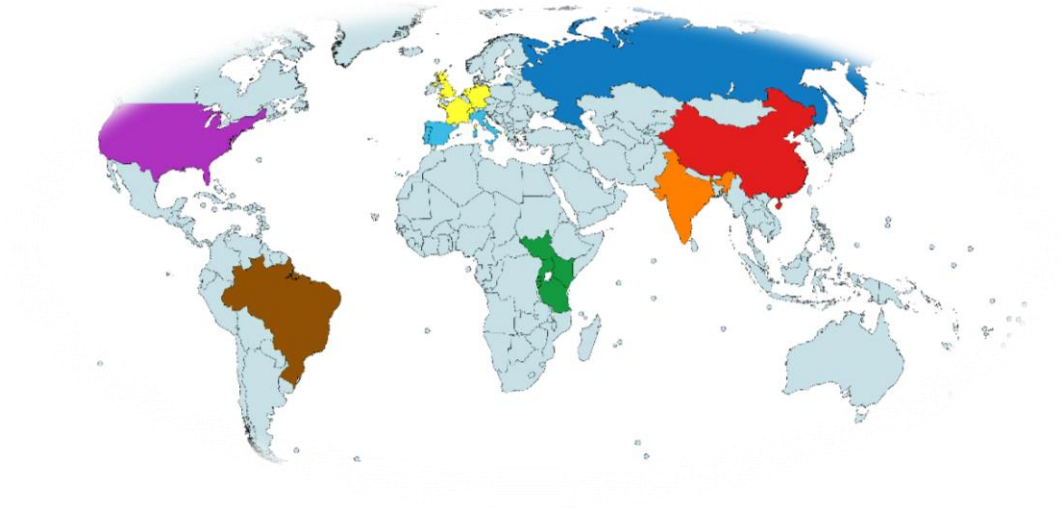
Negotiation of an international agreement on water footprint reduction

Development and application of a Negotiation Game



MASTER THESIS

Contribution to the European Commission Project "Moving Towards Adaptive Governance in Complexity: Informing Nexus Security" (MAGIC), EU-H2020 Grant Proposal No. 689669

B.A. (Bas) Leijser

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UNIVERSITY OF TWENTE.

MAGIC NEXUS

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PREFACE

The basis for this research originally stemmed from my interest in the environmental impact of various diets. In the summer before my first year of the BSc of Civil Engineering, I started researching this topic and found several scientific contributions from Hoekstra (Arjen). However, it was not until I took the course 'Water Footprint Assessment', given by Arjen in the first year of my MSc, when I realised that this is what I wanted to explore further in my Master thesis.

In my second year, I jumped at the opportunity when I saw the topic of this thesis in the list of possible MSc assignments. It was exactly the kind of research that I was interested in: combining multiple disciplines (e.g. economic, political, and negotiation theory) and using conceptual-based thinking.

While working on this research, I certainly faced a challenge, since I combined it with working for the Water Footprint Network (a non-profit foundation at the University of Twente), being a student assistant for the BSc-course 'Water Management', having a biweekly column for U-Today, and working on a construction project for Mobilis TBI.

I could not have achieved combining these various tasks without the strong support I received from various people. First of all, my parents, sister, and dog; who supported me with their love and understanding (for the dog I am not sure if the latter applies). Secondly, my two supervisors, Joep Schyns and Arjen Hoekstra. I remember telling Joep that I felt positively surprised by the large amount of feedback and help I received from them, and the commitment I felt they shared with my research. This was not only a tremendous help but also a great motivator.

Thirdly, I would like to thank my friends, colleagues, various teachers and professors at the University of Twente, and anyone I may have forgotten. Thank you all for your unwavering support.

B.A. (Bas) Leijser
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This Master thesis has been written as a contribution to the European Commission Project "Moving Towards Adaptive Governance in Complexity: Informing Nexus Security" (MAGIC), EU-H2020 Grant Proposal No. 689669.

ABSTRACT

Given the rising water footprint of humanity due to population growth, dietary changes, and increased use of biofuels; there is a need for an international agreement on water footprint quotas per country. Such an agreement could be similar in scope and effect to the Paris and Kyoto climate agreements. This agreement could include objectives, principles, targets, and regulation schemes aimed at achieving a global reduction of the water footprint of national consumption.

The goal of this thesis is to determine how international consensus can be reached on sustainable and equitable water footprint quotas per country. In order to reach such a consensus, negotiations have to take place. Relevant questions will be which countries will take part in these negotiations and what their narratives will be. A 'narrative' is defined here as the rationale of a country, including the perception of the problems and possible solutions. A narrative creates the perspective from which a country forms an opinion and makes decisions.

In order to assess the feasibility of such an agreement, explore the possible narratives by countries and study the dynamics in the negotiation process, a serious game was developed. In this 'Negotiation Game', eight players assemble at a negotiation table, where everyone takes up the role of a negotiator who acts on behalf of a country or a group of countries. These countries have been pre-selected based on a Power-Interest analysis. The goal of the Negotiation Game is to arrive at a final agreement that consists of four articles, namely: objectives, principles, targets, and regulation. Players are encouraged to determine their own position based on some underlying data that are provided.

During the negotiations, players express their own narrative, question the narrative of others, and strive to find common ground. If multiple players arrive at a similar line of reasoning and a comparable stake, we identify this as a shared narrative. Shared narratives may show potential for the direction that actual negotiations in practice might follow, and thus inform us how potential future international negotiations on water footprint reduction may evolve.

After determining the country selection, relevant indicators, and structure of the Negotiation Game, it was tested in practice with a group of professors, post-docs, and PhD and master students from the University of Twente. This experiment was recorded, and the resulting transcript was analysed. After an initial verbal communication analysis and a resulting analysis of characteristics of the narratives, the narrative of each country could be assessed. Combined with the quantitative results from this

game, it is concluded that there is potential for an international water footprint reduction agreement, with the United States, Europe, Africa and India as the key players.

Shared narratives were observed between North-western Europe, Southern Europe, and the United States on the one hand; and Russia, India, and China on the other. The first were supportive of an agreement and a global reduction, while the latter were opposed. However, during the negotiations, the position of both India and China shifted towards being more supportive of at least stabilizing their water footprint (with respect to expected population rise). It seems, therefore, that the main initiative for the negotiations should come from Europe or the United States, and that China and India are the bystanders that should be convinced to become supporters. Nevertheless, it would be recommended to test the Negotiation Game several times more to draw any definitive conclusions.

Table of contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Short	*Long*
GHG	Green House Gases
INDC	Intended Nationally Determined Contribution
MAGIC	Moving towards Adaptive Governance In Complexity: informing nexus security
OECD	Organisation for Economic Co-operation and Development
SDG	Sustainable Development Goal
UNFCCC	United Nations Framework Convention on Climate Change
WF	Water Footprint
WS	Water Scarcity
Ya	Average yield
Yg	Yield Gap
Yp	Potential yield
Yw	Water-limited potential yield

1. INTRODUCTION

Water demand around the world is increasing due to dietary shifts, population growth, and continued urbanisation and globalisation (Liu, et al., 2017) (Hoekstra & Chapagain, 2008). This increases the pressure on our water resources, leading to rapidly rising blue water scarcity.

Falkenmark (1997) analysed the combined effect of these two aspects in her blue water scarcity matrix (Falkenmark, 1997), see Appendix I. Continuing with this matrix, Kummu et al. (2016) found that – since the 1900s – the amount of people experiencing water scarcity has increased by a factor of sixteen, while the annual blue water consumption per capita only increased by approximately 10% (as a global average). One of the main causes of this increased water scarcity, is the population rise from around 1.6 billion in 1900 to 6.1 billion in 2000 (Kummu, et al., 2016). On a global level, blue water scarcity is a major problem in each continent, as seen in Figure 1. In the 2000s, 17% of the global population was experiencing both high water shortage and high water stress, and around 50% was subjected to either moderate water shortage or moderate water stress.

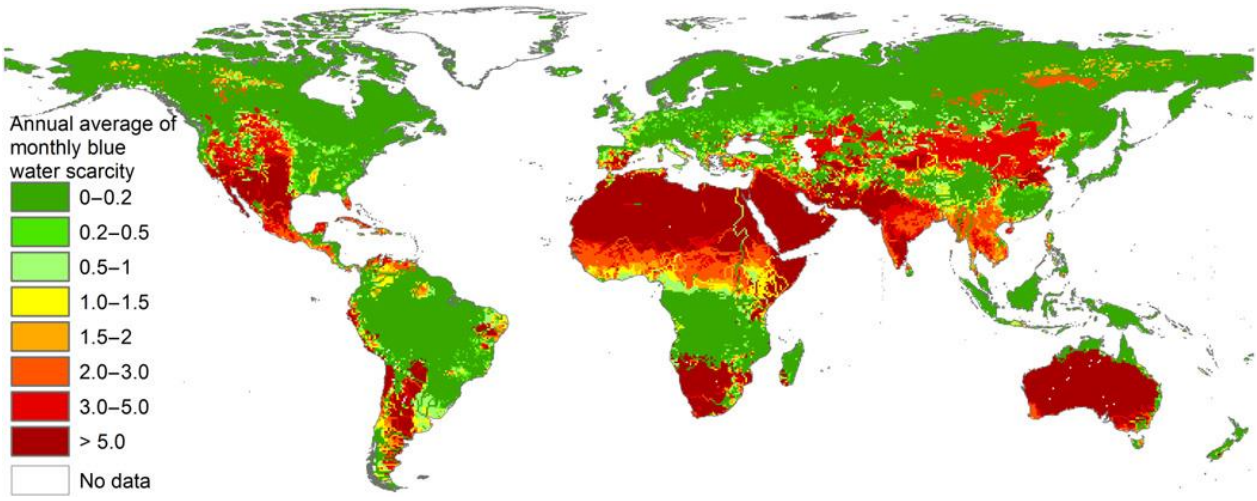


Figure 1: Annual average monthly blue water scarcity, based on measurements between 1996 and 2005 (Mekonnen & Hoekstra, 2016)

Another aspect that plays a significant role in causing water issues are dietary shifts, most notably those in developing Asia. This has also been called the 'Westernisation of Asian Diets', with its shift away from rice and towards increased consumption of wheat-based products, high protein diets, and convenience food and beverages. This shift is caused by both income growth as well as Western influence and global integration (Pingali, 2007). If we look at the changes in the 20th century in Taiwan for example, we see a decrease of annual rice consumption per capita of 45 kilograms between 1940

and 1992, while the meat and wheat consumption increased by 55 and 29 kilograms respectively (Huang & Bouis, 2001).

Prospects for the future show that this trend will likely continue: the per capita consumption of poultry in China for instance is expected to increase from 1.9 to 13.8 kilograms between 2016 and 2026, with a relatively smaller increase for beef from 2.5 to 4.7 kilograms in the same time period (OECD-FAO, 2017). Similar trends are observed elsewhere, for example in India the meat consumption has doubled in the past decade and, similar to Taiwan, the poultry industry in particular has grown rapidly (Hellin et al., 2015). If we link these prospects to the known data of the water footprints of various diets (Vanham, Mekonnen, & Hoekstra, 2013), it becomes apparent that both the internal and external demand of water resources are expected to increase considerably in these countries.

Problem definition

So, the problems are clear: there is increased water scarcity due to population growth, changing consumption patterns, globalisation, and urbanisation. Another way to quantify these water problems, is by using the water footprint concept[1], where it can be stated that the global water footprint of humanity has been increasing and will continue to do so [10]. Ercin and Hoekstra (2014) predicted a 175% increase for the global water footprint of production in 2050, relative to the year 2000, assuming a scenario with a Western 'high meat' diet and a UN medium-fertility population prediction. This raises the question: how do we mitigate these changes – or, in other words, how do we stabilise our current water footprint? We can also take this one step further and ask ourselves: could we also *decrease* the global water footprint?

The main challenge to tackle this problem, is that water is not part of the global agenda and is instead often treated as a regional or local problem (Biswas, 2019) (Gurria, 2017) (Hoekstra & Chapagain, 2008). Policymakers and ministers of economy often underestimate its importance (Biswas, 2019). Yet, there was one major success: the topic of 'water' was included in the Sustainable Development Goals in 2015 (About the Sustainable Development Goals, 2019). In the corresponding synthesis report, there is even mention of the concept of the water footprint (United Nations, 2018, p. 137) and several of the problems that were mentioned before. However, despite being announced as one of the SDG's, the topic of water did not appear in the Paris Agreement three months later (Gurria, 2017, p. 3), and it was also missing in other international agreements such as the Kyoto Protocol of 1992 (United Nations, 1998).

[1] This thesis assumes the reader has basic knowledge of the water footprint concept. If this is not the case, then please refer to Appendix II where a brief explanation is provided.

Thesis goal & narratives

The goal of this thesis is to study how international negotiations for more sustainable and equitable water footprints of national consumption could take place, using a serious game as a method.

It is assumed that countries may have different narratives that guide them in the negotiations, but also that narratives may change during the negotiations. A narrative here is defined as the rationale of a country or group of countries that is taking part in the negotiations, or in other words the perspective from which a country forms an opinion and makes decisions. This narrative can change before, during, or after the negotiations have taken place. Determining these narratives will be done through testing the serious game, henceforth called 'Negotiation Game'. It should be noted that nuanced versions of these shared narratives – e.g. a partially supportive shared narrative – may exist.

What is 'sustainable' and 'equitable' is not predetermined but part of how players perceive that. Players will have to discuss and negotiate on what level they think their water footprints are sustainable and equitable, possibly considering the time dimension and differences between countries. Players could aim for a single convergence point for all nations, a convergence point for groups of nations, or a target level per country based on certain characteristics.

Research gap

The research gap is found in understanding the complexity of the water footprint negotiations were they to happen, as well as achieving an understanding of this complexity through a model. Here, the choice was made to use a serious game, since it can be used to simulate the negotiation process and it leaves the unpredictability of human behaviour open to the players. While various serious games already exist that deal with water use and international water allocation (Hoekstra A. Y., 2012) (Aubert, Bauer, & Lienert, 2018), such as the 'Globalization of water role play', these are not specifically aimed at a hypothetical international agreement on water footprint reduction or international negotiations. Secondly, the research gap is found in the determination of what constitutes as a 'sustainable' level for the water footprint.

Research questions

The general research question is defined as follows:

> *"How can international consensus be reached on quotas towards sustainable and equitable water footprints of national consumption?"*

Subsequently, the following sub research questions are distinguished:

- ☑ **Rq.1** "How can the negotiations for an international agreement on water footprint reduction be simulated through a serious game?"

- ☑ **Rq.2** "What would be the narratives of the various parties taking part in these negotiations, and how do these narratives change during the negotiations?"
- ☑ **Rq.3** **"**What are the shared narratives of the various parties taking part in these negotiations, and how can this be linked to the feasibility of reaching consensus?

Method

I will develop a Negotiation Game that serves as a model of the negotiations in practice. The goal of this game is to obtain the required quantitative and observational (e.g. through a recording) data that can be used to answer research question 2 and 3, as well as the general research question. The next chapter 'Method' describes how this data will be obtained and filtered.

Structure of the thesis

This thesis is structured as follows: the Negotiation Game takes up the core of the Method and Results chapters. It is divided into two parts: the design of the game itself and the (analysis of) negotiation process of the game. E.g. the Method describes how and why to do the stakeholder selection, while the Results describe which stakeholders were selected using this method. The results also include observational and quantitative results from testing the game with a short discussion.

The Discussion chapter is where the validity of the game is put into question, plus several future recommendations are made. The Conclusion chapter is where the general research question is answered. For a visual representation of the thesis structure, see Figure 2 on the next page.

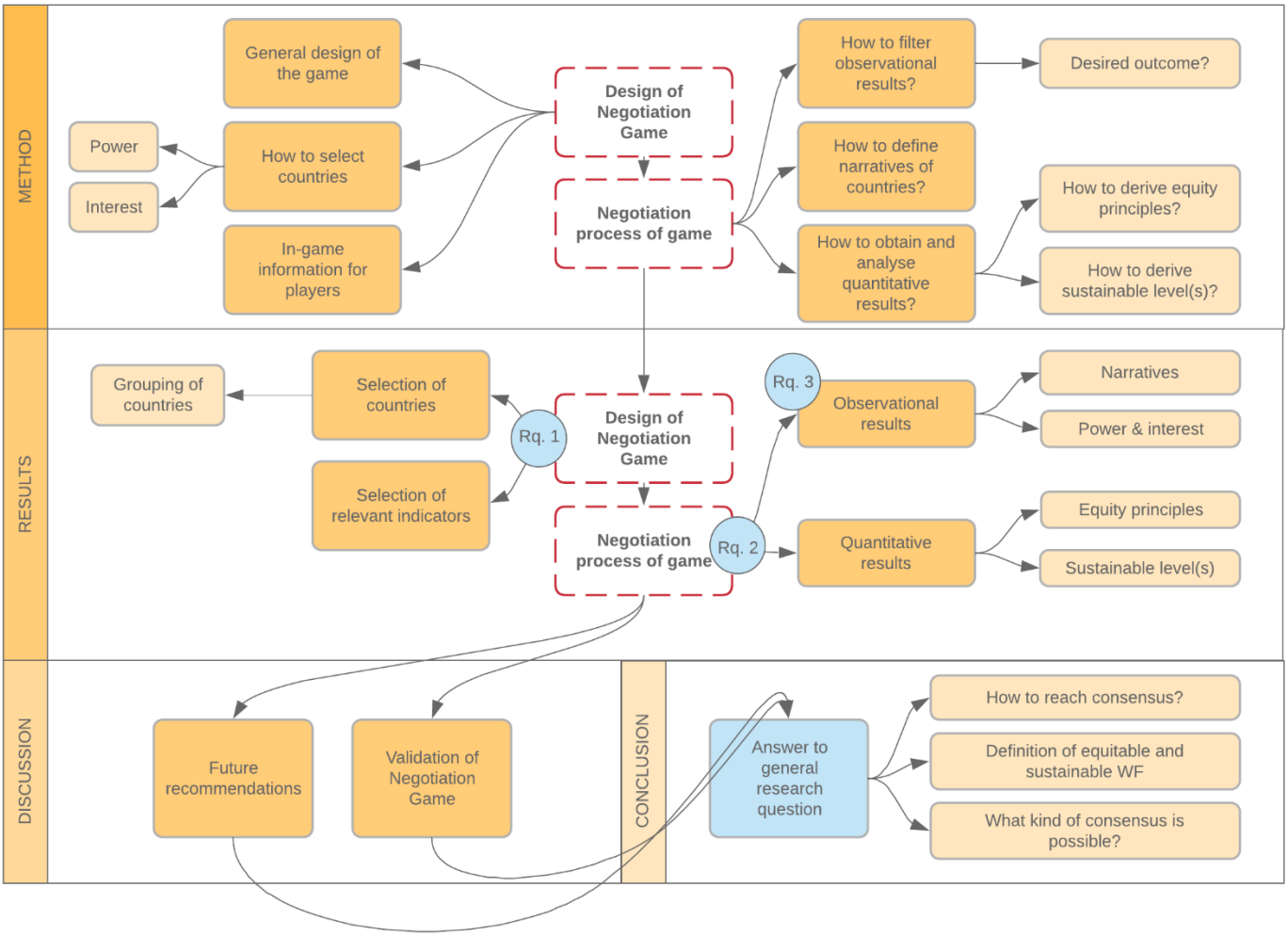


Figure 2: Schematization of the structure of this thesis. Research questions (blue circles) overlap the subchapters that are relevant to answer them.

2. METHOD

In this Method chapter, the design of the Negotiation Game and its negotiation process are described. Essentially, this chapter illustrates the filter that was used on available data and literature in order to create a model – in this case, the Negotiation Game – that mimics the hypothetical negotiations in practice as closely as possible. Additionally, this chapter describes how the results from testing the game will be filtered to derive meaningful conclusions. An overview of the Method chapter is shown in Figure 3.

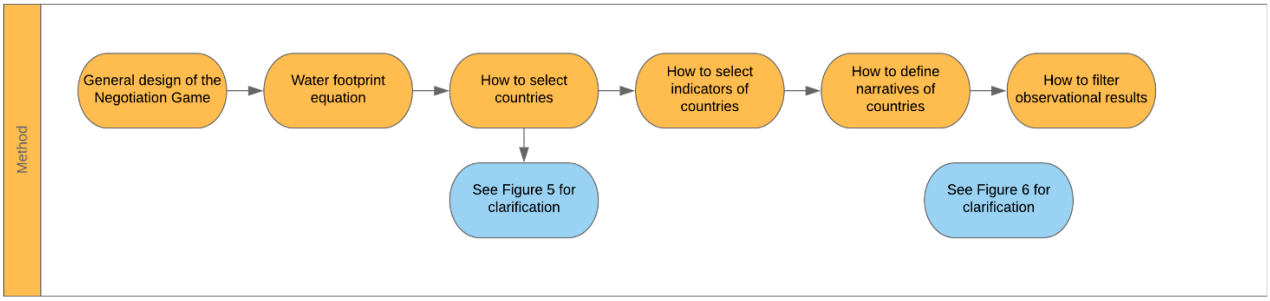


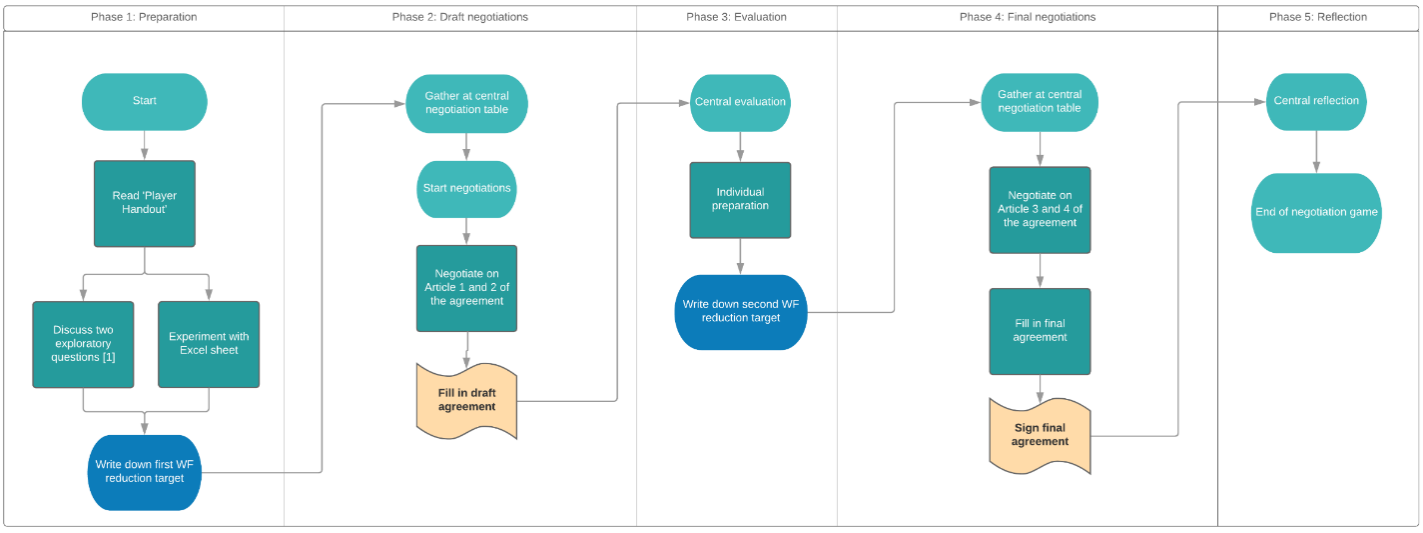
Figure 3: Overview of the Method chapter

2.1. Design of the Negotiation Game

This subchapter explores the process of how the Negotiation Game was designed.

2.1.1. General design of the Negotiation Game

The flow chart of the Negotiation Game is shown in Figure 4.



[1] *1 – Why should we reduce our water footprint?*
2 – How can we reduce our water footprint?

Figure 4: Flow chart of the Negotiation Game

The Negotiation Game consists of five phases and two central negotiation rounds. The phases and their main goals are, in order:

- ☑ Phase 1 Preparation – players are assigned a country and receive instructions, they then write down a (hidden) water footprint reduction target for their own country.
- ☑ Phase 2 Draft Negotiations – players negotiate on Article 1 and 2 (see Appendix IV) of the international agreement on water footprint reduction, namely: the goals and the principles that they can agree on.
- ☑ Phase 3 Evaluation – players receive preliminary results, feedback on their agreement, and are informed of various equity allocation approaches. Finally, they are asked to write down a second (hidden) reduction target for their specific country.
- ☑ Phase 4 Final negotiations – players negotiate on Article 3 and 4 (see Appendix IV) of the international agreement of water footprint reduction, namely: the targets and regulation that they can agree on. The specifics are up to the players, e.g. these could be differentiated or uniform targets.
- ☑ Phase 5 Reflection – players receive final results in a graph showing the water footprint progression up until 2100 using the final agreement and their two (previously hidden) written down reduction targets. Players also receive feedback on the final agreement.

The agreement from Appendix IV was based on the Paris Agreement (Paris Agreement, 2019). The Paris Agreement has 29 articles that were simplified to the four articles as mentioned before. The choice was made to split up the negotiations of these four articles into two parts. This was done for three reasons: one, to allow for a more structured approach of the Negotiation Game, two, to allow for an evaluation phase midway during the negotiations, and three, to more accurately simulate the spread of negotiations as they happen in real-life. For example, the negotiations for the Paris Agreement took place over the course of thirteen days, and were partly based on previous climate negotiations such as the Kyoto Protocol of 1997.

For the Paris Agreement, countries were asked to publish Intended Nationally Determined Contributes (INDCs) before the start of the United Nations Climate Change Conference in France (Nationally Determined Contributions, 2019). This is reflected in the Negotiation Game through the hidden reduction target that each player has to write down at the end of Phase 1. This is repeated in Phase 3 purely for comparative analysis.

For the general design of the Negotiation Game, it was also compared to other serious games. Various simulation games and role plays already exist in the field of water management and hydrology (Hoekstra A. Y., 2012), however none are aimed at international negotiations or an international

agreement on water footprint reduction. The choice of a simulated 'live negotiation' with active participants seems obvious compared to a computer-only alternative, especially considering the human factors that influence negotiations and the complexity of international climate negotiations in general (Van der Gaast, 2017) (Sprinz, et al., 2016). Partially, the design of the Negotiation Game used the 'Role Play on Globalization of Water Management' as inspiration (Globalization of Water Role Play - Player Handout, 2019). This is evident mostly by the fact that the Negotiation Game uses Player Handouts in a similar way and also has indicators for each country that the player can make alter during the course of the game.

General water footprint equation

A general equation is used to combine the various indicators for each country (see Chapter 2.2.1 and Chapter 3.1.3) and calculate their effect on the total water footprint of national consumption (in $m^3/cap/yr$) for a specific country. The equation is shown below:

$$WF_{new} = \left[\left((1 - rp_{total}) * int_{ratio} * WF_0 * \frac{1}{rp_{ygap}}\right) + \left((1 - int_{ratio}) * WF_0\right)\right] * \left(1 - \left(rc_{total} + r_{foodwaste}\right)\right)$$

Essentially, this is the ratio of the external water footprint to the total water footprint

With:

rp_{total}: total water footprint reduction from the production changes, as a fraction (e.g. 0.20 = 20% reduction)

int_{ratio}: ratio internal to total water footprint, as a fraction (e.g. 0.80, meaning 80%)

WF_0: baseline water footprint of national consumption, as an absolute number ($m3/cap/yr$)

rp_{ygap}: factor of the yield gap, factor by which actual yield can be increased to reach the potential yield (e.g. 3.0x)

rc_{total}: total water footprint reduction from the consumption changes, as a fraction

$r_{foodwaste}$: total water footprint reduction from reducing food waste, as a fraction

Since the water footprint has a unit of $m^3/cap/yr$, this is also the required unit output of each indicator. So, each indicator is converted to an absolute water footprint reduction in $m^3/cap/yr$, which is then converted to a fraction of the total water footprint.

Further elaboration on the water footprint equation

The water footprint itself can be divided in two parts: an internal and external part. The 'production changes' and 'yield gap' indicators only affect the production within a nation's borders. Therefore, these indicators should only lead to a decrease of the internal water footprint, not the external one. However, the indicators 'consumption patterns' and 'food waste' should affect both the internal and external water footprint.

This leaves two indicators. The 'blue water scarcity ratio' is used as an output value, it does not make sense to change this as an input value. Instead, it can be decreased by shifting part of the production to external countries (e.g. by lowering the internal water footprint ratio) or by producing more efficiently. Finally, the indicator 'internal water footprint ratio' is an input value and can be changed manually (e.g. the country makes a conscious decision to produce more goods within their nation's borders rather than importing them). The ratio directly affects the effectiveness of the production and yield gap changes.

This equation, as well as the various indicators, are all computed in an Excel model that will be provided to each player taking part in the Negotiation Game, strictly as an optional tool to gain more insight into how the water footprint could be reduced.

Additional decisions during the design process of the Negotiation Game

Below, a few additional decisions that led to the final design are outlined:
First, the 'role' that each participant should fulfil was evaluated. Although it seems apparent that participants should each take up the role of a country that is taking part in the negotiations, other options were also explored. Players could, for example, take up *anonymous* roles, e.g. simulate the role of a 'Pusher' (see also Chapter 2.1.4) without specifying the country. This would be similar to the 'Globalization of water role play' where only four categories of countries (A-B-C-D) exist. However, from a literature analysis I concluded that using specific countries with pre-determined indicators seems the better option here.

For instance, Van der Gaast (2017) wrote that: 'successful negotiation outcomes depend on the extent to which the negotiation process provides sufficient flexibility and scope for dealing with country positions and interests, as well as on tactical and facilitating aspects' (Van der Gaast, 2017, p. 13). Consequently, it seems vital to be precise regarding the specification of the country, while remaining flexible regarding its position and interest. Therefore, assigning a specific country to a player but leaving part of the position and interest of this country to his or her imagination, seems to be the most suitable option here.

In practice, the situation is similar. Typically, in a negotiation process, parties (countries) assign agents who act as their negotiators – and are given a mandate written by their superiors that describes the strategy and position of the country. There is then a certain 'degree of freedom' regarding how this mandate should be carried out, and this flexibility can have a significant effect of the negotiation process as well as its outcome (Meerts, 2015). This mandate is, in this case, the 'Player Handout' that each player receives at the beginning of the Negotiation Game. Each player thus takes up the role of a negotiator and the game can then be designed using general (international) negotiation theory to ensure the negotiations are both flexible and effective.

As an example of this general negotiation theory: Mastenbroek (2002) defines four essential characteristics that a negotiator needs to possess in order to be effective. These characters are: '[a negotiator should] realize his own interests, influence the power balance, promote a constructive climate, and obtain flexibility' (Mastenbroek, 2002, pp. 433-454). From this it can be derived that the Player Handout should provide sufficient information both to transfer the knowledge of the country's interests to the player, as well as the knowledge of the relative power position of the various countries. Flexibility can then be provided by not being too restrictive in the negotiations and the mandate themselves, and by allowing the players various options in how they approach their goals.

Another important aspect is that countries should have a common interest to engage in the negotiations, despite the existence of any asymmetries in the (perceived or real) power of each country (Pfetsch & Landau, 2000; Fjellstrom, 2005).

The parties that negotiate should have a shared belief that their respective purposes will be better served by entering into negotiation with the other parties, rather than if they would try and find a unilateral solution. This betrays a dependence that is present between negotiating parties, which according to Schelling (1960) should be the starting point in a shared agreement (Schelling, 1980). So, while the problems with increasing water footprints as well as water scarcity problems can be explained to the player, this dependency between negotiating parties is an aspect that could be more difficult to implement. This will be further explored in the Discussion chapter.

2.1.2. How to select countries for the Negotiation Game

It is necessary to select countries that are likely to play a significant role in the hypothetical negotiations on water footprint quotas. This same selection can then be used to provide structure to the Negotiation Game. The selection process is shown in Figure 5.

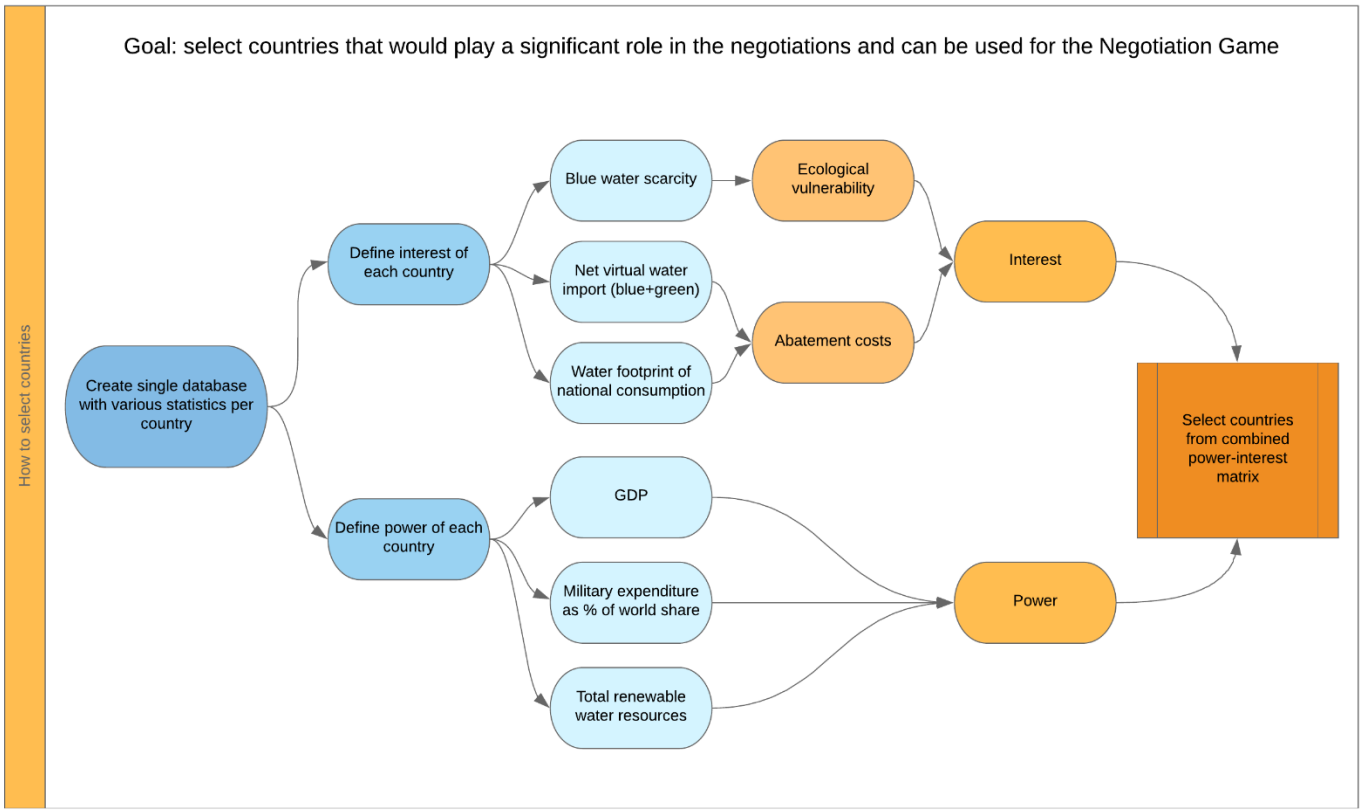


Figure 5: Process on how to select countries that will be used for the Negotiation Game

Using a similar selection as the parties that were participating in the Paris and Kyoto negotiations would be a challenge. Both negotiations had a large policy group, with 192 parties who joined (but did not all sign) the Kyoto Protocol and 185 parties who have ratified the Paris accord (Paris Agreement - Status of Ratification, 2019). Both numbers include the European Union as a single group. For the Paris agreement, all parties that were a member of the United Nations Framework Convention on Climate Change (UNFCCC), a treaty that was signed in Rio de Janeiro in 1992, were eligible to join the negotiations for the new agreement. This was a total of 197 parties (United Nations Framework Convention on Climate Change - Parties, 2019).

Therefore, also for logistical reasons (keeping the minimum required number of players low) this number should be reduced to a smaller group of key stakeholders only. Altamirano-Cabrera & Finus (2006) state that: 'the success of an international environmental agreement is not related to the total number of participants, but to the number of key players for tackling the problem – in the case of global warming USA, China, Russia and India, among others' (Altamirano-Cabrera & Finus, 2006, p. 27). So, identifying the key players only may be enough and, due to the logistics of the Negotiation Game, also a suitable solution.

Based on a logistical requirement, the number of players (and therefore countries) will be limited to eight parties – which can include alliances or groups of countries. Therefore, a selection criterium or criteria are needed that can provide a unit-level explanation of the global relations of these countries. Typical stakeholder mapping and analysis literature use a Power-Interest approach to classify stakeholders, where 'Power' is sometimes called 'Influence'. Additional indicators found in stakeholder literature are, amongst others: 'urgency', 'personality', 'knowledge/experience', and 'legitimacy' (Hujainah et al., 2018; Ginige, Amaratunga & Haigh, 2016; Olaner & Landin, 2005). Young and Osherenko (1993) have called interests, power, and knowledge the three 'social driving forces' (Young & Osherenko, 1993). Additional characteristics, such as leadership and context, are classified as 'cross-cutting factors'. Mitchell (2009) uses a similar classification and states that it is the interaction amongst these factors that will affect the negotiations and determine whether they can succeed or not (Mitchell, 2009).

Since the goal is to classify countries according to certain indicators and to determine the major stakeholders, any number of indicators over two is going to lead to a complex method, with multidimensional matrices or graphs. Yet, none of the literature sources seems to suggest that anything more than accounting for power and interest is necessary for an accurate stakeholder analysis. While Mitchell (2009) does add knowledge as a third indicator, this can easily be neglected due to the nature of this Negotiation Game. After all, players may be assigned a country that they are unfamiliar with, and consequently have limited knowledge of the country that they represent as a negotiator, which to some degree can be remedied using an initial 'obtain knowledge' phase and information provided in the Player Handout. Therefore, knowledge is not expected to be a deciding factor in the selection of these countries and only plays a role during the Negotiation Game, so it can be neglected. Subsequently, the final selection of countries will be based on a Power-Interest approach.

Use of data

As input for this approach, all 199 countries that are part of the World Bank are used (World Bank, 2019). Basic economic and general indicators are then supplemented by data from Mekonnen & Hoekstra (Mekonnen & Hoekstra, 2011). Smaller countries with large missing data sets are then excluded (e.g. some examples are the Faeroe Islands, French Polynesia, and Kiribati). This total data set was merged into a single database (Excel). So, for 191 countries data was available on various general statistics as well as water footprint data. This data was used to determine the Interest and Power of the various countries, as described below.

Interest of countries

The interest of countries is assessed using the approach from Sprinz and Vaahtoranta (1994), which is based on two factors: abatement costs and ecological vulnerability (Sprinz & Vaahtoranta, 1994). The

abatement costs have an inverse relationship with the interest of a country, while the ecological vulnerability is directly proportional to it:

$$Interest = F(abatement\ costs\ [-], ecological\ vulnerability\ [+])$$

This equation is expanded as follows:

$$Abatement\ costs = F\left(WF_{national\ consumption}[+], VW_{import-net,green+blue}[+]\right)$$

And:

$$Ecological\ vulnerability = F(Blue\ water\ scarcity\ [+])$$

With:

$Blue\ water\ scarcity$: a ratio from 0.0 to 5.0, simplified to a top 10 'high' or 'low'

$Ecological\ vulnerability$: top 10 'high' or 'low'

$WF_{national\ consumption}$: in $m^3/cap/yr$, simplified to a top 10 'high' or 'low'

$VW_{import-net,green+blue}$: in Mm^3/yr, simplified to a top 10 'high' or 'low', where 'low' considers only negative values (so more export than import) and 'high' considers only positive values (so more import than export)

$Abatement\ costs$: top 10 'high' or 'low'

$Interest$: simplified to four categories, namely:

- Low interest, if abatement cost is 'high' and ecological vulnerability is 'low'
- Moderate interest, if abatement cost is 'low' and ecological vulnerability is 'low'
- Moderate interest, if abatement cost is 'high' and ecological vulnerability is 'high'
- High interest, if abatement cost is 'low' and ecological vulnerability is 'high'

For each value in these equations, a top 10 'high' and 'low' is defined, meaning the top 10 countries (out of 191) that score the highest and lowest on these variables. For abatement costs, this means that two 'top 10' lists have to be added to one another. This is done by plotting both top 10 lists next to each other, and double counting countries that appear in both lists. As an example: Yemen has both a low water footprint of consumption (901 $m^3/cap/yr$), where it takes up the 9th spot, as well as a high net virtual water import (21040 Mm^3/yr), where it takes up the 10th spot. As a result, Yemen receives a 'low abatement cost' score of 2, since it appears in both lists. For clarification, the matrix of this method is shown in Appendix V.

High abatement costs mean that it is relatively costly for a country to reduce its water footprint, leading to a lower interest in the negotiations. Therefore, a high base water footprint of national consumption,

leads to higher abatement costs for a country. Secondly, net virtual water import also plays a role. A negative net virtual water import means that this country is exporting large amounts of virtual water. These virtual water export flows are potentially susceptible to caps that may result from a water footprint (reduction) agreement. Alternatively, if the country that they export to, decides to reduce its external water footprint and produce more within their own borders, this would reduce these external flows as well. Consequently, it is stated that countries with a negative net virtual water import will have a lower interest, while countries with a positive net VW import will have a higher interest.

For ecological vulnerability, Sprinz and Vaahtoranta use a classification based on the vulnerability to global ozone depletion. Obviously, this cannot be used for the water footprint. Instead, the ecological vulnerability is based on national blue water scarcity estimates (Hoekstra et al., 2012). This indicator was chosen over another, namely: baseline water stress (Gassert et al., 2013). The reason is that Gassert et al. (2013) base their water stress on the ratio of total annual water withdrawals to total available annual renewable supply, while Hoekstra et al. (2012) use the ratio of the total blue water footprint to the blue water availability in a river basin (Hoekstra et al., 2012). Hoekstra et al.'s method is preferable since there is a notable difference between (blue) water abstraction and the blue water footprint.

'Interest' here is defined as the willingness of a country to participate in the negotiations on water footprint quotas, as well as their personal stake in obtaining an agreement. Ergo, a country with a 'high interest' has a high stake in achieving an agreement. A high variety of motives is possible here, as well as a high variety of means. It should be noted that a country could have a *theoretical* high interest in the agreement but only in an agreement that applies (or is stricter) to other players (so using a free rider's perspective). If such a country either has high abatement costs or a low ecological vulnerability, it would show up as a low or moderate interest country per this method. It is thus important to note this limit of the chosen method and this should be taken into account when making the final selection of countries.

Some limits of this method should be included. Most significantly, the ecological vulnerability is abstracted to a ratio on a scale from 0.0 to 5.0, which does not accurately portray the spatial and temporal variations of the blue water scarcity. E.g. a country such as the United States or China may have severe scarcity issues on a local scale, but not so much for the nation as a whole. Therefore, it is essential to include these aspects in some qualitative manner during the Negotiation Game, e.g. by describing them in the initial instruction that is given to each participating player.

The result of this Interest method leads to four categories of countries, see Table 1. Per Luterbacher & Sprinz (2001), it is expected that 'Pushers' will lead the negotiations, while 'Draggers' will either not participate or try to limit the quotas that will be decided upon for the final agreement (Luterbacher & Sprinz, 2001).

Table 1: Four classifications based on the Interest approach

	Low abatement costs	High abatement costs
Low ecological vulnerability	Bystanders	Draggers/laggards
High ecological vulnerability	Pushers	Intermediates/supporters

Power of countries

To determine the Power of countries, the following equation is used:

$$Power = F(GDP\ (2016)\ [+], military\ expenditure\ as\ \%\ of\ world\ share\ (2017)\ [+],\ total\ renewable\ water\ resources\ (2011)\ [+])$$

With:

GDP (2016): in U.S. dollars, simplified to a top 10 'high' or 'low'

$military\ expenditure\ as\ \%\ of\ world\ share$ (2017): a percentage (%), simplified to a top 10 'high' or 'low'

$total\ renewable\ water\ resources$ (2011): in km^2, simplified to a top 10 'high' or 'low'

The top 10 'high' and 'low' variables are used similar to how the Interest of each country was defined.

Weber (1964) defines power as 'the ability to move a party in an intended direction' (Weber, Parsons, & Henderson, 1964). Power can be approached in different ways (Pfetsch, Power in International Negotiations: Symmetry and Asymmetry, 2000): power can be seen as power-as-possession (Hobbes, 1962), power-as-relation (Locke, 1689), or power-as-relativity (Deutsch, 1963). The first can be classified in various ways but comes down to the various resources a party can use to project its power, e.g. economic (GDP) or military power. Relational power is the perception of one party's capability of influencing others in a bi- or multilateral relationship. Relational power is always judged on an individual basis. Finally, relative power is a comparative judgement, where the influence of two or more parties are compared to one another. In other words: these three approaches to power are based respectively on capability, influence, and comparative influence.

We can eliminate two approaches since these are not as useful for the Negotiation Game: these are the power-as-relation and power-as-relativity approaches. Both are more subjective than power-as-possession and will presumably develop naturally during the game (as players learn more about each other and their own relative position) but cannot be accurately determined beforehand. Especially since the Negotiation Game can be played multiple times with an unknown group of people, so their perspective and behaviour remain an unknown quantity. While it would be possible to argue that, for example, the United States has high relative (perceived) power compared to Russia, this would introduce a series of assumptions to the methodology that may not be shared by the eventual players. Using power-as-possession seems the safer route. Thus, the Hobbes (1962) approach is chosen, with total renewable water resources added as an additional indicator (Morgenthau & Thompson, 1993), leading to the equation as described before.

Power is seen as 'power-as-possession', namely: possession of economic resources (GDP), military resources (military expenditure as percentage of world share) and water resources. Without assigning specific weights, military expenditure is seen as less important than the other two characteristics. E.g. if a country has high GDP and high available water resources, it is seen as more powerful than if a country only has high GDP and high military expenditure, given the nature of the negotiation agreement that places emphasis on water issues worldwide.

Finally, GDP is selected over GDP per capita. The latter might seem the more obvious choice, given that the water footprint is viewed from a consumption perspective, and thus a high GDP per capita could in theory result in a high capability of reducing the water footprint (e.g. if a meat tax were introduced). However, the general purpose of the 'power' characteristic is to give a representation of the power of a country, and GDP is more indicative for the country as a whole than GDP per capita. Case in point: India and China both have a relatively low GDP per capita but a high total GDP, and both were also major players in the Kyoto and Paris negotiations (Engels, 2018) (Mohan, 2017). Both matrices for the Interest and Power approach are shown in Appendix X. The combined matrix, leading to the final selection of countries, is shown in the Results chapter.

How to select indicators of countries

Now that the method of selecting of countries for the Negotiation Game is decided upon, the relevant indicators of these countries should be defined. The goal of these indicators is to help the players gain insight into how they can reduce their water footprint and what would be the consequences thereof. These are the indicators and characteristics that help shape the negotiation arena and could play a significant role in its outcome. Identifying these indicators influences not only the structure of the Negotiation Game, but also the analysis of the narratives to the situation in practice. E.g. a water

stress indicator may have a large impact on a country's willingness to negotiate on water footprint quotas, but if this indicator is not assessed at all and not included in the Negotiation Game, then this might be overlooked. The opposite should be less of a problem: if an indicator is included but does not turn out to be meaningful, then this could be a valid conclusion. The key is to provide the players with options and flexibility, as was also advocated by (Meerts, 2015).

Pfetsch and Landau identify various indicators and state that "indicators such as the national product (GNP), per capita income, the size of the market with its purchasing power, the share of world trade, […], natural resources, […] etc., are among the most important potentials on which negotiators can rely" (Pfetsch & Landau, 2000, p. 28). They also include political and social indicators, such as the type of government and its efficiency, social welfare, and income distribution. From Sprinz and Vaahtoranta (year), we already have the two indicators used for the interest-based hypothesis, namely: ecological vulnerability and abatement costs. Additionally, we can derive indicators from the available data: namely Mekonnen & Hoekstra (2012), as well as the various data sets that are available on the WorldBank website (Mekonnen & Hoekstra, 2011) (The World Bank, 2018). Altogether this provides us with a set of available indicators. Only indicators that could be linked to the consumption perspective – since we have chosen this approach for the water footprint – were kept, to allow for expressing these indicators in a unit per capita that could influence the central value 'water footprint of national consumption'. E.g. the national product (GNP) was removed for this reason. The final selection is shown in Table 2.

Table 2: Selection of indicators for each country, with each respective source

Indicator	Source
Blue water scarcity ratio	Hoekstra et al. (2012)
Production changes (3 types): deficit irrigation, organic mulching, and synthetic mulching	Chukalla, Krol & Hoekstra (2017) Chukalla (2017)
Increasing yield gap	Grassini & Van Ittersum (2019), via Global Yield Gap Atlas (Grassini & Van Ittersum, 2019)
Consumption patterns (3 diets): vegetarian diet, healthy diet, combined diet	Mekonnen & Hoekstra (2010)
Food waste	Kummu et al. (2012)
Internal water footprint ratio	Hoekstra, Chapagain, Aldaya & Mekonnen (2011)

2.1.3. In-game information for players of the Negotiation Game

The indicators from Table 2 are included in the Excel tool that each player can use. The purpose of this Excel tool is to provide the players with flexibility and options to see how the water footprint of national consumption can be changed in their country, as well as what some of the negative consequences would be. For the production changes, these negative consequences are expressed in marginal costs as percentage of the total GDP of the country. These values are based on Table G1 (Appendix F, pp.3521) from the paper by Chukalla, Krol, and Hoekstra (2017). These values were given in $US\$/ha\ per\ m^3/ha$, and were converted to $US\$/ha$ by multiplying them with the water footprint reduction achieved by these production changes in m^3/ha. Finally, these three values (for three production changes) were multiplied by the total area of irrigated land in each country in ha to get the final marginal costs in $US\$$.

Apart from these costs, another variable that shows the consequences of some actions is the blue water scarcity ratio. This ratio is dependent on the new water footprint, in other words: if the player manages to decrease the water footprint through various changes, then the blue water scarcity ratio will decrease (linearly) as well. This is done through the following equation:

$$WS_{blue,new} = WS_{blue,old} * r_{new:old\ internal\ blue\ WF}$$

With:

$WS_{blue,new}$: new blue water scarcity ratio (scale from 0.0-5.0)

$WS_{blue,old}$: old blue water scarcity ratio (scale from 0.0-5.0)

$r_{new:old\ blue\ internal\ WF}$: ratio of the new internal blue water footprint compared to the old (before changes) internal blue water footprint

For example: if the internal blue water footprint decreases by 20%, then the blue water scarcity ratio also decreases by 20%.

Finally, several consequences cannot be accurately described in a quantitative manner. These are the consequences of changing consumption patterns, reducing food waste, and changing the internal water footprint ratio (compared to the total water footprint). Both the negative and positive consequences of these actions are, to an extent, described in the Player Handout that each player receives, and are unique for each country.

2.2. Analysing the Negotiation Process of the game

Figure 6 shows how the narrative of each country is defined. This chapter describes the process top-down, first it is discussed how the narratives can be defined (Chapter 2.2.1) and then how the verbal communication analysis ('How to filter observational results') can be executed (Chapter 2.2.2.). Essentially, Table 4 is filled using the results from testing the Negotiation Game, based on the transcript of an audio log. The various variables (e.g. 'long-term orientation') receive +1 'high' or 'low'

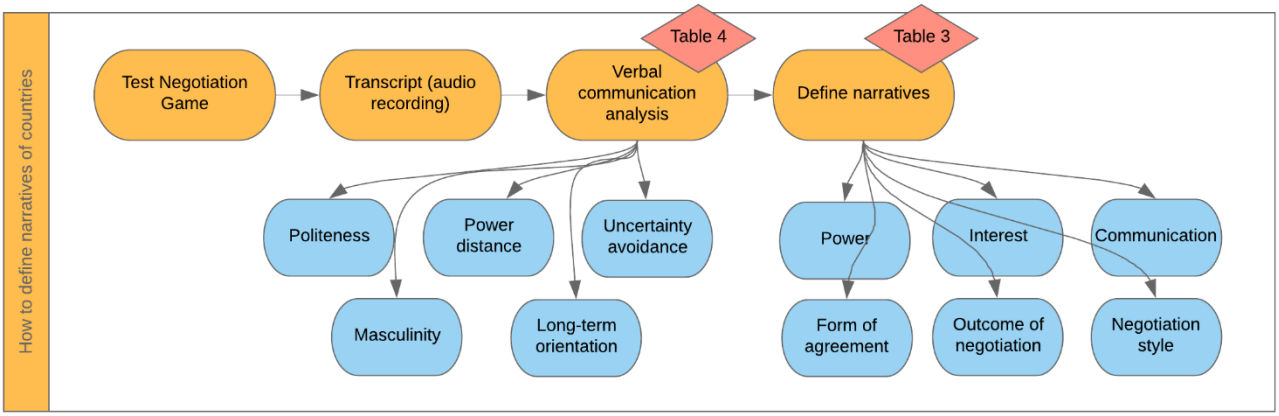


Figure 6: Process on how to define narratives of countries

score based on subjective interpretation of how well the communication by a player fits this category, for each time a player speaks up. E.g. if a player holds a monologue, he can score high or low in various categories. All this results in a complete Table 4 where the various scores for each country can be compared. This is then used as input for Table 3, where the narrative of each country is defined. The narrative is seen as a combination of the six variables as shown in Figure 6.

2.2.1. How to define narratives of countries

In order to provide structure to the observational results from testing the Negotiation Game, countries will be assessed based on their respective *narratives*. As stated before, a narrative is defined as the rational position of a country from which it enters and partakes in the negotiations. The narrative can therefore change during the negotiations and be influenced by other parties or events. It is also possible that a shared or common narrative will appear, which we define as a narrative shared between at least two players. E.g. if two or more players reach common ground on certain principles and goals and approach these from the same rationale, we can then define this as a shared narrative. Consequently, it is possible for multiple shared narratives to exist, and these can reinforce or oppose one another.

Based on the power-interest selection (see Results chapter), the hypothesis is made that all countries with a moderate to high interest, enter the negotiations with complementary or common interests and one or more shared goals. Fulfilling this goal would benefit them in some way but the extent thereof may differ between countries. It should also be noted that two parties having a 'high interest', does not necessarily mean that this interest is shared, it could still be a conflicting one.

The equation, as given in Chapter 2.1.2, depends only on the abatement costs and ecological vulnerability. It is possible, then, that hypothetical countries A and B both have low abatement costs and high ecological vulnerability and are therefore classified as a 'high interest country'. However, perhaps country A has a very small external water footprint and a high GDP and could solve most of its issues by simply importing more goods and improving the yield gap and production effectiveness within its own borders. Consequently, this country may not necessarily be interested in any goals related to water footprint quotas. Simultaneously, perhaps country B has a large external water footprint, and as a result this country may be interested in influencing others to improve their production techniques. To conclude: the interest of a country (in the negotiations) depends on more than just its abatement costs and ecological vulnerability. One factor is, as described in the example, the internal water footprint ratio, but there are others as well, some of which may be difficult to describe in a quantitative manner. E.g. factors such as culture, historic relationships, the exact nature of the nation's water problems (spatial, temporal, causes), land leasing in other countries, et cetera (Fjellstrom, 2005) (Okolo & Akwu, 2015).

Regarding the power position of countries, this can influence their narrative in several ways. High-power countries will more easily identify shared interests, pursue a win-win negotiation, focus on self-interest, and try to achieve their self-interest by any means with little flexibility for compatible interests (Guinote, Behaviour variability and the situated focus theory of power, 2007) (Guinote, 141). Maiwald (2015), in a negotiation experiment, made the hypothesis that "high-power negotiators will achieve higher self-outcome in distributive negotiation and a higher joint outcome in integrative negotiation than low-power negotiators" (Maiwald, 2015, p. 10). This can be tested by comparing the final agreement with the power of each country.

In order to assess the narrative of a country, it will be rated according to several characteristics, as described in the first paragraph of Chapter 2.2. This will be done after the Negotiation Game has been tested in practice. The list of characteristics and their source is given in Table 3. In order to rate countries per these characteristics, first the verbal communication analysis (per Table 4) should be conducted.

Table 3: Characteristics that together define the narrative of a country

Characteristic	Range	Source
Interest	Low – Moderate – High; Bystander – Dragger/Laggard – Pusher – Intermediate/Supporter	Sprinz and Vaahtoranta (1994)
Power	Low – Moderate – High	Hobbes (1962)
Communication	Direct / Indirect; Informal / formal	Vivek (2015) (Vivek, 2015)
Form of agreement	General / specific	Vivek (2015)
Final outcome of negotiation	Relatively high/low self-outcome; Relatively high/low joint outcome	Maiwald (2015)
Proposal outcome of negotiation	Equal outcome shares; Unequal outcome shares	Pfetsch and Landau (2000)
Negotiation style	Cooperative / competitive	Caputo et al. (2019), see also the next subchapter.

2.2.2. How to filter observational results

Several of the characteristics from Table 3 cannot be assessed in a quantitative manner. Instead, they could be derived from a transcript of testing the Negotiation Game, by recording it and analysing the terminology used by the various participants. This excludes any non-verbal communication. In order to filter the transcript(s), a filter is needed that links the use of certain verbal communication to a characteristic, such as power, which also requires a few hypotheses. These are taken from various literature sources:

- ☑ Morand (2000) states that parties with low power will use higher levels of politeness, specifically of *negative politeness*, based on politeness theory from Brown and Levinson (1987) (Morand, 2000) (Brown & Levinson, 1987). Negative politeness tactics are defined as 'avoidance communication', establishing a social distance between the speaker and recipient, using verbal hedges such as 'Could I…', 'Perhaps I could…', or 'Is it possible to…'.
- ☑ Caputo et al. (2019) describes five cultural values that can be linked to two types of negotiation styles (Caputo et al., 2019). For all five values, two hypotheses are made and linked to either a competitive or cooperative style of negotiation. These are:
    - **Power distance**; defined as the extent to which players approve or disapprove of power asymmetries. High-power players are likely to show more dominant behaviour and pursue an asymmetrical/inequal outcome. Low-power players are likely to accept dominant behaviour and seek an outcome with general equality.
    - **Uncertainty avoidance**; players with high uncertainty avoidance oppose players who deviate from expectations, are expected to communicate their need for structure and

clarity and communicate more openly during the negotiations. Players with low uncertainty avoidance implement more competitive and aggressive negotiation styles.

- **Collectivism/individualism**; ties into the cultural background of countries. However, since the Negotiation Game is tested with players who may not share their country of origin with the country that they role play as, and since this value is comparable to the evaluation of how competitive or cooperative each player is (which is already being measured), this value is neglected.
- **Masculinity/femininity**; this contrast has been analysed in various other behavioural and verbal communication literature, which includes various theories on gender role stereotypes and classifying certain traits per gender (e.g. 'assertiveness' as a masculine trait in salary negotiations) (Amanatullah, 2007). Without delving into these complexities, Caputo et al. argue that assertiveness, competitiveness and ambition are related to masculine cultural values and result in competitive negotiation styles. Contrarily, equality and being caring are related to feminine cultural values and lead to cooperative negotiation styles.
- **Long-term/short-term orientation**; similar to collectivism, Caputo et al. link this characteristic to cultural values, but in an altered form it can be useful for the analysis of the Negotiation Game as well. Caputo et al. state that "long-term oriented cultures tend to prefer long-term gain, [their] negotiators [..] will tend to value the relationship more than the outcome and, hence, will cooperate with the other party whenever possible." (Caputo et al., 2019, p.26) So, long-term orientation results in a cooperative style, and vice versa for short-term orientation.

All five of the aforementioned characteristics, their relation to a negotiation style, and how they are reflected in verbal communication, are shown in Table 4. This will be used, together with the characteristics from Table 3, to classify the results of testing the Negotiation Game. Specifically: the narrative of each country will consist of a combination of certain characteristics that are listed in Table 3.

Table 4: Verbal communication analysis and its relation to competitive and cooperative negotiation styles

Characteristic	Expected player behaviour and/or verbal communication	Relation to competitive style	Relation to cooperative style
Politeness	*High*: Negative politeness tactics are dominant, including avoidance communication, e.g. 'could I', 'perhaps I could', 'please…' etc. *Low*: Lack of politeness tactics and usage of	Negative	Positive

	verbal communication that can be considered as impolite.		
Power distance	*High:* Seek inequal/differentiated outcome, shows dominant behaviour *Low:* Acceptive of dominant behaviour, seek general equality outcome	Positive	Negative
Uncertainty avoidance	*High:* Express a need for structure or clarity (*Low:* Uses aggressive negotiation tactics and does not seek structure or clarity	Negative	Positive
Masculinity	*High:* Uses language or behaviour that is assertive, competitive or ambitious. *Low:* Uses behaviour aimed at equality or 'caring', displays 'feminine' traits or uses verbal communication classified as feminine	Positive	Negative
Long-term orientation	*High:* Deems relationship between players more important than the outcome, shows high adaptation to situational changes, communication infers long-term goals. *Low:* Deems outcome more important than relationship, shows low adaptation to situational changes, communication infers short-term goals.	Negative	Positive

This verbal communication analysis will be conducted before the narratives of countries (Table 3) are defined. This is done by analysing the transcript of testing the Negotiation Game. Each spoken segment from a player, is scored in three possible ways: not applicable (no change), fits the 'High' part of a characteristic, or fits the 'Low' part of a characteristic. E.g. if a player expresses the need for a differentiated agreement in an assertive manner, then this is scored 'high' (+) for both 'power distance' and 'masculinity'. The final scores per country for each characteristic are converted to a linear scale of $-3 \leq x \leq 3$, where +3 means the highest possible score for this characteristic (e.g. high masculine communication) and -3 means the lowest possible score (e.g. low masculine and high feminine communication). Based on these scores, each country can be categorized into either the competitive or cooperative negotiation style, based on the relation with the characteristics as shown in Table 4. Then finally the narratives are defined as described in Chapter 3 Results.

3. RESULTS

This chapter discusses the results of two different experiments: the experiment of playing the Negotiation Game with players, as well as the simulation of various scenarios through the Excel tool. It should be noted that the latter is not the primary focus of this chapter and does not directly answer the main research question, unlike the first type of experiment. An overview of the Results chapter is shown in Figure 7.

The results regarding the Negotiation Game experiment are explored through narratives. The idea is that each player (country) either already starts from or develops a narrative. These narratives form the rational perspective from which the player approaches the negotiations. It is possible that resemblances exist between various narratives, and one or more shared narratives may appear during the experiment.

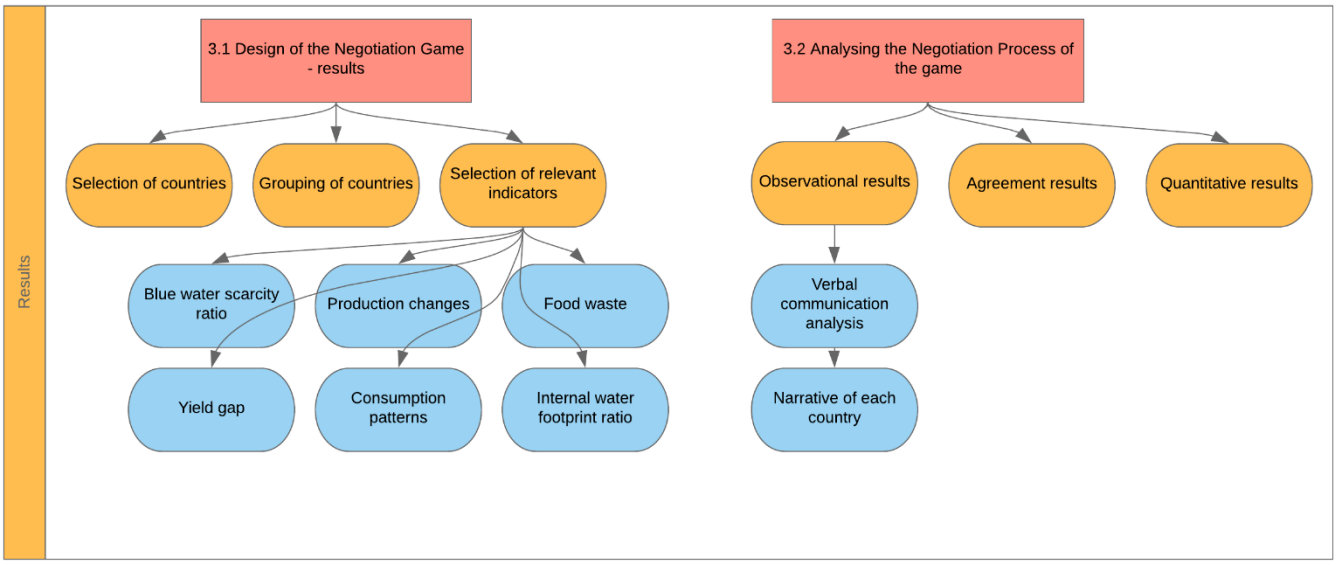


Figure 7: Overview of the contents of the Results chapter

3.1. Design of the Negotiation Game - results

3.1.1. Selection of countries

Combining both matrices of the Power- and Interest-approach, leads to a 3x3 matrix that classifies countries as Low-Moderate-High, for both Interest and Power, see Table 5.

Table 5: Combined matrix of Power-Interest method

	Low power	Moderate power	High power
Low interest		Brazil	Russian Federation
Moderate interest		Southern Europe	United States North-western Europe
High interest	East Africa		India China

In the initial matrix, there were other countries present, such as Small Island States, Japan, and South-Korea. The choice for the final eight countries from Table 5 was based on two reasons: to have at least one representative country from each extreme (except for Low power – low interest), and to have as many countries that have close interdependencies as possible. Hence the combination of Southern and North-western Europe, as well as India and China and the United States and Brazil. East Africa also has a lot of close ties with China (e.g. various land lease projects (Okolo & Akwu, 2015) and Europe. Russia is the only outsider but fits the requirement of a 'high power – low interest' player.

3.1.2. Grouping of countries

In Table 5, several countries were grouped. This is a common phenomenon in climate negotiations. A good example is the European Union, who were participating as one party in both the Kyoto and Paris climate negotiations (United Nations Framework Convention on Climate Change - Parties, 2019). Other examples of groups of countries are the Alliance of Small Island States (AOSIS, consisting of 43 countries), and the Least Developed Countries (LDC, 50 countries). Initially, various countries of Europe were ranked separately based on their power and interest. Due to the similar characteristics, power and interest of these countries, they were grouped together. The three groups consist of:

- ☑ North-western Europe: United Kingdom, Germany, France, The Netherlands, Switzerland
- ☑ Southern Europe: Italy, Spain, Portugal
- ☑ East Africa: Tanzania, Kenya, Uganda, Rwanda, Burundi

Some countries, such as Belgium, were excluded because they did not result from the power-interest selection (e.g. Switzerland's water footprint was marginally larger than Belgium's). Other countries, such as South Sudan, were excluded because not enough data was available for them (specifically the water footprint accounts).

Regarding the data of these groups, averages and sums had to be taken. For the water footprint, the average value was used, while most water and economic indicators were summed up (e.g. GDP, population, total irrigated land). An example for Southern Europe is shown in

Table 6: Example of how data was handled for grouped countries

Country	Water footprint (2000)	Population (2016)	Irrigated land (2016)	Blue water scarcity ratio
	$m^3/cap/yr$	mln	Ha	(-)
Southern Europe	2384	116	8290000	1.38
Italy	2303	59	3950000	0.35
Spain	2461	46	3800000	2.35
Portugal	2505	10	540000	1.44

Source of data: Mekonnen & Hoekstra (2011), The World bank (2016), Hoekstra (2011)

3.1.3. Selection of relevant indicators

Based on the method and water footprint equation as described in the Method, the indicators are put into an Excel tool and their effect on the new water footprint (after reductions) is implemented as well. A brief explanation of each indicator is given below, as well as – where applicable – a description of the equation that was used to calculate the absolute water footprint reduction (in $m^3/cap/yr$) of that indicator.

Blue water scarcity ratio

This indicator is an output value, as described before. The water scarcity indicator, per Hoekstra et al. (2012), is based on the ratio of the blue water footprint of national production to the blue water availability per month (Mekonnen and Hoekstra, 2016). A more extensive definition would be: the National Blue Water Scarcity, defined as:

$$Water\ Scarcity_{area,national,internal} = \frac{Water\ footprint_{area,national}}{Water\ availability_{national,internal}}$$

So, only internal water resources are assessed and the average ratio per month is used, so there could be additional variation of this scarcity indicator per month.

The scarcity indicator can be classified into four levels:

- Low blue water scarcity ($0 \leq r < 1$), meaning that the blue water footprint is lower than the blue water availability and environmental flow requirements are not violated.
- Moderate blue water scarcity ($1 \leq r < 1.5$), environmental flow requirements are not reached, blue water footprint is 20-30% of natural runoff.
- Significant blue water scarcity ($1.5 \leq r < 2$), environmental flow requirements are not reached, blue water footprint is 30-40% of natural runoff.
- Severe blue water scarcity ($2 \leq r \leq 5$), environmental flow requirements are not reached, blue water footprint is >40% of natural runoff.

The water scarcity ratio after a certain decrease of the water footprint of national consumption, is calculated by assuming a proportional relationship to the internal blue water footprint (per the formula given before). In other words: if the national water footprint of consumption decreases by 20%, it is assumed that the total internal water footprint and blue internal water footprint also decrease by 20%. As a result, the water scarcity ratio will also decrease by 20%.

Production changes

Per Chukalla, Krol & Hoekstra (2017) and Chukalla (2017), various production changes are assessed (Chukalla, 2017; Chukalla, Krol & Hoekstra, 2015). The dissertation of Chukalla (2017) analyses various types of irrigation techniques and strategies, as well as mulching practices, and their effects on the water footprint. In order to have tangible numbers for the Negotiation Game and Excel tool, two assumptions had to be made. The first is that the marginal cost curves for water footprint reduction of maize will be used and extrapolated to the full area of irrigated land per country. So, no distinction is made with other types of agriculture. Secondly, it is assumed that all countries have a baseline of sprinkler irrigation, combined with a full irrigation strategy and no mulching. This allows for a direct implementation of the results from the dissertation, as shown in Figure 8.

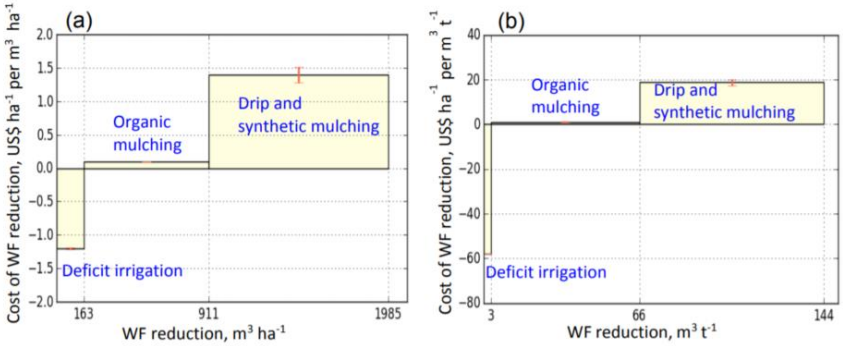


Figure 8: Marginal cost curve for water footprint reduction, assuming maize & sprinkler irrigation (Chukalla, Krol, & Hoekstra, 2017). Graphs respectively show:
a) water footprint reduction per area
b) water footprint reduction per unit of product

With a similar process as shown in Figure 8, the marginal costs are shown in Table 7 (Chukalla, Krol, & Hoekstra, 2017, pp. Table G1, Appendix G). These values are based on a baseline with full irrigation and no mulching and thus the values are slightly different from the ones shown in Figure 8.

Table 7: Marginal costs for the three different production changes, assuming maize and sprinkler irrigation as baseline

Measures	Marginal cost	WF reduction	Total cost
	$USD\ ha^{-1}\ per\ m^3 ha^{-1}$	$m^3 ha^{-1}$	USD ha^{-1}
Deficit irrigation	-1.7	161	-274
Organic mulching	0.2	583	117
Synthetic mulching	2.4	1037	2489

Source of data: Chukalla, Krol & Hoekstra (2017)

By multiplying these marginal costs with each respective water footprint reduction (in m^3/ha), this leads to a costs value in US$ per ha. To make comparison possible between this graph and the other indicators, the x-axis has to be converted from 'Water footprint reduction in m^3/ha' to 'water footprint reduction in $m^3/cap/yr$'. This is done by first multiplying the reduction with the total area of irrigated land and then dividing the result by the total population. For a description of how the marginal costs were calculated, see Chapter 2.1.3.

Although Chukalla (2017) states that 'One should be cautious in applying the reported specific values for costs and water footprint values in other areas than the ones studied here' (Chukalla A. D., 2017, p. 47), this is deemed to be an insignificant risk in this particular case, since the calculations are only used for an extra insight with the (optional) Excel tool.

Yield gap

Yield gap (Yg) is defined as the difference between either the potential yield (Yp) of crops or the water-limited potential yield (Yw), and the average yield (Ya) (Van Ittersum, et al., 2013). Here, the difference between Yw and Ya is used, since the goal is to extract an absolute water footprint reduction from this indicator and using the full potential yield would introduce another uncertainty – namely the increased use of water to achieve this potential.

The yield gap (in metric tonnes per hectare) was calculated using a weighted average for each country, using the following equation:

$$Y_{g,average} = \frac{(Yw_1 - Ya_1)p_{crop_1} + (Yw_2 - Ya_2)p_{crop_2} + \cdots + (Yw_n - Ya_n)p_{crop_n}}{100}$$

With:

p_{crop_x}: percentage of production of this crop compared to total production in this country

As an example, if a country produces crops A and B, that account for 40% and 60% of the production respectively, then $Y_{g,B}$ will count for 60% towards the average yield gap and $Y_{g,A}$ for only 40%. The weighted averages of groups of countries (e.g. Northwestern Europe) are again converted to a weighted average for the whole group, with population as the deciding factor.

The agricultural production and corresponding available yield data are shown in Table 8. For the grouped countries (Southern Europe, North-western Europe and East Africa), a final average is taken of the various sub countries. Only for Russia and Rwanda data was missing. Russia's yield gap data will be derived from Schierhorn et al. (2014). Rwanda's data is deemed negligible since there is enough data from the other East African countries. Brazil's high yield gap is a result of its limited achieved potential in sugarcane production.

Table 8: Agricultural production (with available yield data) per country, yield gap is based on a weighted average

Country	Agricultural production	Yield gap ($y_{g,average}$) Metric tonnes per hectare
Brazil	Maize, rice, sugarcane	21.46
India	Maize, rice, wheat, sorghum, millet	2.56
China	Maize, rice	3.52
United States	Maize, rice	2.79
Southern Europe		3.76
Spain	Maize, barley, wheat	3.86
Portugal	Maize, barley, wheat	3.86
Italy	Maize, barley, wheat	2.71
North-western Europe		2.54
Germany	Maize, barley, wheat	2.01
France	Maize, barley, wheat	2.23
Netherlands	Maize, barley, wheat	2.45
Switzerland	Maize, barley, wheat	3.38
U.K.	Barley, wheat	3.42
East Africa		4.24
Kenya	Maize, wheat, sorghum, millet	5.34
Rwanda	Rice	-
Tanzania	Maize, rice, wheat, sorghum, millet, beans, peas	3.54
Uganda	Maize, rice, sorghum, millet	3.90
Russia	N/A	3.22

Source of data: Global Yield Atlas (2019)

Consumption patterns

One of the largest contributors to the water footprint of national consumption are the consumption patterns of a country. Mekonnen & Hoekstra (2010) showed that bovine meat requires over 15,000 litres of water to produce 1 kilogram, compared to only 322 litres for most typical vegetables (Mekonnen & Hoekstra, 2010). Pig meat, butter, and various other dairy products have similar high water footprints of production. Vanham, Mekonnen & Hoekstra (2013) showed that the difference between diets can be up to 1610 $l/cap/day$, when looking at the water footprint of national production (Vanham, Mekonnen, & Hoekstra, 2013). Therefore, the division of various diets in a country has by far the most significant effect on the water footprint of national consumption.

Using the paper from Vanham, Mekonnen & Hoekstra (2013) as a source, we distinguish four types of diets:

- ☑ REF (Reference diet), the current average diet in the relevant country.
- ☑ HEA (Healthy diet), a diet based upon dietary recommendations (recommended intake of calories and different nutrients).
- ☑ VEG (Vegetarian diet), the healthy diet with 100% of meat products replaced by vegetarian alternatives.
- ☑ COM (Combination diet), the healthy diet with 50% of meat products replaced by vegetarian alternatives.

The current vegetarian population per country was determined based on research by (Leahy, Lyons, & Tol, 2010). It is assumed that the baseline HEA & COM population in each country is zero. The REF population is thus the difference between the total population and the vegetarian population.

Then, the effect of more people adopting a different diet can be calculated. This is done by first calculating the water footprint of a typical REF and VEG diet in the baseline scenario, before the player has adjusted any sliders. This is a simple linear system with two unknowns:

$$population_{VEG} * water\ footprint_{VEG} = \alpha$$

$$population_{REF} * water\ footprint_{REF} = \beta$$

$$\frac{\alpha + \beta}{total\ population} = current\ water\ footprint$$

One these two water footprint values are known, it becomes straightforward to calculate the effect on the water footprint if the vegetarian population were to increase (and simultaneously the reference population would decrease proportionally).

For the COM and HEA diet, more information is needed. The paper provides values for the water footprint of production in $l/cap/day$ for each different diet. By assuming that the potential decrease of each diet is the same for the water footprint of national consumption, we can calculate the water footprints of a COM and HEA diet. The results are shown in Table 10.

Table 9: Potential water footprint reductions for different diets, in the EU

	Water footprint of production $l/cap/day$	Water footprint of production $m^3/cap/yr$	Water footprint savings %
EU – REF diet	4265	1557	0
EU – HEA diet	3291	1201	22.8
EU – VEG diet	2655	969	37.8
EU – COM diet	2973	1085	30.3

Source of data: Vanham (2013)

However, this same method cannot be used for the VEG diet, to bypass the earlier method. After all, the given water footprint of a country is the *average* water footprint of that country, and it includes the vegetarian population. Therefore, the water footprint savings as shown in Table 10, need to be applied to the REF water footprint, which should be higher than the given water footprint of national consumption. E.g., for the United States, the water footprint of national consumption is 2842 $m^3/yr/cap$, but the water footprint for a REF diet is 2886 $m^3/yr/cap$, and for a VEG diet it is 1796 $m^3/yr/cap$. The HEA and COM diets then have water footprints of, respectively, 2227 and 2011 $m^3/yr/cap$.

Food waste

Food waste, or more specifically avoidable food waste, increases the water footprint through sheer increase of total volume of consumed goods. Moreover, the amount of food waste differs highly per continent and per sector. E.g. estimated yearly per capita food loss in the United States is more than twice as large as in South and Southeast Asia (Extent of food losses and waste, 2019). Per Kummu et al. (2012), the food waste per continent is shown in Table 10 (Kummu, et al., 2012).

Table 10: Food waste per region, in terms of food supply in kcal that is wasted per capita per day, as well as its impact on water resources

Region	Food supply	Minimum loss scenario	Difference (food supply)	Baseline (water resources)	Minimum loss scenario	Difference (water resources)
	kcal/cap/day	kcal/cap/day	%	$m^3/cap/yr$	$m^3/cap/yr$	%
Sub-Saharan Africa	506	351	-31	12	9	-27
Europe (incl. Russia)	720	266	-63	18	9	-53
Industrialised Asia	678	314	-54	19	8	-59
Latin America	693	404	-42	22	13	-42
North Africa & West-Central Asia	775	375	-52	86	46	-46
North America & Oceania	1334	495	-63	42	18	-57
South & Southeast Asia	404	270	-33	30	20	-34

Source of data: Kummu et al. (2012)

The 'minimum loss scenario' here means that all (readily) avoidable food waste is reduced to 0%. So, apart from any losses such as those in the production chain, the consumers now buy exactly what they need to consume and do not throw anything away.

In the Excel tool, the column 'Difference (food supply)' is included as a slider, of which the maximum differs per country and is equal to the value as shown in Table 10. E.g. for Russia, this would be a reduction of 63%. The following formula is then used to calculate the effect on the total water footprint reduction:

$$water\ footprint\ reduction\ (m^3/yr/cap) = waste\ reduction(\%) * \left(\frac{difference_{water\ resources}(\%)}{difference_{food\ supply}(\%)}\right) * baseline_{water\ resources}$$

E.g. for Russia, this would be:

$$waste\ reduction(\%) * \left(\frac{53\%}{63\%}\right) * 18\ m^3/cap/yr$$

Internal water footprint ratio

Each country has a different ratio of its internal water footprint to the total water footprint. E.g. for Russia this is 88% and for North-western Europe this is 33%. Hypothetically, a country could make the choice to shift production that takes place elsewhere (in another country), to within its own borders. For example, the United States could produce cattle feed from soybeans themselves, instead of importing them from Brazil. Consequently, this allows one to have more control over the water

efficiency of these products. So, by combining them with more efficient production changes, such as drip mulching and deficit irrigation, one could theoretically decrease its water footprint of national consumption even further by becoming more self-sufficient. This is reflected in the Excel tool by this ratio.

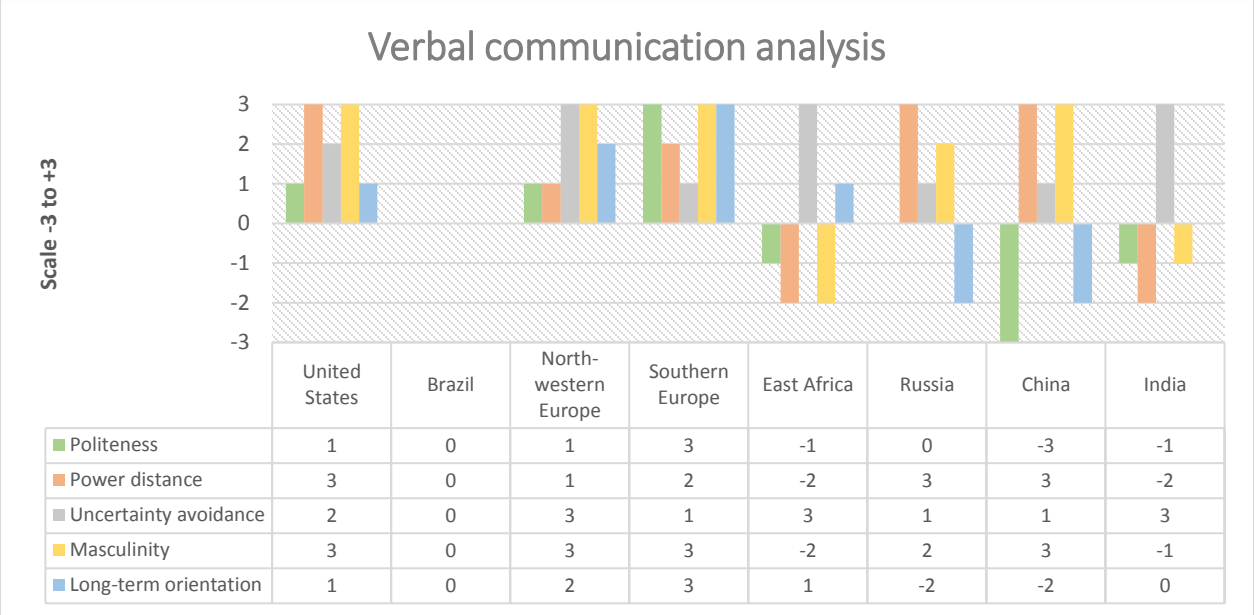
What is currently excluded from the tool, is the effect that changing this ratio would have on other factors. For example, it would reduce the virtual water import flow, affect trade, and likely have economic repercussions. To keep the Negotiation Game manageable and not overly complex, plus since the Negotiation Game is focused on the consumption perspective rather than the production one, it was decided not to include these effects in a quantitative way in the Excel tool. Instead, they are described briefly in the Player Handouts.

3.2. Analysing the Negotiation Process of the game

In this subchapter, the observational results from testing the Negotiation Game are given, according to the methodology as described in the Method chapter.

3.2.1. Observational results from testing the Negotiation Game

The observational results from testing the Negotiation Game, are based on the audio log of one experiment with eight participants. These participants consisted of two professors and a mixed group of six (post-docs, PhD-students and MSc-students). All eight countries (and thus, players) were first analysed on their communication style and frequently used vocabulary, as described in Table 4. The results are shown in Appendix III and Figure 9. Data for Brazil is missing due to a lack of participation from this player.



	United States	Brazil	North-western Europe	Southern Europe	East Africa	Russia	China	India
Politeness	1	0	1	3	-1	0	-3	-1
Power distance	3	0	1	2	-2	3	3	-2
Uncertainty avoidance	2	0	3	1	3	1	1	3
Masculinity	3	0	3	3	-2	2	3	-1
Long-term orientation	1	0	2	3	1	-2	-2	0

Figure 9: Verbal communication analysis based on test of Negotiation Game

The results from Figure 9 were translated to the negotiation styles 'Competitive' and 'Cooperative'. As described in the Method, the characteristics have a positive/direct relation to one of these styles and a negative/inverse relation to the other. For example, for the United States cooperativeness is calculated using:

$$Cooperativeness\ score = (politeness + uncertainty\ avoidance + longterm\ orientation) - (power\ distance + masculinity)$$

Leading to:

$$Cooperativeness = (1 + 2 + 1) - (3 + 3) = -2$$

Finally, all results were converted to a $-5 \leq x \leq 5$ scale, based on the extreme values, leading to the result as shown in Figure 10.

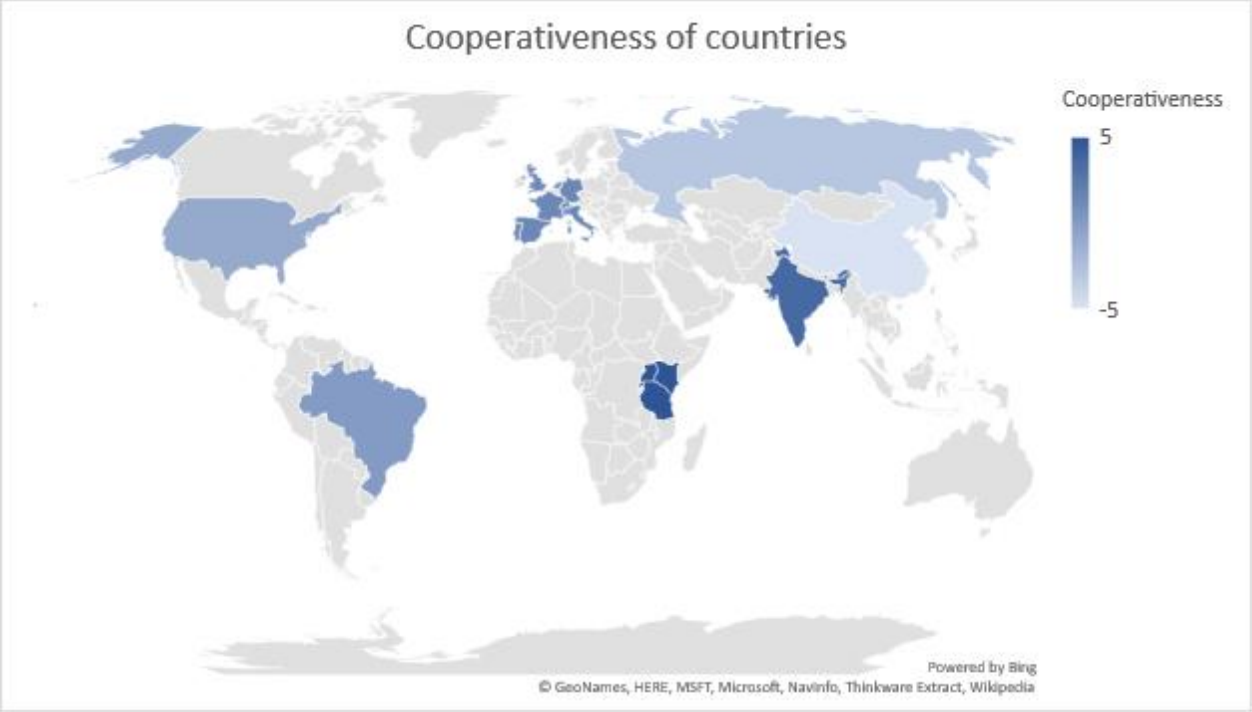


Figure 10: Cooperativeness of countries, based on testing the Negotiation Game

It should be noted here that the participation of each country varied significantly. The Brazil player only spoke once during the entire Negotiation Game and both the East-Africa and India players only communicated in about 3-4 short instances, while Europe, China and the United States were far more outspoken. This affects the scores from Figure 9 and Figure 10.

Next, the narrative of each country is approximated by analysing its various characteristics, as described in Table 3 of the Method. The results are shown in Table 11.

Table 11: Narrative characteristic analysis of each country

Country	Characteristics
United States	High interest, high power, direct & informal communication, specific agreement, relatively high self-outcome, unequal outcome shares, cooperative
Brazil	N/A
North-western Europe	High interest, moderate power, direct & formal communication, specific agreement, relatively low to moderate self-outcome, unequal outcome shares, cooperative
Southern Europe	High interest, moderate power, direct & formal communication, specific agreement, relatively moderate to high self-outcome, unequal outcome shares, cooperative

East Africa	High interest, low power, indirect & formal communication, general agreement, relatively low self-outcome
Russia	Low interest, high power, direct & formal communication, general agreement, relatively low self-outcome, unequal outcome shares, competitive
China	Low interest, high power, direct & informal communication, specific agreement, relatively low self-outcome, unequal outcome shares, competitive
India	Low interest, low power, indirect & informal communication, specific agreement, relatively low self-outcome, unequal outcome shares, cooperative

In the table above, the 'power' classification is based directly on the power distance characteristic from Figure 9. The 'interest' classification is based partly on the 'long-term orientation' characteristic and on personal interpretation of the transcript and final agreement. For example, 'East Africa' scores only one point on long-term orientation but made several comments that it was "disappointed in the negligence of other countries to arrive at an agreement" and "had severe water scarcity issues that needed to be resolved", hence it was put at 'high interest'. As mentioned before, active participation in the Negotiation Game also plays a large role, and participation from East Africa was relatively low. As a result, using the results from Figure 9 directly becomes less viable.

Additionally, the power distance and cooperativeness were converted to a power and interest value respectively, both from a scale of $-2 \leq x \leq 2$, where any value $-1 \leq x \leq 1$ is classified as 'moderate' and both outliers are classified as 'high', leading to nine possible outcomes (high-moderate-low power and interest). The results per country are shown in Figure 11.

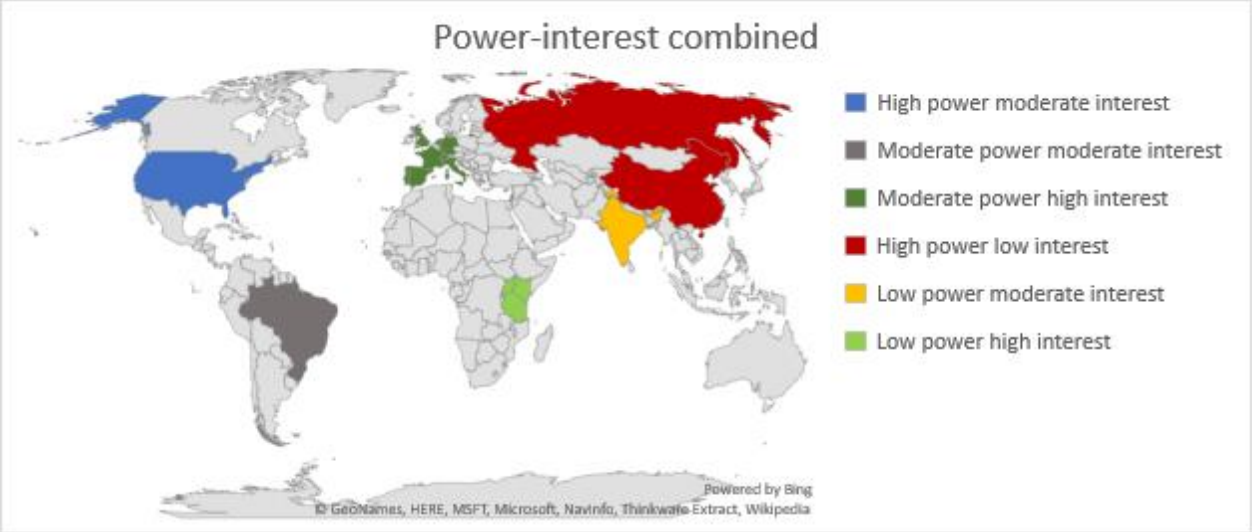


Figure 11: Power-interest combined for each country, based on the power distance and long-term orientation characteristics

As a final observational result, we have the agreement that each player signed at the end of the Negotiation Game. This agreement consists of four Articles, namely: Objectives, Principles, Targets, and Regulation. The results are shown in Table 12.

Table 12: Agreement results from first testing of the Negotiation Game

Article 1 – Objectives	The Parties to this Agreement recognize the mutual goal(s) that… 1. The global water footprint must be reduced by …% by 2050
Article 2 – Principles	The Parties to this Agreement recognize the principle(s) of… 1. differentiated targets
Article 3 – Targets	1. China stabilizes current water footprint per capita 2. India stabilizes current water footprint per capita 3. United States reduces its water footprint per capita by 30%. 4. Southern Europe by 16%. 5. Brazil by 10%. 6. North-western Europe by 10%. 7. Russia strives to stabilize its current water footprint per capita. 8. India and Southern Europe strive to obtain bilateral trade agreements so that India can receive the technology and knowledge that it needs to increase its production effectiveness. 9. Southern and North-western Europe will invest 0.01% of their GDP to improve the water productivity in East-Africa.

3.2.2. Quantitative results from testing Negotiation Game

During the Negotiation Game, players were asked twice to write down the water footprint level that they felt they would be willing to accept as a maximum reduction level. These are called 'Target 1' and 'Target 2'. The first target they had to write down before any negotiations had taken place, and the second halfway during the negotiations. This allows for a comparison to see how this level progresses along with the game. The final target is the target as written down in the final agreement that all parties signed at the end of the Negotiation Game. The results from the first experiment of the Negotiation Game, are shown in Table 13.

Table 13: Water footprint targets per country during the first testing of the Negotiation Game

Country	Target 1	Target 2	Final agreement target	Relative decrease final target
	$m^3/cap/\text{yr}$	$m^3/cap/\text{yr}$	$m^3/cap/\text{yr}$	% (to WF_0)
United States	1681	2000	1989	30
Brazil	1800	1800	1824	10
North-western Europe	1300	1200	1336	10
Southern Europe	2000	2000	2003	16
East Africa	950	950	1027	0
Russia	1750	1750	1852	0
China	1500	1000	1071	0
India	1039	1039	1089	0

Figure 12 shows the absolute reductions for each country. A value of 0 $m^3/cap/yr$ means that the water footprint will remain stabilized.

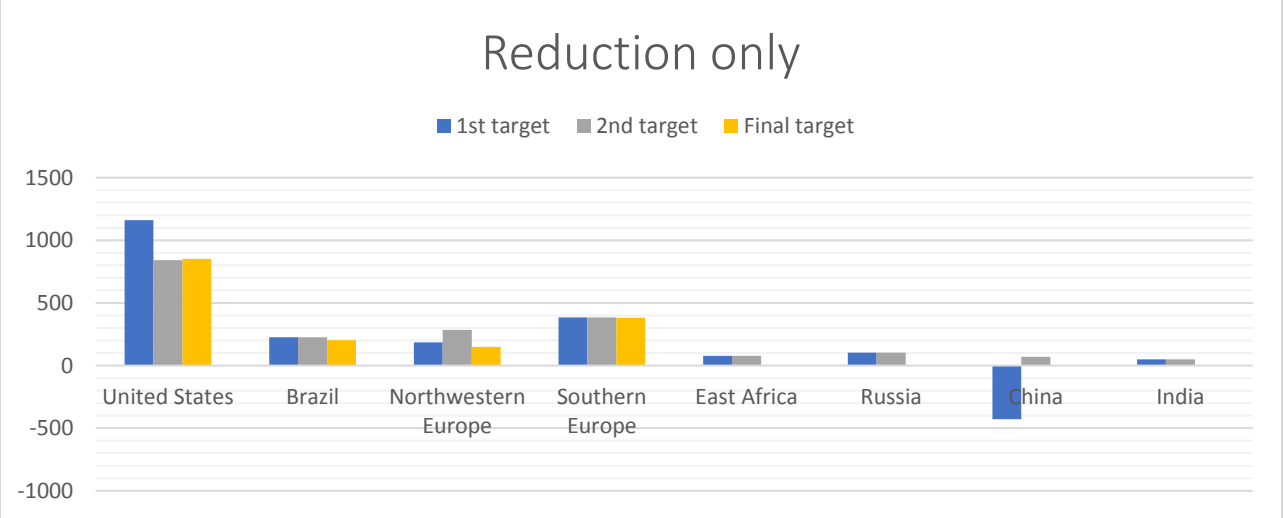


Figure 12: Absolute reduction per country of the water footprint quotas

From Table 13 and Figure 12, there does not seem to be a global trend with the relative decrease of the final target, but there are observable similarities. The three countries with a low starting water footprint (China, India, East-Africa) are all willing to stabilize their water footprint – meaning that the water footprint per capita will remain unchanged even with future population rise – but unwilling to decrease it any further. Russia falls in this same category but has an above-average starting water footprint (1852 $m^3/cap/yr$), and this seems more related to free-rider behaviour.

Deviations between the three targets for each country, are non-existent to rather insignificant, with the exception of China and the United States. China's first target was 50% larger than its second target, and was actually a water footprint increase, rather than a reduction. It seems apparent that the negotiations convinced China to at least stabilize its water footprint. Secondly, the United States initially wanted to reduce by a significant amount (relative difference of 40%), but later reduced its commitment to 30%. Based on comments made by the U.S. player during the Negotiation Game, this seems to be caused by usage of the Excel tool to find out how exactly such a water footprint reduction can be reached. 30% was the result of a considerable part of the population switching to a healthy diet, as well as applying all the production changes.

Other interpretations and conclusions from testing the Negotiation Game, will be discussed in the Discussion chapter.

4. DISCUSSION

In this chapter, the Negotiation Game itself, the method that was used to design it, and the results from testing it are all critically assessed. The chapter is divided into three parts: validation of the Negotiation Game, general discussion, and future recommendations.

4.1. Validation of Negotiation Game

The first point to be addressed is the selection of countries. Using the power-interest method, a final selection was made of eight countries, including three groups of countries. Although the initial method and derivation to an interest and power matrix were accomplished objectively, the final selection was rather subjective. For instance, Canada was removed from the selection and replaced by East Africa, even though the East-African countries did not result as a meaningful stakeholder in terms of interest and/or power. Additionally, countries such as Japan, South-Korea, and the Middle-East were excluded from the selection due to the technical requirements of having only eight players for the Negotiation Game, whereas a grouping of Japan and South-Korea would have been a distinct possibility and both countries also played a significant role in the Kyoto and Paris agreements (Paris Agreement - Status of Ratification, 2019) (Sprinz, et al., 2016). Therefore, the accuracy of the selection of countries can be a matter of debate.

The same can be said about the chosen indicators of these countries. While all indicators were based off various literature sources, there was no empirical method to make this initial selection, nor was there a possibility to conduct a sensitivity analysis (partly due to not meeting a statistically significant amount of repetitions for testing the Negotiation Game). The chosen indicators also have a few points where their applicability and usefulness can be put into question. The blue water scarcity ratio, for instance, was abstracted to a scale from 0.0 to 5.0, but this does not reflect the spatial and temporal variation of the water scarcity. In countries such as China, this can lead to a distorted view of what kind of problems the country is facing. The same conclusion was reached after testing the Negotiation Game. As a result, the Player Handout was expanded to include more qualitative information on the various water- and non-water related issues in a country, plus the water scarcity map was updated with one that has a higher resolution and thus shows the spatial variation to some extent.

Regarding the production changes, several assumptions are at the basis of this indicator. Namely: that all irrigated land in a country produces maize and has sprinkler irrigation. This kind of abstraction

was also done with some of the other indicators, primarily to keep the Excel tool tangible and simple. This was deemed an acceptable trade-off between user friendliness/intuitiveness and accuracy of the indicators. Whether this is true, can only be tested in a precise manner if the Negotiation Game is tested multiple times. Additionally, this also means that some negative consequences of changing the indicators is not included in the scope of the Excel tool and the Negotiation Game. Most notably, the players can change the consumption patterns within their country and reduce the food waste, without seeing any meaningful repercussions such as resistance to change from the population or financial impacts. The latter was excluded because no sufficient data could be found in literature for all participating countries. While research has been conducted on the link between reducing food waste and loss of jobs and economic consequences in Germany, Poland, and Spain, for example (Campoy-Munoz, Cardenete, & Delgado, 2017); the same data is not available for countries such as Tanzania or Russia.

Finally, it would make sense that the indicators 'internal water footprint ratio', 'production changes', and 'yield gap' are linked to the water footprint of production, and that the Negotiation Game includes some capacity of showing these externalities between countries and how they change during the game. E.g. if player A increases his production efficiency, this could affect his export to player B. Currently, to not make the Negotiation Game overly complex from the beginning, the choice was made to only use the consumption perspective for the indicators and the water footprint. However, it could be possible and useful to expand the Negotiation Game and include the production perspective as well. Of course, this would probably result in the Negotiation Game taking considerably longer to play.

4.2. General discussion

The goal of the Negotiation Game was to develop a model that mimics the hypothetical negotiations in practice as closely as possible. This way, the results from the Negotiation Game could be used to make predictions about how the actual negotiations would start and develop, as well as what kind of agreement would follow from it. As with any research, the number of repetitions can improve the statistical significance, and in this case the Negotiation Game was tested only once with a live group. Therefore, for a proper evaluation of the feasibility of the game, it would need to be tested several more times, depending on the range of the 95% confidence interval as well as the sensitivity of the various variables. Typically, with regards to the t-test, a minimum sample size 'greater than 25 or 30' is popular as a rule-of-thumb in literature (Hogg, Tanis, & Zimmerman, 2015). Depending on how easy it would be to find suitable target groups, this could take anywhere between several months to several years. Regardless, it is possible to discuss the results of the single test that has been conducted, and as a result make an approximation of the feasibility of the Negotiation Game.

One of the problems that immediately became apparent, is that the (active) participation of a player has a considerable effect on the results. For example, the Brazil player only spoke up once ("I am willing to reduce by 10%"), and as a result this country was excluded from the verbal communication and narrative analysis. Similarly, the East-Africa and India players also did not engage much in the negotiations, and the United States player was less dominant than could perhaps be expected. For these three countries, this led to all three of them being rated as 'moderate interest', but one can imagine that with a more dominant (personality-wise) player, a different outcome could be possible.

Additionally, based on the power-interest matrix from Table 5, it was expected that India and China would both have a high interest in the agreement, given their predicted population growth and (blue) water scarcity issues. However, based on the results (Figure 11), India only showed a moderate interest in the agreement and China had only a low interest in it. Russia and Brazil did seem to match their initial power-interest position either. Southern and North-western Europe did match it to some extent, although their interest during the Negotiation Game was closer to 'high' than to 'moderate'. East Africa, finally, did not actively participate so could not be assigned to a certain category.

Therefore, the narratives of each country did not exactly match those (in terms of power-interest) as hypothesized before testing the Negotiation Game. Also, it seems that for a few countries, their narrative changed during the course of the game. Most notably, China started the negotiation game being unwilling to reduce or stabilize its water footprint, in fact, it wanted to increase its water footprint by almost 500 $m^3/cap/yr$. After the initial round of negotiations, this narrative changed to China being willing to stabilize its water footprint, and this was also stated in the final agreement. For the United States, the reverse happened. The United States started the Negotiation Game with the incentive for a large reduction (40%), and later reduced this plan somewhat to 30%. The other countries remained relatively constant in their proposed water footprint quota during the Negotiation Game.

As for any shared narratives, we can especially observe an alliance that was formed between Southern and North-western Europe, and both ultimately adopted the same mindset. Both countries also committed to the same target, namely: to invest 0.01% of their GDP in Africa to improve their water productivity, and to share their technology and knowledge with India in exchange for India stabilizing their water footprint. Initially, an opposing shared narrative seemed to originate from both Russia and China, but ultimately China was convinced to stabilize its water footprint and to commit to an agreement and that all countries would benefit even just from knowing China's own goals.

In terms of the feasibility of the agreement itself, the initial testing of the Negotiation Game did lead to a final agreement, including a water footprint reduction target for each country – except for Russia

which only committed to striving to a stabilisation of its water footprint. However, the parties of the joint policy group could only partially agree on one goal, namely, that the global water footprint must be reduced by 2050. The extent to which it should be reduced – e.g. by 10-20% - could not be agreed upon in the given time. Also, only one principle was agreed upon, namely, that there would be differentiated targets. Finally, most of the final targets for each country, which the player who was assigned Russia also pointed out, would only achieve a stabilization of the water footprint given the population rise, but not an actual decrease of the water footprint.

It is possible that this could be improved by providing the player with more information. Specifically, the players should receive information on the expected population increase per country, as well as how this relates to the current water footprint. In other words: if the current water footprint per capita is X, what will be the new value Y given the predicted population rise? Then, players can first determine what kind of reduction they would need simply to stabilize, and possibly use the Excel tool for this purpose. This could help provide more structure to the initial phase of the Negotiation Game. As a final remark on the agreement from this first testing round: these targets do not seem to be based off any equity principles, even though these were introduced during the mid-way evaluation round. An example of various equity allocation approaches is shown in Table 14.

Table 14: Equity allocation approaches per country, on a scale from - - (high mitigation / WF reduction) to ++ (low mitigation / WF reduction required)

Values / Country	CWFR[1]	EPC[2]	C-GDP-C[3]	C-GDP[4]	C-WS[5]	C-VWi[6]
USA	2,842 m^3/yr	1,385 m^3/yr	--	--	+	++
North-western Europe	1,484 m^3/yr	1,385 m^3/yr	-	-	+-	--
Southern Europe	2,384 m^3/yr	1,385 m^3/yr	-	+-	-	--
Brazil	2,027 m^3/yr	1,385 m^3/yr	+-	+-	++	++
Russia	1,852 m^3/yr	1,385 m^3/yr	+-	+-	++	+-
India	1,089 m^3/yr	1,385 m^3/yr	++	+-	--	++
China	1,071 m^3/yr	1,385 m^3/yr	+-	-	+	+
East Africa	1,027 m^3/yr	1,385 m^3/yr	++	++	+	-

With:

[1] Constant Water Footprint Ratio (CWFR) per capita; maintains current water footprint ratio.

[2] Equal Per Capita (EPC); convergence towards equal annual water footprint per capita (a value of 1,358 $m^3/cap/yr$ was chosen, based on Hoekstra and Mekonnen (2012) (Hoekstra & Mekonnen, 2012).

[3] Capability based on GDP per capita (C-GDP-C); high mitigation for countries with high GDP per capita, based on the ratio between the GDP per capita of a specific country and the total GDP per capita for all countries.
[4] Capability based on GDP (C-GDP); high mitigation for countries with high GDP, based on the ratio between the GDP of a specific country and the total GDP for all countries.
[5] Capability based on water scarcity ratio (C-WS); high mitigation for countries with a high water scarcity ratio. The idea is that countries with high water stress should reduce more.
[6] Capability based on net virtual water import (C-VWi); high mitigation for countries with a large positive net virtual water import. The idea is that countries who are net importers of virtual water, which typically involves luxury goods and large water footprints (e.g. for tropical fruits), should reduce more.

These equity allocation strategies are derived from Du Pont et al. (Du Pont, et al., 2016). Based on the IPCC-AR5 equity categories, six equity allocation approaches are distinguished. These cannot be translated directly to a water footprint concept, due to the different characteristics of the water footprint in comparison to greenhouse gas emissions. Historical greenhouse gas emissions have far more of a lingering effect than historical water use, since they are still present in the atmosphere. Greenhouse gas emissions also have a global impact, whereas water mostly has a local impact (typically at the river basin level). So, reducing emissions is a goal that all nations can benefit from, but for water footprint reduction targets, several of the benefits would only be directly noticeable in local ecosystems and river basins (Schyns, 2018). The equity allocation approaches are as follows:

The abbreviations and definitions of the original paper have been translated to reflect the water footprint, rather than greenhouse gas emissions. The EPC-values, reflecting a convergence towards an equal annual water footprint per capita, are here set at the average water footprint level in 2005 of 1,358 $m^3/cap/yr$ (Hoekstra & Mekonnen, 2012). Alternatively, Hoekstra (2017) uses a lower value as the maximum sustainable water footprint, of approximately 900 m^3/yr per capita (Hoekstra A. Y., 2017, p. 3069), while also stating that *"quantifying maximum sustainable WFs is difficult because water availability strongly fluctuates in time and space, so the comparison needs to be done time- and location-specific"* (Hoekstra A. Y., 2017, p. 3075). So, the currently used value of 1,385 $m^3/yr/cap$ is most likely too large, especially considering future development such as population change and the predicted increase of the water footprint by Ercin and Hoekstra (2014) (Ercin & Hoekstra, 2014). See also Figure 13, which shows the progression of the global average water footprint of national consumption, given predicted population growth (assuming that the total water footprint should remain constant).

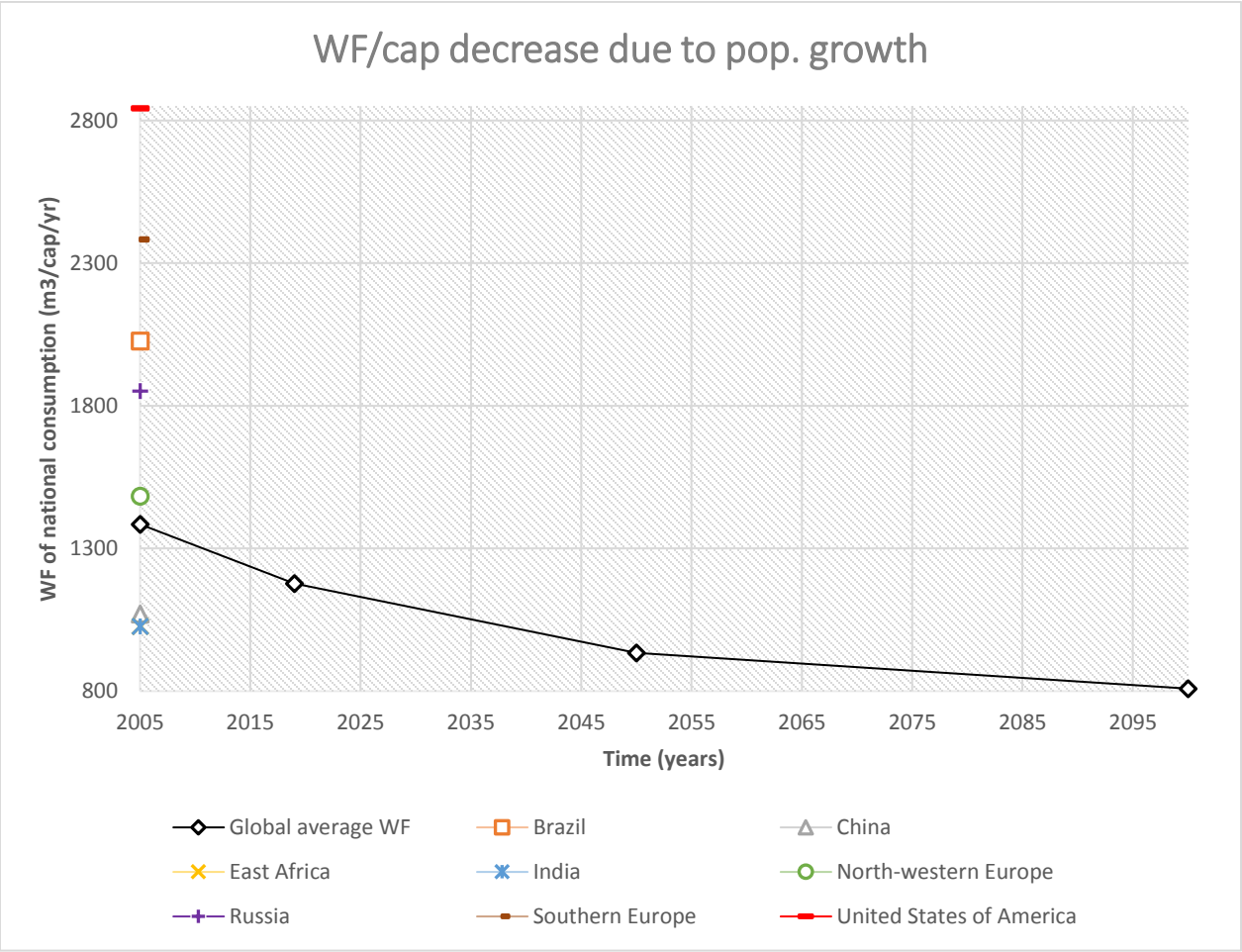


Figure 13: Required decrease of the water footprint of national consumption per capita (global average), given predicted population growth in 2050 and 2100, if the total water footprint should remain constant

Nonetheless, this is all theoretical, and requires further testing of the Negotiation Game where players did receive the graph from Figure 13 to streamline the initial negotiations and ensure that players know that a water footprint reduction is already necessary just to stabilize (given population growth). It seems apparent that the players also need additional external pressure to agree on a principle of equity and enforce it. Currently, the China and Russia players especially could easily back down from the agreement, without any noticeable repercussions. However, these repercussions also do not always exist in real-life, so this is not necessarily a flaw of the Negotiation Game. An example is the withdrawal of the United States from the Paris Agreement, which led to negative responses worldwide, but no discernible repercussions for the United States itself; if anything, it simply led to more commitment from the other parties (Zhang et al., 2017). Further testing of the Negotiation Game could point out how to best motivate the players to make use of equity approaches.

4.3. Future recommendations

Based on the single testing of the Negotiation Game, various audience responses, and the results of the communication and characteristic analysis, the following future recommendations are given for the Negotiation Game:

- ☑ For an expanded version of the Negotiation Game, it could be worthwhile to incorporate the production perspective of the water footprint. This allows for a better use of several of the indicators, especially the production and yield gap changes, and would also allow for a link to the virtual water imports and exports of each player, and the various dependencies between countries. Ideally, the game would use an online Excel tool that is linked to an interactive world map, where these dependencies are shown, and change based on live input from the players.
- ☑ The effect of the participation (or lack thereof) of the players on the outcome was considerable. It is recommended for future testing of the Negotiation Game to, if possible, have two players per country instead of one, especially for potentially more 'challenging' countries such as Brazil or East Africa. Instead of randomly assigning countries, they could also be assigned based on the approximate personality of each player, although this requires some prerequisite knowledge of course.
- ☑ The main area of improvement for the Negotiation Game is that it could provide better and more information to the players. To an extent, this will already be implemented in the updated versions of the Player Handouts. Instead of one general handout, there will now be a specific handout per country, which contains information on that country, as well as a qualitative assessment of its water-related issues. However, further testing of the Negotiation Game should point out whether the level of provided knowledge was sufficient or not.
- ☑ Not all the data was acquired for the same timeframe: the data from Mekonnen & Hoekstra (2012) is based on acquired measurements of water footprints between 1996-2005, while the World Bank data was only available per year. While it would be possible to, for example, determine the average GDP in the same time period, the choice was made to use more recent data for all general and economic indicators, such as GDP or population. 2016 was selected as the most recent year that had data on all these indicators. This choice was made so that the Negotiation Game is based on the most recent status of countries. The water footprint is the only trade-off here, and it is likely that the water footprint has risen (considerably) since 1996-2005. Future research on the water footprint could therefore be implemented in the Negotiation Game to have a dataset that is more consistent.

5. CONCLUSION

In order to find out how international consensus can be reached on an international agreement on water footprint reduction; a Negotiation Game has been designed. Using eight countries (or country groups) and several unique indicators as input, players engage in negotiations and are free to express their narrative and, if they desire to do so, strive towards an agreement. Herein, they are provided with several possibilities, since there is a pre-determined empty agreement consisting of four articles, with Objectives, Principles, Targets and Regulation, respectively.

Using the Power-Interest method and various literature sources, the selection of countries and indicators has been conducted. Additionally, a method was developed to analysis the verbal communication of players who participated in the Negotiation Game, and subsequently the characteristics of their country could be determined which altogether describes the country's narrative. The Negotiation Game was tested with a group of eight people from the University of Twente, including two professors, post-docs, PhD, and master students. This group arrived at a final agreement consisting of one objective, one principle, nine targets and no regulation schemes.

The verbal communication and characteristic analysis showed that there was a slight mismatch with the narrative of the players in practice, and the expected narrative based on the power-interest method. Specifically, China and India showed a lower interest in the international agreement on water footprint reduction than was surmised before the start of the game, and Southern Europe and China were the two most dominant and 'masculine' players, rather than (as expected) the United States.

It has also been shown that the narrative for several players changed during the course of the game, most notably for China, who initially wanted to increase its water footprint by almost 500 $m^3/cap/yr$, but by the end of the negotiations was willing to commit to stabilizing their water footprint. The United States changed its reduction target from 40% to 30%, based on knowledge obtained from the Excel tool, which showed that a 30% reduction was a more realistic value, given the diet change and production changes that the U.S. player was comfortable with.

One of the largest sensitivities in the results, was shown to be the participation of the players. The Brazil player only contributed one statement to the negotiations and, similarly, the India and East Africa players also remained on the background. While this has a considerable impact on the qualitative communication and narrative analysis, this does not necessarily have a significant impact on the results. If the Negotiation Game would be tested for multiple repetitions – say at least 25 to 30

times – then, assuming the players who take up the roles of countries are randomized and different each time, this effect would be expected to reduce over time. Also, it would be expected to have less of an impact on the statistical results, if players who remain passive during the negotiations, still commit to exploring the Excel tool and determining a target for themselves. As a possible improvement to the Negotiation Game, players could also be tasked individually with writing down their personal ideas of what objectives, principles and regulation schemes are appropriate.

The two major limitations from the Negotiation Game, that resulted from this live experiment, are the lack of knowledge of the players, as well as a lack of awareness of the various dependencies and externalities. Regarding the first, this has been mitigated by making the Player Handouts unique for each country and expanding them with qualitative information for each country, where several of the challenges and issues are described that this country is facing in 2019 and the near future (such as Figure 13 to show how the water footprint must change along with population growth in order to stabilize). Regarding the latter, a potential solution could be to implement the production perspective of the water footprint in the Excel tool and the Negotiation Game. This would require the production changes, yield gap, internal water footprint ratio, and blue water scarcity ratio to also be connected to the water footprint of production, which would be a rather considerable expansion of both the Negotiation Game and the Excel tool. While, as an advantage, this would provide the player with more options and opens up the opportunity of showing the changed virtual water flows as a result of choices made in the tool (and, ideally, some type of interactive map of the world where these are visible); as a downside, it could make the Negotiation Game overly complex. Except for the slight lack of knowledge, the initial testing with students and professors from the University of Twente seemed to already be somewhat on the edge of complexity – based on personal evaluations after the game – so this expansion with the production perspective may be counterproductive.

Regarding narratives, an initial assessment was drafted, as seen in Table 11. However, this data would be more reliable if the Negotiation Game was tested several more times. One possibility would be to test the Negotiation Game several times with the same group of people but switch the roles (of countries) around. This could reduce or eliminate the effect of dominant or non-dominant personalities.

Two major shared narratives were observed: one existed between North-western Europe, Southern Europe, and the United States, who all showed a similar interest, willingness to negotiate, and willingness to provide knowledge and technology to other parties (such as East Africa and India). A second shared narrative existed at the start of testing the Negotiation Game between Russia, China, and India. All three countries showed a similar low interest in the negotiations, did not think they would need an international agreement to solve their own water issues (if they had any), and were

generally unwilling to commit to anything. However, this shared narrative later disappeared during the negotiations, as the negotiators representing India and China were both convinced to join the negotiations and commit to a stabilization of their water footprint. India also agreed to bilateral trade agreements with Europe to increase its own water productivity.

Finally, to answer the main research question, the initial testing of the Negotiation Game did result in an agreement with several agreed upon targets, several shared narratives, one agreed principle, and several promises of future bilateral trade agreements and exchange of knowledge and technology. It seems that, if a negotiation on a water footprint reduction agreement were to take place, the main initiative would come from Europe and East-Africa, while India and the United States are willing to join in. China might need some persuasion to stabilize its water footprint and Russia seemed to have no interest in the agreement whatsoever. While all these conclusions are not statistically significant, they do indicate that there may be potential for an agreement between at least several major countries. This agreement seems likely to have differentiated targets and the principle of equity allocation approaches or a sustainable global level remained unresolved in the first round of testing the Negotiation Game. Regarding the latter, this topic was breached, but there was no unison in what global level would be sustainable by 2050. Stabilising the water footprint with future population growth seemed to indicate the extent to which most parties were willing to commit. It remains to be seen whether this would change with different players and/or if the players are given more information on the urgency of why an international agreement on water footprint reduction should happen and could be beneficial.

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APPENDIX

Appendix I: Falkenmark blue water scarcity matrix

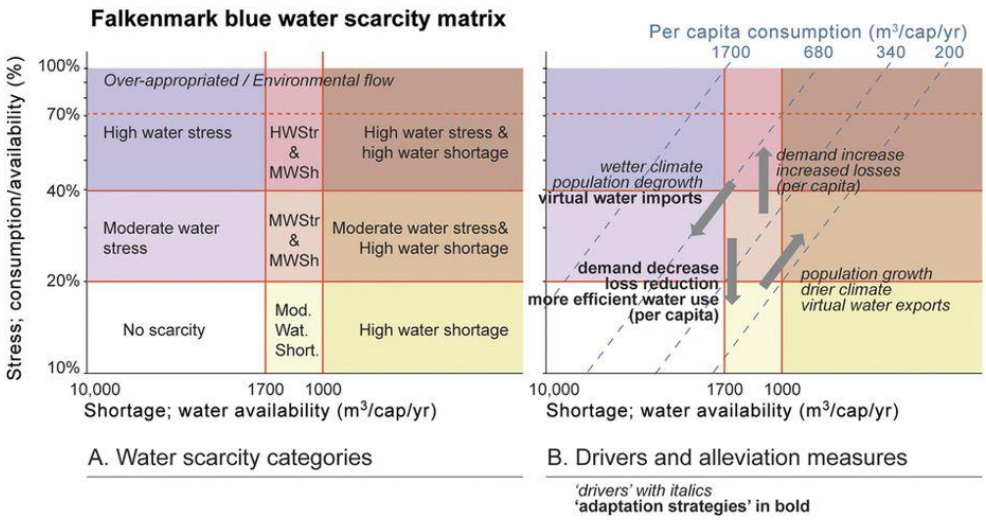

Figure 14: Blue water scarcity matrix, this matrix plots the water shortage (in $m^3/cap/yr$) on the x-axis versus the water stress on the y-axis (in %). The diagonal lines here represent the relation between per capita consumption and both water shortage and water stress.

Appendix II: Basic information on the water footprint concept

The concept of the *water footprint* was established in 2002 by Hoekstra (Hoekstra A. Y., 2002). The comparable *ecological footprint* was already widely known and first appeared in a paper by Rees in 1992 (Rees, 1992). The unit for ecological footprint is global hectares (*gha*), indicating the required biologically productive area per capita (Footprint Network, 2017). Water footprint, on the other hand, is typically expressed in cubic metres of water per year. Essentially, water footprint is one of the underlying indicators that make up the ecological footprint, similar to the carbon footprint (Hoekstra & Wiedmann, 2014).

There are various ways to assess a footprint. For example, one can determine the footprint of a product, an individual, a company, or an entire nation. These all originate from one basic building block, namely, that footprints are based on a single activity or process. These can be summed up, ultimately leading to a footprint on a global level. This can be either the footprint from a production or consumption point of view. On a global level, both are the same, and also equate the total footprint of all human activities across the globe (Hoekstra & Wiedmann, 2014).

Although the global levels for the water footprint of consumption and production are equal, on a national level there is an important difference. The water footprint of production gives an insight into the required water resources for goods and services produced within the borders of a specific nation. So, the export of goods and services is also included. On the other hand, the water footprint of consumption may include water resources that are used in another country, if these goods or services are imported rather than produced locally (Hoekstra et al., 2011), and it excludes the water footprint within a nation related to export. See Figure 15 for the various accounts of national water footprints.

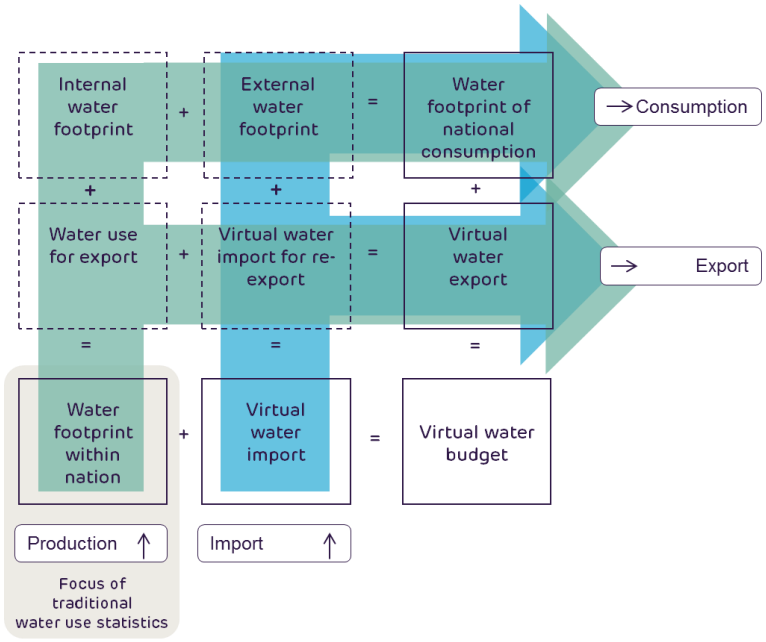

Figure 15: National water footprint accounting diagram (Water Footprint Network, 2018) de juiste (oorspronkelijke) bron is: Hoekstra et al. (2011)

The water footprint can be further distinguished in three types: blue, grey, and green water footprint (Hoekstra & Chapagain, 2008).

Appendix III: Verbal communication analysis, based on transcript from testing the Negotiation Game

Table 15: Communication style and used vocabulary for each country, based on a single experiment, each + mark signifies that the country scores 'High' on this characteristic based on a comment during the Negotiation Game, each – mark signifies that the country scores 'Low'

Characteristic Country	Politeness	Power distance	Uncertainty avoidance	Masculinity	Long-term orientation
United States	-+	-+++++	+++	++++	+
Brazil					
North-western Europe	+	+-+	+++	++++	++
Southern Europe	++++	+-++++-	++	+++++	++++++
East Africa	-	--	+++	--	+
Russia		+++	+	++	--
China	----	++++++++	-++	++++++	-+--
India	-	+---	++++	-	+-

INTERNATIONAL AGREEMENT ON WATER FOOTPRINT REDUCTION

UNIVERSITY OF TWENTE.

2019

INTERNATIONAL AGREEMENT ON WATER FOOTPRINT REDUCTION

The Parties to this Agreement,

Being Parties to the Twente Convention on the Global Water Footprint, consisting of the countries as described in Annex A, hereinafter referred to as "the Convention",

In pursuit of the objectives of the Convention, as stated in its Article 1, and being guided by its principles, as listed in its Article 2,

Recognizing the need for an effective and progressive response to the urgent threat of water-related issues and increasing water footprints worldwide, through the targets as set in its Article 3,

Also recognizing the need for enforcement and compensation schemes to regulate the aforementioned targets, as set in its Article 4,

Have agreed as follows:

Article 1 - Objectives

The Parties to this Agreement recognize the mutual goal(s) that …

1. The global water footprint must be reduced by …….% by …….

2.

3.

4.

5.

Article 2 – Principles

The Parties to this Agreement recognize the principle(s) of…

1.

2.

3.

4.

5.

Article 3 – Targets

1.

2.

3.

4.

5.

6.

7.

8.

Article 4 – Regulation

Enforcing schemes

1.

2.

3.

Compensation mechanisms

1.

2.

3.

Signing

DONE at _____ this _____ day of _____ two thousand and nighteen.

IN WITNESS WHEREOF, the undersigned, being duly authorized to that effect, have signed this Agreement.

_____	_____
Brazil	*China*
_____	_____
East Africa	*India*
_____	_____
North-western Europe	*Russian Federation*
_____	_____
Southern Europe	*The United States of America*

Annex A

Participating countries

Brazil
China
East Africa
- *Burundi*
- *Kenya*
- *Rwanda*
- *Tanzania*
- *Uganda*

India
North-western Europe
- *France*
- *Germany*
- *Switzerland*
- *The Netherlands*
- *United Kingdom*

Russia
Southern Europe
- *Italy*
- *Portugal*
- *Spain*

The United States of America

Appendix V: Matrix used for determining interest of countries

		Low ecological vulnerability	High ecological vulnerability
		1. Central Africa 2. Brazil 3. Western-Europe 4. Canada 5. Russian Federation 6. USA 7. China	1. Small Islands States 2. Saudi Arabia / Middle-East 3. Spain (/Southern Europe) 4. India 5. Korea, Republic 6. Mexico 7. Australia 8. Italy 9. Indonesia 10. Japan 11. Turkey
Low abatement cost		Moderate interest [bystanders]	High interest [pushers]
Water footprint of consumption [$m^3/yr/cap$]	Net virtual water import green+blue [Mm^3/yr]		
1. Congo, Dem Republic 2. Burundi 3. Solomon Islands 4. Bangladesh 5. Congo, Republic 6. Rwanda 7. Gambia 8. Korea, Dem People's Rep 9. Yemen 10. Nicaragua	1. Japan 2. Mexico 3. Italy 4. Germany 5. UK 6. Others 7. Korea, Republic 8. China 9. Russian Federation 10. Yemen	Both lists: Russian Federation (2x) China (2x) Western-Europe (2x) Central Africa (2x) Yemen (3x)	Both lists: Korea, Republic (3x) Japan (2x) Mexico (2x) Italy (2x) Small Island States (2x)
High abatement cost		Low interest [draggers]	Moderate interest [supporters]
1. Mongolia 2. Niger 3. Bolivia 4. Brunei Darussalam 5. United Arab Emirates 6. Bermuda 7. Kiribati 8. USA 9. Dominica 10. Mauritania	1. Argentina 2. USA 3. India 4. Australia 5. Brazil 6. Canada 7. Indonesia 8. Pakistan 9. Côte d'Ivoire 10. Thailand	Both lists: USA (3x) Brazil (2x) Canada (2x)	Both lists: India (2x) Indonesia (2x) Australia (2x) Middle-East (2x)