Freshwater sustainability criteria in ecolabels: the creation of a freshwater sustainability ecolabel and analysis of current ecolabels in the Netherlands

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Preface

This report is my master thesis, which is the conclusion of my master program Water Engineering and Management. My master thesis is called "Freshwater sustainability criteria in ecolabels: the creation of a freshwater sustainability ecolabel and analysis of current ecolabels in the Netherlands" and in this report my findings are presented.

Some nine months ago is started this project, mainly because the concept of freshwater sustainability intrigued me. This is research field which is comprehensive in the University of Twente, where I conducted my study and this thesis. This thesis combines the concepts of freshwater sustainability, of which adequate knowledge was present, and the concept of ecolabeling, which was an unknown field for me and the university.

I like to specially thank the ngo Milieu Centraal and Arriette Dommering, for helping me find my way in the field of ecolabeling and providing the information needed to comprehend ecolabeling. Also I would like to thank both my supervisors from the university: Arjen Hoekstra and Rick Hogeboom, for providing input and guidance which ultimately helped form this thesis.

I sincerely hope you enjoy reading my thesis,

Vok Keijsper

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Summary

This research was conducted to determine what a freshwater sustainability ecolabel (dubbed waterlabel) would look like. The ultimate goal of such a waterlabel is to influence consumer and producer habits in the use of freshwater by providing information. To create an ideal waterlabel, existing literature about freshwater sustainability and ecolabeling was combined. Current ecolabels were assessed on their inclusion of freshwater sustainability criteria by comparing their labeling schemes and missions.

Freshwater sustainability is determined on the basis of (1) geographic and (2) economic criteria. The freshwater used in a given production chain is sustainable only if all criteria are met for each location used in a production chain. (1) The geographic criteria are split into separate criteria for blue-, green- and grey water, here blue water relates to surface and groundwater, green water to precipitation which does not reach the blue water and grey water is the water needed to assimilate pollution. For each type of water use, the total amount used in an area cannot exceed the availability. Otherwise that type of water is unsustainably used. (2) Economic sustainability is determined by setting a benchmark corresponding with amount of freshwater used by the 20 percent most effective water users. Finally, a freshwater sustainability score calculated by expressing the total amount of sustainably used freshwater as a percentage of the total freshwater used.

Determining the freshwater sustainability ecolabel

In a first step the design of the waterlabel was determined. Ecolabeling literature recognizes three basis designs: graded, pass/fail and hybrid. The graded design was chosen for the waterlabel because it is most effective. It however is also hardest to implement. A graded label is given to all products, with the better scoring products receiving higher grades and the lower scoring products receiving lower grades.

The boundaries were set, after this design was chosen. Ten grades were chosen ranking from A to J. For each product group individually, a graph was constructed in the waterlabel, showing the freshwater sustainability score on the y-axis and the cumulative percentage of products on the x-axis. These grade boundaries were set using the cumulative percentage of products, making the boundary dynamic and subject to change over time if the overall freshwater sustainability scores change. This guarantees that the waterlabel remains equally strict in the future. Because of this, the graphs should be updated regularly, at least yearly. Additionally, product groups were set, so products within a group are interchangeable. This way consumers can use the waterlabel to compare products.

With each boundary set at a tenth percentile the best ten percent of producers will be graded with an A-label and the worst ten with a J. Scoring of individual products was done by first determining their freshwater sustainability score and then, using the graph, correlating that score to cumulative percentage score for that product group. Because of the set boundaries, the grade can be given instantly. There is however, a possibility that that products with an overall low freshwater sustainability could still receive an A- or B-grade if overall scores in that product group are low. To avoid this, the A- or B-grades also will have a minimum freshwater sustainability score of respectively 50% and 25%. Without this extra threshold consumers could perceive the final score and the label itself as untruthful.

The waterlabel is most effective if it is made obligatory for producers, meaning it is best managed by a government entity. The setup of the labeling will furthermore be in line with the ten principles for good ecolabels. Principles like sustainability, relevance, efficiency, improvement and rigor are already imbedded in the labeling scheme. The remaining principles accessibility, engagement, impartiality, truthfulness and transparency, however, need to be part of the management style.

Current status of freshwater sustainability in ecolabels

For assessing the current status of freshwater sustainability in existing ecolabels, 44 ecolabels were selected. These represent all ecolabels operating in the Netherlands targeting foodstuffs, paper/wood and clothing products. These ecolabels were all managed by nonprofit organizations, often with government links. 93% of these ecolabels use pass/fail design and none use a graded design, most likely due to the fact that pass/fail designed labels are much easier to implement.

The schemes of these ecolabels were assessed on their mission, whether and how they include freshwater sustainability criteria, how the overall scheme was formulated, whether freshwater criteria were obligatory and whether the supply chain was also included in the freshwater sustainability criteria. Using these criteria, the ecolabels were classified and thereafter ranked in 12 categories, such that the higher the category, the better freshwater sustainability was incorporated into the ecolabel.

The highest two categories, which include five existing ecolabels (shown in Table 1), were assessed in more detail to determine the differences occurring between those labels and the waterlabel. It was deemed that these differences were indicative for the improvements needed to come to better inclusion of freshwater sustainability in existing labels.

The five key elements of the waterlabel are (1) a wider geographic view, (2) the split of freshwater use in blue, green and grey, (3) the inclusion of an economic component, (4) the use of a quantified scheme, and (5) the inclusion of the full supply chain in the scheme. The score of each ecolabel is given in Table 1, where green means that the element is included, yellow means that it is partly included or can be included easily and red means that it is hard and unlikely it can be included in the current scheme.

Table 1: Table linking the selected ecolabels and the five key elements

Key Element: Label:	1	2	3	4	5
Cradle-to-Cradle	Y	R	Y	G	Y
European Ecolabel	R	R	R	G	R
Milieukeur (field production)	R	Y	Y	G	Y
Milieukeur (glass house production)	R	Y	Y	G	Y
Rainforest Alliance	Y	R	Y	G	Y

From Table 1, it should be noted that in the Cradle-to-Cradle label the supply chain was only implemented in the social criteria. Also the last three ecolabels only target fruits and vegetables, so the inclusion of the full supply chain is not deemed absolutely necessary.

In all five ecolabels quick and easy steps towards a better inclusion of freshwater sustainability can be made by including criteria for all types of freshwater use and by including an economic component. These elements can be included into the labeling scheme without changing how and where data is collected. The wider geographic view does, however, require data from new sources and should therefore be the next step. The last step is to include the full supply chain. This is most likely the most invasive improvement and most difficult to implement. If these elements are all present, freshwater sustainability is deemed to be adequately incorporated into the labeling scheme of these five existing ecolabels.

Final notes on the waterlabel

For the purpose of this research and to create the waterlabel some assumptions and decisions were made. First of all, possible trade-offs with other issues, like animal wellbeing and social issues, were disregarded. This may affect how consumers perceive the label. Secondly, the label is designed based on ideal circumstances, such as that all data is available. In reality, many choices will have to be made on the way in which data is collected, on what do when data is missing and many more issues. Some other choices were made which can best be decided if sufficient product scores are available. These choices include the benchmark of 20^{th} percentile, the boundaries, product grouping and more. Also, suggestions on the ideal organization scenario were made whereas in reality it is unlikely that such a scenario is implemented directly, but rather in steps.

Finally, this research has shown a big difference between the approach of the waterlabel and current ecolabels. The waterlabel is designed in such a way to assess all products, and focuses on the supply chain of products with multiple ingredients. Current ecolabels, on the other hand, often focus on a single product group. In these cases the supply chain is often very small and in some cases even irrelevant.

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1. Introduction

The needs to sustain the world's population have changed drastically in the past century. This is mainly due to a vast increase of people (Taageperea, 2014) and to increasing wealth and life standards (Arrowa et al., 2012). Not only are more resources needed to sustain the population as a whole; more resources per person are needed as well. Both developments increase pressure on the existing resources and make that scarcity problems are becoming ever more frequent (Kharraz et al., 2012).

One of the resources under pressure is freshwater. Freshwater supplies are provided constantly, for instance in form of precipitation, so they seem endless. However, the amount of freshwater available is limited in space and time (Hoekstra and Wiedmann, 2014). This can result in local demands exceeding the supply, causing scarcity problems.

The concept of freshwater sustainability is used to determine whether freshwater supplies are used responsibly and were and why scarcity problems occur. This concept is constructed using three pillars (Hoekstra, 2014). (1) The first pillar is environmental sustainability, which states that a certain maximum amount of freshwater is used per river basin. This maximum is set at a level ensuring that the environment is not affected by the freshwater withdrawal (Hoekstra et al., 2011). (2)The second pillar is resource efficiency (Hoekstra, 2014), which increases the productivity per amount of freshwater. When less water is needed to produce the same amount of products, the demand goes down and the chance of scarcity problems occurring decreases. (3) The last pillar is social equity (Hoekstra, 2014). The amount of freshwater used per person in developed countries is nearly twice that of developing countries (Hoekstra, 2014). Leveling this difference by decreasing the amount used in the developed countries will likewise lower the overall use of freshwater.

A key aspect of freshwater sustainability is the concept of waterfootprint. The waterfootprint assesses both direct and indirect freshwater use (Hoekstra et al., 2011). For products this includes all freshwater used in the entire supply chain. By determining the freshwater used per process and adding them, the waterfootprint of a product is calculated.

To determine where freshwater sustainability problems originate, freshwater use is split in three. The three types of freshwater use are blue, green and grey (Hoekstra et al., 2011), where blue water is all surface- and groundwater, green water is precipitation which does not flow into blue water and grey water is the freshwater needed to assimilate pollutants (Hoekstra et al., 2011).

The largest amount of freshwater is needed for the production of consumer goods. 91.5% of freshwater is used for agriculture, 4.7% for industry and the rest for domestic uses (Hoekstra and Mekonnen, 2012). Freshwater is mostly used to grow crops and process products. These products are distributed globally. Scarcity problems in one region may therefore be driven by product demands in another region.

At present, the amount, type and origins of freshwater used in a product cannot be determined by a consumer. It cannot be seen, smelled or tasted. It is therefore an example of a credence good (Bougherara and Combris, 2009), which is a quality of a product that cannot be determined by any sense. Labels are therefore used to provide customers with this necessary information. When the credence good in question is environmental, the labels are called environmental labels. Ecolabels are one such environmental label.

Ecolabeling is a market based tool, which has the potential to steer the market into a more environmental direction (Snoo and Ven, 1999). An ecolabel makes the environmental properties of a product apparent to consumers. In theory this results in more environmentally friendly purchases or pressures producers to manufacture in a way that is less harmful to the environment (Bleda and Valente, 2009).

Ecolabels exist for many different environmental issues. Some ecolabels address broader sustainability issues while others focus on a single environmental issue. To date, no ecolabels exist on freshwater sustainability alone, although some ecolabels may take freshwater into account. Because the total content of ecolabels is not widely known, the ecolabels that do take freshwater sustainability into account are unknown to consumers at large. This research will therefore focus on freshwater sustainability criteria in ecolabels, introducing a newly formed freshwater sustainability label and, through an in-depth examination of existing ecolabels, comparing it to ecolabels already in use.

This thesis was conducted to formulate and assess freshwater sustainability criteria in ecolabeling and create an ecolabel for freshwater sustainability. This firstly done by composing research questions, the research scope and the research methodology in chapter 2. Then the relevant information about freshwater sustainability (chapter 3) and ecolabeling (chapter 4) are assessed. Next, the information found in chapters 3 and 4 are used to formulate the criteria for a freshwater sustainability ecolabel in chapter 5. How these criteria are fitted into the ecolabel is also described in chapter 5. In chapter 6 current ecolabels are assessed on their inclusion of freshwater sustainability criteria and lastly the discussion (chapter 7) and conclusions (chapter 8) are given.

2. Research objective, scope and method

2.1. Goals of the research

The objective of this research is to determine freshwater criteria that can be applied to an ecolabel for freshwater sustainability and to examine whether these criteria or similar criteria are currently already used by existing ecolabels.

The first goal is to determine which criteria and aspects could be included in an ecolabel that includes freshwater sustainability. To this end, a theoretical freshwater sustainability label, dubbed waterlabel, is created. The waterlabel includes criteria for freshwater sustainably produced goods as well as a framework for how to apply the label to products. A small section of the research is used to assess how the ecolabel setup could be implemented.

The second goal of this research is to determine how the freshwater sustainability issue is implemented in current ecolabels and whether this can be improved. Sufficient improvement in existing ecolabels could be an alternative to the creation of a separate ecolabel for freshwater sustainability alone.

2.2. Research questions

From the goal set in 2.1, the main research question is derived:

What would a suitable freshwater sustainability ecolabel look like, and how can freshwater sustainability criteria be better included in existing ecolabels?

The main research question contains two parts that will be examined individually in the following separate sub questions:

1) **What would an ecolabel designed to assess freshwater sustainability look like?**
    a. **What criteria are used to measure freshwater sustainability?**
    b. **How can the criteria be translated into a labeling scheme?**
    c. **What form of labeling would be most effective?**
2) **In what way can freshwater sustainability criteria be better included in existing ecolabels?**
    a. **What existing labels could benefit from including freshwater sustainability and how are these labels currently organized?**
    b. **How is freshwater sustainability currently included in labeling schemes?**
    c. **How could freshwater sustainability be better included?**

2.3. Research scope

This research is about freshwater sustainability and how it is implemented in ecolabels. Freshwater sustainability was chosen rather than a broader sustainability issue, including energy or greenhouse gasses for instance, because it is relatively new and little research on the matter has been done. This means that, for the purposes of this project, the trade-off between freshwater sustainability and other sustainability issues is disregarded.

This research will focus on products with an agricultural origin, because 91.5% of freshwater is used in the agricultural sector (Hoekstra and Mekonnen, 2012). The product groups included will be foodstuffs, wood/paper and clothing. Both the waterlabel as the examined ecolabels will fall in these product groups.

Among the terms used in this research the term ecolabel is common. As ecolabels are labels that include an environmental standard (Gallastegui, 2002), they are a sub category within environmental labels. There are two important distinctions. Environmental labels do not necessarily set a standard; they can also merely be indicative. Secondly, whereas an ecolabel is always impartial, this is not necessarily true for environmental labels. Since most environmental labels actually set a standard and are impartial, they are in fact ecolabels. The distinction is however, not always clear in reality. For this reason all environmental labels used in this research are considered to be ecolabels.

A few other terms are used in this research. First of all the term 'waterlabel' is introduced to refer to the ecolabel created in this research that focuses on freshwater sustainability. Furthermore, the term 'scheme' is used to refer to the checklist used by ecolabels to determine whether a product qualifies for the label. 'Effectiveness' of an ecolabel can be measured over many parameters and differs per goal of the ecolabel. In this research, an ecolabel is deemed effective if it is accepted by both the producers and consumers.

The waterlabel will be developed as an ideal label. This means it operates under ideal circumstances. Financial or practical difficulties will be deemed to not exist. It is also assumed that all relevant data needed to assess products can be provided.

The existing ecolabels examined will be those currently operating in the Netherlands. This includes several Dutch labels, European labels and bigger international labels, but excludes other international labels and European labels that have a Dutch equivalent.

Milieu Centraal currently lists 246 labels in the Netherlands (Milieu Centraal). Of this list the labels in product groups outside the indicated product groups (foodstuffs, wood/paper and clothing) are excluded. Also labels with no environmental score, indicating no environmental issues included in their label, are excluded. Some labels, moreover, do not have their own criteria, but rather show that two or more other labels – usually both about environment and animal wellbeing – are associated with the product. These kinds of labels are called umbrella labels and will be mentioned but not taken into account. Some umbrella labels mentioned are not labels at all, but rather brand names that guarantee certain labels are imbedded. These are also not taken into account.

Also some denotations on paper products – '*kringloop*' (recycled) and '*chloorvrij*' (free of bleach)– where found, which are in fact unofficial labels. There are no organizations controlling these "labels" so they are claims by producers. Because they have no official status they will not be taken into account.

Lastly, some labels are applicable to more product groups. In some cases, like the Milieukeur label, different labeling schemes are used for different product groups. In other cases however, like the EKO label and the waterlabel, the same set of standards or principles are applied to different product groups. In the first case the different schemes are considered as different labels. In the second case, however, the label is assessed as one being label.

2.4. Methodology

In a first step an ecolabel for freshwater sustainability has been constructed. As this ecolabel is aimed at consumer products, a literature study was conducted to determine how freshwater sustainability is determined in products. The freshwater sustainability analysis was conducted using the principles of waterfootprinting. This method is deemed to be most comprehensive and therefore gives most options for how to convert the freshwater sustainability analysis to an ecolabeling scheme. Apart from literature about freshwater sustainability and waterfootprinting, the concept of ecolabeling itself was examined. This provided insight in the different options available for the waterlabel and was used as the framework for constructing the ideal waterlabel.

The waterlabel scheme itself was constructed using the theory about freshwater sustainability. Using this theory, criteria on how freshwater sustainability is measured were created. These criteria were constructed to fit a generic scheme, so that each product can be rated using the same criteria. From the analysis conducted, a single freshwater sustainability score emerges per product, which was then used to make further steps in the labeling scheme. The score is not split into multiple sub scores, because it would unnecessarily complicate the waterlabel and make it harder to apply for both the label and the producers. Also, consumers might find such a split score difficult to comprehend.

Next, using the freshwater sustainability scores, a system was created to determine the boundaries of the waterlabel. In order to determine how many boundaries were needed, the labeling design was chosen first. The boundaries were then set using both the freshwater sustainability score as well as the relative score of the various producers. The freshwater sustainability score guarantees a minimum freshwater sustainability score and the relative score per producer ensures an even distribution of products along the boundaries.

It was chosen to construct a system with dynamic boundaries. When future production becomes more freshwater sustainable, dynamic boundaries will remain equally strict and producers do not lose incentive to produce more freshwater sustainable. In the research, this was done by setting the boundaries over the relative score per producer. In an additional step towards the creation of an ideal waterlabel, it was determined which products are to be rated together. These separate product groups were constructed to allow consumers to compare products with similar products, which is a goal of ecolabeling.

To complete the research into the first question, the necessary organization structure of the waterlabel was determined: what organization is to control the label and what strategy is needed for implementation. Both sub questions were answered through literature study. Extra research on how the waterlabel should be organized was deemed superfluous as a lot of research has already been done on the matter of ecolabeling.

To answer the second research question, first, a list of all relevant ecolabels was compiled. This was done using previous research by Milieu Centraal (Milieu Centraal, 2015) and the criteria set in the research scope. These ecolabels were thereafter examined on their organization structure and their freshwater sustainability policy, on the basis of their labeling scheme or a similar document.

The organization structure of current ecolabels was examined to provide insight on what choices these ecolabels make. This aspect plays only a small part in the research, because it is not deemed relevant for the freshwater sustainability policy. It does, however, give indications on how ecolabeling as a whole is currently conducted. The organization structure was assessed following four criteria:

1. Labeling design. Possible labeling designs are graded, pass/fail and hybrid (Big Room and World Resources Institute, 2010). Here a graded design uses several grades over the entire spectrum of products to indicate how they score, a pass/fail design gives a label to products who pass. This label is always the same. And lastly a hybrid design is a combination of the graded and pass/fail designs.
2. Controlling organization. Controlling organizations have been examined on the relevant organization and how the organization can be classified. Possible classifications of the organization are first party, in which the labeler and producer are the same, second party, in which the labeler is connected to the branch of the producer and third party, in which the labeler has no connection to the producer (Gallastegui, 2002).
3. The accreditation process. The accreditation of the ecolabel to a product can be done by the labeler or a third impartial party.
4. The ecolabel classification. The classification of the ecolabel is split in I, II, and III, with class I being an impartial environmental standard, class II an informative environmental self-declaration claim and class III is an impartial informative environmental label (Gallastegui, 2002).

Next, the freshwater sustainability policy of current ecolabels was examined on five key points by assessing the labeling standards and mission. The following five points were assessed:

1. Does the mission include freshwater sustainability? Even though ecolabels focusing on freshwater sustainability do not exist, some ecolabels view sustainability in a wider context. Ecolabels that suggest a wider view on environmental issues could be expected to include water sustainability as well. These labels could benefit from the suggested waterlabel. In this research a label with a mission statement stating that the ecolabel considered sustainability as a whole or mentioning freshwater specifically, was deemed to include freshwater in their mission.
2. Are freshwater sustainability criteria included and how are they formulated? Three options were determined for this point: quantified, non-quantified and no criteria. This assessment determines which ecolabels include freshwater criteria and assessing if these criteria are quantified or not shows how compatible they are with the waterlabel.
3. Is the scheme quantified or not? Some ecolabels do not have quantified standards and thus do not rate each producer similarly. The ecolabels that use non-quantified standards in their whole scheme, and not just in one part of the scheme, use other trajectories for producers to steer them in a more sustainable direction. These kinds of non quantified labels are not compatible with the quantified waterlabel.
4. Are the freshwater sustainability criteria obligatory? When standards are obligatory, the quality of the freshwater standards is deemed to be better than if these standards are not obligatory. In cases where both obligatory and optional standards are applicable to determining freshwater sustainability, the ecolabel was ranked as obligatory.
5. Is the supply chain included in the freshwater criteria? The waterlabel and theory about freshwater sustainability both measure freshwater use in the supply chain, because this is where most freshwater use occurs (Hoekstra and Mekonnen, 2012). This point was examined in ecolabels to again assess compatibility of the ecolabel with the ideal waterlabel.

After all ecolabels were examined, a ranking was made using these five examined key points as the criteria to show which ecolabels are most promising regarding their inclusion of freshwater sustainability. First, two groups were constructed: ecolabels with freshwater in their mission and ecolabels without. These two groups were then each divided in three: quantified, non-quantified or no freshwater sustainability criteria. Next, further divisions were made based the last three assessment points. The ecolabels were divided in this order because the first three points were deemed to be of decreasing relevance and the last two points are only relevant if freshwater sustainability criteria are part of the label in the first place.

After the above ranking was made the ecolabels in the top two categories were examined more closely. In these categories all key points except the full supply chain were included and quantified. This ranking was made to determine the key differences occurring between the waterlabel and these ecolabels. From these key differences an assessment was made for each ecolabel what changes would be needed to incorporate the waterlabel principles. This was done to finalize the answer to the second research question.

3. Freshwater sustainability

In this chapter freshwater sustainability is explained; the theoretical basis for the waterlabel. The chapter first of all provides an overview of existing literature on freshwater sustainability. It also includes sections about water sustainability analysis and waterfootprint assessment. Both are needed to assess the freshwater sustainability of products.

3.1. Freshwater sustainability analysis

Freshwater sustainability analysis is split into three aspects (Hoekstra, 2014): geographic sustainability, social sustainability and economic sustainability. Geographic sustainability addresses the maximum amount of freshwater that can be used in a certain area in a certain time, social sustainability means that freshwater resources are fairly distributed among all groups of society and economic sustainability is about cost-efficient use of freshwater resources. The relation of each aspect with the waterlabel will be addressed in this chapter more closely.

The waterlabel will eventually be awarded to individual products. The freshwater sustainability analysis will therefore have to be fit for the analysis products and production trees. This question of applicability also is addressed in this section.

3.1.1. Geographic sustainability

A geographic location is sustainable if no water scarcity problems arise at any time (Hoekstra et al., 2011). Geographic sustainability therefore has both a spatial as well as a temporal aspect. Geographic sustainability relates to the waterlabel because production is done in different processes that may each use different locations. The bigger the producer, the more likely it is more locations are used. Freshwater used at any location impacts the geographic sustainability at that location. By assessing each location it can be determined which amount of freshwater used within a production chain is geographically sustainable and which amount is not.

Water scarcity can occur for the three types of freshwater: blue, green and grey. If any water scarcity problems arise in a location at a given time, that location is deemed a hotspot for that time period (Hoekstra et al., 2011). All freshwater used in a hotspot is deemed unsustainable. The amount used does not matter, as the scarcity problem created is deemed a shared responsibility of all freshwater users in the area.

To assess whether a location is a hotspot, three criteria are used (Hoekstra et al., 2011):

1. Total blue water use (x,t) > Total blue water available (x,t)
2. Total green water use (x,t) > Total green water available (x,t)
3. Total grey water use (x,t) > Total grey water assimilation capacity (x,t)

If any of these criteria are met, the location is a hotspot. In section 3.1.1.1 it is explained how the total blue water availability is determined using the available surface- and groundwater. In section 3.1.1.2 green water availability is explained and in section 3.1.1.3 the grey water assimilation capacity is explained.

3.1.1.1. Blue water availability

Blue water availability is determined by the available freshwater from rivers, lakes and groundwater. All need a certain amount of freshwater to sustain the environment so not all freshwater in these sources can be extracted. If either river, lake or groundwater levels are deemed unsustainable, the geographic area will be a hotspot. River sustainability is measured using the environmental flow requirement explained below. Methods to determine lake and groundwater sustainability are explained afterwards.

Rivers (environmental flow requirement)

The environmental flow requirement is a flow amount determined per river, or river section, which indicates the minimum amount needed to ensure that the ecosystem of the river remains unchanged (Acreman and Dunbar, 2004). The amount fluctuates over time because the natural flow, the runoff that occurs if no human intervention would occur, also fluctuates. Usually there is a wet and a dry season in which the river runoff differs. This difference is in fact needed to maintain the ecosystem. The environmental flow requirement acknowledges that high water levels as well as low water levels are necessary to maintain an ecosystem (Dyson et al., 2003).

To determine the amount of water that can be extracted first the natural runoff is determined. From this natural runoff, a certain amount can be extracted without upsetting the ecosystem. This amount differs per river and depends on factors such as the natural runoff, the species that make the ecosystem and the type of river. It is hard and costly to determine the environmental flow requirement for a river, because the natural runoff is often unknown due to prolonged human intervention. In general, the effects of withdrawals on the ecosystem are also difficult to determine. The environmental flow requirement of a river is therefore often unknown (Dyson et al., 2003). For the purposes of the waterlabel it is assumed that all data is available and thus the environmental flow requirement is known for each river.

For rivers that do not have a determined environmental flow requirement a presumptive standard is created which can be applied as a general rule of thumb. This standard sets the environmental flow requirement at 80% of the natural standard and can be used unless a better estimate is established (Richter et al., 2012). This presumptive standard is used to provide an example of the environmental flow requirement of a river. This example is given in Figure 1:

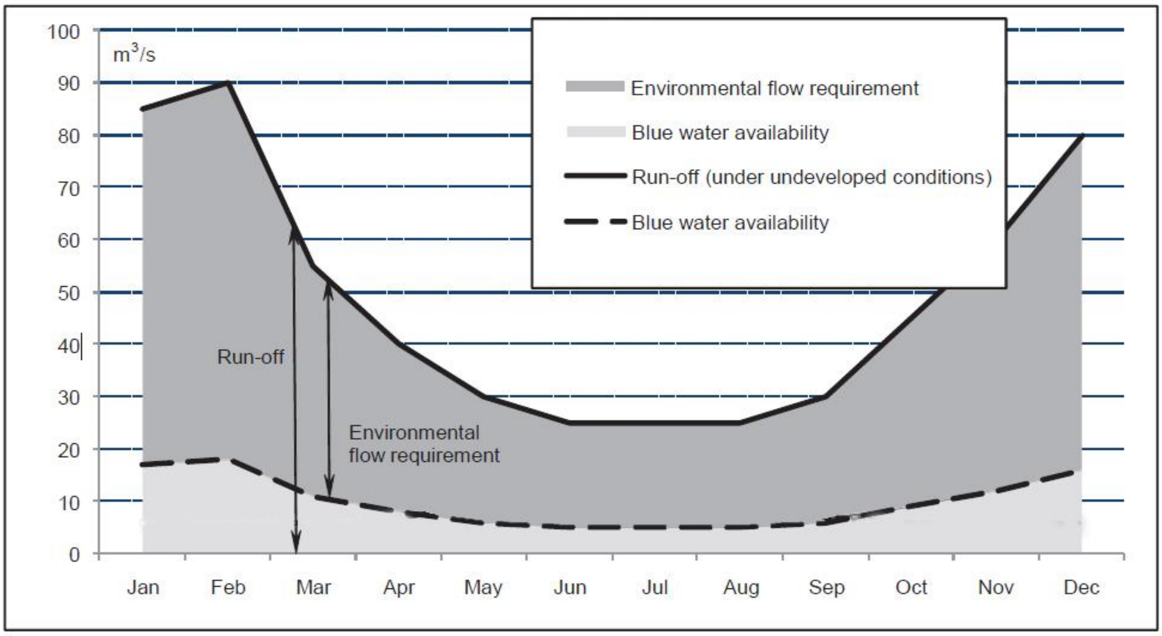

Figure 1: Hypothetical environmental flow requirement of a river

Lakes

Blue water can also be stored in geographic areas, such as lakes and groundwater (Hoekstra et al., 2011). Lakes generally have an in- and outflow through rivers. Differences in the in- and outflow will cause change in the storage of the lake. If the inflow decreases, the lake storage will decrease and in turn, the outflow will decrease until a new equilibrium is reached. Because the inflow has a natural runoff, both the storage in the lake as well as the outflow have a natural storage level and flow, which differ over time. By using the same principles as with the environmental flow requirement, a maximum lake depletion amount per time unit can be set. An environmental minimum water level that differs per month is an example of how lake water can be measured for freshwater sustainability purposes.

For natural lakes the environmental flow requirement principles for rivers can simply be extended to calculate the environmental flow needed. Some lakes, however, are created by dams and thus occur unnaturally. These lakes are different because the storage is not natural and the outflow can be controlled. In these cases the environmental flow requirement can be used for upstream sections of the river. The environmental flow requirement can however still be used on the outflow as well. This is because even with an artificial storage in the river, the principles of the environmental flow requirement can be applied. For the artificial lake itself, sustainability depends on whether changes occur in the ecosystem. This is difficult to quantify, but given that ecosystems are often dependent on a fine balance this research operates on the assumption that all changes in an ecosystem pose a risk and can thus be deemed unwanted and unsustainable. Also, it is assumed that ecosystem changes are measured and therefore known.

Groundwater

Groundwater levels can be split into renewable reserves and fossil groundwater. The latter is a reserve which is not recharged, so any depletion of such a resource is deemed unsustainable (Hoekstra et al., 2011). For the renewable reserves abstraction cannot exceed the availability.

Groundwater availability is determined by the recharge minus the amount of groundwater outflow needed to sustain the environmental flow requirement of rivers. Groundwater levels should be monitored as well. Similar to lake water levels, groundwater levels have a maximum decline that is still deemed sustainable. Groundwater levels should always remain above the corresponding level.

3.1.1.2. Green water availability
Green water availability is the green water available for production uses. It is determined by the amount of evapotranspiration of rainwater (ET) in an area (Hoekstra et al., 2011). The amount of evaporated rainwater of the total area is the maximum amount of green water available. Not all evaporation however comes from areas that can be productive and thus not all green water resources from a given area are in reality available. Evapotranspiration also occurs from areas reserved for wildlife. The green water from these natural areas cannot be used, as it is needed to preserve the natural environment. The green water evapotranspirating from these areas, called environmental evapotranspiration, is therefore not counted as green water available. Other areas are not deemed productive because it is physically impossible to do so. These areas include residential areas and inhospitable areas like mountains. The green water evapotranspirating here, called unproductive evapotranspiration, is likewise not counted as green water available. By subtracting unusable green water for the total amount in an area the green water availability is determined as shown in equation 1 (Hoekstra et al., 2011):

$$Wa_{green}\,(x,t) = ET_{green}(x,t) - ET_{environment}(x,t) - ET_{unproductive}(x,t) \qquad (1)$$

3.1.1.3. Grey water assimilation capacity
Grey water is the amount of freshwater needed to assimilate a certain amount of pollution to an environmentally safe concentration (Hoekstra et al., 2011). The grey water assimilation capacity is defined as the amount of pollution that can be assimilated by an amount of water to safe concentrations. The assimilation capacity is determined by the actual runoff. If the runoff is bigger than the theoretical amount of grey water needed, the assimilation capacity is adequate and the water will not be polluted. If however, the runoff is lower than the grey waterfootprint, the assimilation capacity is not adequate and the water is considered polluted.

3.1.2. Social sustainability
Social sustainability considers fair distribution of freshwater resources among different groups of society (Hoekstra, 2014). Globally, the use of freshwater differs greatly, caused by different consumption patterns worldwide. Typically, a person from a Western country consumes more and also more luxurious products than someone from a developing country. This corresponds with higher freshwater consumption. Social sustainability therefore calls for a fairer distribution of freshwater resources. However, social sustainability is determined by the use of products and can therefore only be determined after a product is consumed. Since this aspect rates sustainability up to the point of consumption it cannot be included in the waterlabel.

Social sustainability can also apply on a smaller scale, when considering the Human Right to sufficient and clean water (Hoekstra et al., 2011). This means that the amount of freshwater available for the local people should be sufficient to survive and that freshwater use in an area cannot lead to polluted water for human use. It is assumed that sufficient freshwater resources are incorporated by the geographic blue and green water sustainability: it can, for instance, be incorporated into the environmental flow requirement. All in all, social sustainability will therefore not be incorporated individually into the waterlabel.

3.1.3. Economic sustainability

Economic sustainability addresses effective use of the available freshwater resources (Hoekstra, 2014). This means that even if freshwater is abounded and scarcity does not occur, the amount of freshwater used to produce a good should be as limited as possible. Economic sustainability is measured by setting a benchmark. Similar products or processes are compared and the best products or processes, which use the least amount of freshwater, are set as the standard. If a product is to be deemed sustainable the amount of freshwater used to produce it should remain within the amount associated with the best products or processes.

3.1.4. Freshwater sustainability analysis per product

A production chain consists of multiple processes, with the combination of processes needed to fabricate the final product. The freshwater use per process determines whether a product is produced freshwater sustainable (Hoekstra et al., 2011). A general production chain consists of three sectors as shown in Figure 2. The primary sector consists of food cultivation. This includes agriculture and livestock processes. In the secondary sector the product is processed from base crop or animal to an end product ready for consumption. In this sector most processes are industrial. The tertiary sector is the services sector, where all processes are included that do not directly influence the product but are necessary to finish production. An example of such a process is transport.

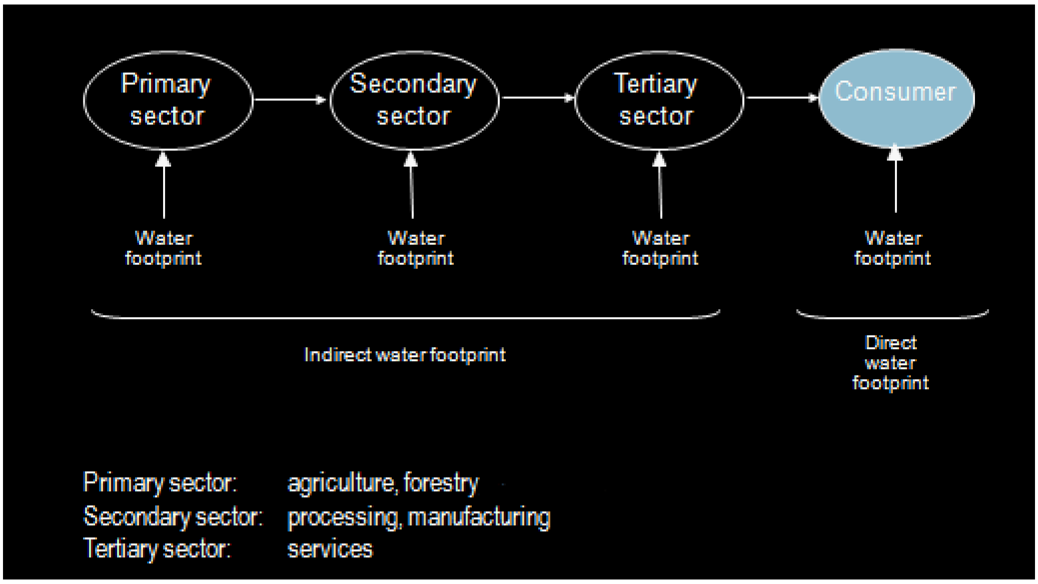

Figure 2: Schematization of a general production chain

A production chain contains all processes on all locations. Some processes require multiple inputs (ingredients), which each have an individual production chain as well. A full production chain of a product is therefore branched will be represented as a tree diagram. An example of this is shown in Figure 9 in section 5.1.

Each process within a production chain can be conducted at several different locations. The overall sustainability analysis is done per different location. Per location it is assessed if that location is a hotspot at the time the process is operative and whether the process passes the benchmark. After assessing all locations it can be calculated what amount of freshwater used within a product is unsustainable and which amount is sustainable.

3.2. Waterfootprint Assessment

To assess the geographic sustainability the available freshwater is compared to the actual freshwater used in an area (section 3.1.1). The economic sustainability is determined by comparing the actual freshwater used per process to other freshwater amounts used in similar processes (section 3.1.3). Key to both aspects is measuring the actual freshwater used. Measuring this is called waterfootprint assessment (Hoekstra et al., 2011). Waterfootprint assessments are done for blue-, green- and grey water separately. This section discusses how waterfootprint assessment is conducted in different sectors. The primary sector of the general production chain is split into livestock farming and agriculture, because these differ greatly. The secondary and tertiary sectors are not split and considered to be the same for all products in relation to waterfootprint assessment. Finally, the accounting of the waterfootprint per process is assessed.

3.2.1. Waterfootprint assessment in the primary sector

The freshwater use in this sector consists of the amount of freshwater incorporated in the products, the amount evaporated and the use of chemicals. It is assumed that most processes in the primary sector are outside and therefore the freshwater losses are less controllable. In most cases, the primary sector is the main user of freshwater (Hoekstra and Mekonnen, 2012).

3.2.1.1. Agriculture

Waterfootprint assessment in agriculture assesses the amount of freshwater needed to grow crops. Crops include both the general annual crops and the perennial crops, like used in the forestry sector. The waterfootprint of the agricultural stage is calculated by adding the blue, green and grey waterfootprints. However, different size farms will naturally have different waterfootprints. In order to be able to compare crops worldwide the waterfootprint of a crop is generally expressed in cubic meter per ton produced (Hoekstra et al., 2011). The agricultural waterfootprint is calculated like equation 2 (Hoekstra et al., 2011):

$$WF_{Agr} = WF_{blue} + WF_{green} + WF_{grey} \tag{2}$$

Here the waterfootprints (WF) are expressed in cubic meter per ton.

The blue and green waterfootprints are usually calculated together, because they are both used to grow crops and therefore supplement each other. Both are therefore calculated similarly:

$$WF_{blue} = \frac{CWU_{blue}}{Y}, CWU_{blue} = 10 \times {}_{d=1}^{lgp}\Sigma \mathrm{ET}_{\mathrm{blue}} \tag{3}$$

$$WF_{green} = \frac{CWU_{green}}{Y}, CWU_{green} = 10 \times {}_{d=1}^{lgp}\Sigma \mathrm{ET}_{\mathrm{green}} \tag{4}$$

The CWU is the crop water use in cubic meter per hectare and the Y is yield in ton per hectare. The CWU is calculated by the summation of the evapotranspiration (ET) per day over the length of the growing period (lgp). The factor 10 is used to convert the unit of evapotranspiration (mm) to cubic meters per hectare.

To determine the evapotranspiration of crops the evapotranspiration can either be measured in the field or be estimated using a model. Measuring evapotranspiration is very uncommon and costly (Hoekstra et al., 2011), however, it is assumed that in ideal circumstances the evapotranspiration is measured precisely.

Equations 3 and 4 do not account for the freshwater incorporated in the crops. This is can easily be calculated by multiplying the wet mass percentage of the crops with the yield (Hoekstra et al., 2011). Here, it is assumed that the ratio of green and blue water is equal to the ratio of evapotranspiration. The typical amount of freshwater incorporated, however, only contributes between 0.1% and 1% of the total waterfootprint (Hoekstra et al., 2011).

A second important aspect which is not yet included in the equations, is the evaporation caused by creating new water bodies. Artificial storage reservoirs and irrigation canals create new water surfaces from which water evaporates which would not have otherwise. Freshwater evaporation is calculated using equation 5 (Shaw et al., 2011):

$$EV = I - O \pm S \tag{5}$$

In equation 5, EV is the amount of water evaporated, I is the water inflow, O is the outflow and S is the amount of water stored. The units in equation 5 are volume units, so for instance liters or cubic meters, and are equal for all terms of the equation. Equation 5 can be used for lake water directly and for irrigation water. In the last case the outflow is the amount of freshwater directly applied to the crops. This is equal to the blue evapotranspiration plus the blue water incorporated in the crops. The inflow will be the inflow from the surface water body into the irrigation network. The storage can be calculated using the irrigation network dimensions, but this is usually constant. By applying equation 5 on an irrigation network, the irrigation losses can be calculated (Schyns and Hoekstra, 2014).

Blue water evaporation can have significant impact on the total waterfootprint and should be taken into account when determining the waterfootprint of crops (Hoekstra et al., 2011).

The grey waterfootprint in crops is calculated using equation 6 (Hoekstra et al., 2011):

$$WF_{grey} = \frac{(\alpha \times AR)/(c_{max} - c_{nat})}{Y} \tag{6}$$

In equation 6, the α is the leeching-run-off fraction. This determines the percentage of pollutant that seeps into the groundwater. The α is a coefficient which depends on the type of pollutant and the type of soil it is used on (Franke et al.). The AR is the application rate (kg/ha) or the amount of pollutant used. The c_{max} is the maximum acceptable concentration and the c_{nat} is the natural occurring concentration (Franke et al., 2013). The grey waterfootprint is also expressed as the amount of water per yield.

3.2.1.2. Livestock

Livestock waterfootprint assessment is split into waterfootprint assessment for the feed and waterfootprint assessment for drinking and service water.

Feed

Most of the freshwater needed to produce animals is imbedded in the feed of the animals (Hoekstra, 2012), generally feed accounts for roughly 98% of the total waterfootprint of animal products. The feed for livestock is divided into two groups: concentrates and roughages (Mekonnen and Hoekstra, 2010). Concentrates are agricultural products, while roughages are usually grass products.

Concentrates are produced similarly to agricultural products. Roughages are foraged by the livestock and are not specifically produced for livestock. The waterfootprint of concentrates is therefore typically higher and can be measured with the same principles as agricultural products. The waterfootprint of roughages is usually harder to measure, because they grow naturally (Mekonnen and Hoekstra, 2010). However, in ideal circumstances the same principles apply as agricultural products. For concentrates it is also known how much is consumed by the livestock. For roughages this is again harder to determine. In non-ideal circumstances the waterfootprint of roughages can be determined by modeling or by using normative averages. Averages can also be used for the amount of roughages consumed by the livestock. However, for the purposes of this research it is assumed that the waterfootprint of roughages and the amount consumed are known.

Three types of livestock farming systems are differentiated: Grazing, mixed and industrial (Sere and Steinfeld, 1996).The key difference between these systems is the composition of the feed.

In grazing systems the livestock has more space to move and the feed consists mainly of dry matter specifically grown for livestock (Sere and Steinfeld, 1996). In general the feed in a grazing system uses less freshwater than the other systems (Gerbens-Leenes et al., 2013). In industrial systems the livestock generally has less space and the feed consists mostly of concentrates (Sere and Steinfeld, 1996). Because this system uses more concentrated feed, it often has a higher waterfootprint. Mixed systems, finally, are systems in which the feed is more equally balanced between roughages and concentrates (Sere and Steinfeld, 1996). The space for livestock is usually also between the grazing and industrial systems.

Whether a system is grazing, mixed or industrial is determined by the amount of roughages, or concentrates, given to the livestock. In grazing systems no less than 90% of the feed must consist of roughages and for industrial systems no more than 10% can consists of roughages. If the amount of roughages fed to the livestock is between 90% and 10% the system is deemed a mixed system (Sere and Steinfeld, 1996).

The waterlabel will differentiate between grazing, mixed and industrial livestock systems. Roughages will be considered as part of the process in grazing and mixed systems and the waterfootprint of roughages will therefore be imbedded in the process. Concentrates will be considered as input and the waterfootprint of concentrates will be determined separately.

Drinking water and service water

Apart from waterfootprint through feed, livestock also uses freshwater through drinking and servicing (Mekonnen and Hoekstra, 2012). This accounts for roughly 2% of the total waterfootprint of animal products (Hoekstra, 2012). Drinking water is the freshwater consumed by the animal and this can be measured because livestock usually drinks from a dispenser. If this is not the case it can be estimated using averages. Service water consists of all other freshwater used to sustain the animal. Usually, this mainly includes the freshwater needed to clean the animal, the living facilities and the farmyard. Since service water is mainly used for cleaning and will therefore wash away pollutants produced by the animals. It will therefore mainly contribute to the grey waterfootprint.

By adding all freshwater consumed by the animals, the waterfootprint of livestock can be calculated:

$$WF_{livestock} = WF_{feed} + WF_{drink} + WF_{serv} \tag{7}$$

3.2.2. Waterfootprint assessment in the secondary sector

In the secondary sector, the manufacturing and industrial processing are included. In this stage freshwater usage may include incorporation of freshwater in the product, but it is most likely that the waterfootprint in this stage is mainly affected by pollution. Freshwater use in such an industrial setting can therefore be measured precisely by measuring the in- and outflow of the plant for green and blue water and by measuring the water concentrations or amount of pollutants produced by the process for grey water. However, the secondary sector will differ per product and even with similar products the industrial stage of these products may differ.

3.2.3. Waterfootprint assessment in the tertiary sector

The tertiary sector is defined as the service sector. Services include the processes that are not needed in direct manufacturing, but help the processes that are needed. Freshwater use in this sector is generally indirect, through the use of energy for instance. The services sector mainly consists of sales and transport. It is assumed that sales do not account for any significant amount of freshwater use. Transport however, becomes more significant when the amount transported increases. The actual sustainability of transport however, depends on the amount of energy consumed, the type of energy consumed and how that energy is acquired.

3.2.4. Waterfootprint accounting in a process

The previous sections explain how the waterfootprint of a process is determined for different types of processes. In waterfootprint accounting however, all freshwater use needs to be balanced. This means that the combined waterfootprint of the inputs and the waterfootprint of the process itself need to be equal to the waterfootprint of the outputs. When a process has only one output this is determined by adding the waterfootprints of the inputs and process. The combined waterfootprint is then the waterfootprint of the single output.

However, it is not uncommon for a process to have multiple outputs: the process of raising a cow for example has the outputs meat, milk and leather. To balance the waterfootprints of the inputs plus process to the outputs, only certain fractions need to be accounted per output. The accounting is done using the financial values of each output as base for the accounting fractions (Chapagain et al., 2006). An example of how this works is given in Figure 3 and Table 2:

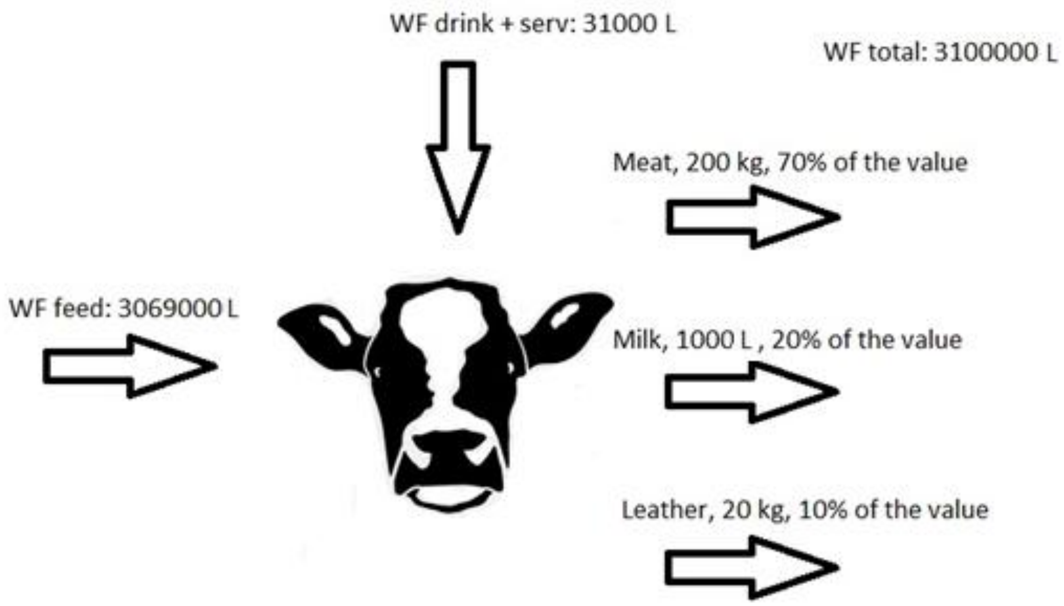

Figure 3: Principle of allocating waterfootprint per value of output

In Figure 3 three outputs are shown over which the total waterfootprint of the process needs to be allocated. This allocation is done based on the value of the products and is shown in Table 2:

Table 2: Table showing the allocation principles of waterfootprint assessment

Output	Value	WF	WF per unit
Meat (200 kg)	0.7	2170000 L	10850 L/kg
Milk (1000 L)	0.2	62000 L	62 L/L
Leather (20 kg)	0.1	310000 L	15500 L/kg
Total:	1	3100000 L	

By applying this principle to every process the waterfootprints of every product can be calculated without double accounting of the water.

3.3. Summary of freshwater sustainability

In summary, freshwater sustainability in the waterlabel will be determined by the geographic sustainability and the economic sustainability. Geographic sustainability is determined for blue, green and grey water separately and economic sustainability is not determined separately, but as the sum of all three.

A location is blue water sustainable when the amounts of surface- and groundwater available for nature stay large enough to sustain the ecosystem in every time period. When the amount of blue water used does affect the ecosystem at a location, that location is deemed unsustainable. By setting minimum flow rates per month for rivers and minimum water levels per month for lakes and groundwater the boundaries for sustainability can be determined.

Green water sustainability is determined by assessing the maximum amount of green water that can be used, where green water is precipitation which does not reach blue water. By assessing whether the green water used exceeds the green water available, green water sustainability is determined. A location is green water sustainable if the use does not exceed the availability.

Grey water sustainability is determined by the concentration of pollutants in the water bodies. If these concentrations exceed sustainable levels, the area is deemed unsustainable.

Finally, in this research economic sustainability is determined per process and set as a benchmark. If a process uses the amount of freshwater associated with that benchmark or less, the process is deemed sustainable.

By assessing the blue-, green-, grey water and economic sustainability of each process individually the freshwater sustainability of a product can be determined. If either the blue-, green-, grey water or economic sustainability are unsustainable, the whole process and all freshwater used is deemed unsustainable.

To assess the freshwater sustainability of a product, the amount of freshwater used needs to be determined. This is done using waterfootprint assessment, in which the amount of freshwater used per process is determined and allocated to the product or products manufactured. In waterfootprint accounting difference is made between the primary sector, secondary sector and tertiary sector. For each sector the waterfootprint is determined differently.

The theory set out in this chapter will be adapted to fit the waterlabel and used to determine the scheme in chapter 5. The scheme will be used to assess the freshwater sustainability of products after which the products can be rated and awarded the waterlabel.

4. Ecolabeling

How the waterlabel is presented and organized is an important factor in the eventual success of the waterlabel. In this chapter, different aspects associated with ecolabeling will be discussed. These aspects are combined from existing literature about ecolabeling and knowledge from leading authorities in the field of ecolabeling.

As the presentation of the waterlabel will largely depend on its design, different labeling designs will be discussed in section 4.1.The type of label design will interact with the presentation of the waterlabel criteria. This too can be classified and that will therefore be described in section 4.2. In section 4.3 the way the waterlabel is organized and the type of organization that controls the label will be discussed. Finally, section 4.4 gives an overview of selected consumer research to provide information on how ecolabeling is perceived in general.

4.1. Labeling designs

There are three basic labeling designs generally used in ecolabeling. These are the graded, pass/fail and hybrid, which is a combination of graded and pass/fail (Big Room and World Resources Institute, 2010). Ecolabels however, do not have to follow strict rules, making other designs possible. As they are very rare this section will focus on graded, pass/fail and hybrid designs.

4.1.1. Graded label

In a graded label, a product is rated over a set of standards whereby the score determines the grade the product gets. The number of gradations can differ, but the range should be full and applicable to any possible product. No products can fall outside of the range. No minimum environmental score is needed to require the label, the score only determines the grade.

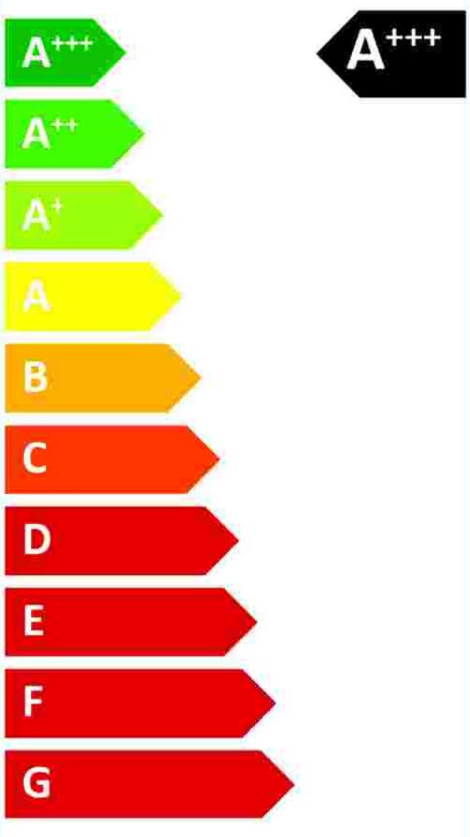

Figure 4: Example of the European Energy Label

The most well-known label which has implemented a graded design is the European Energy label, which can be found in different forms on houses and household appliances in Europe (Brounen and Kok, 2011). An example of how this label looks like is given in Figure 4.

In case of the European Energy Label the grades are spaced from G to A^{+++}. The actual grade for the product is represented with the arrow on the right, as shown in Figure 4.

A graded label has several advantages. First of all, the relative score is easy to understand for consumers. This increases the perceived transparency of the label, giving consumers more trust in the label (Bleda and Valente, 2009). Secondly, research shows that consumers are willing to pay a little extra for a product that is slightly better. This thus increases the overall amount of environmentally friendly products bought (Bleda and Valente, 2009). A product carrying a label is usually more expensive than a product without the label. This is because it is harder and therefore more expensive to produce in an environmentally friendly manner. In graded labels this is also the case, and for each grade higher the product price generally increases. Not all consumers are willing to pay extra for environmentally friendly products. However, it is found that the price increase per grade is relatively low, where in other labeling designs the price difference between labeled and non-labeled products is generally higher. It was found that consumers are more willing to pay a little extra for a product which is slightly better.

A disadvantage of the graded label is that in most cases a label is not obligatory. Producers of a low-scoring product are therefore not likely to apply for the label. The European Energy Label is however an example of a compulsory graded label. All appliances and houses must carry the label before being sold (Brounen and Kok, 2011).

4.1.2. Pass/fail label

Of all label designs this design is most commonly used, about 74% of the time (Big Room and World Resources Institute, 2010). In a pass/fail design, producers can apply for the label and if the necessary standards are met, the label is granted to their products.

In the Netherlands many different pass/fail labels exist, with several examples given in Figure 5.

Figure 5: Examples of pass/fail labels, with from top left to bottom right: Milieukeur, Rainforest Alliance, Fairtrade (Max Havelaar), EKO. Demeter, UTZ Certified, MSC and the European Biological label

The advantages and disadvantages of this label design are opposite to those of the graded label design. It is harder to spot the quality level of a given product, other than the difference of carrying the label versus not carrying the label. Overall, this may result in less transparency about the criteria underpinning the label, which in turn may lead to a lower perceived trustworthiness of the label. A pass/fail label does not give consumers many options and because not all consumers are willing to buy labeled products it might not lead to any significant changes in consumer patterns (Bleda and Valente, 2009). The last disadvantage is that complex issues such as the environment are displayed in the label in a black-and-white manner, which is often a simplification of reality.

The pass/fail label also has advantages. It is, for instance, practical and easier to implement than the graded label, mainly because the pass/fail label also works if only some producers cooperate. The graded label needs a wide range of cooperation in order to establish the necessary ranking.

4.1.3. Hybrid label

The third and final option is the hybrid design. In this design the features of the graded and pass/fail designs are combined. The two types of hybrid design discussed hereafter are most the common.

The first hybrid design is presented like the pass/fail design. A single label is given to a product, but the label is also shows a gradation. In Figure 6, the gold and silver labels of the Cradle-to-Cradle ecolabel are given as an example. This hybrid label is awarded above a certain threshold, like the pass/fail label, and will therefore always represent a positive score, but above this threshold the label is differentiates in how positive the score is.

Figure 6: The gold and silver labels of Cradle-to-Cradle ecolabel

This form of hybrid label combines the advantages of both the graded and pass/fail label. The practical implementation is the same as the pass/fail label and it gives consumers extra information like the graded label. However, this context is only given for the higher scoring products making the relative step between the labeled products and non-labeled products unknown. Consumers who are willing to pay a little extra for a slightly better product will therefore only be encouraged to do so if their usual product is already in the top categories.

Figure 7: Waterfootprint label by Raisio

The second hybrid label is represented in a similar way as the pass/fail label, but, like the graded label, is applicable to the full range of products. It does not qualify products as good or bad, but rather states the score and let the consumer decide how it is qualified. The only currently implemented waterlabel, made by Raisio in Finland and shown in Figure 7 (Raisio Plc., 2015), uses this system.

This labeling design is uncommon because it requires consumer knowledge about the product and subject of the label. It provides little comparability, unless the consumer knows the score of similar products. It is easy to implement, but products with a low score – in case of Raisio those with a high waterfootprint – are unlikely to adopt the label. This type of design, moreover, is likely to have a very limited effect on consumption patterns. The only advantage is that this design gives full information to consumer and is therefore fully transparent.

4.2. Classifying different labeling schemes

The characteristics of different forms of environmental labeling are expressed in their labeling schemes, which is the document expressing the rules and standards of the label and which shows the criteria and the scoring system. There are three general types of environmental labeling which will each be explained in this section (Gallastegui, 2002).

- Class I labels are impartial environmental standards, also called ecolabels. Impartiality means that there can be no connection between the labeler and producer. The label also needs to express an environmental standard, meaning that products with this class of label score above a certain environmental standard or threshold (Gallastegui, 2002). Class I labels are most commonly associated with a pass/fail design or a hybrid design like the Cradle-to-Cradle design.
- Class II labels are informative environmental self-declaration claims, also referred to as logos. These labels are not managed independently and can therefore be seen more as a promise to the consumer than as a tool for comparison between products (Gallastegui, 2002). Class II labels resemble pass/fail labels, although it is unlikely that a product fails to acquire a class II label because the producer manages the logo.
- Class III labels are impartial informative environmental labels. These labels differ from class I labels because they provide information rather than set a standard. The labels show how products score on that particular environmental issue (Gallastegui, 2002). Class III labels are associated with graded labels and a hybrid design like Raisio.

Some graded designs also state a certain environmental standard, like color code used in the European Energy Label, making it both a class I and class III. Because no rules are in effect for labeling, not all labels are easy to define as either class I, II or III.

4.3. Organization structure of ecolabels

This section focuses on the manner in which ecolabels can be organized. It discusses different organizations controlling ecolabels as well as key aspects of their organizing structure.

4.3.1. Organizations controlling an ecolabel

In general, an ecolabel can be controlled by first, second and third parties. First party controlled labels are labels in which the producer and labeler are one and the same organization (Gallastegui, 2002). This is associated with a class II label or logo, which are in general less rigorous than second or third party controlled labels.

Second party controlled labels are controlled by an organization protecting the interests of a branch (Gallastegui, 2002). Depending on the organization structure of the label, these kinds of labels can be classified as either class I, II or III. Second party controlled labels can be as rigorous as third party labels, although generally speaking they are less rigorous.

Third party controlled labels are most rigorous as they are controlled by organizations that have no ties to the products. It is the most common form of labeling, associated with class I or III (Big Room and World Resources Institute, 2010).

Independent organizations controlling a label can be divided into profit, non-profit, governmental and non-governmental organizations (Big Room and World Resources Institute, 2010). Ecolabels that run for profit are rare and have a low perceived level of trustworthiness (Grunert et al., 2014) (Lozano et al., 2010). Most labels are run by a non-profit organization, like a foundation, or a non-government organization (Big Room and World Resources Institute, 2010). In general ecolabels with a well-known and trustworthy organization associated with the label are more effective (Grunert et al., 2014); (Lozano et al., 2010); (Milieu Centraal, 2013b). Labels without such backing run a bigger risk to cease to exist.

When a government is directly involved in an ecolabel the possibilities for making the ecolabel effective increase. Governments can make legislation and thus make the label obligatory so that all associated products carry the label, like the European Energy Label (Brounen and Kok, 2011). The European Energy Label proves that this is an effective to ensure significant changes in consumer patterns and thus in environmental impact.

Usually, only one organization controls an ecolabel or has the biggest stake in it. However, it is not uncommon for more stakeholders to be involved (Lozano et al., 2010). If other stakeholders, such as government, producers or consumers, are involved in a label, the chances increase that a label will succeed (Lozano et al., 2010). With both producers and consumers involved it may be more difficult to find agreement, but this does increase the chance both groups will accept the label (Lozano et al., 2010).

The awarding of ecolabels is primarily handled by a producing party and the labeler. However, to further increase independence and thus trustworthiness of a label, a third party can do the check the product along the labeling scheme and ensure accreditation as well. The Netherlands has a general board of accreditation specially established by the government to ensure all accreditation occurs unbiased (Raad voor Accreditatie, 2015).

4.3.2. Important aspects of ecolabeling

Aspects of ecolabeling that need to be considered are depicted in Figure 8: Sustainability, Relevance, Accessibility, Efficiency, Engagement, Impartiality, Improvement, Rigor, Truthfulness and Transparency. These aspects correspond with the 10 credibility principles of ISEAL (ISEAL Alliance, 2015) and are based on the 14020 norms for environmental labels of the International Standards Organization (International Standards Organization, 2000). ISEAL is an organization set up to enhance sustainability standards and initiatives, whereas ISO is an international organization with 162 member countries that sets standards for various international issues.

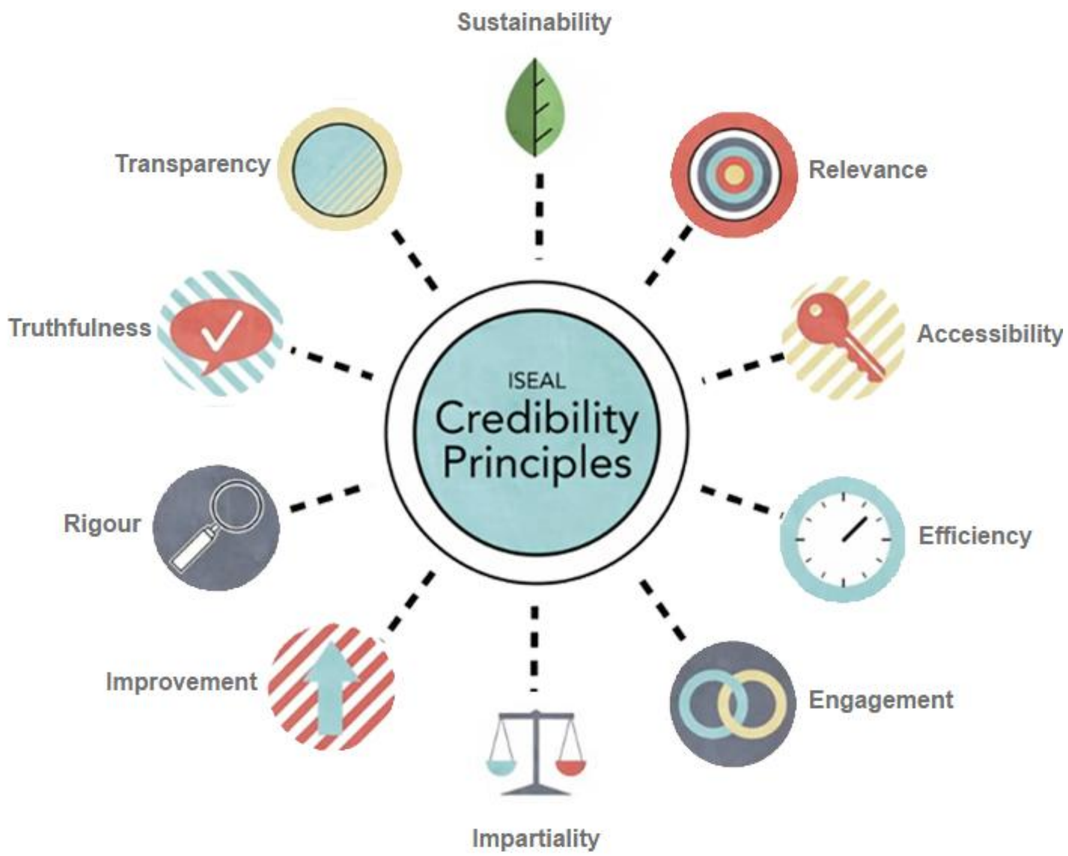

Figure 8: ISEAL credibility principles (ISEAL Alliance, 2015)

Sustainability
Sustainability differentiates ecolabels from other labels. A good ecolabel has a labeling scheme that ensures that sustainability goals are met and which are set at a level that shows a certain ambition.

Relevance
Standards set are relevant if they address the stated environmental goals and if they are in line with scientific understanding of the subject and international norms. Relevance also means that the standards are specific to the subject and can vary when necessary to fit local variations.

Accessibility
To increase likelihood of a producer implementing the label and thus increasing the likelihood of a positive environmental impact, the standards and regulation of a label should be easy accessible. If this is not the case producers must make an effort and thus costs to obtain the label. It is assumed that this decreases the likelihood of a producer taking up the label. In this case not only the accessibility of the labels standards and regulations is important but also the accessibility to the information needed for passing the labels standards.

Efficiency
This criterion addresses the fact that the environmental standards should comply with each other: standards should not conflict with standards elsewhere. This makes the overall system more likely to be implemented such that it has effect on the environment.

Engagement
It is important to keep an open dialogue with stakeholders to ensure broad support for the label. Stakeholders are often experts in the field with knowledge the label may not have. Also, a legislative power may be part of the stakeholders.

Impartiality
As shown before, ecolabels can be divided into first, second and third party controlled labels. Each step increases the impartiality. Also the accreditation itself can be impartially done. The more impartial an ecolabel is, the higher its perceived trustworthiness.

Improvement
The standards of an ecolabel should be set at realistic levels that at least some products can reach, even if this means that overall environmental performance might not be as high as would be desirable. It can also be that new scientific insight changes the understanding of an environmental subject or that new technology makes it much easier to acquire a label. If an ecolabel has rigid standards, eventually these standards will be outdated and no longer viable. Therefore an ecolabel needs to check its own labeling scheme regularly and if needed adjust it.

Rigor
The standards used in the label must works towards quality outcomes: the performance level set in the standard scheme must work towards improving the environment. The label should be strict in setting their standards because easy standards make compliance too easy and therefore significant changes less likely. This principle also applies to standards set to comply with specific laws. An example of this is dolphin free tuna: often used in tuna products, it means that precautions have been made to ensure no dolphins get caught in the fishing nets. This is, however, a legal requirement in the EU and the label therefore means very little. Standards need to be set at so called above the law levels (Milieu Centraal, 2013b).

Truthfulness
Claims made by an ecolabel should be true, whereby truthfulness refers to not misleading. A statement can be both true and misleading. Dolphin free tuna, for example, does not mean that no dolphins were killed. It merely states that precautions were made to avoid killing dolphins.

Transparency
In order to be credible, an ecolabel should be transparent. This includes sharing information about the environmental standards, organization structure, parties evaluated, the stakeholders involved and many more aspects. Transparency shows why certain decisions are made and increases trust and credibility on the part of the consumer.

When all aforementioned aspects are incorporated in an ecolabel it is considered an ecolabel of high quality and thus of significant meaning (Milieu Centraal, 2013b).

4.4. Evidence from consumer research

Over the years, much research has been conducted to understand consumer preferences and motivations in relation with ecolabels. A small summary of those researches is given below to give more insight in general perceptions of ecolabeling.

Consumers do tend to notice labels and factor in labels as one of the attributes they look at when purchasing an item. However, the percentage of consumers doing so differs per research and ranges from about 50% (van der Valk and Zeijden, 2002, Eurobarometer, 2009, TNS-NIPO, 2012) to about 75% (Milieu Centraal, 2007). Moreover, other factors like price and brand also play a major part in the decision to buy a certain product. This explains why the percentage of consumers who consider labels a major incentive to buy a specific product is much lower, between 8% (Rolls et al., 2012) and 25% (Eurobarometer, 2009, TNS-NIPO, 2012).

There are many different reasons why consumers buy ecolabeled products. An important reason is usually that consumers think that ecolabeled products are healthier or safer (van der Valk and Zeijden, 2002, Consumentenbond, 2010). This is motivation is not applicable to the waterlabel, as the amount and origin of freshwater used in a product is not associated with either safety or health. Other motivations can however be applied to the waterlabel. Research conducted by Bougherara and Combris (2009) found that ecolabeled food products are generally bought because consumers want to help the environment, which would mean that these consumers would also consider the waterlabel. Social environment is another important motivation: people tend to buy more ecolabeled products if their peers do so as well (Grunert et al., 2014). If freshwater sustainability becomes more well known, peer pressure will increase and more consumers will buy freshwater sustainable products (Grunert et al., 2014).

Ecolabeling is a relative new concept and not a lot is known about it. Consumer research also supports this. Consumers tend to think that ecolabels are always meaningful and checked by a governing agent, whereas this is not necessarily the case in reality (Consumentenbond, 2010). The knowledge about ecolabel contents also differs. For well known labels such as the fair trade label consumer knowledge was adequate (Intromart GFK, 2009), while on other labels consumers had hardly any knowledge or had false knowledge (Drijver and Broer, 2014). The notoriety of an ecolabel seems to be a big factor in how it performs. Other than more knowledge of content, consumers are also willing to pay more for well known labels (Grunert et al., 2014) and the inclusion of well known stakeholders increase the chance a label persists (Lozano et al.). Consumers generally trust labels more when they are developed by an independent organization or government (Rolls et al., 2012)

Lastly, consumers do tend to think that ecolabeling is a good initiative to address environmental issues (MarketResponse and Schuttelaar & Partners, 2011). 70% is willing to accept a general sustainability label (TNS-NIPO, 2012), which would combine all sustainability issues in a single label. More than half of consumers also support the introduction of an obligatory carbon dioxide label.

In conclusion, it can be stated that ecolabels are generally perceived as a positive development. However, the amount of people actually taking them into account when buying consumer goods remains low. This is partly due to financial aspects. An ecolabel is more effective if it acquires enough attention: consumers must be made aware of its existence and the problem it addresses.

5. Freshwater sustainability analysis in the waterlabel scheme

This chapter combines the theoretical freshwater sustainability analysis and the waterfootprint assessment from chapter 3 to create a labeling scheme for the waterlabel. The scheme will be applicable to any product within the scope of the research. The chapter also incorporates the theory about ecolabeling from chapter 4 to create the ideal framework for the waterlabel.

The waterlabel is created as an ideal label, meaning that it assumes ideal circumstances. First of all this entails that all information needed is provided and all relevant data can be measured or determined. Also this means that the necessary databases of the waterlabel are filled. For the framework of the waterlabel, it means that no legal or financial restrictions are in place.

5.1. Determining the production chain

Before the freshwater sustainability analysis can be done, the full production chain must be determined. This means that every ingredient of the final product must traced to its origin(s) and all steps taken must also be known. Some ingredients require multiple processing steps before being incorporated in the final product, while others need only a few. Generally, a production chain is traced from its origin to the end product. The amount of ingredients and amount of processes however, differ per end product. Hence, to make a scheme that can be applied to all production chains the production chain will be traced the other way round with the scheme starting at the end product. Next, to trace the entire production chain back to its origins, the process in which the end product is finalized as well as all the inputs of that process need to be known. Since each input itself can have multiple inputs, the amount of origin processes can be large. Freshwater is not considered as a separate input, because this is examined in the freshwater sustainability analysis. The tertiary sector is not considered as part of the production chain, but is assessed separately in the freshwater sustainability analysis.

The origins of all input are necessary to determine the end of the entire production chain. This is largely determined by the type of process. In chapter 3 a division has been made between the primary and secondary sector with the primary sector being further divided into agriculture and livestock farming. Livestock itself has been divided into grazing, mixed and industrial livestock farming. In this research it is assumed that only agricultural and grazing livestock are final processes requiring no further inputs.

To establish the labeling scheme the production chain is determined on the basis of the questions below, which are repeated for every input.

1. What process(es) has the end product (subsequently: the ingredient or input) as output?
2. What type of process(es) is this (agricultural/livestock (grazing)/livestock (non-grazing)/secondary)?
3. What inputs are needed for this process(es)?

By repeating questions 1 and 3, an entire production chain can be constructed. Question 2 is used to determine which processes – agricultural and grazing processes – are at the beginning of the production chain and to determine how the waterfootprint of that process is calculated.

An example of a full production chain is given in Figure 9.

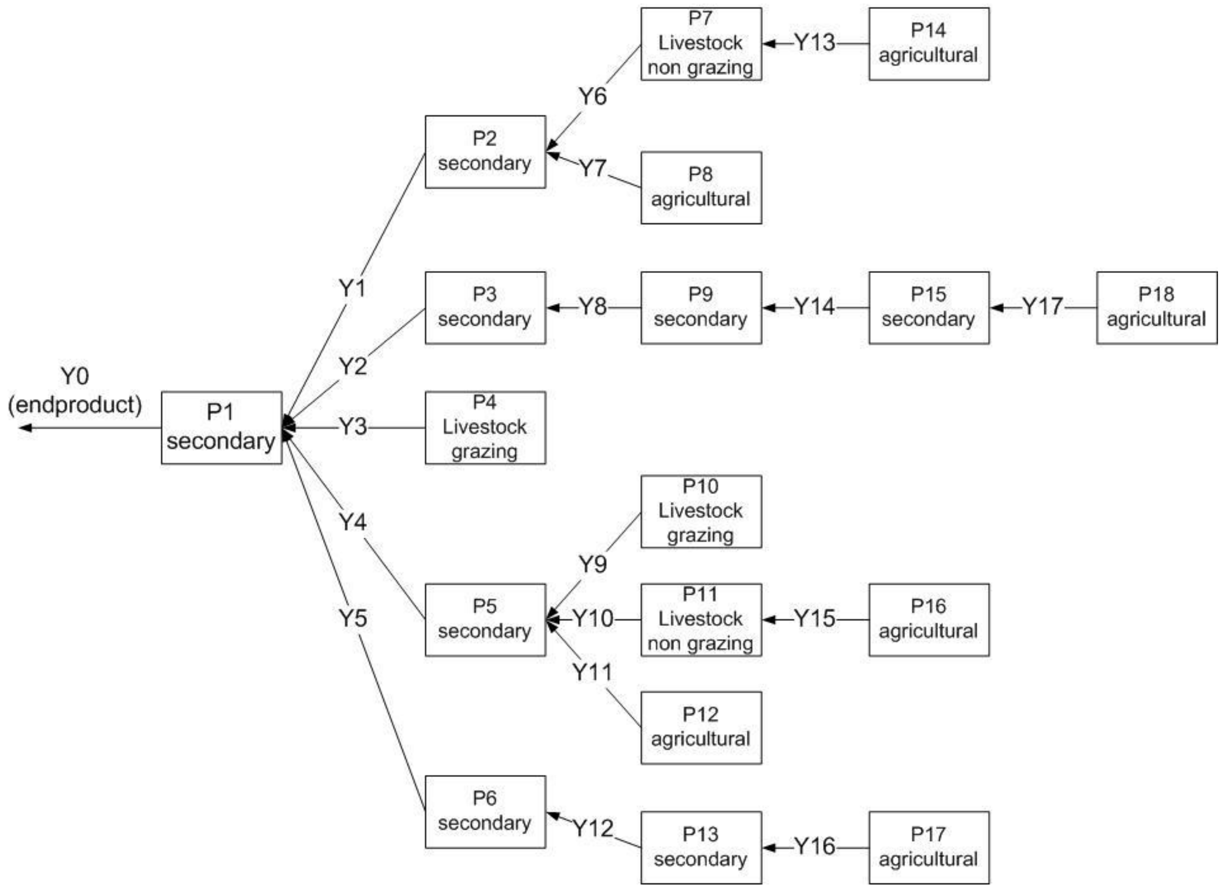

Figure 9: Production chain tree diagram, with Y as inputs and P as process

The same example can be given in the form of a table. An example of this is given in Table 1:

Table 3: Table with the information shown in Figure 9

Process #	Type of process	Input	Input process #	Output	Output process #
P1	secondary	Y1	P2	End product	-
		Y2	P3		
		Y3	P4		
		Y4	P5		
		Y5	P6		
P2	secondary	Y6	P7	Y1	P1
		Y7	P8		
P3	secondary	Y8	P9	Y2	P1
P4	livestock grazing	-	-	Y3	P1
P5	secondary	Y9	P10	Y4	P1
		Y10	P11		
		Y11	P12		
P6	secondary	Y12	P13	Y5	P1
P7	livestock non-grazing	Y13	P14	Y6	P2
P8	agricultural	-	-	Y7	P2
P9	secondary	Y14	P15	Y8	P3

Process #	Type of process	Input	Input process #	Output	Output process #
P10	livestock grazing	-	-	Y9	P5
P11	livestock non-grazing	Y15	P16	Y10	P5
P12	agricultural	-	-	Y11	P5
P13	secondary	Y16	P17	Y12	P6
P14	agricultural	-	-	Y13	P7
P15	secondary	Y17	P18	Y14	P9
P16	agricultural	-	-	Y15	P11
P17	agricultural	-	-	Y16	P13
P18	agricultural	-	-	Y17	P15

From Table 3, the first three columns correspond with the three questions. The other three are to relate corresponding processes. In a digital file this can be automated. In appendix B two examples of realistic production chains are given.

5.2. Determining the freshwater sustainability score of a product

Primary and secondary sector

Now that all processes are determined, the freshwater sustainability analysis per process can be conducted. Whether a process is sustainable depends on the location, period of operation, type of water used and the waterfootprint in relation to a benchmark. The location and period determine the geographic sustainability and the benchmark determines the economic sustainability.

The benchmark is set at the best 20th percentile, for that is assumed to be a good balance between exclusivity and feasibility. If the benchmark would be set at a lower percentile, only a very select few processes could pass. However, if the benchmark is set higher it will be less exclusive and thus overall less beneficial for the environment. The best 20th percentile was chosen and is used in this research to show how the benchmark works. Other percentile levels may be equally valid.

For the freshwater sustainability analysis, the product line as determined by 5.1 is insufficient. In many cases the same processes occur at several locations. For instance big producers of potato chips will have multiple farms supplying potatoes to their production chain. Each location should therefore be assessed separately. Each location will have its own waterfootprint and combining all waterfootprints of all locations gives the total waterfootprint of the product. The waterfootprints are then calculated as waterfootprint per unit of final product and not as the total waterfootprint per location. For calculating the waterfootprint per product from the total waterfootprint per location, the total amount of products produced and relative contribution of the location to the process would be needed.

Because the waterlabel is assumed to be ideal, the actual freshwater sustainability analysis will be conducted by the waterlabel. The waterlabel will therefore need a database including data on where and when hotspots occur and data on what benchmarks are set for each process. The data on each process in each location would be provided by the producers. An example of a blue water hotspot database is given in Appendix A.

In order to determine the freshwater sustainability of a product the following questions are added to the scheme:

6. Which locations are used for the process?
7. In which period is the process active?
8. How much output is produced in the active period?
9. What is the waterfootprint of the process?
10. What type of water is used?

By combining Table 3 and Table 4, an overall table can be constructed. As such a combined table is very big and unhandy, the waterlabel shall use Figure 9 as the visual guide to a freshwater sustainability analysis table like Table 4. Appendix B gives two examples on how this is done.

Table 4: Freshwater sustainability analysis for a certain process

Location	Production period	Amount produced?	WF per product	Which type of water is used?	Is location /time a hotspot?	Is processes WF within benchmark?	Is process sustainable?	Which % of water used is sustainable?
A	Jan-Mar	30%	50L	blue/ grey	N	N	N	
B	Apr-May	10%	20L	blue/ green	N	Y	Y	10%
C	Jan-May	40%	100L	blue/ grey	Y	N	N	
D	Feb-Mar	20%	30L	green/ grey	Y	Y	N	
Total			200L					10%

Table 4 is a hypothetical example of freshwater sustainability analysis of a process, with hypothetical locations, production periods, production amounts, waterfootprint per product and type of water used. The waterfootprints are given as the relative contribution of a location to the end product. Which locations are hotspots is also hypothetical. The benchmark is determined at 30 liters per product. A process is deemed sustainable if no hotspots emerge and the locations waterfootprint is in within the benchmark. The amount of unsustainably used freshwater is determined by dividing the relative waterfootprint per location with the total freshwater used.

Now the production tree can be scored on freshwater sustainability. This accounts for the primary and secondary sectors. However, for a complete picture the tertiary sector needs to be included as well. This is done in the next section.

Tertiary sector

The tertiary sector is simplified to only containing the transport needed within the production tree. All transport is combined into a single waterfootprint. This will be benchmarked on the 20th percentile in comparison with similar products and only when the benchmark is passed, the transport within a product is deemed freshwater sustainable. It is assumed that transport only contributes little to the overall waterfootprint and therefore only benchmarking the waterfootprint of transport is deemed adequate.

Most energy use comes in the form of fuel and the likelihood of tracing fuel back to the freshwater sustainability and waterfootprint is small. The waterfootprint of transport depends on the amount of fuel used, the type of fuel used, how the fuel was acquired and where the fuel was acquired. Fuel production is thus far off from the production of the products within the scope of the waterlabel, that even in an ideal scenario it is not realistic to assume that the information needed to determined the waterfootprint is available. The waterfootprint of transport is therefore calculated using a mean value of water per ton per kilometer of transported goods. It is assumed that the waterfootprint of energy is similar to crude oil, which is 1.06 m^3/GJ (Gerbens-Leenes et al., 2008). Further it is assumed that 50% of transport is done by truck and 50% is done by sea, or with similar energy efficiency. The energy efficiency of truck transport is 4 MJ per ton kilometer (t*km) (Cuff and Goudie, 2001) and sea transport is 9 times more efficient (Milieu Centraal, 2013a). The mean value will therefore be 2.2 MJ/t*km and the waterfootprint will be 2.4 l/t*km.

The waterfootprint of the transport will therefore be determined by multiplying 2.4 l/t*km with the weight of transported goods, per product, and the distance over which it is transported for every transport needed. Adding all waterfootprints of transport gives the total waterfootprint of the transport sector. However, because each process can have several locations, such a calculation method would be much more complex. Because the waterfootprint caused by transport is likely to be very low it is more practical to determine it by multiplying the total amount of ton kilometer of transport with the waterfootprint per ton kilometer and then dividing by the amount of products produced. An example of this is shown in Appendix B.

5.3. Setting the framework of the Waterlabel

In this section the framework of the waterlabel will be set up. First, the labeling design and how the design is implemented will be determined. Next, the best organization structure is described. This includes both the ideal management of the implementation of the waterlabel as well as the way in which the waterlabel is operated.

5.3.1. The labeling design in the waterlabel

As an ecolabel, the waterlabel can have any of three basic designs: graded, pass/fail and hybrid. As shown in section 4.1 a graded design is harder to set up, but gives more information and ultimately has better results in changing consumer habits (Bleda and Valente, 2009). Once the boundaries of a graded label are set they can be easily translated to a pass/fail or hybrid design. For these reasons the waterlabel will be set up with a graded design.

The number of grades within a graded label largely determines how the label is perceived by consumers and producers. If only a few grades are implemented, the differences in freshwater sustainability scores within a grade can actually be large. This can be perceived as less transparent and truthful, which both are important characteristics of a good ecolabel (ISEAL Alliance, 2015). Moreover it is harder to compare products if less comparison can be made, whereas a big advantage of the graded system is the increased options for comparison. The relative step between grades will also increase if only a few grades are implemented. This means that it is harder for a producer to increase the freshwater sustainability score of their product to a higher grade, even though produces are more likely to make changes if a relatively small input has a noticeable result (Bleda and Valente, 2009). Too few grades therefore make it less likely that the freshwater sustainability of products overall will increase, which is a goal of the waterlabel.

If too many grades are implemented, however, other problems emerge. Too many grades may result in a label that is harder to understand for consumers, because too much information is given at once. Also the relative step between labels may be so low that there is virtually no difference between products, while they still receive different grades. Both aspects will decrease the perceived transparency.

Considering the above, the number of grades implemented in the waterlabel will be set at 10. This is the same as the European Energy Label, which is perceived as a good ecolabel (European Commission, 2015b). Different from the European Energy Label, the grades for the waterlabel will rank from A to J. The European Energy Label ranks from A^{+++} to G, with four A categories (European Commission, 2015a). The addition of the A^{+}, A^{++} and A^{+++} categories has actually lessened the effectiveness of the European Energy Label (European Commission, 2015b) and shall therefore be avoided for the waterlabel.

5.3.2. Determining the boundaries for the waterlabel

With the number of grades set, the boundaries can be chosen. The boundaries can be set with the freshwater sustainability score only. For instance every ten percent can be a boundary. However, it is very plausible that products are not distributed evenly over the freshwater sustainability score line. This means that some grades are given much more often, while others may not be given at all. This will decrease the possibilities for consumers to compare products. For this reason it is deemed better if, like the process benchmarks, the boundaries are set over how the freshwater sustainability score of a product compares to other products. By grading per best scoring percentile, it is guaranteed that all grades are given to the same amount of products.

There is, however, a problem with grading per best percentile: it makes it possible for a product with a generally low freshwater sustainability score to receive a high grade. This happens when the overall freshwater sustainability within the product group is low. If a product with a low freshwater sustainability score receives a high grade, this may be perceived as untruthful, because the expectation of the consumer is that high grades in any given product group correlate with high freshwater sustainability scores. To minimize this risk, minimum freshwater sustainability scores are set for grades A and B. These minima need to be both rigorous and feasible. In this research it is assumed that freshwater sustainability scores of products is generally low and that scores of 50% can be perceived as high. Hence, the minimum for grade A is set at 50% and for B at 25%. Once sufficient data becomes available these minimum scores may need to be adjusted. An overview the boundaries set for each grade is given in Table 5.

Table 5: Boundaries set for each grade of the waterlabel

Grade:	A	B	C	D	E	F	G	H	I	J
Percentile criteria	< 10%	< 20^{th}	<30^{th}	<40^{th}	<50^{th}	<60^{th}	<70^{th}	<80^{th}	<90^{th}	<100^{th}
Freshwater sustainability criteria	>50%	>25%	-	-	-	-	-	-	-	-

This means that that when a product is rated in grade B, it has a sustainable freshwater score higher than 25% and relative to other similar products it ranks among the best 20 percent of sustainable freshwater usage.

5.3.3. Determining the grade for a product in the waterlabel

If the freshwater sustainability score of a product is known it can be graded. To do this, a graph is first constructed with the freshwater sustainability score on the y-axis and the percentage of products with that freshwater sustainability score or better on the x-axis. An example of such a graph is shown in Figure 10.

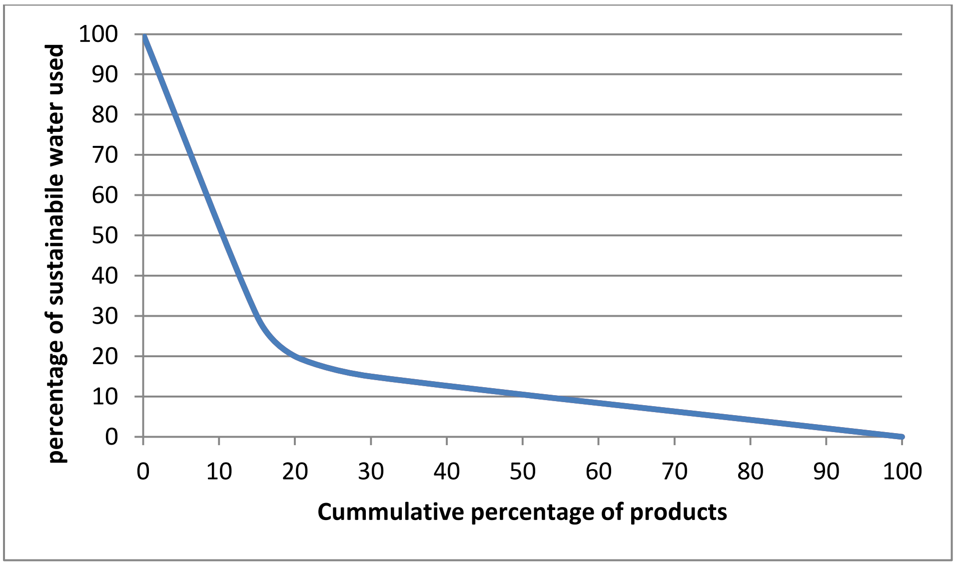

Figure 10: Graph used for setting the waterlabel boundaries (scenario 1)

Figure 10 can be used to relate freshwater sustainability scores to percentile scores. The combination of the two determines the score. In Figure 10, a freshwater sustainability score of 20% correlates with the best 20th percentile.

If another product group is chosen, which is more sustainable, or when production worldwide of the same product group becomes more freshwater sustainable, the graph in Figure 10 changes. Two more sustainable scenarios are therefore shown in Figure 11 and Figure 12.

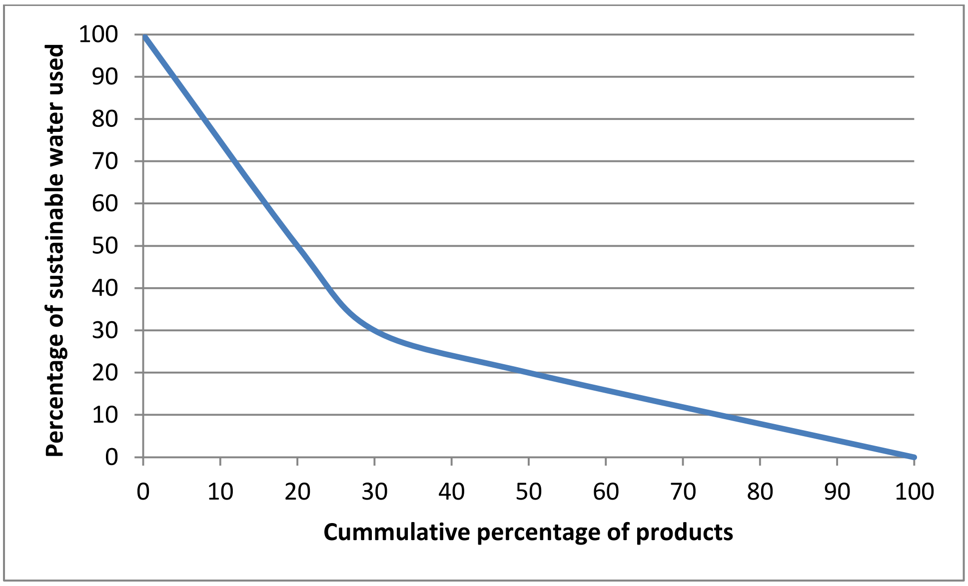

Figure 11: Graph used for setting the waterlabel boundaries (scenario 2)

In Figure 11 the graph has shifted and the same best 20% of products now requires a freshwater sustainability score of 50% or higher.

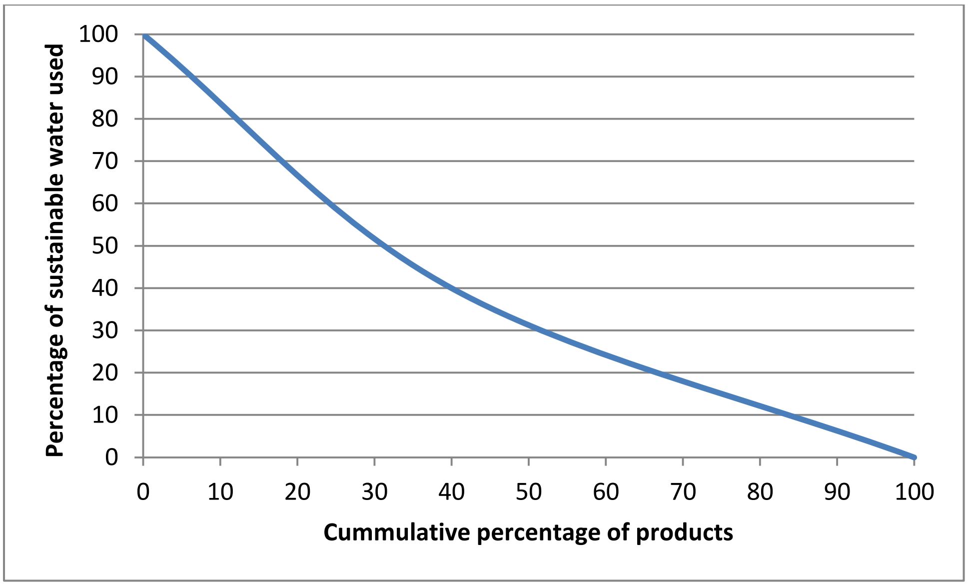

Figure 12: Graph used for setting the waterlabel boundaries (scenario 3)

In Figure 12 the graph has shifted even more and the 20% best products now have a freshwater sustainability score of 65% or higher.

As mentioned before, the freshwater sustainability of production of a product group can change because of general improvements. This changes the graph such that higher freshwater sustainability scores will correlate with the best grades. The graphs are therefore dynamic and will change over time. Ideally, all changes are inserted directly into the waterlabel. However, in practice this will probably prove unrealistic. Since improvement is a principle of good ecolabels (ISEAL Alliance, 2015) it means that relevant changes, like changing freshwater sustainability, need to be implemented regularly. It is assumed that the improvement principle is upheld if the product group graphs are updated at least yearly.

By using the criteria set for each grade and the graph used to determine the criteria, some examples of the grading system are given in Figure 13:

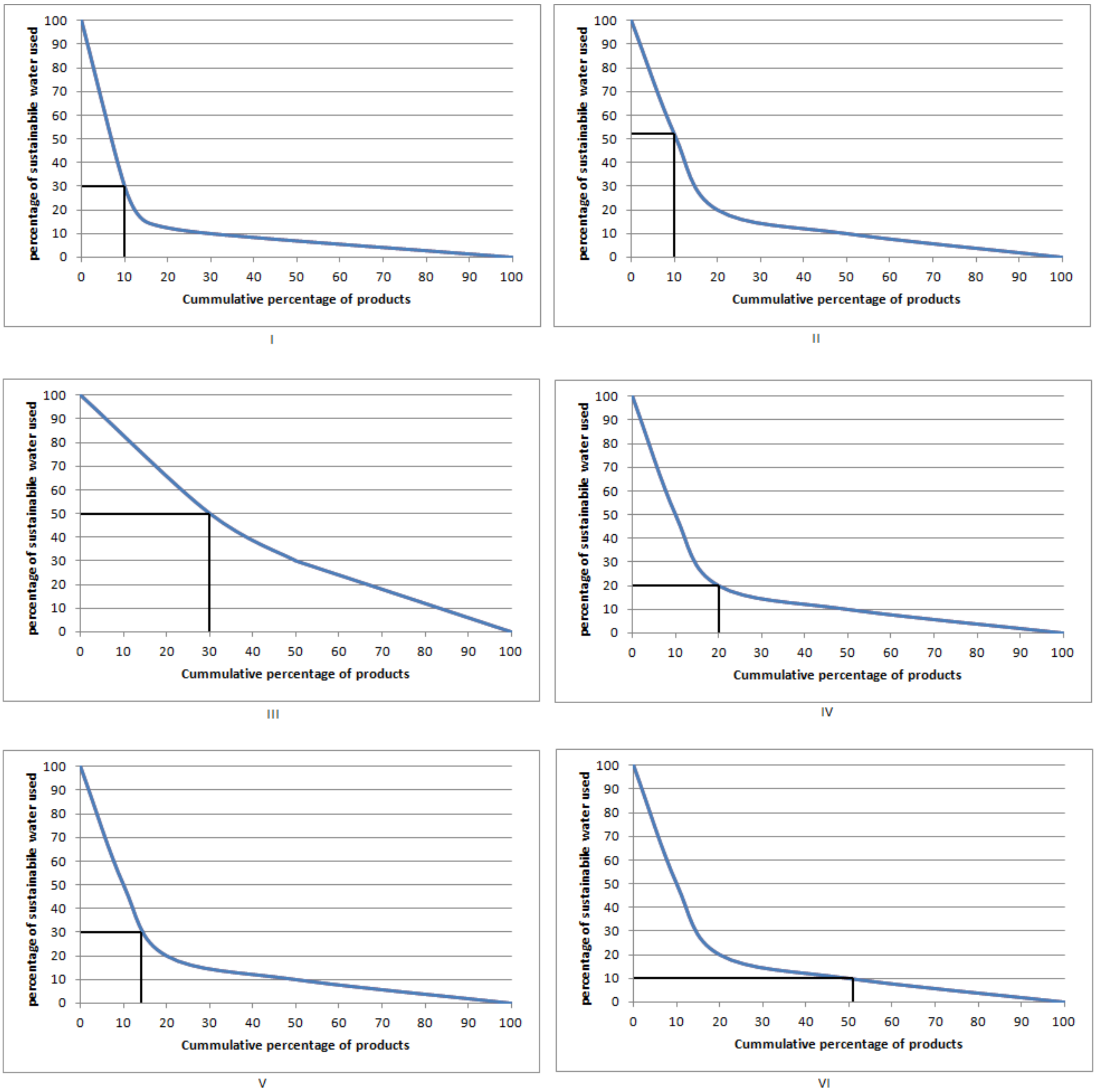

Figure 13: Different hypothetical Freshwater sustainability scores on the score-graph

In Table 1 all examples of Figure 13 are given with their grade:

Table 6: Grades for examples given in Figure 13

Product	Water sustainability %	Percentile	Grade
I	30%	<10th	B
II	52%	<10th	A
III	50%	<30th	C
IV	20%	<20th	C
V	30%	<20th	B
VI	10%	<60th	F

5.3.4. Determining product groups

The products that are grouped to create the scoring graph determine the boundary. Ideally such a graph will consist of a single product, for instance ketchup. However, it is unlikely that the amount of different ketchup products (or bin size) is large enough to create a representative graph. Products will therefore need to be grouped to create such a minimum bin size. Which products are grouped can also determine whether a product receives a high grade or not. If for instance all products are grouped into a single graph, it is likely that some products naturally score higher and thus receive higher grades, while it is nearly impossible for other products to score high grades. This should be avoided because the waterlabel, in part, aims to provide consumers with a means of comparing products: when a consumer wants to buy sustainable ketchup yet cannot compare different types of ketchup on their freshwater sustainability score, that goal of the waterlabel will be missed.

The chosen product grouping will reflect the bin size. In order to differentiate 10 grades, at least 10 products are needed. However, this is still a small bin size and will not accurately display the relative scores within a product group. Therefore it has been chosen that the minimal bin size will be 100. This allows for the scores to be determined per percentile.

The grouping of products can result in some products getting higher grades because they are naturally more freshwater sustainable and vice versa. Products that are grouped need to have relatively similar freshwater sustainability scores. The product groups therefore also need to consist of products that can be interchangeable since grouping ketchup with a cotton shirt, will not provide the consumer with an adequate frame of comparison. For ketchup this could be a cold sauces group containing products like mayonnaise, curry, mustard etcetera.

By pairing similar products it could occur that a product with a bin size below the minimum is ideally paired with a product with a bin size above the minimum. In this case the grouping will only benefit the smaller product. These products will however still be grouped, because providing a frame of comparison for the all products is deemed more important than setting the score graph for small bin sizes.

Determining the actual product groups can only be done after enough the freshwater sustainability scores of products are known in order to assess their similarity. This is therefore not done in this research.

5.3.5. Organizations and ecolabeling principles in the waterlabel

The waterlabel has been set as a graded label, which means that making the waterlabel obligatory, like the European Energy Label, will be ideal. In this way, all labels carry a grade and comparisons can be made over all products and producers will be stimulated to produce more freshwater sustainable (Bleda and Valente, 2009).

In order to make the waterlabel obligatory, legislation changes will be necessary. This automatically means that some government entity needs to be involved. This could either be the European Union or the Dutch government. From the European Energy Label it can be concluded that when an ecolabel is obligatory and applied to a wide range of products, there is no need for other organizations to be involved (European Commission, 2015b). However, the inclusion of other organizations, producers and consumers with the assessment and adjustment of the standards will increase understanding and thus acceptance of the waterlabel (ISEAL Alliance, 2015). The waterlabel is therefore best managed by an organization with governmental connections. This organization should, however, also keep close connections with producers, consumers and environmental organizations with knowledge about freshwater sustainability. The waterlabel will also have external accreditation. This increases impartiality and can easily be implemented.

The ten principles expressed in 4.3.2 will be embedded in the waterlabel. The principles of sustainability, relevance and efficiency relate directly to the criteria used to determine freshwater sustainability. This is determined by a scientific method and thus in compliance with the principles.

The principle of rigor is largely determined by the boundary criteria. The boundary criteria were set at levels deemed to be rigorous. However, if data suggest that the freshwater sustainability score criteria are set too low, these can be adjusted.

Truthfulness, and more importantly perceived truthfulness is another crucial issue. This has been a main reason why the freshwater sustainability criteria were embedded into the boundaries for grade A and B. Truthfulness is thus achieved by setting boundaries that correspond with consumer expectancy. Truthfulness also correlates with transparency. If the waterlabel setup is transparent, consumers will be better informed about the label and their expectancy will align more with reality. To enhance transparency the waterlabel will provide open and easy access to all relevant files, which is best done by publishing all files online. These files include how the freshwater sustainability scores are determined, how the boundaries are set, what scores each product achieves and changes being made. By making these files easily available for everyone, the principle of accessibility will also be addressed in the waterlabel.

Lastly, engagement is achieved by inviting producers, consumers and environmental organizations to discuss the label setup used. This scope of the discussion will not include how freshwater sustainability is determined. This is based on scientific principles and will only change if the scientific understanding changes. The setup of the label, however, including how the boundaries are set, which products are grouped and how information is distributed, is largely based on consumer research. Inviting interested parties can be seen as a form of consumer research and may therefore influence key aspects of the labeling setup.

6. Freshwater sustainability in current ecolabels

There are currently 246 labels identified in the Netherlands (Milieu Centraal, 2015). In this chapter the manner in which the included labels are organized is assessed. Also the freshwater sustainability assessment is done in this chapter. Lastly, an overview of the best scoring ecolabels is given, including steps needed for those ecolabels to include freshwater sustainability more comprehensively.

When filtering all labels that are non-relevant on the basis of the criteria described in the research scope, 44 different labels remain, which have been assessed. All 44 labels and their respective scores are given in Appendix C.

6.1. Organizing structure of the ecolabels

The 44 ecolabels have first been examined on their organizing structure: the labeling design, how their schemes are classified, what type of organization is running the label and whether accreditation is done separately. In examining the ecolabels it was found that not all ecolabels work with a set of standards. Therefore the ecolabels have also been examined on whether they use a set of standards or a code. The distinction between the two is that standards are a set of rules that apply to all products equally, while a code is a set of principles included in the label. Codes are applied as improvement processes in which producer need to improve their production chain in steps. Hence, a product carrying the same label can be in different stages of its improvement process and thus have different environmental impacts.

6.1.1. Labeling designs of current ecolabels

The labeling designs are classified in pass/fail, hybrid and graded (Big Room and World Resources Institute, 2010). Because ecolabels in food, clothes and wood are never obligatory, graded labels are not ideal. This explains why this type of labeling design has not been found in any of the existing 44 labels.

Of the 44 examined ecolabels most use a conventional pass/fail design: 41 (93%). This percentage is much higher than found in the survey from Big Room, which found that 74% use a pass/fail design. The difference is most likely due to the fact that the product groups selected in this research are more suited to pass/fail.

Of the remaining 3 labels, 2 use a hybrid design. This equals to roughly 5%. Both labels are in the non-food sector, one in clothes and the other in paper, and both have their origins and base abroad. The last label is in essence a pass/fail label. It is however not given to specific products, but rather to producers. This is mainly because it is a label promoting sustainable palm oil production, which is mostly used as an ingredient for other products.

6.1.2. Organizations behind and classification of the ecolabels

The organizations controlling ecolabels have, according to ecolabeling theory, been divided into profit, non-profit and governmental. In reality, however, it is rarely as straightforward. In most cases a foundation started by several stakeholders manages the label. The government is often one of these parties, making it difficult to pinpoint exactly how many labels are under control by a government agency. Moreover, even though profit is not a goal in the selected ecolabels, this is in some cases unclear. In a general conclusion, however, one can state that most ecolabels are managed by non-profit organizations, often with (strong) links to government.

Examination of the 44 labels showed that most labels (89%) are, as expected, third party controlled. Third party controlled labels are considered to be more impartial and are thus preferred to first and second party controlled labels (Gallastegui, 2002). Some first party labels were also found, 4 in total (9%). The remaining 2% is second party controlled.

The other classification method is between type-I, II or III labels. Type-III labels are often graded labels, which have not been found in this research. Type-II labels and first party controlled labels are essentially the same labels as both represent a self claim by a producer (Gallastegui, 2002). The amount of type-II labels is therefore 9% as well. The majority of labels examined here are type I (91%). This corresponds with theory of ecolabeling, where type I and III are preferred over type II, since both are deemed more impartial (Gallastegui, 2002).

Lastly, it was examined whether the accreditation is done impartially. Impartial accreditation means that an external party is tasked with checking whether a product is granted the label. This again increases the level of impartiality of a label. It was found that 55% of labels examined use external accreditation.

All in all, most labels examined have a high level of impartiality and can be considered reliable. The fact that profit does not play a part in the labels also increases the apparent reliability. A high perceived reliability is important for the effectiveness of an ecolabel. This means that a label should be third party controlled, type I or III and have an external accreditation process. Labels that do not fall into these categories are generally advised to change accordingly.

6.2. Freshwater sustainability in current ecolabels

Freshwater sustainability in current ecolabels was examined by assessing five points: the mission, the inclusion of freshwater sustainability criteria, how the scheme was constructed, whether freshwater criteria are obligatory and whether the full supply chain is included in the freshwater criteria.

To determine whether a mission suggests water sustainability is included the text was rated for containing specific key words. Ecolabels often use key words like ‘ecologic’ and ‘environmental sustainability’. In this research, both are deemed to suggest a wider environmental view and thus to include water sustainability. Another often-used word is ‘biological’. It is less clear whether water sustainability is included here and this word is therefore not deemed to suggest water sustainability. Finally, labels that mention freshwater specifically are rated to include water sustainability in their mission.

The next step has been to examine whether water sustainability criteria are included in the labeling scheme. The labels are split in three groups: (1) water sustainability criteria are included explicitly and with qualitative standards, (2) water sustainability criteria are included implicitly or with non-specific standards and (3) water sustainability is not included. An explicit, qualitative standard would be: “The maximum amount of water used is 100 liters per acre per week”. A similar non-specific standard would be: “The overall water use must be as little as possible”. With the difference being that the first quantifies the boundaries and the second does not.

Similar to the water standards, the overall standards can be quantified or not. If the overall labeling scheme is quantified, or mainly quantified, the labeling scheme is applied to all products equally. This is not always the case, as some labels work with a non-quantified labeling scheme. In these cases the labels usually agree on an improvement trajectory with the producers. If the agreement is met the producers acquire the label (Bleda and Valente, 2009). Ecolabels are rated on whether their overall labeling scheme is quantified or not.

When a labeling scheme includes freshwater sustainability criteria, these can be divided further based on whether the criteria are optional or compulsory and if the full supply chain is included. When water sustainability is compulsory it is deemed better than when it is optional. Water sustainability is generally assessed over a full supply chain. In most cases, however, ecolabels are only applied to specific processes, like the agricultural process. The research has therefore assessed which ecolabels include the supply chain in their freshwater criteria.

The ranking options are shown in Table 7.

Table 7: Ranking criteria

Mission	Water criteria	Labeling scheme	Compulsory water criteria	Supply chain included
Y/N	Quantified (Q)/ not quantified (nQ)/N	Q/nQ	Y/N	Y/N

Assuming that the compulsory and full supply chain ranking only is applied when water criteria are included 36 potential rankings occur. However, some combinations are impossible, like a quantified water section in a non-quantified scheme, and other do not occur. The ecolabels will therefore be ranked along the 12 categories that remained:

Table 8: Different categories and their ranking criteria

Category	Mission	Water criteria	Labeling scheme	Compulsory water criteria	Supply chain included
1	Y	Q	Q	Y	Y
2	Y	Q	Q	Y	N
3	Y	Q	Q	N	N
4	Y	nQ	Q	Y	N
5	Y	nQ	Q	N	N
6	Y	nQ	nQ	N	N
7	Y	N	Q	-	-
8	Y	N	nQ	-	-
9	N	nQ	Q	Y	N
10	N	nQ	Q	N	N
11	N	N	Q	-	-
12	N	N	nQ	-	-

The score per label is given in Appendix C, where relevant freshwater assessment criteria are further split into either green/blue or grey. The ranking result section in Table 9 below merely shows when either one of these score a yes (Y) or a quantified (Q), and therefore whether the label is deemed to include the relevant criteria. An exception has been made however, for the top two categories. These have been split into on whether they include both blue/green and grey water or just one of both.

Table 9: Current ecolabels ranked in their relevant category

Category:	Label name:	Product group:
1 (both)	Cradle-to-Cradle	Paper
1 (grey only)	European Ecolabel	Paper/clothing
2 (both)	Milieukeur field production	Fruits and vegetables
	Milieukeur glass house production	Fruits and vegetables
	Rainforest Alliance	Fruits and vegetables/coffee, tea and cacao
3	Greenpalm	Other
4	Milieukeur meat processing	Meat
5	Cotton made in Africa	Clothing
6	Cairing Dairy	Dairy
	Duurzame Weidezuivel	Dairy
	Nature and More	Fruits and vegetables
	Bio Equitable	Coffee, tea and cacao
	Blue Sign	Clothing
7	Milieukeur meat	Meat
	Erkend Streekproduct	Meat/local
	Milieukeur eggs	Eggs
	Groene Hart	Eggs/local
	FSC (multiple labels)	Wood/paper
8	Responsibly Fresh	Fruits and vegetables
	Willem en Drees	Local
	Veldleeuwerik	Other
	Made By	Clothing
9	UTZ Certified	Coffee, tea and cacao
10	EKO	Meat/eggs/dairy/fruits and vegetables/coffee, tea and cacao
	Fair Trade (Max Havelaar)	Fruits and vegetables/coffee, tea and cacao/clothing
11	Biologic European Label	Meat/eggs/dairy/fruits and vegetables/coffee, tea and cacao/fish
	Demeter	Meat/eggs/dairy/fruits and vegetables/clothing
	Duurzaam Varkensvlees	Meat
	Nieuwe Standard Kip	Meat
	Weet Wat Je Eet	Fruits and vegetables
	Organic 100 Content Standard	Clothing
	Global Organic Textile Exchange	Clothing
	PEFC (multiple labels)	Wood/paper
	KOMO	Wood
	ASC	Fish
	MSC	Fish
	Waddengoud	Fish
12	Gijs	Eggs/local
	CO2 Neutral	Dairy
	Fair for Life	Fruits and vegetables
	Nestle Cacao Plan	Coffee, tea and cacao

Category:	Label name:	Product group:
	Hier	Other
	Oeket Tex	Clothing
	Friend of the Sea	Fish

From Table 9, it can be derived that there are five very promising labels (the first two categories) that already have an extensive water sustainability section. These labels will therefore be described more extensively in the next section, 6.3.

6.3. How freshwater sustainability can be included better in current ecolabels

This section gives a description of existing ecolabels that score best on their freshwater sustainability: Cradle-to-Cradle, European Ecolabel, Milieukeur field production and glass house products, and the Rainforest Alliance. The two Milieukeur labels were assessed separately, but because these Milieukeur labels are identical on their freshwater sustainability inclusion, they will be described together in this section. Hereafter, the conceptual differences between the waterlabel and the described ecolabels are listed, including the practical adjustments needed if the waterlabel is to become part of the described ecolabel. To compare the ecolabels with the waterlabel, this section first gives the key elements of the waterlabel.

Key elements of the waterlabel

Key elements of the waterlabel are considered to be as follows:

1. It views the freshwater scarcity or pollution problems in a wider geographic sense. The entire area is taken into consideration and not just the process site. Even if the process site is sustainable, it can still contribute to freshwater problems in the area.
2. The waterlabel splits blue, green and grey water. By looking at each individually, problems may emerge which would not be seen these are not split.
3. It includes an economic aspect since it assesses the amount of freshwater used, next to the implications of the freshwater use.
4. The waterlabel, moreover, has quantified standards, which apply to all producers equally. This is not always the case. A change from a non-quantified to a quantified system would require the whole setup of the ecolabel to change.
5. Finally, the waterlabel assesses freshwater over the entire supply chain. Most labels only assess the last process needed to create the product and do not account for the entire supply chain. Most freshwater use however, is embedded in the supply chain of products (Hoekstra and Mekonnen, 2012) which is therefore also included in the waterlabel.

If these five key elements are present in an ecolabel the waterlabel can be easily embedded by changing the data acquired per site. If some aspects are lacking, however, more extensive changes will be needed.

In the next section, the five labels are described by first assessing what water elements exist in the label and then comparing those elements to the key elements of the proposed waterlabel.

Cradle-to-Cradle

Cradle-to-Cradle is an ecolabel that focuses on the full life cycle management. In the Netherlands it is only available for paper products. Cradle-to-Cradle was created by the consultancy bureau McDonough Braungart Design Chemistry and has five levels: basic, bronze, silver, gold and platinum. In the Netherlands, however, only the silver labeled paper is available (Cradle-to-Cradle Products Innovation Institute, 2014).

The freshwater criteria imbedded in the Cradle-to-Cradle scheme are very comprehensive and the label is therefore ranked in the first category. Cradle-to-Cradle has 9 points relating to freshwater sustainability. At the basic level three points are assessed, which can be characterized as the obligatory criteria (Cradle-to-Cradle Products Innovation Institute, 2015).

- The first point is very basic and states that no violations of the discharge permit are allowed. This means that any pollution caused is within the local legal levels.
- The second point addresses local freshwater problems. Producers need to assess the freshwater scarcity and accessibility of clean water for the local population. Any ecological problems relating to the freshwater use need to be considered as well. The label assumes that by giving the manufacturer insight in the problems, he is stimulated to produce more sustainably.
- The third point is water stewardship intent. This requires manufacturers to form a plan to combat any problems found in the second point, which includes measurable goals and a timeline. These points are not fully quantitative, but are quite close to being so.
- The fourth point is needed to apply for the bronze level label and prescribes that a water audit is completed. A water audit traces all water used in the facility to its origin. This includes direct water intake from water bodies and effluent water discharged. Evaporation is also included in this point. Apart from making an extensive scheme of all water in the facility, possible water reductions are assessed as well.
- Point five and six relate to the silver level, and only one of the two needs to be implemented to obtain the silver label. Point five is an improvement on the first point. Instead of just complying with legal standards, pollutants need to be traced back and it needs to be assessed what amount is released when.
- Point six is about supply chain management and encourages manufacturers to assess freshwater problems in their supply chain. It is assumed that the manufacturer does not own the supply chain. By assessing freshwater problems in the supply chain, manufacturers get insight in any problems occurring elsewhere due to their product.
- Points seven and eight are related to the gold level and, again, only one needs to be passed to receive the gold label. Points seven and eight relate to point five and six, but take the manufacturer’s responsibilities further: problems that arise in five and/or six need to be addressed and optimized.
- Point nine, finally, relates to the platinum level and addresses clean drinking water. In order to obtain the platinum level, facilities need to discharge clean drinkable water. Drinkable water is defined according to the local standards for clean water.

Compared to the key elements of the waterlabel, the first key element is present. The Cradle-to-Cradle ecolabel has an obligatory standard addressing the local freshwater scarcity problems. The Cradle-to-Cradle ecolabel also takes the wider geographic area into account.

The second key element however is lacking. Freshwater is not split explicitly in blue, green and grey, or similar. Distinction between scarcity (blue) and pollution (grey) is made implicitly, but green water is not mentioned at all. In order to include green water, a wider range of data is needed. The scarcity problems addressed in the Cradle-to-Cradle ecolabel are all surface water based, while green water problems are not implemented. This requires data from another data point.

The third key element, the economic use of freshwater, is not included in the Cradle-to-Cradle ecolabel. It is implicitly mentioned, by calling for a water audit, but the label does not set a maximum for freshwater used. This can however be embedded quite easily by creating a new criterion with a maximum amount of freshwater used per type of process.

The fourth element is partly included. Some standards of the Cradle-to-Cradle ecolabel are quantified, while others are not. It does treat every producer equally, but often hard boundaries are lacking. This could be imbedded by changing the standards, but this will drastically change the setup of the Cradle-to-Cradle ecolabel and is therefore probably not feasible.

The last key element is the full supply chain element. The Cradle-to-Cradle ecolabel has a standard in its freshwater section stating that 10% of tier 1 suppliers need to be assessed (Cradle-to-Cradle Products Innovation Institute, 2015). This however is not enough for the waterlabel, which needs the full supply chain. Also, this standard is not obligatory. However, in their social standards section, a standard is present that addresses the social aspects of all suppliers in the full supply chain (Cradle-to-Cradle Products Innovation Institute, 2015). The full supply must be known to compute with this standard. This standard is again not obligatory. Yet considering that the full supply chain is known it is easier to assess all freshwater used, which is needed for the waterlabel.

Overall, the changes that need to be made to incorporate the proposed waterlabel are: (1) making the freshwater supply chain standards obligatory and inserting them for all suppliers, (2) including green water and (3) full quantification of the freshwater section, including a standard on economic use of freshwater. The first change is fairly invasive because they need a large amount of data from new sources. The Cradle-to-Cradle label has however already lain the groundwork for this. Including green water into the scheme will also require the acquisition of data from new data points. The other aspects of the waterlabel can be included simply by adding standards and will not imply major changes.

European Ecolabel

The European Ecolabel is found on both paper and clothing, with slight differences between both schemes. It is an ecolabel of the European Union, managed nationally by Milieukeur. It can therefore be seen as a joint venture and contains large resemblances with the Milieukeur ecolabel (Stichting MilieuKeur, 2015a).

The European Ecolabel addresses the full life cycle of paper and clothing, and therefore includes the full supply chain of freshwater. Freshwater management is very implicit, but some standards for suppliers exist in the scheme of the European Ecolabel. The ecolabel only addresses which pollutants can be discharged and in what concentration. The European Ecolabel therefore only assesses grey water and good water management is not a priority (European Commission, 2015a).

In relation with the key aspects of the waterlabel, the first three aspects are fully lacking as the European Ecolabel only assesses pollution levels on site. The fourth aspect however, is present, since the European Ecolabel uses only quantified standards. The fifth aspect is partly present because producers are obliged to know their full supply chain, and a declaration is needed from suppliers stating what chemicals are used and in what quantities.

If the waterlabel is to be embedded into the European Ecolabel, the biggest change will be that a whole new section needs to be added. The current European Ecolabel only assesses pollution and social issues and the waterlabel will expand that with freshwater management. This will mean that extra data from the local environment and freshwater data as a whole are needed, and that the supply chain assessment has to be expanded. The difference between the waterlabel and European Ecolabel is therefore most likely too big to include the waterlabel. Data acquired for the European Ecolabel hardly covers the key aspects of the waterlabel and the additional data needed cannot be acquired at the current data points. If, however, the waterlabel is to be inserted into the European Ecolabel, these data points need to be expanded to include all geographic freshwater data from all suppliers.

Milieukeur, field production and glass house production

Milieukeur is a foundation that manages the Milieukeur label and European Ecolabel. Milieukeur uses different schemes to fit different product groups. Two of those product groups are fruits and vegetables from field production and from glass house production. Because the freshwater criteria are the same for both they will be addressed as one (Stichting MilieuKeur, 2015b).

The Milieukeur label has a specific water section in which both quantitative and non-quantitative standards are given. Some standards are obligatory, while others are not. This water section states that the water source needs to be indentified and calls for the reduction of the used freshwater by setting a water plan, in which a reduction path is agreed, and by making it obligatory to install at least one water saving measure. This accounts for blue and green compulsory water standards (Stichting MilieuKeur, 2015d, Stichting MilieuKeur, 2015c). The grey water standards are given similar to the European Ecolabel: it is not allowed to surpass the maximum stated amount of pollutants and their concentrations.

The Milieukeur ecolabel does not include the supply chain or a wider geographic assessment. It also does not include a clear distinction between blue- and green water. It does address grey water in a way similar to the European Ecolabel, and it includes some statements about the amount of freshwater used, in this case blue, meaning that the economic aspect is partly present. The ecolabel also uses quantified standards.

If the waterlabel is to be embedded into the Milieukeur ecolabel, first the wider geographic area needs to be included in current scarcity and pollution data. This requires different data. Secondly, the freshwater quantities used need to be addressed better. Since these are already monitored only a benchmark is needed. The freshwater used however, and the geographic data, need to be split into blue, green and grey. This requires some adaption, especially for acquiring data about green water. The supply chain is not included because the Milieukeur ecolabel assesses agricultural products and processes. Given that the supply chain of agriculture is not part of the waterlabel and it neither has to be included in the Milieukeur ecolabel. It seems feasible to embed the waterlabel into the Milieukeur ecolabel if geographic data can be acquired.

The Rainforest Alliance

The Rainforest Alliance is an organization that focuses on preservation of tropical rainforest. While it also addresses other ecological issues, the main focus is on the rainforest. This organization has an own ecolabel that has criteria for agriculture and tourism. Forestry is assessed as well, but this is implemented in the FSC-label (Rainforest Alliance, 2015).

The Rainforest Alliance ecolabel uses critical standards and non-critical standards. Critical standards are obligatory and non-critical standards determine the grade of the label: bronze, silver and gold. The more non-critical standards are complied with, the higher the grade.

The Rainforest Alliance scheme has a specific freshwater section. The critical standards only address pollution of water bodies and the maximum amount of pollutant that can be discharged. For the total amount of freshwater used, other standards are used. These address freshwater conservation and over exploitation of water sources, without going into much detail. Total volumes used are also part of the label, but this is done without setting maxima (Sustainable Agricult Network, 2010).

The Rainforest Alliance ecolabel has a specific section about the preservation of the ecosystem, which includes freshwater ecosystems. It does not specifically address scarcity, but this is part of the ecolabel. Furthermore the Rainforest Alliance ecolabel already calls for acquiring data from a wider geographic area than the site. This aspect is therefore present as well. The Rainforest Alliance ecolabel does not address green water and while grey water is addressed, it is not done in a wider geographic sense. Freshwater quantities used are also not monitored, which makes the economic aspect lacking. Lastly, there is no supply chain mentioned in the Rainforest Alliance ecolabel.

If the Rainforest Alliance ecolabel is to embed the waterlabel, the geographic data acquired need to be expanded to include specific freshwater data. This would be a small step from acquiring ecological data. The separation of blue, green and grey water is a little bigger, but likewise feasible given the geographic data and site data. For embedding the economic aspect, a benchmark is needed. Doing so will not change the ecolabel much. Lastly the supply chain, which is lacking, could be disregarded for similar reasons as with the Milieukeur ecolabel because the Rainforest Alliance ecolabel only addresses agriculture. Overall, the Rainforest Alliance ecolabel is a very likely candidate for imbedding the waterlabel.

6.4. Conclusion

From section 6.1 it is found that most ecolabels are class I, third party controlled and use a pass/fail design. This could be expected because this combination has a high degree of impartiality and is easy to implement.

For freshwater sustainability criteria it was found that freshwater sustainability in general is only a minor aspect within ecolabeling. When examined more closely it was shown that most ecolabels neither include freshwater sustainability in their mission (50%) nor include any freshwater sustainability criteria in their scheme (52%). This is in line with the expectation that the freshwater sustainability issue has not yet spawned a widespread interest.

50% of ecolabels does have a mission statement that promises full environmental sustainability. This is expected to include freshwater criteria, but 40% of these labels (20% in total) do not mention freshwater in their scheme and 3.5% (7% in total) only use non-quantitative terms.

There are, however, six ecolabels that use quantitative terms in describing their freshwater criteria and of these six ecolabels five were chosen for closer examination because they have a good chance to incorporate the waterlabel. In total only one ecolabel (Cradle-to-Cradle) has reached the highest category (category 1 with both blue/green and grey standards), making this label most promising for including the freshwater sustainability criteria of the waterlabel. None of the five ecolabels examined more closely match the waterlabel closely enough to state that freshwater sustainability is already adequately incorporated.

The five selected ecolabels were assessed further to determine how they compared to key elements of the waterlabel. It was found that a wider geographic view was implemented in two ecolabels (Cradle-to-Cradle and the Rainforest Alliance) and that none of the ecolabels split blue-, green- and grey water. Some ecolabels suggest economic use of freshwater (Cradle-to-Cradle and Milieukeur), however, none really quantifies these standards. The selected ecolabels were already assessed on their scheme, so all use quantified standards. Some (Cradle-to-Cradle and Milieukeur) however, also contained non-quantified standards. Lastly, only the Cradle-to-Cradle ecolabel and the European Ecolabel had the supply chain embedded in their scheme, with the European ecolabel doing this in a very rudimentary way, and the Cradle-to-Cradle label in a more elaborate way. However, the Cradle-to-Cradle label mainly uses the supply chain to assess social criteria and not freshwater use. The other ecolabels (Milieukeur and the Rainforest Alliance) did not include the supply chain, but because these labels target fruits and vegetables this is not deemed absolutely necessary.

Table 10 is made as a gap assessment of the five best scoring ecolabels, were green (G) means that the key element is adequately imbedded, yellow (Y) means that it is possible to imbed the key element without changing much or that a key element is partly imbedded and red (R) means that imbedding the element is deemed difficult and changes the current setup of the ecolabel

Table 10: Gap assessment of the five best ranked ecolabels

Key Element: Label:	1	2	3	4	5
Cradle-to-Cradle	Y	R	Y	G	Y
European Ecolabel	R	R	R	G	R
Milieukeur	R	Y	Y	G	Y
Rainforest Alliance	Y	R	Y	G	Y

7. Discussion and recommendations

7.1 The waterlabel

In the first part of this research, a waterlabel is created. The suggested waterlabel solely concentrates on the freshwater sustainability and operates under ideal circumstances.

By disregarding other environmental, social and animal wellbeing issues, it is shown how an ecolabel for freshwater sustainability alone can operate. Not taking other issues into account however, may pose problems. It is unlikely that consumers who pay attention to ecolabels only will look at the waterlabel. Interaction between issues is therefore likely to be a factor in consumer behavior.

In most cases there is a direct tradeoff between energy use and freshwater use. Producing goods with less water is usually harder and will cost more energy. This (negative) interaction will likely be present in a lot of products that qualify for the higher waterlabel grades. There is also a link between freshwater use and animal wellbeing. If it is assumed that grazing systems score highest on animal wellbeing and industrial systems score lowest, this link does not necessarily conflict with freshwater sustainability. In grazing systems the waterfootprint of the feed is usually lower and thus the overall waterfootprint of the livestock is lower. There are, however, important exceptions. When rearing chickens the feed of industrial systems and grazing systems is often very much alike in terms of waterfootprint. Grazing chickens, however, use more energy so their feed to meat conversion rate is much lower. Industrial chickens are therefore more likely to receive a high waterlabel grade than grazing chickens.

Another link not examined in this research is the link between social issues and freshwater sustainability. In order to produce more freshwater sustainable, it is not unrealistic that corporations would need to relocate their processes to an environment more conducive to sustainable production. This means that in some regions employment options will be limited. The link can therefore have important social implications if unsustainable production sites are mainly found in poorer regions where big companies currently operate.

If the waterlabel is to be implemented, more research is needed on the interaction between the waterlabel and other issues. This research should include how consumers view the waterlabel if they know that other issues are disregarded. If it is shown that not incorporating other issues negatively affects the waterlabel, the goal of the waterlabel could be adapted to: “the waterlabel aims to increase freshwater sustainability without negatively affecting other environmental and social standards.” The waterlabel should then also include a section about tradeoffs and how to avoid negative effects on other issues or lessen negative effects.

In the waterlabel itself there is also a link between freshwater sustainability and waterfootprint. In this research it was chosen to label based on freshwater sustainability. The waterfootprint is only taken into account for benchmarking processes. This means that products which generally have a high waterfootprint can receive a high grade of the waterlabel. This can be perceived as untruthful, because a waterlabel might suggest that not a lot of freshwater was used. It is however, deemed better to also allow products with a high waterfootprint to be able to receive the high grades, because it is deemed more likely that consumer are willing to buy the best scoring product within a product group rather than not buying a particular product because it does not score high in general

(Bleda and Valente, 2009, Schumacher, 2010). Comparability of the products has preference over this potentially perceived untruthfulness.

Secondly, the waterlabel is set in ideal circumstances with the advantage that no restrictions are set. If the waterlabel would be implemented, however, some restrictions and problems will occur. It is probable that most problems cannot be foreseen before actually encountering them. For instance, some production chains may differ from the theory in such a way that the waterlabel simply cannot be applied. Some of such problem areas can already be identified.

The first problem area will be the gathering of data. In the waterlabel it is assumed that all geographic areas on all scales are assessed on the basis of their freshwater sustainability. This requires a vast database and it is unlikely that such a database is created in a short period. It is, moreover, likely to be an expensive process. Follow up research should focus on creating with little costs as possible. This could be done for instance by modeling hotspot databases. This could be realistically done by starting on a big scale and increasingly going into more detailed models for smaller grit sizes.

The waterlabel also assumes that all waterfootprints are known. Waterfootprints of crops are measured as are waterfootprints of feed and the amount of feed consumed by livestock. In reality however, it is unlikely that the waterfootprint of crop production is measured. This depends largely on the evapotranspiration, which is costly and uncommon to measure. When the waterlabel is implemented, some practical choices will have to be made on many of these data gathering issues. Evapotranspiration for instance can be modeled. This requires additional data, amongst others on crop parameters and climate date, for which several different models can be used. Each model has its own strengths and the model that is best used may depend on the area it is used in and the available data. Further research is needed to optimize these choices, taking the following considerations in to account: if measuring is possible, how missing data can be modeled and else if missing data can be estimated on basis of similar processes and climate data.

A second problem of the assumed ideal circumstances is that fact that there are legal and financial restrictions. The proposed waterlabel is set as a graded label. This however, only works properly if the label is obligatory to all products. To realize this scenario legislation needs to be changed which is in itself improbable on the short term. It is more realistic that the waterlabel is implemented in another form and slowly evolves into an obligatory graded label. This is possible because the scoring system of the waterlabel is easily converted for a pass/fail or hybrid label. Another related issue is the fact that there are no financial restrictions. It is possible that the current setup of the waterlabel is not realistic because this setup will simply cost too much. These costs lay within the unlimited data gathering and the fact that all products participate for instance. This would, again, require more research.

In the waterlabel standards, the economic sustainability is set at a benchmark. This benchmark is the maximum amount of waterfootprint allowed for that process without becoming unsustainable on economic grounds. In the current setup, were freshwater sustainability is scored in percentages, it is better for a producer to precisely use the benchmark's waterfootprint rather than less. Using more freshwater in a sustainable way will increase the relative amount of freshwater used. This is a conceptual problem, which can be made as small as possible by setting the benchmarks at a strict level. It should therefore be assessed if the chosen 20th percentile is strict enough, by assessing the relative benefit of increasing a process' waterfootprint to exactly the benchmark. If this relative benefit is too big, the benchmark should be set stricter.

The waterlabel is setup with a generic scheme to fit all products within the scope. This has the benefits that it is easier to implement and that all products can theoretically be compared. While the differences in production have been accounted for in the scheme, the scheme may result in more accurate results were it to be fitted into more specific products groups. Current ecolabels are generally split into specific product groups or are only applicable to a single product group. The schemes represent a high level of detail, which is much harder to implement on a generic scheme. More specific schemes, like the ones currently implemented, however are rarely applied to products with multiple ingredients and a large part of the products in the scope of the waterlabel cannot be labeled if such products are disregarded. Therefore, the generic scheme as implemented is deemed the best choice.

In the scheme of the waterlabel the freshwater sustainability score is the combined score over blue, green and grey water. This can potentially be split, so that the freshwater sustainability assessment will have three scores, which would in turn increase clarity for both the producer and the consumer on where problems arise. In this research a single score system is chosen for the waterlabel, because it is quickly understood and requires no extensive knowledge on freshwater sustainability. A higher understanding increases the transparency and truthfulness perceived by consumers. Interested producers and consumers can still be informed about problem areas if all freshwater sustainability assessments are accessible online.

In the waterlabel scheme, transport is taken into account as a benchmark only by using a mean waterfootprint value per tonkilometer traveled. This is done because it is deemed highly improbable that energy can be trace over its supply chain and therefore the geographic sustainability and exact waterfootprint cannot be determined. However, the generic mean value can be extended if needed. The waterfootprint of transport is determined by many factors, like type of transport, type of energy used, efficiency of the engine etcetera. Ideally these factors are all taken into account for each traveled tonkilometer. This could be implemented into the waterlabel, however, a lot of additional data is needed and transport does not contribute a lot to the overall waterfootprint of most products. It was therefore chosen not to include transport that extensive, but more extensive inclusion could be added.

The waterlabel uses dynamic boundaries because this will maintain the same level of strictness even if (technological) progress makes it easier to produce more freshwater sustainable. It also means that if a producer does not respond to shifting freshwater sustainability practices in time whereas his competitors do, the grade will be lower. It could be perceived as unfair by the producer and it is possibly confusing for consumers. The dynamic boundary system however prevents the system becoming outdated and encourages all producers, including producers with high grades, to become more freshwater sustainable. To minimize the perceived unfairness, adequate information should be provided on the fact that the boundaries are dynamic and what this implies.

In relation to the dynamic boundaries, the frequency with which the boundaries are updated plays a vital part. Since improvement is a principle of good ecolabeling, this frequency should be chosen to fit the waterlabel as best as possible. In this research it was chosen to set this frequency at a yearly base. For setting the frequency two aspects are taken into account. Firstly, changing the boundaries means that the grading changes for some products, these products need to update their packaging displaying the waterlabel. If the frequency is set to high these package may have to change very often, which is not feasible for producers and might confuse consumers. On the other hand if the frequency is set to low, the grade displayed on product may be long outdated. This may be perceived as untruthful and not rigorous. An annual update is therefore deemed to be in line with the principles of good ecolabeling, however, it should be perceived as an indication.

As mentioned before, setting the product groups can influence which products receive high grades and which low grades. This research made conceptual grouping based on the comparability of products for consumers, as this increases information for consumers and helps decision-making. Other groupings are in fact possible. For instance, if the main goal is to inform producers on their freshwater sustainability scores, it is better to group products based on similarities in production. For the purpose of the waterlabel it is deemed that informing the consumer has a higher priority; producers are already adequately informed about their relative production score by the benchmark criterion.

In the ideal situation, the waterlabel is graded and managed by government. This situation is in reality not likely on the short term as it is improbable that the waterlabel will be made obligatory instantly. The waterlabel will most likely be implemented step by step until the ideal situation is reached. Even though for this reason the waterlabel will not work as a graded label at first, by not awarding the lower grades (E to J) the graded design can be easily transformed into a hybrid or pass/fail design. With such a design virtually any organization can implement the waterlabel. The best organization to start implementation will have knowledge about freshwater sustainability and good connections with producers, to be able to make the necessary practical decisions and to increase chances of producers participating.

Ideally, the waterlabel is implemented for the entire scope of products. However, expected practical problems and the unlikelihood that the waterlabel is obligatory from the start, make it more realistic to initially implement the waterlabel in a smaller range. Possible product groups are cereals, meat and fruits/vegetables. The cereal group has the highest waterfootprint contribution (27%) and meat is second (22%) (Hoekstra and Mekonnen, 2012). Applying the waterlabel to either group will therefore yield the highest results. The groups also have a relative small supply chain, which in most cases makes implementation easier. For the same reason the fruits/vegetables group is also a viable starting point. This group has a very limited supply chain and which will make the waterlabel easy to implement. These products, however, have a smaller waterfootprint and a waterlabel here will therefore have less impact on overall freshwater sustainability.

7.2. Current ecolabels

The second part of the research assessed current ecolabels on their use of freshwater sustainability criteria and showed a big difference between existing ecolabels and the proposed waterlabel. Current ecolabels in the foodstuff categories are mostly aimed at products with very direct links to their origins: all concern products which come directly from agriculture (fruits, vegetables, coffee, tea and cacao) or from livestock (meat, dairy and eggs). The waterlabel on the other hand is applicable for products with multiple ingredients, like ketchup or soft drinks.

Because the products in the scope of current ecolabels have a very small production chain, it is not surprising that in nearly all cases the supply chain is not included in the labeling scheme. Products from agriculture, for instance, have little to no supply chain as do some livestock products. As these labels are still assessed on whether they include the supply chain, they are ranked lower but perhaps should not be. This was however, deemed the best way to assess which labels are closest to the waterlabel. Supply chain assessment is vital for the waterlabel and only if it is included in a current ecolabel, the waterlabel standards can be embedded in that ecolabel.

Current ecolabels were also assessed on whether their missions suggest that freshwater sustainability is included. In most cases, the mission did not name freshwater explicitly. Even though, the assessment done in this research gives an indication of the extent to which freshwater is included, it is possible that current ecolabels are not interested in incorporating waterlabel standards. Reaching out to current ecolabels with this question is a first step towards actually incorporating the waterlabel standards into a current ecolabels. Such steps are not included in this research as the research was primarily conducted to assess the differences between current ecolabels and the waterlabel, and to determine what is needed to incorporate the standards.

In the assessment of the current ecolabels, five key points were used: mission, inclusion of freshwater sustainability, type of scheme, compulsory freshwater sustainability criteria and inclusion of the supply chain in the freshwater sustainability criteria. These points were deemed to represent the best method of ranking the ecolabels on freshwater sustainability criteria. Other points however, could have been included. For instance, the inclusion of a wider geographic sustainability scope was not used in this assessment, but was used in a later assessment of the best ecolabels. It was not taken as a key assessment criterion because this is more about compatibility than about freshwater sustainability. Other points, like splitting blue- and green water, were disregarded for similar reasons.

The order in which the key points were put was chosen because it allows for the best comparability and ranks the most promising ecolabels highest. Using a different order would potentially change the ranking. This was checked and it appears that changing the order has no significant effect on the ranking outcome. Changing the first three key points will not change the rankings in the first five categories, whereas switching the fourth and fifth changes nothing. Only if the compulsory freshwater criteria point is moved up, changes in category three and four occur. These categories are not further examined in the research so again this would not lead to big changes. Moreover, these changes only occur when the compulsory freshwater criteria point is moved in front of the inclusion of freshwater criteria point. This is illogical since the compulsory point can only be examined if inclusion of freshwater criteria is already established.

8. Conclusion

This research was conducted to answer the following objective: what would a suitable freshwater sustainability ecolabel look like and how can freshwater sustainability criteria be better included in existing ecolabels? These two questions were each answered by first answering three sub questions for both questions.

The first sub question answered was: what criteria are used to measure freshwater sustainability? This question was answered with existing literature about waterfootprint analysis and freshwater sustainability assessment. The criteria embed geographic sustainability for blue-, green- and grey water separately and add a benchmark for economic sustainability. Social sustainability, often used in ecolabeling, was not included in this research. For each separate process in production the geographic sustainability and economic sustainability should be determined. A process is only freshwater sustainable if all points are sustainable. By adding all freshwater used from all processes within a production chain, the amount of sustainably used freshwater, expressed as an percentage of the total used water, can be determined.

Geographic sustainability is determined by assessing for each process whether the total amount of blue water used in an area exceeds the blue water availability, whether the green water used in an area exceeds the green water availability and whether the amount of pollutants used in an area can be assimilated to legal concentrations by the available freshwater. The economic sustainability is determined by a benchmark, which is set at the best 20th percentile for the purposes of this research. If the amount of freshwater used exceeds the 20th percentile limit for that process, the process is economically unsustainable.

The second sub question was: how are the criteria translated into a labeling scheme? This question was answered by combining knowledge about ecolabeling and the determined freshwater sustainability criteria. The labeling scheme proposed uses the freshwater sustainability score as the base for setting the boundaries. These boundaries are determined by constructing a graph with the freshwater sustainability score on the y-axis and the cumulative percentage of producers on the x-axis. The boundaries are set on each 10th percentile, so the highest rank is given to the highest ten percent of products with the highest freshwater sustainability score. An addition was made to minimize the risk of high grades being achieved with a low freshwater sustainability score because only the percentile of producers was used as a boundary. The highest ranks must therefore include freshwater sustainability score criteria as well. For the highest grade (A) this is 50% or higher and for the second grade (B) this is 25% or higher. In all, the waterlabel has ten grades, ranking from A to J.

To determine the graph needed to grade the products, certain products were grouped. It is improbable that for every type of product enough different brands are available to create a representative graph and grouping all products together may favor certain products that score higher naturally. To create a representative graph at least hundred different products are needed and ideally these groups consist of as little different types of products as possible, so the grouping of products is based on their exchangeability. If products are grouped in this way, the waterlabel can be used to compare products, an important goal of ecolabeling.

The third sub question was: what form of labeling is most effective? This question was answered by combining literature from ecolabeling theory and the goals and scheme of the waterlabel. The waterlabel was chosen to be a graded label, as was made clear in setting the boundaries. This entails that a government entity is the best organization to control the waterlabel. Further suggestions were made on how important ecolabeling principles could be managed within the waterlabel, like open and easy access to all relevant files of the waterlabel. This include the labeling scheme, but also the scores given to products and how those scores where determined.

By combining these three sub questions, the outline of the waterlabel was created and thus the first research question was answered.

The first sub question of the second research question, fourth in all, was: what existing labels could benefit from including freshwater sustainability and how are these labels organized? To answer this question a list of 44 different ecolabels operating in the Netherlands was compiled. From these ecolabels 93% use a pass/fail design and 5% use a hybrid design. No graded designs were found. The organizations behind the ecolabels were all non-profit and often linked to government. 89% of labels were third party controlled and 9% were first party controlled. Of the schemes, 91% is classified as a class I scheme and 9% as a class II. Most ecolabels have high impartiality and are deemed reliable.

The fifth sub question was: how is freshwater sustainability currently included in labeling schemes? This question was answered by assessing the labeling schemes on whether their mission includes freshwater, in what way freshwater criteria are implemented, how the labeling scheme is formulated, whether freshwater criteria are compulsory and whether the supply chain is part of the freshwater sustainability criteria. In general, it was found that with the exception of seven ecolabels, the majority uses non-quantified standards when describing freshwater sustainability. Half the ecolabels (23 out of 44) have a mission statement that suggests freshwater sustainability, but ten of those have no freshwater sustainability criteria. Compulsory freshwater criteria are found in eight ecolabels, yet only two of those also include some part of the supply chain. In all, freshwater sustainability criteria are lacking in current ecolabels and where they are included they rarely are a prime concern.

The sixth sub question was: how could freshwater sustainability be better included? To answer this question, the five labels from the top two categories from the ranking were assessed more closely. These labels were: the Cradle-to-Cradle label, the European Ecolabel, the Milieukeur field production label, the Milieukeur glass house production and the Rainforest Alliance label. The other ecolabels differ too much from the waterlabel to make a comparison; to better include freshwater these would need to incorporate quantified and compulsory freshwater criteria.

The five labels examined where compared to five key elements of the waterlabel: a wider geographic view, splitting freshwater use in blue-, green- and grey water, including economic sustainability, quantifying the criteria and including the full supply chain. If these key elements where present in the ecolabels, the waterlabel could be included in the scheme. Missing elements are regarded as points on which the ecolabels could improve. None of the ecolabels thus examined included all five elements. Two had a wider view, yet neither green water nor economic water use was ever quantified. All five ecolabels had a quantified scheme and two mentioned the supply chain of which one mentioned the full supply chain. However, this last aspect was mentioned as part of the social criteria and not the freshwater criteria. Also, three of the examined labels were agricultural and it is therefore doubtful whether the supply chain can be included. First steps to include freshwater criteria should be adding an economic aspect and splitting freshwater use in blue-, green- and grey water, as these elements are least invasive. Including a wider geographic area is more invasive and should be the next step towards inclusion of the waterlabel. Last steps should be to include the full supply chain and make the scheme quantified.

In all the principles of freshwater sustainability are rarely included in current ecolabels. By incorporating the key aspects of the waterlabel, these principles will be better included.

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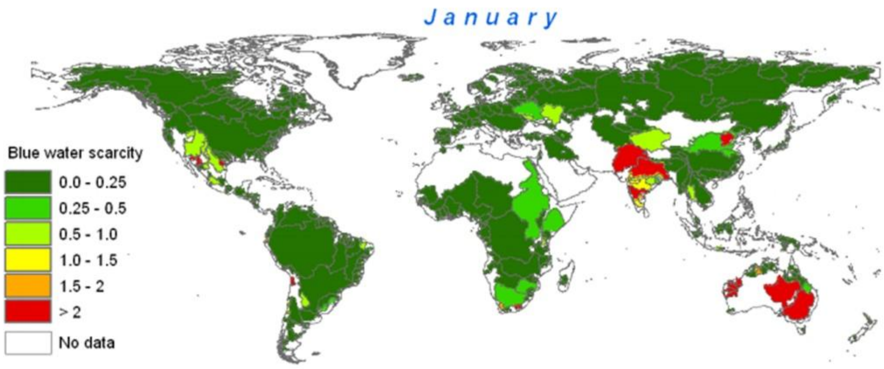
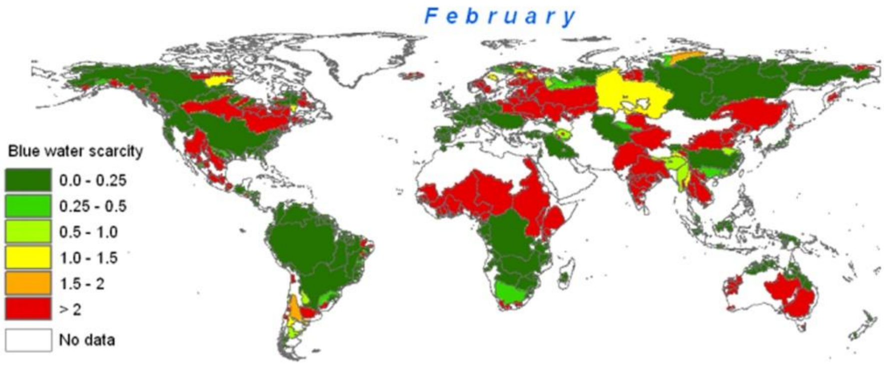
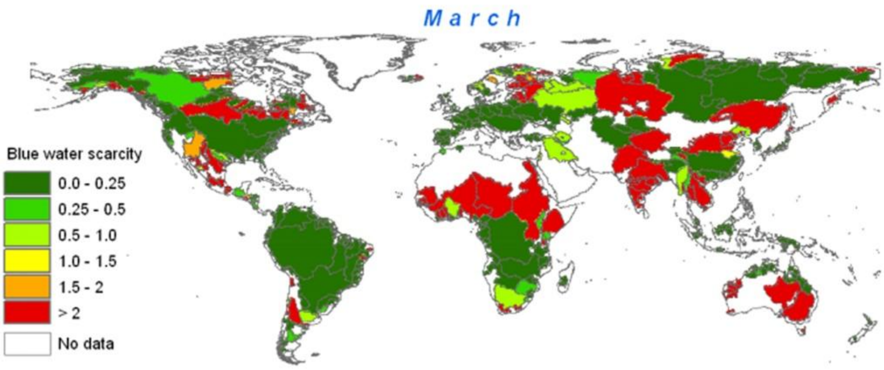
Appendices

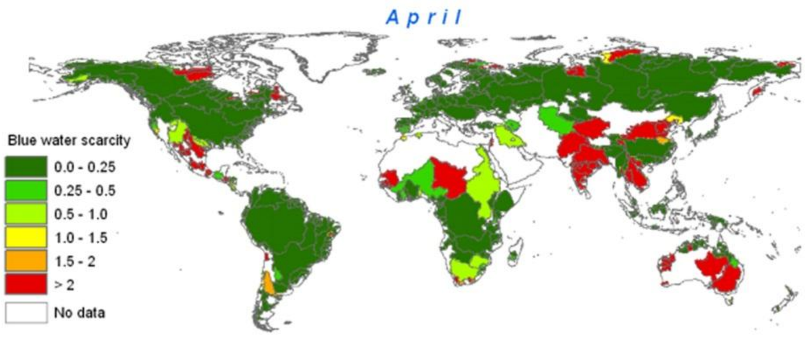
Appendix A: visualization of a blue water hotspot database per month

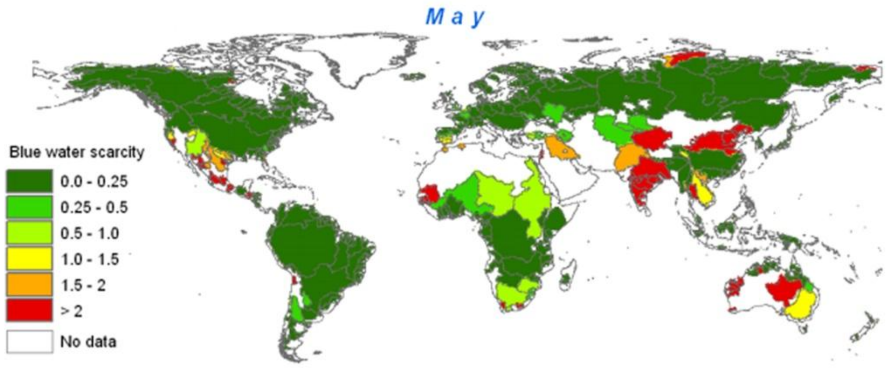
Appendix A presents a graphic representation of a freshwater sustainability hotspot database. The database is shown in Figure 14, which is adopted from the Value of Water no.53 report by Hoekstra and Mekonnen (2011), determining blue water scarcity per month for all major river basins. The proposed waterlabel will use a similar database to link geographic locations and time periods to water scarcity. The waterlabel will however assess water scarcity on a sub basin scale. The database needed will therefore have to be of a higher resolution. The waterlabel will also assess green and grey water scarcity in addition to blue water scarcity. This means that the amount of input information for the database will be bigger. However, Figure 14 gives a good indication of what a freshwater scarcity database could look like and how it can be used to quickly assess if a process at a location is freshwater sustainable or not.

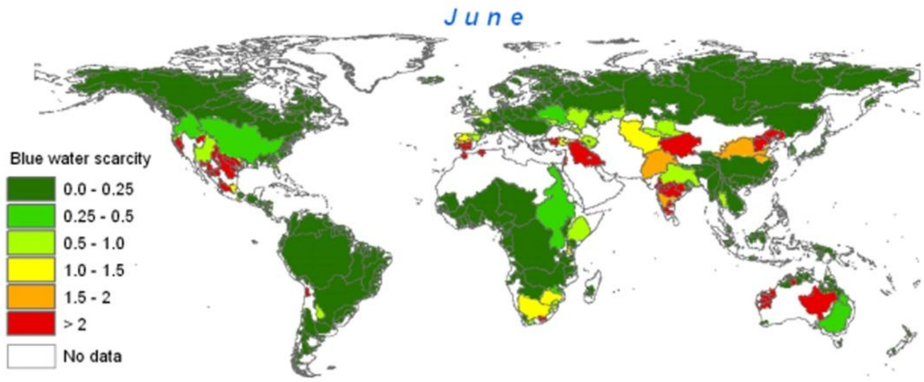

January
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data

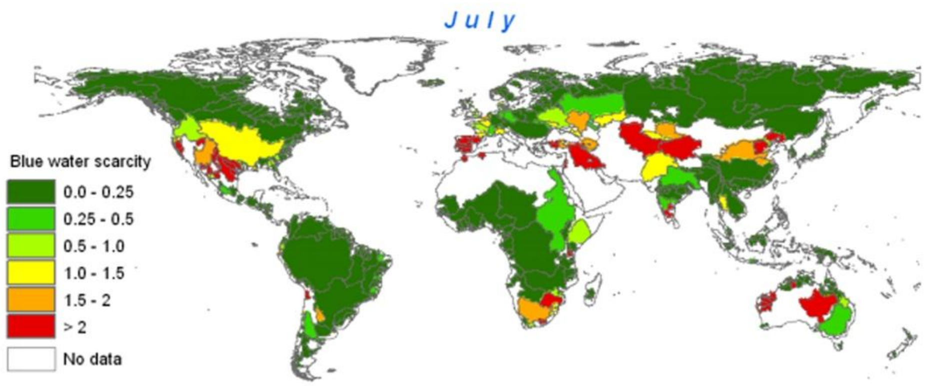

February
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data

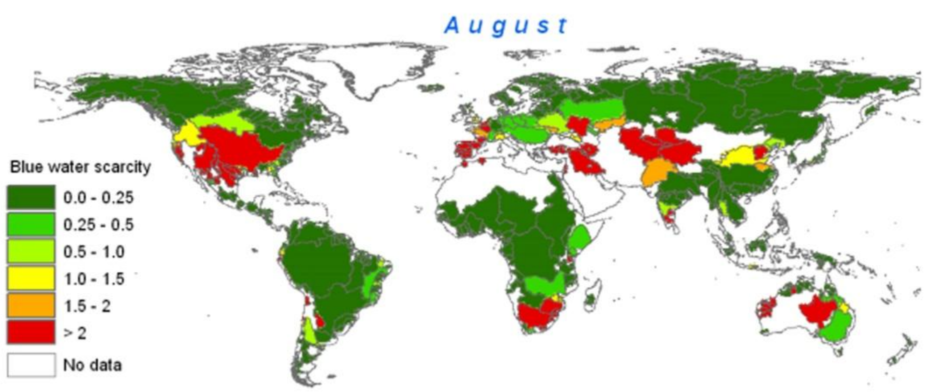

March
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data


April
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data


May
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data


June
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data


July
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data


August
Blue water scarcity
0.0 - 0.25
0.25 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2
> 2
No data

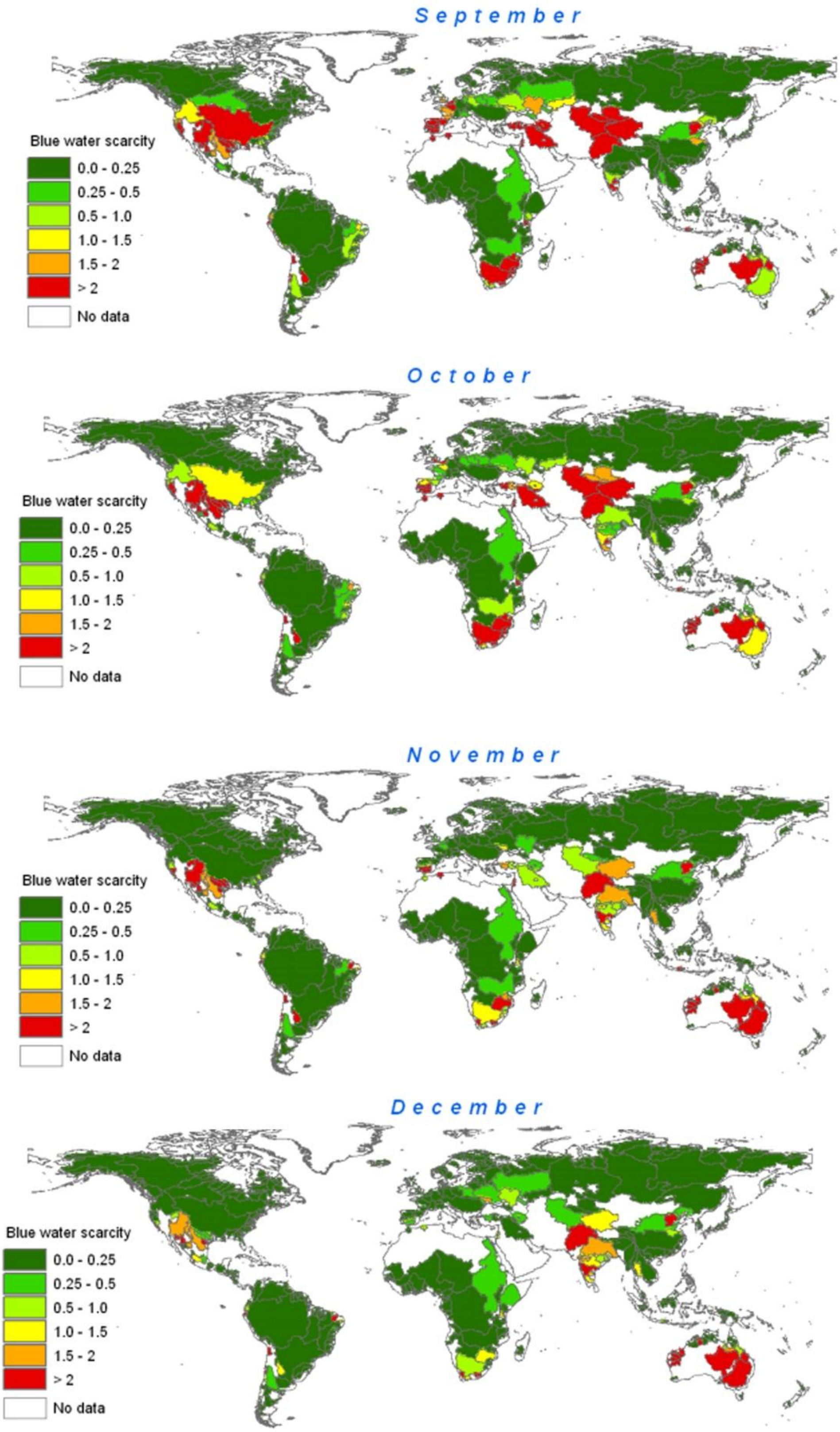


Figure 14: A visual representation of how a hotspot database would operate (Hoekstra and Mekonnen, 2011)

Appendix B: Examples of the waterlabel scheme for ketchup and chicken meat

In appendix B two examples are used to show how the waterlabel scheme operates. These examples are of ketchup and chicken meat. The data used in these examples is readily available data. Where data was available this was used, for instance the growing locations and time of sugar, and when data was not available this was estimated with the available data, for instance the ton*kilometer transport can be estimated using process locations and product weights. In all these examples should show realistic scenarios for how the waterlabel scheme operates.

Example 1: ketchup

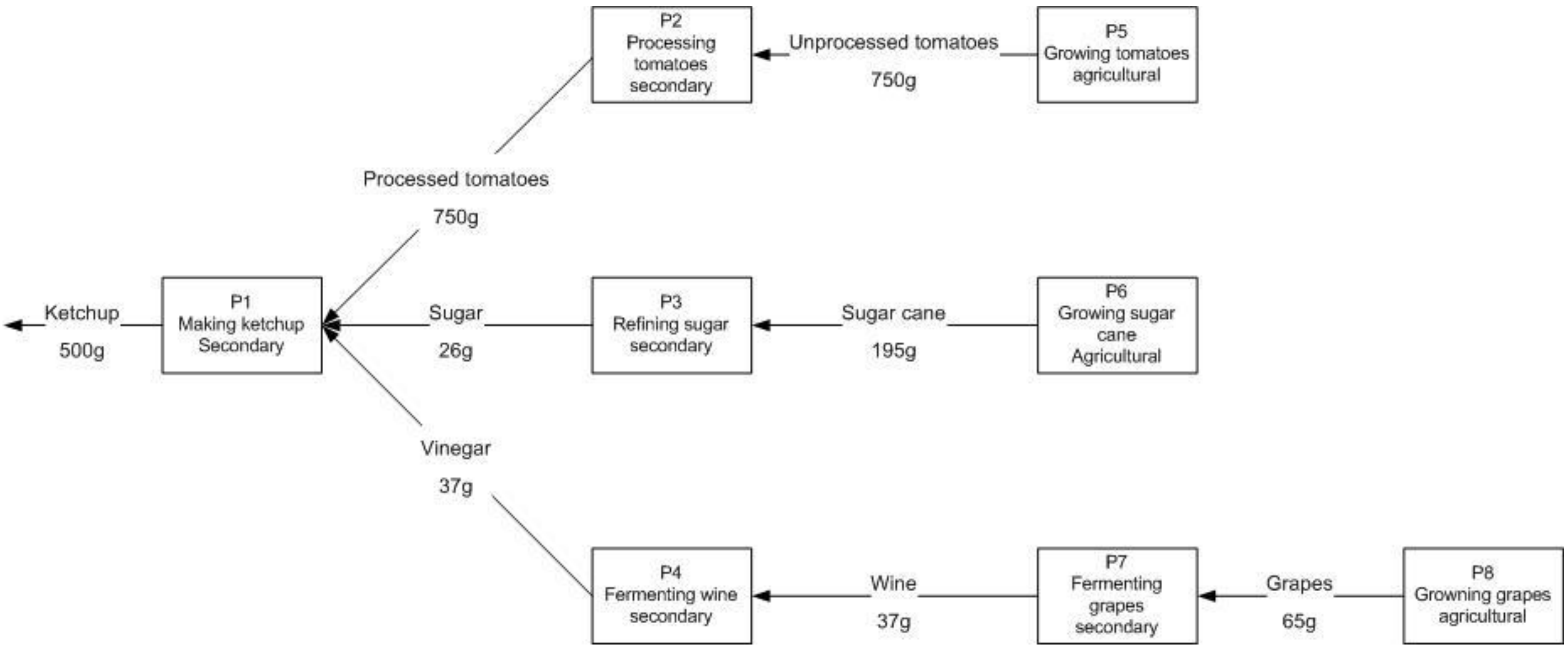


Figure 15: Production chain of ketchup (Heinz, 2015);(uit Pauline's keuken, 2012); (Thangavelu, 2004); (Cornell University, 2011)

In Figure 15 a production chain of a 500 gram ketchup bottle is represented with the most relevant ingredients and their respective amounts of in- and output per process. Using this production chain the freshwater sustainability analysis can be conducted which is given in Table 11:

Table 11: Freshwater sustainability analysis of ketchup (Sources: (Mekonnen and Hoekstra, 2014); (Ercin et al., 2010); (FAO, 2015b); (FAO, 2015a); (Robinson, 2006)

Process #	Type of process	Location	Production period	Production %	WF (l/product)	Type of water used	Is location/time a hotspot?	Is processes WF within benchmark?	Is process sustainable?	Which % is sustainable?
P1 Making Ketchup	secondary	The Netherlands	Jan-Dec	60%	0		Na	Y	Y	
		Germany	Jan-Dec	40%	0		Na	Y	Y	
P2 Processing tomatoes	secondary	Brazil	Jun-Dec	40%	2,0	Grey	Y	N	N	
		Spain	Jul-Dec	15%	0		Na	Y	Y	
		Italy	Jul-Dec	20%	1,0	Grey	N	N	N	
		The Netherlands	Jan-Dec	25%	0		Na	Y	Y	
P3 Refining Sugar	secondary	Brazil	Jan-Dec	60%	0		Na	Y	Y	
		India	Jan-Dec	40%	0		Na	Y	Y	
P4 Fermenting wine	secondary	France	Jan-Dec	50%	0		Na	Y	Y	
		Italy	Jan-Dec	25%	0		Na	Y	Y	
		Spain	Jan-Dec	25%	0		Na	Y	Y	
P5 Growing tomatoes	agricultural	Brazil	Feb-May	40%	45,0	Blue/ green/ grey	Y	Y	N	
		Spain	Mar-Jun	15%	24,7	Blue/ green/ grey	Y	N	N	
		Italy	Mar-Jun	20%	34,5	Blue/ green/ grey	Y	N	N	

Process #	Type of process	Location	Production period	Production %	WF (l/product)	Type of water used	Is location/time a hotspot?	Is processes WF within benchmark?	Is process sustainable?	Which % is sustainable?
		The Netherlands	Jan-Dec	25%	26,3	Blue/ green/ grey	N	Y	Y	12,7%
P6 Growing sugar cane	agricultural	Cuba	Jan-Dec	10%	3,3	Blue/ green/ grey	N	N	N	
		Pakistan	Jan-Dec	10%	2,7	Blue/ green/ grey	Y	N	N	
		Brazil	Jan-Dec	50%	1,3	Blue/ green/ grey	Y	Y	N	
		India	Jan-Dec	30%	1,5	Blue/ green/ grey	N	Y	Y	
P7 Fermenting grapes	secondary	France	Jan-Dec	50%	0		Na	Y	Y	
		Italy	Jan-Dec	25%	0		Na	Y	Y	
		Spain	Jan-Dec	25%	0		Na	Y	Y	
P8 Growing grapes	agricultural	France	Mar-Jul	50%	13,0	Blue/ green/ grey	N	Y	Y	6,3%
		Italy	Mar-Aug	25%	8,0	Blue/ green/ grey	Y	N	N	
		Spain	Mar-Aug	25%	8,3	Blue/ green/ grey	Y	N	N	

Process #	Type of process	Location	Production period	Production %	WF (l/product)	Type of water used	Is location/time a hotspot?	Is processes WF within benchmark?	Is process sustainable?	Which % is sustainable?
	Total transport (ton*km) per product		Mean WF transport (l/tonkm)							
Transport		15,14	2,4		36,3		-	N	N	
Total					207,9					19%

The freshwater sustainability analysis of ketchup shows that this brand of ketchup has 19% of sustainable freshwater use. This can now be compared to other ketchup brands to score this brand and determine which grade of the waterlabel is given to this ketchup brand:

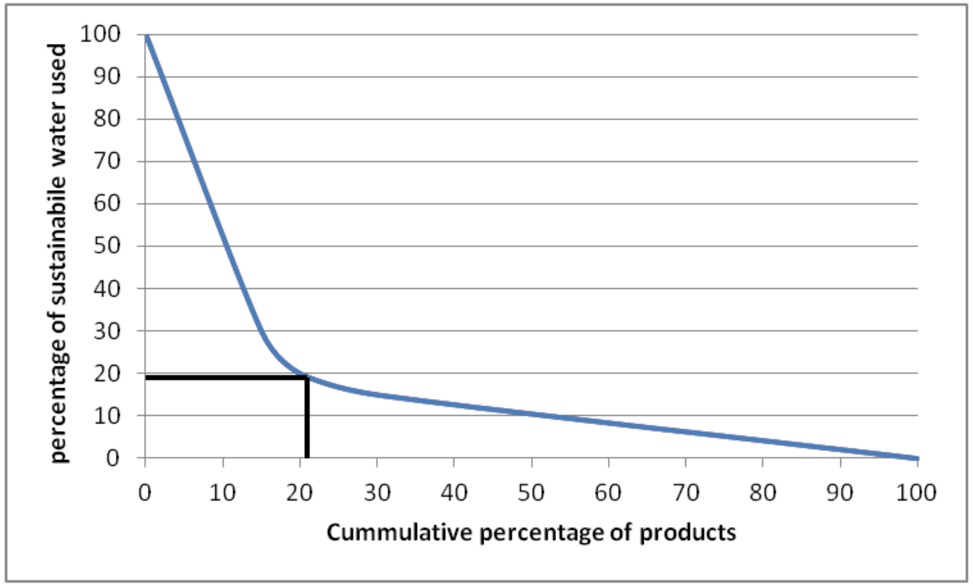


Figure 16: Freshwater sustainability score line for ketchup with the score for this example

Example 1 has a freshwater sustainability score of 19%. In this example that correlates with the best 21st percentile. This means that the grade awarded to this brand of ketchup would be a C.

From example 1 it should be noted that the transport waterfootprint is really high, 17% of the total. This is because the locations used in the example are globally distributed and in case of ketchup, which has a relatively low waterfootprint, this is perhaps not realistic. Ketchup sold in the Netherlands is not likely to originate from Brazil or India, however, this was chosen in the example, because it shows how the setup of the waterlabel works.

Example 2: chicken meat

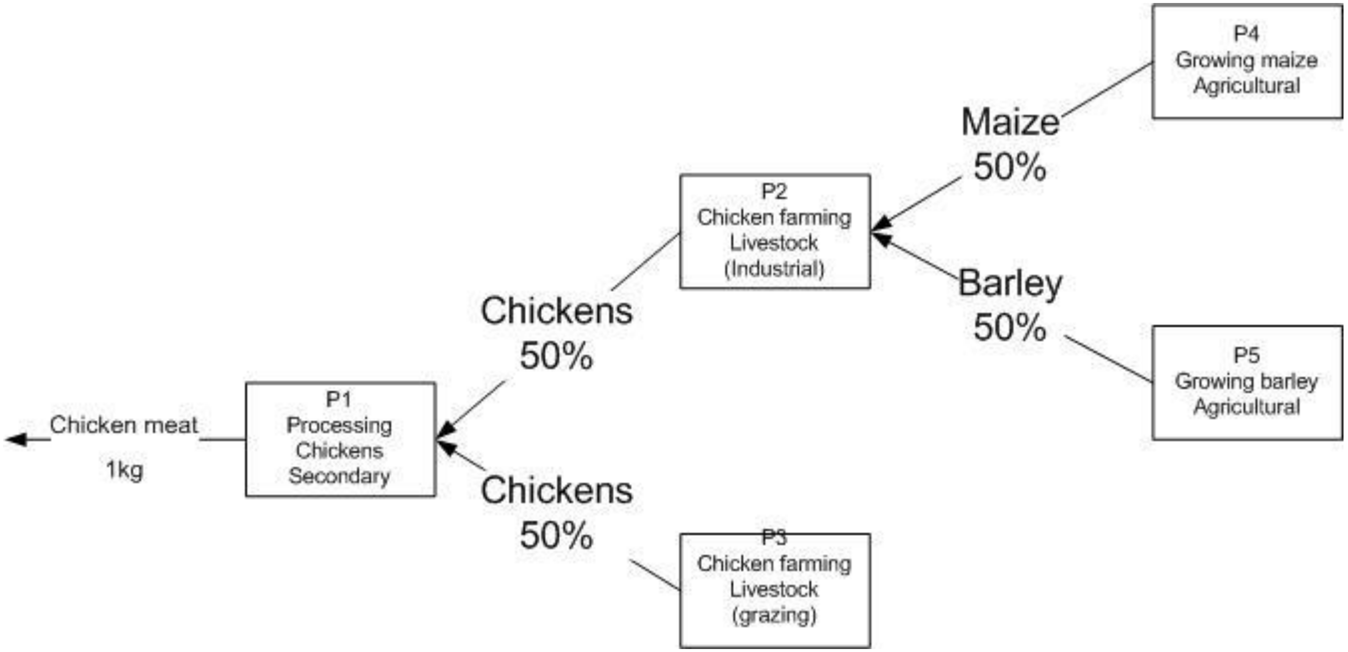


Figure 17: Production chain of chicken meat

In Figure 17 a production chain of 1 kilogram of chicken meat is given. In this example the inputs are given as percentages instead of weights. The calculations however, will be done similarly to example 1. The freshwater sustainability analysis of chicken meat is given in Table 12:

Table 12: Freshwater sustainability analysis of chicken meat (Sources: (Mekonnen and Hoekstra, 2012); Gerbens-Leenes et al., 2013; Mekonnen and Hoekstra, 2014; FAO, 2015a; University of Minnesota, 2013)

Process #	Type of process	Location	Production period	Production %	WF (l/product)	Type of water used	Is location/time a hotspot?	Is processes WF within benchmark?	Is process sustainable?	Which % is sustainable?
P1 Processing Chickens	Secondary	The Netherlands	Jan-Dec	70%	0		Na	Y	Y	
		Belgium	Jan-Dec	30%	0		Na	Y	Y	
P2 Chicken farming	Livestock Industrial	The Netherlands	Jan-Dec	60%	36	Grey	N	Y	Y	0,6%
		Germany	Jan-Dec	40%	24	Grey	N	Y	Y	0,4%
P3 Chicken farming	Livestock grazing	The Netherlands	Jan-Dec	65%	2900	Green/ grey	N	N	N	
		France	Jan-Dec	35%	1600	Green/ grey	N	N	N	
P4 Growing Maize	Agricultural	France	Apr-Jun	80%	620	Blue/ grey	Y	N	N	
		The Netherlands	Apr-Jun	20%	80	Blue/ grey	N	Y	Y	1,3%
P5 Growing Barley	Agricultural	The Netherlands	Apr-Jun	60%	450	Blue/ grey	N	N	N	
		Germany	Apr-Jun	40%	290	Blue/ grey	N	N	N	
	Total transport (ton*km) per product		**Mean WF transport (l/tonkm)**							
Transport		2,1	2,4		5		-	Y	Y	0,1%
total					6005					2,4%

In this example only 2,4 % of the freshwater used for producing chicken meat is sustainable. Compared to other chicken meat products this gives:

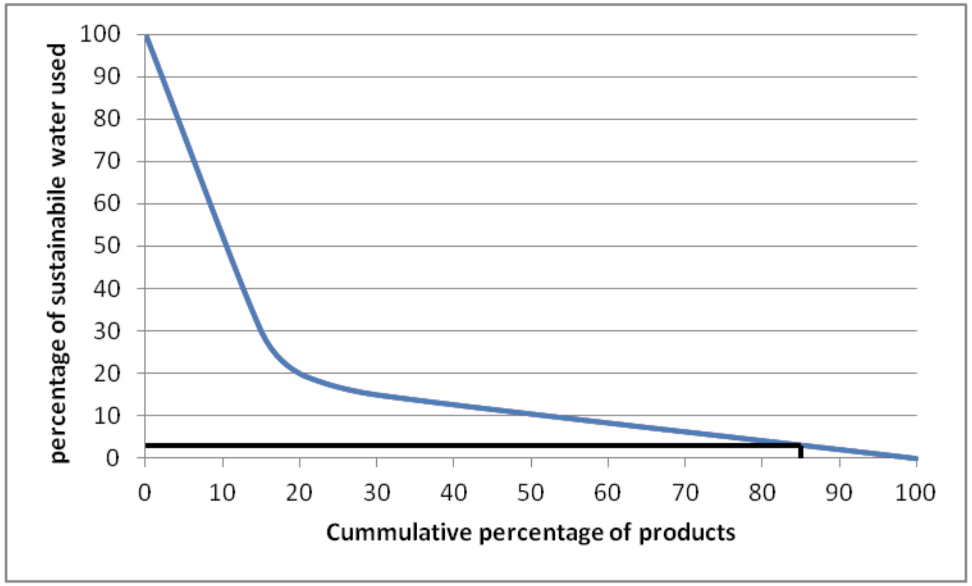


Figure 18: Freshwater sustainability score line for chicken meat with the score for this example

In Figure 18 the score line is given for chicken meat. The score line is such, that even with a very low freshwater sustainability score of 2,4%, still the lowest grade is not reached. In this example, the grade will be I.

Appendix C: all examined labels with their scores

Appendix C gives the results per label examined. The results are split in two: the organizing structure and the freshwater sustainability assessment. In the organizing structure the labeling system, controlling organization, certification party method, accreditation method and classification of the label following (Gallastegui, 2002) are given. In the freshwater sustainability assessment the scores for mission (blue and green/grey), freshwater standards (blue and green/grey), type of labeling scheme, compulsory standards (blue and green/grey), full supply chain (blue and green/grey) and rank of the label are given.

Organizing structure

Labels	Labeling system	Organization	Certification	Accreditation	Classification
Meat					
European Biological Label (Biologisch Europees Keurmerk)	pass/fail	SKAL	3th	Y	I
EKO	pass/fail	EKO-Label foundation	3th	Y	I
Biotrend	Brandname	Lidl	Na	Na	Na
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Bio-Oke	Brandname	Dirk Supermarket	Na	Na	Na
Milieukeur meat	pass/fail	SMK (Milieukeur foundation)	3th	Y	I
Milieukeur meat processing	pass/fail	SMK	3th	Y	I
Demeter	pass/fail	Vereniging voor Biologisch-Dynamische Landbouw (Associaton for Biological-Dynamic Agriculture)	3th	Y	I
Erkend streekproduct (Licensed local product)	pass/fail	Stichting streekeigen producten Nederland (Local products Netherlands foundation)	3th	N	I
Duurzaam Varkensvlees (Sustainable Pigmeat)	pass/fail	Stichting Keten Duurzaam Varkensvlees (Sustainable chain of pigmeat foundation)	3th	N	I
Nieuwe standaard Kip (New chicken norm)	pass/fail	Jumbo supermarket	3th	N	I

Labels	Labeling system	Organization	Certification	Accreditation	Classification
Eggs					
European Biological Label	pass/fail	SKAL	3th	Y	I
EKO	pass/fail	EKO-label foundation	3th	Y	I
Rondeel	Umbrella	Rondeel BV	Na	Na	Na
Milieukeur Eggs	pass/fail	SMK	3th	Y	I
Demeter	pass/fail	Vereniging voor Biologisch-dynamische Landbouw.	3th	Y	I
Biotrend	Brandname	Lidl	Na	Na	Na
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Bio-Oke	Brandname	Dirk Supermarket	Na	Na	Na
Groene hart (Green hart)	pass/fail	Groenehart corporatie (Green hart corporation)	3th	N	I
Gijs	pass/fail	Streekselecties (Local selections)	3th	N	I
Dairy					
European Biological Label	pass/fail	SKAL	3th	Y	I
EKO	pass/fail	EKO-Label foundation	3th	Y	I
Biotrend	Brandname	Lidl	Na	Na	Na
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Bio-Oke	Brandname	Dirk Supermarket	Na	Na	Na
Demeter	pass/fail	Vereniging voor Biologisch-dynamische Landbouw.	3th	Y	I
Ecosocial	pass/fail	Instituto Biodinâmico for Rural Development (IBD)	3th	N	I
Caring dairy	pass/fail	Ben and Jerries	1st (logo)	N	II
CO2 Neutral	pass/fail	Provomel	1st (logo)	N	II
Duurzame weidezuivel (Sustainable free range dairy)	pass/fail	De Zuivelmakers (Dairy makers) and Lebo	1st (logo)	N	II
Fruits and vegetables					
European Biological Label	pass/fail	SKAL	3th	Y	I

Labels	Labeling system	Organization	Certification	Accreditation	Classification
Fruits and vegetables					
EKO	pass/fail	EKO-Label foundation	3th	Y	I
Milieukeur glass house production	pass/fail	SMK	3th	Y	I
Milieukeur field production	pass/fail	SMK	3th	Y	I
Biotrend	Brandname	Lidl	Na	Na	Na
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Bio-Oke	Brandname	Dirk Supermarket	Na	Na	Na
Demeter	pass/fail	Vereniging voor Biologisch-dynamische Landbouw.	3th	Y	I
Nature and more	pass/fail	Eosta	3th	N	I
Responsibly fresh	pass/fail	Verbond van Belgische tuinbouwcooperaties (Alliance of Belgion horticulture cooperations)	2th	N	I
Weet wat je eet (Know what you eat)	pass/fail	FrEsteem, Milieudefensie (Environmental defence), Natuur&Millieu (Nature&Environment)	3th	Y	I
Rainforrest alliance	pass/fail	Sustainable Agriculture Network	3th	Y	I
Fairtrade (Maxhavelaar)	pass/fail	Max Havelaar foundation	3th	Y	I
Fairglobe	Umbrella	Lidl	Na	Na	Na
Fair for life	pass/fail	Bio-foundation	3th	Y	I
Coffee, tea and Cacao					
Rainforrest alliance	pass/fail	Sustainable Agriculture Network	3th	Y	I
UTZ certified	pass/fail	UTZ	3th	Y	I
Fairtrade (Maxhavelaar)	pass/fail	Max Havelaar foundation	3th	Y	I
European Biological Label	pass/fail	SKAL	3th	Y	I
EKO	pass/fail	EKO-Label foundation	3th	Y	I
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Bio equitable	pass/fail	Bio Partenaire	3th	Y	I

Labels	Labeling system	Organization	Certification	Accreditation	Classification
Coffee, tea and Cacao					
Fairglobe	Umbrella	Bio Partenaire	3th	Y	I
Nestle cacao plan	pass/fail	Nestle	1st	N	II
Local Products					
Erkend streekproduct	pass/fail	Stichting Streekeigen Producten Nederland	3th	N	I
Mijn boer (My farmer)	Umbrella	Smeding	Na	Na	Na
Eigen erf (Own premise)	Umbrella	Stichting Biologisch Goed Van Eigen Erf (Biological stuff from own premise foundation)	Na	Na	Na
Groene hart	pass/fail	Groenehart corporatie	3th	N	I
Willem en Drees	pass/fail	Willem en Drees	3th	N	I
Gijs	pass/fail	Streekselecties	3th	N	I
Other foodlabels:					
Greenpalm	Companylogo	Roundtable for Sustainable Palm Oil	3th	Y	I
Hier (Here)	pass/fail	Hier klimaatbureau (Here climatebureau)	3th	N	I
Veldleeuwerik (Skylark)	pass/fail	Stichting veldleeuwerik (Skylark foundation)	3th	Y	I
Clothing					
Organic 100 content	pass/fail	TextileExchange	3th	Y	I
EU ecolabel clothing	pass/fail	EU (controlled by Milieukeur)	3th	Y	I
Demeter	pass/fail	Vereniging voor Biologisch-dynamische Landbouw.	3th	Y	I
Fairtrade (Maxhavelaar)	pass/fail	Max Havelaar foundation	3th	Y	I
Cotton made in Africa	Hybrid	Aid For Trade Foundation	3th	N	I
Global Organic Textile Exchange	pass/fail	The Global Organic Textile Standard International Working Group	3th	Y	I
Made by	pass/fail	Made-By	3th	N	I
Blue sign	pass/fail	Bluesign	3th	N	I
Oekot tex	pass/fail	Oekotex	3th	N	I

Labels	Labeling system	Organization	Certification	Accreditatio n	Classificatio n
Wood					
FSC 100%	pass/fail	FSC	3th	Y	I
FSC mixed	pass/fail	FSC	3th	Y	I
PEFC EU/AM wood	pass/fail	PEFC	3th	Y	I
PEFC Tropical	pass/fail	PEFC	3th	Y	I
KOMO	pass/fail	KOMO	3th	Y	I
Paper					
FSC 100%	pass/fail	FSC	3th	Y	I
FSC Recycled	pass/fail	FSC	3th	Y	I
FSC mixed	pass/fail	FSC	3th	Y	I
PEFC Paper	pass/fail	PEFC	3th	Y	I
PEFC Recycled	pass/fail	PEFC	3th	Y	I
Europees Ecolabel	pass/fail	EU (controlled by Milieukeur)	3th	Y	I
Kringloop	not official	Na	Na	Na	Na
Cradle-to-Cradle	Hybrid	C2C	3th	N	I
chloorvrij gebleekt	not official	Na	Na	Na	Na
Fish					
ASC	pass/fail	ASC	3th	Y	I
MSC	pass/fail	MSC	3th	Y	I
Biologisch Europees Keurmerk	pass/fail	MK	3th	Y	I
Bio+	Brandname	Bio+ brand foundation	Na	Na	Na
Waddengoud	pass/fail	Waddengoud	3th	N	I
Friend of the sea	pass/fail	Friend of the sea	3th	N	I

Freshwater sustainability scores

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Meat										
European Biological Label	N	N	N	N	Q	Na	Na	Na	Na	11
EKO	N	N	nQ	nQ	Q	N	N	N	N	10
Biotrend	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio-Oke	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Milieukeur meat	Y	Y	N	N	Q	Na	Na	Na	Na	4
Milieukeur meat processing	Y	Y	nQ	N	Q	Y	N	N	N	7
Demeter	N	N	N	N	Q	Na	Na	Na	Na	11
Erkend streekproduct	Y	Y	N	N	Q	Na	Na	Na	Na	7
Duurzaam Varkensvlees	N	N	N	N	Q	Na	Na	Na	Na	11
Nieuwe standaard Kip	N	N	N	N	Q	Na	Na	Na	Na	11
Eggs										
European Biological Label	N	N	N	N	Q	Na	Na	Na	Na	11
EKO	N	N	nQ	nQ	Q	N	N	N	N	10
Rondeel	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Milieukeur Eggs	Y	Y	N	N	Q	Na	Na	Na	Na	7
Demeter	N	N	N	N	Q	Na	Na	Na	Na	11

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Eggs										
Biotrend	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio-Oke	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Groene hart	Y	Y	N	N	Q	Na	Na	Na	Na	7
Gijs	N	N	N	N	nQ	Na	Na	Na	Na	12
Dairy										
European Biological Label	N	N	N	N	Q	Na	Na	Na	Na	11
EKO	N	N	nQ	nQ	Q	N	N	N	N	10
Biotrend	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio-Oke	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Demeter	N	N	N	N	Q	Na	Na	Na	Na	11
Ecosocial	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Caring dairy	Y	Y	nQ	nQ	nQ	N	N	N	N	6
CO2 Neutral	N	N	N	N	nQ	Na	Na	Na	Na	12
Duurzame weidezuivel	Y	Y	N	nQ	nQ	Na	N	Na	N	6
Fruits and vegetables										
European Biological label	N	N	N	N	Q	Na	Na	Na	Na	11
EKO	N	N	nQ	nQ	Q	N	N	N	N	10
Milieukeur glass house production	Y	Y	Q	Q	Q	Y	Y	N	N	2

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Fruits and vegetables										
Milieukeur field production	Y	Y	Q	Q	Q	Y	Y	N	N	2
Biotrend	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio-Oke	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Demeter	N	N	N	N	Q	Na	Na	Na	Na	11
Nature and more	Y	Y	Q	Q	nQ	N	N	N	N	6
Responsibly fresh	Y	Y	N	N	nQ	Na	Na	Na	Na	8
Weet wat je eet	N	N	N	N	Q	Na	Na	Na	Na	11
Rainforrest alliance	Y	Y	Q	Q	Q	N	Y	N	N	2
Fairtrade (Maxhavelaar)	N	N	nQ	nQ	Q	N	N	N	N	10
Fairglobe	Na	Na	Na	Na	nQ	Na	Na	Na	Na	
Fair for life	N	N	N	N	nQ	Na	Na	Na	Na	12
Coffee, tea and Cacao										
Rainforrest alliance	Y	Y	Q	Q	Q	N	Y	N	N	2
UTZ certified	N	N	nQ	nQ	Q	Y	Y	N	N	9
Fairtrade (Maxhavelaar)	N	N	nQ	nQ	Q	N	N	N	N	10
European Biological Label	N	N	N	N	Q	Na	Na	Na	Na	11

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Coffee, tea and Cacao										
EKO	N	N	nQ	nQ	Q	N	N	N	N	10
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Bio equitable	Y	Y	nQ	nQ	nQ	N	N	N	N	6
Fairglobe	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Nestle cacao plan	N	N	N	N	nQ	Na	Na	Na	Na	12
Local Products										
Erkend streekproduct	Y	Y	N	N	Q	Na	Na	Na	Na	7
Mijn boer	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Eigen erf	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Groene hart	Y	Y	N	N	Q	Na	Na	Na	Na	7
Willem en Drees	Y	Y	N	N	nQ	Na	Na	Na	Na	8
Gijs	N	N	N	N	nQ	Na	Na	Na	Na	12
Other foodlabels:										
Greenpalm	Y	Y	Q	Q	Q	N	N	N	N	3
Hier	N	N	N	N	nQ	Na	Na	Na	Na	12
Veldleeuwerik	Y	Y	N	N	nQ	Na	Na	Na	Na	8
Clothing										
Organic 100 content	N	N	N	N	Q	Na	Na	Na	Na	11
EU ecolabel clothing	Y	Y	N	Q	Q	Na	Y	Na	Y	1

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Clothing										
Demeter	N	N	N	N	Q	Na	Na	Na	Na	11
Fairtrade (Maxhavelaar)	N	N	nQ	nQ	Q	N	N	N	N	10
Cotton made in Africa	Y	Y	nQ	nQ	Q	N	N	N	N	5
Global Organic Textile Exchange	N	N	N	N	Q	Na	Na	Na	Na	11
Made by	Y	Y	N	N	nQ	N	N	N	N	8
Blue sign	Y	Y	nQ	nQ	nQ	N	N	N	N	6
Oekot tex	N	N	N	N	nQ	Na	Na	Na	Na	12
Wood										
FSC 100%	Y	Y	N	N	Q	Na	Na	Na	Na	7
FSC mixed	Y	Y	N	N	Q	Na	Na	Na	Na	7
PEFC EU/AM wood	N	N	N	N	Q	Na	Na	Na	Na	11
PEFC Tropical	N	N	N	N	Q	Na	Na	Na	Na	11
KOMO	N	N	N	N	Q	Na	Na	Na	Na	11
Paper										
FSC 100%	Y	Y	N	N	Q	Na	Na	Na	Na	7
FSC Recycled	Y	Y	N	N	Q	Na	Na	Na	Na	7
FSC mixed	Y	Y	N	N	Q	Na	Na	Na	Na	7
PEFC Paper	N	N	N	N	Q	Na	Na	Na	Na	11
PEFC Recycled	N	N	N	N	Q	Na	Na	Na	Na	11
Europees Ecolabel	Y	Y	N	Q	Q	Na	Y	Na	Y	1

Labels	Mission (Blue/Green)	Mission (Grey)	Water criteria included (Blue/green)	Water criteria included (grey)	Labeling scheme	Compulsory (Blue/Green)	Complusory (Grey)	Full cycle (Blue/Green)	Full Cycle (Grey)	Rank
Paper										
Kringloop	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Cradle-to-Cradle	Y	Y	Q	Q	Q	Y	Y	Y	Y	1
chloorvrij gebleekt	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Fish										
ASC	N	N	N	N	Q	Na	Na	Na	Na	11
MSC	N	N	N	N	Q	Na	Na	Na	Na	11
Biologisch Europees Keurmerk	N	N	N	N	Q	Na	Na	Na	Na	11
Bio+	Na	Na	Na	Na	Na	Na	Na	Na	Na	
Waddengoud	N	N	N	N	Q	Na	Na	Na	Na	11
Friend of the sea	N	N	N	N	nQ	Na	Na	Na	Na	12