FP/TP)	36	47
Criterion 3 (water stress + borehole-water)	20	24

5.2.2.2 Combined results form Global Water Tool

The assessment in Global Water Tool indicates water stress in the basins where 56 sites are located when the results of both Annual Renewable Water Supply per Person – 1995 and Baseline Water Stress are combined. In this case all sites are counted that get moderate to high scores in at least one of the indices Annual Renewable Water Supply per Person – 1995 or Baseline Water Stress. In the assessment in Global Water Tool there were 48 sites that meet the first criterion, see Table 5.2.

There are 12 PC sites but no FP sites that meet the first criterion in the Global Water Tool. After excluding the PC sites from the list of sites with indication of water stress in the Global Water Tool 36 TP sites remain, see Table 5.2.

Relatively few sites in the Global Water Tool meet the third criterion concerning borehole use. There are 20 sites that withdrew water from a borehole source among the TP sites located in areas that appears to experience water stress according to the selected indices from the Global Water Tool, see Table 5.2.

5.2.2.3 Combined results from Water Risk Filter

The assessment in the Water Risk Filter showed that all sites except nine Swedish sites are located in basins with a moderate to high risk of water stress. That many sites get moderate to high scores in at least one of the indices Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat. In other words, most sites get scores in the assessment levels 3 - 5 in at least one of selected WWF-DEG indices. By consequence, more sites appear to be located in water stressed areas according to the Water Risk Filter than the Global Water Tool, specifically 87 compared to 56, see Table 5.2.

In the Water Risk Filter there are 71 sites that meet the first criterion about annual water intake. Some of those sites can be excluded based on the second criterion used to compare the tools. After the exclusion of PC sites from the list of sites in possibly water stressed areas according to the Water Risk Filter, 47 sites remain that meet the second criteria, see Table 5.2. Finally there are 24 sites that withdrew water from a borehole among the sites that showed indications of water stress in at least one of the selected WWF-DEG indices, see Table 5.2.

5.3 Screening of results

In this section the results of the measurement of the five indices in this study are shown side by side. The aim of screening the results is to highlight some results from the water stress assessments, for the full assessments see Tables B.1 – B.2.

The first screening showed that none of the selected water stress indices in this study indicated a high risk of water stress for any of the pulp & paper mills. The second screening showed that there were at least 24 sites that were known to use groundwater and also showed an indication of water stress in at least one of the indices in this study, in addition the second screening showed that those 24 sites belonged to the TP division. In some areas surface water could be used instead of groundwater but unsustainable surface water use could also cause water stress [FAO & WWC, 2015].

5.3.1 First screening: pulp & paper mills

5.3.1.1 Selected sites

Among the 96 sites that were assessed there were four pulp & paper mills (Munksund, Obbola, Ortviken and Östrand). All those mills are located in Sweden. Moreover, the pulp & paper mills have another thing in common, namely that they withdrew above 10 million m^3 freshwater per year, see water data for 2014 in Table 5.3. Besides the pulp & paper mills there was only one other site that withdrew that much water in 2014; it was Mannheim, a TP mill with a documented water intake of 38 million m^3 freshwater per year.

Table 5.3: Water use for Pulp & Paper mills according to SCA water data for 2014.

Site	Total water intake (m^3/year)
Munksund	17 785 528
Obbola	16 051 953
Ortviken	25 187 730
Östrand	49 722 288

Table 5.4: Assessments of five indices for all pulp & paper mills. Annual Renewable Water Supply per Person - 1995 and Baseline Water Stress was measured in Global Water Tool. Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat was measured in the Water Risk Filter.

	Annual Renewable Water Supply per Person - 1995 (WRI)	Baseline Water Stress (WRI)	Risk of Scarcity (WWF-DEG)	Risk of Pollution (WWF-DEG)	Risk of Ecosystem Threat (WWF-DEG)
Munksund	No Data	No Data	Very Limited Risk	Very Limited Risk	Limited Risk
Obbola	Abundant	No Data	Very Limited Risk	Limited Risk	Limited Risk
Ortviken	No Data	No Data	Very Limited Risk	Some Risk	Limited Risk
Östrand	Abundant	Abundant	Very Limited Risk	Some Risk	Limited Risk

5.3.1.2 Results of the first screening

With regard to the mill in Östrand, neither Annual Renewable Water Supply per Person - 1995 nor Baseline Water Stress showed an indication of water stress, see Table 5.4. The former index showed no indication of stress for Obbola but no assessment for Munksund and Ortviken because their locations (GPS coordinates) were not covered in the datasets. Östrand is the only pulp & paper mill that got an assessment in Baseline Water Stress. In contrast, all pulp & paper mills could be given an assessment based on the results of the indices Risk of Scarcity, Risk of Pollution and Risk of Ecosystem Threat.

There is some indication of water stress for Ortviken and Östrand because the results show some risk of pollution, see Table 5.4. It is possible to find out which kind of pollution the index measured. The risk assessment document, which was downloaded from the Water Risk Filter's webpage, shows the results of 10 pollution indices. Most pollution indices indicate low risk of pollution for the pulp & paper mills. It is the indices for "organic loading" and "potential acidification" that show an indication of pollution. Both Ortviken and Östrand get the assessment high risk of organic loading and very high risk of potential acidification. Ortviken and Östrand get the assessment "some risk", see Table 5.4, in the index Risk of Pollution due to the fact that Risk of Pollution was calculated as an average score. For the names of all 10 pollution indices, see Table A.2 Appendix A.

To summarise, the first screening shows the water stress assessment for the pulp & paper mills, which were the most water demanding type of sites in this study. In short, the index results show no indication of water stress for Munksund and Obbola but the results show a moderate risk of water stress due to pollution for Ortviken and Östrand.

5.3.2 Second screening: groundwater use

5.3.2.1 Selected sites

The second screening is based on two conditions; the groundwater use as well as the estimated level of water stress in the basins is considered in the selection. Firstly the sites are selected if they were known to use groundwater according to SCA's water data for 2014. Because the water from a borehole source was known to be groundwater, the documented value for borehole-water was used as an estimation of groundwater use. The water data for 2014 gave the source for the water withdrawal (borehole, surface or "community tap water") but it was not specified how much groundwater was withdrawn. Per definition, surface water is not groundwater but the community tap water could have been municipal water originally withdrawn from a groundwater aquifer. To take one example, in the United Kingdom about one third of the public water supply is provided by groundwater [UK groundwater forum, 2015]. Governmental information about the public water supply is not used in this study but it could be used in a future study to investigate which sites rely on groundwater. According to SCA's water data for 2014 only sites that belonged to the TP division had used borehole-water. Thereof follows that all PC and FP sites were excluded in the second screening, those sites were not known to use groundwater.

The second condition used to select sites for the second screening is that the sites should be located in areas that appear to experience water stress according to at least one of the indices used in this study to measure water stress. In other words the sites should get at least one index score that corresponds to assessment levels 3 – 5, see Table 5.1. In total 24 paper mills meet the conditions mentioned above, see Table 5.5.

Although all mills in the second screening used water from a borehole source some mills withdrew very little and some mills withdrew more than a million m^3 freshwater from borehole, see Table 5.5. The estimated groundwater use is shown for all mills selected through the second screening, see Table 5.5. In addition Table 5.5 shows the percentage of borehole-water intake compared to total water intake. That information could possibly be of interest with regard to the question of how much a mill can change the groundwater use. Mills that only, or almost only, use borehole-water are assumed to have different possibilities to affect their groundwater use compared to mills that use surface water, community tap water or both. Clearly the estimated groundwater use varied among the sites in the second screening. Half of the 24 sites withdrew 90 – 100 % of their water form a borehole, see Table 5.5. In comparison, four sites withdrew less than 10 % of their total water from a borehole.

5.3.2.1 Results of the second screening

The assessments of the five selected indices can be seen side by side for the sites selected in the second screening. Table 5.6 shows the 24 sites in the second screening and the results of the selected indices in this study.

The results of the first index, Annual Renewable Water Supply per Person –1995, gives an indication of water stress for 17 sites in the second screening, see Table 5.6. The second index, Baseline Water Stress gives an indication of water stress for 18 sites, see Table 5.6. The third index Risk of Scarcity gives an indication of water stress for 11 sites, which makes Risk of Scarcity the index showing the fewest number of sites with water stress in the second screening, see Table 5.6. Risk of Scarcity is also the index that gives the lowest scores in general among the selected indices in this study, see Figure 4.3. The forth index Risk of Pollution gives an indication of water stress for 22 sites, i.e. all sites in the second screening except La Riba and Sao Paolo, see Table 5.6. Finally, the fifth water stress index in this study, Risk of Ecosystem Threat, gives an indication of water stress for all sites selected through the second screening.

To summarise, the second screening shows that there are 24 sites known to use groundwater among the sites that are located in areas that appear to experience water stress according to at least one of the selected indices used in this study to measure water stress. Those sites are considered especially important with regard to water stress because groundwater depletion have been recognised as an important water issue [FAO & WWC, 2015; Srinivasan et al., 2012].

5.3.2.1 Comment: Different indices give different assessments

Although Table 5.6 shows a selection of the 96 sites that were assessed, this table could be used to illustrate the fact that different indices give different assessments.

For example, five sites are located in areas that appear to experience water stress according to one of the two selected indices in the Global Water Tool but not the other. These sites are Mannheim, Kunheim, Le Theil and Sovetsk, see Table 5.6. The results for those sites illustrate the variability within a tool.

Furthermore, the results of the second screening show an example of the fact that the assessment depends on which tool is used. The sites Gien, Orlean, Ortmann and Sao Paolo are located in areas that do not appear to experience water stress according to the Global Water Tool assessment (i.e. the scores of Annual Renewable Water Supply per Person – 1995 and Baseline Water Stress). Still, these sites are included in the second screening. By consequence, the above-mentioned sites are located in areas that appear to experience water stress according to at least one of the three indices in the Water Risk Filter.

Table 5.5: List of sites in the second screening with SCA water data for 2014. Estimated groundwater intake is the documented value for volume water withdrawn annually from a borehole source. % Groundwater is annual borehole-water compared to annual total water intake.

Site	Country	Estimated groundwater intake (m3/year)	% Groundwater
Hondouville (Tissue)	France	1 897 191,0	99%
Mannheim	Germany	1 777 202,0	6%
Sahagun	Mexico	1 098 802,5	100%
Gien	France	1 095 503,0	45%
Kunheim	France	1 046 576,0	99%
Orleans	France	507 211,0	98%
Le Theil	France	504 298,0	99%
Hondouville (Cotton)	France	402 873,0	99%
Uruapan	Mexico	394 273,0	38%
Lucca 1	Italy	332 532,0	56%
Manchester	UK	289 263,0	31%
Suameer	Netherlands	239 632,0	99%
Altopascio	Italy	220 251,0	97%
Ortmann	Austria	204 243,0	6%
Monterrey	Mexico	157 693,7	19%
Stubbins	UK	92 484,0	6%
Mediona	Spain	88 085,0	100%
Collodi	Italy	61 646,0	19%
La Riba	Spain	58 486,0	91%
Sovetsk	Russia	31 393,0	4%
Sao Paolo	Brazil	13 651,0	71%
Puigpelat	Spain	7463,0	1%
Greenwich	USA	5061,0	75%
Santo Domingo (Tissue)	Dom. Rep.	3216,9	100%

Table 5.6: List of sites in the second screening, with assessments of all indices used to measure water stress in this study. WRI indices were measured in the Global Water Tool and WWF-DEG indices were measured in the Water Risk Filter.

	Annual Renewable Water Supply per Person - 1995 (WRI)	Baseline Water Stress (WRI)	Risk of Scarcity (WWF-DEG)	Risk of Pollution (WWF-DEG)	Risk of Ecosystem Threat (WWF-DEG)
Hondouville (Tissue)	Scarcity	Medium To High	Some Risk	High Risk	High Risk
Mannheim	Stress	Low To Medium	Very Limited Risk	High Risk	High Risk
Sahagun	Stress	High	High Risk	Very High Risk	High Risk
Gien	Sufficient	Low To Medium	Some Risk	High Risk	High Risk
Kunheim	Stress	Low To Medium	Very Limited Risk	Some Risk	High Risk
Orleans	Sufficient	Low To Medium	Some Risk	High Risk	High Risk
Le Theil	Sufficient	Medium To High	Some Risk	High Risk	High Risk
Hondouville (Cotton)	Scarcity	Medium To High	Some Risk	High Risk	High Risk
Uruapan	Stress	Medium To High	Limited Risk	Some Risk	High Risk
Lucca 1	Stress	High	Limited Risk	High Risk	Very High Risk
Manchester	Extreme Scarcity	High	Some Risk	High Risk	Some Risk
Suameer	Stress	High	Very Limited Risk	High Risk	Some Risk
Altopascio	Stress	High	Limited Risk	High Risk	Very High Risk
Ortmann	Sufficient	Low	Limited Risk	Some Risk	Some Risk
Monterrey	Scarcity	Extremely High	Very High Risk	Very High Risk	High Risk
Stubbins	Stress	High	Some Risk	High Risk	Some Risk
Mediona	Extreme Scarcity	Medium To High	Limited Risk	High Risk	High Risk
Collodi	Stress	High	Limited Risk	High Risk	Very High Risk
La Riba	Extreme Scarcity	High	Limited Risk	Limited Risk	High Risk
Sovetsk	Abundant	Medium To High	Some Risk	High Risk	High Risk
Sao Paolo	Abundant	Low To Medium	Limited Risk	High Risk	High Risk
Puigpelat	Extreme Scarcity	High	Limited Risk	Limited Risk	High Risk
Greenwich	Sufficient	Medium To High	Some Risk	Some Risk	Some Risk
Santo Domingo (Tissue)	No Data	High	Limited Risk	High Risk	Some Risk

Chapter 6
Conclusions

There is no absolute definition of water stress, which makes it a difficult subject to discuss and measure. Although there is no universally accepted method to measure water stress, there appears to be a consensus about what water stress means. The general opinion seems to be that there is no water stress in an area if there is sufficient amount of freshwater of good enough quality for humans and the ecosystem. That definition could motivate that the selected indices in this study are suitable water stress indices.

Regarding the use of indices to measure water stress, the method provides both great advantages and difficulties. On the one hand, to use water stress indices is a practical way for a company to make a water stress assessment. On the other hand, there are many indices and the choice of index will affect outcome of the assessment. The results of this project show that different indices give different results.

Among the five evaluated indices in this study the WRI index Baseline Water Stress is found to be the most suitable index. It is mainly preferred because of the clear connection to water stress. SCA as a global company is likely to be affected by water stress since water stress has been reported to be a global problem. For instance, Revenga et al. [2000] estimated that 40 % of the world's population in 2000 lived in water stressed areas, and that percentage was expected to increase. As a result of using Baseline Water stress 47 SCA sites are located in areas where the estimated level of water stress is moderate to high. That can be regarded as a relatively large number of sites, although it is worth noting that some of the 47 sites use very little water.

All indices in this study were calculated based to types of information. Firstly, the results were based on GPS coordinates for the sites. Secondly, the results were based on information connected to the GPS coordinates that was available in the datasets of the indices. The GPS coordinates were thus the only corporate site information that affected the outcome of the assessment. Because there were gaps in the datasets of all indices the results for any kind of water stress assessment based on water stress indices should be used with some caution. Furthermore, the indices in this study were measured on a basin or grid level. By consequence, the results do not represent the water situation at the actual sites. The results give an estimation of the water situation in the basins where the respective sites are located. The water condition in a basin could possibly represent a site condition but it is by no means certain.

The great advantage of water stress indices is that they provide valuable information about water stress as a global issue. However, the use of this water stress assessment is limited, the results are not site-specific enough to be used for anything except for general discussions about water stress. This is a limitation that remains regardless of how many indices are used because of the inherent uncertainty due to the large gaps in the datasets that are required to calculate water stress indices. Therefore it would be necessary to gather knowledge of the local water condition in order to get a more accurate estimate of water stress at a site level. Two water assessment tools that are mentioned in this report could be used to gather local knowledge and do water stress assessments for specific sites, these tools are WBCSD's GEMI Local Water Tool and WWF-DEG's Water Risk Filter.

With regard to water stress assessment as a CSR-strategy there are question marks concerning the efficiency of such a strategy. This study concludes that a company would need to rely on some type of water tool in order to make a water stress assessment. The main drawback of using water stress assessment as a CSR-strategy is the deep uncertainty of the assessment, see [FAO & WWC, 2015]. At the time of this project neither of the water tools used to measure the indices in this study provided information about the confidence of the results. Because of this lack of sensitivity analysis of the results, the tools could be argued to generate results with a false sense of precision.

However, water tools and water stress indices could possibly become more reliable in the future since efforts are being made to increase the spacial resolution of climate models. This is done by investing in research (e.g. hydrological, ecological and social) and by filling gaps in the datasets with country and municipal data of for example water, land use and biodiversity [WWAP, 2015b].

To conclude, water stress assessment is expected to be more important, and possibly more reliable, in the following years. It is difficult to predict if the term water stress will disappear or become more common. Possibly some other term (e.g. scarcity) will replace what is defined as water stress in this study. A potential extension of this study is to estimate business water risk. In that case water stress would be one factor among many factors that are measured to estimate the risk of water related events at the sites.

Bibliography

Brown, A. and M. Matlock
2011. A review of water scarcity indices and methodologies. University of Arkansas, The Sustainability Consortium White Paper, 106.

Burke, L., J. Ranganathan, and R. Winterbottom
2015. Revaluing ecosystems: Pathways for scaling up the inclusion of ecosystem value in decision making. World Resources Institute, Washington, DC. Available at http://www.wri.org/sites/default/files/Revaluing_Ecosystems_April_2015_2.pdf.

Carroll, A. and K. Shabana
2010. The business case for corporate social responsibility: A review of concepts, research and practice. *International Journal of Management Reviews*, 12(1):85 – 105.

Ceres
2015a. Ceres Aqua Gauge TM. Ceres's Website. Available at http://www.ceres.org/aquagauge.

Ceres
2015b. The Ceres AQUA GAUGE The Framework for 21st Century Water Risk Management. Ceres's Website. Available at http://www.ceres.org/issues/water/corporate-water-stewardship/aqua-gauge/aqua-gauge.

Eicker, A., M. Schumacher, J. Kusche, P. Döll, and H. Schmied
2014. Calibration/Data Assimilation Approach for Integrating GRACE Data into the WaterGAP Global Hydrology Model (WGHM) Using an Ensemble Kalman Filter: First Results. *Surveys in Geophysics*, 35(6):1285 – 1309. Available at http://waterfootprint.org/en/resources/interactive-tools/national-water-footprint-explorer/.

Eriksson, E., M. Ek, A. Öman, P. Karlsson, and J. Stål
2011. Water profile for the Swedish forest industry. IVL- Svenska Miljö Institutet. Available at http://www.forestindustries.

se/MediaBinaryLoader.axd?MediaArchive_FileID=8c7cdaf6-b3e6-47ab-aa45-3cc0adfbe35e&FileName=EN+Water+Profile+111227.pdf.

FAO AQUASTAT
2014. Summary table: Municipal, industrial and agricultural water withdrawal around 2007. FAO (Food and Agriculture Organisation of the United Nations) database AQUASTAT. Available at http://www.fao.org/nr/water/aquastat/tables/WorldData-Withdrawal_eng.pdf.

FAO (Food and Agriculture Organisation of the United Nation) and WWC (World Water Council)
2015. Towards a water and food secure future: Critical perspectives for policy-makers. FAO, Rome & WWC, Marseille. Available at http://www.fao.org/3/a-i4560e.pdf.

Frederiksen, C. and M. Juul Nielsen
2013. Ethical foundations for CSR. In *CSR Sustainability, Ethics & Governance Corporate Social Responsibility 2013*, J. Okpara and S. Idowu, eds. Berlin Heidelberg: Springer - Verlag.

Gassert, F., M. Landis, M. Luck, P. Reig, and T. Shiao
2013. Aqueduct Global Maps 2.0. Working Paper. WRI - World Resources Institute's webpage. Available at http://www.wri.org/publication/aqueduct-metadata-global.

GEMI (Global Environmental Management Institute)
2015. GEMI's Local Water Tool. GEMI's website. Available at http://gemi.org/localwatertool/.

Jaeger, W., A. Plantinga, H. Chang, K. Dello, G. Grant, D. Hulse, J. McDonnell, S. Lancaster, H. Moradkhani, A. Morzillo, P. Mote, A. Nolin, M. Santelmann, and J. Wu
2013. Toward a formal definition of water scarcity in natural-human systems. *Water Resources Research*, 49:4506–4517.

Jimenez Cisneros, B., T. Oki, N. Arnell, G. Benito, J. Cogley, P. Döll, T. Jiang, and S. Mwakalila
2014. Freshwater resources. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, V. Field, C.B.and Barros, D. Dokken, K. Mach, M. Mastrandrea, T. Bilir, M. Chatterjee, K. Ebi, Y. Estrada, R. Genova, B. Girma, E. Kissel, A. Levy, S. MacCracken, P. Mastrandrea, and L. White, eds., Pp. 229–269. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Kabongo, J. and J. Okpara
2013. Environmental Performance: The Impact of R&D Intensity on Firms' Environmental Concerns. In *CSR Sustainability, Ethics & Governance Corporate Social Responsibility 2013*, J. Okpara and S. Idowu, eds. Berlin Heidelberg: Springer - Verlag.

Maitra, S. and M. Stuchtey
2013. The mispriced resource. *The Water Factor*, 58:42–44.

Mancosu, N., R. Snyder, G. Kyriakakis, and D. Spano
2015. Water scarcity and future challenges for food production. *Water*, 7(3):975.

Mekonnen, M. and A. Hoekstra
2011. National water footprint accounts: the green, blue and grey water footprint of production and consumption. Value of Water Research Report Series No. 50. Available at `http://waterfootprint.org/en/resources/interactive-tools/national-water-footprint-explorer/`.

Mueller, S., A. Carlile, B. Bras, T. Niemann, S. Rokosz, H. McKenzie, H. C. Kim, and T. Wallington
2015. Requirements for water assessment tools: An automotive industry perspective. *Water Resources and Industry*, (9):30–44.

Okpara, J. and S. Idowu
2013. Corporate social responsibility: A review of the concept and analysis of the business case for corporate social responsibility in the twenty-first century. In *CSR Sustainability, Ethics & Governance Corporate Social Responsibility 2013*, J. Okpara and S. Idowu, eds. Berlin Heidelberg: Springer - Verlag.

Reig, P., T. Shiao, and F. Gassert
2013. Aqueduct Water Risk Framework, Working Paper. WRI - World Resources Institute's webpage. Available at `http://www.wri.org/our-work/project/aqueduct/methodology`.

Revenga, C., J. Brunner, N. Henninger, K. Kassem, and R. Payne
2000. Pilot Analysis of Global Ecosystems: Freshwater Ecosystems. World Resources Institute, Washington, DC. Available at `http://www.wri.org/sites/default/files/pdf/page_freshwater.pdf`.

Rodrigues, D. B. B., H. V. Gupta, and E. M. Mendiondo
2014. A blue/green water-based accounting framework for assessment of water security. *Water Resources Research*, 48:7187–7205.

SCA in cooperation with Hallvarsson and Halvarsson
2015. SCA Sustainability Report 2014. Göteborgtryckeriet 2015. Available at `http://www.sca.com/Documents/en/Env_Reports/2014/SCA-sustainability-report-2014.PDF?epslanguage=en`.

Smakthin, V., C. Revenga, and P. Döll
2004. A Pilot Global Assessment of Environmental Water Requirements and Scarcity. *Water International*, 29(3):307 – 317.

Srinivasan, V., E. Lambin, S. Gorelick, B. Thompson, and S. Rozelle
2012. The nature and causes of the global water crisis: Syndromes from a meta-analysis of coupled human-water studies. *Water Resources Research*, 48(10).

Strzepek, K., A. Schlosser, A. Gueneau, X. Gao, E. Blanc, C. Fant, B. Rasheed, and H. D. Jacoby
2013. Modelling water resource systems within the framework of the MIT Integrated Global System Model: IGSM-WRS. *Journal of Advances in Modeling Earth Systems*, 5(3):638 – 653.

The 2030 Water Resources Group
2009. Charting our water future, economic framework for informed decision-making. The 2030 Water Resources Group. Available at http://www.mckinsey.com/client_service/sustainability/latest_thinking/charting_our_water_future.

UK groundwater forum
2015. Is the water in my tap groundwater? UK Groundwater Forum Website. Available at http://www.groundwateruk.org/Is-The-Water-in-my-tap-groundwater.aspx.

Van Oosterhout, J. H. and P. P. M. A. R. Heugens
2008. Much ado about nothing a conceptual critique of corporate social responsibility. In *The Oxford Handbook of Corporate Social Responsibility*, A. Crane, D. Matten, A. McWilliams, J. Moon, D. Siegel, and van Oosterhout, eds. Oxford University Press.

Vörösmarty, C. J., P. B. McIntyre, M. O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S. E. Bunn, C. A. Sullivan, C. R. Liermann, and P. M. Davies
2010. Global threats to human water security and river biodiversity. *Nature*, 467(7315):555 – 561.

Water Systems Analysis Group
2014. Data and Tools. Water Systems Analysis Group, University of New Hampshire. Available at http://www.wsag.unh.edu/DataAndTools.htmll.

WBCSD (World Business Council for Sustainable Development)
2015a. Dataset and definitions – March 2015. Global Water Tool's Website. Available at http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx.

WBCSD (World Business Council for Sustainable Development)
2015b. Global Water Tool Version 1.2 – March 2015. Global Water Tool Website. Available at http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx.

WBCSD (World Business Council for Sustainable Development)
2015c. What is the Global Water Tool? How to use it? Version 1.2 – March 2015. Global Water Tool's Website. Available at http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx.

WRI (World Resources Institute)
2015. Aqueduct Water Risk Atlas. WRI's Website. Available at http://www.wri.org/applications/maps/aqueduct-atlas.

WWAP (United Nations World Water Assessment Programme)
2015. Facing the Challenges. Case Studies and Indicators. Paris, UNESCO.

WWAP (United Nations World Water Assessment Programme)
2015b. The United Nations World Water Development Report 2015: Water for a Sustainable World. Paris, UNESCO. Available at http://www.unwater.org.

WWF (World Wide Fund for Nature) and DEG (Deutsche Entwicklungsgesellschaft)
2014. Water Risk Filter – User Guide. WWF's website. Available at http://waterriskfilter.panda.org.

WWF (World Wide Fund for Nature) and DEG (Deutsche Entwicklungsgesellschaft)
2015a. Risk Indicators. WWF's website. Available at http://waterriskfilter.panda.org.

WWF (World Wide Fund for Nature) and DEG (Deutsche Entwicklungsgesellschaft)
2015b. Water Risk Filter. WWF's website. Available at http://waterriskfilter.panda.org.

Appendices

Appendix A
Global Water Tool & Water Risk Filter

Table A.1: Overview of the Global Water Tool.

Data: Selection of providers of datasets	Spatial scale
Food and Agriculture Organization (FAO) AQUASTAT	Country
World Health Organization and UNICEF Joint Monitoring Program	Country
United Nations Population Division (UNDESA)	Country
World Resources Institute (WRI)	Country & Watershed
International Water Management Institute (IWMI)	Watershed
Conservation International (CI)	Watershed

Tool input: Selected user inputs	Required (Yes/No)
Site Name, Site ID nr, Site Location (GPS)	Yes
Water withdrawal specified by source:	No
Surface water	
Groundwater	
Municipal/Portable Water Supply	
External waste water	
Rainwater	
Water discharge specified by receiving body:	No
Ocean	
Surface	
Subsurface/well	
Off-Site Water Treatment	

Tool output: Indices measured on a sub-catchment (watershed) level	Year of data capture
Indices measured by WRI:	
Annual Renewable Water Supply per Person - 1995 (2000)	1995
Annual Renewable Water Supply by Projections - 2025	1995
Baseline Water Stress (2013)	2010 and 1950-2008
Inter-annual variability (2013)	1950-2008
Seasonal variability	1950-2008
Indices measured by IWMI (Watershed data)	
Environmental Water Scarcity Index by Basin (2006)	AQUASTAT 2008-2015 IWMI 1900-2006
Areas of Physical and Economic Water Scarcity	2007
Index measured by CI (Watershed data)	
Biodiversity Hotspots	2011

Table A.2: Overview of the Water Risk Filter. Indices in parenthesis are not included in the average final basin risk.

Data: Selection of providers of datasets		Spatial scale
Water Footprint Network (WFN)		Basin
WaterGAP Global Hydrology Model WGHM		Basin
World Wildelife Found (WWF)		Country, Basin & Grid
Tool input: Selected user inputs		**Required (Yes/No)**
Site Name, Site Location (GPS)		Yes
Industry (e.g. Forestry & Paper)		Yes
Facility Specific Questionnaire (30 questions)		No
Tool output: Indices measuring Basin Related Risks		**Weighting**
Physical risk scarcity, quantity (6 indices)	1. Annual monthly water depletion (WaterGap)	25%
	2. Number of months >40 % water depletion (WaterGap)	25%
	3. Scarcity in most depleted month (WaterGap)	20%
	(3a. Arid area)	
	4. Groundwater overabstraction	10%
	(5. Forecasted impact of climate change)	
	6. Estimated occurrence of droughts (2012-2015)	10%
	(6a. Estimated occurrence of droughts (2013-2015))	
	(6b. Estimated occurrence of droughts (2014-2015))	
	7. Estimated occurrence of floods	10%
Physical risk pollution, quality (9 indices)	General situation of water pollution around the facility: Nitrogen (weighting 13%), Phosphorus (13%), Pestizide loading (13%), Soil salination (11%), BOD (17%), Sediment loading (12%), Mercury (9%), Potential Acidification (7%) and Thermal alteration (7%)	
Physical risk eco-system threat (4 indices)	9. Threat to freshwater biodiversity threat around the facility	50%
	(9a. WWF priority basin)	
	10. Vulnerability of water ecosystems in the country	10%
	11. Access to safe drinking water (% of population)	20%
	12. Access to improved sanitation (% of population)	20%
Physical risk dependence on hydropower (1 index)	13. Dependency on hydropower	
Regulatory risk (4 indices)	14. Water strategy of government	20%
	15. Sophistication of legislation	30%
	16. Enforcement of legislation	25%
	17. Basin stakeholder forum	25%
Reputation risk (3 indices)	18. Cultural/religious importance of local water sources	15%
	19. Exposure of this country to national/local media	45%
	20. Exposure of this country to global media	40%

Appendix B

Raw Data

Table B.1: Results of measurements of Annual Renewable Water Supply per Person - 1995 (WRI).

Site name	Country	Division	Assessment	Score (m3/pers/year)
Box Hill, Melbourne	Australia	TP	Extreme Scarcity	< 500
Beijing	China	TP	Extreme Scarcity	< 500
Liaoning (Anshan)	China	TP	Extreme Scarcity	< 500
Shangdong (Laiwu)	China	TP	Extreme Scarcity	< 500
La Riba	Spain	TP	Extreme Scarcity	< 500
Mediona	Spain	TP	Extreme Scarcity	< 500
Puigpelat	Spain	TP	Extreme Scarcity	< 500
Manchester	UK	TP	Extreme Scarcity	< 500
Oakenholt	UK	TP	Extreme Scarcity	< 500
Aconcagua	Argentina	PC	Extreme Scarcity	< 500
Springvale	Australia	PC	Extreme Scarcity	< 500
Stembert	Belgium	TP	Scarcity	500 - 1,000
Pisa	Chile	TP	Scarcity	500 - 1,000
Hondouville (Cotton)	France	TP	Scarcity	500 - 1,000
Hondouville (Tissue)	France	TP	Scarcity	500 - 1,000
Monterrey	Mexico	TP	Scarcity	500 - 1,000
Cuijk	Netherlands	TP	Scarcity	500 - 1,000
Prudhoe	UK	TP	Scarcity	500 - 1,000
Guadalajara	Mexico	PC	Scarcity	500 - 1,000
Gennep	Netherlands	PC	Scarcity	500 - 1,000
Kunheim	France	TP	Stress	1,000 - 1,700
Kostheim	Germany	TP	Stress	1,000 - 1,700
Mannheim	Germany	TP	Stress	1,000 - 1,700
Neuss	Germany	TP	Stress	1,000 - 1,700
Witzenhausen (Tissue)	Germany	TP	Stress	1,000 - 1,700
Altopascio	Italy	TP	Stress	1,000 - 1,700
Collodi	Italy	TP	Stress	1,000 - 1,700
Lucca 1	Italy	TP	Stress	1,000 - 1,700
Uruapan	Mexico	TP	Stress	1,000 - 1,700
Sahagun	Mexico	TP	Stress	1,000 - 1,700
Suameer	Netherlands	TP	Stress	1,000 - 1,700
Chesterfield	UK	TP	Stress	1,000 - 1,700
Skelmersdale	UK	TP	Stress	1,000 - 1,700
Stubbins	UK	TP	Stress	1,000 - 1,700
Ecatepec Personal Care	Mexico	PC	Stress	1,000 - 1,700
Hoogezand	Netherlands	PC	Stress	1,000 - 1,700
Olawa PC	Poland	PC	Stress	1,000 - 1,700
Veniov	Russia	PC	Stress	1,000 - 1,700
Ortmann	Austria	TP	Sufficient	1,700 - 4,000
Zhejiang (Longyou)	China	TP	Sufficient	1,700 - 4,000
Guangdong (Sanjiang)	China	TP	Sufficient	1,700 - 4,000
Guangdong (Jiangmen)	China	TP	Sufficient	1,700 - 4,000
Guangdong (Xinhui)	China	TP	Sufficient	1,700 - 4,000
Hubei (Xiaogan)	China	TP	Sufficient	1,700 - 4,000

Site name	Country	Division	Assessment	Score (m3/pers/year)
Sichuan (Deyang)	China	TP	Sufficient	1,700 - 4,000
Gien	France	TP	Sufficient	1,700 - 4,000
Le Theil	France	TP	Sufficient	1,700 - 4,000
Orleans	France	TP	Sufficient	1,700 - 4,000
Hlohovec	Slovakia	TP	Sufficient	1,700 - 4,000
Bellemont	USA	TP	Sufficient	1,700 - 4,000
Flagstaff	USA	TP	Sufficient	1,700 - 4,000
Greenwich	USA	TP	Sufficient	1,700 - 4,000
South Glens Falls	USA	TP	Sufficient	1,700 - 4,000
Hubei	China	PC	Sufficient	1,700 - 4,000
Gemerska	Slovakia	PC	Sufficient	1,700 - 4,000
Mölnlycke	Sweden	PC	Sufficient	1,700 - 4,000
Sao Paolo	Brazil	TP	Abundant	> 4,000
Cajica	Colombia	TP	Abundant	> 4,000
Medellin	Colombia	TP	Abundant	> 4,000
Lasso	Ecuador	TP	Abundant	> 4,000
Nokia	Finland	TP	Abundant	> 4,000
Kawerau	New Zealand	TP	Abundant	> 4,000
Te Rapa	New Zealand	TP	Abundant	> 4,000
Sovetsk	Russia	TP	Abundant	> 4,000
Svetogorsk	Russia	TP	Abundant	> 4,000
Allo	Spain	TP	Abundant	> 4,000
Lilla Edet	Sweden	TP	Abundant	> 4,000
Barton	USA	TP	Abundant	> 4,000
Menasha	USA	TP	Abundant	> 4,000
Neenah	USA	TP	Abundant	> 4,000
Sao Paolo	Brazil	PC	Abundant	> 4,000
Drummondville	Canada	PC	Abundant	> 4,000
Cali	Colombia	PC	Abundant	> 4,000
Rio Negro	Colombia	PC	Abundant	> 4,000
Lasso	Ecuador	PC	Abundant	> 4,000
Selangor	Malaysia	PC	Abundant	> 4,000
Te Rapa	New Zealand	PC	Abundant	> 4,000
Bowling Green	USA	PC	Abundant	> 4,000
BM Stugun (sawmill)	Sweden	FP	Abundant	> 4,000
Bollsta (sawmill)	Sweden	FP	Abundant	> 4,000
Gällö (sawmill)	Sweden	FP	Abundant	> 4,000
Obbola	Sweden	FP	Abundant	> 4,000
Östrand	Sweden	FP	Abundant	> 4,000
Santo Domingo	Dom. Rep	TP	No Data	No data
Sotteville	France	TP	No Data	No data
Santo Domingo	Dom. Rep	PC	No Data	No data
Falkenberg	Sweden	PC	No Data	No data
Taipei	Taiwan	PC	No Data	No data
Tuzla (Istanbul1)	Turkey	PC	No Data	No data
Yildiz (Istanbul2)	Turkey	PC	No Data	No data
BioNorr (sawmill)	Sweden	FP	No Data	No data

Site name	Country	Division	Assessment	Score (m3/pers/year)
Munksund	Sweden	FP	No Data	No data
Munksund (sawmill)	Sweden	FP	No Data	No data
Ortviken	Sweden	FP	No Data	No data
Rundvik (sawmill)	Sweden	FP	No Data	No data
Tunadal (sawmill)	Sweden	FP	No Data	No data

Table B.2: Results of measurements of Baseline Water Stress (WRI).

Site name	Country	Division	Assessment	Score (%)
Box Hill, Melbourne	Australia	TP	Extremely High	> 80 %
Pisa	Chile	TP	Extremely High	> 80 %
Beijing	China	TP	Extremely High	> 80 %
Liaoning (Anshan)	China	TP	Extremely High	> 80 %
Shangdong (Laiwu)	China	TP	Extremely High	> 80 %
Sotteville	France	TP	Extremely High	> 80 %
Monterrey	Mexico	TP	Extremely High	> 80 %
Bellemont	USA	TP	Extremely High	> 80 %
Aconcagua	Argentina	PC	Extremely High	> 80 %
Springvale	Australia	PC	Extremely High	> 80 %
Stembert	Belgium	TP	High	40 - 80 %
Zhejiang (Longyou)	China	TP	High	40 - 80 %
Santo Domingo	Dom. Rep.	TP	High	40 - 80 %
Kostheim	Germany	TP	High	40 - 80 %
Altopascio	Italy	TP	High	40 - 80 %
Collodi	Italy	TP	High	40 - 80 %
Lucca 1	Italy	TP	High	40 - 80 %
Sahagun	Mexico	TP	High	40 - 80 %
Suameer	Netherlands	TP	High	40 - 80 %
La Riba	Spain	TP	High	40 - 80 %
Puigpelat	Spain	TP	High	40 - 80 %
Allo	Spain	TP	High	40 - 80 %
Manchester	UK	TP	High	40 - 80 %
Skelmersdale	UK	TP	High	40 - 80 %
Stubbins	UK	TP	High	40 - 80 %
Flagstaff	USA	TP	High	Arid & Low Water Use
Menasha	USA	TP	High	40 - 80 %
Neenah	USA	TP	High	40 - 80 %
Santo Domingo	Dom. Rep.	PC	High	40 - 80 %
Ecatepec Personal Care	Mexico	PC	High	40 - 80 %
Hoogezand	Netherlands	PC	High	40 - 80 %
Yildiz (Istanbul2)	Turkey	PC	High	40 - 80 %
Hubei (Xiaogan)	China	TP	Medium To High	20 - 40 %
Sichuan (Deyang)	China	TP	Medium To High	20 - 40 %
Hondouville (Cotton)	France	TP	Medium To High	20 - 40 %
Hondouville (Tissue)	France	TP	Medium To High	20 - 40 %
Le Theil	France	TP	Medium To High	20 - 40 %
Witzenhausen (Tissue)	Germany	TP	Medium To High	20 - 40 %
Uruapan	Mexico	TP	Medium To High	20 - 40 %
Sovetsk	Russia	TP	Medium To High	20 - 40 %
Mediona	Spain	TP	Medium To High	20 - 40 %
Chesterfield	UK	TP	Medium To High	20 - 40 %
Greenwich	USA	TP	Medium To High	20 - 40 %
South Glens Falls	USA	TP	Medium To High	20 - 40 %

Site name	Country	Division	Assessment	Score (%)
Hubei	China	PC	Medium To High	20 - 40 %
Selangor	Malaysia	PC	Medium To High	20 - 40 %
Olawa PC	Poland	PC	Medium To High	20 - 40 %
Sao Paolo	Brazil	TP	Low To Medium	10 - 20 %
Lasso	Ecuador	TP	Low To Medium	10 - 20 %
Kunheim	France	TP	Low To Medium	10 - 20 %
Gien	France	TP	Low To Medium	10 - 20 %
Orleans	France	TP	Low To Medium	10 - 20 %
Mannheim	Germany	TP	Low To Medium	10 - 20 %
Cuijk	Netherlands	TP	Low To Medium	10 - 20 %
Sao Paolo	Brazil	PC	Low To Medium	10 - 20 %
Lasso	Ecuador	PC	Low To Medium	10 - 20 %
Gennep	Netherlands	PC	Low To Medium	10 - 20 %
Gemerska	Slovakia	PC	Low To Medium	10 - 20 %
Mölnlycke	Sweden	PC	Low To Medium	10 - 20 %
Falkenberg	Sweden	PC	Low To Medium	10 - 20 %
Ortmann	Austria	TP	Low	< 10 %
Guangdong (Jiangmen)	China	TP	Low	< 10 %
Guangdong (Sanjiang)	China	TP	Low	< 10 %
Guangdong (Xinhui)	China	TP	Low	< 10 %
Cajica	Colombia	TP	Low	< 10 %
Medellin	Colombia	TP	Low	< 10 %
Nokia	Finland	TP	Low	< 10 %
Neuss	Germany	TP	Low	< 10 %
Kawerau	New Zealand	TP	Low	< 10 %
Te Rapa	New Zealand	TP	Low	< 10 %
Svetogorsk	Russia	TP	Low	< 10 %
Hlohovec	Slovakia	TP	Low	< 10 %
Lilla Edet	Sweden	TP	Low	< 10 %
Oakenholt	UK	TP	Low	< 10 %
Prudhoe	UK	TP	Low	< 10 %
Barton	USA	TP	Low	< 10 %
Drummondville	Canada	PC	Low	< 10 %
Cali	Colombia	PC	Low	< 10 %
Rio Negro	Colombia	PC	Low	< 10 %
Guadalajara	Mexico	PC	Low	< 10 %
Te Rapa	New Zealand	PC	Low	< 10 %
Veniov	Russia	PC	Low	< 10 %
Bowling Green	USA	PC	Low	< 10 %
BM Stugun (sawmill)	Sweden	FP	Low	< 10 %
Bollsta (sawmill)	Sweden	FP	Low	< 10 %
Gällö (sawmill)	Sweden	FP	Low	< 10 %
Östrand	Sweden	FP	Low	< 10 %
BioNorr (sawmill)	Sweden	FP	Low	< 10 %
Rundvik (sawmill)	Sweden	FP	Low	< 10 %
Taipei	Taiwan	PC	No Data	No Data

Site name	Country	Division	Assessment	Score (%)
Tuzla (Istanbul1)	Turkey	PC	No Data	No Data
Obbola	Sweden	FP	No Data	No Data
Munksund	Sweden	FP	No Data	No Data
Munksund (sawmill)	Sweden	FP	No Data	No Data
Ortviken	Sweden	FP	No Data	No Data
Tunadal (sawmill)	Sweden	FP	No Data	No Data

Table B.3: Results of measurements of Risk of Scarcity (WWF-DEG).

Site name	Country	Division	Assessment	Score (unitless)
Monterrey	Mexico	TP	Very High Risk	4,7
Beijing	China	TP	High Risk	4,2
Shangdong (Laiwu)	China	TP	High Risk	4,1
Sahagun	Mexico	TP	High Risk	4,2
Bellemont	USA	TP	High Risk	4
Flagstaff	USA	TP	High Risk	4
Ecatepec Personal Care	Mexico	PC	High Risk	4,1
Guadalajara	Mexico	PC	High Risk	4,4
Guangdong (Jiangmen)	China	TP	Some Risk	2,9
Guangdong (Xinhui)	China	TP	Some Risk	2,9
Nokia	Finland	TP	Some Risk	2,7
Gien	France	TP	Some Risk	2,5
Hondouville (Cotton)	France	TP	Some Risk	3
Hondouville (Tissue)	France	TP	Some Risk	3
Le Theil	France	TP	Some Risk	2,6
Orleans	France	TP	Some Risk	2,6
Sovetsk	Russia	TP	Some Risk	2,6
Svetogorsk	Russia	TP	Some Risk	2,7
Allo	Spain	TP	Some Risk	3,2
Manchester	UK	TP	Some Risk	2,9
Stubbins	UK	TP	Some Risk	3,3
Barton	USA	TP	Some Risk	3,4
Greenwich	USA	TP	Some Risk	2,6
Menasha	USA	TP	Some Risk	2,7
Neenah	USA	TP	Some Risk	2,7
South Glens Falls	USA	TP	Some Risk	2,6
Selangor	Malaysia	PC	Some Risk	2,6
Veniov	Russia	PC	Some Risk	2,6
Taipei	Taiwan	PC	Some Risk	2,5
Tuzla (Istanbul1)	Turkey	PC	Some Risk	2,7
Yildiz (Istanbul2)	Turkey	PC	Some Risk	2,7
Bowling Green	USA	PC	Some Risk	3,3
Ortmann	Austria	TP	Limited Risk	1,9
Sao Paolo (TP)	Brazil	TP	Limited Risk	1,7
Pisa	Chile	TP	Limited Risk	1,9
Guangdong (Sanjiang)	China	TP	Limited Risk	1,8
Hubei (Xiaogan)	China	TP	Limited Risk	1,7
Liaoning (Anshan)	China	TP	Limited Risk	2,2
Sichuan (Deyang)	China	TP	Limited Risk	1,8
Santo Domingo	Dom. Rep.	TP	Limited Risk	2,2
Sotteville	France	TP	Limited Risk	1,6
Witzenhausen (Tissue)	Germany	TP	Limited Risk	1,6
Altopascio	Italy	TP	Limited Risk	2,4
Collodi	Italy	TP	Limited Risk	2,4

Site name	Country	Division	Assessment	Score (unitless)
Lucca 1	Italy	TP	Limited Risk	2,4
Uruapan	Mexico	TP	Limited Risk	2
Kawerau	New Zealand	TP	Limited Risk	1,5
Hlohovec	Slovakia	TP	Limited Risk	1,7
La Riba	Spain	TP	Limited Risk	1,8
Mediona	Spain	TP	Limited Risk	1,8
Puigpelat	Spain	TP	Limited Risk	1,8
Lilla Edet	Sweden	TP	Limited Risk	2,4
Chesterfield	UK	TP	Limited Risk	2,4
Oakenholt	UK	TP	Limited Risk	2,4
Prudhoe	UK	TP	Limited Risk	2
Skelmersdale	UK	TP	Limited Risk	2,2
Sao Paolo (PC)	Brazil	PC	Limited Risk	1,7
Drummondville	Canada	PC	Limited Risk	2,4
Santo Domingo	Dom. Rep.	PC	Limited Risk	2,2
Gemerska	Slovakia	PC	Limited Risk	1,9
BM Stugun (sawmill)	Sweden	FP	Limited Risk	1,7
Gällö (sawmill)	Sweden	FP	Limited Risk	1,7
Box Hill, Melbourne	Australia	TP	Very Limited Risk	1,4
Stembert	Belgium	TP	Very Limited Risk	1,3
Zhejiang (Longyou)	China	TP	Very Limited Risk	1,4
Cajica	Colombia	TP	Very Limited Risk	1,3
Medellin	Colombia	TP	Very Limited Risk	1,4
Lasso	Ecuador	TP	Very Limited Risk	1,3
Kunheim	France	TP	Very Limited Risk	1,3
Kostheim	Germany	TP	Very Limited Risk	1,3
Mannheim	Germany	TP	Very Limited Risk	1,3
Neuss	Germany	TP	Very Limited Risk	1,2
Cuijk	Netherlands	TP	Very Limited Risk	1,2
Suameer	Netherlands	TP	Very Limited Risk	1,2
Te Rapa	New Zealand	TP	Very Limited Risk	1,2
Aconcagua	Argentina	PC	Very Limited Risk	1,4
Springvale	Australia	PC	Very Limited Risk	1,4
Hubei	China	PC	Very Limited Risk	1,4
Cali	Colombia	PC	Very Limited Risk	1,3
Rio Negro	Colombia	PC	Very Limited Risk	1,4
Lasso	Ecuador	PC	Very Limited Risk	1,3
Gennep	Netherlands	PC	Very Limited Risk	1,2
Hoogezand	Netherlands	PC	Very Limited Risk	1,4
Te Rapa	New Zealand	PC	Very Limited Risk	1,2
Olawa PC	Poland	PC	Very Limited Risk	1,3
Falkenberg	Sweden	PC	Very Limited Risk	1
Mölnlycke	Sweden	PC	Very Limited Risk	1
BioNorr (sawmill)	Sweden	FP	Very Limited Risk	1
Bollsta (sawmill)	Sweden	FP	Very Limited Risk	1
Munksund	Sweden	FP	Very Limited Risk	1,2
Munksund (sawmill)	Sweden	FP	Very Limited Risk	1,2

Site name	Country	Division	Assessment	Score (unitless)
Obbola	Sweden	FP	Very Limited Risk	1,4
Ortviken	Sweden	FP	Very Limited Risk	1,4
Östrand	Sweden	FP	Very Limited Risk	1,4
Rundvik (sawmill)	Sweden	FP	Very Limited Risk	1
Tunadal (sawmill)	Sweden	FP	Very Limited Risk	1,4

Table B.4: Results of measurements of Risk of Pollution (WWF-DEG).

Site name	Country	Division	Assessment	Score (unitless)
Pisa	Chile	TP	Very High Risk	5
Hubei (Xiaogan)	China	TP	Very High Risk	5
Liaoning (Anshan)	China	TP	Very High Risk	5
Shangdong (Laiwu)	China	TP	Very High Risk	5
Monterrey	Mexico	TP	Very High Risk	5
Sahagun	Mexico	TP	Very High Risk	5
Cuijk	Netherlands	TP	Very High Risk	5
Ecatepec Personal Care	Mexico	PC	Very High Risk	5
Guadalajara	Mexico	PC	Very High Risk	5
Gennep	Netherlands	PC	Very High Risk	5
Taipei	Taiwan	PC	Very High Risk	5
Bowling Green	USA	PC	Very High Risk	5
Box Hill, Melbourne	Australia	TP	High Risk	4
Stembert	Belgium	TP	High Risk	4
Sao Paolo (TP)	Brazil	TP	High Risk	4
Zhejiang (Longyou)	China	TP	High Risk	4
Guangdong (Sanjiang)	China	TP	High Risk	4
Guangdong (Jiangmen)	China	TP	High Risk	4
Guangdong (Xinhui)	China	TP	High Risk	4
Sichuan (Deyang)	China	TP	High Risk	4
Cajica	Colombia	TP	High Risk	4
Santo Domingo	Dom. Rep.	TP	High Risk	4
Lasso	Ecuador	TP	High Risk	4
Gien	France	TP	High Risk	4
Hondouville (Cotton)	France	TP	High Risk	4
Hondouville (Tissue)	France	TP	High Risk	4
Le Theil	France	TP	High Risk	4
Orleans	France	TP	High Risk	4
Kostheim	Germany	TP	High Risk	4
Mannheim	Germany	TP	High Risk	4
Neuss	Germany	TP	High Risk	4
Witzenhausen (Tissue)	Germany	TP	High Risk	4
Altopascio	Italy	TP	High Risk	4
Collodi	Italy	TP	High Risk	4
Lucca 1	Italy	TP	High Risk	4
Suameer	Netherlands	TP	High Risk	4
Sovetsk	Russia	TP	High Risk	4
Hlohovec	Slovakia	TP	High Risk	4
Mediona	Spain	TP	High Risk	4
Chesterfield	UK	TP	High Risk	4
Manchester	UK	TP	High Risk	4
Oakenholt	UK	TP	High Risk	4
Prudhoe	UK	TP	High Risk	4
Skelmersdale	UK	TP	High Risk	4
Stubbins	UK	TP	High Risk	4

Site name	Country	Division	Assessment	Score (unitless)
Barton	USA	TP	High Risk	4
Menasha	USA	TP	High Risk	4
Neenah	USA	TP	High Risk	4
Aconcagua	Argentina	PC	High Risk	4
Springvale	Australia	PC	High Risk	4
Sao Paolo (PC)	Brazil	PC	High Risk	4
Hubei	China	PC	High Risk	4
Santo Domingo	Dom. Rep.	PC	High Risk	4
Lasso	Ecuador	PC	High Risk	4
Selangor	Malaysia	PC	High Risk	4
Hoogezand	Netherlands	PC	High Risk	4
Olawa PC	Poland	PC	High Risk	4
Veniov	Russia	PC	High Risk	4
Mölnlycke	Sweden	PC	High Risk	4
Tuzla (Istanbul1)	Turkey	PC	High Risk	4
Ortmann	Austria	TP	Some Risk	3
Beijing	China	TP	Some Risk	3
Medellin	Colombia	TP	Some Risk	3
Nokia	Finland	TP	Some Risk	3
Kunheim	France	TP	Some Risk	3
Uruapan	Mexico	TP	Some Risk	3
Svetogorsk	Russia	TP	Some Risk	3
Allo	Spain	TP	Some Risk	3
Lilla Edet	Sweden	TP	Some Risk	3
Bellemont	USA	TP	Some Risk	3
Flagstaff	USA	TP	Some Risk	3
Greenwich	USA	TP	Some Risk	3
South Glens Falls	USA	TP	Some Risk	3
Drummondville	Canada	PC	Some Risk	3
Cali	Colombia	PC	Some Risk	3
Rio Negro	Colombia	PC	Some Risk	3
Gemerska	Slovakia	PC	Some Risk	3
Yildiz (Istanbul2)	Turkey	PC	Some Risk	3
Ortviken	Sweden	FP	Some Risk	3
Östrand	Sweden	FP	Some Risk	3
Tunadal (sawmill)	Sweden	FP	Some Risk	3
Sotteville	France	TP	Limited Risk	2
Kawerau	New Zealand	TP	Limited Risk	2
Te Rapa	New Zealand	TP	Limited Risk	2
La Riba	Spain	TP	Limited Risk	2
Puigpelat	Spain	TP	Limited Risk	2
Te Rapa	New Zealand	PC	Limited Risk	2
BM Stugun (sawmill)	Sweden	FP	Limited Risk	2
Gällö (sawmill)	Sweden	FP	Limited Risk	2
Munksund (sawmill)	Sweden	FP	Limited Risk	2
Obbola	Sweden	FP	Limited Risk	2
Rundvik (sawmill)	Sweden	FP	Limited Risk	2

Site name	Country	Division	Assessment	Score (unitless)
Falkenberg	Sweden	PC	Very Limited Risk	1
BioNorr (sawmill)	Sweden	FP	Very Limited Risk	1
Bollsta (sawmill)	Sweden	FP	Very Limited Risk	1
Munksund	Sweden	FP	Very Limited Risk	1

Table B.5: Results of measurements of Risk of Ecosystem Threat (WWF-DEG).

Site name	Country	Division	Assessment	Score (unitless)
Altopascio	Italy	TP	Very High Risk	5
Collodi	Italy	TP	Very High Risk	5
Lucca 1	Italy	TP	Very High Risk	5
Stembert	Belgium	TP	High Risk	4
Sao Paolo (TP)	Brazil	TP	High Risk	4,2
Zhejiang (Longyou)	China	TP	High Risk	4,3
Guangdong (Sanjiang)	China	TP	High Risk	4,3
Guangdong (Jiangmen)	China	TP	High Risk	4,3
Guangdong (Xinhui)	China	TP	High Risk	4,3
Hubei (Xiaogan)	China	TP	High Risk	4,3
Liaoning (Anshan)	China	TP	High Risk	4,3
Sichuan (Deyang)	China	TP	High Risk	4,3
Shangdong (Laiwu)	China	TP	High Risk	4,3
Cajica	Colombia	TP	High Risk	3,9
Medellin	Colombia	TP	High Risk	3,9
Gien	France	TP	High Risk	3,9
Hondouville (Cotton)	France	TP	High Risk	3,9
Hondouville (Tissue)	France	TP	High Risk	3,9
Kunheim	France	TP	High Risk	3,9
Le Theil	France	TP	High Risk	3,9
Orleans	France	TP	High Risk	3,9
Sotteville	France	TP	High Risk	3,9
Kostheim	Germany	TP	High Risk	3,9
Mannheim	Germany	TP	High Risk	3,9
Neuss	Germany	TP	High Risk	3,9
Witzenhausen (Tissue)	Germany	TP	High Risk	3,9
Monterrey	Mexico	TP	High Risk	4
Uruapan	Mexico	TP	High Risk	4
Sahagun	Mexico	TP	High Risk	4
Te Rapa	New Zealand	TP	High Risk	3,8
Sovetsk	Russia	TP	High Risk	3,6
Allo	Spain	TP	High Risk	3,9
La Riba	Spain	TP	High Risk	3,9
Mediona	Spain	TP	High Risk	3,9
Puigpelat	Spain	TP	High Risk	3,9
Aconcagua	Argentina	PC	High Risk	4,3
Sao Paolo (PC)	Brazil	PC	High Risk	4,2
Hubei	China	PC	High Risk	4,3
Rio Negro	Colombia	PC	High Risk	3,9
Selangor	Malaysia	PC	High Risk	3,8
Ecatepec Personal Care	Mexico	PC	High Risk	4
Guadalajara	Mexico	PC	High Risk	4
Te Rapa	New Zealand	PC	High Risk	3,8
Olawa PC	Poland	PC	High Risk	4,4
Veniov	Russia	PC	High Risk	3,6

Site name	Country	Division	Assessment	Score (unitless)
Tuzla (Istanbul1)	Turkey	PC	High Risk	4,1
Yildiz (Istanbul2)	Turkey	PC	High Risk	4,1
Box Hill, Melbourne	Australia	TP	Some Risk	3,1
Ortmann	Austria	TP	Some Risk	2,9
Pisa	Chile	TP	Some Risk	3,4
Beijing	China	TP	Some Risk	3,3
Santo Domingo	Dom. Rep.	TP	Some Risk	3,2
Lasso	Ecuador	TP	Some Risk	3,3
Nokia	Finland	TP	Some Risk	2,7
Cuijk	Netherlands	TP	Some Risk	3,4
Suameer	Netherlands	TP	Some Risk	2,9
Kawerau	New Zealand	TP	Some Risk	3
Svetogorsk	Russia	TP	Some Risk	3,1
Hlohovec	Slovakia	TP	Some Risk	3,2
Lilla Edet	Sweden	TP	Some Risk	2,7
Chesterfield	UK	TP	Some Risk	3,4
Manchester	UK	TP	Some Risk	3,4
Oakenholt	UK	TP	Some Risk	2,9
Prudhoe	UK	TP	Some Risk	3,4
Skelmersdale	UK	TP	Some Risk	3,4
Stubbins	UK	TP	Some Risk	3,4
Barton	USA	TP	Some Risk	3,2
Bellemont	USA	TP	Some Risk	2,7
Flagstaff	USA	TP	Some Risk	2,7
Greenwich	USA	TP	Some Risk	3,2
Menasha	USA	TP	Some Risk	3,2
Neenah	USA	TP	Some Risk	3,2
South Glens Falls	USA	TP	Some Risk	3,2
Springvale	Australia	PC	Some Risk	3,1
Drummondville	Canada	PC	Some Risk	3,1
Cali	Colombia	PC	Some Risk	3,3
Santo Domingo	Dom. Rep.	PC	Some Risk	3,2
Lasso	Ecuador	PC	Some Risk	3,3
Gennep	Netherlands	PC	Some Risk	3,4
Hoogezand	Netherlands	PC	Some Risk	2,9
Gemerska	Slovakia	PC	Some Risk	2,7
Mölnlycke	Sweden	PC	Some Risk	2,7
Taipei	Taiwan	PC	Some Risk	3,2
Bowling Green	USA	PC	Some Risk	3,2
Falkenberg	Sweden	PC	Limited Risk	2,2
BioNorr (sawmill)	Sweden	FP	Limited Risk	2,2
BM Stugun (sawmill)	Sweden	FP	Limited Risk	2,2
Bollsta (sawmill)	Sweden	FP	Limited Risk	2,2
Gällö (sawmill)	Sweden	FP	Limited Risk	1,7
Munksund	Sweden	FP	Limited Risk	2,2
Munksund (sawmill)	Sweden	FP	Limited Risk	1,7
Obbola	Sweden	FP	Limited Risk	1,7

Site name	Country	Division	Assessment	Score (unitless)
Ortviken	Sweden	FP	Limited Risk	2,2
Östrand	Sweden	FP	Limited Risk	2,2
Rundvik (sawmill)	Sweden	FP	Limited Risk	1,7
Tunadal (sawmill)	Sweden	FP	Limited Risk	2,2